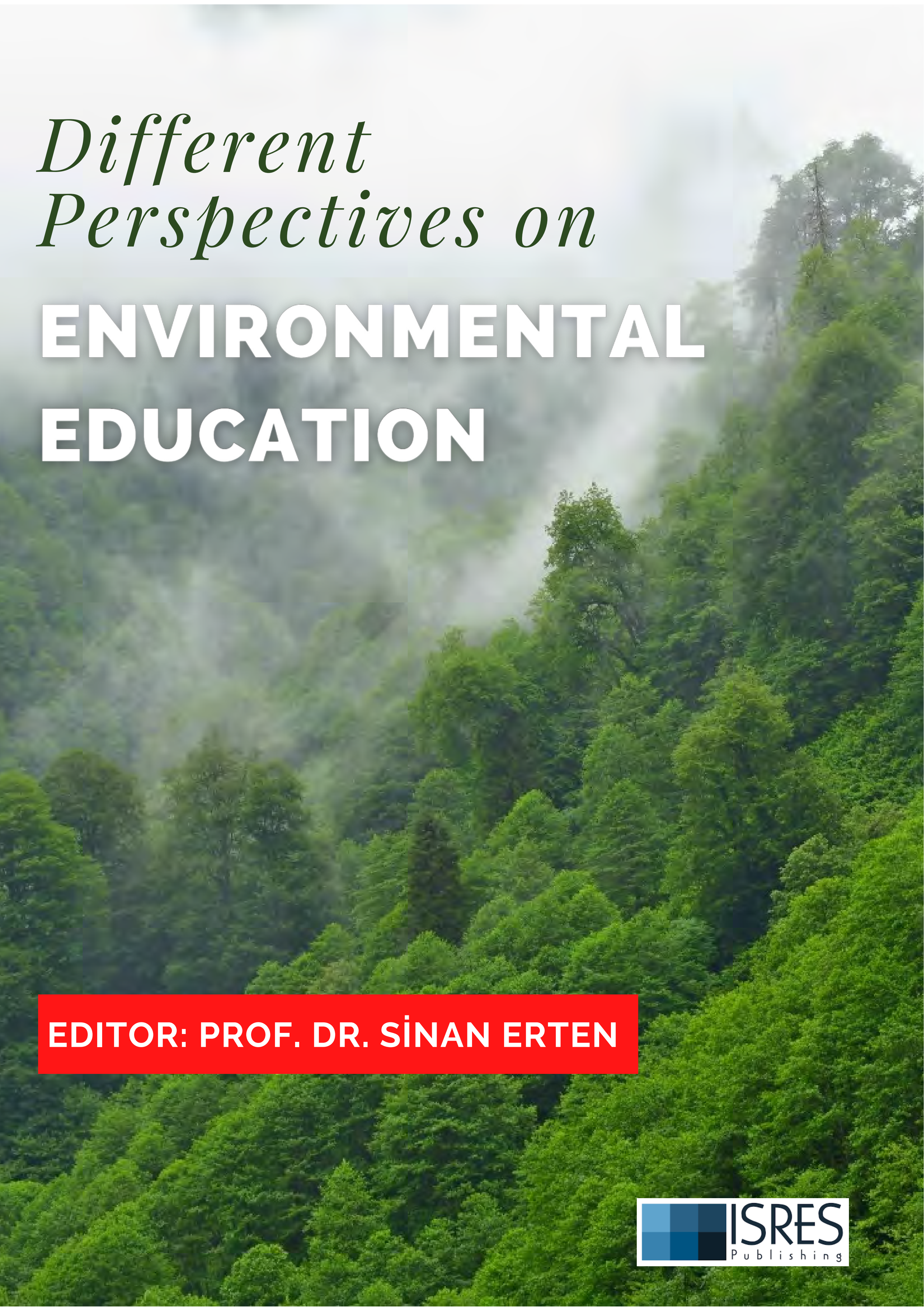

Different Perspectives on ENVIRONMENTAL EDUCATION

EDITOR: PROF. DR. SİNAN ERTEN

ISRES Publishing

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PREFACE

Mankind could not exist without the earth to which it owes its life and could not have continued to exist to this day. This earth we call our world is an ecosystem. Mankind could not survive alone in this ecosystem. Mankind was able to continue its existence to the present day forming a whole with the other elements of this ecosystem. Aware of this, mankind continued to exist for a long time in keeping with this fact, but in the name of making more and living more prosperously, it could not hold back from destroying nature with the means offered by industrialization and technology rather than protecting nature, to which it owes its life. Although this situation started about 300 years ago, mankind today now has to look for another planet where future generations can live.

The biggest characteristic of environmental problems is that they are not local but global. These environmental problems affect everyone, regardless of religion, language, race, old or young, male or female, rich or poor, academic or farmer, villager or city dweller, science or music teacher, mathematics, chemistry, or physics teacher. Therefore, protecting the environment is not only the duty of environmentalists, and giving environmental education is not only the duty of environmental educators. Protecting the environment is everyone's duty. In all lessons, a connection should be made between the courses in question and the protection of the environment.

Making changes in people's behavior is one of the main aims of education and is also included in the definition of education. To overcome environmental problems, we first need a tool. That tool is environmental education. The goal here is to raise individuals who can exhibit environmentally friendly behavior, and we say that individuals who behave in this way are "environmentally-conscious" individuals.

There are three purposes for the preparation of this book. The first of these is to reveal the situation of environmental problems, which is a global problem, in Turkey and the perspectives of scientists working on this issue. The second is to explain the importance of raising environmentally friendly individuals to reduce environmental problems. This is only possible by creating changes in the behavior of individuals through environmentally friendly activities. The third is to reveal the importance of societies' value judgments and cultural understandings in solving global environmental problems. Therefore, new understandings, philosophical understandings and religious understandings about environmental protection are included in this book.

04.09.2021
Editor
Prof. Dr. Sinan ERTEN

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CHAPTER 1

Environment, Environmental Education, Environmental Awareness and Environmentally Friendly Individual

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Scenario 1

Mankind could not exist without the earth to which it owes its life and could not have continued to exist to this day. This earth we call our world is an ecosystem. Mankind could not survive alone in this ecosystem. Mankind was able to continue its existence to the present day forming a whole with the other elements of this ecosystem. Aware of this, mankind continued to exist for a long time in keeping with this fact, but in the name of making more and living more prosperously, it could not hold back from destroying nature with the means offered by industrialization and technology rather than protecting nature, to which it owes its life. Although this situation started about 300 years ago, mankind today now has to look for another planet where future generations can live. How and why did mankind come to be in this situation? Before answering this question, let us first dwell a bit on the question “What is the environment we call an ecosystem?”

What is the Environment (Ecosystem)?

The setting in which living and non-living beings interact with each other in balance is called the environment or ecosystem. The living beings here are what we call biotic factors such as producers, consumers, and decomposers. Non-living things are called abiotic factors and consist of soil, water, air, wind, heat, light, and all the physical and chemical conditions that depend on them such as inorganic (elements) and organic (nutrients) matter. All the living and non-living things here form the elements of the ecosystem. For an ecosystem or environment to thrive and be healthy, first and foremost, the balance between living and non-living elements must be maintained. If this environmental balance is disturbed, what are known as environmental problems will emerge (Campbell, 1997; Kiziroğlu, 2004).

It has been recorded by scientists that the most important cause of environmental problems is human activities (Sciama, 2007). Man is only one of the living things in the definition of the environment. There are so many living things apart from humans that neither humans nor other living things can survive without these living and non-living beings. Furthermore, if the non-living parts of the ecosystem such as water, soil, and air, which all living beings including man need to survive, are disrupted, this planet will no longer be able to support human life.

With the opportunities offered by industry and technology, extensive plundering of the ecosystem (nature) has begun, and this required more people. To meet the increasing human population's requirements for food and shelter, etc., the need for even more of the limited resources on the surface and underground was felt. With its requirements met abundantly as a result of this, mankind multiplied uncontrollably, leading to a rapid increase in the world's population. Other important reasons for the increase in the human population are those factors that affected the change in the birth and death rates. The prevention of diseases that cause mass deaths through developments in medicine, the increase in the amount of food as a result of technological developments, good developments in social life, the decrease in wars and changes in their methods, etc. may be counted among these. Thus, the average life expectancy of people has increased and continues to increase. These seemingly positive developments not only put a strain on the carrying capacity of the ecosystem but also caused the ecosystem to be plundered. Technological solutions have been and are being produced to eliminate these negative aspects. For example, the production of pesticides to protect crops from pests, the use of fertilizers to increase yield in crops, the production of GMO (genetically modified organisms) crops, the drying of wetlands, cloning, the production of hormones for early maturation of crops, etc. Good or bad, the purpose of many technological breakthroughs is to protect the world's population from hunger. "Can technological inventions really be a solution to environmental problems?" The answer to this question will be discussed in future topics.

Due to the above reasons, and many other reasons, the human population in our world is doubling at a rate never before seen in history.

Table 1. World Population Growth (Kiziroğlu, 2008)

Year	Billion People	Doubling up	Growth Rate
BC.8000	0.05	1650	0.042
AD. 1650	0.5		
AD.1850	1	200	0.35
AD.1930	2	80	0.875
AD.1975	4	45	1.56
AD.2010	8	35	2

Scientists state that along with the other environmental problems that are going to emerge in quick succession, this will make it impossible to sustain life in our ecosystem. For example, speaking on this subject on the BBC's "Expedition New Earth" program, Stephen Hawking said: "With climate change, people will have to find a new planet in order to survive in the future." According to Hawking's calculations, this period is closer to 100 years. Since the global environmental problems caused by human activities other than the increasing human population problem in the world are discussed in their own chapter in this book, only the topic of zero waste is given as an example here.

An Example Global Environmental Problem: The Garbage Problem and Zero Waste

The waste generated as a result of us being a consumer/throw-away society, extravagance, not utilizing waste enough, lack of education, and other human activities have not only resulted in air, water, and soil pollution, it has also affected the health and living spaces of man and other living creatures and threatens their survival.

Waste is a problem that needs to be addressed urgently due to the consequences of the excessive use of energy and raw materials such as these resources being on the verge of depletion, surface and subterranean water being too polluted to use, soil being contaminated by harmful materials from garbage and no longer fertile, all creatures living in and on the soil being under threat, air pollution, and pandemics.

To find a solution to this problem, we have to look at the causes of the problem. To date, we have not seen any method for solving the waste problem in our society other than support for “recycling.” The philosophy of “eat and drink, there is always recycling” was discussed. However, the solution is for individuals to acquire the behavior of reducing garbage/waste production. The zero-waste project that has been put forward in recent years can be a solution to the garbage problem.

The “Zero Waste” project is a project implemented by the Ministry of Environment and Urbanization in 2017 within the framework of sustainable development principles to manage waste and leave a cleaner and more livable world to future generations and is carried out under the auspices of Mrs. Emine Erdoğan. This project has been put into effect in all state institutions and organizations through circulars and further expansion is emphasized. Studies made on its existence in school programs and its implementation in other institutions and organizations to date have shown that it is no different than other zero-waste activities (Erten, 2019). Yet, zero waste means reducing all kinds of waste and garbage production. The first goal of zero waste management is to prevent and reduce waste during production. Zero waste should be included as a subject in the primary and secondary education curriculums, and assistance from subject experts should be sought when adding this subject to the programs. Zero waste does not mean recycling products that can be recycled. Training should be given, particularly to teachers, so this subject can be understood (Erten, 2019).

The path to be followed in the zero-waste process should be like this

1. Reducing the production of garbage/waste across the entire process from manufacturing products to the end-user consumer

2. Repurposing the waste left behind from the products we use

3. Garbage/waste that cannot be reduced after the above reduction work should be sorted into groups, collected, and sent for recycling.

It is always better to reduce the production of garbage/waste as an individual and to seek how and where to utilize any garbage/waste that remains despite this than to recycle garbage or waste. It is better to recycle garbage than to dispose of it using physical or chemical methods or incineration. Zero-waste, on the other hand, means not producing any waste at all, if possible, from the production stage to the final consumption of the product. How is that possible? The examples given below can guide individuals about zero waste (in garbage/waste reduction) (Erten, 2000):

- ✓ If possible, prefer unpackaged products (such as buying unpackaged toothpaste, vegetables and fruits that are not wrapped in plastic, etc.)
- ✓ Leave unnecessary packages at the mall
- ✓ Shop at public markets
- ✓ Buy durable foods in large portions, if possible
- ✓ Prefer refillable products such as Cologne, Milk, Perfume, Detergent, etc. with bottles we can refill when empty.
- ✓ Buy deposit-return products if possible (The country's rulers and the public should insist on the production and use of deposit-return products.)
- ✓ Multi-purpose, environmentally friendly products such as baskets or string or cloth bags should be used for shopping.
- ✓ Products that do not harm human health or the environment, are recyclable, and that can be washed in a natural environment should be purchased.
- ✓ If possible, avoid buying disposable products; products that can be used for a long time should be purchased; for example, the charging devices in such products as cheap, rechargeable hand-held vacuum cleaners break down quickly and cannot be used.
- ✓ We should give the products we do not want to use to other people who will use them, or to charities.
- ✓ We must sort waste: if we throw out waste items together, the products to be recycled cannot be recycled.
- ✓ We should prefer recycled products.
- ✓ If possible, we should compost household and garden waste.
- ✓ We should use environmentally friendly products. We should not buy products such as plastics, short-lived products, or plastic school bags.
- ✓ We should use rechargeable batteries and not buy disposable batteries and we must not throw them away under any circumstances.
- ✓ Our children soon get bored with the toys we buy for them and stop playing with them. They want new toys instead. We can reduce their toy waste by creating

exchange markets instead of buying new toys.

- ✓ Packing individual cubes of sugar to have the company's name written on each one or packaging food like this not only consumes energy resources but also increases environmental problems. We should consider it our duty to renounce such behavior and adopt environmentally friendly behavior when we buy these kinds of products.
- ✓ We need to stop buying all kinds of food sold in mini portions and make our young people realize that this is wrong. For example, tiny cheeses, jellies, honey, oil, and similar products cannot be the behavior of environmentally conscious people.
- ✓ The Zero Waste project should be approached with an Ecocentric perspective, not an Anthropocentric philosophy.
- ✓ Nowhere in the world can environmental problems be solved without the money coming out of our own pocket and without compromising our own comfort.
- ✓ To achieve this, people need to be informed about this issue starting in pre-school education all the way through to university graduation. The zero-waste subject should be included in preschool, primary, secondary, and high school education programs.

The pictures below will be enough to see what waste is doing to our world.

Picture 1.

The Garbage Crisis That Threatened War: After the accumulation of garbage containers over the years, Philippine President Rodrigo Duterte announced that he would declare war on Canada.

The Seventh Continent is the name given to the huge pile of waste in the middle of the Pacific Ocean, one of the most visible consequences of the Anthropocene era and global warming. The "Seventh Continent," as it is called in popular science, consists of a pile of plastic 3.4 million square kilometers wide and weighing 7 million tonnes. It shows how human waste has given the world a new continent in the middle of the ocean (Web).

What must we do?

"Humanity is at an historical turning point. We face continuing disparity between nations and each other, increasing poverty, hunger, disease, and illiteracy, and the growing collapse of the ecosystems on which we depend for our survival. However, by integrating environmental and development considerations and paying more attention to them, it will be possible to achieve a safer, more prosperous future by meeting basic needs, improving living standards for all, and protecting and managing ecosystems better. No nation can do this alone; only together through a global partnership for sustainable development can it be achieved" (Ministry of Environment). The above statements, which hit the world's agenda exactly 30 years ago, revealed that the agenda of the 21st century is environmental issues, as can be understood from the name of the conference, also referred to as Agenda 21.

The owners of giant international shopping mall chains throughout the world have turned us into a "consumer society" with their consumption habits to earn more. With our consumer society habits, the more we shop outside of our basic needs, the happier we become. Consumption society means the consumption of the world's surface and subterranean resources and those human communities that do not know there are global environmental problems.

If we do want to get rid of environmental problems, we must abandon our Consumer Society habits. As individuals, we should only shop for our basic needs because energy is used to produce every product we buy. In secondary school, we learn that energy is the power to do work. Whatever is produced, energy must be used. If energy is used, there are bound to be waste gas emissions. Of these gas emissions, methane gas plays the lead role in global warming. As these emissions increase, it becomes less and less possible to reduce environmental problems. Every shoe purchased, every phone, every computer, every extra meal eaten, every wasted light bulb in public or private buildings, radiators on for no reason, radiators hidden among furniture, every torn notebook, starting electric and motor vehicles, using cars to travel walking distances, using an electrical device such as a hairdryer when a towel will suffice, using dryers to dry clothes that could be dried in the open air; these and similar activities done by us mean air pollution, damage to the ozone layer, global warming; it means the rain that is called a blessing becoming a disaster; it means floods, typhoons, climate change; it means 1 billion people going without food, 1 billion people going without water; it means various diseases caused by pesticides and fertilizers. It means children born into the world disabled (See. 17.8). Ultimately, it means our world returning to the Ice Age.

Humans cause 49% of global warming with energy use, 24% with industrialization, 14% with deforestation, and 13% with agriculture (Ministry of Environment and Forestry, 2008). If we were to plant only trees, global warming would fall by 14% as a result. In this way, not only will absorption be reduced but also production will increase. If we use energy sparingly, we may be able to prevent global warming.

Characteristics of Environmental Problems and Environmental Education

The biggest characteristic of environmental problems is that they are not local but global. These environmental problems affect everyone, regardless of religion, language, race, old or young, male or female, rich or poor, academic or farmer, villager or city dweller, science or music teacher, mathematics, chemistry, or physics teacher. Therefore, protecting the environment is not only the duty of environmentalists, and giving environmental education is not only the duty of environmental educators. Protecting the environment is everyone's duty. In all lessons, a connection should be made between the courses in question and the protection of the environment.

What Is Environmental Education?

Making changes in people's behavior is one of the main aims of education and is also included in the definition of education. To overcome environmental problems. we first need a tool. That tool is environmental education. The goal here is to raise individuals who can exhibit environmentally friendly behavior, and we say that individuals who behave in this way are "environmentally-conscious" individuals. In terms of its features, environmental education differs from environmental science or other ecological education.

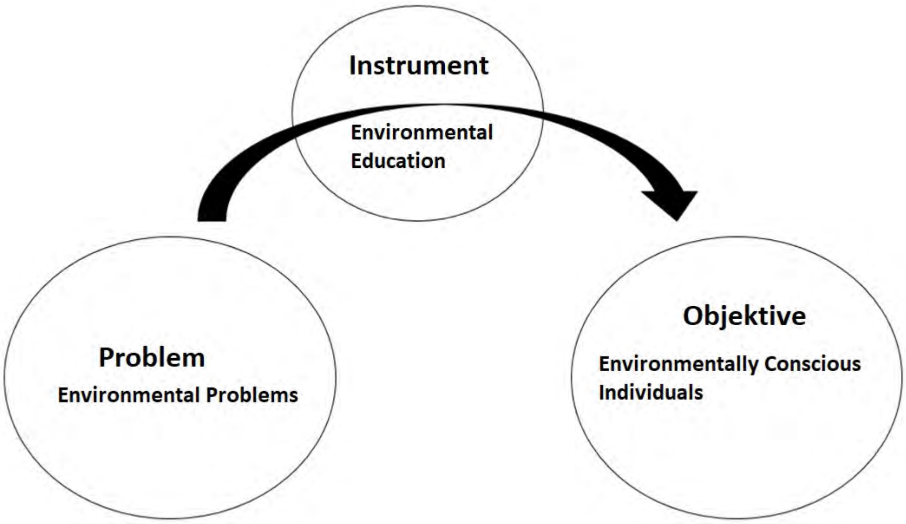

Figure 1. The Relationship between Environmental Problems, Environmental Education, and Environmental Consciousness

Environmental education imparts ecological information while at the same time promoting the development of attitudes toward the environment in individuals and converting these attitudes into behavior. Environmental education appeals to students' cognitive, affective, and psycho-motor learning areas. Environmental education is the process of developing attitudes, value judgments, knowledge, and skills for the protection of the environment, exhibiting environmentally friendly behaviors, and seeing the outcome of all this.

The earlier environmental education starts, the better. This is because the interests and attitudes formed at pre-school and school age form the basis of desired behaviors in the future. Value judgments and attitudes, particularly those formed in childhood and young ages, are very important for the development of empathy and affection for nature in relationships with nature at an early age. Their formation means protecting the environment and exhibiting environmentally friendly behaviors. These developmental stages will be the learning in the affective field that should be taken into account and that will later help the development of environmentally beneficial behaviors and consciousness in individuals. At these ages, children are made to play games that endear nature and they get to experience nature. Through these games and experiences, children acquire positive emotions and learn to behave in an environmentally friendly manner. The individual who learns that nature is a value becomes aware of its beauties with all his senses and makes an effort to protect it. People protect their loved ones, so making children love animals and plants should be one of the most basic aims of environmental education. Environmental education at all levels of education should not be limited to a certain lesson period but should be given in every lesson, if possible, by associating it with each subject. For this, every teacher has to be mindful of environmental problems, that is, be an environmentally conscious individual.

What Does Environmental Consciousness Mean?

Although the concept of environmental consciousness has a wide range of uses, the area where it manifests itself most intensely today is politics. Aimed at environmental consciousness, as many scientists have emphasized, environmental knowledge is an attitude towards the environment and behavior that is beneficial for the environment. We can briefly explain them like this:

Environmental Knowledge: All information about environmental problems, solutions sought to these problems, developments in the ecological field, and nature.

Attitudes Toward the Environment: All the attitudes and ideas, beautiful or ugly, beneficial or harmful, agree or disagree, positive or negative, etc. that people have about the environment such as fears stemming from environmental problems, anger, disgruntlement, value judgments, and readiness to solve environmental problems.

Environmentally Beneficial Behaviors: They are genuine behaviors shown for the protection of the environment. Such behaviors are regarded in the literature as environmentally friendly or environmentally beneficial behaviors.

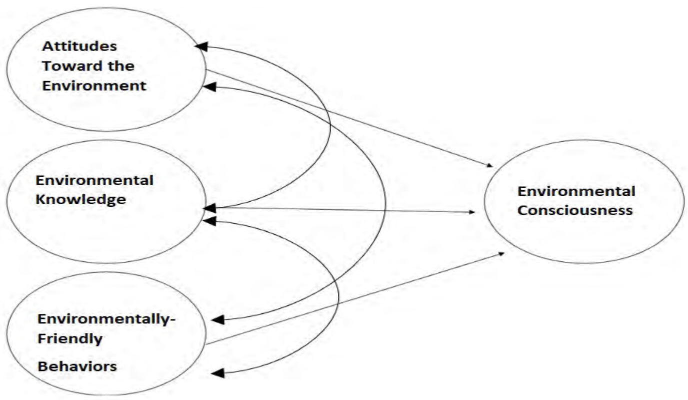

Figure 2: Environmental consciousness and aspects of environmental consciousness

However, studies carried out in the field of environmental consciousness so far have shown that *environmental knowledge* has little effect on *environmentally beneficial behaviors* and *attitudes toward the environment* do not have much meaning in *environmentally beneficial behaviors*. An environmentally conscious person is someone who, in addition to having environmentally friendly behaviors, does not remain impartial or insensitive to environmental degradation, does not act selfishly, and does not turn his personal gains into ambition (Haan et al., 1997; De Haan & Kuckartz, 1998; Erten, 2004; 2012).

Who is an environmentally conscious individual? If a person with a lot of knowledge about the environment does not make any effort to reduce waste, does not act frugally or economically in energy use, for example, if he uses his private car by himself, even to places where he can go on foot or by public transport, if he speeds over 100 km while driving although it is not necessary, if he does not look at the energy labels when buying a car and white goods and does not buy a car or furniture that consumes the least energy, if he keeps the room temperature at work above 20 degrees C., if he has door and windows open when the radiator is on and this does not bothers him, if he is not bothered by his computer staying on for hours even though it is not working, if he does not turn off the light bulbs even when it they are not needed at all, does not use water sparingly, for example, if water running for hours or days from broken faucets at work or anywhere does not bother him or push him to do anything about it, etc., if he does not have the behavior of preferring deposit-return products in his shopping as much as possible, if he does not have a habit of looking at how harmful the product he will buy is to the environment; if he shops with a consumer society mentality, if he stays silent when he sees people harming the environment and does not inform the authorities or exhibit similar environmentally protective behavior, we cannot say this person is environmentally conscious. This knowledge that this person has about the environment has no meaning either. Even if the person who does not demonstrate environmentally friendly behaviors knows all about the environment, this does not mean a thing.

Points to Consider in Environmental Consciousness Research

The study of behavior for environmental protection is difficult, just as it is with almost all empirical studies on environmental consciousness. This difficulty stems from the methods used in the research as well as the fact that the individual behaviors of the individuals participating in the research cannot be observed and are limited only to verbally expressed behaviors. These can be briefly explained as follows: In empirical studies conducted to date on environmentally beneficial behaviors, behavioral questions have been asked only in one area (for example, only sorting garbage, using public transportation, determining attitudes towards the environment, and the extent of environmental knowledge). In a study conducted in this way, the fact that individuals do the behavior in the area in question does not indicate that they also engage in other behaviors that are beneficial to the environment. This means that a study cannot obtain sufficient general information about individuals' environmentally beneficial behaviors or environmental awareness. Therefore, studies should include questions from many areas of behavior beneficial to the environment and not be limited to specific areas. In addition, the fact that a group's attitudes or knowledge about environmental protection are high does not mean that this group or these individuals display or will display environmentally friendly behaviors. Studies also need to include environmentally friendly behaviors in addition to these. Only with the information obtained this way can we talk about individuals' environmental awareness (Erten, 2004).

Another problem in studies is that questions that provide information about how much individuals can sacrifice their comfortable lives for the protection of the environment are almost never included in the questionnaire. For example, it is not a very taxing behavior for a person to take bottles to the bottle bank near his house. On the other hand, if the bottle bank is a few kilometers from the person's home, will he still be able to display this behavior? If the residents of a house or building that is not insulated refrain from spending money on making it insulated, even if they do engage in other environmentally friendly behaviors, it will not be easy to say that these people are environmentally conscious. Therefore, future studies should consider how much the person or people are willing to sacrifice materially or morally for an environmentally beneficial behavior.

Apart from this, it should also be taken into account whether the behaviors for the protection of the environment to be investigated are really for the protection of the environment. For example, in our country and in many developing countries, especially in big cities, some people collect garbage and make a living from it. We cannot talk about the people being environmentally conscious by looking at them or doing research with them because they do this for their livelihood, not for the protection of the environment. In Ankara, 67.6% of families reported being "often and very often" angry that their children leave their doors and windows open while the heating is on. Is this behavior due to the families having a high degree of environmental consciousness, or is it due to them having trouble getting by due to the recent economic crisis (Erten, 2003)? Considering these and similar factors in studies will provide us with sounder and more reliable information about individuals' environmental consciousness.

Environmental Consciousness in Turkey

Studies conducted so far have revealed that students' knowledge of the environment is incomplete and that their attitudes are insufficient and have an insignificant effect on their behavior. If the following research examples are examined carefully, the contrasts between knowledge, attitudes, and behaviors can easily be seen. In addition, these studies can give us a general idea about what students know from the 5th Grade of primary school to university, what their attitudes are, and how environmentally friendly they behave (Erten, 2003). The study results below are not given in detail due to space constraints, but only as a summary to provide a general point of view.

Anthropocentric, Ecocentric, and Antipathic Attitudes

Before exhibiting any behavior, a person considers what they stand to gain or lose if this behavior occurs in their mental world. He calculates profit and loss (Diekmann & Preisendörfer 1992). We can think of it as utilitarian philosophy. Scientists have conducted a lot of research to reveal ecocentric, anthropocentric, and antipathic attitudes and value judgments about the environment and the differences between them. What is meant by an ecocentric, anthropocentric, or antipathic person? If a person sees the world as a value in its own right, believes that nature should be protected without prioritizing his own interests, and acts accordingly, such a person has ecocentric thought. Such persons may regard plants, animals, and people as having equal worth. An ecocentric-thought-centered individual prioritizes the protection of the environment in the recovery or recycling of wastes and the efficient use of water and energy and avoids any behavior that may cause environmental problems. Considering the protection of the environment, except in cases of necessity, he prefers public transportation over his private vehicle.

Anthropocentric people want to protect the environment because it is indispensable for improving people's quality of life and maintaining people's lives. According to them, the environment should be protected because it is for the benefit of humanity, and protecting the environment means protecting people. They aim to do whatever is in man's best interest, so it does not matter whether the environment is damaged or not.

Environmental pollution (air, soil, and water pollution, etc.) should be prevented as it threatens human health. Natural resources should be used sparingly so that we do not lose energy in the future or see our quality of life decrease. Anthropocentric attitudes are based on utilitarian philosophy (Erten, 2007; 2008). The person who has a dislike for the environment believes that environmental problems are exaggerated, does not enjoy talking about environmental protection, says that he is tired of environmental issues, and believes that environmental problems are artificial agendas.

Fossil-Based Energy and its Importance in Terms of Environmental Problems

It is a well-known fact that coal, natural gas, oil, and derivatives, which are currently used as energy sources in our world, are exhaustible or non-renewable energy sources. However, instead of engaging in more frugal behaviors in the use of energy resources, the use of energy has increased and is increasing day by day. As a result, the harmful effects of gases, which are the waste of fossil energy sources, on the environment we live in are constantly increasing and threaten the existence of people and other creatures on earth. First of all, in response to the energy crisis that started in the world in 1973/74, many developed countries and scientists started work on finding a solution to this problem. Among the solutions they considered, they saw finding new energy sources (renewable energy sources) and adopting many measures such as reducing the use of vehicles as energy-saving solutions. They reached the consensus that this would be possible, in part, with the measures to be taken in the production of energy-efficient technologies, and also through education to reduce the energy consumption of social institutions and individuals (Erten, 2000; Wortmann, et al., 1988; Wortmann, 1994).

Just as in other fields, teaching theoretical information in the field of energy-saving is not enough; the most important thing is the emergence of energy-saving behavior. Many people in society know why they need to save energy but cannot turn this knowledge into behavior. And herein lies the problem. To be successful in energy saving, work is needed on improving behavior.

It is possible to list a few examples of creative projects that improve students' energy-saving behavior and that I have done in class without going into details due to space constraints (only the last project is explained as an example), as follows:

1. Investigating the amount of garbage (plastic cups and bottles) produced by bus companies while offering refreshments to passengers and the energy spent on them.
2. Investigating the relationship between gases that cause global warming and energy extravagance.
3. Identifying deposit-return products and investigating the relationship between these products and energy saving.
4. Investigating why some products need to be recycled in terms of energy saving.
5. Using wastepaper to make paper that can be used by students in various fields and investigating its connection with energy-saving.
6. Having students follow up energy-saving work at home or school and investigating the efficiency of their work.
7. Enabling students to acquire environmentally friendly behaviors toward more efficient use of energy, by having 50%-50% projects done in schools and similar projects.
8. Cars, which almost everyone wants to have today, play a leading role in the formation of environmental problems, especially in air pollution and global warming. Of course, air, land, and sea transportation vehicles have made distances smaller and effectively stopped time and have become indispensable today. However, they also play an important role in the creation of environmental problems. For this, it will be enough to look at the energy label of an ordinary car, below. The car that has been given the energy label in question puts 130 grams of carbon dioxide (carbon dioxide emissions) into the atmosphere per kilometer (km). This makes 1 kilogram of carbon dioxide per 7 km. Emissions other than carbon dioxide are not yet counted.

Figure 2.

Case Study: The distance between Hacettepe University Beytepe Campus and Eskişehir road, which is the main road, is 5 km, becoming approximately 7 km to reach the various departments. A person who travels to Beytepe campus from the Eskişehir road and back covers 14 km. This means 2 kg of carbon dioxide emissions for just one car. By having the students count these cars at noon one or two days each semester, we determine the approximate number of cars per day and calculate the daily emission amount. Getting this confirmed by officials, we learn that this number is over 15,000 cars. This means 15,000x2=30,000 kg of carbon dioxide emission. The carbon dioxide emission of the cars entering and leaving the Beytepe campus from the Eskişehir road alone in one day is 30 tonnes. We would have done less harm to ourselves, our world, and future generations if public transportation had been used instead, or if there had been 5 people coming to campus in a car. When it comes to complaining about environmental problems, we all refrain from complaining.

9. What does it mean to identify electrical devices and equipment that are left on unnecessarily and calculate their monthly electricity consumption?
10. What does it mean to compare a domestic product with an imported product in terms of energy consumption, and how should an environmentally conscious person act?

For example, we import citrus fruits from Israel, onions from Romania, and peaches, tea, barley, wheat, rice, apples, etc. from European Union countries, and when we join the European Union many more such products will come to our country. Environmentally conscious people will prefer to buy whichever product causes the least harm to the environment by the time it reaches the consumer to prevent more damage to the environment by considering the table below. In short, an environmentally conscious individual protects the environment and his country by purchasing the products closest to where he lives. It is necessary to carry out these studies to instill this consciousness. At the same time, this will ensure that energy-saving behavior is realized in the long term and on a global scale. The energy used in the construction of transport vehicles and the replacement or repair of their parts should not be forgotten.

Table 3. The Amount of Energy to Produce Imported Products

Country	Agricultural Product	Distance to Ankara (km)	Energy Spent (Diesel/lt)	Emission Amount (kg)
European Union countries	Tea, peach, apple, rice, barley, crude oils	2200	440	314,3
Romania	Onion	800	160	114,3
Israel	Citrus	1040	208	148,6

Table 4. Domestic Products and the Amount of Energy Consumed According to their Distance

Country	Agricultural Product	Distance to Ankara (km)	Energy Spent (Diesel/lt)	Emission Amount (kg)
Rize	Tea	675	135	96,4
Ankara	Onion	0	0	0,0
Antalya	Citrus	450	80	64,3

**NOTE: The distances of the countries from Ankara are calculated approximately

Interpretation of the Results of the Studies Conducted to Date and Recommendations

Caring for plants and animals and getting to know them instills affection for them and the need to protect them. People protect what they love and are familiar with. In the development of environmental consciousness, the main starting point is to get to know plants and animals, to increase interest in them, and to destroy fear and phobias regarding animals. Studies have revealed that people who care for plants and animals in their childhood and have childhood experiences in nature are more mindful of environmental problems or take on more voluntary roles in non-governmental organizations than people who do not exhibit these behaviors in their childhood.

It is understood that teachers and students cannot grasp the relationship between fossil fuels or natural resources and the products used and cannot transform the knowledge they have learned into behavior in their daily lives. On the other hand, the results can be explained with the Low-cost/High-cost (easy/difficult behavior) theory. According to this theory, individuals consider the "cost-benefit" aspect from their own perspective when engaging in environmentally beneficial behaviors. If a behavior does not require sacrificing the comfort of the individual, spending money out of their own pocket, and is easy to do, such behavior is "Low-cost" while behaviors that are the opposite of this are considered to be "High-cost" behaviors. For example, behaviors such as sorting garbage, switching off electrical appliances, and turning off faucets are "Low-cost" while behaviors such as choosing public transportation by reducing the use of private cars, insulating uninsulated houses, not speeding the car over 100 kph when there is no emergency, providing financial assistance for the protection of the environment, collecting used bottles and taking them to bottle banks located far away are considered to be "High- cost" behaviors. It will be possible to explain many results in studies with this theory (Diekmann & Preisendörfer, 1992).

Perceiving environmental problems as a risk and seeing them as a threat is also very important in terms of motivating environmentally beneficial behaviors, but it cannot be a correct and desirable education method to talk to children about negativities all the time, because children should not lose hope for the future. If an individual cannot look to his future with confidence, his joy of life is lost (Erten, 2002).

As can be seen from the results, possessing high environmental knowledge and environmentally conscious attitudes in environmental consciousness studies is not enough for people to engage in environmentally beneficial behavior. In environmental consciousness research, it is not a correct approach to say that environmental consciousness is high by looking only at positive attitudes toward the environment or a person having sufficient environmental knowledge. Studies show that it will take time for positive attitudes to turn into behavior (Erten, 2012).

What can be done?

Rather than teaching this knowledge in artificial environments, it should be transformed into a practical form that can be used in everyday life.

For the desired environmental education to be delivered effectively in schools, first of all, the teachers working in these schools must be environmentally conscious. Furthermore, the environmental consciousness of other personnel working in these schools needs to be improved through in-service training or seminars. This is because a person who does not learn cannot teach another person; to put it another way, a farmer will not plant a product that he is not familiar with in his field or garden.

The environmental work carried out in the schools where the study was conducted is not sufficient. Environmental education is not among the priorities in schools' education programs, at least not in practice. Few schools have plant cultivation and animal husbandry studies. Apart from these, some schools organize day trips. However, the primary purpose of these trips is to have a picnic instead of getting to know nature or gaining experiences in nature.

Environmental issues on the agenda of Turkish and Azeri students rank 4th place among Azerbaijani students and 5th place among Turkish students. Even though global warming, which is one of the environmental problems, has been on the agenda of the world recently, the fact that it is not at the top of the agenda of Turkish and Azerbaijani students reveals the need to improve these students' environmental consciousness. There is a need to increase the interest of Turkish and Azerbaijani students in plants and animals. The fact that the variables of caring for plants and animals appeared as predictors of general environmental consciousness scores in the findings reveals how necessary this is. Protecting the environment is the same as protecting all living things in the environment. In their lessons, teachers should strive to increase students' interest in living things, develop empathy towards living things, and develop a love for living things instead of the hatred and disgust for them formed in children (Eschenhagen et al., 1998). Tales, stories, poems, and songs that denigrate animals, portray them as monsters, make them hate and disgust them (e.g., Little Red Riding Hood, the We Go Chopping Trees song, etc.) should be avoided by teachers in kindergartens, primary, and secondary education, and even undergraduate education. Teachers should instill interest and love toward living things in their lessons. This is because interest teaches love and love teaches protection, and people only protect what they love.

Turkish students' total scores in knowledge, attitudes and behaviors toward the environment are higher than the total scores of Azeri students in these areas. In light of this outcome, it can be said that Turkish students are more environmentally conscious than Azeri students. The lowest scores among the dimension are the behavioral scores.

This finding also emerged in the effects of attitudes and knowledge on behavior. This is particularly evident among Azerbaijani students. There is a need for environmental education starting with kindergartens to increase students' environmental consciousness in both countries. It might be possible to develop environmentally-friendly behavior by teaching the knowledge to be taught in the settings in which it will be used later. It is not possible to use the knowledge learned in artificial settings in real and complex life settings (Gräsel, 1997). For this reason, in environmental education, students need to be taught in the affective, cognitive, and psychomotor areas, lessons should be taught through activities to be carried out outside the school and in natural settings, and environmental problems should be discussed.

Easy behaviors explain 21% of the environmentally friendly behaviors in Turkish students. An individual considers the "cost-benefit" aspect from his own perspective when engaging in environmentally beneficial behaviors. If a behavior does not require sacrificing the comfort of the individual, spending money out of their own pocket, and is easy to do, such behavior is "Low-cost" while behaviors that are the opposite of this are considered to be "High-cost" behaviors (Martens & Rost, 1998; Erten, 2005).

To create environmentally conscious individuals, first of all, education should be given to reinforce the environmentally centered (ecocentric) attitudes of the students so that they can move away from the "cost-benefit" approach in protecting the environment. Today, the biggest handicap to environmentally friendly behaviors is the "utilitarian" philosophy.

The fact that attitudes and knowledge cannot explain behaviors, especially in Azeri students, and that it has an effect of only 21% on Turkish students is an interesting but no less expected result. To solve this problem, it is necessary to change the social makeup. Attitudes do not turn into behavior in societies that are not democratic or where democracy has not fully taken root (Frey et al., 1993). This issue should be addressed in lessons by all teachers and all students should be supported to become individuals who can make their own decisions from an early age, have self-confidence, and do what they think is right.

To create an environmentally conscious society in general, supradisciplinary environmental education should be given to all teachers in a way that will develop environmentally friendly behaviors, starting with kindergartens, primary and secondary education institutions, and undergraduate education (De Haan, 1989). In primary and secondary education, in particular, environmental education lessons that evaluate students' environmental consciousness with points should not be included as lessons. Every teacher has to do something to protect the environment in their lessons and every individual has to be an environmentalist.

Statistically significant differences were found between boys and girls in aiming to save energy. These are as follows:

1. Girls and boys know about energy conservation from their schools; however, this knowledge does not have a significant impact on the behavioral objectives of conserving energy at home.
    - The study shows that student's knowledge about energy conservation comes from school. In other words, although the students have acquired the knowledge that they should use energy sparingly, the probability of this knowledge turning into behavior is low. This shows us that the information given in schools cannot be used to solve problems in daily life. Education and training on this subject should not be theoretical and based on memorization; rather, it needs to be aimed at developing behaviors in practice.

    - Behaviors that are beneficial to the environment are acquired through family and friends, through the experiences gained from the beauties of nature, through learning experiences in nature, through behavior-instilling environmental knowledge, and through being informed by media institutions.

2. Although female students have the opportunity to save more energy at home, male students believe that they will do far more energy conservation activities at home than the girls (recommendation for this is in Item 4).
3. I have "so many.... too few" opportunities at home to save energy or

it is "so easy..........too hard" for me to do. The answers given by female students to these question propositions are more negative than those given by male students. However, in a country like Turkey, aiming to save energy at home is expected from female students rather than male students. This indicates that female students are less confident than male students in their own efficacy and influence on saving energy at home.

4. Girls should be reassured to recognize the impact of their own behavior; they should be supported in realizing that their own ideas are just as important and worthy of respect as the male student's ideas. Considering that most of the housework is carried out by women and girls in our country, it is quite clear how effective women and girls can be in using the energy in the house sparingly. More efficient outcomes would be obtained if female students had confidence in their activities to save energy at home.

When the behavioral objective of *"using energy sparingly"* is compared with the behavioral objectives of "*using water sparingly"* and "*reducing garbage,"* there are fewer explanations for this behavioral objective.

The fact that Turkish teachers' anthropocentric centered attitudes average higher than German teachers' attitudes on the same subject may be because the cultural structure of Turkish society on this subject is based on the idea that humans are created superior to other living things. It should be investigated whether this notion leads our people to the wrong idea of using nature without limits and the results used in re-educating our people on this topic.

While the German teachers agreed with the ecocentric attitude recommendations, they were undecided on the anthropocentric attitude recommendations. This outcome can be explained as follows: One of the most important differences between Turkish society and German society is the difference in the education system. In the past 40-50 years, Germany has made great progress, particularly in the field of environmental education, and they have made great efforts in the family and education system to protect the environment. In addition, as Germany is an industrial country, the people living there have been bothered for a long time by many environmental problems such as environmental pollution, acid rain, noise pollution, and nuclear waste problems. This negative situation has led to the rapid development of environmental consciousness studies. This is because research shows that "when environmental problems are perceived as a risk and seen as a threat, this motivates the individual to adopt environmentally beneficial behaviors." In addition to all this, the effect of penal sanctions to protect the environment should not be forgotten.

Among German teachers, just as with Turkish teachers, there was an inverse correlation between ecocentric attitudes and dismissive attitudes toward environmental protection. This shows that the more ecocentric a person is, the less dismissive they are toward solving environmental problems. The fact that German teachers and Turkish teachers have similar dismissive attitudes toward environmental issues may be because in Germany, environmental issues have been occupying the agenda constantly for the past 50 years, many laws on this have been enacted, and there are frequent demonstrations. In addition, some of the regulations made must have disrupted their interests. In light of the information obtained from short interviews with Turkish teachers, the dismissiveness seen in Turkish teachers can be explained as follows: It may be because economic and terrorism problems, not environmental problems, are first among the problems of people living in Turkey. When the ecocentric, anthropocentric, and dismissive attitudes of the Turkish and Azerbaijani preservice teachers are examined, the difference between the overall scores shows that the Turkish teacher candidates have more ecocentric attitudes than their Azerbaijani counterparts. When the overall scores of anthropocentric attitudes were examined, no significant difference was observed between Turkish and Azerbaijani preservice teachers. The scores of both Azerbaijani and Turkish preservice teachers toward the environment are quite low. This shows that the pre-service teachers participating in the study do not have concerns about environmental problems and do not intend to do anything toward solving environmental problems. The reason for these results can be explained by the fact that some of the people in both countries have different problems to think about before environmental problems, in addition to having low environmental consciousness (Erten, 2007; 2008; 2011).

Can Technology Be the Solution to Environmental Problems?

Some people claim that developments in technology will be enough to solve environmental problems. Yet, it is technology that causes environmental problems to emerge. What kind of solution can be expected from technology when it is primarily responsible for the creation of environmental problems?

The discovery of radioactive material in the 20th century delighted people at that time. This joy turned to ashes when it was later discovered that it was a major cause of cancer. The same joy was experienced in the discovery of chlorofluorocarbon (CFC) gases, and humanity was shocked to learn that they also play a leading role in the destruction of the ozone layer today. The discovery of DDT and pesticides also took its place in human history as a miracle. DDT is a pesticide that was used for many years before its use was banned by the United Nations in the 1970s. Interestingly, DDT is still used in our country.

What are pesticides? Pesticides are all the chemicals that scientists have discovered to destroy the creatures that damage agricultural produce. There are thousands of these types of chemicals in use today. The production and use of pesticides have become widespread, as if scientists, whose research discovered that one-third of crops planted were eaten by other living things, said: “Why are we going to share our crops with other living things, we shall destroy them with science and technology,” as it were.

Why did the northern bald ibis species go extinct? Some of us may not agree with the statement that the northern bald ibis species is extinct, because these birds can be produced on production farms under human control. Migratory birds that leave our country in the fall and come back in the spring on their own in nature can no longer carry out this cycle. So, what is the reason for the disappearance of these birds? The northern bald ibis birds have disappeared due to the use of pesticides in agriculture. How did this happen? Since these birds are insectivores, they had to feed on insects that were poisoned by insecticides. The insecticides accumulated in dead insects harmed the birds, affected their reproductive function, reduced their egg numbers, crippled the hatched chicks, stunted the growth of new offspring, and caused the bald ibis to come to the point of extinction by stopping the reproductive function. To feed the increasing world population and earn more, scientists discovered fertilizer. It was produced with technology and used in agriculture for years and is still being used. Naturally, through precipitation, these fertilizers, which were dumped onto agricultural areas, mixed with the sources of drinking water under the ground and polluted it. Not only that, but they also get into lakes and seas through streams, disrupting aquatic ecosystems and negatively affecting the living population.

Biology, which is the science of living things, is a branch of science that developed as a result of people's curiosity from ancient times to the present day, the results of which people benefit from the most. The developments in biology in the last 200 years have reached a point that no one could ever have imagined. The world's population has increased rapidly as a result of the end of large-scale wars in the world, the discovery of the causes of epidemics by biologists, and positive developments. In the early years of the Gregorian calendar, it would take more than 1,000 years for the world's population to double but in the last century, it took just 50 years for the world's population to double (Kiziroğlu, 2004).

The rapid increase in the world population has brought with it many global problems, and if it continues like this, the problems will increase. The first of these problems is that of "feeding." To solve this problem, scientists have used and will continue to use findings from biology. Knowledge in the field of genetics, in particular, has initiated plant and animal breeding studies.

Plant and animal breeding has resulted in a great increase in plant and animal products. For example, cows once yielded 5 kg of milk but now yield 40 kg. Vegetables and fruits that quickly decay or rot are being produced that can last for a very long time. With the developments in biology and technology, fields now yield 5-10 times what they used to in crops. Great success has been made and will continue to be made in four-season produce, better fruits, more milk, milk that does not go off for months, meat the can be consumed after being kept waiting for months or even years, and other produce.

Thanks to the developments in biotechnology and genetics, many diseases have become curable, artificial hormones and interferon have been produced, and it is now possible to deal with unwanted genes. In the future, it will be possible to remove diseased genes from DNA and create healthier new generations. Genes that can cause other diseases that may occur before or after birth will be rendered harmless.

The mapping of the human genome as we entered the 21st century will reveal what secrets these genes have. This is one of the greatest achievements of biology ever made concerning man.

The acceleration of space studies in the 1950s and later imposes on biology the task of researching life forms that are likely to be found in space. Stem-cell research at the beginning of this century has delivered concrete results. It is expected that diseased genes and organs can be regenerated with stem cells.

In addition, “live copies (cloning),” which was first performed in salamanders and frogs in 1950, took place with “Dolly” the sheep through work on mammals in 1996. Scientists are trying out cloning on many creatures and there may even be some who want to clone human beings.

The main reason for the emergence of studies to clone living things is to prevent endangered species from becoming extinct. This may prevent some living species from disappearing in the future.

The joint work of biology and other sciences and technology has, of course, extended the average life expectancy of human beings. In addition, people will be able to lead a more comfortable life than in previous years.

Many of the above-mentioned biological and technological developments have resulted in a wide variety of diseases and environmental problems, polluted water, soil, and air, flavorless foods that have deviated far from their primary ancestor, and scientifically unethical research (such as human cloning, etc.).

Technological inventions have provided people with comfort and convenience, but they have also brought many problems. For example, environmental pollution, especially air pollution, harms human health. The most harmful gases that are seen in air pollution come from the exhausts of cars and the chimneys of factories and houses. It is known that these toxic gases affect the respiratory tract, destroy lung tissue, adversely affect the functioning of the nervous system, and cause breathing difficulties and asthma.

Another toxic waste from fuels causes damage to children’s brains. The chemical substances that get into the water through various paths such as industrial complexes and the detergents we use at home are extremely harmful to human health. Bacteria and viruses in drinking water can cause diseases such as typhoid and cholera. Therefore, water must be cleaned. However, excessive chlorination to clean drinking water and swimming pools can also harm human health. It is a fact that the chemicals used in the cultivation of foods also cause many diseases.

In the past century, humanity has witnessed the dark and frightening uses of many scientific developments. The positive image of science has been eroded by the unpredictable environmental and social impacts of various scientific and technological developments. We have learned that with developing technology, the habitats of living things are endangered, resources are decreasing, and our environment is becoming increasingly polluted due to the increase in the human population and developing industry.

As the human population increases, so do the needs of the people. Their needs increasing, people consume more materials and create more waste. As the number of cars on the roads increases day by day, the environment in which people live is shrinking. The air is polluted and our energy resources are also running out. People have made inventions that not only feed the increasing population but also make their own lives more convenient. We can easily go anywhere we want with our cars, and we can easily access all kinds of information thanks to our computers and the Internet. We can buy the fruits and vegetables we want in every season. Unfortunately, this convenient life and these technological discoveries have upset the relationship between man and the environment.

For example, the garbage accumulated in the coastal part of Northern Honduras, especially in the past three years, started to turn into huge trash islands in November. These "trash islands" have become a major ecological problem not only in the Caribbean but also in all of Central America, and they threaten the ecosystem in the region.

It is claimed that the garbage, which is mostly hospital waste and plastic, is dumped by communities in Guatemala. The plastics that make up these garbage islands have been floating in rivers and streams for years. While the garbage islands cause fatal damage to the underwater fauna, tests carried out in November found that these trash islands had caused the death of many fish and turtles that had been found dead. According to the data of the UN Environment Institute for 2017, 70 percent of the 6.4 million tonnes of garbage in all seas goes to the depths of the ocean every year, while a significant part of the remaining amount turns into garbage islands, as in the Caribbean.

The examples mentioned above are enough to explain the effects of practices in science and technology on the environment. All these environmental problems threaten human existence and make our world uninhabitable. One way to put a stop to this great disaster is for scientists, technology producers, decision-making rulers, in short, for all people to give up their traditional fossil fuel-based development and developmental habits now and in the future.

Some environmentally friendly inventions in recent years concerning the future of the world and reducing environmental problems, environmentally friendly technologies, development efforts based on renewable energy, the gradual emergence of minimalist and zero-waste lifestyles, the obligation to use recyclable products when making new products, the fact that cleaning products to be made in the future are environmentally friendly, the increase in organic farming activities, and similar developments, while not enough, do give people hope for the future.

Another issue that is at least as important as all those is the need to raise environmentally conscious individuals. An environmentally conscious individual is an environmentally friendly individual. It is a person who avoids all kinds of waste with their behavior, who uses underground and surface resources sparingly, who avoids extravagance, realizing that energy is spent even in manufacturing a needle (not forgetting that this energy is also there in the creation of environmental problems), and who knows that a lot of effort and sweat and tears goes into all kinds of manufactured products when using them. When societies are made up of people with these characteristics, it means this beautiful world of ours will become a habitable planet again.

Final Word: It should not be forgotten that "We did not inherit the underground and surface natural resources we have now from our grandfathers, we borrowed them from our grandchildren." Let us be environmentally friendly so we can deliver what has been entrusted to our care without betraying it.

Scenario 1

Başak, Esra, and their father got off the bus this evening, as they do almost every day. Başak told her father that they needed to go to the stationery store, saying she wanted to buy a notebook and a pen. They went into the stationery store and Başak got what she wanted. Her father suddenly remembered that they had bought a notebook and a pen for Başak two days ago. "Tell me, daughter, what happened to the notebook and pen we bought you two days ago?" he asked. Başak told her father, "Dad, it's still there, but we tore out the pages and paper airplanes. Still have the pen, though. I won't use them because my friends' pens are nicer and they have nice pictures on their notebooks." Esra, Başak, and their father then went to the market to buy what their mother wanted. When they got to the checkout, Başak immediately prepared two plastic bags in which to put the products passing through the checkout. Seeing this, her father handed the cloth bag he was carrying to his daughter and told her to put the food and drinks they bought in this bag. Put out by this situation, Esra and Başak asked, "Everyone puts it in a bag, why don't we?" The father and his daughters arrived home from the market and were met with the mother's smiling face. As they were about to sit at the table for dinner, Esra's father asked her for tomatoes, peppers, and cucumbers. Esra rinsed them in running water and brought them over. Esra's father told her that vegetables and fruits needed to be washed very well. Esra replied saying, "Just washing off the dust is enough." Her father then asked her, her mother, and Başak to listen carefully and he explained how harmful this behavior was. After dinner, the family drank tea and chatted. After a while, the father examined the electricity, water, and natural gas bills that came that day, and compared the bills of the past months with the latest ones. He told his daughters and wife that they use water, electricity, and natural gas more and more each passing day. Then his daughters said, "Dad, you are so stingy!" Their father told his daughters, "This has nothing to do with stinginess, it's about protecting our present and our future." When it was time to go to bed that evening, Esra and Başak asked: "Can you drive us to school tomorrow?" Their father said, "What's happening tomorrow, are we going to stop by somewhere after school?" Then his daughters said, "No, we don't have any plans; we just want to go by car." When their father said, "No, why should we go by car when we can go by bus," his daughters said, "Dad, you say you're not stingy, but you're hyper stingy." At this, the father got a little angry and said, "Aren't you the one who complains about the pollution of our environment and air?" The next day, after returning from school, Başak said, "Dad, you aren't stingy." When she said that, her elder sister Esra and her father looked at her in surprise and asked what she meant. Başak said that they had covered the subject of "The Relationship Between Man and the Environment" in the science class at school that day and that she understood how much it matched her father's behavior.

References

Campbell, N.A. (1997). *Biologie*. Spektrum Akademischer Verlag. Berlin, Oxford.

Çevre ve Orman Bakanlığı (2008). Çevre El Kitabı. Ankara.

De Haan, G. (1989). Ökologie-Handbuch *Grundschule-Sieben Themen mit* über *100 praktischen Vorschlägen für den Unterricht.* Beltz Verlag. Weinheim und Basel.

De Haan, G., Jungk, D., Kutt, K., Michelsen, G., Nitschke, C., Schnurpel, U., & Seybold, H. (1997). Umweltbildung als Innovation. Springer Verlag. Berlin, Heidelberg.

De Haan, G., & Kuckartz, U. (1998):*Umweltbewusstseinsforschung und Umweltbildungsforschung:* stand, Trends, Ideen. In: G. de Haan, U. Kuckartz (Hrsg.): Umweltbildung und Umweltbewusstsein. Opladen

Diekmann, A., & Preisendörfer, P. (1992): "Persönliches UmweltverhaIten. Diskre-panzen zwischen Anspmch und Wirk-lichkeit". Kölner Zeitschrift (Ür Soziolo-J!ie und Sozialvsvcholo$lie, 44, 226-251.

Erten, S. (2000). Empirische Untersuchungen zu Bedingungen der Umwelterziehung -ein interkultureller Vergleich auf der Grundlage der Theorie des geplanten Verhaltens-. Tectum Verlag. Marburg.

Erten. S. (2002a). Kız ve Erkek Öğrencilerin Evde Enerji Tasarrufu Yapma Davranış Amaçlarının Plânlanmış Davranış Teorisi Yardımıyla Araştırılması. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, 22, 67-73. Ankara.

Erten, S. (2002b). Research on Environmentally Beneficial Behaviours in Primary School Students. V. National Science and Mathematics Education Congress. METU. Ankara

Erten, S. (2003). 5. sınıf öğrencilerinde" çöplerin azaltılması" bilincinin kazandırılmasına yönelik bir öğretim modeli. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 25*(25).

Erten, S. (2004). Çevre eğitimi ve çevre bilinci nedir, çevre eğitimi nasıl olmalıdır? Çevre ve İnsan Dergisi, 65/66.

Erten, S. (2005). Okul öncesi öğretmen adaylarında çevre dostu davranışların araştırılması. *Hacettepe Eğitim Fakültesi Dergisi, 28*(28).

Erten, S. (2007). Insights to ecocentric, anthropocentric and antipathetic attitudes towards environment in diverse cultures. *Eğitim Araştırmaları [Eurasian Journal of Educational Research], 33*, 141-156.

Erten, S. (2008). Insights to ecocentric, anthropocentric and antipathetic attitudes towards environment in diverse cultures. *Egitim Arastirmalari - Eurasian Journal of Educational Research. 33*, 141-156.

Erten. S. (2002). Kız ve Erkek Öğrencilerin Evde Enerji Tasarrufu Yapma Davranış Amaçlarının Plânlanmış Davranış Teorisi Yardımıyla Araştırılması. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi,* 22:67-73. Ankara.

Erten, S. (2012). Türk ve Azeri öğretmen adaylarında çevre bilinci. *Eğitim ve Bilim*, *37*(166), 88.

Erten, S. (2019). *"Sıfır Atık" Projesinin İlköğretim Fen Programlarına Uygulanabilirliği* International Conference on Science and Education (IConSE), October 26-29, 2019, Antalya/Turkey

Erten, S. (2020). *Fen ve teknoloji uygulamalarının çevreye etkileri. Teknoloji ve elektromanyetik dalgalar*. Güven Yıldırım, E. & Önder, A. N. (Ed.) *Senaryolarla desteklenmiş fen ve teknoloji uygulamaları*. Anı Yayıncılık.

Erten, S. (2019). Çevre ve çevre b*ilinci.* Aydoğdu, C. & Kıngır. S. (Ed.) *Fen* Öğretimi. Nobel Yayıncılık.

Frey, D., Stahlberg, D., & Gollwitzer, P.M. (1993): "Einstellung und Verhalten: Die Theorie des Überlegten Handelns und die Theorie des geplanten VerhaItens". In: Frey, D. & Irle M Hrsg.): The-orien der Sozial-psychologie.Bem u.a.

Gräsel, C. (1997): Problemorientiertes Lernen: Strategieanwendung und Gestaltungsmöglichkeiten. Hogrefe.

Kiziroğlu, İ. (2004). *Genel biyoloji, canlılar bilimi*. Okutman Yayıncılık.

Martens, T., & Rost, J. (1998). "Der Zusammenhang von wahrgenommener Bedrohung durch Umweltgefahren und der Ausbildung von Handlungsinten-tionen". *Zeitschrift für Experimentelle Psychologie, 45*, 4, 345-364

Sciama, Y. (2007). Klimaerwärmung: Es ist höchste Zeit. Research-eu, Magazin des Europoischen Forchungsraums. Nr.52. Europäische Kommission.

Yuzuak, A. V., & Erten, S. (2018). An evaluation of science teacher canditates' energy saving behaviour intention based on theory of planned behaviour. *International Journal of Environmental Education, 8*(2), 123-149.

Wortmann, K., Stahlberg, D., & Frey, D.(1988). Energiesparen. In: D. Frey; GB. CarI & D. Stahlbei", (Ursg.): *Angewandte Psvchologie,* 299-316. München/Weinheim.

Wotmann, K. (1994). *Psvchologische Determinanten des Energiesnarens.* Weinheim. web: https://bienal.iksv.org/tr/16-istanbul-bienali/yedinci-kita

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CHAPTER 2

Biodiversity, Wildlife and Endangered Plants and Animals

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Introduction

It is clear that the concept of biodiversity is formed by combining the terms biology and diversity. Considering the depth of concept, it may come to mind that it is a measure of the diversity of species. In this case, biodiversity can be defined as the diversity of life defined through the quantity of distinct species in a particular region. However, although this definition is correct, it is an incomplete definition. The deficiency stems from the complex and abstract nature of biology and life. Although there is some certainty that biology is the branch of science that studies life, there is no certainty about where life begins and ends. In this case, life and the diversity of living things need to be addressed from a broader perspective.

From what we know so far, apart from the blue planet Earth, there is no life anywhere else in space. Although it is said that there are candidate planets that are thought to be able to provide the living environment that the Earth provides for us, the investigations do not seem promising in terms of vitality or suitability for life. That is, what is necessary for life can only be met by the world. Living things can exist within the balance of life established in interaction with other living and non-living elements in the surrounding environment. The environmental conditions that affect life and the differences in genetic characteristics acquired through participation result in the diversity of living things.

Scientists' studies so far show that the world began to take shape 5.5 billion years ago. The available evidence indicates that life on earth began 1.5-2 billion years ago. It is understood that life began in a simple form and then evolved over the years into highly complex organisms. In this process, many living species have existed on earth. Most of these creatures could not keep up with the changing environmental conditions and disappeared. However, by adapting to the conditions, the surviving species continued their existence by diversifying. For example, the reptile class, which is represented in 4 ordos such as snakes, lizards, turtles and crocodiles today, was represented in 20 ordos in the Jurassic Period 200 million years ago. As reptile ordos that do not exist today disappeared, they pioneered the bird and mammal classes. Thus, the earth began to take its present shape about 1 million years ago, with the spread of dicotyledonous herbaceous plants and the dominance of mammals over vertebrate animal species. In other words, while some species disappeared due to natural reasons in the adventure of life, some species continued to live, while some species changed over the years and led to different species, while some species remained unchanged until today as fossil species. However, life has shown great variation and diversity since its inception (Brooker et al., 2020).

When life is considered theoretically, it appears as an abstract concept that is not easy to understand. Because it is seen as a very difficult situation to decide where the vitality begins in the vitality organization that exists in a living thing. It is said that the smallest building block of life in school learning is the cell. However, it is known that structures such as viruses, prions, and virions also gain vitality in a cell. Despite the passing of years, the viability of viruses is still a matter of debate. On the other hand, the viability of the molecules or organelles that make up the cell, known as the building blocks of life, is also a matter of debate. In fact, the idea that organelles such as mitochondria and chloroplasts originate from bacteria that enter the cellular structures, which are the ancestors of eukaryotic cells, through endocytosis further complicates the limit of life. In this context, biological diversity will be discussed as a concept and its importance will be emphasized. Then, threats to biodiversity, natural life and conservation of biodiversity will be discussed in this chapter.

Biodiversity

Biodiversity can be expressed as the vitality characteristics of living things in a living environment, their habitats and the abundance of ecological relations that occur in these habitats or the diversity of life. Biodiversity is found everywhere in the desert, mountain, ocean, garden, the inside of our hands, the bottom of our feet, etc. and means more than the diversity of species (Alonso, Dallmeier, Granek & Raven, 2001). Therefore, understanding biological diversity only as species diversity would be an incomplete definition in terms of the continuity, interactions and functions of species. There are three types of biodiversity that should be considered: genetic, species and ecosystem diversity (Erten, 2004).

Genetic Diversity

The diversity or inherited properties of genes present in a population is called the genetic diversity that that population has. Figure 1 shows ladybugs with different body colors. The diversity of body colors is due to the diversity seen in the body color genes of ladybugs. Ladybugs differ from each other not only in their body color. There are other distinctive features as well. These properties may include factors that strengthen the immune system, increase nutritional capacity, and facilitate survival. Of course, ladybugs with features that facilitate living conditions have a higher chance of surviving and multiplying. Thus, genes with superior characteristics spread to the population. However, when factors limiting genetic diversity arise, the population's capacity to adapt or survive in devastating conditions is curtailed (Biggs et al., 2007).

Figure 1. Ladybugs with Various Body Colors

Species Diversity

The quantity of various species that have been surviving at a specific habitat and the relative abundance of each species is called species diversity. Figure 2 shows a habitat inhabited by various species. The habitat photographed here has a high species diversity consisting of several species. There is a tremendous diversity of vertebrate species such as elephants, zebras and deer, as well as other animals such as birds, plants and invisible bacteria. However, the distribution of species diversity does not show homogeneity on earth. It is especially high in the equatorial regions and decreases towards the poles (Karabal, 2011).

Figure 2. A Habitat Rich in Species Diversity

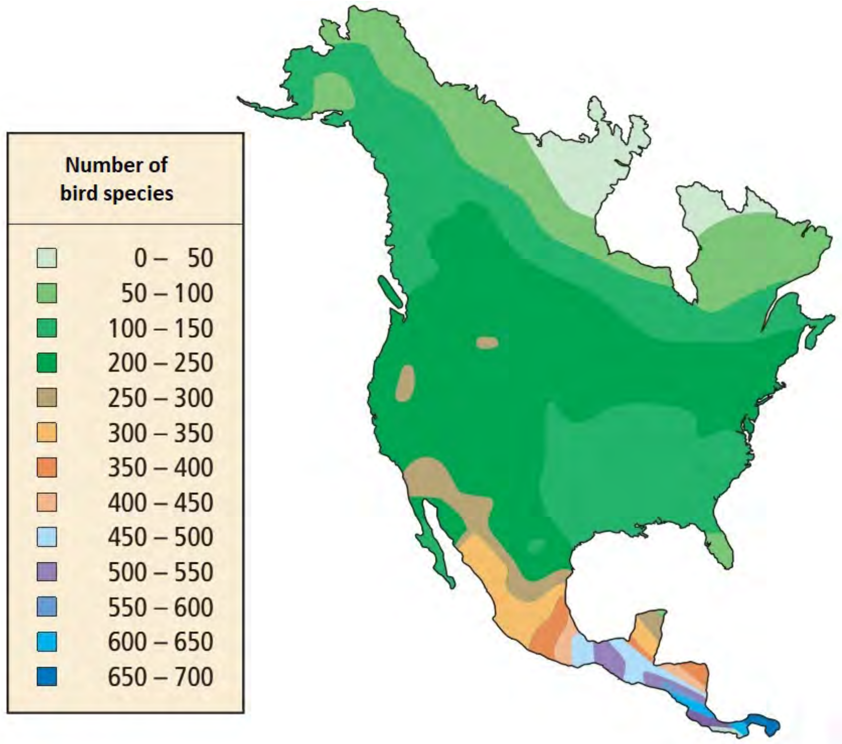

Figure 3. Bird Species Distribution in North and Central America

Ecosystem Diversity

The layer of the earth where living things live is called the biosphere. In the biosphere, there are ecological units called ecosystems, which consist of living and non-living elements that form a self-sufficient system with the living things it contains. The amount of ecosystem in a particular region is called **ecosystem diversity**. In the ecosystem, the emphasis is on living things and the inanimate environment with which they interact. For instance, Anatolia as an ecosystem includes different characteristics that make it possible for the Anatolian leopard, shown in Figure 4, to survive. All ecosystems in the world have features that make it possible for various organism communities to survive (Bulut, 2019).

Figure 4. Anatolian Leopard Living in a Certain Ecosystem.

Importance of Biodiversity

Many people, countries, organizations and institutions strive to conserve existing biodiversity and leave a rich biodiversity to the upcoming generations. There are also economic, ecological, aesthetic and cultural reasons for preserving biodiversity.

Economic Value

Nature meets human needs. In other words, some living things in nature are consumed by humans. Consumable species are traded and a price can be drawn. Valuable species are man-made or protected to avoid extinction. However, species that do not have direct commercial value should also be protected. Because the ecosystem is a whole. Living things interact with each other. A tobacco extinction that is neglected because it has no commercial value will also negatively affect species with commercial value. This negativity should be addressed in a broad framework, from the decrease in yield to the extinction of the commercial species. In addition, species that do not have economic value because they remain in the wild can function as gene banks for their close relatives. Genes of wild species can gain functionality in overcoming the problems that may be encountered in the future. For example, corn seeds are sold to farmers every year and produced by growing them. The genomes of the seeds prepared by genetic engineering are programmed to obtain the highest yield. However, most of the time, the reproduction of plants growing from these seeds has been restricted or produced as clones. In other words, an emerging disease will be effective in all plants. However, *Teosinte sterilene*, a relative of the modernized maize plant, grows in the wild and has high virus resistance (Figure 5). Plant pathologists have developed maize varieties resistant to viral diseases using these wild species (Starr et al., 2018).

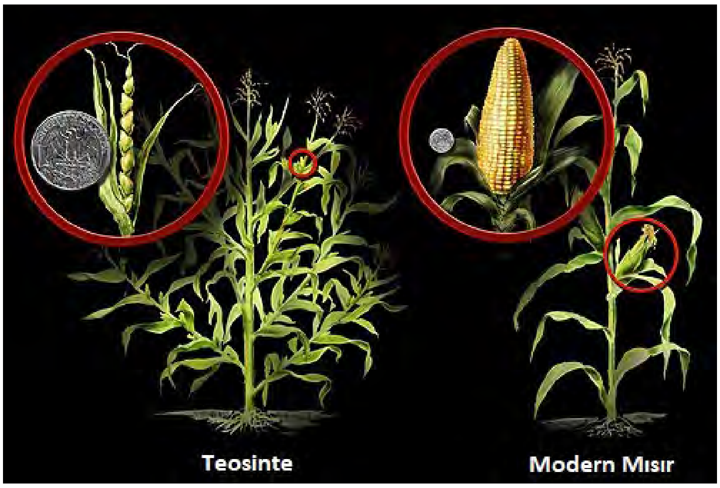

Figure 5. Teosinte and Modern Maize Plants

In addition, biologists are becoming more and more aware of how to pass on the genes that drives hereditary traits among the members of species. Today, scientists can determine the characteristics of a living thing, identify the gene region responsible for the relevant feature, and transfer these genes to another living thing and make it work. Characterization, duplication and transfer of genes is the subject of genetic engineering. Genetic engineering has produced crops which have strength against insect damage, advantages to cope with diseases and extra quality in terms of nutrient capacity. Despite all this progress, most wild plant and animal species haven't determined in terms of genetical diversity. If wild species go extinct, the opportunity to exploit the genes that they have will be lost. Therefore, even species that are currently considered to be of no economic value must be protected as they may gain importance for economic or research purposes in the future (Dilbirliği, 2007).

Although it can be produced under laboratory conditions today, the source of the drugs we use is other living things and nature. For example, penicillin, a powerful antibiotic, was obtained from a bread mold. The substance, salicin, obtained from the willow tree, was used as a pain reliever. A version of this drug, known today as aspirin, is synthesized in laboratories. On the other hand, the leaves of the propeller flower plant have been used to obtain an extract that increases the survival chances of patients with leukemia by five times (Figure 6). Scientists continue to find solutions to diseases by making use of plants and other organisms that can be used because of their properties (Raven et al., 2019).

Figure 6. Propeller Flower Plant used in the Treatment of Leukemia

Ecological Value

In a balanced and healthy ecosystem, activities such as energy flow, matter cycle, and food chain take place depending on biological diversity. The uptake and return of energy and nutrients, in other words, the provision of energy and nutrient cycles, occur with the presence of biological diversity. Considering the requirements such as the amount of oxygen, nitrogen, carbon dioxide and water in the living environments of living things and the effect of these elements on environmental cleanliness, the importance of biological diversity will be understood. The greater the biodiversity enable the greater the contribution to environmental cleanliness. Clean air, clean water and clean soil are the basic requirement and basic result of biodiversity. While saprophytes decompose waste materials, green plants use carbon dioxide in the air to create the oxygen necessary for living things and prevent global warming because they hold atmospheric carbon (Kurumlu, 2008).

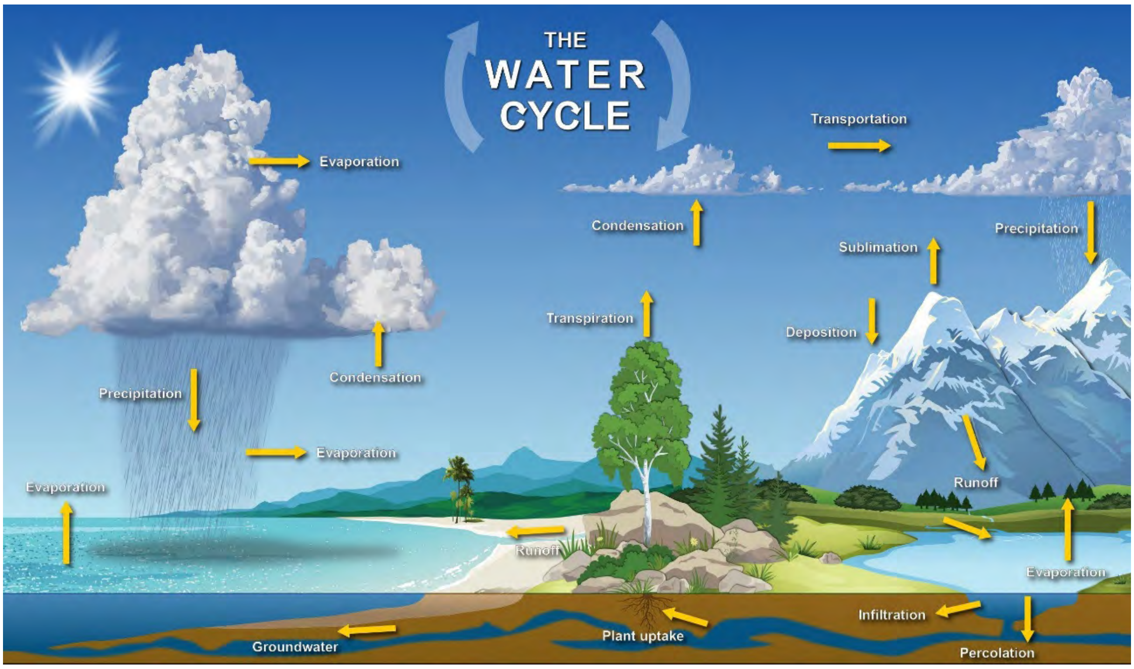

Figure 7. Water Cycle

In addition to these, the presence of various filtering creatures in the waters ensures that the water resources are clean, from the rivers to the oceans. In addition, trees clean the air by absorbing greenhouse gases. One of the most striking importance of biological diversity on ecosystem is that it protects the physical environment from environmental disasters such as floods and erosion. Soils that are moist or wet are difficult to be dragged by external forces, so the probability of erosion in an area with plenty of forest will be very low, as forests keep the soils moist. The biodiversity of trees in a forest is highly effective on the matter cycle and food chain in that ecosystem. Microorganisms feed on fallen tree leaves. As a result of this feeding, called decay or decomposition, the leaves turn into humus and mix with the soil. Plants grown in humus-rich soils can take up plenty of minerals from the soil. In addition, the water holding capacity of humus soils is higher than other soils. Similarly, some plant species fix the free nitrogen in the air through the bacteria that settle in the tubers in their roots and contribute to the nitrogen cycle of the ecosystem. As can be understood from all these examples, biological diversity is the basic element of ecological functions that ensure the continuation of life (Çepel, 1997).

Aesthetic and Cultural Value

The interaction of human beings with the environment they live in is not limited to the exchange of matter and energy. The environment we live in also has an impact on the human mind and thoughts. People are often positively affected by the beauties of a healthy ecosystem (Figure 8). When people encounter a deserted or barren landscape, they have different emotions. Aesthetics, which emerged as a result of the diversity and harmony of living things, has undoubtedly reflected on human thoughts and works over time. Lines, motifs and structures inspired by nature have become a part of human life and are engraved on the basic building blocks of human culture (Karabal, 2011).

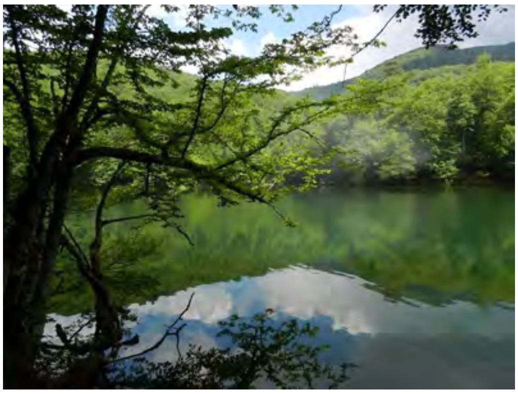

Figure 8. A View from Büyükgöl in Yedigöller Region

Threats to Biodiversity

Living things continue their lives on earth under the influence of many factors. The composition of the factors affecting living things determines the environmental conditions. Environmental conditions can make certain living species advantageous over others. The same conditions can have limiting or destroying effects on other living things. The environmental conditions prevailing on earth are not static. Moreover, environmental conditions are not the same for all parts of the earth. Furthermore, environmental conditions show great changes in geological time periods and threaten the life of certain living species.

Mass Extinctions

Extinction, like speciation, is a natural process. Species constantly appear and disappear. Based on a variety of evidence, scientists estimate that %99 of all ever-lived species are now extinct. Extinctions took place in some periods in a way that affected a large part of the organisms on earth. Large extinction rate increases experienced in the history of life are defined as mass extinctions (Solomon et al., 2019).

There have been five major mass extinctions estimated to have been completed in the last 500 million years. These major mass extinctions also mark the boundaries of geological time periods (Figure 9). The mass extinction at the end of the Cretaceous period was most likely caused by an asteroid impact. The largest mass extinction in terms of extinct species occurred at the end of the Permian. The mass extinction at the end of the Permian occurred after increased volcanic activity in what is now Siberia released large amounts of carbon into the atmosphere. Thus, the warming in the oceans is thought to cause the release of methane gas (natural gas) from the frozen sediments in the depths of the ocean. As a result, the oceans were deprived of oxygen, and methane sprayed to the air caused explosive fires on land. (Mader & Windelspecht, 2017).

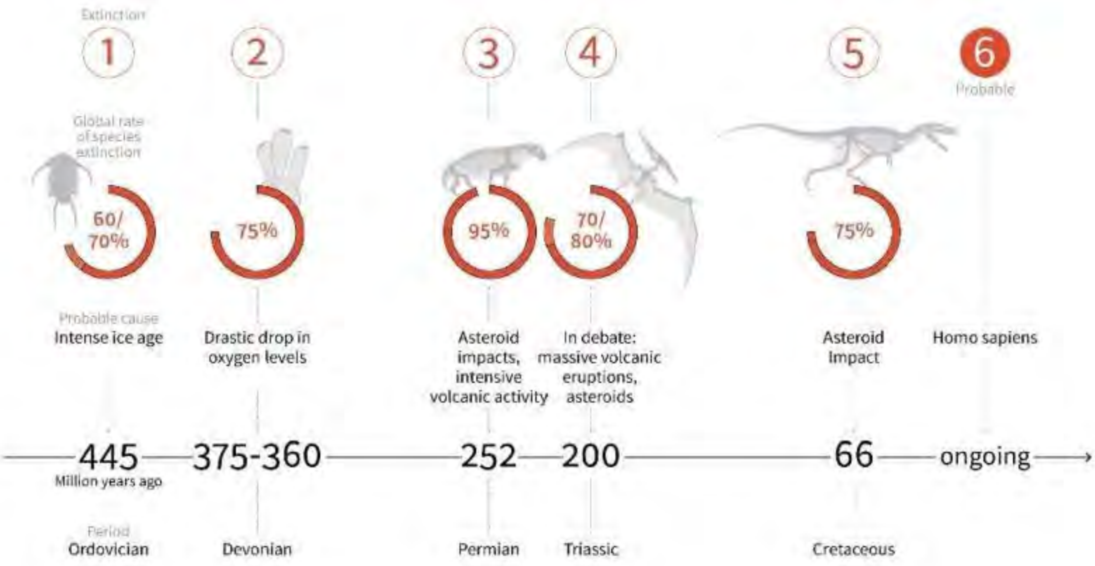

Figure 9. Massive Extinctions

Mass extinctions affect all living species. However, living species differ according to the periods in which they appear on the earth's scene, their tendency to diversify or create new species, and the duration of their resistance to environmental conditions. When the measure of success for any living species is considered as the number of species, it is seen that not all living species are equally successful. Figure 10 shows how the number of species in some main living groups has changed over time. With the diversification of angiosperm plants towards the end of the Mesozoic, the number of species diversity in the gymnosperm groups decreased or disappeared (Biggs et al., 2007).

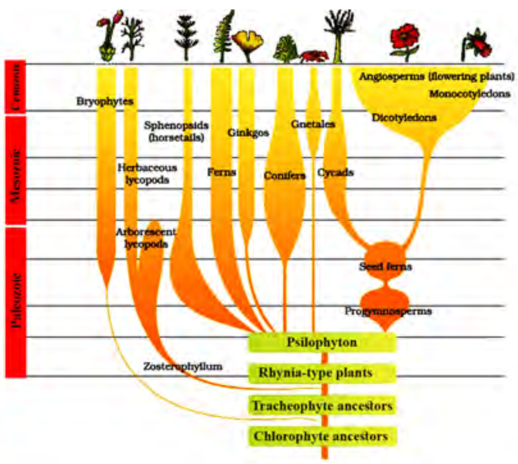

Figure 10. Variation of Plant Species Diversity over Geological Times (URL6, 2021).

Sixth Major Mass Extinction

Some data obtained by scientists indicate that a mass extinction has now begun and is continuing at an accelerating rate. The current extinction rate is estimated to be 100 to 1,000 times greater than the extinction rate that should have been in normal times. The rate of extinction in the time period we live in is at the same level as the five major mass extinctions in the past. But unlike previous extinctions, the current extinction is not the inevitable result of a physical disaster such as an explosion or an asteroid impact. Humans are the driving force behind the current increase in extinction rate, and human actions are determinants of this extinction (Brooker et al., 2020).

Indirect evidence points to the decline in biodiversity experienced by humans entering the habitats of living things. For example, the arrival of people in Australia about forty thousand years ago encountered with the onset of the extinction of the continent's largest marsupials, birds and lizards. In North America, the arrival of humans about 15,000 years ago was followed by the extinction of large herbivores such as camels, giant ground sloths, mammoths, and mastodons (relatives to elephants). Carnivores such as lions and saber-toothed cats have also disappeared (Raven et al., 2019).

According to one of the respected hypotheses, humans preyed on herbivorous species such as mammoths, directly causing their decline. The decline in mammoth numbers has led to the extinction of other predatory species that preyed on them. Evidence that humans hunted such creatures supports the hypothesis. For example, a spearhead was found embedded in the rib of a 13,800-year-old mastodon fossil. However, not all researchers are convinced that hunting was the sole or most important factor in the extinction of such creatures. The death of these animals can also be attributed to climate change, a meteorite impact, or the effects of human-made pathogens. Continuous examination of areas dated to the time of extinction will help clarify the relative importance of these factors (Bulut, 2020).

Perhaps more recent extinctions are more clearly attributable to humans. For example, in the 1600s, Dutch sailors came to the island of Mauritius in the Indian Ocean, where the dodo, a flightless bird, is abundant. About 80 years after the arrival of the sailors, the dodo birds became extinct. It is a real case that sailors ate Dodo birds. However, the destruction of nests and habitats by rats, cats and pigs brought in by sailors is likely to have a greater impact on this extinction (Solomon et al., 2019).

Figure 11. Dodo Bird Model

Current Biodiversity and Threats

The number of existing species currently existing on earth is not known exactly. Estimates of the number of living species suggest it could be between 5 million and 50 million. About 2 million of the species that dominate the earth have been named and classified. In other words, it was discovered and examined by scientists and accepted as a species, believing that it met the criteria of being a species. Simply, it is not yet known how much biodiversity the earth actually has. However, scientists working especially in areas related to the classification of living things are in a race to discover new living species and to reveal the diversity of life in the world. However, naming a living thing does not mean that it has been extensively studied or known with all its characteristics (Brooker et al., 2020).

There are also scientists who work on determining which species will become extinct if the existing biodiversity is not preserved. A species that is currently at a high risk of extinction in the nature is called an endangered species. Species that are supposed to become extinct in the near future are called threatened species. All rare species are threatened. Some species have always been rare. If there has been a decrease of more than 50 percent in the number of species belonging to a species in the last ten years, or if the probability of extinction of a species in the wild is more than 20 percent in the last 20 years, that species is recorded as an endangered species (Bulut, 2020). The statistics on the number of threatened species are presented in Table 1

Table 1. List of Globally Threatened Species

	Number of Classified Species	Number of Species Evaluated for Threat	Number of Species under Threat
Vertebrates			
Mammals	5.416	4.863	1.094
Birds	9.956	9.956	1.217
Reptiles	8.420	1.385	422
Amphibians	6.199	5.915	1.808
Fishes	30.000	3.119	1.201
Invertebrates			
Insects	959.000	1.255	623
Mollusks	81.000	2.212	978
Crustaceans	40.000	553	460
Corals	2.175	13	5
Other	130.200	83	42
Plants			
Algae	15.000	92	79
Ferns	13.025	211	139
Open-seeded	980	909	321
Angiosperm	258.650	10.771	7.899
Protists			
Green algae	3.715	2	0

Red algae	5.956	58	9
Brown algae	2.849	15	6
Fungi			
Lichens	10.000	2	2
Mushrooms	16.000	1	1

Factors Threatening Biological Diversity

It has been addressed that the increasing extinction ratio today is different from mass extinctions in the past. The current high extinction rate is due to human activities. There has been a tremendous decrease in the number of species living on earth in the extinctions that have occurred so far. After the extinction events, the remaining species started to diversify again and a new balance was established. However, unlike the last balance established after the last mass extinction about 66 million years ago, it is thought that the process of establishing a balance after the extinction will be different this time. Because the human factor causes the conditions in nature to change at a rate that the adaptation capacity of living things cannot reach. This change makes it necessary to discuss the factors that threaten biological diversity (Çakır, 2019).

Overexploitation

Nature embraces human beings with all its generosity, meets their needs and becomes a home for them. On the other hand, people consume what is offered to them and often think only of their own needs. However, life; The order in nature is knitted with many events that are interrelated and keep each other in balance. Excessive consumption of species with commercial value is at the forefront of human-induced events. Excessive consumption or use can cause extinction of the species. For instance, 27 species of sturgeon are represented, with a wide distribution in Europe, Asia and North America (Figure 12). There are 5 species in the Black Sea waters of our country. Sturgeon is hunted and consumed because of its quality caviar and meat. In addition, the spawning grounds of the sturgeon, which prefer rivers to lay their eggs, have been destroyed due to the stone processing facilities and dams built on the river, and have become one of the endangered species. Similarly, the white rhino is one of the five rhino species in danger of extinction. White rhinos are hunted for their horns. Historically, overuse has been the predominant reason for extinction (Biggs et al., 2007).

Figure 12. Overused Species: a. Sturgeon (Ustaoğlu Tiril, 2021) b. White Rhino

Habitat loss

If the living house or environment does not meet the needs, one either move from there or continue to stay and condemned to inadequacies until death. Habitats are the homes of living things. The habitat in which a species lives can be degraded as a result of natural processes or by human hands. Humans are destroying or degrading habitats for the purpose of urbanization or opening up more agricultural areas (Raven et al., 2019).

Destruction of habitat

Habitats, which are the home of living things, are eliminated for reasons such as creating settlements or making room for agricultural land. There are some habitats which are considered to be very important for the biodiversity. One of these places are tropical rainforests. Tropical forests contain most of biodiversity found on the earth. To put it in numbers, rainforests host more than half of the world's biodiversity.In fact, estimates show that more than half of all species in the world live in tropical rainforests. The elimination of a large part of a natural forest of great importance will lead to the extinction of many species on earth due to habitat loss (Karabal, 2011).

Habitat degradation

The conditions prevailing in the habitats that host various species are built on very fine balances. Sometimes the habitat's conditions protect the habitat from extinction, but can upset the balance in the habitat. The destruction of habitat, but the deterioration of its balance, is called habitat degradation. degradation can occur in a number of factors that the habitat has and affects living species. Let us suppose that in an aquatic ecosystem, as shown in Figure 13, there is a decrease in fish population due to hunting. In this case, the herons and elephant seal populations that feed on fish will decrease due to famine-related reasons. In addition, there will be an undesirable increase in the populations of plankton and crustaceans consumed by the fish. These creatures, which have an important role in the balance of the habitat, are called keystone species. These species can create a chain effect that leads to a disruption of the balance (Bulut, 2019).

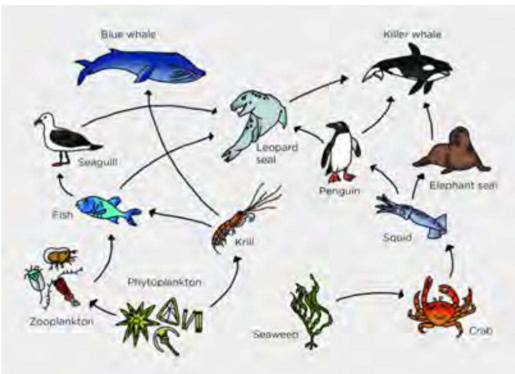

Figure 13. Food Web and Keystone Species in a Habitat

Habitat fragmentation

Habitats are ecosystem units with their own specific conditions. Habitat conditions allow some species to live, while not allowing or limiting the survival of some species. Features such as habitat size, opportunities provided by the habitat, and climate have a direct impact on biodiversity. Habitats are also not fixed ecological units. Their conditions may vary. Even a habitat can be divided into smaller parts for various reasons. This phenomenon is called habitat fragmentation (Starr, Taggart & Evers, 2018). Newly formed habitat fragments limit living things because organisms prefer to stay inside habitat pieces. Habitat fragmentation causes various problems with life. First, a smaller habitat will have less biodiversity. Because changing habitat sizes will cause some living species to stay in other habitat parts or not be able to adapt to newly formed conditions. In addition, habitat fragmentation reduces an individual's chances of reproduction. A smaller piece of habitat will have limited breeding options. This will mean a narrowing of genetic diversity. Decreased genetic diversity will make the population more susceptible to disease and disaster. Adaptation abilities of living things will be limited. Finally, the edge effect will be felt more in smaller habitat fragments. Conditions at the edges of a habitat are not the same as conditions inside. External factors are more effective at the margins (Figure 14).

Figure 14. A Terrain with Habitat Fragmentation

Pollution

The presence of a certain substance in an undesirable environment is called pollution. The substance in an undesirable environment is called a pollutant. pollutants can interact with the components in the environment they enter and cause undesirable changes in the environment. If it is considered for biological systems, pollutants are effective on air, soil and water environments. Pollutants, on the other hand, can show a wide variety of properties and cause devastating changes in biological environments for living things.

Most pollutants do not occur naturally. It can occur intentionally or unintentionally as a result of human activities. For example, pesticides are the leading chemicals used to reduce the effects of agricultural pests. Pesticide is applied to the land to be protected. The pesticide exerts its toxic effect on the target organism. The pesticide taken into the body by the target organism is normally processed and excreted as a result of metabolic activities. However, it has been determined that some pesticides accumulate in the soil and are taken into the body by other living things other than the target organisms. Since the pesticides taken into the body cannot be excreted, they accumulate in the tissues. With the consumption of organisms with pesticide accumulation in their tissues, an increasing amount of substance will be encountered as the upper trophic level in the food chain is reached. The increase in the concentration of a substance as the upper trophic steps in the food pyramid are climbed is called **biological magnification**. For example, a pesticide such as DDT (dichloro-diphenyltrichloroethane) was used extensively in agricultural lands for a period of time. DDT, which is a highly effective pesticide, has accumulated in living tissues as well as the desired effects. Figure 15 shows the accumulation of DDT concentration in the food chain and its increase towards upper trophic levels in an ecosystem. The use of DDT pesticides is prohibited when its harmful effects occur (Solomon et al., 2019).

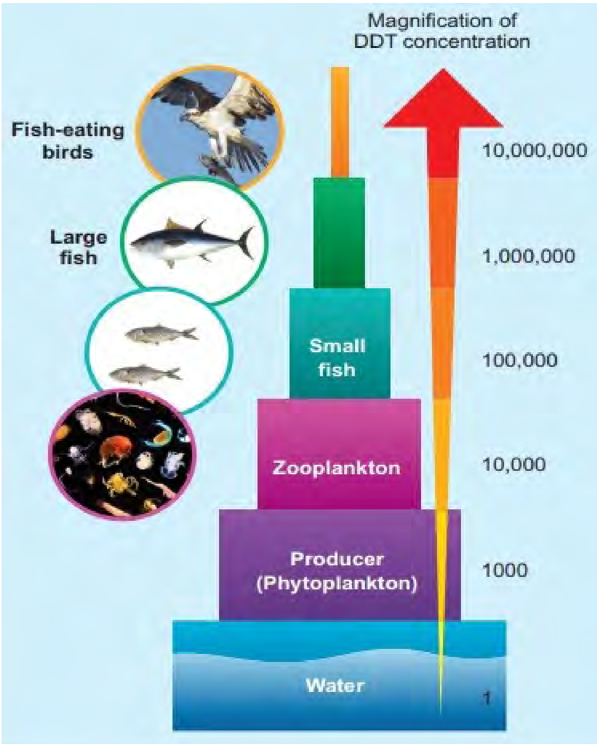

Figure 15. Increased DDT Concentration in the Food Chain with Biological Growth

Acid rain

A large amount of sulfur dioxide is released by the combustion of fossil fuels such as coal. Similarly, fuels used in vehicles are of fossil origin and when they are burned, nitrous oxide is released into the air. These substances react with water and some compounds in the atmosphere to form nitric and sulfuric acids. Acid rain is the precipitation of acidic compounds formed in the atmosphere as a result of the compounds released into the air by the burning of sulfurous and nitrogenous fuels. Acid rain is actually effective on all surfaces. It has a corrosive effect on monuments and statues made of metal. More importantly, by affecting the soil, it destroys the nutritive compounds for plants, destroys plant tissues and slows down plant growth (Figure 16). Acid rains also disrupt the acid balance in the waters and cause mass death in rivers or lakes (Brooker et al., 2020).

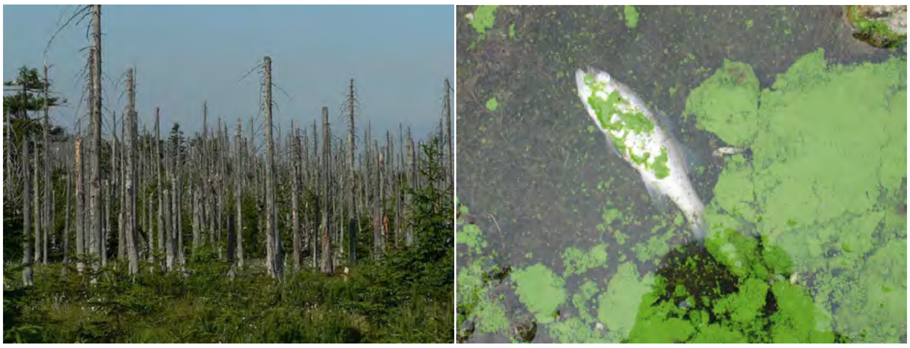

Figure 16. The Effect of Pollution on Living Things

Eutrophication

Contrary to popular belief, most of the oxygen in the biosphere is released by algae, not plants. Algae are organisms that have a high rate of photosynthesis. When suitable conditions are created, they consume a very high amount of oxygen, perform photosynthesis and release carbon dioxide. Mixing of manure, sewage or other chemicals rich in nitrogen and phosphorus into streams encourages algae growth. During development, algae deplete the underwater environment in terms of oxygen. In addition, the processes of death and decay of algae reduce the oxygen rate. In this case, other underwater creatures die by drowning (Figure 16). In some cases, algae even release toxins that limit the aquatic habitat for other creatures. This phenomenon, characterized by algae covering the aquatic habitat and overgrowth, is called eutrophication (Brooker et al., 2020).

Introduced (exotic) species

Certain biotic and abiotic factors prevail in every environment. Living things develop and reproduce when conditions are suitable for them. Thus, species living in a unique balance in each habitat develop over the years. Introduced species are non-native species that come from outside to any habitat. In fact, the introduced species is harmless in its habitat. Because the balances in its own habitat are enough to keep the species in balance within certain limits. But since it has no predator in a new habitat, it invades the habitat by multiplying disturbingly by other creatures. The increase in temperature due to global warming causes fish species, whose natural environment is the Red Sea and the Indian

Ocean, to spread to the warming Mediterranean waters. For example, the lionfish from Mediterranean waters, which is not a predator, consumed the young of other fish as food and became an important introduced species of the region (Figure 17). Since introduced species cause extinction of species in the habitats they dominate, they are at the top of the world's ecology agenda. Countries take various measures to limit introduced species. For example, in recent years, a monetary reward has been introduced to encourage the fishing of pufferfish, whose population has been increasing in the eastern Mediterranean in recent years. However, such measures are not among the measures aimed at eliminating the source of the problem (Mader & Windelspecht, 2017).

Figure 17. Introduced Lionfish

Conservation of Natural Life and Biodiversity

Natural is a term used to express the phenomena that occur as a result of processes occurring in nature without human touch. Natural life, on the other hand, is used to express that an ecosystem is in balance, that the balance has developed as a result of natural processes, and that people live carefully and respectfully to this balance. It can be easily predicted that living things will live in environments where natural life exists, increasing their numbers and diversity. Therefore, natural life and biodiversity must be protected (Stoltze & Schraer, 1987).

Natural Resources

No matter how far humanity moves away from nature, no matter how much the influence of man on nature increases, no matter how far the world civilization level goes, the existence of human beings depends on the existence of nature from the first day of its existence. However, many resources of nature, which are used for free, now give the signals of extinction. For a sustainable life, the possibilities and benefits of nature should be considered within the economy and give the necessary value to nature. However, the increase in the world population day by day has caused our environment to become more polluted and the consumption of natural resources to increase day by day. Despite the increase in the human population, the earth still has enough natural resources and production for all living things. However, there is injustice in the distribution of production and natural resources. As seen in Figure 18, North American and European countries lead the world in energy consumption. Developed and developing countries take a large part of the production. Underdeveloped countries, on the other hand, spend their natural resources rudely in order to increase their welfare. However, the use of natural resources necessitates a plan that takes care of the rights of all living things (Gould, Keeton & Gould, 1996).

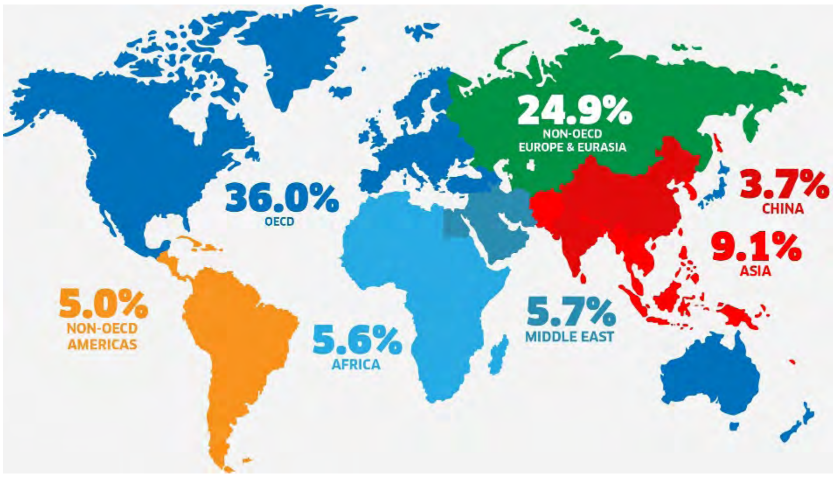

Figure 18. Distribution of world energy consumption by regions

Renewable resources

Long term management of natural resources should be made taking into account the difference between the two natural resource groups – renewable and non-renewable resources. Resources that are renewed by nature at a faster rate than they are consumed are called renewable resources. Solar energy is renewable because its source is endless. Clean air and water can also be renewed at a faster rate than they are consumed. Unfortunately, the resources found in nature stand in a fine balance established under the influence of various factors and are never infinite. If consumption exceeds its regenerative capacity, resources are depleted (Karabal, 2011).

Non-renewable resources

Resources that are in a limited number in nature or that require a long process to renew nature are called non-renewable resources. It is difficult to renew the underground richness that took years to form. For example, it is known that the hard coal resources that exist today were formed as a result of the carbonization of the vegetation covering the earth during the Paleozoic era, 500-600 million years ago. It is believed that a substance called pristane with a high carbon content, whose formation is estimated to have started in this period, is also effective in the formation of petroleum. The grouping of a resource according to its renewal status differs depending on the context considered. A living species has a chance to reproduce and regenerate until its last members are destroyed. In this context, living species are renewable resources. However, when the last member of the species disappears, it becomes non-renewable. For example, in a forest ecosystem, living things live together in interaction with each other. However, when trees are cut down and forests are destroyed, their habitats are destroyed for many living things. Only species native to a particular forest area can be destroyed by clearing that forest habitat (Bulut, 2019).

Figure 19. Use of natural sources a. A destroyed forest b. A crop field

Sustainable use

By ignoring other living things, man uses all the richness of the earth for his own benefit, comfort and even to prevail in the struggle for supremacy. Despite the negative behavior of man, nature has always found a way to repair itself and continue to live. **Sustainable use** is the consumption of natural resources in accordance with nature's self-renewal rate by keeping up with the rhythm of nature (Figure 19b). Sustainable use requires taking responsibility for issues such as the responsible use of resources, recycling and nature protection (Goodenough & McGuire, 2014).

Conservation of Biodiverse Areas

As can be seen, human activities deeply affect many ecosystems. Many efforts are being made around the world to support the natural life and increase the survival opportunities of living things.

Protected areas

Scientists draw attention to the importance of creating protected areas that can contribute to biological diversity. In this direction, natural areas have been determined and taken under protection by giving various statuses. These areas are called National Parks, Nature Protection Areas, Natural Monuments, Nature Parks, Wildlife Protection Areas, Wildlife

Development Areas, Conservation Forests, Gene Conservation Forests, Seed Stands, In-Forest Resting Areas, Fisheries Production Areas and Protected Areas. In addition, in recent years, countries have established seed banks to preserve their genetic diversity. While the seeds are disappearing due to natural reasons, on the other hand, they are in extinction due to the alienation from organic farming practices. Establishment of seed reserves to be used when necessary is important in terms of preventing species loss (Dilbirliği, 2007).

Hotspots for biodiversity

Every living thing tends to live in an environment where it can develop and reproduce best. Various conditions in different parts of the earth increase the chance of survival of certain species in those regions, while limiting the chances of survival of some species. In fact, some living species only live in a certain region of the earth where conditions are suitable for them. Species that live only in a certain geographical region on earth are called endemic species. Some other species may show a wider spread on the earth or may live in various geographical regions on earth. Considering that the geographical regions and the widths of the habitats are not equal, it is understood that the biological diversity on earth does not show a homogeneous distribution. Some regions may be rich in biodiversity, while others may remain poor. Areas on Earth that are rich in endemic species and are facing significant habitat loss are called **hotspots**. Some scientists argue that the protection and rescue of hotspots where biodiversity is seen at the highest level should be emphasized by considering that the intervention possibilities are limited. On the other hand, some of the scientists disagree on the grounds that concentrating funds for species conservation in hotspots does not solve serious problems occurring elsewhere. These scientists are of the opinion that funds are better be used in various parts of the globe without focusing on biodiversity hotspots (Solomon et al., 2019).

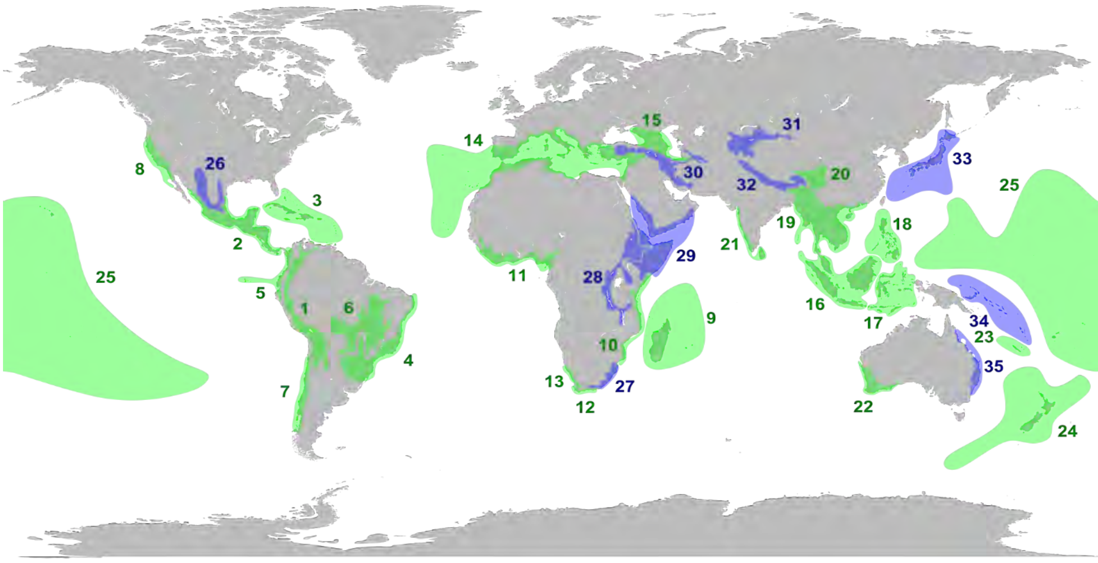

Figure 20. Biodiversity Hotspots

Corridors between habitat fragments

Environmental scientists say that they will contribute to the protection of biological diversity by constructing corridors or passages between areas that have been separated from each other and turned into separate habitat parts (Figure 21). Corridors enable habitants to move safely from one part to another. A larger habitat is obtained by the formation of passages between the habitat fragments. A wider habitat means greater genetic diversity. However, the creation of passages also brings some risks for the habitat. For example, disease seen in one part of the habitat may spread to other parts. In addition, the multi-segmented but single structure of the habitat is an edge effect-enhancing factor. The edge effect increase has a negative effect on the health of the habitat (Reece et al., 2014).

Figure 21. A Corridor Connecting Parts of the Habitat

Regeneration of Ecosystems

It is the biotic and abiotic factors that keep an ecosystem alive. When species diversity in the ecosystem is damaged, these factors are also degraded. For example, the use of land taken from cleared forests in agricultural lands results in low yields. Abandoned lands cannot be used for agricultural purposes after mineral exploration and extraction processes. Living things lose their lives and habitats as a result of detergents, toxins and petroleum products polluting natural habitats. However, habitats can renew themselves after a while even after the harmful effect disappears (Figure 22). The renewal period does not change depending on whether the harmful effect is related to natural or human factors. The type of harmful factor and the size of the habitat in which it is effective determine the renewal period. Of course, the longer the renewal period should be expected for the larger the affected habitat. Environmental scientists developed some methods called bioremediation and biological augmentation to accelerate the recovery process in the damaged habitats (Starr, Taggart & Evers, 2018).

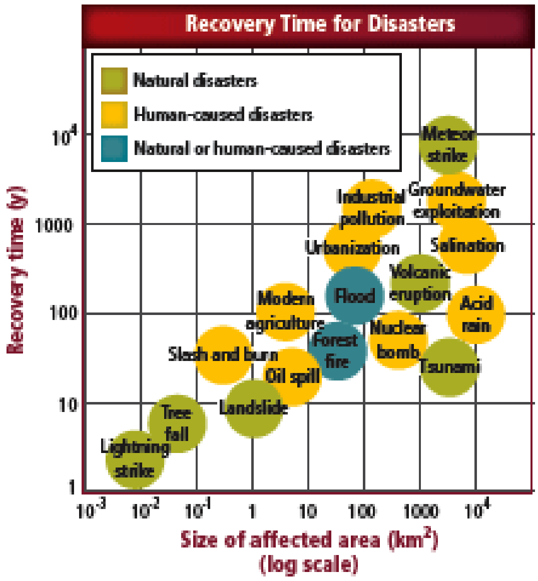

Figure 22. Recovery Time After a Disaster

Biological recovery

Biological remediation is the use of living organisms in clearing contaminated habitat. Fossil fuels such as petroleum may be released into the environment as a result of leakages that occur during the extraction, transportation, processing and storage (Figure 23a). The size of the leaked amount can sometimes reach a level that can be considered a natural disaster. While oil covers aquatic ecosystems, preventing light and gas ingress, it can also mix with the soil at the bottom, contaminating the underground table and groundwater. Among the many microorganisms naturally found underground, some have the ability to decompose this oil into carbon dioxide. Through inclusion of microorganisms and beneficial substances, scientists have succeeded in increasing the ratio of clean the habitat and have made a breakthrough that will greatly reduce pollution in the oil spill area within a few years (Mason et al., 2017).

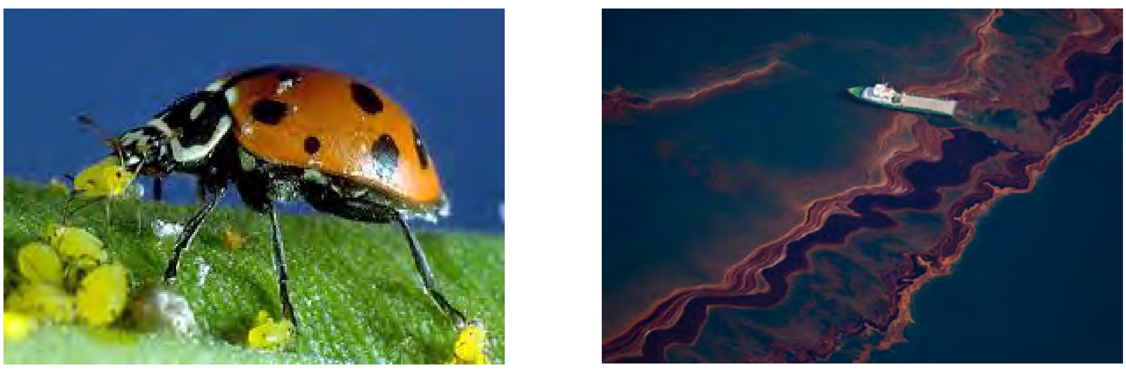

Figure 23. Bioremediation Samples: a. Oil Spill b. Aphid-Eating Ladybug

Some plants tend to accumulate toxins such as heavy metals in their tissues. The accumulating plants are useful for the removal of toxins from unhealthy habitats. As plants grow and develop naturally in unhealthy habitats, they continue to accumulate toxic substances in the soil in their tissues. By harvesting plants of a certain size, toxic substances are completely removed from the soil. Biological remediation is a relatively new practice. However, it shows great promise in transforming damaged ecosystems into healthy ecosystems (Biggs et al., 2007).

Biological Augmentation

Each ecosystem has its own nutrient chain. In this chain, each species has its own role known as ecological niche. Some of them can be producers and some are consumers. Some consumers consume producers and some consume other consumers. Most of the consuming consumers are predators. In healthy ecosystem production and consumption rates are in balance. But somehow some species can break this chain. In these cases, scientist find a way to make the ecosystem healthy again through placing predator of chain breaker species. This placement is called biological augmentation. For example, aphids, settle on the leaves and young shoots of plants and eat them. It is an undesirable situation especially on vegetables, fruits and other plant species with commercial value. If it is not intervened in time, it may cause plant loss as well as reducing the quality of the product. Aphids can also transfer diseases from a plant to another. The natural predators of aphids are ladybugs. So, aphids' population can be taken under control through ladybugs (Figure 23b). Also, ladybugs do not reduce product quality.and aphids are removed from the fields (Brooker et al., 2020).

Conventions Concerning the Conservation of Natural Life and Biodiversity

The balance of natural life can be disturbed for various reasons, especially the desire of people to dominate nature and to spend resources only for their own comfort. Natural life is under threat all over the world due to reasons such as climate change, nuclear energy, genetically modified organisms, urbanization or urbanization that we have heard frequently in recent years. The local use of carbon-based fossil fuels in various parts of the world has caused the temperature to increase by several degrees all over the world, and the species that have established a very tight life balance with each other have been affected or destroyed. While the emerging life problem is affecting the whole world, its solution is sought locally. For example, in order to reduce the use of fossil fuels that cause global warming, it is necessary to raise awareness of people and mobilize thoughts. It is also clear that the protection of natural life and biological diversity in a particular region cannot be left solely to the efforts of human groups living in that region or interested in solving the problem. For this reason, international conventions have been accepted for the conservation of natural life and biodiversity (Bulut, 2019). The agreements made for the protection of biological diversity, their responsible institutions, their years, and contents are presented in Table 1.

Table 2. Conventions for Conservation of Natural Life and Biodiversity

Convention	Responsible Institutions	Year	Content
Convention on Biological Diversity	United Nations Environment Program	1992	Conservation of biodiversity
Cartegana Biosafety Protocol	United Nations	2000	Use of genetically modified organisms
CITES	United Nations Environment Program	1973	Control of international trade in endangered species
Barcelona Convention	United Nations Environment Program	1976	Protection of the marine environment and coasts of the Mediterranean
Framework Convention on Climate Change (UNFCC)	United Nations	1994	Protecting the world's climate system
Convention to Combat Desertification	United Nations	1994	Preventing desertification in arid countries, especially in Africa
European Landscape Convention	European union	2000	Conservation of the European landscape
Bern Convention	European union	1979	Conservation of important species and habitats in Europe
Ramsar Convention	Independent	1971	Protection of wetlands important to waterfowl

Eco-Friendly Person Activities

Investigation of Fallen Leaves

Aim: It is aimed to examine the plant diversity in our close environment through research.

Materials: fallen leaves, bag, gloves

Method:

- [ ] Augmented reality apps
- [x] Experimental applications
- [ ] E-learning applications

- [x] Observation
- [ ] Computational science applications
- [ ] Activities those content is brought through games
- [ ] Activities whose content is gained through artistic activities
- [x] Collaborative group work

- [ ] Mobil apps
- [ ] Game-based apps
- [ ] Measurement and evaluation activities
- [ ] Field work
- [ ] Sporting events
- [ ] Other methods and techniques

Plan: Students are told that they will work in groups in this activity. Each group is given a small bag of dry fallen leaves. It will be easy to find dry leaves that fall in autumn. First, students in each group are asked to classify the leaves. Second, they are asked to make guesses about which trees the leaves belong to. For estimates, systematic books, diagnostic keys or reliable internet sources can be used. Third, students are asked to find out whether the predicted or identified leaves belong to native or introduced species. Fourth, they are asked to comment on whether there is an introduced species in the habitat by looking at the number of leaves of the same species. Fifth, they are asked to calculate index of biodiversity using the formula below.

Index of biodiversity =

Finally, each of the groups is asked to submit a written report on these five steps.

Biodiversity Court

Aim: It is aimed to research the factors that threaten biodiversity and the measures that can be taken against the threats.

Materials: paper, pen

Method: Simulation drama, role play

- [ ] Augmented reality apps
- [ ] Experimental applications
- [ ] E-learning applications

- [ ] Observation
- [ ] Computational science applications
- [x] Activities those content is brought through games
- [ ] Activities whose content is gained through artistic activities
- [x] Collaborative group work
- [ ] Mobil apps
- [ ] Game-based apps
- [ ] Measurement and evaluation activities
- [ ] Field work

- [ ] Sporting events
- [x] Other methods and techniques

Plan: Students are asked to stage a courtroom. Students are informed that they will take on roles such as judge, bailiff, clerk, defendant, plaintiff, lawyers, experts, jury and audience for this activity. In the settlements, a biodiversity threat that students are thought to be familiar with is determined and the subject of the case is shaped. For example, in a classroom with students living in an area close to the thermoelectric power plant, the court case is based on the plant's harm to biodiversity. Plaintiff expresses his arguments as to how the thermoelectric plant is a threat to biodiversity and blames the plant. The defendant expresses the necessity of the power plant and the measures taken. Opinions of experts and experts may be requested. Lawyers defend their clients. The judge conducts the hearing. As a result, a reasoned decision is reached by asking the jury for its decision. Thus, students review biodiversity in all its dimensions.

Chapter Summary

Biodiversity is not limited to the living species around us. It is a much broader framework concept that includes all the biological units that make up living things, as well as the species that we cannot see with the naked eye, as well as the biotic and abiotic factors surrounding them. This framework includes the living species themselves, their genetic units, and the ecosystem they interact with and are a part of.

It is important to determine the biodiversity of a particular region or ecosystem. Because some species are used directly by humans. The needed species are collected or cultivated by human hands and traded. Although some species do not have commercial value, they have an important place in the ecological balance. The extinction of specific species, such as keystone species, causes the ecosystem to lose its health. In that case, it is necessary to act by considering the needs of all living things in an ecological unit. However, it is possible to keep nature and life sustainable by taking care of biodiversity.

In order to maintain biodiversity, the factors that threaten the health of the ecosystem should be determined first. The prevailing factors in the world are never static. The factors that affect the living life are built on fine balances. Changes force living things to change. Species that can adapt to the new situation that occurs as a result of change continue to live. Changes have followed a natural process until now. As a result of the great changes seen on earth, great mass extinctions have occurred 5 times in the last 500 million years. According to scientists, factors such as meteorites, tectonic movements, very cold or very hot climate are responsible for these great extinctions. Again, according to some scientists, the sixth mass extinction process has started and continues in the current time period. Unlike other mass extinctions, this time the cause of extinction is seen as the human species. Therefore, human behavior is very effective in determining the dimensions of extinction.

Humans continue to take actions that threaten natural life and biodiversity to a great extent. Actions such as excessive use of resources and biodiversity, destruction, fragmentation and pollution of natural habitats adversely affect living things. However, preferring renewable resources, creation of protected areas, biological improvement and protection of ecosystem balance will ensure the protection of natural life and biological diversity. Despite international conventions and efforts regulating actions and studies on the subject, natural life is still under threat.

As a result, the earth is home to many living species. Living things have changed and transformed over the years as a result of the balance they have established in their natural environment, creating today's living diversity. Studies have not yet reached a sufficient point to explain the biological diversity existing on earth. However, human actions threaten natural life and cause the rapid disappearance of biological diversity. Recognizing people's actions, taking responsibility for their actions and taking action so that wrong actions are not repeated will make natural life and biodiversity sustainable.

References

Alonso, A., Dallmeier, F., Granek E., and Raven, P. (2001). Biodiversity: Connecting with the Tapestry of Life. Smithsonian Institution Monitoring and Assessment of Biodiversity Program, President's Committee of Advisors on Science and Technology. Washington, DC.

Biggs, A., Hagins W.C., Holliday W.G., Kapicka C.L. & Lundgren L. (2007). Glencoe Science: Biology, California Edition. New York, N.Y: Glencoe/McGraw-Hill.

Brooker, R., Widmaier, E., Graham, L. & Stiling, P. (2020). Biology (4th edition). NY: McGraw-Hill.

Bulut, A. (2020). Fen bilgisi öğretmen adaylarının eleştirel düşünme becerileri ile biyoçeşitlilik okuryazarlığı arasındaki ilişki. Yayınlanmamış Yüksek Lisans Tezi, Manisa Celal Bayar Üniversitesi, Manisa.

Bulut, M. (2019). Fen bilimleri, biyoloji, coğrafya ve sosyal bilgiler öğretmenlerinin biyoçeşitlilik konusundaki görüşleri ve çalıştıkları bölgedeki biyoçeşitliliği derslerinde işleme düzeyleri. Yayınlanmamış Yüksek Lisans Tezi, Sakarya Üniversitesi, Sakarya.

Chesek, C. (2021). Dodos Might Have Been Quite Intelligent, New Research Finds. https://www.amnh.org/about/press-center/dodos-might-have-been-quite-intelligent adresinden 30.08.2021 tarihinde erişilmiştir.

Çakır, H. (2019). Ortaokul öğrencilerinin biyolojik çeşitlilik konusunda bilgi düzeylerini arttırmak için otantik öğrenme temelli materyal tasarımı ve değerlendirilmesi. Yayınlanmamış Yüksek Lisans Tezi, Balıkesir Üniversitesi, Balıkesir.

Çepel, N. (1997). Biyoçeşitlilik Önemi ve Korunması (1. Baskı). İstanbul: TEMA Vakfı Yayınları 15

Dilbirliği, E. (2007). Bitkisel biyolojik çeşitlilik ve genetik kaynaklarının sürdürülebilir kullanım stratejilerinin değerlendirilmesi. Yayınlanmamış Doktora Tezi, Ankara Üniversitesi, Ankara.

Erten, S. (2004). Uluslararası Düzeyde Yükselen Bir Değer Olarak Biyolojik Çeşitlilik. Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 27 (27), 98-105.

Goodenough, J., & McGuire, B. (2014). Biology of humans : concepts, applications, and issues (Fifth edition.). Pearson.

Gould, J. L., Keeton, W. T., & Gould, C. G. (1996). Biological science (6th ed.). W.W. Norton & Co.

Karabal, M. (2011). Fen ve teknoloji öğretmen adaylarının biyolojik çeşitliliğe ilişkin görüşleri. Yayınlanmamış Yüksek Lisans Tezi, Mehmet Akif Ersoy Üniversitesi, Burdur.

Kurumlu, M.S. (2008). Biyoçeşitliliğimizi Koruyabiliyor Muyuz: Önem ve Koruma Stratejileri Üzerine Biyoloji Öğretmenlerinin Yeterliliklerinin Araştırılması. Yayınlanmamış Yüksek Lisans Tezi, Gazi Üniversitesi, Ankara.

Küstür, S. (2015). BP petrol sızıntısı nedeniyle 20.8 milyar dolar tazminat ödeyecek. https://www.teknoblog.com/bp-petrol-sizintisi-nedeniyle-20-8-milyar-dolar-tazminat-odeyecek/ adresinden 30.08.2021 tarihinde erişilmiştir.

Macit, H. (2019). Yalnızca Türkiye'de Yaşayan Endemik Hayvan Türleri. https://www.turktoyu.com/yalnizca-turkiye-de-yasayan-endemik-hayvan-turleri adresinden 30.08.2021 tarihinde erişilmiştir.

Mader, S. & Windelspecht, M. (2017). Biology. NY: McGraw-Hill.

Mason, K. A., Losos, J. B., Singer, S. R., & Raven, P. H. (2017). Biology (Eleventh edition.). McGraw-Hill Education.

National Geographic (2018). Kuzey Beyaz Gergedanını Nasıl Bir Gelecek Bekliyor?

https://www.nationalgeographic.com.tr/kuzey-beyaz-gergedanini-nasil-bir-gelecek-bekliyor/ adresinden 30.08.2021 tarihinde erişilmiştir.

O'Doherty, J., Mayor, K.; Tol, R. S. J. (2007). Irish sustainable development model (ISus) literature review, data availability and model design, ESRI Working Paper, No. 186, The Economic and Social Research Institute (ESRI), Dublin

Piperno, D.R., Holst I., Winter K. & McMillan O. (2015). Teosinte before domestication: Experimental study of growth and phenotypic variability in Late Pleistocene and early Holocene environments. Quaternary International, 363 (30), 65-77.

Raven, P., Johnson, G., Mason, K., Losos, J., & Duncan, T. (2019). ISE EBook Online Access for Biology. McGraw-Hill US Higher Ed ISE.

Reece, J. B., Urry, L. A., Cain, M. L., Wasserman, S. A., Minorsky, P. V., Jackson, R. B., & Campbell, N. A. (2014). Campbell biology (Tenth edition.). Pearson.

Solomon, E.P., Martin, C.E., Martin, D.W. & Berg, L.R. (2019). Biology. Mason, OH: Cengage.

Starr, C., Taggart, R., & Evers, C. (2018). Biology: The Unity and Diversity of Life. Mason, OH: Cengage.

Stoltze, H. J., & Schraer, W. D. (1987). Biology: the study of life (2nd ed., Teacher's ed.). CEBCO.

Tepedelen Ağaner, G. & Başbağcı, G. (2020). Türkiye'de Pervane Çiçeğinde (Catharanthus roseus L.) Kök ve Kök Boğazı Çürüklüğüne Neden Olan Rhizoctonia solani AG-4'ün İlk Tespiti. The Journal of Turkish Phytopathology, 49 (2), 41-44.

ThinktoSustain (2011). Save Forests: Avoid Forest Fragmentation. https://thinktosustain.com/2011/06/save-forests-avoid-forest-fragmentation/ adresinden 30.08.2021 tarihinde erişilmiştir.

URL1 (2021). Asian ladybugs looking for Western Mass. houses to live in for the winter. https://www.masslive.com/news/2009/11/asian_ladybugs_looking_for_wes.html adresinden 30.08.2021 tarihinde erişilmiştir.

URL2 (2021). The Spectacular Botswana Wildlife Safari. https://www.itravelto.com/okavango-delta-wildlife-adaptations.html adresinden 30.08.2021 tarihinde erişilmiştir.

URL3 (2021). Matter and Energy Cycles: Modeling. https://www.nationalgeographic.

org/activity/matter-and-energy-cycles-modeling/ adresinden 30.08.2021 tarihinde erişilmiştir.

URL4 (2021). Yedigöller Milli Parkı, Bolu. https://www.kulturportali.gov.tr/turkiye/bolu/gezilecekyer/yedigoller-milli-parki adresinden 30.08.2021 tarihinde alınmıştır.

URL5 (2021). Here we go again: Earth's major 'mass extinctions'. https://phys.org/news/2019-04-earth-major-mass-extinctions.html adresinden 30.08.2021 tarihinde erişilmiştir.

URL6 (2021). A sketch of the evolution of plant forms through geological periods NEET. https://skmonug.blogspot.com/2020/04/figure-79-sketch-of-evolution-of-plant.html adresinden 30.08.2021 tarihinde erişilmiştir.

URL7 (2021). Antra's Ocean Food Web - Food Web Sea. https://www.jing.fm/iclip/owxxmi_antras-ocean-food-web-food-web-sea/ adresinden 30.08.2021 tarihinde erişilmiştir.

URL8 (2021). Chapter: 12th Zoology : Environmental Issues Biomagnification. https://www.brainkart.com/article/Biomagnification_38169/ adresinden 30.08.2021 tarihinde erişilmiştir.

URL9 (2021). Global consumption. https://www.energymix.co.nz/our-consumption/global-consumption/ adresinden 30.08.2021 tarihinde erişilmiştir.

URL10 (2021). Old-growth forest cleared for dam in Oregon. https://utahpopulation.org/archive/overpopulation-overconsumption-in-pictures/attachment/old-growth-forest-cleared-for-dam-in-oregon adresinden 30.08.2021 tarihinde erişilmiştir.

URL11 (2021). Sustainable Resource Use. https://usys.ethz.ch/en/research/research-foci/sustainable-resource-use.html adresinden 30.08.2021 tarihinde erişilmiştir.

URL12 (2021). https://en.wikipedia.org/wiki/Biodiversity_hotspot#/media/File:Biodiversity_Hotspots.svg adresinden 30.08.2021 tarihinde erişilmiştir.

URL13 (2018). https://www.earth.com/news/wildlife-corridors-habitat-fragmentation/ adresinden 30.08.2021 tarihinde erişilmiştir.

URL14 (2021). https://www.hirerush.com/blog/10-easy-garden-pest-control-tips/ adresinden 30.08.2021 tarihinde erişilmiştir.

Ustaoğlu Tırıl, S. (2021). Dinazorlarla aynı dönemden gelen mersin balıkları yok olmamaya direniyor. http://www.bafrahabergazetesi.com/haber/350/dinazorlarla-ayni-donemden-gelen-mersin-baliklari-yok-olmamaya-direniyor.html adresinden 30.08.2021 tarihinde erişilmiştir.

Ülgen, H., Zeydanlı, U. (2008). Biyolojik Çeşitlilik ve Orman Ekosistemlerindeki Önemi. In: Orman ve Biyolojik Çeşitlilik. Doğa Koruma Merkezi, Ankara. 15-36.

Yıldız, A. (2020). Aslan balığı tezgahlarda yerini almaya başladı. https://www.aa.com.tr/tr/ekonomi/aslan-baligi-tezgahlarda-yerini-almaya-basladi/1833592 adresinden 30.08.2021 tarihinde erişilmiştir.

About the Author

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Chapter 3

Education Dimension of Sustainable Development

Ahmet Volkan YÜZÜAK
Bartın University

Education Dimension of Sustainable Development

Our Common Future report offered the classic definition of sustainable development: "*Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own need" (WCED, 1987:43).* The term sustainability is broadly used. The three-pillar conception of sustainability (social, economic, and environmental) commonly represented by three intersecting circles with overall sustainability at the centre. Figure 3.1 illustrates the typical representation, alternative depictions: literal pillars and a concentric circles approach (Purvis, Mao & Robinson, 2019: 682).

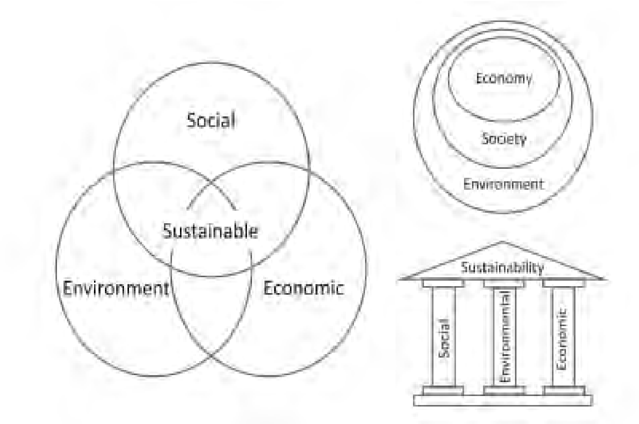

Figure 3. 1. Representations of Sustainability

As shown in Figure 3.1, three dimensions or pillars of sustainability are: Environment, society and economy. Economy refers to production and consumption of goods, environmental dimension is related to water sources, forests, ecology etc., society is related to living together. There are also other pillars fundamental to sustainability: The human and social factors. Human dimension, which is related to health, education, skillls, knowledge, leadership, and access to services, aims to maintain and improve the human capital in society (Purvis et al., 2019; Goodland, 1995).

The Origins of Sustainability and Sustainable Development

The term *sustainability* has a history. Especially after the 1970s the relationship between economic development and environment became more explicit (Meadows et al., 1972) and environmental problems were increased due to industrialization, population growth and migration. In addition, some international conferences were organized and reports were presented such as:

- *Declaration of the United Nations Conference on the Human Environment* in Stockholm (United Nations, 1972)
- *Intergovernmental Conference on Environmental Education* organized by Unesco in co-operation with UNEP in Tbilisi (Unesco, 1977)
- *Report of the World Commission on Environment and Development: Our Common Future* presented to the UN General Assembly (WCED, 1987)
- Brundtland Report- Our Common Future-*the Rio Declaration on Environment and Development*" In Rio de Janerio, Brazil (United Nations, 1992)
- *World Summit on Sustainable Development* (WSSD)- Johannesburg Summit in South America (United Nations, 2002),
- *United Nations Sustainable Development Summit 2015-UNCED, Earth Summit* in New York (UNCED, 2015).

In addition to these, new agenda was planned such as "Transforming our World: the 2030 Agenda for Sustainable Development" which is a plan of action people, planet and prosperity (United Nations, 2015). These international conferences are all directly or not directly related to sustainability and sustainable development. Due to this reason, they will be explained in detail.

Declaration of the United Nations Conference on the Human Environment

Stockholm, 5-6 June 1972

The United Nations Conference on the Human Environment having met at Stockholm from 5 to 16 June 1972 and it was a guide for the preservation and enhancement of environment. Stockholm decleration contains 26 principles. Principle 1 stated that:

> "*Man has the fundamental right to freedom, equality and adequate conditions of life, in an environment of aquality that permits a life of dignity and well-being, and he bears a solemn responsibility to protect and improvethe environment for present and future generations. In this respect, policies promoting or perpetuatingapartheid, racial segregation, discrimination, colonialand other forms of oppression and foreign domination stand condemned and must be eliminated*" (United Nations, 1972: 4).

Principle 2 stated that: "*The natural resources of the earth, including the air, water, land, flora and fauna and especially representative samples of natural ecosystems, must* be *safeguarded for the benefit of present and future generations through careful planning or management, as appropriate*." Principle 3 stated that "*The capacity of the earth to produce vital renewableresources must be maintained and, wherever practicable, restored or improved*" (United Nations, 1972: 4). The framework of the action plan is illustrated in Figure 3.2.

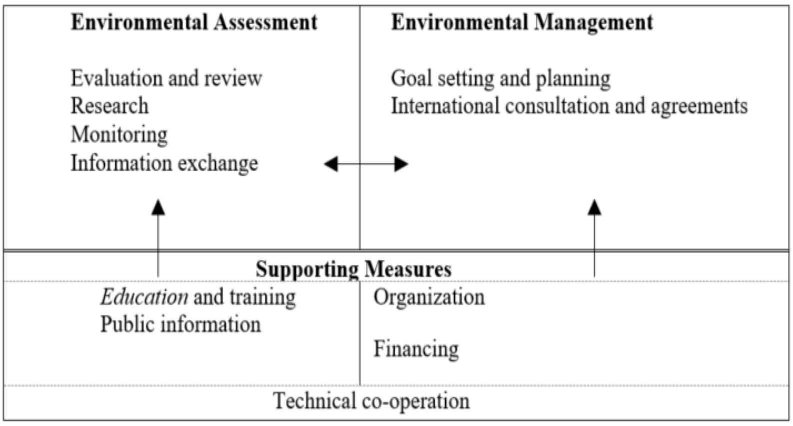

Figure 3. 2. The framework of the Action Plan

As illustrated in Figure 3.2, action plan includes environmental assessment, environmental management and supporting measures. "Education and training" were located under the heading "Supporting Measures" (United Nations, 1972).

Intergovernmental Conference on Environmental Education

Tbilisi, 14-26 October 1977

The conference was organized by Unesco in co-operation with United Nations Environment Programme (UNEP). Totally 265 delegates and 65 representatives and observers participated in the conference. The Tbilisi Decleration focused on major environmental problems in contemporary society, role of education. The role of education in the face of environmental problems is crucial. The goals of environmental education are to increase the awareness about economic, social, political, and ecological interdependence in urban and rural areas, to provide every person with opportunities to protect and improve the environment as well as to create new patterns of behavior towards the environment. The categories of environmental education *objectives* are awareness, knowledge, attitudes, skills and participation. Moreover, guiding principles were explained in the report. For instances, environmental education should consider the environment in its totality, be a continuous lifelong process, be interdisciplinary in its approach, examine major environmental issues, focus on current and potential environmental situations, promote the value, consider plans for development and growth (Unesco, 1977).

Report of the World Commission on Environment and Development: Our Common Future

October 1987

The term *sustainable development* was popularized in *Our Common Future* in 1987. Also known as the Brundtland report since the publication was in recognition of Gro Harlem Brundtland's, former Norwegian Prime Minister, role as Chair of the World Commission on Environment and Development (WCED). *Our Common Future* included the "classic" definition of sustainable development: "development which meets the needs of the present without compromising the ability of future generations to meet their own needs." (WCED, 1987: 16). It contains two key concepts: needs and future generations (WCED, 1987).

The World Commission on Environment and Development suggested these:

1. *"Re-examine the critical issues of environment and development and to formulate innovative, concrete, and realistic action proposals to deal with them;*
2. *strengthen international cooperation on environment and development and to assess and propose new forms of cooperation that can break out of existing patterns and influence policies and events in the direction of needed change; and*
3. *raise the level of understanding and commitment to action on the part of individuals, voluntary organizations, businesses, institutes, and governments" (*WCED, 1987: 347*).*

The Rio Declaration on Environment and Development

Rio de Janerio, Brazil, 3 -14 June 1992

Acceptance of the report by the United Nations General Assembly gave the term political salience; and in 1992 leaders set out the principles of sustainable development at the United Nations Conference on Environment and Development in Rio de Janeiro, Brazil. After two decades from Stockholm declaration- Declaration of the United Nations Conference on the Human Environment, The Rio Declaration or UNCED (United Nations Conference on Environment and Development) or Earth Summit. Agenda 21, which was a dynamic programme and a special product of the Earth Summit, addressed the problems and aimed to prepare the world for the challenges of the 21st century. It was adopted by 178 countries. A set of principles is center of UNCED. The declaration included 27 principles for sustainable development. The first principle stated that "Human beings are at the center of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature", *Principle 3* stated that "The right to development must be fulfilled so as to equitable meet developmental and environmental needs of present and future generations”, *Principle 4* stated that “In order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it”. *Principle 5* is also important that “All states and all people shall cooperate in the essential task of eradicating poverty as an indispensable requirement for sustainable development, in order to decrease the disparities in standards of living and better meet the needs of the majority of the people of the world” (UN Documentation Centre, 1992: 1-5).

World Summit on Sustainable Development (WSSD)

Johannesburg, South America 26 August – 4 September 2002

Between Rio and Johannesburg, the world nations organized different conferences such as International Conference on Financing for Development, Doha Ministerial Conference. The United Nations convened WSSD (World Summit on Sustainable Development) after ten years The Rio Declaration on Environment and Development, on 26 August–4 September 2002. Declaration recommended to endorse the Johannesburg Declaration. The general assembly recognized that poverty eradiction, changing consumption and production patterns and protecting and managing the natural resource base for economic andsocial development are overarching objectives of and essential requirements for sustainable development (United Nations, 2002). “The UNDP Report on Human Development 2001 confirms a growing gap between the North and The South/East: The richest 1/5 of the World population earns 73 times more income than the poorest 1/5 does, which means a further increase since the 1990 ratio of 60:1” (Göll & LaFond, 2002: 318).

United Nations Sustainable Development Summit 2015

New York 25-27 September 2015

The United Nations summit for the adoption of the post-2015 development agenda was held from 25 to 27 September 2015 in New York. *Transforming our world: the 2030 Agenda for sustainable development* is an action plan for humanity, planet and prosperity. According to new agenda United Nations General Assembly determines eradicating poverty is the greatest global challenge for sustainable development. United Nations also determined to protect the planet from degradation, to ensure that all of the human beings should be able to live economically, socially and technologically well in harmony with nature, foster peaceful society (United Nations, 2015a).

Sustainable Development Goals

The 17 sustainable development goals (SDGs) and their related 169 targets were announced. They are related to three dimensions of sustainable development which are economic, social and environmental. SDGs are goals set by the United Nations for advancements in sustainability by 2030. The 17 SDGs are illustrated in Figure 3.3 (United Nations, 2015b).

Figure 3. 3. The Sustainable Development Goals

As seen in Figure 3.3 *Quality Education* (Goal 4) is one of the sustainable development goals (United Nations, 2015c). Education and training are key drivers for sustainable development since they help to improve employability, productivity, innovation and competitiveness. Also, education is pre-condition for many other SDGs (Eurostat, 2021e; Tekbiyik & Celik, 2019; Kurtuluş & Tatar, 2021; İcoz, 2015).

Indicators for Sustainable Development Goals

For more detailed information about SDG 4's targets and indicators, see https://sdgs.un.org/goals/goal4. The assessment of indicator trends is visualised in the form of arrows. Table 3.1 illustrates the meaning of arrows (Eurostat, 2021a).

Table 3.1. Assessment Categories and Associated Symbols

Symbol	With quantitative target	Without quantitative target
↑	Significant progress towards the EU target	Significant progress towards SD objectives
↗	Moderate progress towards the EU target	Moderate progress towards SD objectives
↘	Insufficient progress towards the EU target	Moderate movement away from SD objectives
↓	Movement away from the EU target	Significant movement away from SD objectives
:	Calculation of trend not possible (i.e time series too short)	

Indicator trends are assessed over two periods: long term and short term. Long-term trend is based on over the past 15-year period. Short-term period is based on over the past five period. Figure 3.4 illustrates the trends for quality education.

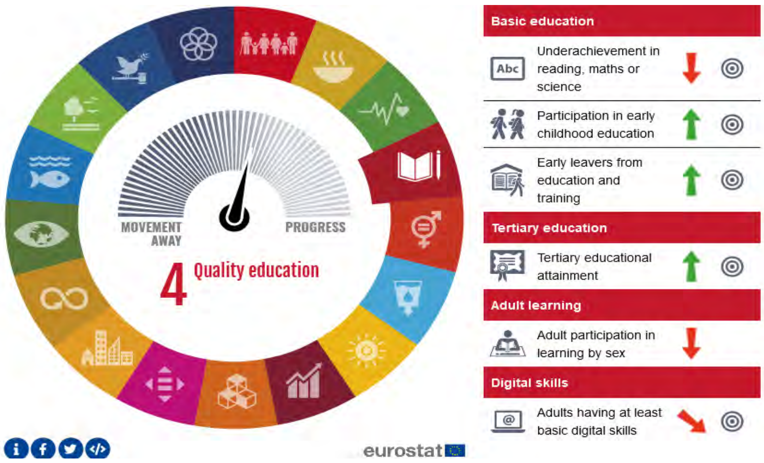

Figure 3. 4. Trends for Quality Education

As seen in Figure 3.4 for basic education, underachievement in reading, maths or science moves away from the EU target, participitation in early childhood education and early leavers from education and training have significant process toward the EU target. Tertiary education attainment has significant process toward the EU target. For adult learning adult participation in learning by sex moves away from EU target. For digital skills adults having at least basic skills has insufficient progress towards the EU target (Eurostat, 2021b). Table 3.2 illustrates target and policy reference for only SDG 4.

Table 3. 2. EU Policy Targets Considered for Assessing Indicator Trends for SDG 4

Indicator	Target	Policy reference
Underachievement in reading, maths and science (SDG 4)	The share of low-achieving 15-year-olds in reading, mathematics and science should be less than 15 % by 2030	European Education Area
Participation in early childhood education (SDG 4)	At least 96% of children between 3 years old and the starting age for compulsory primary education should participate in early childhood education and care by 2030	European Education Area
Early leavers from education and training (SDG 4)	The share of early leavers from education and training should be less than 9 % by 2030	European Education Area
Tertiary educational attainment (SDG 4, SDG 9)	The share of 25–34-year-olds with tertiary educational attainment should be at least 45 % by 2030	European Education Area
Share of adults with at least basic digital skills (SDG 4)	By 2025, 230 million adults should have at least basic digital skills, which covers 70 % of the adult population in the EU	European Skills Agenda

Statistics Related to Sustainable Development Goal 4 (Quality Education)

At this point for statistics related to sustainable development goals, Eurostat (https://ec.europa.eu/eurostat/) should be checked. As mentioned, there are different indicators for each sustainable development goals. For example, for SDG 4; underachievement in reading, maths or science; participation in early childhood education, early leavers from education and training, tertiary educational attainment; adults having at least basic digital skills, adult participation in learning. In this part of the chapter, graphs country scores related to SDG 4 will be given related to these indicators

Figure 3. 5. Sustainable Development Goals- Quality Education (Goal 4)

According to Figure 3. 5 United Nations (2021a) indicates that "617 million children and adolescents lack minimum profiency in reading and mathematics. Figure 3.6 indicates the graph related to reading, maths or science.

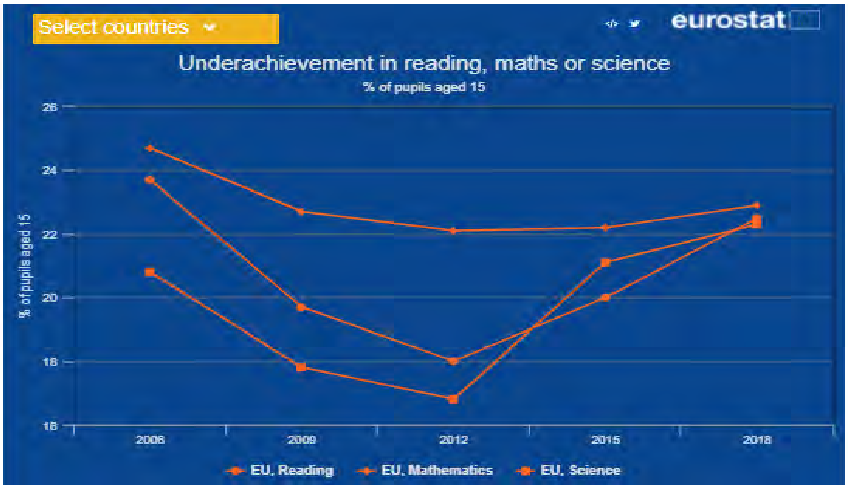

Figure 3. 6. Underachievement in Reading, Maths or science

Table 3.3 indicates the scores for maths (first line), reading (second line) and science (third line) (EU).

Years	Maths	Reading	Science
2006	24.7	23.7	20.8
2009	22.7	19.7	17.8
2012	22.1	18	16.8
2015	22.2	21.1	20
2018	22.9	22.5	22.3

Table 3. 3. Scores for maths, reading and science

The data were obtained from OECD (PISA). The indicator measures the share of 15-year-old students failing to reach level 2 ('basic skills level') on the PISA scale for the three core school subjects of reading, mathematics and science (Eurostat, 2021b). Figure 3. 7 indicates the graph for particion in early childhood education (Eurostat, 2021c).

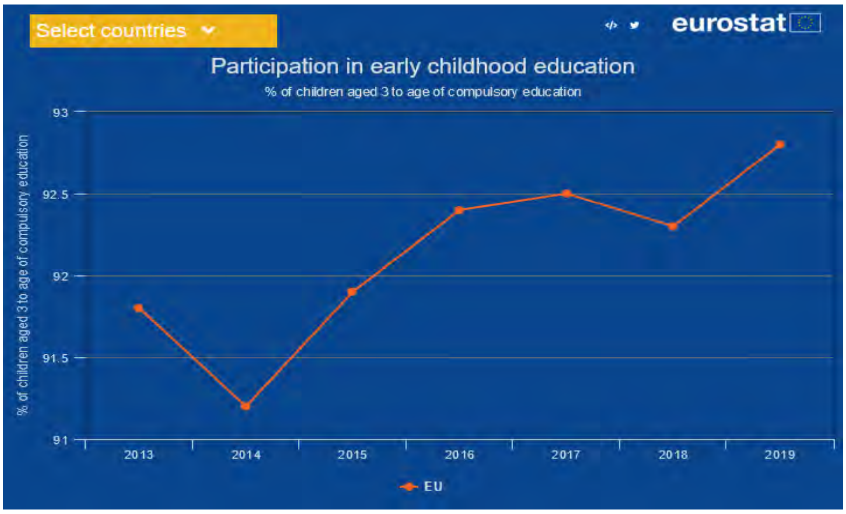

Figure 3. 7. Participation in Early Childhood Education

Data source for Figure 3.7 is European Statistical System (ESS). The indicator measures the share of the children between the age of three and the starting age of compulsory primary education who participated in early childhood education (Eurostat, 2021f). Figure 3.8 illustrates trend for early livers from education and training (Eurostat, 2021c).

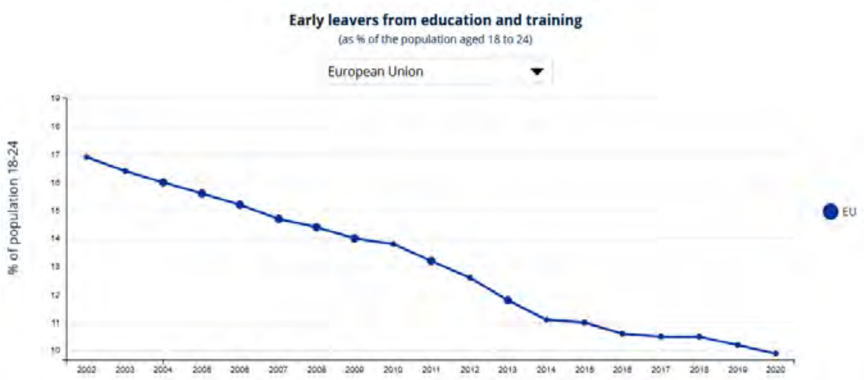

Figure 3. 8. Early Leavers from Education and Training

Early school leaving may lead to unemployment, social exclusion, and poverty. SDG 4 aims to increase quality education through all stages of life and the number of youth and adults having skills for employment, decent jobs and entrepreneurship. According to Figure 3.8 it may be interpreted those early leavers from education and training decreases for European Union (Eurostat, 2021d: 124). Figure 3.9 illustrates that people with tertiary educational attainment (Eurostat, 2021d: 122).

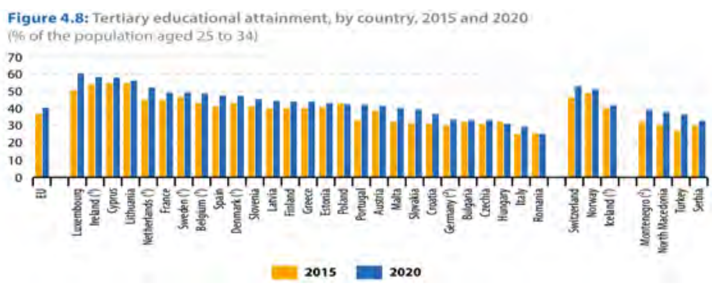

Figure 3. 9. Tertiary Educational Attainment (2015-2020)

Figure 3.9 illustrates the share of people aged 25-34 who have successfully completed tertiary studies such as university, higher technical institution. The data depends on the EU Labour Force Survey (EU-LFS) (Eurostat, 2021e: 122). Figure 3.10 illutrates the adults having at least basic digital skills (Eurostat, 2021e: 124).

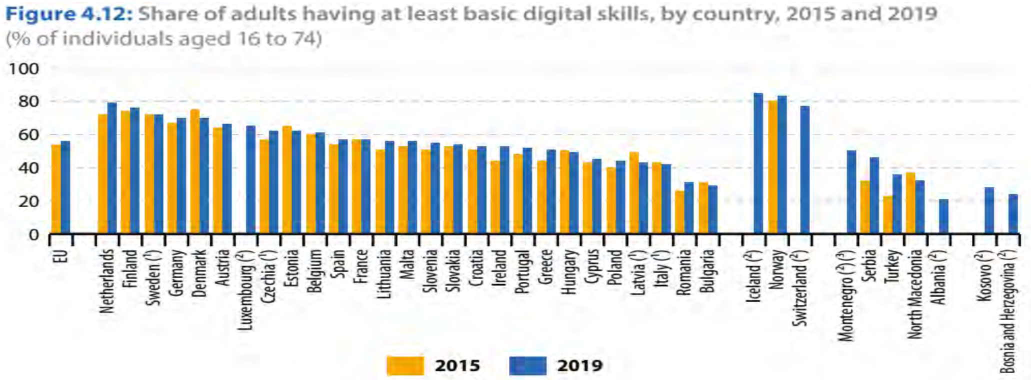

Figure 3. 10. Share of Adults Having at Least Basic Digital Skills (2015-2019)

Figure 3.10 illustrates % of individuals aged 16 to 24. Digital skills include four specific areas: information, communication, problem solving and software skills. The data were obtained from EU survey on the ICT (information and communication technologies) (Eurostat, 2021e: 124). Figure 3.11 illustrates the adults participating in learning (Eurostat, 2021e: 123).

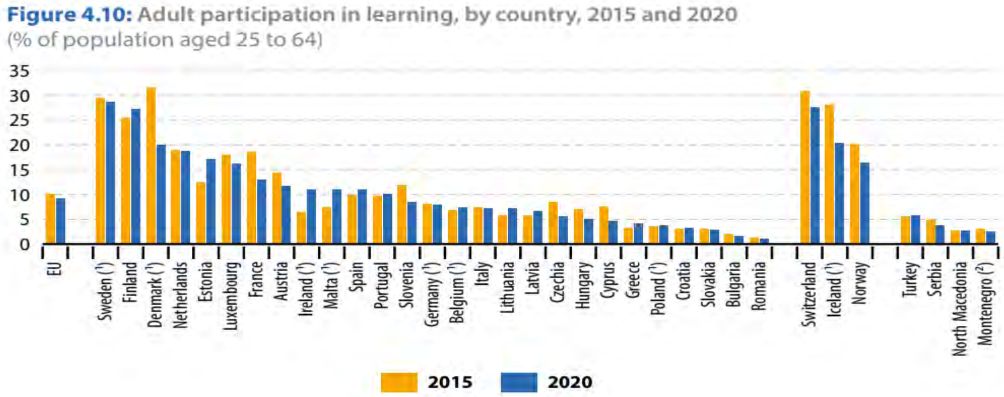

Figure 3. 11. Adult Participation in Learning (2015-2020)

Figure 3.11 illustrates the share of people aged 25 to 64. Adult learning includes both general and vocational formal and non-formal learning activities. Data were obtained from the EU Labour Force Survey (EU-LFS) (Eurostat, 2021e: 123). It may be also compared the sustainable development goals country scores for Austria, Belgium, Bulgaria, Crotia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, and Greece etc. Figures 3.12-3.38 illustrate the sustainable development goal for *Quality Education (Goal 4) country scores* (Eurostat, 2021f)

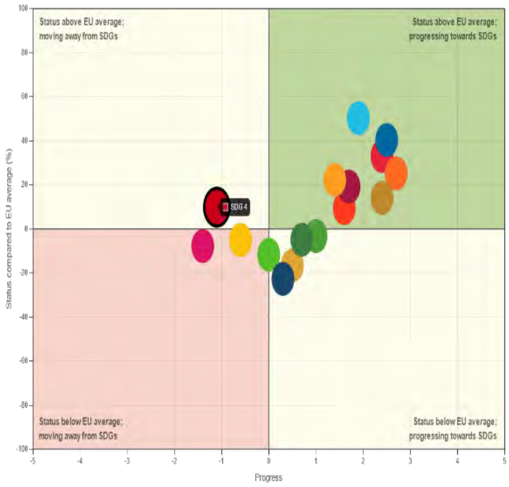

Figure 3. 12. SDG4 Country Scores (Austria)

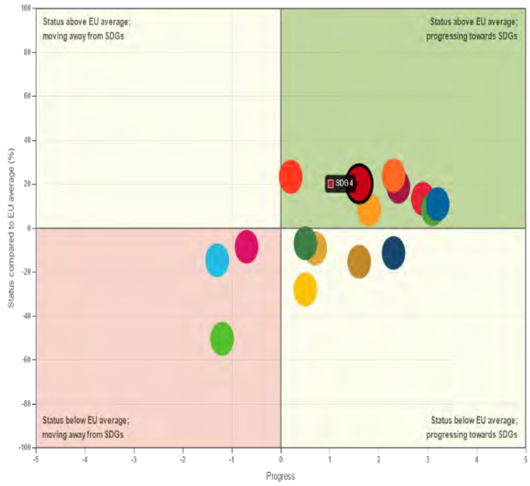

Figure 3. 13 SDG4 Country Scores (Belgium)

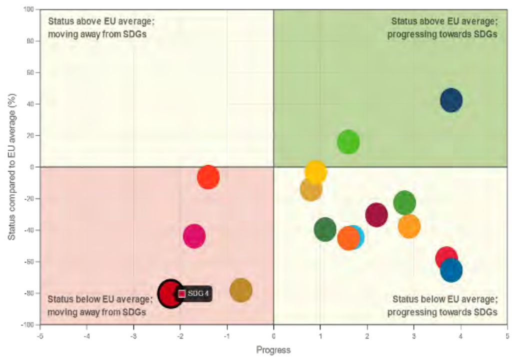

Figure 3. 14 SDG4 Country Scores (Bulgaria)

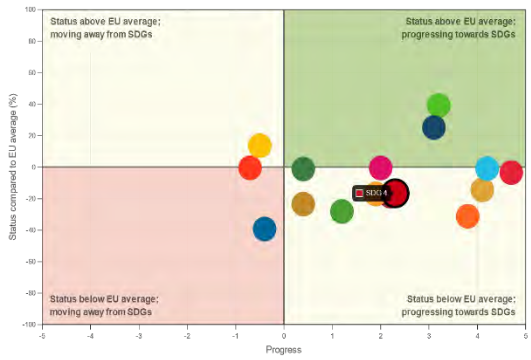

Figure 3. 15. SDG4 Country Scores (Croatia)

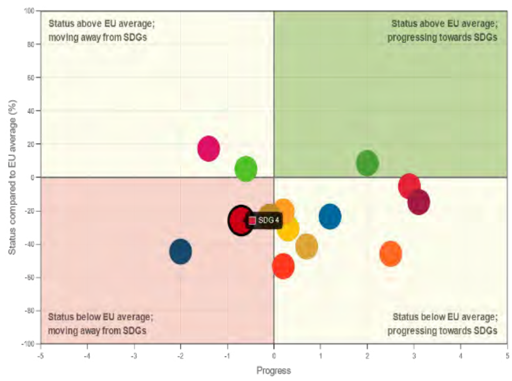

Figure 3. 16. SDG4 Country Scores (Cyprus)

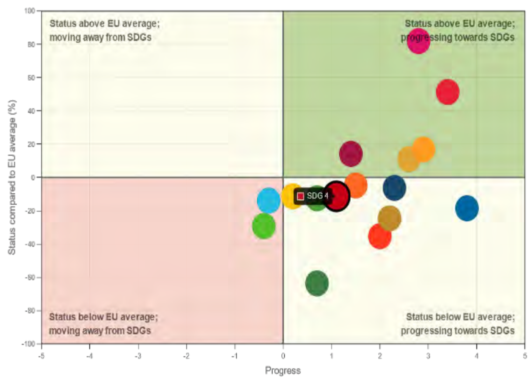

Figure 3 SDG4 Country Scores (Czechia)

Figure 3. 18. SDG4 Country Scores (Denmark)

Figure 3. 19. SDG4 Country Scores (Estonai)

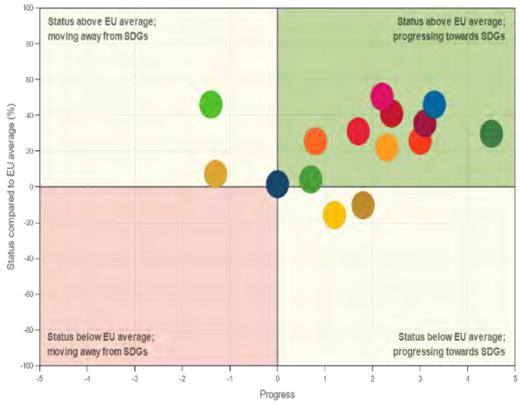

Figure 3. 20. SDG4 Country Scores (Finland)

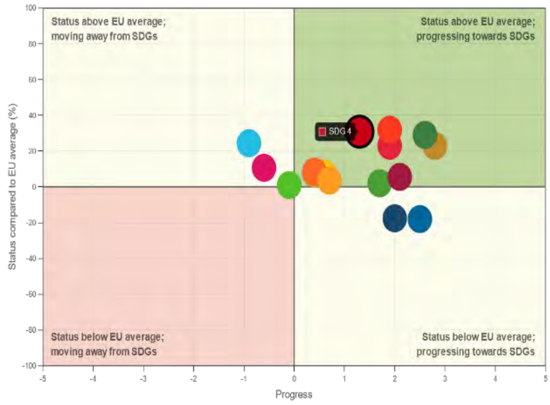

Figure 3. 21. SDG4 Country Scores (France)

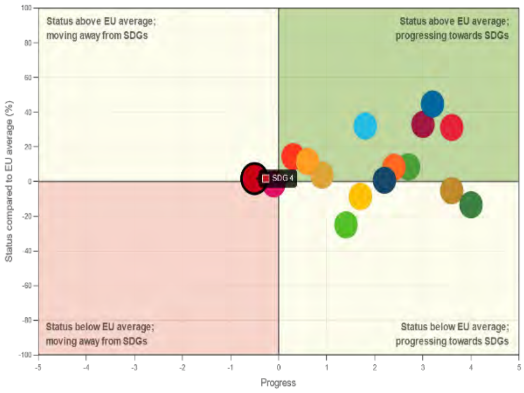

Figure 3. 22. SDG4 Country Scores (Germany)

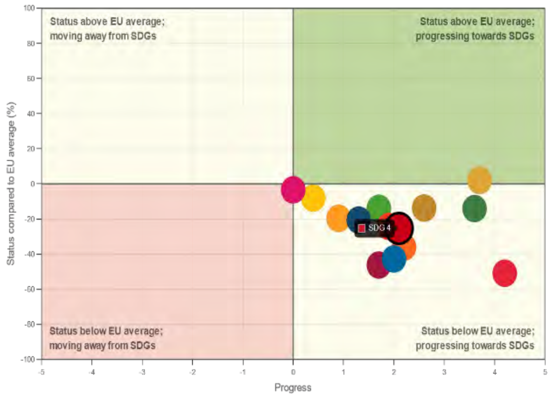

Figure 3. 23. SDG4 Country Scores (Greece)

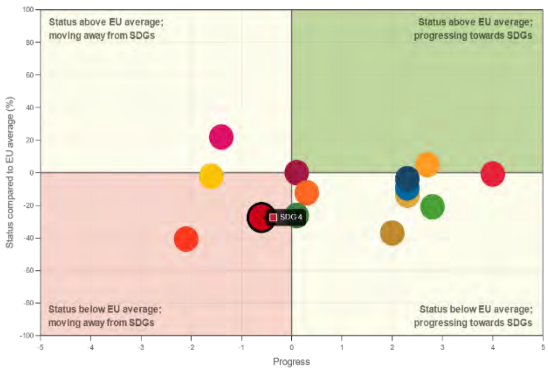

Figure 3.24. SDG4 Country Scores (Hungary)

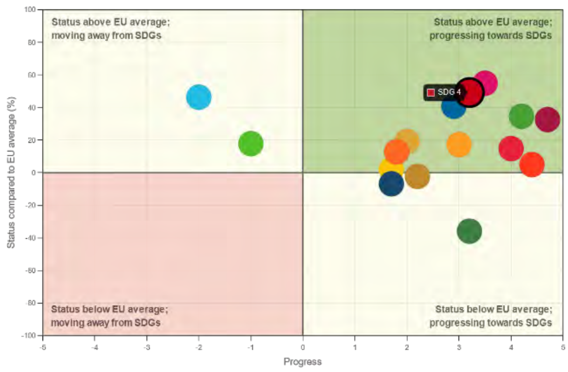

Figure 3.25. SDG4 Country Scores (Ireland)

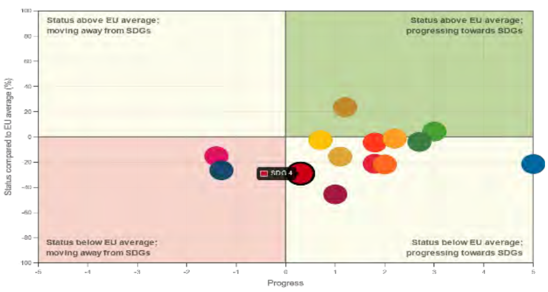

Figure 3. 26. SDG4 Country Scores (Italy)

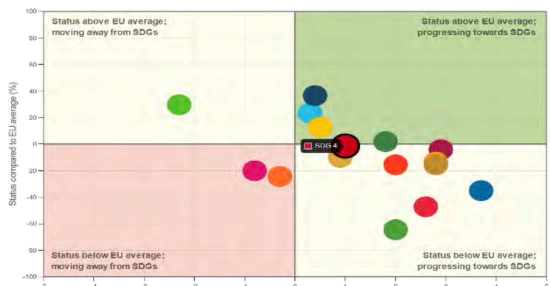

Figure 3.27. SDG4 Country Scores (Latvia)

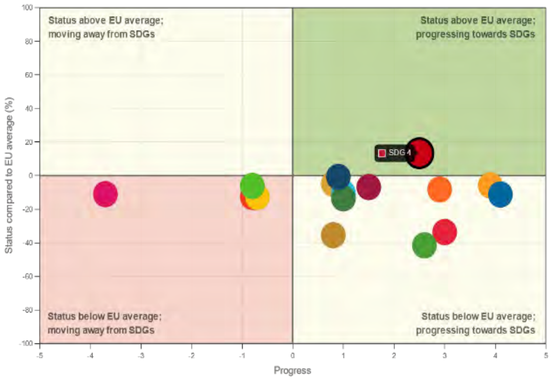

Figure 3.28. SDG4 Country Scores (Lithunia)

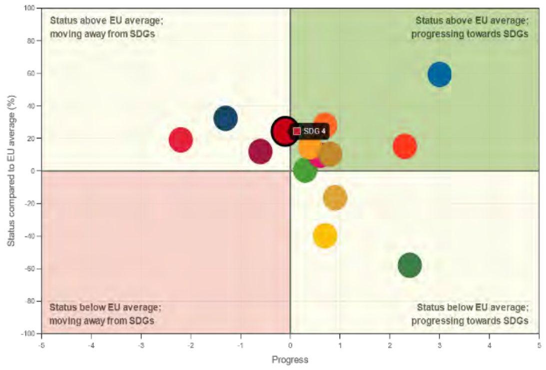

Figure 3.29. SDG4 Country Scores (Luxembourg)

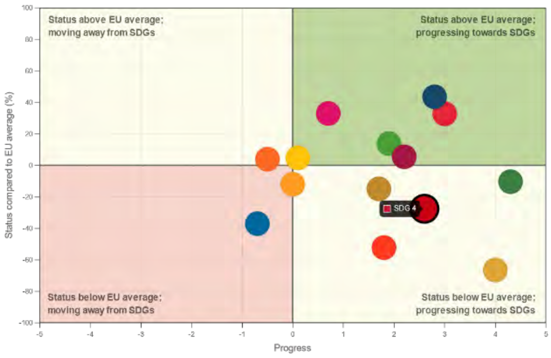

Figure 3.30. SDG4 Country Scores (Malta)

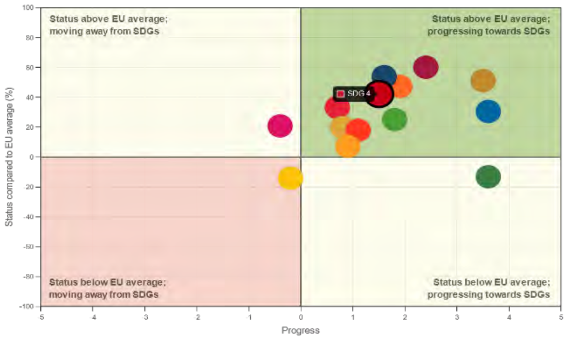

Figure 3.31. SDG4 Country Scores (Netherlands)

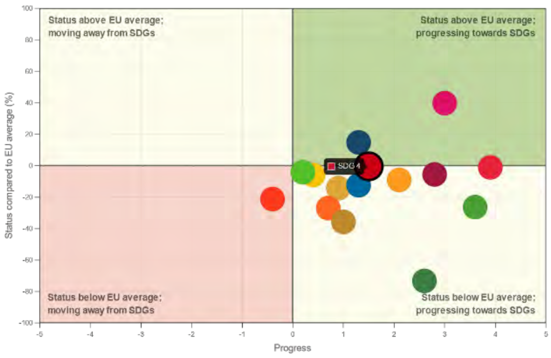

Figure 3.32. SDG4 Country Scores (Poland)

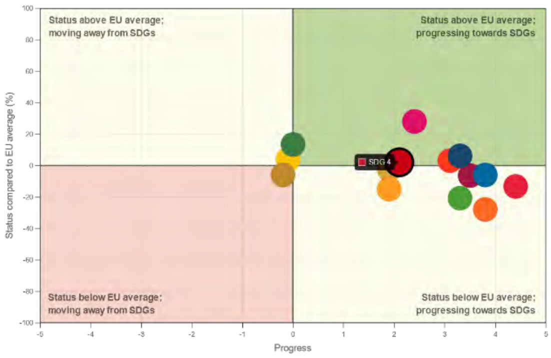

Figure 3.33. SDG4 Country Scores (Portugal)

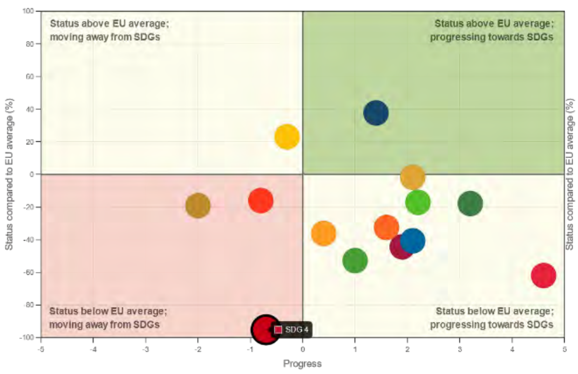

Figure 3.34. SDG4 Country Scores (Romania)

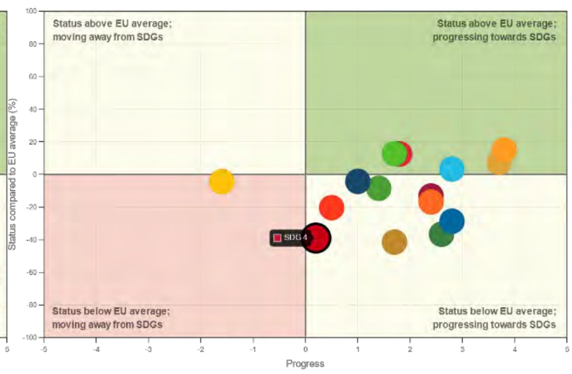

Figure 3.35. SDG4 Country Scores (Slovakia)

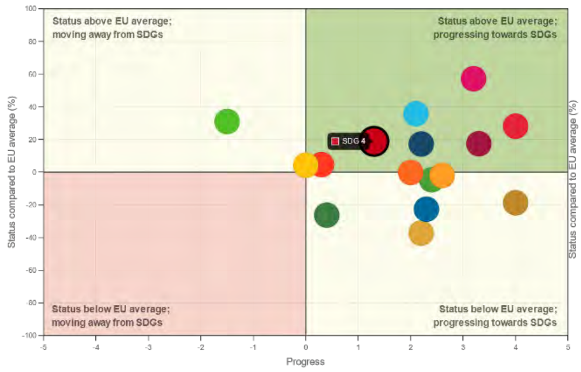

Figure 3.36. SDG4 Country Scores (Slovenia)

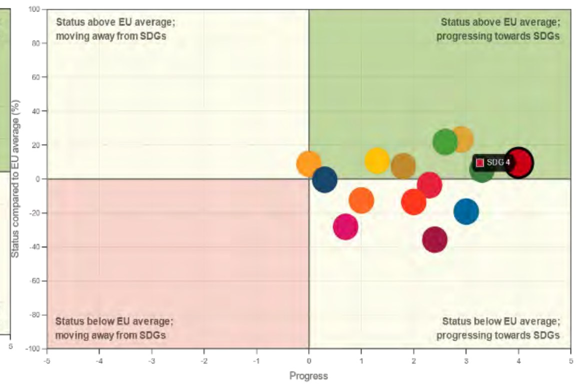

Figure 3.37. SDG4 Country Scores (Spain)

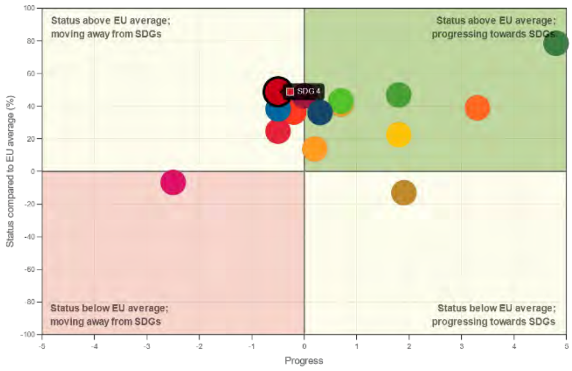

Figure 3.38. SDG4 Country Scores (Sweden)

Country scores related to sustainable development goals may compared to the EU avarage easily over the last five years. Green quadrant shows the status above EU avarage, yellow quadrant upper one shows the status above EU avarage however the country moves away from sustainable development goals. Red quadrant means that status below EU avarage and the country moves aqay from sustainable deelopment goals. Yellow quadrant lower one shows the status below EU avarage but the country progress towards sustainable development goals Table 3.4 illustrates more detailed information about the scores for SDG 4 (Eurostat, 2021f).

Table 3. 4. Country scores for SDG 4

Country	Score (Quality Education)	Progress
Austria	9.87	-1.1
Belgium	20.23	1.6
Bulgaria	-80.38	-2.2
Croatia	-16.65	2.3
Cyprus	-25.89	-0.7
Czechia	-11.32	1.1
Denmark	47.76	-2.4
Estonai	34.96	1.2
Finland	41.03	2.4
France	7.53	0.4
Germany	1.69	-0.5

Greece	-25.35	2.1
Hungary	-27.51	-0.6
Ireland	49.16	3.2
Italy	-29.09	0.3
Latvia	-1.43	1.0
Lithunia	13.33	2.5
Luxembourg	24.31	-0.1
Malta	-27.60	2.6
Netherlands	42.21	1.5
Poland	-0.51	1.5
Portugal	2.09	2.1
Romania	-95.21	-0.7
Slovekia	-38.99	0.2
Slovenia	18.87	1.3
Spain	9.52	4.0
Sweden	48.83	-0.5

Aim of the SDG 4 is to "ensure inclusive and equitable quality education and for all people promote lifelong learning opportunities" (United Nations, 2021b). According to Table 3.3 Sweden has the highest scores (48.83) and Romania has the lowest scores (-95.21). It should be investigated situation of countries (Eurostat, 2021f). To conclude this chapter, the history of sustainable development; SDGs in deed SDG 4 'Quality Education" were discussed; statistics related SDG 4 were explained in this chapter. For more detailed information and statistics related to scores and graphs or other statistics for 17 SDGs, one should look for the websites which were given in reference list.

Eco-Friendly Person Activities

Seed's Journey

Aim: It is aimed to realize that the fruits they consume are seeds

Materials: Apple, cotton, transparent bag

Method:

- [ ] Augmented reality apps
- [x] Experimental applications
- [ ] E-learning applications

- [x] Observation
- [ ] Computational science applications
- [ ] Activities those content is brought through games
- [ ] Activities whose content is gained through artistic activities

- [x] Collaborative group work
- [ ] Mobil apps
- [ ] Game-based apps
- [ ] Measurement and evaluation activities
- [ ] Field work
- [ ] Sporting events
- [ ] Other methods and techniques

Plan: Students are given one apple and after the apples are eaten, how do you think these apples formed? What is the function of beans in the apple? Then the apple kernels are carefully separated and the outer shells are peeled and kept in a transparent bag between wet cotton. It is observed during the project.

Drawing My Future

Aim: It is aimed to reveal the mental images of the environment based on the students' readiness levels.

Materials: A4 paper, dry paints.

Method:

- [ ] Augmented reality apps
- [ ] Experimental applications
- [ ] E-learning applications
- [ ] Observation
- [ ] Computational science applications
- [ ] Activities those content is brought through games
- [x] Activities those content is gained through artistic activities
- [ ] Collaborative group work
- [ ] Mobile apps
- [ ] Game-based apps
- [ ] Measurement and evaluation activities
- [ ] Field work
- [ ] Sporting events
- [ ] Other methods and techniques

Plan:

Questions are asked to srudents, such as

- When you think of environment and nature, may you say a sentence related to them?
- Can you say about the things which are in environment?
- Can you imagine the environment and nature for the future?

Time is given for thinking these questions. Meanwhile, A4 paper and dry paints are distributed to students. At the end of the period, students are asked to draw the environment and nature they dream. Students are asked to finish their pictures within the specified period.

References

Eurostat. (2021a). *EU SDG monitoring report 2021- assessment approach.* https://ec.europa.eu/eurostat/documents/276524/7736915/EU-SDG-methodology-2021.pdf/d5414981-8adb-ca19-e539-609dfe553bf7?t=1623344039383

Eurostat. (2021b). *SDG 4 'quality education'.* https://ec.europa.eu/eurostat/web/sdi/quality-education

Eurostat. (2021c). *SDGs & me.* https://ec.europa.eu/eurostat/cache/digpub/sdgs/index.html

Eurostat. (2021d). *Sustainable development in the European Union monitoring report on progress towards the SDGs in an EU context 2021 edition.* https://ec.europa.eu/eurostat/documents/3217494/12878705/KS-03-21-096-EN-N.pdf/8f9812e6-1aaa-7823-928f-03d8dd74df4f?t=1623741433852

Eurostat. (2021e). *Sustainable development in the European Union monitoring report on progress towards the SDGs in an EU context 2021 edition.* https://ec.europa.eu/eurostat/documents/3217494/12878705/KS-03-21-096-EN-N.pdf/8f9812e6-1aaa-7823-928f-03d8dd74df4f?t=1623741433852

Eurostat. (2021f). *SDG country scores.* https://ec.europa.eu/eurostat/cache/infographs/sdg-country-scores/

Göll, E., & LaFond, M. (2002). From Rio to Johannesburg and beyond: a long and winding road. *Local Environment*, *7*(3), 317-324.

Goodland, R. (1995). The concept of environmental sustainability. *Annual review* *of ecology and systematics*, *26*(1), 1-24. https://doi.org/10.1146/annurev.es.26.110195.000245

https://doi.org/10.1080/1354983022000001679

Icoz, O. (2015). Turkish chemistry teachers' views about secondary school chemistry curriculum: A perspective from environmental education. *Journal of Education in Science Environment and Health*, *1*(2), 79-87. https://www.jeseh.net/index.php/jeseh/article/view/8

Kurtulus, M.A. & Tatar, N. (2021). A bibliometrical analysis of the articles on environmental education published between 1973 and 2019. *Journal of Education in Science, Environment and Health (JESEH), 7*(3), 243-258. https://doi.org/10.21891/jeseh.960169.

Meadows, D. H. Et al. (1972). *The limits to growth.* New York: Universe Books.

Purvis, B., Mao, Y., & Robinson, D. (2019). Three pillars of sustainability: in search of conceptual origins. *Sustainability science*, *14*(3), 681-695. Retrieved from https://doi.org/10.1007/s11625-018-0627-5.

Tekbiyik, A. & Celik, M. (2019). Education for sustainable development in primary school: Improvement of students' ecocriticism skills. *Journal of Education in Science, Environment and Health (JESEH), 5*(2), 178-191. DOI:10.21891/jeseh.568716.

UN Documentation Centre. (1992). *Report of the United Nations conference on environment and development - A/Conf. 151/26 (Vol. I).* Retrieved from https://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_CONF.151_26_Vol.I_Declaration.pdf

UNCED. (2015). *United Nations Sustainable Development Summit (A/RES/70/1).* Retrieved from https://sustainabledevelopment.un.org/post2015/summit,

Unesco. (1977). *Intergovernmental Conference on Environmental Education organized by Unesco in co-operation with UNEP Tbilisi* (USSR). 14-26 October 1977. Retrieved from http://www.gdrc.org/uem/ee/EE-Tbilisi_1977.pdf

United Nations (1972). *Report of the United Nations Conference on the Human Environment, Stockholm, 5-16 June 1972.* Retrieved from http://www.un-documents.net/aconf48-14r1.pdf

United Nations. (1992). *Rio declaration on environment and development.* Retrieved from https://sustainabledevelopment.un.org/content/documents/Agenda21.pdf.

United Nations. (2002). *Report of the world summit on sustainable development*. South Africa (Johannesburg).A/CONF.199/20. https://digitallibrary.un.org/record/478154.

United Nations. (2015a). *Resolution adopted by the General Assembly on 25 September 2015*. http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E

United Nations. (2015b). *#Envision2030: 17 goals to transform the world for persons with disabilities*. https://www.un.org/development/desa/disabilities/envision2030.html

United Nations. (2015c). *Transforming adopted by the general assembly on 25 September 2015 [without reference to Main Commmittee (A/70/L.1)]*. https://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E

United Nations. (2021a). *Communication materials*. https://www.un.org/sustainabledevelopment/news/communications-material/

United Nations. (2021b). *Department of economic and social affairs sustainable development*. https://sdgs.un.org/goals/goal4.

WCED/*World Commission on Environment and Development*. (1987). *Our common future*, Retrieved from http://www.un-documents.net/our-common-future.pdf..

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Chapter 4

Approaches to Environmental Ethics

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Approaches to Environmental Ethics

Today, environmental problems occupy a substantial part of the international agenda. The prospective precautions against such issues have led scientists to carry out research in related fields. Almost all studies inevitably point out “human” as the primary actor in both the prevention and the emergence of problems (Duran, 2021; Erten, 2008), which prompts scientists exploring the field of environmental education to sought answers to some fundamental questions: “How can people become environmentally conscious?”, “What does environmental awareness mean?”, “How can people adopt environmentally friendly behaviors?”, “What is the relationship between environmentally sensitive behaviors and attitudes towards environmental knowledge and the environment itself?”, “Do people have an ethical sense of their environments?”, and “What kind of dilemmas exist in such ethical sense?” (Erten, 2008). This section expands ethical understandings to find answers to the questions above.

Ethics

People tend to use the term “ethics” in two different ways. In its purest form, ethics is a set of standards (among other factors) we utilize to determine our acts. It is prescriptive in the sense that it tells us what we should or should not do and what values we should adopt. It also helps us evaluate whether something is good or bad, right or wrong. Ethics explains why anything is important to us; it is concerned with how and why we value certain things and what actions appropriately reflect those values (Nelson, 2002). It leads us to question the concepts “good” and “bad” and attempts to identify which behavior is good or right - bad or wrong - and to keep people away from bad or wrong behaviors regarding their relations with each other or their environments. It also encourages people to exhibit good and righteous behaviors. In other words, ethics prevent and limit people from doing whatever they want (Ergun & Cobanoglu, 2012) by drawing a framework for which rules must be followed to be a good person (Smith, 2018). Ethics symbolizes a compass and indicates the right directions on the road (Mahmutoglu, 2009).

Environmental Ethics

In the modern age, the world is described as a “big village;” thus, what happens in any part of the world becomes a phenomenon concerning humanity (Birden, 2016; Goz, 2011). In this sense, environmental issues have unfortunately taken place among the most important problems of humanity. Yet, it is not prudent to assert that states, communities, and organizations have responsibilities for such problems at diverse scales (see Figure 1).

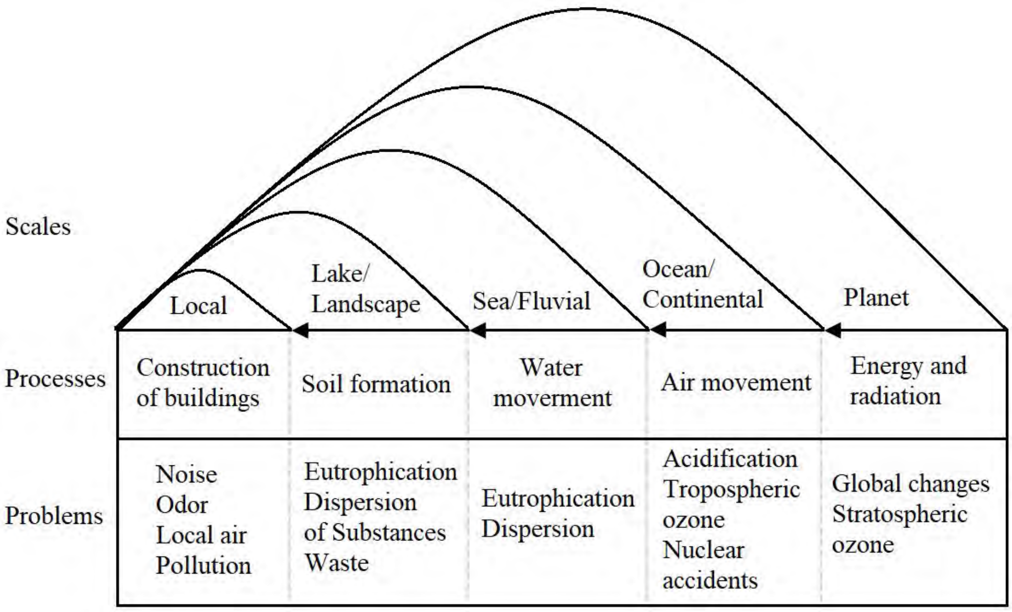

Figure 1. Geographical Scales of Environmental Problems; Proceses and Problems Characteristic for Local, Regional, Fluvial, Continental and Planetary Scales

The large and small environmental problems have proven that the environment should be preserved and improved (Basci Namli & Sever, 2018; Kayaer, 2013). Accordingly, some philosophical ideas and approaches have been proposed to solve these problems (Kayaer, 2013) since environmental problems are fundamentally philosophical and ethical issues by their nature (Nelson, 2002). In this respect, environmental ethics has emerged as a significant discipline due to increasing environmental problems and natural crises in recent years (Omay, 2019). Along with environmental problems (e.g., land exploitation, biodiversity loss, and pollution), ethical issues underlying them also come to the fore. In addition, complex philosophical concepts underlie conflicts over what we should do with the land, how we should value other species, and what policies we should enact to reduce pollution (Nelson, 2002).

Environmental ethics scrutinizes the relationships between humans and their ecological environments (Akkoyunlu Ertan, 1998; Ergun & Cobanoglu, 2012; Palmer et al., 2014; Sandler, 2013) and deals with the values in these relationships (Omay, 2019). It suggests people ask about which of their environmental behaviors are good and which are bad, adopt good behaviors, and avoid bad ones, which inevitably imposes limits to people's behaviors in their relationships with the environment (Ergun & Cobanoglu, 2012). In addition, it is concerned with shaping the human-nature relationship within social values and rules and human responsibilities regarding the questions starting with "what" and “who” (Karaca, 2007). A good many environmental issues, such as the conservation of endangered species, sustainable resource management, use of genetically modified crops, greenhouse gas reduction, population growth, and chemical pollution, are considered to be ethical subjects as well as economic or legal issues. Therefore, it is essential to assess the related policies and practices in terms of what is right and good, in addition to what is efficient or what fits specific purposes (Palmer et. al., 2014).

Environmental ethics is a part of applied ethics that examines the moral basis of our responsibility towards the environment. In this context, it seeks answers to the following fundamental questions (Naess, 1973):

What are the obligations of humans towards the natural world?

How are the benefits and fees resulting from complying with these obligations distributed?

What policies and institutional structures should be established to implement such obligations?

Bourdeau (2004) has brought specific answers to these questions. Regarding the first question, he states that we have obligations that impose quantitative and qualitative limits on our exploitation of nature. For the second question, he cites the argument of international justice and equality. Also, he responds to the question, “Can we say that developing countries are entitled to compensation for the exploitation of their natural resources by industrialized countries, both in terms of product and waste disposal?” For the third question, he questions whether there is a need for a worldwide structure beyond the existing regulations such as national and EU policies and international conventions.

Yang (2006) groups the features of environmental ethics under five headings. First, environmental ethics has a broad scope. It does not only include people in ethical concerns but also extends it to include animals and nature – the biosphere – as well as future generations, both now and beyond the immediate future. Second, environmental ethics is interdisciplinary. It has overlapping aspects with disciplines such as environmental policy, environmental economics, and environmental sciences. The different perspectives and methodologies of these disciplines make noteworthy contributions to environmental ethics; disciplines reinforce, influence, and support each other. Third, environmental ethics is plural. Since the day it appeared, it has always been a field where different ideas and perspectives compete. Anthropocentrism, animal liberation/ rights theory, biocentrism, and ecocentrism all provide unique and somewhat plausible ethical justifications for environmental protection. All these have different approaches with broadly same goals and agree that protecting the environment is everyone’s duty. Fourth, environmental ethics is global. The ecological crisis is a global problem because it is impossible to draw national borders for environmental pollution. To cope with the global environmental crisis, people must agree on certain values and cooperate at the personal, national, regional, multinational, and global levels since no country can solve the problem alone. Finally, environmental ethics is revolutionary. At the intellectual level, environmental ethics challenges the dominant and deeply rooted anthropocentrism of modern mainstream ethics and extends the object of our mission to future generations and non-humans (Yang, 2006).

Approaches

Increasing environmental awareness and social movements in the 1960s shifted the public interest to questions underscoring the ethical dimension of people's relationship with nature. In these years, several theorists thought that traditional ethical theories were unable to suggest satisfying explanations for such a relationship. Thus, the motivation for early studies in environmental ethics was the desire to formulate ethical theories that would better explain our moral obligations to the natural world. The inadequacy of traditional ethical theories was initially attributed to anthropocentrism, the assumption that humans and/or their interests are morally important on their own, whereas everything else is morally important only to the extent that it affects humans and/or their interests. According to early theorists, it cannot be claimed that humans have direct moral obligations to the natural world since morality is understood only as a matter of human obligations to one another. Therefore, such view/s focus on only one aspect of humans' relationship with the natural world and fail to capture the other dimensions. This situation can be explained by Richard Routley's "Last Man" argument. Routley establishes a hypothetical scenario where a disaster has killed all the other people in the world so that only one person survived. He then asks the question: If this person were to die too, and before he died, he had to press a button that would destroy life on Earth on his last breath, would it be morally wrong for him to do so? Routley proposes that anthropocentric theories will fail to explain why it would be morally wrong to push the button under these circumstances. If moral obligations arise from human interests, the moral obligations disappear when humans and their interests cease. In other words, if the natural world has value only insofar as it serves human interests, then it has no value when it stops serving human interests, and so there is nothing wrong with destroying it. However, the fact that the natural world has value independent of humans and/or their interests and that people have moral obligations at this point brings up environmental ethics rather than ethics for the use of the environment (McShane, 2009).

Professional environmental ethics emerged in 1970 with the increasing interest in the environment thanks to the effect of Earth Day. Many environmentalists were influenced by Aldo Leopold's "Land Ethic" and drew attention to the philosophical foundations of environmental problems. These environmentalists opposed instrumental arguments for nature conservation and even thought that these arguments are part of the problem.

Thus, they turned to the examination of non-human-centered intrinsic value arguments. Although the term “non-human-centered” causes some problems in definitions, the concepts “anthropocentric” and “instrumental” become synonymous. The non-human-centered intrinsic value theory is also examined both objectively and subjectively. While Paul Taylor and Holmes Rolston III are the proponents of objectivist theories of intrinsic value (Hargrove, 1992), J. Baird Callicott adopts a subjectivist standing (Ozer, 2017). The objectivist theory of intrinsic value argues that non-human beings have an intrinsic value even if humans do not value them. On the other hand, subjectivist theory draws attention to the necessity of being valued by people (Hargrove, 1992). The concepts “instrumental value” and “intrinsic value” are associated with the concepts “protection” and “conservation.” Is it right here to “protect” nature or to “conserve” it? In other words, should we protect nature for our needs? Or should we conserve nature and its components for its intrinsic value, without any benefit? Those who state that nature should be protected in line with human needs attribute instrumental value to nature and its components (Ozer, 2018). How to understand instrumental value has been the subject of little debate in environmental philosophy. In general terms, the instrumental value of an asset is the value it has to the point of being a means for another asset to achieve its goals. All the objects surrounding humans have an instrumental value, like musicians’ instruments as a means of making music or the equipment that doctors have for diagnosing diseases or performing surgery. Simply a shovel is a tool for someone to dig a hole. It is possible to list the types of nature’s instrumental values by human purposes as follows (Callicott, 2012):

1. Nature is valuable to humans as a source of various materials that we consume in various ways (e.g., food, fuel).

2. Nature is valuable to humans for its various services (e.g., nitrogen fixation).

3. Nature is valuable to humans as a source of aesthetic experience (e.g., wide sky, amber grain waves). It is also a source of inspiration (e.g., the solitude of the desert, the expanse of the ocean).

4. Nature is valuable to humans as an object of scientific studies.

Instrumental value is the value that something has as a means of achieving a desirable or valuable purpose. Different environmental assets have different types of instrumental value. For example, a plant species may have medicinal value, while another may not. An environmental asset may have different instrumental values to different people (or appraisers). For example, a rock face is instrumentally valuable to people who enjoy rock climbing (Sandler, 2012). On the other hand, those arguing that nature should be conserved, whether it is beneficial or not, without serving any purpose, attribute intrinsic value to nature, not instrumental. This approach proposes that nature and its non-human components are valuable on their own (Ozer, 2018). Regarding something as intrinsically valuable is to regard it as necessarily valuable in and for itself, whereas regarding it as instrumentally valuable is to consider it conditionally valuable to something else with intrinsic value (Burchett, 2014). O'Neil (1992) understands intrinsic value in three different senses. First, intrinsic value is expressed as a synonym for non-instrumental value. An object has instrumental value as long as it is a means to another end. Yet, an object has intrinsic value if it is an end in itself. Second, intrinsic value refers to the value of an object simply because of its 'intrinsic properties.' Third, intrinsic value is used synonymously with 'objective value,' meaning the value of an object regardless of those valuing it. This approach rejects the subjectivist view arguing the source of value of something is found in those who value it - in their attitudes, preferences.

Approaches to environmental ethics have emerged based on people's environmental perspectives mentioned above. These approaches are expanded under three headings: anthropocentric, biocentric, and ecocentric (see Figure 2).

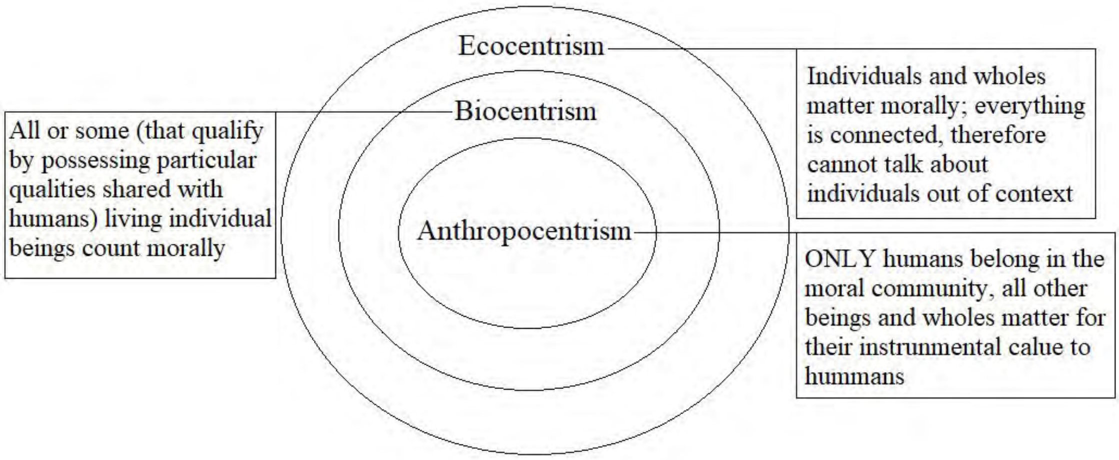

Figure 2. Moral Community in Approaches to Environmental Ethics

Anthropocentric Approaches

Anthropocentrism consists of the words "antro" (human) and "centrism" (center) (Oakley, 2007). Thus, etymologically, anthropocentrism means "human-centered." As such, it refers to the belief or worldview that humans are at the center of the universe. Anthropocentrism is enerally seen as the main cause of today's eco-crisis, overpopulation, and endangered species (Sarkar, 2012).

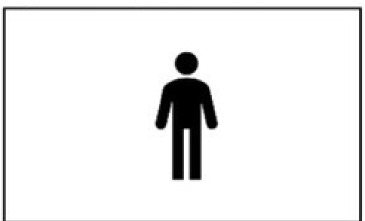

Figure 3.Anthropocentrism

Definitions for anthropocentrism are given below (Oakley, 2007)

"A human-centered perspective" (Adams & Donovan, 1999, p. 4) "Vested interests in the prospects of our own species; any moral perspective that takes humans as central or paradigmatic" (Benton, 1993, p. 75) "Any view that magnifies the importance of humans in the cosmos; for example, seeing it as created for our benefit" (Blackburn, 2005, p. 17) "The attitude that humans are the most important beings in the universe" (Brute Ethics, 2006) "To place humanity and human interests at the center of value" (Katz, 1997, p. 122) (anthropocentric): "considering humans as the center of existence" (Oxford Canadian Dictionary, 2006, p. 32) "Drawing frames at the human species frontier" (Plumwood, 1997, p. 328) "Human chauvinism: the idea that humans are the crown of creation, the source of all values, and the measure of all things" (Seed, 2000, p. 1) "The 'human superiority complex' that sees humans as superior or the apex of all life forms" (Smith, p. 2) "The view that humans are primary and central in the order of things" (Steiner, 2005, p. 1)

Anthropocentric ethics argues that only people have moral values (Gansmo Jakobsen, 2017). It emphasizes that the natural environment does not have an intrinsic (non-instrumental, non-derivative) value beyond humans (Kelbessa, 2005). Accordingly, the value of nature is measured by the benefits it provides and the happiness it gives to humans. To increase such benefits and happiness, it is considered legitimate for humans to do everything and utilize nature as they wish (Ozdemir, 1998). As a bias against other life forms, anthropocentrism does not accept that we, humans, are a part of these life forms and that they are a part of us (Drengson & Inoue, 1995).

The argument of mutual respect obligation presupposes a moral community that includes (potentially) all humans (but until recently excluding all non-human organisms) (Traer, 2019). Anthropocentrism regards humans as the most important life form and views other life forms as important only to the extent that they have a desirable effect on humans. Besides, anthropocentric ethics adopts a moral evaluation of nature because degrading or protecting nature can in turn harm or benefit people, respectively. In this understanding, for example, clearing rainforests is considered wrong because it contains potential treatments for human diseases (Kortenkamp & Moore, 2001). The anthropocentric view assumes the environment acts as a repository for raw materials beyond a holistic system; however, it ignores its situation of producing and supporting life and hosting the relations between all elements is not taken into account (Kirkpinar Ozsoy & Cini, 2020).

Anthropocentric people's motivation for protecting the environment is to increase their quality of life and maintain human life; the environment should be protected as long as it is for the benefit of humans. Environmental problems should only be prevented and resolved as they threaten human health. Besides, natural resources need to be used economically so that future generations do not have environmental problems.

Anthropocentric attitudes are based on utilitarian philosophy (Erten, 2007; Erten & Aydogdu, 2011).

Examples of anthropocentric approaches include stewardship, enlightened anthropocentrism, weak anthropocentrism, reformist anthropocentrism, and modern anthropocentrism.

Stewardship

John Passmore refers his belief in humans' responsibility to nature to Plato's Phaedrus who states, "It is always the responsibility of the animate to take care of the inanimate," and the neo-Platonian Iamblichus, who deduced from this passage that humans were sent to Earth by God to "rule the things in the world" and care for them in the name of God (Passmore, 1974, as cited in Attfield, 2016). Passmore argues that there is no need for new environmental ethics; values are always anthropocentric and created by humans (Passmore, 1974, as cited in Vena, 2009). From this point of view, he states that humans can serve and steward animals in a compassionate way, even if it is for their own interests; therefore, they can lead a life in harmony with animals (Tont, 1996). Stewardship supports the myth that humans can control and, thus, "rule" nature. Yet, it is likely to create new problems rather than settling old ones. It assumes that humans have a God-given responsibility to rule, develop, dominate, subjugate, or direct the world (Vena, 2009). The steward humans, as Passmore puts forward, are the ones fulfilling their responsibilities towards nature. While they fulfill these responsibilities, they are not affected by the intrinsic value of nature. In other words, they do not fulfill their responsibilities just because they respect the intrinsic value of nature or nature deserves it. Instead, they perform these responsibilities to make nature perfect for themselves (Akalin, 2019; Ertan, 2004). The stewardship proposes limiting the freedom of humans to act in their interactions with nature, after experiencing a period of excessive intervention in nature, overhunting for the benefit of humanity until several species are almost extinct, and indiscriminateness (Akalin, 2019). At the same time, Passmore states that environmental problems have reached an irreversible point and that an excessive consumer lifestyle cannot be maintained. However, he does not accept that this situation is caused by humans' hostile behaviors towards nature (Tont, 1996).

Enlightened Anthropocentrism

It is an ethical approach raised by Rene Dubos. Dubos (1973) reminds us that we must avoid placing humans in a predominant role over nature, but we cannot escape anthropocentrism. He also states that humans must love nature for their own sake and managing nature effectively (as cited in Scapple, 1998). According to enlightened anthropocentrism, there is no need for a new non-anthropocentric ethical model to solve environmental problems. Enlightened anthropocentrism argues that humans have the right to utilize the environment as they wish but assumes that the long-term interests of current and future generations require protecting the environment or ecological balances (Akalin, 2019).

Weak Anthropocentrism

Norton argues that we need constraints on traditional anthropocentric behaviors to regulate consumption habits instead of a new theory. This approach argues that nature should be protected without ignoring the needs and interests of people (Norton, 1984; Ozer, 2018) and criticizes nature-exploiting value systems. In addition, he asserted that although environmental problems are largely human-induced, it is also human beings who need to take responsibility for resolving these problems. In a world where humans exist, the protection of nature should again be realized by human involvement. The participation of the majority of humans can also be achieved not with a strict nature-centered perspective that equates humans with any component of nature but with a weak anthropocentric approach emphasizing the necessity of protecting nature for the sake of the existence of humans. In the weak anthropocentric approach, nature is valued only in its relationship with humans, which may take forms other than instrumental ones such as aesthetic, educational, or restorative (Norton, 1984).

Reformist Anthropocentrism

The reformist anthropocentric movement considers living beings that can suffer and, thus, values non-human beings too. This approach aims to prevent people from inflicting pain on living beings without any reason, distinguishing the reformist anthropocentric approach from other anthropocentric approaches. Bad behaviors towards animals will find humans as well, which may be explained by Immanuel Kant's statements in his article "Duties to Animals and Spirits" in "Lecture on Ethics" that one's mistreating a dog will increase the likelihood of mistreating other people. From this point of view, it is wrong to mistreat and despise animals not because of their intrinsic values but instrumental values. Animals continuing their lives in better conditions can serve humans more efficiently (Akalin, 2019).

Modern Anthropocentrism

Biologist W.H. Murdy states that it is anthropocentric to value the factors making us uniquely humans, seek to preserve and enhance these factors, and counteract the anti-human forces that threaten to reduce or destroy them. Nature other than humans will not act to protect human values; it is under humans' responsibility. Modern anthropocentrism is proposed as a valid and necessary perspective that humanity should adopt to assess its place in nature. Our current ecological problems arise not from an anthropocentric attitude per se but a too narrowly conceived one. Anthropocentrism is consistent with a philosophy that values all elements in nature. Valuing assets in nature for human interest is to consider them to be means of human survival or well-being, which is an anthropocentric perspective. As an instance, phytoplanktons become valuable when we recognize the key role of these organisms in providing free oxygen. Yet, continuous learning may lead to such awareness that no event in nature has an impact on the whole of which we are a part; therefore, we must value all elements in nature. The foundation of modern anthropocentrism is the recognition that an individual's well-being depends on the well-being of both their social group and the ecological system (Murdy, 1975).

Biocentric Approaches

Two closely related terms are commonly used under the non-anthropocentric umbrella: "biocentrism," which recognizes the intrinsic value of all living beings, and "ecocentrism," which emphasizes the intrinsic value of interrelated ecological systems, including humans (Quinn et. al., 2016). A group of non-anthropocentric environmental ethicists suggests that ethics should be expanded to include all living beings (Kelbessa, 2005).

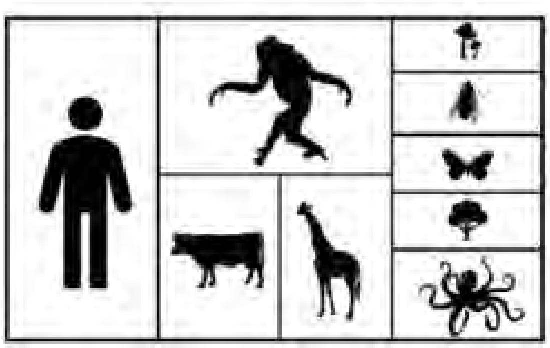

Figure 4. Biocentrism

Biocentric approaches expand the boundaries of moral importance to include other members of the biotic community, namely plants and animals. Besides, some philosophers advocate the principle of biocentric egalitarianism, in which humans are not only a part of nature but an equal part of it. Biocentrists also value ecosystems, but they do so on the grounds that protecting ecosystems will allow the protection of plants and animals (Karsli & Kurt, 2019; Thompson, 1998).

Biocentrism is a view contending that all living organisms should be respected (Ergun & Cobanoğlu, 2012; Rolston, 2012). It is sometimes understood as naturalistic or non-anthropocentric ethics. Opponents of anthropocentric views emphasize that the root cause of the ecological crisis and bad behaviors towards non-human creatures is the tradition of interpreting the world and nature with upon anthropocentric perspective. In general, biocentrism refers to the ethics of respect for life and focuses on all living beings, including plants, microbes, and animals. In this approach, only humans or superior animals that can suffer are not central to ethics. The key question here is not “Can it suffer?” but “Is it alive?” (Rolston, 2012).

Among the biocentric approaches, respect for life, respect for nature, the Gaia hypothesis, and the animal rights theory are discussed below.

The Ethics of Respect for Life

It is an approach raised as an alternative to limiting environmental ethics to animals only. It adopts the view that all living beings on Earth have the right to self-actualization, just like human beings. It is, therefore, the life that must be glorified. Reagen and Schweitzer lead the way of this approach (Ozdemir, 2017). Albert Schweitzer expresses the concepts of good and bad as preserving and promoting life and destroying or hindering it, respectively. Schweitzer considers the preservation and promotion of life and any attempts to increase the possibilities in life to be the essence of goodness. On the other hand, destroying, harming, and hindering the promotion of life are the essence of evil. Schweitzer’s “Respect for Life” encompasses all living creatures, rejecting the view that only humans have value and importance. This approach embodies compassion for all living beings, love for life, sympathy, empathy, peace, and the power of forgiveness (Armstrong & Boetzler, 1993, as cited in Ozyol, 2013). Love is a significant component of respect for life since the disposition of all living beings is fertilized with love (Schweitzer, 1966, as cited in Eren, 2015). Schweitzer rejects the anthropocentric value understandings and puts all living beings on the basis of his approach. Whereas he finds life sacred, he accepts that it may be necessary to kill in some cases to survive. In the case of ending a life, it is needed to have a clear thought about the necessity of this act. For example, a scientist conducting experiments on animals should question whether it is vital to kill an animal during the research (Armstrong & Boetzler, 1993, as cited in Ozyol, 2013). The respect for life extends the moral community to include all living beings, especially animals; however, inanimate objects are not included in this scope. In this approach, inanimate elements are valuable to living beings only for their benefit. It is an example of a non-strict and individualistic biocentric approach (Ertan, 2004).

The Ethics of Respect for Nature

Paul Taylor is another representative of bicentric ethics. While similar to Schweitzer’s views, Taylor offers more robust justifications for the valuation of life. Respect for nature examines the relationships between humans and other living beings and accepts that all living organisms have an intrinsic value. In this approach, all living organisms are good in their own right simply because they exist; it cannot be considered whether they have any value to humans (Des Jardins, 2013). Taylor distinguished his standing from anthropocentric approaches, thanks to the view that respecting the rights of animals and plants is as important as respecting the rights of humans (Keles & Ertan, 2002).

The Greek word "telos," meaning "purpose" or "goal," is a concept central to Aristotle's philosophy of life. According to Aristotle, all living beings (and many inanimate objects) have a telos. In Taylor's biocentric view, neither the human telos is superior to the telos of any other creature nor vice versa. Besides, environmental ethics provides a framework of principles that allows us to broaden our moral sensibilities regarding the broader association of animals, plants, and even geological features known as biomes or ecosystems in environmental science (Gudorf & Huchingson, 2010).

Humans' duties to respect the harmony of natural ecosystems, protect endangered species, and prevent environmental pollution stem from the fact that there are always ways to help wild species populations survive and maintain a healthy life in a natural environment. Such obligations arise from recognizing their innate values; this approach always advocates that a living being has intrinsic value. Each organism, population of species, and community deserves well-being, and the well-being of a non-human organism occurs to the extent that it is strong and healthy. It has all the capacities it needs to successfully cope with its environment and, thus, survive throughout the various stages of its life cycle. Humans can help or hinder the well-being of a living being. For example, trees may be harmed by human actions or offer benefits to them.

Another point is intrinsic value. Since each living being is a being with its own good, it must be considered (principle of moral consideration). Moreover, regardless of what type of being it is, if it is a community member in natural ecosystems, the realization of its well-being indicates that it is intrinsically valuable (the intrinsic value principle). Once any organism, species population, or community is recognized as an entity of intrinsic value, it is no longer treated as though it were merely an object or as something whose entire value lies in being a means of the well-being of another. The duties owed to wild organisms, species populations, and communities in natural ecosystems are based on their intrinsic values (Taylor, 1981).

Respect for nature encompasses four fundamental concepts (Yilmaz, 2014):

1. Not doing evil corresponds to not doing bad things to any organism and avoiding any behavior and action that will cause harm. It is primarily the responsibility of humans.

2. Non-interference means not interfering or restricting the freedom of the entire ecosystem and the living beings in it, not depriving them of their health and food.

3. Loyalty condemns evil behaviors, betrayal, or deception to living beings in nature because such behaviors will be disrespectful to nature. Accordingly, all kinds of hunting should be questioned.

4. Restorative justice refers to that a living being does not have the right to kill another or itself. It is predicted that the one harming the justice will compensate for the damage.

The Gaia Hypothesis

The Gaia hypothesis was first proposed by James Lovelock, a British atmospheric chemist, in 1969 and supported by the microbiologist Lynn Margulis (Lovelock et al., 2004). In 1965, while working as part of NASA's planetary exploration team, Lovelock thought that an atmospheric analysis could be used to detect life on Mars. He also wondered what kept Earth's chemically unstable atmosphere stable, so suitable for life, and alive. Besides, the climate had always been tolerable, despite a 30% increase in sunlight since the Earth's formation. Such considerations led Lovelock to the hypothesis that living organisms regulate the atmosphere in their own interests, and he suggested the novelist William Golding Gaia as a name for this view. According to this view, Earth does not just host life but also is, in a way, life or organism itself (Lovelock, 2003).

Although the idea that Earth is a living being has quite ancient roots in Western thought, James Lovelock made the modern expression of the idea through the Gaia hypothesis in the mid-1970s. In fact, he believes that the planet creates a self-regulating environment that is also alive. Just as there is no point in valuing or respecting a brain cell or liver separately from the whole organism to which it depends for life, a proper approach to environmental ethics requires the whole world to be valued. Since humans, conceived of brain cells in the hypothesis, are the only morally conscious members of this community, they have a unique ability to restrain themselves in a way that is consistent with the continuing well-being of Earth being to which they belong. Such propositions have given rise to what might be termed the planet's consciousness in ethical accountability and capacity to feel pain and happiness. In short, Earth is recognized as a superior being with the rights that smaller beings have. For many philosophers, the Gaia hypothesis refers to the Earth's capacity to purify itself from destructive elements, just as a simpler organism that can eliminate potentially toxic liquid and solid wastes and attempts to eradicate cancers and infections (Nash, 1989).

The below are the fundamental concepts of the Gaia hypothesis (Lovelock et al., 2004):

1. Earth is the only living ecosystem powered mostly by solar energy.

2. Individual species and ecosystems function like organs of a body.

3. Humans have no exclusive place or role in Gaia.

4. Gaia is a system with many regulators.

5. The sole purpose is the tendency to maintain homeostasis.

6. Gaia is the result of evolution and works opportunistically

7. Organisms produce and maintain the current composition of the reactive gases of the atmosphere, surface temperature, and acidity/alkalinity.

8. Organisms may depend on minerals or produce them in their bodies, which is a fact that somewhat blurs the distinctions between animate and inanimate things.

Animal Rights Theory

Regan (1986) sees himself as an animal rights advocate as part of the animal rights movement. The movement has a number of goals, listed below:

- Complete abolition of the use of animals in science,

- Complete abolition of commercial animal agriculture,

- Complete abolition of commercial and sports hunting and traps.

Regan also disagrees with people advocating animal rights but supporting traditional animal husbandry while finding factory farming to be wrong and with those arguing that toxicity tests of cosmetic products on animals violate animal rights but that this is not the case in cancer research, and even he finds these thoughts wrong. He states that how animals are treated is not a detail that varies from case to case. In addition, he criticizes the system that regards animals as resources to be consumed or exploited for sports or money since anybody considering animals to be resources will not be worried about their loneliness, pain, and death. The perspective that animals exist for humans makes them insignificant if they do not benefit humans in any way (Regan, 1986).

As animal rights gained national attention in the late 1970s and 1980s, the issues raised by the movement largely concerned animals recruited in product testing and research, which might be due to the unquestioned acceptance of speciesism. In speciesism, humans tolerate atrocities if applied to members of other species that would offend if done to members of their own species. Speciesism allows researchers to see the animals on which they experiment not as living beings, suffering from pain but as ordinary equipment, laboratory tools. The exploitation of laboratory animals is part of the larger speciesism problem and is unlikely to be eradicated until speciesism itself is eliminated. “You say we’re cruel because we shoot deer,” the hunters say. “But you eat meat. What’s the difference other than you pay someone else to kill it for you?” “You oppose killing animals to dress their skin,” the furriers say, “but you wear leather shoes.” Experimenters may ask why people should object to killing animals to advance knowledge, although they accept killing animals to appeal to their tastes, and they may point out that if the objection is purely for pain, animals killed for food cannot live without suffering either. Bullfighting enthusiasts may argue that the death of a bull delights thousands of onlookers but that its death in a slaughterhouse gives pleasure to the few who eat it, and eventually, the bull in the arena may suffer more severe pain than the one in the slaughterhouse but is better treated for most of its life. Yet, a clear ethical principle has been established that can identify which practices affecting animals are right and which are wrong. This principle is that the interests of all animals should be considered equally. The principle of equal consideration of interests requires being vegetarian. At the same time, it is necessary to abandon animal products that cause the killing or suffering of animals. For example, one should not wear fur or buy leather products. In addition, this principle asserts that the difference between chicken and corn, which will benefit people, is "feeling pain." At this point, someone will surely ask, "How do we know that plants do not feel pain?" However, there is no reliable evidence that plants can feel pleasure or pain. Although unlikely, let's suppose that researchers have found evidence that plants do feel pain. If we have to suffer or starve, then we have to choose the less bad option. Probably because plants suffer less than animals, it is better to eat plants than animals (Singer, 2002).

The basis of biocentric ethics relies on the common capacities of humans and animals. However, this is not the case for insentient beings. In this sense, the problem of the limits of biocentrism is a question that is not easy to answer for Singer (Unsalan, 2019).

Ecocentric Approaches

Many environmental ethics supporters are uncomfortable with the philosophies of Singer and Regan. They do not see the focus on animals much better than the traditional moralists' obsession with humans. These critics agree that environmental ethics will require better treatment of animals, but such concern for animals stems from greater concern for nature. Yet, Singer and Regan think quite the opposite: their concern for nature stems from their concern for animals (Jamieson, 2008).

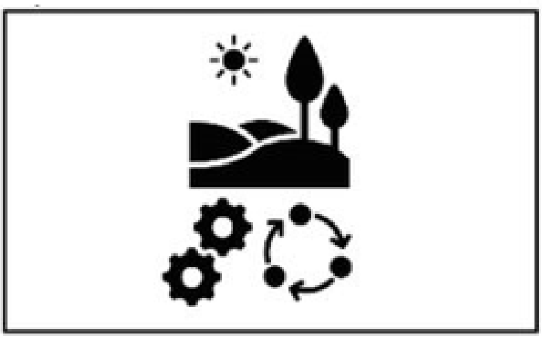

Figure 5. Ecocentrism

Beyond biocentric ones, the transition to ecocentric approaches appeared in important environmental conventions at the end of the twentieth century. Preambles of these conventions utter that nature/species/ecosystems have an intrinsic value (e.g., the 1992 Convention on Biological Diversity, the 1982 World Nature Declaration, the 1979 Bern Convention on the Conservation of European Wildlife and Natural Habitats (Wilkinson, 2005).

Land ethic and deep ecology among ecocentric approaches are explained in this section.

Land Ethic

Globalized environmental problems, such as global climate change, ozone layer depletion, global warming, decrease in biodiversity, acid rains, and deforestation, threaten Earth, which elevates the importance of Aldo Leopold's thoughts, who bring a new perspective to environmental ethics in preventing and eliminating these problems (Akkoyunlu Ertan 2015). The most important factor driving Leopold to philosophy was that he concluded that being conscious is not enough to protect the environment (Firat, 2003).

Leopold reveals the "Land Ethic" by retelling the story of Odysseus, who hanged a dozen of his female slaves for uselessness after returning from the Trojan War. In this story, Odysseus' action was not considered unethical or inappropriate, as slaves were properties of nobles. However, since then, ethics has evolved to a point where moral stance covers all people. The "Land Ethic" is Leopold's call to extend ethics to include soil, plants, and animals. The land is understood as pure property, like the slaves of Odysseus. People had privileges on lands but no obligations. An ecological understanding of land refutes Locke's view of land as property. This understanding mandates that land should no longer be treated as just an asset, a dead object that can be used and shaped however humans want. Instead, land should be viewed as a living organism that can be healthy or unhealthy, injured or killed (Des Jardins, 2013). Leopold unveiled the essence of his understanding with the words, "The land is not just land; it is a fountain of energy flowing through a circuit composed of plants and animals." Leopold uses the concepts of "biotic pyramid" or "land pyramid" to explain the mechanism in the land. Accordingly, plants absorb the energy from the sun to get the energy they need. The energy passes through a circuit called biota, which can be represented by a pyramid of layers. The bottom layer of the pyramid is soil. It continues with a layer of vegetation on the soil, a layer of insects on plants, a layer of birds and rodents on insects, and various animal groups until it extends at the apex to larger carnivores. The fact that the elements in the land pyramid are in harmony ensures that the functioning continues healthily (Leopold, 1968).

The Land Ethic recognizes inanimate nature elements, namely the land (Tont, 1996). It sees human being not as the ruler of the planet, but only as a member of the community connected to land (Ardogan, 2019). The Land Ethic should not be regarded from a purely philosophical point of view. Nor should it be considered a technical phenomenon that concerns agriculturalists or soil scientists; it concerns all humanity. The utilitarian perspective, where land is seen as an environment where food products are obtained, has begun to change because land contains and maintains biodiversity and regulates climate, water, and nutrient cycles. From this point of view, no living being on Earth can be considered independent of the effects of human beings and natural land dynamics since the lives and future of all living beings largely depend on the health of our land resources and the quantity and quality of the services offered by land (Temiz & Turgay, 2020).

Deep Ecology

The problems that may arise due to current and future harm to organisms inevitably have an ethical dimension. When it comes to answering the question of which living beings are superior in terms of better living, there are those claiming all living organisms, as well as those pointing out species, ecosystems, or the whole biosphere. Consequently, the concept of deep ecology has emerged within the efforts to find answers to such questions (Ozyol, 2013).

Rachel Carson's book Silent Spring introduced the deep ecology approach in 1962. Carson's thoughts are deemed important in guiding the deep ecology approach. However, Leopold's idea of land ethic formed the basis and was a source of inspiration for this approach (Session, 1995, as cited in Demir, 2020). Besides, Arne Naess became influential in the systematization of deep ecology by distinguishing shallow and deep approaches at the Conference on the Future of the Third World held in 1972. Shallow ecology values assets in nature for their instrumental value, while deep ecology appreciates their intrinsic values. Any asset in nature cannot be valued in terms of its value for human use. Every living being is a member of Earth; that is why it has value. When considered in terms of human benefit and/or use, it is likely to reduce the diversity and number of plants that are not useful in fields, such as agriculture and medicine; thus, creating a relationship of exploitation and oppression (Demir, 2020). The table below presents the distinction between shallow and deep ecology (Tamkoc, 1994).

Shallow Ecology Formulation	Deep Ecology Formulation
1. Diversity in nature is a valuable resource for humans.	1. Diversity in nature is a valuable resource in itself.
2. It is nonsense to mention values that are not for human beings.	2. Considering "value" only to be value for humans is a racial bias.
3. Plant species are valuable because they are used to benefit humans, medicine, and agriculture.	3. Plant species should be protected because their values are in their essence.

4. Pollution must be stopped if and only it affects economic growth	4. Stopping pollution must come before economic development.
5. Population growth in developing countries endanger the ecological balance.	5. The increase in the world population endanger the ecological balance. However, the populations and behaviors of developed countries are more dangerous.
6. “Resource” refers to a helpful resource for humans.	6. “Resource” means the source for all life.
7. Humans cannot accept a large-scale regression in their standards of living.	7. People should not settle for the decline in the standard of living of the overdeveloped nations but the decline in the general quality of life.
8. Nature is cruel, and it should be.	8. Humans are cruel and need not be.

Naess (2005, pp. 7-9) compared shallow and deep ecology considering pollution, resources, population, cultural diversity and appropriate technology, land and sea ethics, and education and science.

Pollution:

Shallow ecology: The technology aims to purify air and water and spread pollution more evenly. Laws limit pollution. The polluting industries are preferably exported to developing countries.

Deep ecology: It considers pollution from a biospheric perspective; thus, it focuses not on the effects of pollution on human health but life as a whole, including the habitats of all species and systems. For example, instead of investigating trees that tolerate acidity in acid rains, it puts the struggle against the economy and technology that creates this situation. It fosters the view that exporting pollution is not only a crime against humanity but also against life.

Resources:

Shallow ecology: In this view, Earth’s resources belong to those who have the technology to exploit them. Animals, plants, and natural assets are valuable to the extent that they are useful to humans. They can be destroyed by indifference unless they are for human use.

Deep ecology: No natural object is considered just a resource. Emphasis is placed on an ecosystem approach rather than considering only isolated life forms or local situations.

Population:

Shallow ecology: An increase in the number of humans is considered a value in itself or economically profitable. Severe reductions in wildlife forms tend to be accepted as long as species are not driven to extinction, despite the destruction of wildlife habitats caused by increased human populations.

Deep ecology: Extreme pressures on living conditions are considered to result from the explosion of the human population. Pressure from industrial societies is an important factor, and population reduction should be a high priority in developing countries as well as in these societies. It is recognized that there should be a long-term reduction in the human population through moderate but persistent political and economic measures.

Cultural diversity and appropriate technology:

Shallow ecology: Industrialization as in the West is recognized as a target for developing countries. Universal adoption of Western technology does not adversely affect cultural diversity in today's non-industrial societies.

Deep ecology: Cultural diversity is the human-level equivalent of the biological richness and diversity of life forms. Industrial societies should place a high priority on cultural anthropology in education. The impact of Western technology on non-industrialized countries should be restricted.

Land and sea ethics:

Shallow ecology: Lands, ecosystems, rivers, and other wholes of nature are fragmented, and larger units are not taken into account. These parts are considered the properties and resources of individuals, organizations, or governments. Conditions, such as reducing land or groundwater quality, are seen as a loss to humans.

Deep ecology: Earth does not belong to humans. The lands, rivers, and fauna and flora of any country and the surrounding sea are not the properties of the citizens of that country. Humans live only on the land, using resources to meet their vital needs. Humans can surrender if their non-vital needs clash with the vital needs of non-human life forms.

Education and science:

Shallow ecology: As global economic growth makes further disruption inevitable, there will likely be a need for manipulative technology. Scientific attempts should continue to prioritize positive sciences, requiring high educational standards and intense competition in related learning areas in positive sciences.

Deep ecology: Education should focus on increased sensitivity to non-consumption goods and products that are consumable for all, provided that reasonable ecological policies are adopted. Besides, there should be a shift from positive sciences to social sciences.

Naess (2005) outlined eight basic principles regarding deep ecology.

1. The well-being and development of human and non-human life on Earth have value in themselves. Their values are independent of the usefulness of the non-human world for human purposes.

Ecological processes on the planet must remain intact, as a whole. "The world environment must remain 'natural'" (Gary Snyder). The term life is used in a broad and non-technical way, not as it is known in the literature but also for rivers (watersheds), landscapes, and ecosystems that biologists classify as "non-living." Slogans, such as "Let the river live" expressed by supporters of deep ecology, may be examples of the meaning of this term.

2. The richness and diversity of life forms contribute to the relationship of these values and are considered "values" in themselves.

Species of plants and animals characterized as simple, lower, or primitive mainly contribute to the richness and diversity of life. They have value in themselves and should not be seen as steps towards higher or rational ways of life.

3. Humans have no right to reduce this richness and diversity except to meet their vital needs.

The term vital need is left ambiguous. Along with differences in climate and related factors, differences in the currently existing structures of societies should be considered (e.g., the Inuit need snowmobiles today to meet their vital needs; the same cannot be said for tourists).

4. The development of human life and cultures is in line with the significant reduction of the human population. The development of non-human life also requires such a reduction.

Humans in developed countries cannot be expected to reduce their excessive intervention in the non-human world to a moderate level overnight. It will take time and strategic efforts to stabilize and reduce the human population.

5. The current human intervention in the non-human world is excessive, and the situation is rapidly deteriorating.

Humans have changed the world and will likely continue to do so. Yet, what is at issue is the nature and scope of such interference. The struggle to protect and expand wild or near-wild areas should continue and focus on the overall ecological functions of these areas.

6. Therefore, policies must be changed; these policies will affect fundamental economic, technological, and ideological structures. The resulting situation will be somewhat different from the current one.

Economic growth conceived and practiced by industrial states today is incompatible with principles 1-5. There is little overlap between ideal forms of sustainable economic growth and current policies of industrial societies. Moreover, the concept of "sustainable" is still human-oriented. Although there are expressions, such as "self-determination," "local community," and "think globally, act locally," uttered within societies, global action is required for profound changes.

7. Ideological change will mainly be towards the valorizing quality of life (being with an intrinsic value) rather than adhering to increasingly higher standards of living. There will be a deep awareness of the difference between great and sublime.

Some economists criticize the term quality of life for being vague. What is important to quality of life cannot be adequately measured and need not be.

8. Those who agree with the above are obliged, directly or indirectly, to attempt to implement the necessary changes. It is this principle that emphasizes the importance of deep inquiry as a process of following/developing/legislation of other principles.

Of course, there are various opinions on points such as "What should be done first?" "What should be done next?" "What is most urgent?" "What is not urgent but necessary?".

Naess calls anyone who endorses these principles a "supporter" of the deep ecology movement. Naess emphasizes that those who support these principles can do so from a wide variety of different ultimate views. Just as birds build different kinds of nests in different habitats, human cultures growing by respecting the values of their ecological spheres have developed various forms of practices, technologies, and social orders (Drengson & Inoue, 1995).

In general, deep ecology is based on the principle of biospheric equality (Naess, 1973). Accordingly, every being on Earth has the right to live equally and realize themselves (Sakaci, 2013; Smith, 2018); therefore, they have an equal intrinsic value. However, no instrumental value can be attributed to them (Sakaci, 2013). On the other hand, deep ecology is criticized for the equality principle, which includes the effort to equalize all beings. In addition, deep ecologists' describing primitive cultures as ideal habitats is another subject of criticism. While appraising primitive cultures as the most suitable society for environmental ethics, it is thought that all of these societies do not have an environmentalist ethical understanding in the sense advocated by deep ecologists (Yayli & Celik, 2011).

Environmental ethics approaches are examined under anthropocentric, biocentric, and ecocentric approaches. Below is a comparison of these approaches.

Anthropocentrism	Biocentrism	Ecocentrism
Anthropocentrism is the belief that considers human beings are the most important entity in the universe or earth	Biocentrism is the belief that all living beings have an inherent value	Ecocentrism is the belief that considers ecosystems including both living and non-living components have inherent value
	HUMAN BEINGS	
Humans have greater intrinsic value than other species	Humans do not have a more inherent value than other species	Humans do not have more inherent value than other things
	SYSTEM	
Human centered	Centered on all living organisms	Nature or ecosystem centered

To summarize these approaches, anthropocentric approaches adopt the understanding of protecting the environment as long as it benefits people. Biocentric ones also attach importance to other living beings other than humans and propose that these beings have value. Ecocentric approaches, on the other hand, argue that all living and non-living assets are valuable.

Eco-Friendly Person Activities

Activity

Students are divided into groups. Each group is given the text below and asked to read the text. They are expected to find an answer to the question at the end of the text.

The village, where you work as an administrator, hosts dozens of species and has walking paths. Wild monkeys, which are among these living species and roam freely on the walking paths, are very popular among tourists visiting the village. Tourists feed the monkeys they encounter on the walking paths with the food they bring with them. Over time, this situation has made monkeys addicted to these foods, and they have begun to demand foods from humans. In cases where humans do not want to share their foods with the monkeys, from time to time, they try to capture these foods. A new one of these events occurred at the end of this week, and a monkey trying to capture the fruit from a family's little child on the walking path caused the child to be afraid. The father, who saw his child crying, took the monkey away from there.

As the village administrator, you need to find a solution to this issue. What is your solution?

Groups are asked to present their solutions to the problem. Then, group discussions help identify which of these solutions is an effective one. Then, the solutions may be classified according to anthropocentric, biocentric, and eccentric ethical understandings.

Figure 6. Comparison of these Approaches to Environmental Ethics

References

Akalin, M. (2019). Çevre etiği. Çevreye felsefi yönelimler. İksad Yayınevi .

Attfield R. (2016) Stewardship. In H. ten Have (Ed.), *Encyclopedia of global bioethics*. Springer.

Akkoyunlu Ertan, K. (1998). Çevre etiği. *Amme İdaresi Dergisi, 31*(1), 125-139.

Akkoyunlu Ertan, K. (2015). Leopoldcü düşünce ve yeryüzü (toprak) etiği. *Memleket Siyaset Yönetim, 10*(23), 1-20.

Ardogan, R. (2019). Çevre felsefesi. In F. Ozkan & I. Altuner (Eds.), *Felsefeye giriş sistematik düşüncenin kodları* (pp. 264-279). KLM Yayınları.

Basci Namli, Z., & Sever, R. (2018) Çevre eğitiminde etik ve değerler. In R. Sever & E. Yalcinkaya (Eds.), Çevre eğitimi (pp. 335-348). Pegem Akademi.

Birden, B. (2016). Çevre etiğinde bireyin ahlaki sorumluluğuna kısa bir bakış. *Türkiye Biyoetik Dergisi, 3*(1), 4-14.

Bourdeau, P. (2004). The man-nature relationship and environmental ethics. *Journal of Environmental Radioactivity, 72*(1-2), 9–15.

Burchett, K. (2014). Anthropocentrism and nature. An attempt at reconciliation. *Teoria-Rivista di Filosofia, 34*(2), 119-137.

Callicott, J. B. (2012). Intrinsic and instrumental value. In R. Chadwick (Ed), *Encyclopedia of applied ethics* (pp. 760-768). Elsevier.

Demir, A. B. (2020). Yeryüzü ile yeni bir ilişki: Biyosantrizm ve derin ekoloji. *Felsefe Arkivi*, 52, 97-111.

Des Jardins, J. R. (2013). *Environmental ethics. An introduction to environmental philosophy*. Wadsworth.

Drengson, A., & Inoue, Y. (Eds). (1995). *The deep ecology movement: An introductory anthology.* North Atlantic Books.

Duran, M. (2021). Perception of preschool children about environmental pollution. *Journal of Education in Science, Environment and Health (JESEH), 7*(3), 200-219.

Eren, M. (2015). Çevre sorunları karşısında sorumluluk etiği. *Kader Kelam Araştırmaları Dergisi, 13*(1), 423-437.

Ergun, T., & Cobanoglu, N. (2012). Sürdürülebilir kalkınma ve çevre etiği. *Ankara Üniversitesi Sosyal Bilimler Dergisi, 3*(1), 97-123.

Ertan, B. (2004). 2000'li yıllarda çevre etiği yaklaşımları ve Türkiye. *Yönetim Bilimleri Dergisi*, *2*(1), 93-108.

Erten, S. (2007). Ekosentrik, antroposentrik ve çevreye yönelik antipatik tutum ölçeğinin Türkçeye uyarlama çalışması. *Eurasian Journal of Educational Research,* 28, 67-74.

Erten, S. (2008). Insights to ecocentric, anthropocentric and antipathetic attitudes towards environment in diverse cultures. *Eurasian Journal of Educational Research.* 33, 141-156.

Erten, S., & Aydoğdu, C. (2011). Türkiyeli ve Azerbaycanlı öğrencilerde, ekosentrik, antroposentrik ve çevreye karşı antipatik tutum anlayışları. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi,* 41, 158-169.

Firat, A. S. (2003). Çevre etiği üzerine yeniden düşünmek. *Ankara Üniversitesi SBF Dergisi, 58*(3), 105-144.

Gansmo Jakobsen, T. (2017). Environmental ethics: Anthropocentrism and non-anthropocentrism revised in the light of critical realism. *Journal of Critical Realism, 16*(2), 184-199.

Goralnik, L., & Nelson, M. P. (2012). Anthropocentrism. In R. Chadwick (Ed), *Encyclopedia of applied ethics* (pp. 145-155). Elsevier.

Goz, K. (2011). Çevre ahlakı ve insan. *Artvin Çoruh Üniversitesi Orman Fakültesi Dergisi, 12*(1), 92-100.

Gudorf, C. E., & Huchingson, J. E. (2010). *Boundaries: A casebook in environmental ethics*. Georgetown University Press.

Hargrove, E. C. (1992). Weak anthropocentric intrinsic value. *The Monist*, *75*(2), 183-207.

Hens, L., & Susanne, C. (1998). Environmental ethics. *Global Bioethics, 11*(1-4), 97-118.

Jamieson, D. (2008). *Ethics and the environment: An introduction.* Cambridge University Press.

Karaca, C. (2007). Çevre, insan ve etik çerçevesinde çevre sorunlarına ve çözümlerine yönelik yaklaşımlar. *Çukurova Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, *11*(1), 19-33.

Karsli, G., & Kurt, M. (2019). Çevre etiği. In M. Kurt (Ed.), Çevre eğitimi (pp. 195-214). Eğiten.

Kayaer, M. (2013). Çevre ve etik yaklaşımlar. *Siyaset, Ekonomi ve Yönetim Araştırmaları Dergisi, 1*(2), 63-76.

Kelbessa, W. (2005). The rehabilitation of indigenous environmental ethics in Africa. *Diogenes, 52*(3), 17–34.

Keles, R., & Ertan, B. (2002). Çevre hukukuna giriş. İmge Kitabevi Yayınları.

Kirkpinar Ozsoy, N., & Cini, P. (2020). Antroposentrik küresel çevre politikalarının ekosentrik çevre etiği görüşü çerçevesinde değerlendirilmesi. *Alternative Politics, 12*(1), 20-49.

Kortenkamp, K. V., & Moore, C. F. (2001). Ecocentrism and anthropocentrism: Moral reasoning about ecological commons dilemmas. *Journal of Environmental Psychology, 21*(3), 261-272.

Latombe, G., Lenzner, B., Schertler, A., Dullinger, S., Glaser, M., Jaric, I., Pauchard, A., Wilson, J. R. U., & Essl, F. (2020). *A mathematical framework for dissecting the normative foundations of conservation decisions*. bioRxiv. https://doi.org/10.1101/2020.09.04.282947

Leopold, A. (1968). *A sand county almanac*. Oxford University Press.

Lovelock, J. (2003). Gaia: the living earth. *Nature, 426*(6968), 769-770.

Lovelock, J. E., Margulis, L., Lovelock, J., & Torres, P. R. (2004). *Scientists debate Gaia: the next century.* MIT Press.

Mahmutoğlu, A. Y. (2009). *Kırsal alanda çevre sorunlarına etik yaklaşım: Kırsal çevre etiği* (Doctoral dissertation), Ankara University.

McShane, K. (2009). Environmental ethics: An overview. *Philosophy Compass, 4*(3), 407-420.

Murdy, W. H. (1975). Anthropocentrism: A modern version. *Science, 187*(4182), 1168-1172.

Naess, A. (1973). The shallow and the deep, long-range ecology movement. *Inquiry,* 16, 95-100.

Naess, A. (2005). The deep ecology movement: Some philosophical aspects. In A. Drengson & H. Glasser (Eds.), *Selected works of Arne Naess, X* (pp. 33–55). Springer.

Nash, R. F. (1989). *The rights of nature: a history of environmental ethics*. The University of Wisconsin Press.

Nelson, M.P. (2002) Introduction to environmental ethics. In B*iodiversity project ethics for a small planet: A communications handbook* (pp. 40–53). Madison, WI: University of Wisconsin Press and the Biodiversity Project.

Norton B.G. (1984). Environmental ethics and weak anthropocentrism. *Environmental Ethics,* 6, 131–148.

Oakley, J. (2007). *Human-animal divide: anthropocentrism and education (Doctoral dissertation),* Lakehead University.

Omay, N. M. (2019). Çevre etiği ve asıl değer. In B. Gonencgil, T. A. Ertek, I. Akova, & E. Elbasi (Eds.), *1st Istanbul international geography congress proceedings book* (pp. 856-863). Istanbul University Press.

O'Neill, J. (1992). The varieties of intrinsic value. *Monist, 75*(2), 119–137.

Ozdemir, O. (2017). *Ekolojik okuryazarlık ve çevre eğitimi*. Pegem Akademi.

Ozer, M. (2018). "Niçin doğayı korumalıyım?" sorusuna iki olası yanıt. *Felsefe ve Sosyal Bilimler Dergisi,* 25, 519-533.

Ozyol, A. İ. (2013). Çevre etiği çerçevesinde *biopolitikaların oluşturulmasında katılımcılık* (Doctoral dissertation), Ankara Üniversitesi.

Palmer, C., McShane, K., & Sandler, R. (2014). Environmental ethics. *Annual Review of Environment and Resources,* 39, 419-442.

Quinn, F., Castéra, J., & Clément, P. (2016) Teachers' conceptions of the environment: anthropocentrism, non-anthropocentrism, anthropomorphism and the place of nature, *Environmental Education Research, 22*(6), 893-917.

Regan, T. (1986). A case for animal rights. In M.W. Fox & L.D. Mickley (Eds.), *Advances in animal welfare science 1986/87* (pp. 179-189). Springer

Rolston, H. (2012). *A new environmental ethics: The new millennium for life on earth.* Routledge.

Sakaci, K. B. (2013). Değer kavramı ekseninde derin ekoloji yaklaşımının çözümlenmesi. *Mülkiye Dergisi, 37*(1), 9-29.

Sandler, R. (2012). Environmental ethics, overview. In R. Chadwick (Ed), *Encyclopedia of applied ethics* (pp. 105-113). Elsevier.

Sandler, R. L. (2013). *Environmental virtue ethics.* International encyclopedia of ethics. https://doi.org/10.1002/9781444367072.wbiee090

Sarkar, P. (2012). *Anthropocentrism: A study inenvironmental philosophy* (Doctoral dissertation), The University of Burdwan.

Scapple, K. (1998). Is consensus necessary for effective environmental treaties?. *The Journal of Environment & Development*, *7*(4), 364-386.

Singer, P. (2002). *Animal liberation*. Harper Collins Publishers.

Smith, K. K. (2018). *Exploring environmental ethics: An introduction*. Springer.

Tamkoc, G. (1994). Derin ekolojinin genel çizgileri. *Birikim Dergisi,* (57-58), 87-91.

Taylor, P. W. (1981). The ethics of respect for nature. *Environmental Ethics, 3*(3), 197-218.

Temiz, C., & Turgay, O. C. (2020). Toprak sorunlarının çözümünde yeryüzü etiğinin rolü. *Türkiye Biyoetik Dergisi, 7*(3), 144-150.

Thompson, I. H. (1998). Environmental ethics and the development of landscape architectural theory. *Landscape Research, 23*(2), 175-195.

Tont, S. A. (1996). Çevre ve etik. *Bilim ve Teknik Dergisi,* 343, 18-21.

Traer, R. (2019). *Doing environmental ethics*. Routledge.

Udayangani, S. (2020, July 5). Difference between anthropocentrism biocentrism and ecocentrism. https://www.differencebetween.com/difference-between-anthropocentrism-biocentrism-and-ecocentrism/

Unsalan, F. (2019). Küresel ekolojik kriz ve felsefe: paradigmadan kaçış mümkün mü?. *Alternatif Politika, 11*(1), 86-112.

Vena, C. J. (2009). *Beyond stewardship: Towards an agapeic environmental ethic* (Doctoral dissertation), Marquette University.

Wilkinson, D. (2005). *Environment and law*. Routledge.

Yang, T. (2006). Towards an egalitarian global environmental ethics. *Environmental Ethics and International Policy,* 1, 23-45.

Yayli, H., & Celik, V. (2011). Çevre sorunlarının çözümü için radikal bir öneri: Derin ekoloji. *Selçuk Üniversitesi Sosyal Bilimler Enstitüsü Dergisi,* 26, 369-377.

Yilmaz, A. (2014). Yerel yönetimlerde çevre etiği üzerine incelemeler. *Kent Akademisi, 7*(17), 26-36.

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CHAPTER 5

Environmental Education in Out-of-School Settings

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The Place of Environmental Education in Science Teaching

Science is the process and effort of systematically examining nature and the environment we live in, the natural events and phenomena that occur here, and predicting what has not occurred. Science education, on the other hand, aims to raise individuals who act to produce scientific solutions to all the problems they encounter in daily life. The emphasis on daily life in science education comes from the interpretation that science is directly intertwined with nature and the environment and that it is daily life itself (Köseoğlu & Kavak, 2001). The current science curriculum considers it necessary that students realize the mutual interaction between people, society, and the environment and act with the awareness of sustainable development (Turkish Ministry of National Education, 2018).

Environmental problems are one of the greatest problems of daily life that require a solution be found on the world's agenda. Environmental problems occur as a result of the balance between all living and non-living factors being disrupted by human hands and activities. The most important feature of these problems is that they are global problems that concern all humanity regardless of gender, socioeconomic and sociocultural status, race, belief, language, or age and that harm all life (Erten, 2004; Erten, 2019; Escobar, 1995; Nag & Vizayakumar, 2005; Rees, 1995). What, then, is the solution to environmental problems? The answer to this question is quite unequivocally environmental education. Environmental education, which aims to raise environmentally aware generations, is an important tool for individuals to develop environmentally-friendly behaviors, protect the environment, and acquire all the knowledge, skills, values, attitudes, and abilities necessary to do this (Erten, 2002; 2004). A transdisciplinary process, environmental education increases students' ecological knowledge and instills positive attitudes toward the environment. In addition, it shows the entire process needed to turn these attitudes into behavior. Therefore, it addresses the cognitive, affective, and psychomotor domains (Erten, 2004; 2020). The main purpose of environmental education is to raise environmentally aware individuals. Environmental awareness encompasses attitudes toward the environment, environmental knowledge, and environmentally friendly behavior. Environmental knowledge is knowledge of environmental problems and the information necessary to fix them. Attitude toward the environment, on the other hand, means all positive or negative attitudes and thought developed regarding environmental problems. Environmentally friendly behaviors mean making it a habit to protect the environment (Erten, 2004). Environmental education is a tool for raising environmentally friendly individuals, and it is also a necessity for the future to create a sustainable society (Carson, 2007). Many studies say that students do not have sufficient environmental knowledge, their attitudes are not at the desired level, and they do not engage in environmentally friendly behaviors (Erten, 2002, 2003, 2005). To develop environmentally-friendly behavior, students need to participate in science teaching activities related to this subject. Both the design and the implementation of teaching activities are directly related to the curriculum. For this reason, examining curricula from the standpoint of environmental education will present a different perspective.

Environmental Education in the Science Curriculum

Education is the process of developing behaviors in the desired direction, and the ability to develop environmentally-friendly behaviors, teach environmental knowledge, and develop attitudes toward the environment is directly related to the curriculum, which is an important part of the education process. The place of environmental education, which is seen as the most important solution to a global problem, has become more evident both on the world agenda and in education policies and curricula in parallel with this (Alım, 2006). Curricula are undoubtedly important teaching tools in the planning and management of education and teaching processes, and in determining the behaviors that students will acquire. Defined as transdisciplinary, environmental education requires that curricula contain environmental goals and objectives that will cover all programs, not just the learning outcomes within the scope of science teaching. Environmental education in out-of-school settings is a process that is planned in line with a learning outcome and aims to support formal learning with informal learning. Therefore, the design and implementation of teaching processes in such settings are directly affected by the underlying approaches of science teaching programs.

Entirely from this perspective, two curricula that reflect the ecocentric and anthropocentric approaches are examined in detail under this topic heading. In this section, the ecocentric approach reflects the Canadian Science Curriculum (2007), and the anthropocentric approach reflects the State of Nebraska Science Curriculum (2011) in the United States. To do this, the concepts of ecocentric and anthropocentric first need to be discussed. According to Kortenkamp and Moore (2001), people's ethical understandings toward the environment are either ecocentric or anthropocentric in approach (as cited by Erten, 2007). For ecocentric individuals, the entire world is a value and these individuals are conscious of recycling, not using anything wastefully, and the efficient use of resources. Anthropocentric thinkers, on the other hand, are those who only care about environmental problems because they are affected by them. The attitudes of these people are mostly underpinned by utilitarianism and are limited to dealing with environmental problems so they do not adversely affect human existence (Erten, 2007; Erten & Aydoğdu, 2011).

Examples of environmental education in the Canadian and Nebraska Science Curriculum are given below. The learning outcomes of Turkey's 2018 Science Curriculum are also included to examine where Turkey stands between these two curricula.

Table 1. Canada, Nebraska and Turkey Science Curriculum Environmental Education Learning Outcomes

	TURKEY	
Subject	Unit	Outcomes
Creatures and Life	Energy Conservation and Environmental Issues	1. Discusses the causes and possible consequences of global climate change. *a. The greenhouse effect is explained. b. In the context of global climate change, how environmental problems can affect the future of the world and human life is questioned. c. Students are asked to express their predictions about the impact of environmental problems on the future of the world through artistic means. d. Students are made to calculate their ecological footprint (safe sites with such domain extensions as .edu, .org, and .mil may be utilized). e. The measures taken by the countries of the world to prevent global climate change (e.g., Kyoto Protocol) are touched on.*
	Sustainable Development	1. Takes care to use resources sparingly.
		2. Designs projects to use resources sparingly.
		3. Explains the importance of sorting solid waste for recycling.
		4. Offers solutions by using research data on the contribution recycling makes to the country's economy.
		5. Offers solutions by identifying the problems that may be encountered in the future if resources are not used sparingly.
		6. Discuss the importance of the conscious and economic use of electrical energy in terms of both family and national economy. *a. Studies carried out by official institutions and non-governmental organizations in our country on energy efficiency and what needs to be done in terms of electrical energy use are specified. b. The damage caused to the country's economy by the illegal use of electricity is emphasized.*
		7. Takes care to use electricity economically at home. Students are asked to do long-term studies to reduce their electricity bill, the process is monitored.
	NEBRASKA (USA)	
Subject	Unit	Outcomes
Social Studies	Flow of Matter and Energy in Ecosystems	GENERAL EXPECTATIONS Students will define the relationships in an ecosystem.
		1. Flow of Energy: Defines the roles of producers, consumers, and decomposers in an ecosystem.
		2. Ecosystems: Recognizes living and non-living factors that affect the survival of organisms in an ecosystem.
		3. Impact on Ecosystems: Acknowledges that all organisms cause changes in their environment, some beneficial and some harmful.
		4. Biological Adaptations: Defines the adaptations made by plants or animals to survive environmental changes.

Social Studies	Structure and Function of Living Systems	1. Impact on Ecosystems: Determines the positive and negative effects of human activities on an ecosystem.
	CANADA	
Subject	Unit	Outcomes
Understanding the System of Life	Interactions in the Ecosystem	GENERAL EXPECTATIONS 1. Evaluates the impact of human activities and technology on the environment and ways to manage these effects.
		2. Explores the interactions within the ecosystem and identifies all the factors that affect the balance between the different components of the ecosystem.
		3. Shows that he/she understands the interaction between biotic and abiotic factors in the environment.
		SPECIFIC EXPECTATIONS *1. Associating Science and Technology with Society and Environment* 1.1. Evaluates the effects of new technologies on the environment.
		1.2. Analyzes the costs and benefits of the strategies chosen to protect the environment.
		2. Developing Research and Communication Skills 2.1. Designs an ecosystem model. Uses this model to explain the interactions between biotic and abiotic components.
		2.2. Uses scientific process and inquiry skills to explain the events that affect the balance within the ecosystem.
		2.3. Uses the concepts of sustainability, biotic, ecosystem, community, and population in verbal and written communication.
		2.4. Uses different ways to communicate with different audiences for various purposes. E.g., designs a presentation that explains the reciprocal relationships between the biotic and abiotic components in a particular ecosystem.
		3. Understanding Basic Concepts 3.1. Defines ecosystem as a system of interaction between living organisms and their environment.
		3.2. Defines the biotic and abiotic elements in an ecosystem and their interactions.
		3.3. Defines the roles and interactions of producers, consumers, and decomposers within an ecosystem.
		3.4. Describes the energy transfer in a food chain and explains the effects of eliminating any part of the chain.
		3.5. Explains how matter and energy circulate in the environment and support sustainability.
		3.6. Explains why an ecosystem is limited by the number of living things.
		3.7. Describes how human activities and technology change the balances and interactions in the environment.
		3.8. Defines how Aborigines view sustainability.

Understanding Matter and Energy	Pure Substances and Mixtures	SPECIFIC EXPECTATIONS *1. Associating Science and Technology with Society and Environment* 1.1. Evaluates the positive and negative environmental effects related to the disposal of pure substances and mixtures.
Understanding Earth and Space Systems	Heat	SPECIFIC EXPECTATIONS *1. Associating Science and Technology with Society and Environment* 1.1 Evaluates the social and environmental benefits of technologies that reduce heat loss or transfer.
		1.2. Evaluates the environmental and economic effects of using traditional and alternative forms of energy.

In Canada's Science Curriculum, where the ecocentric perspective is clearly seen, it is seen that environmental education is included in almost all subject areas and units under the title of "Relating Science and Technology to Society and the Environment." This situation defines environmental education as a supradisciplinary process that should be extended to all educational processes, as can be seen in the learning outcome examples in Table 1. An example of the anthropocentric perspective, the approach in Nebraska's curriculum is completely different from that in Canada. This curriculum has been prepared based on the STEM approach. The STEM approach, which is based on solving daily life problems, is the continuation of the technological developments up to the present day, meaning, it is a philosophy underpinned by an anthropocentric understanding. Since the competition between societies is fundamental to this idea, people are more burdened with nature due to the technology race between countries and the need for more raw materials. This philosophy argues that man is the most important creature and has introduced many environmental problems that have brought the world to the point of extinction today. Recent studies show that there is a belief that STEM is only related to the disciplines that make up its name (Bybee, 2010). But, the Organisation for Economic Co-operation and Development-OECD 2006 report says that environmental science can be added to STEM as a discipline. This program, which is based on the amalgamation of science, technology, mathematics, and engineering disciplines, includes environmental education learning outcomes in a broad perspective only at the 5th-grade level. Other than that, there are no learning outcomes related to environmental education at the 6th- and 7th-grade levels, while there is only one learning outcome at the 8th-grade level. These learning outcomes are only in the Social Studies subject, where biology topics are fundamental. Whereas, in Canada's science curriculum, every subject area, every unit, and every learning outcome is treated with an environmental education dimension. In addition to all these results, it is seen that there are many differences between these two programs when it comes to environmental education. Another of these differences is the level of learning outcomes. In the Canadian Science Curriculum, the learning outcomes are those relating to the steps of analysis, synthesis, and assessment, which require high-level thinking and appeal to the cognitive, affective, emotional, and psychomotor domains. The state of Nebraska, however, takes only knowledge outcomes as a basis. Learning outcomes that require explanation and definition for ecological concepts take the form of environmental education outcomes. In our country's Science Curriculum, there are environmental education learning outcomes at every grade level. These outcomes do not belong only to the discipline of biology or the subject area of Creatures and Life. They are spread throughout almost every subject area. In this respect, it is similar to Canada. However, it is also seen that the learning outcomes in these subject areas are not in harmony with other outcomes. Many studies measure student achievement at the international level. One of them, PISA (The Program for International Student Assessment), is a study that measures the raising of scientifically literate individuals on a country basis and forms the basis of Turkish National Education's science curricula. In the first PISA exam held after the 2005 curriculum, in which environmental education started to be practiced in science teaching with the constructivist approach in Turkish National Education, Canada ranked first among OECD countries, while Turkey ranked 47th (OECD, 2006). The 2018 PISA results show Canada ranking 5th among OECD countries, the United States 13th, and Turkey 30th (OECD, 2019). All these results show the international success of the Canadian Science Curriculum, which is prepared with an ecocentric perspective.

The Place and Importance of Out-of School Setting in Science Teaching

Informal Learning and Informal (Out of School) Learning Environments

The aim of education in general, and formal and informal education in particular, is to ensure the personal development of individuals and become a contemporary society. Formal education is carried out in schools in a planned, programmed, and purposeful manner. Informal education, on the other hand, includes unplanned, random, and individual experiences. Informal learning environments are defined as learning environments based on communication and interaction, where students gain first-hand experience, individually and in groups, and share this experience with teachers, experts, families, and peers. Examples of out-of-school learning environments include such settings as zoos, botanical gardens, national parks, and industrial establishments (Diamond, 1986). It is very difficult to distinguish between formal and informal education concepts because they contain the same concepts in their definitions (Dierking, 1991; McGivney, 1999). This can be better demonstrated with an example. Consider a class of students who are taken to a botanical garden for environmental education. When these students approach the exhibitions in the botanical garden freely and without the influence of any authority, this type of learning is defined as informal learning. However, these students can participate in the planned teaching activities in the botanical garden accompanied by a guide. In this case, they will be taught in a teacher-centered and planned process. For this reason, this type of learning can be said to be closer to formal learning. For this reason, it is not possible to separate formal and informal learning distinctly (Eshach, 2007). To be able to define science teaching in informal (out-of-school) environments, it is first necessary to understand and explain the social details between formal and informal learning including physical details such as being in school and outside of school, and the communication between the teacher and the learner (Dierking, 1991; McGivney, 1999). Teaching science in informal (out-of-school) environments is the bridge between formal education and informal education, a way of bringing together formal and informal learning by creating experiences. These environments create a bridge between the school and the natural environment and contribute to making the best use of the students' potential (Hannu, 1993).

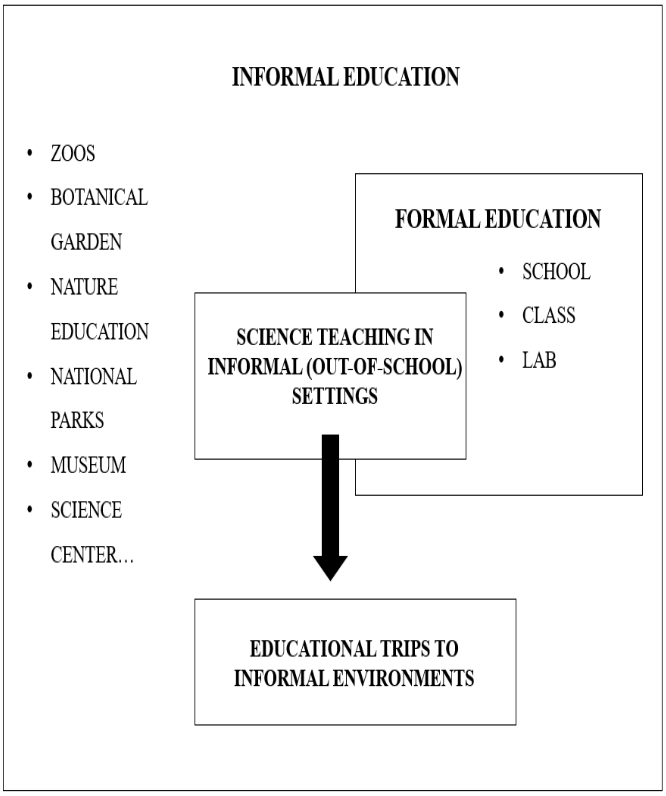


Figure 1. Formal, Informal Education and Science Teaching in Informal Settings

Generally speaking, learning is not a process to be confined between walls. For this reason, the activities to be carried out in out-of-school learning environments should be geared toward the learning outcomes in the science curriculum outside the school walls and should, therefore, be able to improve students' science learning (Karademir, 2018). Another important issue here is that students should be free in this process and involved in it by gaining first-hand experience (Han & Bilican, 2018; Ünsal & Karademir, 2017; Türkmen, 2010). Studies on science teaching in out-of-school settings suggest that the focus in teaching activities is fun and that this prevents the activity from serving any learning outcome (Rennie & McClafferty, 1996, Shortland, 1987, Wymer, 1991, Ansbacher, 1998, as cited in Eshach, 2007). The most important step to be taken here is for teachers to prevent this process from straying from the goal (Rapp, 2005, as cited in Bozdogan, 2008). According to Dewey, if the learner has fun and participates in the learning process by doing, this indicates that he is learning better (Eshach, 2007). In other words, learning is related to individual experiences. All this shows that when learners, driven by curiosity, contribute to the process by doing and experiencing and having fun, this contributes to them learning in a meaningful and lasting way. In other words, teaching science in out-of-school settings is much more comprehensive than a field trip and includes detailed design and implementation processes.

Effects of Out-of-School Learning Environments on the Science Teaching Process

Many studies examining how science activities that are planned and implemented effectively in out-of-school learning environments contribute to students' learning mention two positive effects. The first is the long-term effect. The long-term effect states that trips made with a learning objective in out-of-school learning environments are not forgotten for years (Anderson and Lucas, 1997, Duterroil, 1975, Falk & Dierking, 1992, Field, 1975, Peart, 1984, Wright, 1980, cited in). Piscetelli & Anderson, 2001). For example, Falk and Dierking (1997) revealed in their study that a trip made in primary school made an impression that lasted for years and that what was learned there was not forgotten during that time. The study reported that 0% of the individuals in the study group forgot the information they learned back then. Wolins, Jensen, and Ulzheimer stated in 1992 that the biggest reason for permanent learning in teaching activities done in out-of-school settings is learning by doing and students managing this process with a sense of curiosity. Another positive effect is the learning-enhancing effect. Many studies state that teaching science in out-of-school settings will not only provide cognitive but also affective and psychomotor development in students if an effective plan is prepared and implemented. The learning-enhancing effect is a reflection of a student-centered process. A learning environment that fosters learning by doing and experiencing is the basis of communication and social interaction. This interaction and communication should be between peers, teacher and student, child and family, in short, every individual in that setting (Davidson et al., 2010; Falk & Adelman, 2003; Randler, 2010; Randler et al., 2012; Tunniclife, 1998; Türkmen et al., 2018; Yardımcı, 2009). In addition, results show that the communication between the expert and the teacher while preparing the plan for the trip improves students' learning (Davidson et al., 2010).

Out of School Learning Activities, Design, and Implementation

For a science teaching activity in an out-of-school setting to be considered successful in terms of students' learning, an effective plan needs to be made and implemented (Hodge, 2004). In recent years, using out-of-school settings has been seen as an important part of science teaching programs and therefore the science teaching process. Important elements for a successful trip are a fully prepared plan, cost, ties to the curriculum, plus parental support and participation (Israel, 2000, Johnson, 2000, Kiefer 1998, cited in Hodge, 2004). A detailed plan of the activity before, during, and after the trip should be created for teaching science in effective out-of-school environments.

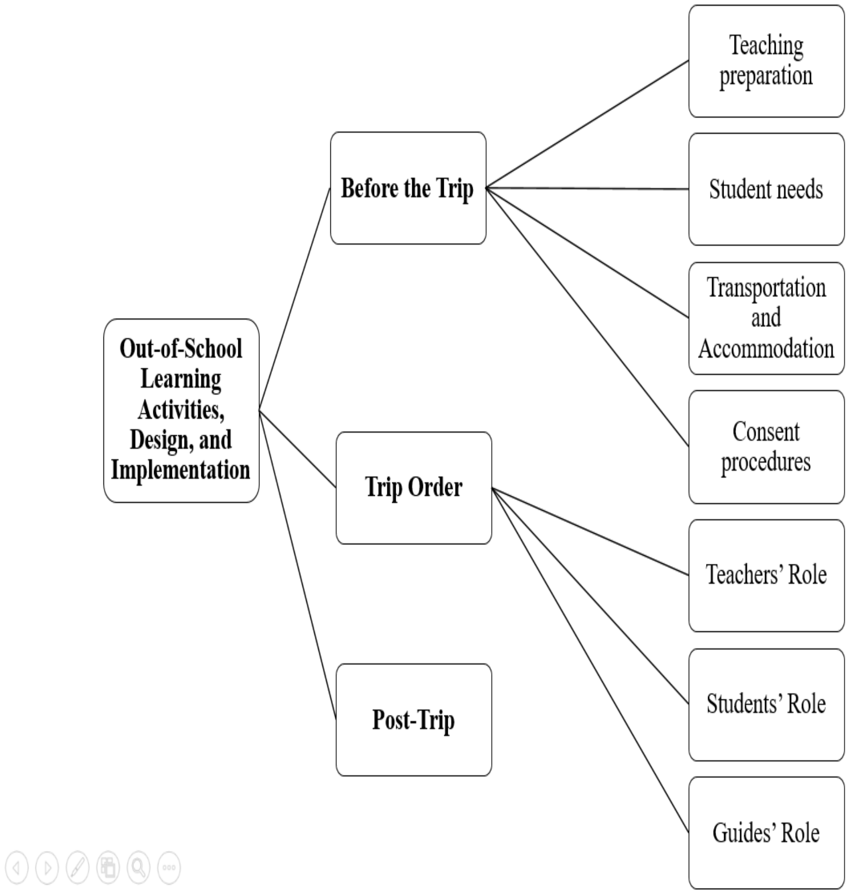


Figure 2. Out-of-School Learning Activities, Desing and Implementation

Before the Trip

The preparations made before the trip include the educational design, the physiological needs of the students, transportation and accommodation, and consent procedures. Effective planning beforehand directly affects how the process works both during and after the trip (Türkmen, 2010).

Teaching preparation: Teachers should first visit the learning environment where they plan to travel. First of all, information should be gathered about the quality of the education provided in the out-of-school setting, any exhibitions there, as well as plants and animals (Bozdoğan, 2014; Laçin-Şimşek, 2011; Orion & Hofstein, 1994; Türkmen 2010). Then, a learning outcome should be determined within the scope of the curriculum. In the 2018 science curriculum prepared by the Turkish Board of Education and used today, these learning outcomes are usually implicitly given. However, considering the scope and parameters of these curricula, teachers have to actively use out-of-school settings (Karademir, 2018). If we look particularly at the science teaching activity in out-of-school settings within the scope of environmental education, the activity's design process will be directly affected by the curriculum having an ecocentric or anthropocentric perspective. Any environmental education activity in out-of-school settings prepared for the learning outcome of a curriculum that has an ecocentric perspective will be a process that directly affects ecology knowledge, attitudes, and behaviors to improve students' environmental awareness. Environmental education learning outcomes in an anthropocentric curriculum will require lesson planning only to develop cognitive knowledge. The learning outcome examples given in Table 1 under the title Environmental Education in the Science Curriculum support this interpretation. For environmental education to be an effective process in out-of-school settings, teachers must have an awareness of the subject.

The next step should be preparing a lesson plan by establishing a relationship between the selected outcome and the chosen environment. This plan covers the outcome determined directly by the teachers in the science curricula, the basic concepts and skills associated with this outcome, the entire out-of-school learning environment, or the part of it that relates to the selected learning outcome (Bozdoğan, 2014; Laçin-Şimşek, 2011; Orion & Hofstein, 1994; Turkmen 2010). The next process is nothing more than a complete lesson plan. When making this plan, it is important to prepare a worksheet that will guide the students on the trip. This material should guide the students in the activity, increase their sense of curiosity, and assist their observations. In this way, the learning process will become directly student-centered (Laçin-Şimşek, 2011). After planning, an appointment should be made with the chosen environment by determining an appropriate time. Another task that teachers need to do is to inform students about the process (Bozdoğan, 2014; Laçin-Şimşek, 2011; Orion & Hofstein, 1994; Türkmen 2010).

Student needs: Care should be taken to ensure that there are places near the destination where individuals can meet their physiological needs such as food and toilet (Bozdoğan, 2014; Laçin-Şimşek, 2011; Orion & Hofstein, 1994; Türkmen 2010).

Transportation and Accommodation: At this time, transportation should be arranged, the starting time and the duration of the trip should be calculated, the number of students participating and the cost, if any, of this transportation should be determined, and its safety should be ensured in advance. If the chosen location for the trip is outside the city, a hotel/B&B should be arranged for accommodation (Bozdoğan, 2014; Laçin-Şimşek, 2011; Orion & Hofstein, 1994; Türkmen 2010).

Consent procedures: Teachers are required to obtain consent from the parents, school administration, and District/Provincial Directorates of National Education depending on the location of the trip. Each country's education policy has a different consent process

(Bozdoğan, 2014; Laçin-Şimşek, 2011; Orion & Hofstein, 1994; Türkmen 2010).

Trip Order

The trip order is the order in which the teaching takes place. The plan made before the trip is put into practice at this time. This process can be examined under the headings of teacher's role, student's role, guide's role. Teachers should not only keep the process under control but also ensure that it is student-centered. For students to achieve the objective at this time, the teachers need to use special teaching methods in line with the plan. The students need to undergo an appropriate experience to achieve this objective (Bozdoğan, 2008). Care should be taken to make this process as free as possible for students and not set too many tasks that will distract or tire them (Bozdoğan, 2014; Laçin-Şimşek, 2011; Orion & Hofstein, 1994; Türkmen 2010). Students must be actively involved in this process and interact with it. Students should experience this process as if it is a part of daily life, by doing and having fun (Bozdoğan, 2014; Laçin-Şimşek, 2011; Orion & Hofstein, 1994; Türkmen 2010). The guide is there to provide students with information about the location, the subject area associated with it, any exhibitions, objects, and creatures. For an ideal learning process, guides should avoid giving direct information to students. First of all, students should be offered the opportunity to gain experience by doing, experiencing, and exploring. (Bozdoğan, 2014; Laçin-Şimşek, 2011; Orion & Hofstein, 1994; Türkmen 2010). The exhibitions in the informal setting and their themes directly affect the guides' attitudes toward the students as much as the quality of the environment of discovery and active participation offered to the students. According to the literature, when a limited discovery environment is offered to the students, or they are given direct information by the guides, or they are unable to act freely in that setting, this results in them getting bored (Piscitelli & Anderson, 2001). In other words, simply taking students to an informal learning environment is not enough for meaningful learning. In addition, the relationship between the exhibitions and objects that students encounter in the informal learning environment and the subject covered must be established (Laçin-Şimşek, 2011).

Post-Trip

The post-trip process is important in terms of associating what was learned on the trip with the subject's terminology and getting the most out of it. In the post-trip process:

- ✓ Students should share their experiences on the trip and the information in the worksheet that guided the trip.
- ✓ Students' experiences and observations at this time should be associated with the terms and concepts of the underlying subject area. The place of these terms and concepts in daily life should be mentioned.
- ✓ The post-trip process can be done in the informal setting or on return to the

classroom. An assessment must be made at this time. This assessment is necessary not only for the students but also for the entire process and the teacher. As a result of the assessment, teachers will reveal the extent to which the stated objectives were met, where the students had trouble learning, what they could not learn, and their misconceptions. Teachers will learn from this to better plan the next trip by considering the positive and negative aspects of the entire process. They will be able to observe how the process affects students' achievement scores and attitudes. (Bozdoğan, 2008; Laçin Şimşek, 2011).

The Relationship Between Environmental Education and Out-of-School Learning Settings

The environment is defined as the setting in which all living and non-living entities interact and live in balance (Erten, 2004). The recent developments in science, and therefore in technology, particularly disrupt the balance of the environment, resulting in many environmental problems. All people regardless of age are affected by this situation. Undoubtedly, one of the groups most affected by the excessive and irregular urbanization we are facing today is children. Children today spend most of their time away from nature. Instead of playing games in natural settings, they prefer the games on computers, tablets, and phones offered by today's technology. For this reason, they are on their way to becoming individuals who are strangers to nature, know little about environmentally friendly behavior, and are not environmentally aware. The biggest reason for this is the decrease in natural areas, uncontrolled and unregulated urbanization, education systems and teaching programs that are not based on ecocentric thinking, and no steps being taken to address this shortcoming in children (Erten, 2004; Kahyaoğlu, 2016; Karataş & Aslan, 2012). In addition to curricula prepared on the basis of ecocentric thought, such as the Canadian Science Curriculum, there is also the school of thought that advocates an independent environmental education program by considering environmental education to be superior to all disciplines (Sokoli & Doka, 2004; Duan & Fortner, 2010). Although it is thought that this form of environmental education will be more effective in raising environmentally friendly individuals, it is not very common. After all, science is nature itself. Being away from nature, using only formal learning environments, and not being able to go outside the school walls shows that this process is lacking in science, in general, and in environmental education, in particular. This is because it is not possible to expect individuals who do not know the environment and are not part of the environment to protect the environment. Studies on this subject say in support of this comment that there is no connection between the theoretical knowledge covered by environmental education and the application of this knowledge in daily life (Bolstad, 2003; Barker & Lynnette, 2004; OECD/CERI, 2008). Environmental education should be student-centered rather than teacher-centered, the activities designed should be based on current educational approaches rather than direct theoretical knowledge transfer and supported by different learning environments. However, studies have revealed the importance of environmental education in out-of-school settings.

Carrying out environmental education in out-of-school settings will create a holistic view of the environment and will provide first-hand environmental information, which is necessary to create environmental awareness. During this process, students will understand the importance of the environment by freely doing, experiencing, and observing since they will participate in teaching activities in a more natural and social setting compared with formal learning environments. Students will form a physical and psychological communication bond with the natural environment and will be able to empathize. In addition, out-of-school learning environments come with an abundance of teaching materials. In this respect, out-of-school learning environments are likened to fun and free open-air laboratories where students obtain first-hand experiences and spend time socially in communication and interaction. This is an easier and more effective way of developing a positive attitude toward the environment and environmental friendliness because teaching activities carried out in out-of-school settings have both a long-term effect and a learning-enhancing effect. Today, it is crucial to raise ecologically literate individuals as well as develop environmentally-friendly behaviors and a positive attitude toward the environment. Ecologically literate individuals are individuals who are conscious of sustainable development, strive not to disturb the balance underpinning the environment, internalize the rules and limits of nature, and live their lives as a part of the environment. According to these individuals, the environment is superior to humans and it is the greatest legacy to be left to the future (Harrison, 2010; Küçük & Yıldırım, 2019).

The time that students spend in zoos, botanical gardens, nature education, camps, on field trips, and the experiences they gain increase their emotional bonds with the environment, their mindfulness and sense of responsibility toward the environment, and their social relations, as well as their cognitive development (Dresner and Mary, 1994; MacRae, 1990; Palmberg & Kuru, 2000). For example, let us consider an activity where students are to collect garbage during a trip in the forest. Although it may seem like a simple activity, the experiences that students will gain during this activity will make them think directly about environmental problems. In this way, the processes of researching and questioning environmental problems, in general, and waste and garbage problems, in particular, will begin. Then, the process will continue with assuming responsibility for nature, acting mindfully, and establishing a social bond with nature. As a learning outcome of this activity, students might not litter anywhere again. Environmental education in out-of-school settings will not only teach science by addressing the cognitive, affective, and psychomotor domains, it will also enable students to take many courses related to ethics (Woodhouse & Knapp, 2000). A historical review of environmental education in out-of-school settings shows that environmental protection-themed meetings held at the international level occupy an important place. The 1972 "Human Environment" conference held by the United Nations, known as the first organization to conduct studies on environmental conservation internationally, stands out. Similarly, the Tbilisi Declaration, published in 1977, in which environmental problems were brought to the agenda and environmental education was handled with the most up-to-date approaches, occupies an important place. Then, with the meeting held in Rio in 1992, the widest-ranging decisions regarding environmental education were made. In Turkey, after 1994, the first steps were taken toward the environmental education strategies outlined in the Seventh Five-Year Development Plan and the Tbilisi Declaration (Küçük & Yıldırım, 2019).

Another issue that needs to be discussed under this heading is undoubtedly the out-of-school learning settings that are suitable for the aims and objectives of environmental education. Zoos and natural life parks, botanical gardens, nature education, national parks, and industrial establishments are learning environments identified with environmental education in this sense. Zoos are natural parks with wild and domestic animals (Balkan-Kıyıcı, 2011); botanical gardens are learning environments that include plants, the groups formed by these plants, and the kinship relations between these groups (Nuhoğlu, 2011). National parks are natural areas that have both national and international value in terms of science and nature and are far from industrialization and urbanization (Varnacı-Uzun, 2011), while industrial organizations are learning environments that show the existing needs of people and the processing process of raw materials using the required physical and chemical processes (Atabek-Uzun, 2011). What all these environments have in common, regardless of their aims and objectives or the living and non-living entities they display, is that they are places where students can learn the five senses by working, where they are socially affected and can develop many skills, especially scientific processes, higher-order thinking, and social skills, and feel like they are a part of daily life (Karademir, 2018; Türkmen, 2010). For this reason, it is necessary to take students to out-of-school settings as if it were a part of their routine daily life. In this way, students will behave as if they are scientists, be at the center of the learning environment, and have lasting learning experiences (Türkmen, 2018). Another common point is the efforts made by people to stop the natural areas they need from being removed from their lives, especially since natural areas such as zoos, botanical gardens, and national parks are disappearing in big cities and metropolises. By way of a new approach, the use of digital environments is becoming widespread while the teaching and training processes that take place in formal learning environments for educational purposes are supported by out-of-school learning environments. Virtual museums, zoos, botanical gardens, and aquariums have gained importance especially during the pandemic where education has become digital. However, given that the purpose of out-of-school environmental education is to raise individuals with environmental awareness by directly observing nature, and considering the effects of technology on nature, it can be said that this process will not be effective without proper planning. Another criterion is that the teacher who will practice this must be well-versed in not only the teaching process in out-of-school settings but also environmental education and technology (Karademir, 2018).

Zoos

Zoos are places many different types of animals (wild and domesticated alike) are fed, looked after, and put on display so that people can watch and study them (Shettel-Neuber, 1998). People today are faced with climate crises caused by global warming. These changes in the balance of the environment lead to a reduction in animal and plant species, and many groups of creatures are in danger of becoming extinct. That is why the Association of Zoos & Aquariums (AZA) was founded in 1924. Zoos, organizations that protect endangered species in their natural habitats, that ensure the continuation of existing wildlife, accomplish all this with an expert staff, and that also design training courses on this subject and support scientific studies are recognized by this institution (AZA, 2019). Zoos are environments that provide mutual interaction between humans and animals, design and implement various training courses with experts, and can bring about changes in visitors' knowledge, attitudes, and behaviors (Falk et al., 2007). Zoos, which are one of the important out-of-school learning environments, also possess institutional characteristics. Although zoos have separate goals when considered as separate institutions, it is possible to focus on five fundamental goals when looking at them in general. The first of these goals is the exhibition of various species of animals so they can be observed by people. The second is recreation, which allows animals to be renewed regularly so that they can continue their natural lives. The third is education as it shows how diverse natural life is. The fourth is to facilitate the study of wild and natural life. The fifth is to protect endangered species, which is an important outcome of environmental education (Türkmen, 2019). In addition, zoos are very important for environmental education as they will ensure people take responsibility for preserving biodiversity (Lee, 2015).

Following the industrial revolution, which is regarded all over the world as the greatest step toward globalization, excessive and unregulated urbanization and the increase in the number of skyscrapers and high-rise buildings in settlements caused people to move away from natural life, and rural life suddenly turned into urban life. Working processes have also changed in this new order, and agricultural society has become an industrial society. This situation has affected people's lives not only economically but also socially. This whole process parallels the environmental problems that have arisen due to changing human behavior and life. Nature is an integral part of man. Having distanced itself from nature, man has started making an effort to move large national parks into the city. It is also known that as people move away from the natural environment and this situation becomes a way of life, so interest in natural environments increases. This is why the first designs for zoos began to emerge in the 20th century. In the 1970s, in particular, increasing environmental problems caused states to place environmental science and solutions to environmental problems on the world agenda. This situation directly affected the institutional structure of zoos. These institutions aim to protect animals in addition to providing education and recreation, which are key raisons d'etre for zoos, and they frequently change the way animals are exhibited. It is very important both for the animals there and the visitors that the animals are in their natural habitat. This is why, although many zoo typologies have emerged, the main purpose of all zoos is to provide visitors with the most accurate information about animals and to be places that can best describe natural life (Yılmaz, Özbilen & Mumcu, 2010).

When different science lesson curricula are examined, the aims, objectives, and learning outcomes show that science lessons can be carried out by associating them with zoos. Zoos support not only students' cognitive skills but also their affective and psychomotor domain skills (Randler, Baumgärtner, Eisele & Kienzle, 2007). In addition, students find the science subjects taught at the zoo more interesting than when they are taught at school. In this situation, students acquire positive attitudes and behaviors toward science lessons, natural life, the environment, and animals (Lukas & Ross, 2005).

Picture 1. Examples of Zoos (Berlin Zoological Garden, Berlin-Germany

Botanical Gardens

Botanical gardens are institutions where plants are exhibited and preserved in collections to continue scientific research and educate individuals. They are educational institutions where training is given directly or indirectly to protect endangered species and to raise environmental awareness in individuals of all age levels. More than 4 million plants are preserved and exhibited in more than 2,500 botanical gardens all over the world (Botanic Gardens Conservation International, 2018). Botanical gardens play very important roles in environmental education. In particular, many plant species are in danger of becoming extinct due to global warming. The collections created in botanical gardens plus the fact that these collections form separate exhibition areas not only attract the attention of individuals but they also make them realize what they need to know about biodiversity. During the time they spend in botanical gardens, they experience the ideal habitats that plants need to live and get the opportunity to compare factors such as temperature, humidity, and light with their condition in real life. In doing so, they learn why plant species are endangered, and as a result, experience directly related to global warming is created (Önder & Konaklı, 2011). In this respect, botanical gardens are a window that reveals information about the causes of global warming and how it affects the world (Ali & Trivedi, 2011).

As a learning environment, botanical gardens are a great place of discovery for people of all ages. They offer opportunities for everyone from early childhood to adulthood where they can gain experience by doing, studying, and questioning. In addition to all this, they host educational activities designed to raise environmentally aware individuals. Through these activities, students gain experience regarding environmental problems and environmental pollution. Students who gain first-hand information about the consequences of environmental problems and how these results affect plant species begin to think about the causes of environmental problems (Önder & Konaklı, 2011). In this respect, they contain information that supports many of the subject areas and learning outcomes in the science curriculum. Many units such as living things and life, the living world, man and the environment, the relationship between living things and energy, energy transformations, and environmental science can be supported by botanical gardens as well as by the formal education given in schools.

Picture 2. Examples of Botanical Gardens (Royal Botanic Gardens, Istanbul University Alfred Heilbronn Botanical Garden)

Nature Education

It is important to raise awareness among students about the place in the natural order of all living and non-living entities on the planet, their importance, and value, and to raise awareness of what needs to be done to maintain the mutual interaction within this balance. It is known that individuals who do not know the order and holistic structure of the ecosystem cannot make sense of the concept of nature and the importance of the environment (Atasoy, 2005). Environmental education programs that include field trips in nature, camps, nature walks, and various adventure activities allow individuals to become one with the natural environment, establish deep relationships and take responsibility for nature (Palmberg & Kuru, 2000). Nature education is defined as learning the language of nature in the shortest way. The purpose of nature education, which includes many disciplines, is to treat everything that nature offers as a teaching subject area, a learning outcome, and material, and to present students with the opportunity to examine all of this in its natural habitat (Ozaner, 2004). Rousseau says that for students to be able to realize for themselves, the teaching processes should be directly based on nature. For this reason, every child must develop in harmony with nature (Clark & Martin, 2016). The first examples of nature education in the world were seen in the United States in the 1980s. It came to the agenda in Turkey with the "Scientific Environmental Education in National Parks" project supported by TÜBİTAK (Scientific and Academic Research Council of Turkey) toward the end of the 1990s. Today, nature education projects are mostly carried out with TÜBİTAK's support (Keleş, 2011).

One of the environmentalist settings necessary to show the importance of nature and the environment to students with new approaches is the forest school. Forest schools are open-air schools where students participate in activities in the woodland and forest areas and develop their individual and social skills (FSA, 2002). In forest schools, all the living things in that environment, especially trees, are used to improve students' self-esteem and sense of freedom. They develop many skills such as cooperation and problem-solving through practice in woodland areas (Onur, 2016). This is known as a modern school approach that provides concrete outdoor experiences and is particularly important for science education. Although forest school theory emerged in the United States in the 1920s, forest schools continue to gain importance today (Marshall, 2013).

Picture 3. Examples of Forest Schools

National Parks

According to the Turkish National Parks Law (1983), national parks are defined as "from a scientific and esthetic viewpoint, parts of nature that possess natural and cultural resource values rarely found nationally or internationally and that include areas for conservation, recreation, and tourism." The International Union for the Conservation of Nature (IUCN) defined national parks in 2008 as "large natural areas that are compatible with environmental and cultural considerations, provide a basis for scientific, educational, recreational, and visiting opportunities, and are reserved for the conservation of entire species and ecosystems endemic to the region, as well as large-scale ecological processes." In short, national parks are places that ensure the conservation of natural areas on a country basis by attaching importance to biodiversity and passing them down to future generations (Blanco, 2002). National parks allow students to experience nature and wildlife one-on-one and are key learning environments for raising environmental awareness (Lugg & Slattery, 2003). In addition to all these services that they offer, they are important educational institutions in that they support scientific research so that societies can prosper. Furthermore, many countries support the use of national parks as part of the environmental education process (Blanco, 2002; Gurnett, 2009; Lugg & Slattery, 2007). Thanks to this, like other out-of-school learning environments, students get to know nature and become aware of the issues they need to consider to conserve nature. In this way, it is possible to teach many science concepts to students permanently.

Picture 4. Examples of National Parks (Yosemite National Park, Yedigöller National Park)

Industrial Organizations

Industry directly affects people's daily lives and is the sum of the methods and tools used for the efficient application of the energy resources it provides while producing products that meet the needs and expectations of people by processing raw materials. Industrial organizations may be listed as packaging, iron-steel, electricity-electronics, food, chemistry, cosmetics, building-construction, automotive, textile, machinery-metal industry and power plants, and recycling facilities (Atabek-Yiğit, 2011). Industrial organizations are one of the important environments that can be used in teaching science effectively (Braund & Reiss, 2006; Uitto et al., 2006). In the teaching activities that will take place in these settings, students learn how the products they use in their daily lives are produced, what stages they go through until they take their final form, and how they relate to the concepts they learn in the science lesson at school. In particular, they learn first-hand how the environment is used in the production of industrial products and how to combat the resulting environmental pollution (Balkan-Kıyıcı & Atabek-Yiğit, 2010.). Considering the place and importance of recycling facilities, recycling, and zero waste concepts in environmental education, it is thought that they are very important places to study how waste is transformed into secondary raw materials after seeing the necessary processes and their inclusion in the re-production processes. Nuclear energy, thermic, natural gas, geothermal, solar, and wind power plants are very important learning environments for gaining concrete experience in the subject of renewable and non-renewable energy sources. In particular, acquiring first-hand knowledge in these settings and communicating and interacting with the guides who work there will be a unique experience for students in terms of gaining environmental awareness and developing garbage- and waste-reduction, and energy-saving behaviors and attitudes.

Eco-Friendly Person Activıtiy

Before the Trip

Teaching preparation

First of all, the out-of-school learning environment and the learning outcome from the science curriculum should be determined. The botanical garden was chosen as the learning environment and "Students will question the importance of biodiversity for natural life." from Turkish 2018 Science Curriculum as the learning outcome for this teaching activity. Then, the process Trip Order was designed by establishing a relationship between the environment and the learning outcome. A worksheet has been prepared to guide students through the process. Detailed information on this subject is given under the heading of Trip Order.

Determination of the out-of-school environment

Ege University Research and Application Center of Botanical Garden and Herbarium is a garden with 13 greenhouses in order to contribute to the science of biology, to promote the plant richness of the world and Turkey, the plant diversity of the Aegean Region, and to preserve and keep these examples alive. It is an out-of-school learning environment where graduate students and research assistants inform visitors as guides. There are also information boards. Within the scope of this course, students will have the opportunity to examine the plant diversity in the Aegean Region in the botanical garden, and they will gather their knowledge by working like scientists.

NOTE: Plants are systematically explained and introduced to the students by experts in the botanical garden. The plan should be mentioned when making an appointment, as the teacher wants to provide an environment for students to explore. For this reason, in this process, instead of giving direct information, the guide should be in the environment to answer the questions asked when needed. Students will freely explore the garden.

Picture 5. Ege University Research and Application Center of Botanical Garden and Herbarium

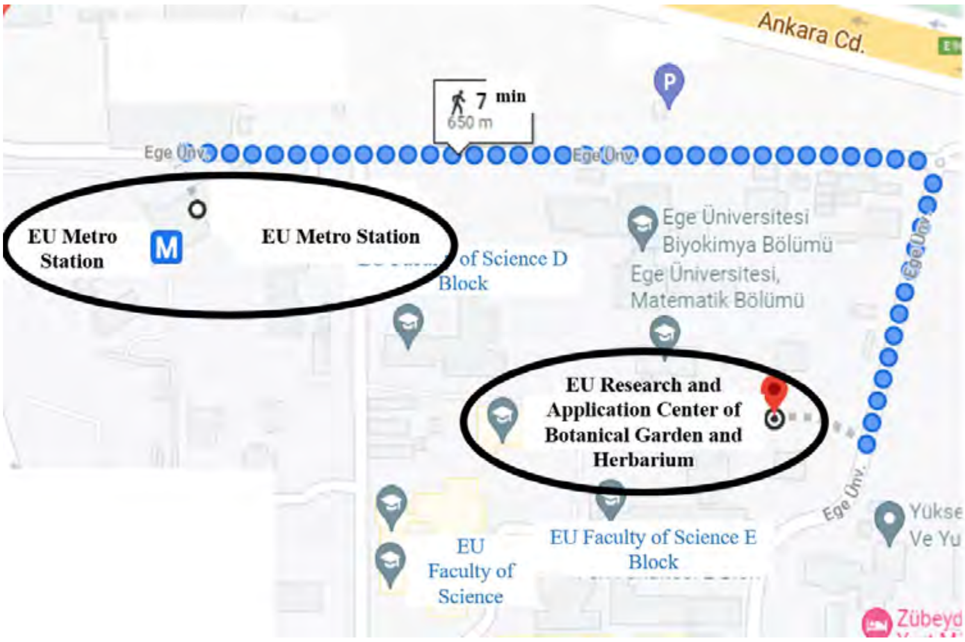
Student needs

Students will be able to meet their needs from the E-Cafe located near the Ege University Botanical Garden and from the canteens of the Faculty of Science. The location of these places is given in the picture below.

Picture 6. The place of Ege University Research and Application Center of Botanical Garden and Herbarium and E-Cafe

Transportation and Accommodation

The botanical garden is located very close to the EU metro station. Depending on the location of the school, it may be preferable to use the shuttle vehicles. It may also be a more appropriate choice for students' safety. The location of these places is given in the picture below.



Picture 7. The place of Ege University Research and Application Center of Botanical Garden and EU Metro Station

Consent procedures: Before the trip, permission should be obtained from the principal, parents and, if necessary, from the district national education directorates.

Trip Order

It is a process that takes place entirely in the botanical garden during the trip. Students will act in 5 homogeneous groups. There will be a parent at the head of each group. Students will meet the guide in the environment, the guide will be there to provide information and answer questions. The teacher will distribute worksheets to the students. In this process, students will seek answers to the questions in the worksheet. In this process, they will be in intense communication with the guide, teachers and parents. The questions on the paper are as follows. The process will end after students find answers to all questions.

1. Which plants did you study in the botanical garden? Select these 5 that you have examined and write down their similarities and differences in detail.

For this question, students will examine plants, compare the similarities and differences of the 5 plants they have chosen, and write them in a chart. They will be expected to find the answer that the species of plants, their appearance and physiological characteristics are different, but the region they live in is the same. This information is on the information plates next to it. Also, the guide is there to provide this information.

2. **How many different plants have you seen living in the Aegean Region in the botanical garden? Do these differences also apply to other regions and living beings?**

For this question, students can examine plants, count and collect information from information boards. With this question, they will be expected to deduce that there are many different plants living in the Aegean Region and that this difference will be valid for other regions and living things.

3. What benefits does this diversity bring us? What would happen if living things were not so diverse? Explain with an example from the botanical garden.

With this question, students will question the importance of biodiversity and they can do this with the data they collect

4. What information did you find about endangered creatures in this environment? How does this affect the environment? What can we do about this issue?

Students who question the importance of biodiversity will also learn about endangered creatures with this question. They will become aware of the scientific studies of the botanical garden for endangered plants. They will understand what responsibilities they have as an environmentally friendly individual on this subject.

Post-Trip

It is a process that takes place entirely in the school, classroom. At this stage, students will share their answers with the class and discuss the questions. The teacher will gather and summarize the answers to the students’ questions, the information they have gathered. The evaluation part will take place in the classroom. At this stage, all aspects of the students’ educational activities will be evaluated. Students will be asked open-ended and multiple choice questions. In general, students are expected to reach the following information in this process.

Biodiversity includes plants, animals, ecosystems and habitats. Biodiversity is one of the most basic elements for the continuation of life on Earth. Unfortunately, biodiversity is rapidly decreasing day by day. Biodiversity has become one of the most important problems affecting all living species today. Today, biodiversity is disappearing at a rate of 1000 times its normal rate. Overexploitation of resources, climate change, excessive air pollution and the spread of diseases; accelerates the loss of biodiversity. This human population growth will reveal overconsumption, climate change and the incredible loss of biodiversity. However, this is not an irreversible path. We can take measures to slow or stop the decline of biodiversity.

References

Alım, M. (2006). Environment and environmental education in primary school in turkey within the process of the membership of European Union. *Kastamonu Education Journal, 14*(2), 599-616.

Ali, N. S., & Trivedi, C. (2011). Botanic gardens and climate change: a review of scientific activities at the Royal Botanic Gardens, Kew. *Biodiversity and conservation*, *20*(2), 295-307.

Atabek Yiğit, E. (2011). Sanayi kuruluşları. C. Laçin-Şimşek (Ed.), *Fen öğretiminde okul dışı* öğrenme ortamları (p.105-116). PegemA.

Atasoy, E. (2005). *Education for environment: Study on environmental attitudes and environmental knowledge of elementary school students* (Unpublished Doctoral Thesis). University of Uludağ, Bursa.

Balkan-Kıyıcı, F. (2011). Hayvanat bahçeleri. C. Laçin-Şimşek (Ed.), *Fen öğretiminde okul dışı öğrenme ortamları* (p.51-64). PegemA.

Bozdoğan, A. E. (2008). Planning and evaluation of field trips to informal learning environments: Case of the 'Energy Park'. Journal of Theory and Practice in Education*, 4*(2), 282-290.

Bozdoğan, A. E. (2014). Okul dışı çevrelerde gezi-gözlem çalışmaları. Ö. Keleş (Ed.), *Uygulamalı etkinliklerle fen eğitiminde yeni yaklaşımlar* (p.1-44). PegemA.

Braund, M., & Reiss, M. (2006). Towards a more authentic science curriculum: The contribution of out-of-school learning. *International journal of science* *education*, *28*(12), 1373-1388.

Bybee, R. W. (2010). Advancing STEM education: A 2020 vision. *Technology and Engineering Teacher, 70*(1), 30- 35.

Davidson, S. K., Passmore, C., & Anderson, D. (2010). Learning on zoo field trips: The interaction of the agendas and practices of students, teachers, and zoo educators. *Science Education, 94*(1), 122-141.

Diamond, J. (1986). The Behaviour of Family Groups in Science Museums. Curator: *The Museum Journal, 29*(2), 139 – 154.

Dierking, L. D. (1991). Learning theories and learning style: An overview. *Journal of Museum Education, 23,* 12-17.

Erten. S. (2002). Research on about energy saving of intention toward the behaviour at homes for male and female students by the application of the Theory of Planned Behaviour. *Hacettepe University Journal of Education, 22,* 67-73.

Erten, S. (2003). By the study of a teaching model on development of awareness on “garbage reduction” for the fifth class students. *Hacettepe University Journal of Education, 25*(25).

Erten, S. (2004). Çevre eğitimi ve çevre bilinci nedir, çevre eğitimi nasıl olmalıdır? Çevre ve İnsan Dergisi, 65-66.

Erten, S. (2005). Investigation of preservice preschool teachers’ behaviors related to environmental awareness. *Hacettepe University Journal of Education, 28*(28).

Erten, S. (2007). Insights to ecocentric, anthropocentric and antipathetic attitudes towards environment in diverse cultures. *Eurasian Journal of Educational Research, 33*, 141-156.

Erten, S., & Aydoğdu, C. (2011).The ecocentric, anthropocentric and antipathetic attitudes toward environment in Turkish and Azerbaijani students. *Hacettepe University Journal of Education, 41* (41).

Erten, S. (2019). Çevre ve çevre bilinci. C. Aydoğdu & S. Kıngır (Eds.). *Fen öğretimi kitabı* (p. 305-344). Nobel.

Erten, S. (2020). Fen ve Teknoloji Uygulamalarının Çevreye Etkileri. E. G. Yıldırım & A. N. Önder (Eds.). *Senaryolarla Desteklenmiş Fen ve Teknoloji Uygulamaları* (p.449-490). Nobel.

Escobar, A. (1995). *Encountering development: The making and unmaking of the third* *world,* Princeton Universty Press, Princeton.

Eshach, H. (2007). Bridging in-school and out-of-school learning: formal, non-formal, and informal education. *Journal of Science Education and Technology, 16*(2), 171–190.

Falk, J. H., & Adelman, L.M. (2003). Investigating the impact of prior knowledge and interest on aquarium visitor learning. *Journal of Research in Science Teaching, 40*(2), 163-176.

Falk, J. H., & Dierking, L. D. (1997). School field trips: Assessing their long-term ımpact. *Curator: The Museum Journal, 40*, 211–218.

Falk, J. H., Reinhard, E. M., Vernon, C., Bronnenkant, K., Heimlich, J. E., & Deans, N. L. (2007). *Why zoos & aquariums matter: Assessing the impact of a visit to a zoo or aquarium* (p. 24). Silver Spring, MD: Association of Zoos & Aquariums.

Han, B., & Bilican, K. (2018). Bilim merkezlerinde bilimin doğası öğretimi. *Trakya University Journal of Education Faculty, 8 (1)*, 1-27.

Hannu, S. (1993). *Science centre education. motivation and learning in* ınformal *education* (Doctoral dissertation). Helsingin Yliopisto, Finland.

Hodge, S. L. (2004). *Outdoor learning environments: evaluating need, success and sustainabilty.* University of Texas, Arlington.

Kahyaoğlu, M. (2016). Analysis of nature education studies in Turkey: A Meta-Synthesis study. *Academia* Eğitim Araştırmaları Dergisi, 1(1), 1-14. Retrieved from https://dergipark.org.tr/tr/pub/egitim/issue/28259/300089

Karataş, A., & Aslan, G. (2012). İlköğretim öğrencilerine çevre bilincinin kazandırılmasında çevre eğitiminin rolü: Ekoloji temelli yaz kampı projesi örneği. *Zeitschrift für die Welt der Türken/Journal of World of Turks, 4*(2), 259-276.

Karademir, E. (2018). Okul dışı ortamlarda fen öğretimi. O. Karamustafaoğlu, Ö. Tezel & U. Sarı (Eds.). *Güncel yaklaşım ve yöntemlerle etkinlik destekli fen öğretimi* (p.426-447). PegemA.

Konaklı, S. Ö. N., & Önder, S. (2011). *The Determination of Planning Principles of Botanic Garden for Konya. Journal of Tekirdag Agricultural Faculty, 8* (2) , 1-11. Retrieved from https://dergipark.org.tr/tr/pub/jotaf/issue/19042/201397

Köseoğlu, F., & Kavak, N. (2001). Fen öğretiminde yapılandırıcı yaklaşım. *G.Ü. Gazi Eğitim Fakültesi Dergisi, 21*(1), 139-148.

Köseoğlu, F., & Tümay, H. (2015). *Fen Eğitiminde Yapılandırmacılık ve Yeni Öğretim Yöntemleri.* Palme.

Küçük. A., & Yıldırım, N. (2019). Doğa eğitimi ve doğa okulları. A.İ. Şen (Ed.) *Okul dışı öğrenme ortamlar*ı (p. 246-272). Pegem A.

Laçin-Şimşek, C. (2011). Okul dışı öğrenme ortamları ve fen eğitimi. C. Laçin-Şimşek (Ed.), *Fen öğretiminde okul dışı öğrenme ortamları* (p. 1-23) içinde. PegemA.

Lukas, K. E., & Ross, S. R. (2005). Zoo Vistor Knowledge and Attitudes Toward Gorillas and Chimpanzees. *Journal of Environmental Education*, *36*(4), 33.

Lugg, A., & Slattery, D. (2003). Use of national parks for outdoor environmental education: An Australian case study. *Journal of Adventure Education & Outdoor Learning*, *3*(1), 77-92.

MacRae, K. (1990). *Diverse purposes and practices*. K. MacRae (Ed.), Outdoor and environmental education. Melbourne.

McGivney, V. (1999) *Informal learning in the community: a trigger for change and development.* (Leicester: NIACE).

Nag, A. & Vizayakumar, K. (2005). *Environmental education and solid waste management.* New Age International (P) Ltd., Publishers: New Delhi.

Nuhoğlu, H. (2011). Botanik bahçeleri. C. Laçin-Şimşek (Ed.), *Fen öğretiminde okul dışı öğrenme ortamları* (p.65-84.). PegemA.

Orion, N. & Hofstein, A. (1994). Factors that influence learning during a scientific field trip in a natural environment. *Journal of Research in Science Teaching*, *29*, 1097–1119.

Organisation for Economic Co-operation and Development. (2006). *Assessing scientific, reading and mathematical literacy: A framework for PISA 2006.* Paris: OECD.

Organisation for Economic Co-operation and Development. (2019). *Assessing scientific, reading and mathematical literacy: A framework for PISA 2019.* Paris: OECD.

Piscitelli, B. & Anderson, D. (2001). Young Children's Perspectives of Museum Settings and Experiences. *Museum Managment and Curatorship, 19 (3),* 269 – 282.

Randler, C. (2010). Animal related activities as determinants of species knowledge. *EURASIA Journal of Mathematics, Science & Technology Education, 6*(4), 237-243.

Randler, C., Baumgärtner, S., Eisele, H., & Kienzle, W. (2007). Learning at workstations in the zoo: A controlled evaluation of cognitive and affective outcomes. *Visitor Studies*, *10*(2), 205-216.

Randler, C., Kummer, B., & Wilhelm, C. (2012). Adolescent learning in the zoo: Embedding a non-formal learning environment to teach formal aspects of vertebrate biology. *Journal of Science Education and Technology, 21*(3), 384-391.

Rees, W. E. (1992). Ecological footprints and appropriate carrying capacity. *Environment and Urbanisation, 4*(2), 121-130.

Shettel-Neuber, J. (1988).Second and thirdgeneration zoo exhibits: A comparison of visitor, staff, and animal responses. *Environment and Behavior, 20*, 452-473.

Tunnicliffe, S.D. (1998). Down on the farm: The content of conversations generated by school children viewing live animals as exhibits and on a farm. *Journal of Elementary Science Education, 10*(1), 1-17.

Turkish Ministry of National Education (2018). *Talim ve Terbiye Kurulu Başkanlığı, İlköğretim Fen Bilimleri Dersi (3., 4., 5., 6., 7. ve 8. Sınıflar) öğretim programı.* MEB.

Türkmen, H. (2010). İnformal (Sınıf-Dışı) Fen Bilgisi Eğitimine Tarihsel Bakış ve Eğitimimize Entegrasyonu. Çukurova Üniversitesi Eğitim Fakültesi Dergisi, 3 (39), 46-59.

Türkmen, H., Doğru, Ö. & Özen-Göktaş, Ş. (2018). İnformal Öğrenme Ortamlarında Fen Öğretimi: Sasalı Doğal Yaşam Parkı Gezisine Yönelik Ortaokul Öğrencilerin Görüşleri. *TURAN-SAM Uluslararası Bilimsel Hakemli Dergisi, 10*(40), 641-650.

Türkmen, H. (2019). Hayvanat bahçeleri. A.İ. Şen (Ed.) *Okul dışı öğrenme ortamlar*ı (p. 136-158). Pegem A.

Uitto, A., Kalle, J., Jari, L. & Veijo, M. (2011). Secondary school students' interests, attitudes and values concerning school science related to environmental issues in Finland. *Environmental Education Research, 17*(2), 167-186.

Ünsal, Ü., & Karademir, E. (2017). Fen öğretiminde okul-üniversite işbirliği. E. Karademir (Ed.) Örnek ve uygulama destekli fen öğretiminde *disiplinlerarası beceri etkileşimi* (p. 191-211). PegemA.

Varnacı-Uzun (2011). Milli parklar. C. Laçin-Şimşek (Ed.), *Fen öğretiminde okul dışı öğrenme ortamları* (p. 117-130). PegemA.

Woodhouse, J. L., & Knapp, C. (2000). *Place-based curriculum and instruction: Outdoor and environmental education approaches*. Clearinghouse on Rural Education and Small Schools, Appalachia Educational Laboratory.

Yardımcı, E. (2009). *The effect of activity based nature education at a summer science camp on 4th and 5th grader's conceptions of the nature.* (Unpublished master thesis), University of Abant İzzet Baysal, Bolu.

Yılmaz, S., Mumcu, S., & Özbilen, A. (2010). Effects of spatial differences on visitor perceptions at zoo exhibits. *Scientific Research and Essays, 5*(16), 2327-2340.

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CHAPTER 6

Socio-scientific Issues in Education for Sustainable Development

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Socio-Scientific Issues

In today's world, rapid developments in science and technology continuously create new complex and controversial issues in society because science and society mutually affect each other. In other words, dilemmas in society could arise from scientific developments (Sadler & Zeidler, 2005a; Topçu, Muğaloğlu & Güven, 2014). Today's societies often try to cope with political, social and moral dilemmas caused by socio-scientific issues (SSIs). SSIs are defined as complex social issues including conceptual, procedural, and technological associations related to science (Sadler, Romine & Topçu, 2016). SSIs are generally controversial issues and needs the assessments of ethical or moral concerns for multiple possible solutions of these issues (Zeidler & Nichols, 2009). Sadler (2011) emphasized that these solutions cannot be specified by only scientific considerations because SSIs are affected by social factors like economic, politics and ethics. According to Eastwood et al. (2012), there are two important characteristics of socio-scientific issues: the connection with science content and social importance. SSIs require considering both the science dimension and the social ramifications of the issue for developing solutions (Sadler et al., 2019; Zeidler et al., 2005). Therefore, SSIs can help students learn science contents by gaining awareness about the relations among social, political and scientific perspectives. Alternative medicine, climate change, global warming, nuclear energy, genetically modified organisms (GMOs), cloning, gene therapy and stem cells are some examples of SSIs. These issues show the characteristics of SSIs that is complex, debatable, open-ended and ambiguous issues involving both science and society (Eastwood et al., 2012; Sadler, 2004; Sadler & Zeidler, 2005b; Topçu, Yılmaz-Tuzun, & Sadler, 2011).

SSIs are widely used to develop different skills like critical thinking, problem solving, communication etc. (Chung, Yoo, Won Kim, Lee, & Zeidler, 2016; Hestiana & Rosana, 2020; Solbes, Torres, & Traver, 2018). In general, SSIs is basically crucial and effective in terms of fostering students' scientific literacy (Ke, Sadler, Zangori, & Friedrichsen, 2021; Kolstø, 2001; Sadler, 2004; Sadler & Zeidler, 2005a, 2005b). That is, the practices of SSIs in science classroom enable students to become scientifically literate. Scientific literacy provides students to understand connections inherent among SSIs as well as the ability to analyze, synthesize, and assess information, informed decision making, and moral reasoning (Zeidler, 2001). In other words, scientific literacy help students to become responsible citizens and have sensitivities to the issues around their lives.

Education for Sustainable Development

In our age, sustainable development is one of the most crucial issues to achieve because as humanity, we have been facing to various environmental, economic and social problems and their harmful effects day by day. Sustainable development means "the development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, p. 43). Sustainable development involves three dimensions: environment, economics and society and interactions between each other (McKeown, 2002). Therefore, understanding the principles of sustainable development, their implementation, the ramifications of their implementation and the values involved can be realized with the knowledge base from natural sciences, social-sciences and humanities (Hopkins & Mckeown, 2002). In order to achieve sustainable development, education is a main tool undoubtedly. This type of education that is, "Education for Sustainable Development (ESD)" requires a holistic and transformational approach that integrates different fields with the aim of building sustainable life for humanity.

Education for Sustainable Development (ESD) aims to promote learners' knowledge, skills, attitudes and values about the interrelated global issues that people are facing such as environmental degradation, climate change, loss of biodiversity etc. (UNESCO, 2021). ESD aims to prepare young people to become responsible future citizens and participate in social decision making (Burmeister, Rauch & Eilks, 2012; Hofstein, Eilks & Bybee, 2011; Stuckey, Hofstein, Mamlok-Naaman & Eilks, 2013). Gough (2006) stated that ESD comprises environmental education in the broader context of the socio-cultural and socio-political issues of poverty, equity, quality of life and democracy, besides an improvement perspective on social change and evolving circumstances. ESD guide and motivate individuals to make an effort for sustainable livings, participating in a democratic society, and living in a sustainable manner (McKeown, 2002).

Socio-scientific Issues in Education for Sustainable Development

At the 21st century, socio-scientific issues and sustainable development are involved in much of the socio-political rhetoric (Dani, 2011). One of the reasons of that SSIs and sustainable development are closely related and both of them include similar important issues and aims for the society. Most of the issues in education for sustainable development links to SSIs. Tytler (2012) stated that the research, which all relate centrally to SSIs as an approach to teaching and learning, focus to a varying degree on sustainability at the same time. This is why, as Herman, Sadler, Zeidler, and Newton (2017) emphasized, SSIs cover a large amount of real-world issues involving disputative environmental issues like global warming, climate change, greenhouse effect, ozone depletion, environmental pollution, waste disposal, nuclear or hydroelectric power plants, alternative energy fuels. Mamlok-Naaman, Katchevic, Malka, Burmeister, Feierabend and Eilks (2015) stated that many chemistry-related issues of sustainable development like traditional or alternative fuels, bioplastics, climate change etc. meet the criteria of SSIs. These criteria are authencity, relevance, evaluation, allowing for open discussions, dealing with questions based on science and technology (Stolz, Witteck, Marks, & Eilks, 2013). According to Herman et al. (2017), the challenging moral nature of environmental issues, the importance of decisions concerning these issues, and the chance to link learning opportunities with the lived experiences of learners can be promoted with SSIs based education. In terms of environmental issues, SSIs-based education helps train individuals as responsible and conscious citizenry. In other words, it develops individuals' self-regulation, self-awareness, and apparent moral recognition of being very effective component of a larger system. SSIs-based education is one of the ideal ways of teaching controversial environmental issues because these issues are challenging and cannot be solved by understanding the science simply. With the SSIs based education, individuals have chances to discover complicated problems, discuss multi-solutions, and improve and justify their own perspectives about environmental issues. Responsible scientific literacy, citizenship and environmental stewardship can be achieved with the discussion of multiple dimensions of controversial environmental issues such as unequal effects on different groups and the environment, ethical concerns, political and ideological dimensions (Herman et al., 2017).

As Herman et al. (2017) emphasized that SSIs-based education is one the ideal way to contribute individuals to conceptualize and respond to environmental issues in terms of the various aspects (e.g., scientific, social, political, and ethical). SSIs promote students to learn by discussing effectively controversial ethical issues like sustainable development (Gresch, Hasselhorn, & Bögeholz, 2013). In addition, SSIs in education for sustainable development help students consider multiple perspectives from local to global issues. Scientific dimension of SSIs in education for sustainable development could be taught to students like at below:

Global Warming

The gradual heating of Earth's atmosphere, surface and oceans and the effect on the climate caused by human activities that leading to the release of carbon as carbon dioxide into the atmosphere with substantial quantities of greenhouse gases (methane, nitrous oxide and chlorofluorocarbons (CFCs)) because of the combustion of fossil fuels like coal, oil and gas and large-scale deforestation (Houghton, 2005).

Climate Change

A long-term change of weather patterns identifying Earth's local, regional and global climates (NASA, 2021)

Greenhouse Effect

A natural process warming the Earth's surface by the reason of greenhouse gases like carbon dioxide, methane, nitrous oxide, chlorofluorocarbons (CFCs), and water vapor which absorb and re-radiate some energy of the sun reaching the Earth's atmosphere while the rest is reflected back to space (Houghton, 2004).

Biotechnology

The technology which uses living organisms and biological systems to develop and produce different products (Bhatia, 2018).

Nuclear Power Plants

A thermal power station that produces electricity by using a nuclear reactor as heat source to provide vapor for a turbine generator (U.S. NRC, 2021).

Environmental pollution

Any unnatural and negative changes in physical, chemical and. biological characteristics of the ecosystem causing harmful effects on various forms of life (Singer, 1970).

Socio-Scientific Issues related to Sustainable Development in Turkish Science Curriculum

One of the goals of Turkish Science Curriculum is to 'improve reasoning skills, scientific thinking habits and decision making skills with socio-scientific issues' (MOE, 2018). In this manner, there are different SSIs relate to sustainable development at different grade level in science curriculum. At 5th grade level, local and global environmental issues are taught as SSIs. Alternative thermal insulation materials, fuels (solid, liquid, gas, fossil) and renewable and nonrenewable energy sources are emphasized as SSIs at 6th grade level. Domestic waste and waste management, recycling (recyclable-non-recyclable wastes) are SSIs of 7th grade level. At 8th grade level, global climate changes, global warming, ozone layer, greenhouse effect, biotechnology are SSIs which are taught. Table 1 shows the SSIs related to sustainable development and the objectives of these issues in Turkish science curriculum.

Table 1. Socio-Scientific Issues Related to Sustainable Development in Turkish Science Curriculum

Grade Level	Socio-scientific Issues	Objectives
5	-Local and Global Environmental Issues	Students; -offer suggestions about the solutions for an environmental issue in immediate environment or our country -infer environmental issues which may occur at future as a result of human activities -discuss the advantages and disadvantages of human-environment interactions on examples
6	-Alternative thermal insulation materials -Fuels (Solid, Liquid, Gas, Fossil) -Renewable and nonrenewable energy sources	Students; -develop alternative thermal insulating products -argue about the significance of thermal insulation of structures in terms of household and national economy, and efficient usage of resources -give examples of commonly used fuels by classifying as solid, liquid and gases -explain that fossil fuels are finite and nonrenewable energy resource, and the significance of renewable energy sources with examples -discuss the effects of usage of different kind of fuels for the purpose of heat on human and environment
7	- Domestic Waste and Waste Management - Recycling (Recyclable-Non-recyclable wastes)	Students; -distinguish renewable and nonrenewable domestic waste products -design the project related to the recycling of domestic solid and liquid waste -inquire the recycling in terms of effective usage of resources and the contribution of recycling plants on economy. -take care of waste management at immediate environment and the workings of public institutions and nongovernmental organizations related to waste management.

8	-Global Climate Changes -Global Warming -Ozone Layer -Greenhouse Effect -Biotechnology	-Students; -link genetic engineering with biotechnology by giving examples about reclamation, vaccination, gene transfer, cloning, gene therapy. -discuss the dilemmas caused by biotechnological application and advantages and disadvantages of biotechnological applications -predict what genetic engineering and biotechnological applications can be at future. -discuss the causes and possible effects of global climate changes, greenhouse effect, how environmental issues affects the future of world and humans' life. -discuss precautions taken by World countries by calculating their ecological footprint with websites.

As understood from Table 1, Turkish science curriculum covers different SSIs which are open-ended problems and have multiple solutions. These issues serve one of the most important basic aims of science curriculum which is to raise individuals as scientifically literate. With SSIs in science curriculum are not only taught the science content but also help students better to cope with the challenges of science in the real issues of society (Sadler, 2011).

Eco-friendly Person Activities

Nuclear Power Plants

Purpose of the Activity:

- To explain the advantages and disadvantages of nuclear power plants
- To discuss environmental, economic and social effects of nuclear power plants for sustainable development

Time: 30 min.

Activity Procedure:

Students are divided 6 different groups consisting of 5-6 students. The case including the information about what nuclear power plants are and how they work is distributed to students. Teacher states that each group will evaluate the nuclear power plants in different aspects. That is, students in 1st group support the nuclear power plants and discuss the advantages of nuclear power plants in terms of environment between each other. Students in 2nd group support the nuclear power plants and discuss the advantages of nuclear power plants in terms of economics between each other. Students in 3rd group support the nuclear power plants and discuss advantages of nuclear power plants in terms of society between each other. On the other hand, students in 4th group reject the nuclear power plants and discuss the disadvantages of nuclear power plants in terms of environment between each other. Students in 5th group reject the nuclear power plants and discuss the disadvantages of nuclear power plants in terms of economics between each other. Students in 6th group reject the nuclear power plants and discuss the disadvantages of nuclear power plants in terms of society between each other. After 10 minutes' discussion in groups, all groups explain the determined arguments and discuss their arguments about nuclear power plants as all groups at 20 minutes.

Ecological Footprint

Purpose of the Activity:

- To aware the ecological footprint (the measurement of the demand on and supply of nature)
- To discuss what can be done to reduce ecological footprint locally and globally

Time: 30 min.

Activity Procedure:

Students enter the website Ecological Footprint Calculator (https://www.footprintcalculator.org/) and answer the questions about food, housing, transportation individually in 15 minutes. They calculate ecological footprint and share their results to their teacher and classmates. Under the guidance of teacher, they discuss with each other about their results and suggest what can be done to reduce their ecological footprint in 15 minutes.

References

Bhatia, S. (2018). History, scope and development of biotechnology. In S. Bhatia and D. Goli (Eds.), *Introduction to Pharmaceutical Biotechnology.* (pp. 1–61). Bristol: IOP Publishing. doi: 10.1088/978-0-7503-1299-8ch1.

Burmeister, M., Rauch, F. & Eilks, I., (2012). Education for Sustainable Development (ESD)and chemistry education. *Chemistry Education Research and Practice*, 13, 59-68. DOI: 10.1039/C1RP90060A

Chung, Y., Yoo, J., Won Kim, S., Lee, H. & Zeidler, L. D. (2016). Enhancing students' communication skills in the science classroom through socioscientific issues. *International Journal of Science and Mathematics Education*, 14(1), 1–27. DOI:10.1007/s10763-014-9557-6

Dani, D. (2011). Sustainability as a Framework for Analyzing Socioscientific Issues. *International Electronic Journal of Environmental Education*, 1(2), 113–128.

Eastwood, J. L., Sadler, T. D., Zeidler, D. L., Lewis, A., Amiri, L. and Applebaum, S. (2012). Contextualizing Nature of Science Instruction in Socioscientific Issues. *International Journal of Science Education*, 34 (15): 2289–2315. https://doi.org/10.1080/09500693.2012.667582

Ecological Footprint Calculator (2021). https://www.footprintcalculator.org/

Gough, A. (2006). Sustainable schools in the UN Decade of Education for Sustainable Development: Meeting the challenge? *Southern African Journal of Environmental Education* 23: 48–63.

Gresch, H., Hasselhorn, M., Bögeholz, S. (2013). Training in decision-making strategies: An approach to enhance students' competence to deal with socio-scientific issues. *International Journal of Science Education*, 35(15), 2587–2607. https://doi.org/10.1080/09500693.2011.617789

Herman, B. C., Sadler, T. D., Zeidler, D. L., & Newton, M. H. (2017). A Socioscientific Issues Approach to Environmental Education. *Environmental Discourses in Science Education,* 145–161. doi:10.1007/978-3-319-67732-3_11.

Hestiana, H., & Rosana, D. (2020). The effect of problem-based learning based sosio-scientific issues on scientific literacy and problem-solving skills of junior high school students. *Journal of Science Education Research*, 4(1), 15–21. https://doi.org/10.21831/jser.v4i1.34234.

Hofstein, A., Eilks, I., & Bybee, R. (2011). Societal issues and their importance for contemporary science education: A pedagogical justification and the state of the art in Israel, Germany and the USA. *International Journal of Science and Mathematics Education*, 9, 1459–1483. https://doi.org/10.1007/s10763-010-9273-9

Hopkins, C. and Mckeown, R. (2002). Education for sustainable development: an international perspective. In D. Tilbury, R. Stevenson, J. Fien, and D. Schreuder (Eds.), *Education and Sustainability: Responding to the Global Challenge*. (pp. 13-24). IUCN, Gland.

Houghton J. (2004). *Global warming: The complete briefing,* 3rd edn. Cambridge: Cambridge University Press.

Houghton, J. (2005). Global warming. *Reports on Progress in Physics* 68, 1343–1403.

Ke, L., Sadler, T. D., Zangori, L., & Friedrichsen, P. J. (2021). Developing and Using Multiple Models to Promote Scientific Literacy in the Context of Socio-Scientific Issues. *Science & Education*, 30, 589–607. https://doi.org/10.1007/s11191-021-00206-1

Kolstø, S.D. (2001). Scientific literacy for citizenship: Tools for dealing with the science dimension of controversial SSI. *Science Education*, 85(3), 291-310. DOI:10.1002/sce.1011

Mamlok-Naaman R., Katchevich D., Malka Y., Burmeister M., Feierabend T. & Eilks I., (2015). Learning about sustainable development in socio-scientific issues-based chemistry lessons on fuels and bioplastics. In Z. Vania and L. Mammino (Eds.), *World Wide Trend on Green Chemistry*. (pp. 45–60). UK: Royal Society of Chemistry.

McKeown R. (2002). Education for sustainable development toolkit. Knoxville, Tennessee: University of Tennessee. http://www.esdtoolkit.org/esd_toolkit_v2.pdf.

MOE (2018). Fen Bilimleri Dersi Öğretim Programı (İlkokul ve Ortaokul 3, 4, 5, 6, 7 & 8. Sınıflar). (Science Curriculum) (Elementary and Secondary 3, 4, 5, 6, 7 & 8. Grades). Ministry of Education, Ankara.

NASA (2021). *Weather, Global Warming and Climate Change*. https://climate.nasa.gov/resources/global-warming-vs-climate-change/

Sadler, T.D., Romine, W.L. & Topçu, M.S. (2016). Learning science content through socio-scientific issues-based instruction: a multi-level assessment study. *International Journal of Science Education*, 38:10, 1622-1635, DOI: 10.1080/09500693.2016.1204481

Sadler, T. D. (2011). *Socio-scientific issues in the classroom. Teaching, Learning and Research.* Dordrecht: Springer.

Sadler, T. D., Friedrichsen, P., & Zangori, L. (2019). A framework for teaching for socio-scientifc issue and model based learning (SIMBL). *Educação e Fronteiras/ Education and Borders*, 9(25), 8–26.

Sadler, T.D. (2004). Informal reasoning regarding SSI: A critical review of research. *Journal of Research in Science Teaching*, 41(5), 513536. DOI: 10.1002/tea.20009

Sadler, T. D., & Zeidler, D. L. (2005a). The significance of content knowledge for informal reasoning regarding SSI: Applying genetics knowledge to genetic engineering issues. *Science Education*, 89, 71–93. DOI:10.1002/sce.20023

Sadler, T. D., & Zeidler, D. L. (2005b). Patterns of informal reasoning in the context of socioscientific decision making. *Journal of Research in Science Teaching*, 42, 112–138. https://doi.org/10.1002/tea.20042

Singer, S. F. (1970). *Global Effects of Environmental Pollution*. New York: Springer-Verlag.

Solbes, J., Torres, N., & Traver, M. (2018). Use of socio-scientific issues in order to improve critical thinking competences. *Asia-Pacific Forum on Science Learning and Teaching*, 19(1), 1–22.

Stolz, M., Witteck, T., Marks, R., & Eilks, I. (2013). Reflecting socio-scientific issues for science education coming from the case of curriculum development on doping in chemistry education. *Eurasia Journal of Mathematics, Science and Technological Education*, 9, 273-282. https://doi.org/10.12973/eurasia.2014.945a

Stuckey, M., Mamlok-Naaman, R., Hofstein, A., & Eilks, I. (2013). The meaning of 'relevance' in science education and its implications for the science curriculum. *Studies in Science Education*, 49, 1-34. DOI:10.1080/03057267.2013.802463

Topçu, M. S., Muğaloğlu, E. Z. ve Güven, D. (2014). Socioscientific Issues in Science Education: The Case of Turkey. *Educational Sciences: Theory and Practice,* 14 (6), 1-22. DOI: 10.12738/estp.2014.6.2226.

Topçu, M. S., Yilmaz-Tuzun, O., & Sadler, T. D. (2011). Turkish preservice science teachers' informal reasoning regarding socioscientific issues and the factors influencing their informal reasoning. *Journal of Science Teacher Education,* 22(4), 313-332. https://doi.org/10.1007/s10972-010-9221-0

Tytler, R. (2012). Socio-scientific issues, sustainability and science education. *Research in Science Education*, 42, 155–163. doi:10.1007/s11165-011-9262-1.

UNESCO. (2021). *What is Education for sustainable development*? https://en.unesco.org/themes/education-sustainable-development/what-is-esdU.S.

NRC. (2021). *Nuclear power plant*. https://www.nrc.gov/about-nrc/radiation/around-us/uses-radiation.html#npp

World Commission on Environment and Development (WCED). (1987). *Our common future*. http://www.un-documents.net/ocf-02.htm#I

Zeidler, D.L., Herman, B.C. & Sadler, T.D. (2019). New directions in socioscientific issues research. *Discip Interdscip Sci Educ Res* 1, 11. https://doi.org/10.1186/s43031-019-0008-7

Zeidler, D.L., & Nichols, B.H. (2009). Socioscientific issues: Theory and practice. *Journal of Elementary Science Education*, 21(2), 49–58. DOI:10.1007/BF03173684

Zeidler, D. L. (2001). Participating in program development: Standard F. In D. Siebert & W. McIntosh (Eds.), *College pathways to the science education standards* (pp. 18 – 22). Arlington, VA: National Science Teachers Press.

Zeidler, D. L., Sadler, T. D., Simmons, M. L., & Howes, E. V. (2005). Beyond STS: A research-based framework for socioscientifc issues education. *Science Education*, 89(3), 357–377. https://doi.org/10. 1002/sce.20048.

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CHAPTER 7

Chemical Wastes and Environmental Pollution

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Chemical Wastes and Environmental Pollution

What is Environment?

The environment is the sum of all the actions that surround all living beings and affect their lives positively or negatively, or the physical, biological, chemical and social factors that can have an indirect or direct effect on human activities and living beings immediately or over time (Nebel et al., 1993).

That is, the environment;

- Human's mutual relations with other people,
- People's influencing each other in the process of these relations,
- Human being's mutual relations and interaction with all living beings other than himself, namely plant and animal species,
- It describes the reciprocal relations of human beings with all the non-living things that are outside the world of living things but in the environment where living things live, namely air, water, soil, underground riches and climate (Johnson et. al., 1997)

In short, the environment is the environment in which biotic and abiotic entities interact in harmony with each other (Erten, 2004).

Environmental Problems and Environmental Pollution

The intensive mixing of foreign substances in the air, water and soil, which adversely affects the living and non-living elements of the environment, causes structural damages on them and impairs their qualities, is called "environmental pollution".

The rapidly increasing world population, unplanned industrialization and unhealthy urbanization, nuclear tests, regional wars, the use of pesticides, artificial fertilizers and chemicals such as detergents cause environmental problems.

In general, environmental problems damaging the natural structure of the environment. This destruction is faster in cities and slower in rural areas. The most important factor in the occurrence of environmental problems is chemical wastes. Chemical waste is the waste that occurs in health facilities or industrial establishments and consists of harmful chemicals, which is harmful to humans, animals and organisms in the environment.

Types of Chemical Waste

Carcinogenic Toxic Waste

Exposure to toxic waste carcinogens in some way causes cancer to be seen more. While individuals are exposed to such toxic substances in waterways and groundwater sources, some toxins, such as mercury, remain in the environment, accumulating intact. Humans and animals often consume such toxins when eating fish. Toxic wastes containing organic carcinogens can be destroyed by incineration at high temperatures, but this process is very costly. If the waste contains heavy metals or radioisotopes, it should be stored as non-degradable material. Children born near toxic waste sites such as factories, landfills, and places of industrial accidents are often physically deformed or have various developmental disabilities. Such children are often born without eyes or teeth, or have extra fingers, missing brains, skin lesions, and many other serious physical illnesses (He et al., 2019).

Radioactive Substances

Radioactive materials play a vital role in our lives. Most of the electricity used in the world is produced from nuclear reactors. In addition, radioisotopes are used in many medical applications. However, since even minor exposure to nuclear radiation is harmful to health, it is necessary to know how to safely dispose of the waste of these materials. A person may feel nauseous and vomit after exposed to radioactive materials and continued exposure can lead to fever and chronic fatigue, and a person may develop radiological illness as a result of prolonged exposure to radioactivity, which is referred to as acute anemia. Caused by inability to produce red blood cells. The body is weakened by ionizing radiation and cannot produce red blood cells.(UNSCEAR, 1996).

Liquid Chemical Waste

Liquid wastes that are mixed with the liquids formed as a result of washing the laboratory equipment and the impurities such as detergent residue and dissolved substances. These wastes pose a danger to the environment and cause diseases. They carry the oxides of gases dissolved in them into the drainage pipes. It can occur as a result of domestic and industrial processes, as well as a result of agricultural production. It may result from irrigation and harvesting processes, especially depending on the type of fertilizer used to improve crop quality or pesticides used for pest control (Arbanah et al., 2012).

Industrial Waste Residues

Liquid wastes, especially heavy-duty liquids such as oils and greases, not only threaten the ecological life, but also pollute the river environment and the seas where the streams flow, causing unpleasant images on the beaches and negatively affecting the movement of tourism and recreational activities (Hogland et al, 1996; Gunkel et al., 2007).

Hazardous Wastes

It is a waste that can harm people and the environment with various effects when interacting with flammable, toxic or other substances. Nowadays, there are many household products that are considered hazardous waste, such as sink cleaners, paints, air freshener, nail polishes, and adhesives. It can be in liquid, solid and gaseous state mainly containing toxic chemical compounds, Hazardous wastes including, but not limited to, mercury, dioxins, and pesticides, various acids that interact with oxygen, rainwater and groundwater (Hogland et al, 1996).

Liquid-Gas Wastes

These wastes can be toxic organic substances, inorganic and non-toxic substances, gaseous wastes formed as a result of various human activities. Waste water, factory water, mining activities, fertilizers and pesticides, and liquids filtered from products considered in this group. For example, gaseous wastes include carbon monoxide, carbon dioxide, nitrogen oxides, sulfur oxides, methane and its compounds (Manisalidis et al., 2020).

Effects of Chemical Wastes on the Environment

The effects of chemical wastes on the environment are air pollution, soil pollution, water pollution, thermal pollution, radioactive pollution, and it will be broadly express as environmental pollution in the later sections. In this section, it will be briefly stated and more pollutants and their effects will be emphasized.

Air Pollutants and Their Effects

Air Pollution is the presence of foreign substances in the air in the form of solid, liquid and gas in the atmosphere in an amount, density and duration that will harm human health, living life and ecological balance. The air layer is polluted with the wastes generated during the production and consumption activities that occur as a result of various activities of people, and the living life on earth is adversely affected. For example, acid rain occurs as a result of mixing harmful gases with wet or semi-wet materials such as rain, clouds or snow (Moores, 2009).

Sulfur Dioxide (SO2)

SO2 is a colorless reactive gas with a pungent odor. It is formed as a result of combustion of sulfur-containing fuels such as coal, fuel-oil, metal smelting processes or other industrial processes. Its main sources are thermal power plants and industrial boilers. In general, the highest SO2 concentrations are found near major industrial sources (Chen et. al. 2007).

Particulate Matter (PM10)

The term particulate matter (PM) refers to solid particles and liquid droplets found in the air. It mixes directly with the atmosphere as a result of human activities and natural sources. They form PM by reacting with other pollutants in the atmosphere and are released into the atmosphere (Manisalidis, 2020). The sizes of solid and liquid particles span a wide range. Particles subject to health are particles with an aerodynamic diameter of less than 10 µm. Particles in this size range can accumulate in the respiratory tract (Kloog et. al., 2013).

Particles smaller than 2.5 µm are called “fine particles”. Fine particle sources include all combustion processes and some industrial processes. Particles in the 2.5-10 µm range are called “coarse” particles. The sources of coarse particles are the dust removed from the roads as a result of crushing and grinding processes (Maji et al., 2017; Wilson et al., 1997).

Carbon monoxide (CO)

Carbon monoxide is an odorless and colorless gas. It is formed as a result of incomplete combustion of carbon in the structure of fuels. There are couple of sources, such as wild fires or combustion of fuels in industrial processes. The CO concentration reaches its highest value during the cold seasons. Because low temperatures cause incomplete combustion and cause pollutants to collapse at ground level (Chen et. al. 2007).

Nitrogen Dioxide (NO2)

NO2 is reddish brown in color. When nitrogen monoxide (NO) combines with oxygen in the atmosphere, NO2 is formed as a highly reactive gas. Once formed, it reacts with other pollutants such as NO2, VOCs. These reactions result in the formation of ground-level ozone. The main sources are motor vehicles and thermal power plants (Hesterberg et. at., 2009; Chen et. al. 2007).

Ozone (O3)

Ozone is an odorless, colorless gas consisting of 3 oxygen atoms. Ozone occurs both at ground level and in the upper atmosphere. Ozone can be beneficial or harmful depending on its location (Bezirtzoglou et al., 2009).

Useful Ozone: Ozone naturally occurs in the upper layer of the atmosphere 15-40 km above the earth's surface, and as a protective layer, it protects the atmosphere from the harmful ultraviolet rays of the sun. This beneficial ozone is slowly destroyed by chemicals containing fluorine gas by humans (Bezirtzoglou et al., 2009).

Harmful Ozone: Near the earth's surface; Pollutants released into the atmosphere from motor vehicles, thermal power plants, industrial boilers, refineries, chemical factories react chemically in the presence of sunlight to form Ozone. Ground-level Ozone is a harmful to human health. Ozone pollution occurs in sunny weather and high temperature, especially in summer (Villányi et al., 2010).

Water Pollutants and Their Effects

The situation that is observed in the form of a negative change in the chemical, physical, bacteriological, radioactive and ecological properties of the water source and which creates directly or indirectly obstructive deterioration in biological resources, human health, fisheries, water quality and the use of water for other purposes is called "water pollution"(Güler et al., 1994; Egemen, 1999).

Acid Rain

Industrial activities, fossil fuels used for heating in houses, exhaust gases from motor vehicles and thermal power plants that produce energy based on fossil fuels pollute the air and emit sulfur dioxide, nitrogen oxide, particulate matter and hydrocarbons as a result of these activities (WHO, 2000). These pollutants, which can hang in the air for 2 to 7 days, undergo various chemical and physical reactions in the atmosphere, react with water vapor and other components in the atmosphere, forming pollutants such as sulfuric acid (HSO), sulfuric acid (H2SO4) and nitric acid (HNO3) (Hesterberg et al. 2009). During the natural cycle of water, it falls to the earth by taking the gases, dust, radioactive fallout and microbes found in the polluted air layers as rain, snow or hail, which is called Acid Rain (Zuhara et al. 2018).

Although this problem is experienced intensely in developed countries today, it threatens the whole world. Because these pollutants, which are released in the atmosphere, are carried by the winds and affect other regions. Acid rain affects the chemical structure and biological conditions of the soil. It washes the elements such as calcium and magnesium in the soil structure and carries them to the ground water, causing the soil to weaken and agricultural productivity to decrease. The substances that contribute most to the acidification of the soil are the sulfur compounds that pass into the soil as a result of accumulation in the atmosphere (Kjellstrom et al., 2006). 2 Nitrogen compounds, on the other hand, play a role in the acidification of the soil when the amount is more than the plants can absorb (Hesterberg et al., 2009). Statistics show that about 80% of diseases, especially in developing countries, are related to water contamination. In fact, it is known that about five million babies die every year due to insufficient hygienic water resources (Farhat et al., 2013).

One of the most important direct effects of acid precipitation is seen on lakes and their aquatic ecosystems. Acidic chemicals can reach lakes in many ways; rain, snow, fog, haze in the form of precipitation as wet particles into lakes. Apart from direct precipitation, precipitation falling on the land discharges its water into lakes through wastewater channels or runoff. Another way, with the rapid melting of snow in spring due to sudden temperature change, chemical pollutants in the snow are released and reach lakes by mixing with rivers. These pollutants reaching the lake suddenly cause a drastic change in the pH of the lake, which is called spring acid shock. Aquatic ecosystems cannot find time to prepare themselves for this sudden change, and since the spring season is a very sensitive period for the reproduction of fish and insects, the sudden pH change causes serious changes in the offspring (Yeager, 1999). One of the indirect but also very important effects of acidification on the environment is acid moisture, which is formed as a result of industrial activities. They can react with toxic substances such as mercury, cadmium or aluminum that have landed in the soil or lake beds, and these substances, which are considered insoluble under normal conditions, reach humans through drinking water and cause toxic effects as a result of the reaction with acidic moisture (Goyer et al., 1990; Bellinger, 2008).

Bacteria, Viruses and Other Disease-Causing Creatures

Organisms that cause hygienic pollution of waters usually originate from the feces and urine of diseased or carrier animals and humans. The contagious effect occurs either by direct contact with these wastes or by the waters where the wastes are mixed. This type of water is not drinkable and unusable (Güler et al., 1994).

Contamination from Organic Substances

It occurs when dead animals, plant residues and agricultural residues mix with surface waters. It affects the water quality by causing changes in the oxygen level of the water. It also provides a suitable breeding and development environment for microorganisms (Bülbül et al. 1997; Abbasi et al. 2011).

Industrial Residues

They consist of substances with toxic effects such as phenol, arsenic, cyanide, chromium, cadmium, mercury from various industries (Gunkel et al., 2007).

Oils and Similar Substances

This type of pollution occurs when oil transported by tankers and pipelines mixes with surface waters as a result of accidents and leaks. It is important in terms of the negative effects of mixing with surface waters (Fried et al., 1979).

Synthetic Detergents

The phosphates they contain cause eutrophication, pollution and poisoning in surface waters (Goel et al, 2012).

Radioactive Wastes

The reaction products of the facilities where nuclear energy is used are radioactive. During long-term storage of nuclear wastes underground or under the sea, their toxic properties may appear when they leak from the containers and mix with the waters. It may originate from hospital research organizations. Nuclear weapons tests contaminate rainwater and create radioactive contamination of surface and groundwater (Bonavigo et al. 2009).

Artificial Organic Chemicals

They are produced by the pharmaceutical, petrochemical, and chemical industries. These substances are more difficult to degrade than the natural organic substances they replace. Over time, it accumulates in the body and creates a toxic and carcinogenic effect (Díaz-Cruz et al., 2008).

Inorganic Salts

Dissolved salts are found in waters and discharge points as sodium, potassium, calcium, magnesium, iron, sulfate, nitrate, bichromate, and phosphates. It makes the waters unsuitable for drinking, irrigation and many industrial uses (Zhang 2017).

Eutrophication (Phosphate Contamination)

Eutrophication is an excessive increase in plant existence in any large aquatic ecosystem, such as a lake, as a result of a large increase in nutrients for various reasons, especially those coming from land (Harper, 1992). This can reduce the amount of dissolved oxygen in the water, which can lead to the death of the aquatic ecosystem in the long run. Phosphorus, nitrogen and other nutrients gradually increase in older aquatic ecosystems. The increase in organic material that can be converted into nutrients in a system increases the productivity level of the system (Gilbert et al., 2005). The aquatic ecosystem contains soil living residues that are dragged from the surrounding land. Algae and microscopic organisms collected on the water surface prevent the absorption of oxygen, which is vital for underwater life, by blocking the sun's rays. Eutrophication, particularly from phosphate, is also known as phosphate contamination (Burkholder, 2007).

The so-called cultural eutrophication occurs when the aging process of water is accelerated by humans dumping excessive nutrient-containing substances such as sewage, cleaning materials, and fertilizers into an aquatic ecosystem (Gilbert et al., 2005). Among the factors that accelerate eutrophication are the dry climate, excessive evaporation, and the use of lake water for irrigation with a canal. Eutrophication may disrupt wetland ecosystems and cause the decline or extinction of birds, fish and other living things. In the advanced stages of eutrophication, since oxygen will be depleted, the related system first turns into a swamp and then a meadow. Thus, the system moves from the aquatic ecosystem to the terrestrial ecosystem (Khan et al., 2005).

Soil Pollutants and Their Effects

Soil pollution, with a general definition, is the deterioration of the physical, chemical, biological and geological structure of the soil as a result of human activities. Soil pollution occurs as a result of the application of wrong agricultural techniques, the use of wrong and excessive fertilizers and agricultural pesticides, the accumulation of waste and residues, toxic and dangerous substances in the soil (Pettry et al., 1973; Alloway, 1996).

Pesticides, which contain many chemicals, have an important role in water and soil pollution. As they pass to higher organisms in the food chain, they become increasingly concentrated at each stage and cause significant damage to the carnivores, which gradually form the last link of the chain (Rodríguez-Eugenio et al., 2018). That is, harmful chemicals are present in very small quantities in simple organisms, which intensify as these organisms are eaten by more complex organisms; when it reaches carnivores that eat herbivores, it has reached harmful levels. Negative effects of pesticides have been observed especially in birds of prey such as hawks and eagles or birds that feed on fish such as pelicans and cormorants (Mirsal, 2008). Today many insect species are immune to these substances; In addition, the resistance of the next generations to toxic drugs increases through heredity. On the other hand, the continued use of these chemicals has led to the emergence of previously nonexistent pest communities in some regions. This is mainly because pesticides destroy the carnivorous insects that keep the herbivorous insect population in check (Mishra et al., 2015).

Sediments

Sediment accumulating as a result of erosion is another factor that leads to soil degradation and turbidity of waters. Sediment production is a growing problem resulting from the misuse of forest and agricultural lands. Mining and construction activities also play a role in this area (Provoost et al., 2008).

Mineral Wastes

Although mineral wastes constitute a significant part of the total solid wastes on the earth, they are relatively less harmful as a pollutant. The main reason for this is that they are not concentrated at certain points, such as wastes from residential areas and industry, but spread over wider areas (Razo et al., 2004).

The main source of mineral solid wastes is mining activities and related industries. Pollution caused by open coal mining not only affects rivers and drainage basins, but also leads to barren soil.

Animal Wastes

Animal excrement and waste from slaughterhouses are the most important sources of soil pollution. Farm animals such as cattle, pigs, sheep and chickens produce 1,000 times more feces than the total human population. While nutrients in the past were returned to the soil through pasture or farm animals, today's innovations cause these wastes to concentrate in certain areas (Rodríguez-Liébana et al., 2014).

Industrial Wastes

Water and air pollution that occurs during industrial activities tend to mix with the soil by chemical means. In addition, it is a common practice to spread various industrial residues around the factories or in a more open place. In some branches of industry, such as the sugar industry, pulp is formed, which is thrown onto the soil (Mirsal, 2008). Some occupations such as copper mining and marble mining also have significant pollutants. Air pollution caused by industrial activities, thermal power plants, exhaust or heating-based polluting gases affects the ecological structure of the soil.

Low quality and highly polluting lignite is used in thermal power plants in Turkey. Since Turkey is a lignite-rich country, it is the backbone of energy production for the country. However, as a result of the use of this coal, high amounts of sulfur 15 oxides (SOX), nitrogen oxides (NOX), carbon monoxide (CO), ozone, hydrocarbons, particulate matter (PM) and ash are formed. SOX and NOX gases are the main responsible gases in the formation of acid rain (Zuhara et al., 2018).

Acid rain caused by toxic gases released into the air pollutes the soil. Acid rain affects the chemical structure and biological conditions of the soil and is harmful to the plants growing on these soils. Sulfuric acid reaching the soil increases the acidity of the soil solution, that is, the density of active hydrogen ions (Kjellstrom et al., 2006; Zuhara et al., 2018). The increased amount of hydrogen ions replaces plant nutrients such as Ca, K, Mg and Na, which are held by clay minerals and humus colloids, which are colloidal complexes of the soil, and causes these elements to be washed from the soil to mix with the ground water. In addition, heavy metals and elements carried by particulate matter in polluting gases and radioactive wastes mixed with the air reach the soil and cause radiation pollution in the soil (Qin et al., 1994).

Industrial establishments that use soil as raw material cause soil loss. The brick and tile industry uses the most fertile soils of 40-50 cm on the land surface as raw materials. The land structure of the remaining part deteriorates and loses its ability to be suitable for agriculture.

Domestic Waste

Soil quality is noticeably deteriorated in areas where urbanization is intense. Poor use of the land, pollution of construction techniques, inadequacies of infrastructure, polluted water and sewage mixing into the soil and garbage accumulation significantly affect soil pollution (Pettry et al., 1973). Another factor that causes soil pollution around the city is air pollution. Both the toxic gases coming out of the chimneys during the heating of the city and the exhaust gases of the vehicles condense and fuse with the soil and kill the living things in the soil. One of the most important causes of soil pollution around the city is the accumulation of urban residues in the soil by the septic tank method. The pollution concentrated in this way infiltrates the deeper layers of the soil and also pollutes the groundwater (Azimov et al., 2019).

Pesticides

In general, all pesticides contaminate the soil when they are used. Pesticides are reduced to less toxic or non-toxic components such as carbon dioxide, methane and water as they make their way into the groundwater (Edwards, 2013). As the half-life of the pesticide shortens, its degradation accelerates and it loses a significant portion of it before reaching groundwater. When the opposite happens, a significant portion of the pesticide is likely to reach groundwater and contaminate the source where it reaches. On the other hand, pesticides with cationic properties are strongly absorbed in the soil and the movements of these chemicals in the soil are reduced. Therefore, the risk of cationic pesticides to contaminate groundwater is lower than neutral or anion pesticides (Khan, 2016).

The techniques used in agricultural control have a special importance in terms of human and environmental health. In general, it is known that product loss occurs when plant diseases and pests are not dealt with in a timely and correct manner. Chemical control is among the most used methods to prevent this loss. Intense pesticides are used especially in the Mediterranean and Aegean Regions where polyculture agriculture is carried out (Rodríguez-Liébana et al., 2014).

Excessive Fertilization

The effect of fertilization on the soil is soil reaction, deterioration of the structure, destruction of living things in the soil and enrichment of toxic substances in the soil. The negative effects of fertilization on surface waters and drinking water are mostly due to the unbalanced use of nitrogenous and partly phosphorus fertilizers. Nitrate, which mixes with waters with fertilization or can accumulate in the plant, is the main environmental pollutant. Drinking water should not contain nitrates higher than 20 mg/kg. This limit value can be exceeded in places close to water sources and in loose soils with high infiltration capacity. For this reason, many European countries restrict nitrogen fertilization in areas close to groundwater (Boawn et al., 1971).

Fertilization can have positive and negative effects on the air. Fertilization increases the amount of oxygen in the atmosphere thanks to the oxygen released by photosynthesis. In this way, the amount of oxygen produced in one hectare of grain production increases to 12 tons per year. Oxygen production in this way in agricultural areas is higher than in forests or uncultivated lands. However, despite the air-healing effect of fertilization, the use of increased nitrogen fertilizer may adversely affect the air due to ammonia and nitrogen oxide outputs. The increasing use of nitrogen fertilizers, nitrous oxide gas, which passes into the atmosphere in increasing amounts, encourages the decomposition of the ozone layer (Bezirtzoglou et al., 2009).

As a result of excessive nitrogen fertilization, a significant accumulation of nitrate and nitrite is observed in plant tissues. The accumulation of these nitrogen forms in the plant can cause significant health problems in humans and animals fed with these plants. Contamination of soils with phosphorus fertilizers is greater than with nitrogen fertilizers. Compared to nitrate, phosphates have low mobility in the soil profile. Therefore, phosphate enrichment in groundwater in deep layers is not as high as nitrate.

Cadmium

Batteries pollute the soil with various heavy metals and chemicals they contain. The most dangerous of these pollutants is Cd metal. There is a great danger in the contamination of soils by heavy metals such as Cd. Because the contamination and accumulation of these elements on the soil is irreversible. Cd in the structure of waste batteries and phosphorus fertilizers accumulates in the soil. Batteries can be kept away from the soil by special disposal methods, but this is not the case for fertilizers (Qin et al., 1994; Satarug et al., 2003).

Various alternatives are sought to reduce Cd entry into agricultural areas with phosphorus fertilizers. One of them is the use of raw phosphate rocks of volcanic origin with less Cd content in fertilizer production. The other one is to reduce Cd content of sedimentary sourced raw phosphate material and phosphoric acid used in fertilizer production (Provoost et al 2008). Phosphate deposits of volcanic origin with low Cd content are only found in Russia and South Africa. This situation causes the countries with raw materials to form a monopoly and cause the prices to rise excessively. During the production of phosphorus fertilizers, 70-80% of the Cd in the raw phosphate rock passes into the fertilizer (Orlov., 1992).

Remaining Materials from Water Treatment

Sewage sludge is a dry intermediate product obtained as a result of the applications of wastewater. The treatment and disposal of solid materials, which are defined as "sludge sludge" and where pollutants carried with water are collected intensively, are as important as wastewater treatment. It has been observed that it causes soil pollution, especially when used as fertilizer or to store them in agricultural lands (Gülümser et al., 2001).

Petroleum

During the use of petroleum products, ecological resources, which are very difficult to recover, are rapidly polluted. Oil pollution is the contamination of the environment through spills, explosions and accidents during the refining, storage and transportation stages after drilling (ASCE 1996). First of all, oil fills the pores in the soil, preventing the air inlet and outlet necessary for plant roots and soil creatures living in layers close to the surface. In addition, the clay and humus in the soil act as a filter to temporarily or permanently hold the substances included in the soil. Oil and its products completely cover the clay and humus surfaces, eliminating this natural filtration feature of the soil. Depending on these changes, losses occur in the physical properties of the soil. Petroleum, which contains high molecular weight components in its structure, has very low solubility in water (Wong et al., 1989). This situation also prevents the entry of water into the soil and the movement of water in the soil. For this reason, the transport of nutrients necessary for the continuation of life in the soil is interrupted. Thus, in addition to the loss of physical quality, various damages occur in the chemical properties of the soil (Ceyhan et al., 2012).

Economy Friendly, Environmentally Enemy: Polymers

Polymers are high molecular weight compounds formed by the regular bonding of many molecules by chemical bonds. Polymers remain in nature for a long time and pose serious dangers in environmental pollution. It is possible to say that the world plastic consumption is gradually increasing.

The use of many plastic packaging materials for packaging many foods, such as pickles and canned goods, can be of serious concern. In particular, containers made of recycled materials carry impurities left over from their first use. In addition, it is possible for poor quality plastics to deteriorate and turn into monomers and other harmful substances. For this reason, plastics are not preferred much, especially in the food sector. Since disposable plastic materials are cheap, throwing them into the environment can cause serious pollution (Kayan & Küçük, 2020)

For this reason, it is possible to minimize the damage to the environment by considering the recycling of these materials. The two most important types of plastics whose recovery is focused on are Polyethylene Terephthalate (PET) and Polyvinyl Chloride (PVC). Due to the risk of mixing toxic gases and hydrochloric acid in the environment, the additives in PVC are separated from PET and other plastics in order to prevent these damages.

Polyesters

Polyester is an artificial fiber synthesized from petrochemical products such as ethylene glycol and dimethyl terephthalate through a process called polymerization.

This fabric is not environmentally friendly. The manufacture of the fabric involves the use of large amounts of water, chemicals and fossil fuels. Raw materials and by-products are toxic, pollute water and air. Many garments are made from a mix of polyester and other materials. In this case, recycling them makes it difficult if not impossible. It doesn't matter if the garments are polyester or recycled polyester, both contribute to microplastic pollution (Arslan, 2018).

Polyamides

Polyamides are polymers that contain amide groups in repeating units in the main polymer chain. (Taşdemir, 2019)

In the production process of polyamide fabric, serious damages are given to ecosystems. The water used to cool the polyamides often introduces pollutants into the surrounding ecosystems where the production plant is located. During the production of adipic acid, which is used to produce most polyamides, nitrous oxide is released into the environment. However, nitrous oxide is 300 times more harmful to the environment than carbon dioxide gas and 15 times more harmful than methane, and is a very powerful greenhouse gas. It causes depletion of stratospheric ozone. Also, nylon and other synthetic polyamides are not biodegradable (Taşdemir, 2019).

According to the World Bank, the textile industry is responsible for 17-20% of the world's wastewater. A large amount of water is used to produce polyamide. The wastewater generated in this process carries the pollutants to the water resources (Vijaraghavan, 1999). However, only 20% of the world's wastewater undergoes proper treatment, as reported by the United Nations (Handa, 1991). At the same time, workers exposed to the nylon manufacturing process experience irritation of their skin, nose, eyes, and throat from by-products, dust, and fumes (Kant, 2012).

Polyethylene

Among the total thermoplastics, the most consumed commercial polymer with a rate of 34% is polyethylene, which is synthesized by the polymerization of ethylene gas.

Especially due to environmental laws and other sanctions enacted in recent years, this method is not applied much. On the other hand, toxic gases generated by the burning of wastes threaten human health. In addition to the waste of resources, the burning of plastic waste in the recycling method requires expensive investments to remove and control harmful gases such as furan, dioxin and heavy metal vapors entrained by flue gas during combustion (Hakkarainen et al., 2004).

Polyurethane

It is a polymer that is synthesized in the laboratory environment and then used in many parts to make people's lives easier, and diversified with its hard or soft properties. Polyurethane has a smooth foam structure, 90-95% of the cells in its structure are closed. This allows polyurethanes to have excellent heat retention, that is, to be the best insulator known in the world. When polyurethane is thrown into the environment, it preserves its structure in nature for up to 1000 years because it is made of polymer (Kairyte et al. 2018).

PVC

Polyvinyl chloride is one of the amorphous plastics. Hard PVC is mostly used in areas such as pipes, window profiles, and wall coverings. They are resistant to weather conditions, have high strength, hardness and self-ignition properties. Soft or flexible PVC types are mostly used in cable industry, flooring, toys and gloves production (Taşdemir, 2019).

Normal PVC contains 53-55% chlorine. It is possible to operate polyvinyl chloride up to 60ºC. It dissolves by chlorinated hydrocarbons when heated. The production of PVC powder involves the transport of hazardous explosives such as vinyl chloride monomer (VCM) and leads to the generation of toxic wastes, especially ethylene dichloride (EDC) tars (Taşdemir, 2019). In particular, tar wastes contain large amounts of dioxins and emit dioxins over an even larger area when incinerated or discharged (Persico et al., 2009). Previously, this waste was incinerated on oceanic incinerators until a worldwide ban was imposed in 1991. The ban was due to their toxic emissions and threatening the underwater ecosystem. These wastes are currently incinerated in land incinerators or dumped into deep pits. Numerous additives are added to PVC to create a wide variety of products. Some of these additives are plasticizers for softening and pliability, heavy metals as stabilizers or colorants, and fungicides used to prevent fungi from ingesting other additives. Thus, PVC production includes a separate industry that produces a very large secondary poison (Bidoki et al., 2010).

In addition to being harmful to the environment, PVC consumer products also pose dangers to consumers. Plasticizers do not bind to plastic and spread by breaking over time. For example, plasticizers in PVC flooring will start to float in the room. The most used plasticizers (phthalate DEHP) are suspected to be carcinogenic. Phthalate softeners are global pollutants and 90% are used only in making soft PVC (Persico et al., 2009).

The disposal of PVC creates more environmental problems. In case of combustion (in an open area or incineration plant), PVC will emit an acidic gas along with dioxins due to its chlorinated content. In case of landfill, it will eventually leave a contribution that will threaten groundwater resources (Kayan et al., 2020). Incineration of PVC-containing waste in open landfills will lead to the release of even more dioxin sources. Recycling PVC is neither technically nor financially viable. Currently, less than one percent of PVC is materially recycled. Post-consumer products or PVC waste cannot be converted to the required PVC quality to make products of the same quality. Much of this collected waste is downcycled or used to make downstream products such as garden benches and sound barriers along highways. Many recycled PVC products have to be reconstituted with toxic heavy metal compounds or other stabilizers. This further increases the sequence of toxic compounds in the secondary product.

Teflon

Teflon is the trade name for polytetrafluoroethylene (PTFE) polymer. It has very inert properties due to its molecular structure consisting of a long and straight carbon chain saturated with fluorine atoms and strong bonds between atoms.

Chemical substances, after absorption and distribution in the body, can be stored in the body, eliminated from the body or interact with the body. The areas where they are most stored in the body are adipose tissue, bones, hair and nails. The stored chemicals continue to increase in the body as the exposure continues, and their accumulation exceeds the excretion amounts over time. Most studies have shown that inhalation of gases from Teflon causes lung toxicity and death in mammals and birds (Dong et al., 2019).

Since Teflon does not interact with any substance, Teflon particles entering our body do not interact with the atoms that make up our body. Therefore, Teflon has no effect on our body. However, it has been found that the substance called PerFloric Octanoic Acid (PFOA), which is used in the bonding process of Teflon to the metal pan surface, increases the risks of some tumors in animal experiments.

Like other polymers, the biggest problem in Teflon in nature is that they do not decompose like organic substances. When plastic materials used in very large quantities are thrown into the environment after use, they do not rot, do not rust, do not dissolve, do not biodegrade and remain in nature for many years without decomposition (Dong et al., 2019). It causes pollution of water and soil. It harms aquatic creatures and even causes their death.

PMMA

Polymethylmethacrylate is a starting material used for the production of polymers and is a type of acid. It is used in a wide area from the automotive to the cosmetics industry, from the medical industry to the lighting industry. PMMA is a polymer and acrylic based material.

Acrylic acid is a very harmful type of acid. Causes damage to the skin and respiratory tract. It can cause irreversible health problems in contact with skin, inhalation and eye contact. Since PMMA is a polymer, it may not disappear for a long time when thrown into the nature. This causes soil pollution, which in turn affects the food chain (Van Grimbergen et al., 2018).

Disposal Methods of Chemical Wastes

The fact that chemical wastes are so harmful to human health and the environment has made it necessary to take some measures for the disposal of these wastes. Disposal of liquid wastes by discharge into sewer pipes deteriorates the quality of groundwater, causes food spoilage and creates unpleasant odors, as well as can cause the formation of gases harmful to human health, such as hydrogen sulfide, carbon dioxide and methane. Liquid wastes often contain microorganisms that cause disease in living things. It can also occur in new chemicals that may affect human health and physiological functions. These effects appear sometime after exposure to these substances (Amour, 2016). For this reason, various disposal methods have been developed according to the characteristics of the wastes. For example, some of the liquid wastes are disposed of in landfills immediately after being treated, while others are incinerated to prevent pollution. They can also be turned into new products that can be reused.

Chemical wastes can be disposed of as follows:

Incineration

It is the process of converting organic materials in solid waste into ash, gas and heat by burning. The burning heat is used to generate electrical energy. The advantage of incineration is that it does not pollute the groundwater and the furnaces do not occupy a lot of land. The disadvantages are that incinerators pollute the air, leave behind about 10% of the waste that cannot be incinerated but still need to be disposed of, and is very costly (Ott et al., 2020).

Landfill

It is one of the ways of disposal of solid wastes by throwing them into landfills or pits prepared for this purpose. The gases that emerge as a result of the decomposition of wastes such as methane and carbon dioxide by microorganisms are released into the atmosphere. When these pits are full, they are covered with a layer of soil and mud to prevent rainwater from reaching (Barnes et al., 2012). These areas can then be used as picnic areas or resting areas.

Recycling

It is the reuse of waste to produce new materials. One of the advantages of this method is that it reduces the need for new resources. The energy required to recycle materials is less than to manufacture a product using new materials, and above all, recycling reduces the amount of waste that must be disposed of by incineration or landfilling. The most important recyclable materials include metals, glass, paper and plastic.

Conversion to Organic Fertilizers

This method is based on leaving the domestic waste in the open for the decomposition of aerobic bacteria, insects, worms and fungi. It is necessary to allow oxygen to penetrate the waste so that bacteria do not perform anaerobic decomposition by inverting the waste from time to time. This process produces methane and other gases that cause an unpleasant odor (Mrozik 2003). When the decomposition process ends, the waste turns into a biological fertilizer, sometimes called black gold, which can be mixed with soil or placed around plants.

Converting Solid Organic Waste to Biogas Technology

It is the process to produce biogas consisting of methane and carbon dioxide while decomposing wastes containing organic matter under the influence of anaerobic bacteria (Mrozik et al., 2003).

Water Treatment

It is the whole of filtration, precipitation and chemical cleaning processes to treat wastewater. Bioremediation is done by passing sewage water through beds of aerobic bacteria that decompose organic material. Undissociated materials are pumped into settling tanks, where they precipitate as clay sediment, the liquids are separated from the sediment and treated with chlorine to kill pathogenic organisms (Petterson, 1985). Thus, waste water can be reused for both physical and chemical cleaning structures. It can be reused for irrigation of crops, algal blooms and aquatic plants.

Waste Disposal Methods for Radioactive Materials

From 1946 to the 1990s, the United States destroyed hundreds of thousands of barrels of radioactive waste at about 50 locations in the ocean. Of these, only 50,000 barrels were literally thrown from the ship into the ocean, 50 kilometers off the coast of San Francisco, near the Farallon Islands. When the barrels did not sink, artillery fire was opened from the ships and holes were made in the barrels in order to sink them. This has led to the leakage of radioactive waste such as plutonium, strontium and uranium. Other countries, including Russia, China, Japan, New Zealand and many other European countries, were also disposing of their waste in similar ways during this time (Medalia, 2008).

The main purpose of the disposal process is to neutralize radioactive materials and prevent them from moving to neighboring areas. In order to prevent waste from mixing with air and water, solid masses of 20 kg are formed by melting with glass bottles and metal cans, and placed in metal containers and buried on the ocean floor. Thus, it is not affected by erosion and does not leak harmful radiation (Friedman, 2011). This process, in which radioactive material wastes are mixed with glass and a solid material is obtained, is called nuclear waste glazing. In addition, it can also be disposed of by solidifying the radioactive materials at a very high pressure and placing them in concrete and metal cylinders and burying them in predetermined pits on the surface (Medalia, 2008).. Post-uranium waste is one of the most dangerous types of radioactive waste and consists of highly concentrated radioactive materials from which nuclear weapons are made. It is disposed of in leaded containers under strict control. The containers are buried about 100 meters underground and are located in certain lands. It takes about ten thousand years for such packages to become low-level waste. Nuclear wastes cannot be disposed of like other wastes because they harm living things.

Toxic Waste Legislation and Regulations

The first regulation on waste in Turkey was made in 1983. The provisions regarding the protection of the environment and the disposal of toxic wastes have been determined in the Environmental Law No. 2872. In addition, the disposal of toxic wastes to other waste areas is defined as “illegal waste disposal”. Several current draft laws have been prepared to regulate the illegal dumping of toxic waste (MoEaU, 1983).

Activity: What Happened to the Materials?

Purpose: To observe the changes in the soil for a certain time period of the substances that cause soil pollution.

Duration: 3 Months

Making the Activity:

1. Identify a zone in a garden or soil area and mark it.
2. Scrape the area you marked.
3. Place fruit peel (remains), plastic bottles, cans and bags on the excavated area and cover it with soil.
4. Wait three months to observe what happens to the items you buried.
5. Make predictions about what might happen to the items after burial.
6. At the end of three months, dig up the buried materials and write down your observations.
7. Compare your observations with your previous estimates and draw conclusions about what could be causing soil pollution.

References

Abbasi, T., & Abbasi, S. A. (2011). Water quality indices based on bioassessment: the biotic indices. *Journal of Water and Health, 9*(2), 330-348.

Alloway, B. J. (1996). Soil pollution and land contamination. *Pollution, Causes, Effects and Control*, 318-339.

Arbanah, M., Najwa, M. M., & Halim, K. K. (2012). Biosorption of Cr (III), Fe (II), Cu (II), Zn (II) ions from liquid laboratory chemical waste by Pleurotus ostreatus. *International Journal of Biotechnology for Wellness Industries, 1*(3), 152-162.

Armour, M. A. (2016). *Hazardous laboratory chemicals disposal guide.* CRC press.

ASCE Task Committee on Modeling Oil Spills. (1996). State-of-the-art review of modeling transport and fate of oil spills, Water Resources Engineering Division, ASCE. *Journal of Hydraulic Engineering 122*(11):594-609.

Aslan, R. (2018). Mikroplastikler: hayatı kuşatan yeni tehlike. *Göller Bölgesi Aylık Hakemli Ekonomi ve Kültür Dergisi, 6(*66), 61-67

Azimov, O. T., Kuraeva, I. V., Trofymchuk, O. M., Karmazynenko, S. P., Dorofey, Y. M.,

& Voytyuk, Y. Y. (2019, May). Estimation of the heavy metal pollution for the soils and different environmental objects within the solid domestic waste landfills. *In 18th International Conference on Geoinformatics-Theoretical and Applied Aspects* (Vol. 2019, No. 1, pp. 1-7). European Association of Geoscientists & Engineers.

Barnes, I., & Rudziński, K. J. (Eds.). (2012). *Disposal of dangerous chemicals in urban areas and mega cities: role of oxides and acids of nitrogen in atmospheric chemistry.* Springer.

Bellinger, D. C. (2008). Very low lead exposures and children's neurodevelopment. *Current opinion in pediatrics, 20*(2), 172-177.

Bezirtzoglou, E., & Alexopoulos, A. (2009). Ozone history and ecosystems: a goliath from impacts to advance industrial benefits and interests, to environmental and therapeutical strategies. *Ozone depletion, chemistry and impacts, 135*-45.

Bidoki, S. M., & Wittlinger, R. (2010). Environmental and economical acceptance of polyvinyl chloride (PVC) coating agents. *Journal of cleaner production, 18*(3), 219-225.

Boawn, L. C., & Rasmussen, P. E. (1971). Crop response to excessive zinc fertilization of alkaline soil 1. *Agronomy Journal, 63*(6), 874-876.

Bonavigo, L., Zucchetti, M., & Mankolli, H. (2009). Water radioactive pollution and related environmental aspects. *Journal of International Environmental Application and Science, 4*(3), 357-363.

Bülbül, G., Aksu, Z., (1997). Atıksulardaki fenol kirliliğnin serbest ve caljinat'a tutuklanmış p. putida ile giderilmesinin kesikli karıştırmalı tepkime kabında karşılaştırmalı olarak incelenmesi, *Turkish Journal of Engineering and Environmental Science, 21*, 175- 181.

Burkholder, J. M., Tomasko, D. A., & Touchette, B. W. (2007). Seagrasses and eutrophication. *Journal of experimental marine biology and ecology, 350*(1-2), 46-72.

Ceyhan, N., & Esmeray, E. (2012). Petrol kirliliği ve biyoremediasyon. *Türk Bilimsel Derlemeler Dergisi, 5*(1), 95-101.

Chen, T. M., Kuschner, W. G., Gokhale, J., & Shofer, S. (2007). Outdoor air pollution: nitrogen dioxide, sulfur dioxide, and carbon monoxide health effects. *The American journal of the medical sciences, 333*(4), 249-256.

Díaz-Cruz, M. S., & Barceló, D. (2008). Trace organic chemicals contamination in ground water recharge. *Chemosphere, 72*(3), 333-342.

Dong, Y., Gao, M., Song, Z., & Qiu, W. (2019). Adsorption mechanism of As (III) on polytetrafluoroethylene particles of different size. *Environmental Pollution*, 254, 112950.

Edwards, C. A. (Ed.). (2013). *Environmental pollution by pesticides (Vol. 3).* Springer Science & Business Media.

Erten, S. (2004). Uluslararası düzeyde yükselen bir değer olarak biyolojik çeşitlilik. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 27*(27).

Farhat, A., Mohammadzadeh, A., Balali-Mood, M., Aghajanpoor-Pasha, M., & Ravanshad, Y. (2013). Correlation of blood lead level in mothers and exclusively breastfed infants: a study on infants aged less than six months. *Asia Pacific Journal of Medical Toxicology, 2*(4), 150-152.

Fried, J. J., Muntzer, P., & Zilliox, L. (1979). Ground-water pollution by transfer of oil hydrocarbons. *Groundwater, 17*(6), 586-594.

Friedman, S. M. (2011). Three Mile Island, Chernobyl, and Fukushima: An analysis of traditional and new media coverage of nuclear accidents and radiation. Bulletin of the atomic scientists, 67(5), 55-65.

Glibert, P. M., Seitzinger, S., Heil, C. A., Burkholder, J. M., Parrow, M. W., Codispoti, L. A., & Kelly, V. (2005). *Eutrophication. Oceanography, 18*(2), 198.

Goel, G., & Kaur, S. (2012). A study on chemical contamination of water due to household laundry detergents. *Journal of Human Ecology, 38*(1), 65-69.

Goyer, R. A. (1990). Transplacental transport of lead. *Environmental Health Perspectives, 89*, 101-105.

Güler, Ç., & Çobanoğlu, Z. (1994). Su kirliliği. Çevre Sağlığı Temel Kaynak Dizisi, 12.

Gülümser, G., & Çolak, S. (2001). Retanaj işlemi sırasında ortaya çıkan atık sıvıların çevre kirliliği açısından incelenmesi üzerine bir araştırma. *Ege Üniversitesi Ziraat Fakültesi Dergisi, 38*(2).

Gunkel, G., Kosmol, J., Sobral, M., Rohn, H., Montenegro, S., & Aureliano, J. (2007). Sugar cane industry as a source of water pollution–Case study on the situation in Ipojuca River, Pernambuco, Brazil. *Water, Air, and Soil Pollution, 180*(1), 261-269.

Hakkarainen, M., & Albertsson, A. C. (2004). Environmental degradation of polyethylene. *Long term properties of polyolefins,* 177-200.

Handa, B.K. (1991) *Treatment and recycle of wastewater in industry*. National Environmental Engineering Research Institute, Nagpur.

Harper, D. M. (1992). *Eutrophication of freshwaters* (p. 327). London: Chapman & Hall.

He, J., Liu, H., & Salvo, A. (2019). Severe air pollution and labor productivity: Evidence from industrial towns in China. *American Economic Journal: Applied Economics, 11*(1), 173-201.

Hesterberg, T. W., Bunn, W. B., McClellan, R. O., Hamade, A. K., Long, C. M., & Valberg, P. A. (2009). Critical review of the human data on short-term nitrogen dioxide (NO2) exposures: evidence for NO2 no-effect levels. *Critical reviews in toxicology, 39*(9), 743-781.

Hogland, W., Bramryd, T., & Persson, I. (1996). Physical, biological and chemical effects of unsorted fractions of industrial solid waste in waste fuel storage. *Waste Management & Research, 14*(2), 197-210.

Johnson, D. L., Ambrose, S. H., Bassett, T. J., Bowen, M. L., Crummey, D. E., Isaacson, J. S., et al. & Winter-Nelson, A. E. (1997). Meanings of environmental terms. *Journal of environmental quality, 26*(3), 581-589.

Kairytė, A., Kirpluks, M., Ivdre, A., Cabulis, U., Vaitkus, S., & Pundienė, I. (2018). Cleaner production of polyurethane foam: Replacement of conventional raw materials, assessment of fire resistance and environmental impact. *Journal of Cleaner Production, 183,* 760-771.

Kant, R. (2012) Textile dyeing industry an environmental hazard. Natural Science, 4, 22-26. doi: 10.4236/ns.2012.41004.

Kayan, A. & Küçük, A. (2020). Plastik kirliliğin çevresel zararları ve çözüm önerileri. *Ankara Hacı Bayram Veli Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi , 22* (2) , 403-427 . Retrieved from https://dergipark.org.tr/tr/pub/ahbvuibfd/issue/56396/659700

Khan, F. A., & Ansari, A. A. (2005). Eutrophication: an ecological vision. *The botanical review, 71*(4), 449-482.

Khan, S. U. (2016). *Pesticides in the soil environment*. Elsevier.

Kjellstrom, T., Lodh, M., McMichael, T., Ranmuthugala, G., Shrestha, R., & Kingsland, S. (2006). Air and water pollution: burden and strategies for control. *Disease Control Priorities in Developing Countries.* 2nd edition.

Kloog, I., Ridgway, B., Koutrakis, P., Coull, B. A., & Schwartz, J. D. (2013). Long-and short-term exposure to PM2. 5 and mortality: using novel exposure models. *Epidemiology (Cambridge, Mass.), 24*(4), 555.

Maji, K. J., Arora, M., & Dikshit, A. K. (2017). Burden of disease attributed to ambient PM 2.5 and PM 10 exposure in 190 cities in China. Environmental Science and Pollution Research, 24(12), 11559-11572.

Manisalidis, I., Stavropoulou, E., Stavropoulos, A., & Bezirtzoglou, E. (2020). Environmental and health impacts of air pollution: a review. *Frontiers in Public Health, 8,* 14. https://doi.org/10.3389/fpubh.2020.00014

Medalia, J. (2008). *Comprehensive nuclear-test-ban treaty: Background and current developments*. Diane Publishing.

Ministry of Environment and Urbanisation (1983). *Environmental Law* (Publication No. 5-22). Republic of Turkey Ministry of Environment and Urbanisation. https://www.mevzuat.gov.tr/MevzuatMetin/1.5.2872.pdf

Mirsal, I. A. (2008). Soil pollution (pp. 117-136). New York, NY: Springer.

Mishra, R. K., Mohammad, N., & Roychoudhury, N. (2015). Soil pollution: Causes, effects and control. *Tropical Forest Research Institute, 3*(1), 20-30.

Moores, FC. (2009). Climate change and air pollution: exploring the synergies and potential for mitigation in industrializing countries. *Sustainability. 1*, 43–54. 10.3390/su1010043.

Mrozik, A., Piotrowska, Z., Labuzek, S. (2003). Review:Bacterial degradation and bioremediation of polycyclic aromatic hydrocarbons, Vol. 12, No. 1 (2003), 15-25.

Nebel, B. J., & Wright, R. T. (1993*). Environmental science: the way the world works.* Prentice Hall Professional.

Orlov, D. S. (1992). *Soil chemistry*. AA Balkema Publishers.

Ott, J., Tan, D., Loveless, T., Grover, W. H., & Brisk, P. (2020). Chemstor: using formal methods to guarantee safe storage and disposal of chemicals. *Journal of chemical information and modeling, 60*(7), 3416-3422.

Patterson, W.J. 1985. *Industrial Wastewater Treatment Technology*. Butterworth. p:235-255, 371-391,

Persico, P., Ambrogi, V., Acierno, D., & Carfagna, C. (2009). Processability and mechanical properties of commercial PVC plastisols containing low-environmental-impact plasticizers. *Journal of Vinyl and Additive Technology, 15*(3), 139-146.

Pettry, D. E., Reneau Jr, R. B., Shanholtz, M. I., Graham Jr, S. A., & Weston, C. W. (1973). Soil pollution and environmental health. *Health services reports, 88*(4), 323.

Provoost, J., Reijnders, L., Swartjes, F., Bronders, J., Carlon, C.D., Allessandro, M. et al. (2008). Parameters causing variation between soil screening values and the effect of harmonization. *Journal of Soils and Sediments, 8*, 298–311.

Qin, T.C., Wu, Y.S. and Wang, H.X. (1994). Effect of cadmium, lead and their interactions on the physiological and biochemical characteristics of Brassica chinensis. *Acta Ecologica Sinica, 14*(1), 46–49.

Razo, I., Carrizales, L., Castro, J., Díaz-Barriga, F., & Monroy, M. (2004). Arsenic and heavy metal pollution of soil, water and sediments in a semi-arid climate mining area in Mexico. *Water, Air, and Soil Pollution, 152*(1), 129-152.

Rodríguez-Eugenio, N., McLaughlin, M., & Pennock, D. (2018). Soil pollution: a hidden reality. *FAO*.

Rodríguez-Liébana, J. A., ElGouzi, S., Mingorance, M. D., Castillo, A., & Pena, A. (2014). Irrigation of a Mediterranean soil under field conditions with urban wastewater: effect on pesticide behaviour. *Agriculture, ecosystems & environment, 185*, 176-185.

Satarug, S., Baker, J.R. and Urbenjapol, S. (2003). A global perspective on cadmium pollution and toxicity in non–occupationally exposed population. *Toxicology Letters, 137*, 65–83.

Taşdemir, M. (2019). Poliamid (PA). *Ticari Plastikler* içinde (s. 178-188). Ankara: Seçkin Yayıncılık.

United Nations Scientific Committee on the Effects of Atomic Radiation. (1996). Sources and effects of ionizing radiation. *UNSCEAR 1996 report to the General Assembly*, with scientific annex.

Van Grimbergen, M., Reybrouck, G., & Van de Voorde, H. (1975). Air pollution due to the burning of thermoplastics II (author's transl). Zentralblatt fur Bakteriologie, Parasitenkunde, Infektionskrankheiten und Hygiene. *Erste Abteilung Originale. Reihe B: Hygiene, Praventive Medizin, 160*(2), 139-147.

Vijaraghavan, N.S. (1999) Environmental unit in textile industry. Director BIS, bhopal science tech. *Entrepreneur, 7,* 3-9.

Villányi V, Turk B, Franc B, Csintalan Z. (2010). Ozone Pollution and its Bioindication. In: Villányi V, editor. *Air Pollution.* Intech Open. Doi:10.5772/10047.

WHO Regional Office of Europe (2000). Available at: https://euro.who.int/_data/assets/pdf_file/0020/123086/AQG2ndEd_7_4Sulfuroxide.pdf

Wilson, W. E., & Suh, H. H. (1997). Fine particles and coarse particles: concentration relationships relevant to epidemiologic studies. *Journal of the Air & Waste Management Association, 47*(12), 1238-1249.

Wong, O., & Raabe, G. K. (1989). Critical review of cancer epidemiology in petroleum industry employees, with a quantitative meta-analysis by cancer site. *American journal of industrial medicine, 15*(3), 283-310.

Yeager, L. (1999). *The Canada-wide acid rain strategy for post-2000*.

Zhang, Q., Qu, G., Wang, T., Li, C., Qiang, H., Sun, Q., ... & Hu, S. (2017). Humic acid removal from micro-polluted source water in the presence of inorganic salts in a gas-phase surface discharge plasma system. *Separation and Purification Technology, 187*, 334-342.

Zuhara, S., & Isaifan, R. (2018). The impact of criteria air pollutants on soil and water: a review. *Journal Enviromental Science and Pollution Research, 4*(2), 278-284.

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CHAPTER 8

E→STEM Approach Applications in Environmental Education

Sevcan CANDAN HELVACI
Kastamonu University

Introduction

Education is a complex system with a dynamic structure and every rational step in the field of education is of great importance. Education is necessary at the point of development, getting a profession, progress, equality, democracy and self-realization. Recent studies around the world focus on mastering education with a perspective away from politics and certain stereotypical educators (Colebrook, 2017). In the focus of this research, the idea of walking on more than one path at the same time rather than choosing a single path in education has been suggested, and it has been determined that the use of different disciplines together contributes to cognitive development, creativity, imagination and solving the problems encountered (Perkins, 1994). The STEM approach has emerged with the use of science, mathematics, which are the basic disciplines, engineering, which uses science and mathematics together for the design of the world, and technology, which makes science a tool in changing the world, in education.

The STEM approach has merged with disciplines such as entrepreneurship (STEM-Entrepreneurship, STEM+E), art (STEM-Art, STEAM) and programming (STEM-Computing, STEM+C) over time. One of the current interpretations of the STEM approach, created by considering the needs of the 21st century, is E→STEM, which is the combination of Environment and STEM. In order to understand the framework, impact and goals of the E→STEM approach, it is important to understand the STEM approach and 21st century skills that it is rooted in.

STEM Approach and 21st Century Skills to Understand the E→STEM Approach

STEM consists of Science, Technology, Engineering and Mathematics disciplines. The interdisciplinary approach, which emerged about 30 years ago and was first acronymous as SMET by the National Science Foundation, later took the form of STEM (Martín-Páez et al., 2019) and has taken place in the literature with this form today. STEM is a combination and is applied to comprehend situations encountered in daily life and to find solutions to problems (Siekmann & Korbel, 2016). While the STEM approach is based on constructivism and constructionism theories (Ah-Namad & Osman, 2018), it is thought to be closer to constructivist theory since it tends to measure critical thinking, creativity, productivity and entrepreneurship with performance-based evaluation (Çepni, 2017).

The new structure formed by the STEM approach disciplines is bigger than each part of the STEM disciplines (Shanahan et al., 2016). In this context, individuals who acquire a profession with the STEM approach can find original outputs with their complex competencies (Breiner et al., 2012). STEM is interested in the real problems of the world and the cumulative impact of these problems on the present and where it can lead the future.

The education that can be given with STEM disciplines can be examined in two groups, as disciplinary-focused and interdisciplinary, as shown in Figure 1 (Siekmann & Korbel, 2016).

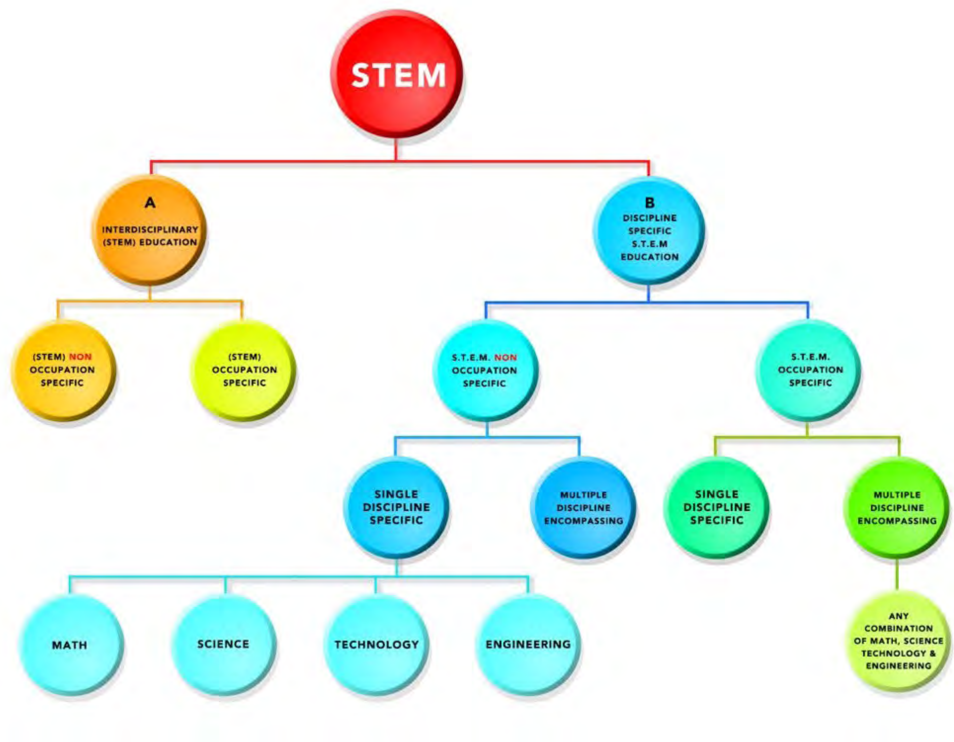


Figure 1. Interdisciplinary STEM Education and Discipline-Focused S.T.E.M Education

Interdisciplinary STEM education comes in two forms: if it is focused on STEM professions, it is a *profession-oriented interdisciplinary STEM*; *non-profession-oritented interdisciplinary STEM* if it includes an education for daily life problems. Discipline-oriented S.T.E.M education, on the other hand, is also divided into two groups as *Profession-oriented S.T.E.M education,* which can combine single or multiple disciplines, and *Non-profession-oriented S.T.E.M education*. Interdisciplinary STEM education should be the party to be chosen at this point.

Although STEM follow-up and assessment is an interdisciplinary approach with difficulties (Siekmann & Korbel, 2016), it is a meaningful educational path. This approach can provide efficient and diverse learning with the use of multiple disciplines (Takeuchi et al., 2020). The STEM approach also establishes deep ties with the skills, in other words, with the ability to produce solutions to the problem it emphasizes, to think original, to open alternative ways, and to conclude appropriate for the purpose. Skill development is a point that the STEM approach values and in this context, it attaches importance to the development of 21st Century Skills. These skills are both a building block and pathways within the STEM approach. The concept of skills takes place in international policies and systems with many different classifications (e.g. OECD Future of Education and Skills 2030, Partnership for 21st Century Skills (P21), ATSC21 skills framework, Wagner's skills framework, NRC skills framework, enGauge (NCREL) skills framework, AACU skills framework, ISTE skills framework, Iowa skills framework, Turkis qualifications framework) (Cansoy, 2018). Among these skills, the *OECD skills framework*, which sets a proficiency target for a future point in time, points out the skills that students should have in 2030, and the most researched and recognized *Partnership for 21st Century Skills (P21)* differ from the others, there is also an environmental theme in P21.

OECD (2018) skills are grouped under three headings: Cognitive and meta-cognitive skills, social and emotional skills, and physical and applied skills. These skills can be summarized as follows (OECD, 2018):

- *Cognitive and meta-cognitive skills:* These are the skills that allow students to apply their knowledge in situations they have not encountered before.
- *Social and emotional skills:* These are the skills required to communicate with other individuals, such as empathy, self-efficacy and cooperation.
- *Physical and applied skills:* Skills that require the use of dynamic and practical skills, such as using new information and communication technology devices.

P21, on the other hand, has a structure that aims to achieve the learning goals of the 21st century, to enable individuals to acquire knowledge and skills in their professional, daily and citizen lives, to be successful in the disciplines within the school, as well as to adapt to the changing world (P21, 2012).

Figure 2. Partnership for 21st Century Skills (P21) Content

Within this framework, there are themes and competencies (P21, 2019):

1. Life and Career Skills:

It refers to the development of individuals' knowledge, thinking skills, social and emotional competencies in their daily and professional lives and is examined under five headings.

- Flexibility and Adaptability
- Initiative and Self-Direction
- Social and Cross-Cultural Skills
- Productivity and Accountability
- Leadership and Responsibility

2. Learning and Innovation Skills

Learning and innovation skills, also known as 4C (Levin-Goldberg, 2012), are skills that aim to prepare students for daily life and business life in an increasingly complex world (P21, 2019). It is examined under four headings.

- Creativity and Innovation
- Critical Thinking and Problem Solving
- Communication
- Collaboration

3. Information, Media and Technology Skills

It includes skills such as accelerating access to information in the technology and media ecosystem, adapting to technological change and individualization. It is analyzed under three headings.

- Information Literacy
- Media Literacy
- ICT (Information, Communications, and Technology) Literacy

In P21, there are key subjects on which their skills are based, and 21^{st} Century Themes based on key subjects and student success is grounded on. Key subjects were determined as English, reading, or language arts, world languages, arts, mathematics, economics, science, geography, history, government and civics. 21st Century Themes are Global Awareness, Financial, Economic, Business and Entrepreneurial Literacy, Civic Literacy, Health Literacy, Environmental Literacy.

STEM Skills

21st century skills are not recognized and unknown before, but a newly discovered structure (Silva, 2009). The STEM approach also plays a role in understanding this importance and taking concrete steps to develop skills. The STEM approach includes specialized skills as well as aiming to develop 21st century skills. STEM skills are Engineering Based Problem Solving Skill, Skills for Establishing Relevance, Engineering Based Design Skills, Innovation Skills, Digital Competence, Creativity, Communication and Collaboration (Şen et al., 2018).

Engineering Based Problem Solving Skill: Problem solving skill is the ability to eliminate an obstacle or problem (Yılmaz et al., 2018). It is structured as an engineering-based problem solving skill within the engineering design process in the STEM approach. In STEM application, it develops itself while making progress in the product creation process that leads to the definition and solution of the problem. Success in the STEM approach is closely related to this skill.

Skills for Establishing Relevance: Providing meaningful learning by integrating disciplines and knowledge with new ones. As information can be associated with new information, STEM disciplines can be associated within themselves and with other disciplines (such as art, environment, astronomy) (Şen et al., 2018).

Engineering Based Design Skills: Engineering based design skills are learning scientific concepts by students and using them for the benefit of society in solving engineering problems (Bamberger & Cahill, 2013). Mastery of the process in the engineering design process is closely related to this skill.

Innovation Skills: Innovation, which expresses a renewal in the process and in the result, is in the nature of STEM approach. STEM creates cumulative progress in its disciplines with this innovative thinking. In order to be stronger in competition today and in the future, one of the features that individuals should have at university is innovation (Yılmaz & Sünbül) and it enables progress in the fields of economy, industry and technology.

Digital Competence: Digital competence is a concept that describes technological skills (Ilomäki et al., 2011). It is defined as the basic skill of accessing and evaluating, storing and presenting information using computers and the Internet (MoNE, 2018a). Digital competence, one of the eight key competences of the European Union (2010), is also included in the Turkish curriculum (MoNE, 2018a). It is related to the concepts of digital literacy, computer science, media science/education.

Creativity: Creativity is not only a skill for STEM, but also a starting reason and a rule to be followed in the process. Creativity, which means the realization of a flexible responsibility, problem solving or product making, the result of which cannot be determined exactly (Amabile, 2012), is also among the P21 skills. Creativity that feeds curiosity and imagination is the building block of the STEM approach.

Communication and Collaboration: Communication and Collaboration, which are included in the Learning and Innovation Skills in P21 (2012), are collaborative working and communication skills. Working in harmony in the face of a question/problem means the effective use of thoughts and feelings in solving problems and in expression. Especially being able to work collaboratively is one of the important concepts for STEM.

E-STEM

It is known that new interdisciplinary approaches emerge with the association of STEM approach with other disciplines (e.g. STEAM, STEM-C), and STEM approach evolves with the advent of the new discipline. This situation occurs when the boundaries of the disciplines are erased with the new formation and a unique new structure is formed with the unity. The disciplines work in harmony, away from the selfishness of realizing their own discipline goal. One of the disciplines partnering with STEM is Environment. If a current education focused on the real problems of the world, the cumulative impact of these problems on the present, where it can lead to the future, and a solution-oriented education, STEM and Environment, namely E→STEM, is the way to be chosen.

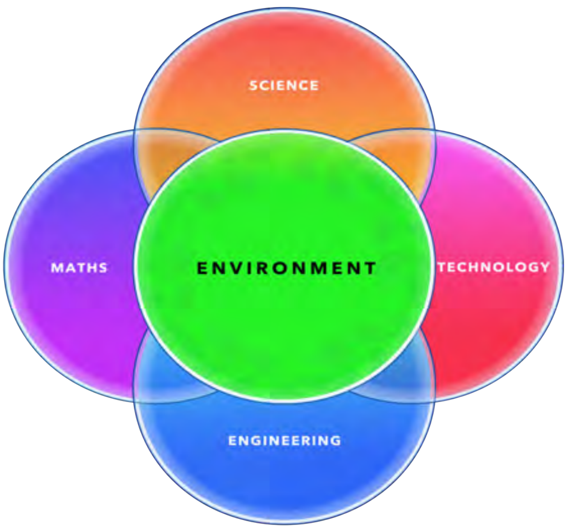


Figure 3. E→STEM Disciplines

As in STEM, E→STEM (Environment, Science, Technology, Engineering, Mathematics), which is an acronym of the initials of the disciplines, has also been expressed differently by some institutions and studies (e.g. Green STEM by the National Wildlife Federation or

E→STEM by Fraser et al., 2013, Gupta et al., 2018 and the North American Association for Environmental Education (NAAEE). Since E-STEM acronym is included in the literature as Entrepreneurship and STEM, E→STEM acronym in Environment and STEM-oriented studies (Fraser et al., 2013; Gupta et al., 2018; NAAEE, 2013) is also used in this study. E→STEM is a new concept in environmental education and is a suitable starting point for STEM delivery of environmental education (Fraser et al., 2013). In the E→STEM approach, a mutualistic partnership is established between science education and environmental education, thus achieving the goals of both disciplines together (Gupta et al., 2018).

A study was carried out by NAAEE (2013) in E→STEM and an innovative environmental education approach and the determination of rational ideas in the STEM approach, their evaluation, and a research experience aimed at solving environmental problems affecting the immediate environment with a deep research were carried out. In this context, attention was drawn to the following indicators for the development of E→STEM.

Professional Development: E→STEM professional development should be a priority.

Real connections: An environmental education should be given in which individuals experience the environment personally. Extracurricular activities are very effective in this sense.

Creativity in Critical Thinking: Creativity is important in E→STEM applications and is the condition of innovation.

Practical Synthesis: Since the E→STEM approach should be given within a program, a curriculum should be prepared with the cooperation of discipline experts and educators. For this, the first item, professional development, is important.

E→STEM includes actions and targets for the environment. The motivator of the process and the effect of the product at the end of the process are environment-centered. In addition to Engineering Based Problem Solving Skill, Skills for Establishing Relevance, Engineering Based Design Skills, Innovation Skills, Digital Competence, Creativity, Communication and Collaboration that come with STEM skills, environmental literacy, one of the P21 21st century themes, is also skills and competencies targeted by E→STEM. The E→STEM approach is in a structure that can strengthen and organicize the connection between sustainable development and STEM. However, due to the scope of environmental education, there is an environmental awareness development target. The focal points of the development/change of the E→STEM approach are briefly STEM skills, environmental literacy, sustainable development and environmental awareness.

E→STEM and Environmental Literacy

Environmental literacy consists of the combination of an individual's knowledge, skills, attitudes and behaviors related to the environment (Roth, 1992). Thanks to this combination, the individual who realizes that he is a part of the ecosystem can make beneficial choices for the environment. Responsibility and awareness are the keywords of environmental literacy.

The domains of environmental literacy, which is one of the goals of environmental education, are as follows (Hollweg et al., 2012):

Knowledge: Ecological knowledge of the environment and knowledge of sociopolitical systems.

Dispositions: Interest, sensitivity, responsibility towards the environment.

Competencies: The ability to understand environmental problems, to offer solutions, to take action for the solution of environmental problems and to base it.

Environmentally Responsible Behavior: Behavior that is desired and expected through an individual or collaborative effort to solve an environmental problem.

Context: Awareness of local, regional and global situations of the environment.

In the process of developing an environmentally oriented product in the approach, an awareness is provided by drawing attention to environmental problems, information about the environment is provided, an interest and responsibility towards the environment is gained thanks to this information, and most importantly, an atmosphere of beneficial behavior is created. With this process, which includes the conditions of environmental literacy, the link between E→STEM and environmental literacy is established.

E→STEM and Environmental Awareness

Environmental awareness, which forms the core of environmental education, is knowing basic information about the environment, taking an attitude towards the environment and showing beneficial behavior in line with this information (Erten, 2005, 2012, 2019). Environmental awareness can also be explained as a sensitivity formation towards environment (Dikmenli, 2017). Environmental consciousness, which consists of three basic dimensions as interconnected environmental knowledge, positive attitude towards the environment and beneficial behavior towards the environment, is gradually formed in individuals. When environmental awareness is mentioned, the components of environmental awareness should not be considered separately (Uzun et. al, 2019). Knowing the information about the environment is the trigger for the formation of environmental awareness. The individual starts to think about the environment by knowing basic ecological information, the role of living and non-living elements in the ecosystem, the structure of interaction and balance. The awareness and the process of seeing the environment by understanding cause individuals to have feelings about the environment. Being uncomfortable with the pollution of the environment, concern for the future of the environment, a sense of responsibility for the protection of the environment and positive attitudes towards the environment are formed. With these positive attitudes, the individual now tends to act for the benefit of the environment by taking action. The last point reached is considered to be the individual's environmental awareness. Everything in this process must be done "consciously".

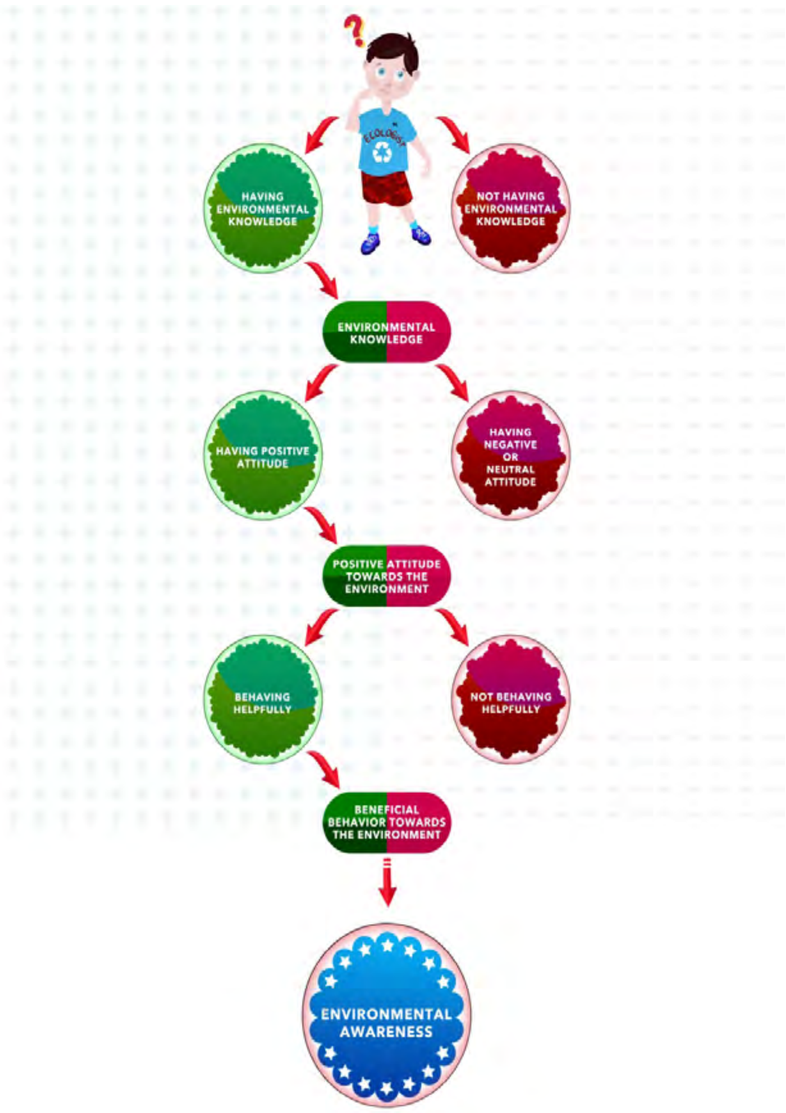


Figure 4. Environmental Awareness' Pathway

E→STEM is an effective discipline in the development of environmental awareness as well as in environmental literacy. With its structure coming from the STEM approach, the process proceeds consciously in the E→STEM approach, and this is one of the features that environmental awareness gives importance. It is in a structure that can provide all the steps for knowledge, attitude and especially behavior towards the environment with the skills and themes within it. It is seen that environmental awareness development can be achieved with E→STEM when the process of putting out a product in the step of showing beneficial behavior in environmental awareness is evaluated as taking action in solving an environmental problem.

E→STEM and Sustainable Development

Today, the concept of sustainability is used in all disciplines, and the foundations of the idea of sustainable development date back to the 19th century (Kılıç, 2012). It became known with Our Common Future published in 1987, known as the Brundtland Report (Brundtland, 1987). It is based on the philosophy of consuming today's needs by thinking of future generations without compromising their own needs. Sustainable development has also been included in the special objectives of Turkish curriculum in recent years (MoNE, 2018a). Sustainable development, which consists of three dimensions as economic, environmental and social (Harris, 2000), is the orientation of solving environmental problems based on an anthropocentric ethical approach.

Economic Dimension: The economic dimension, which is the conservation of capital and the prevention of loss (Goodland, 2002), is the conservation of available opportunities over time. It can also be summarized as the maximum economic benefit with less resource and environmental damage.

Environmental Dimension: The environmental dimension, which considers the efficient use of natural resources and the balance of the ecosystem, emphasizes the limited resources of the planet (Harris, 2000). It is the meeting of human needs by considering the balance without harming the ecosystem.

Social Dimension: It is a strong system formation where education, health and gender equality exist and everyone can access services equally. Equity, diversity, interconnectedness, quality of life, democracy and governance are its principles (McKenzie, 2004).

Sustainable development and E→STEM association is passed by African Union Commission (2015) in Agenda 2063. When the dimensions of sustainable development are examined, it is seen that E→STEM and the skills in the focus of E→STEM are also related to environmental literacy and environmental awareness. The E→STEM approach is in a structure to contribute to this multi-dimensional concept development, which is a long-term solution proposal for the solution of environmental problems.

E→STEM Approach Applications

Environmental education is important for education programs and this importance is understood more and more every day (Aydos & Yağcı, 2015). It is known that education is an effective way to find sustainable solutions to environmental problems (Artvinli & Demir, 2018). Although environmental education is given more place in educational revisions, there are deficiencies in terms of teaching materials (Derman & Gürbüz, 2018). At this point, it is thought that the outputs of E→STEM applications will be useful. The E→STEM approach is one of the most up-to-date forms of environmental education. This education contributes to the ability to think critically about the environment, the effects of people on the environment, and the interest in science professions (Gupta et al., 2018). It is also known that applied environmental programs increase the permanence of science concepts (Dieser & Bogner, 2016). While environmental education helps the effectiveness of the STEM approach, the STEM approach can offer new ways for environmental education (Kuvaç & Koç-Sarı, 2018). It is an area that has been researched on the E→STEM approach and its frame is being tried to be drawn. Nature Works Everywhere (NWE) is an sample program that includes the use of the environment in science, technology, engineering and mathematics teaching and supplementary materials for a nature-centered science teaching and has been the subject of research (e.g. Gupta et al., 2018).

Many teaching approaches can be used within the scope of the STEM approach. 5E learning model, cooperative learning, inquiry-based learning, problem-based learning are some of them. Engineering design-based science education and project-based learning have a structure that will provide a solid ground for environmental education delivered in the atmosphere of STEM approach. These two approaches, which are the most effective ways for STEM applications, will provide comfort in the integration of the environment. Reconciling engineering design-based science education and project-based learning with E→STEM and concretizing it with sample activity may contribute to the approach.

E→STEM Approach and Engineering Design Based Science Education

STEM education also includes the design process due to the relationship of engineering with innovation and problem solving (Okulu et. al, 2019). Engineering design-based science education (Apedoe et al., 2008), which is a combination of scientific research and engineering design process, is a combination of the engineering design process and the concurrent research cycle that surrounds it. One of the most fundamental aspects of this process, modeled by Barnett et al. (2008) and Wendell et al. (2010), is that students can learn from their mistakes (Kolodner et al., 2003; Wendell & Rogers, 2013). Engineering design and science teaching approaches are considered appropriate for the basic education level (Bozkurt, 2014), and the engineering design-based science education process is recommended for primary school (Kınık-Topalsan, 2018).

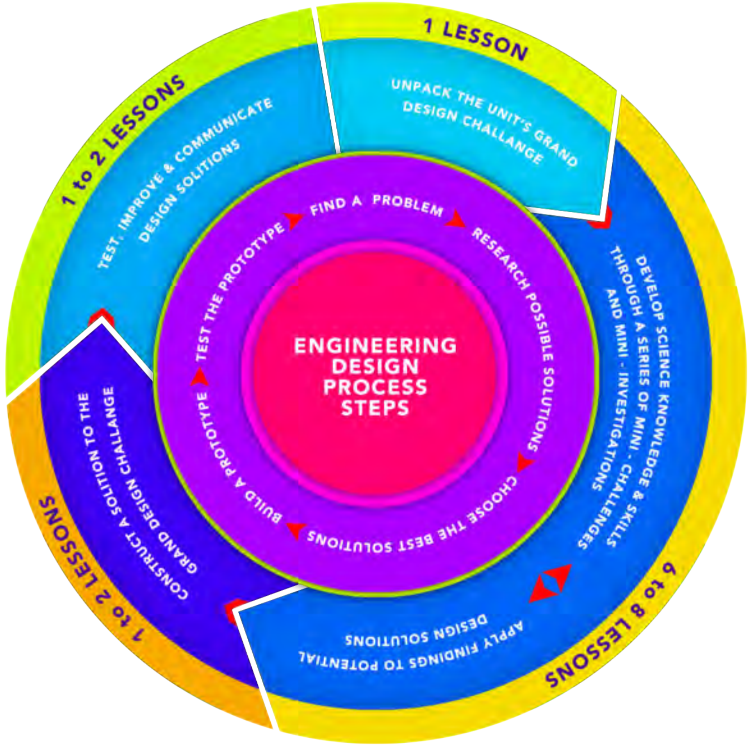


Figure 5. Engineering Design-Based Science Education Process (Wendell et al., 2010)

The processes in the two cycles in Figure 5 are carried out together in the course with the following stages:

1. Problem identification-Explanation of the major design task

2. Identifying possible solutions and choosing the best possible solution - Determining the most appropriate solution according to the expected situation from the big design task, with the students having the necessary knowledge and skills for the big design task through mini researches and mini designs. Decision-making skills are important at this stage.

3. Prototype development-Creating a prototype for the proposed and considered optimal solution for the major design task

4. Prototype testing-Developing or redesigning prototypes by testing and deficiencies

By Hynes et al. (2011) the engineering design process for the secondary education level was staged with more steps, and the freedom of transition between the steps in the process and the nature of the engineering design process ensured not to be afraid of mistakes and to continue the process. The engineering design process is illustrated in Figure 6.

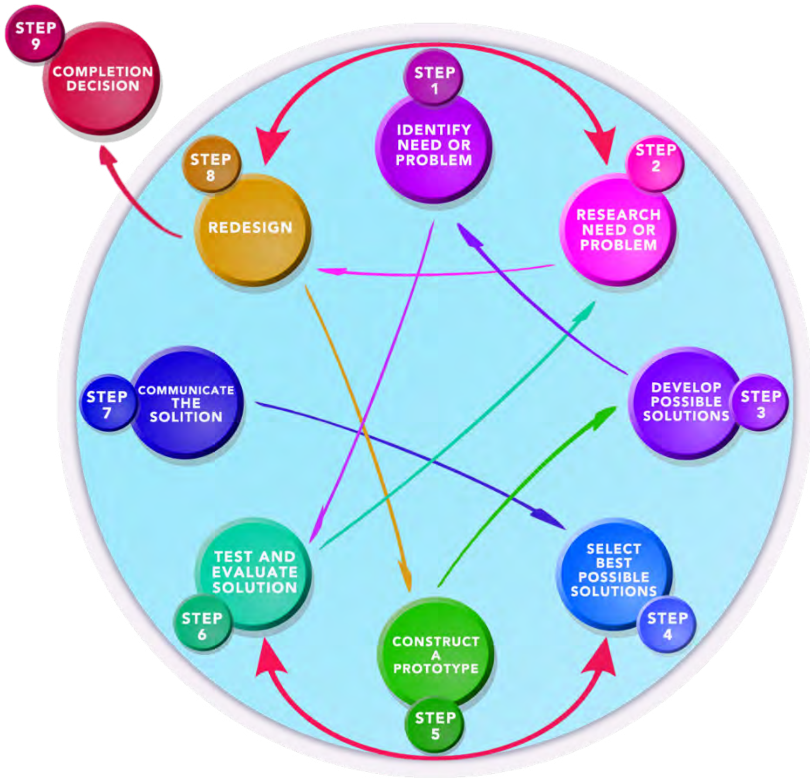


Figure 6. Engineering Design Process (Hynes et al., 2011)

It is known that the engineering design process is used for educational purposes by institutions such as NASA. The National Aeronautics and Space Administration (NASA) (2015) aims to develop STEM disciplines with its eight-step process.

In the engineering design-based science teaching process, the following can be included for the integration of the environment and its use within the scope of E→STEM:

1. An environmental problem/environment-oriented problem can be selected.

2. Environmental awareness and environmental literacy have an impact on the determination of possible solutions and the selection of the best solution. Sustainable development awareness dimensions can be taken into account while determining and selecting solutions, and environmental attitudes and environmental literacy can be developed during this selection.

3. Beneficial behavior can be targeted in the development of the prototype. Together with the product that will emerge, the materials in the emergence of this product can be selected to protect the environment.

4. It must be ensured that the resulting prototype is built with a conscious propensity

to display beneficial behavior. The environmental-oriented performances of the students at this stage can be accepted as an indicator of their environmental literacy level and the presence of environmental awareness.

E→STEM Approach and Engineering Design-Based Science Education Sample Activity

We Protect Water Activity

Grade Level: 7th and 8th Grade
Duration: 9 Lesson Hours
Goals and Achievements for E→ STEM Disciplines:

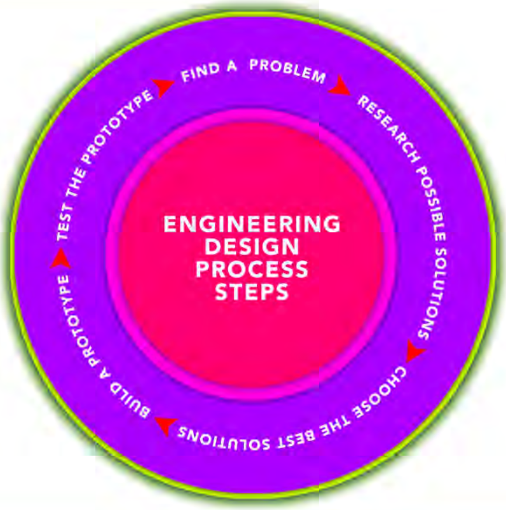
Environment	Performs the Reuse and Recyle stages of the Waste Hierarchy. Understands the importance of water. Explain the causes of water pollution. Develops projects to prevent water waste and pollution. Carries out applied environmental activities for the development of environmental awareness.
Science	F.7.4.5.2. Designs a project for the recycling of domestic solid and liquid wastes. F.7.4.5.4. Pays attention to waste control in its immediate surroundings. F.8.6.4.1. Takes care to be economical in the use of resources. F.8.6.4.2. Designs projects for the efficient use of resources.
Technology	TT.7.B.1.3. Shares the solution proposal he/she has developed for the problem he/she has determined. TT.7.B.2.1./ TT.8.B.1.1. Makes draft drawings for design. TT.7.D.1.3. Prepares the design plan. TT.7.D.1.4. Creates the model or prototype of the design. TT.7.D.1.6. Restructures the designed product according to the evaluation results. TT.8.C.3.4. Designs a product using the engineering design process TT.8.D.2.1. Prepares promotional materials for the product to be exhibited.
Engineering	Makes a product prototype. Applies engineering design processes.
Mathematics	M.7.1.1.5. Solves problems that require operations with integers. M.7.2.2.3. Solves first-order equations with one unknown.
21st Century skills	Creativity and Innovation Critical Thinking and Problem Solving Collaboration

We Protect Water Activity Worksheet

Environmental-Friendly Engineer Group Name:	
Environmental-Friendly Engineer Group Members:	**Duties**

Big Design Task

Water is one of the inanimate elements of the environment. Water, which is of great importance for the living elements of the environment (humans, plants, fungi, microscopic creatures), is indispensable. Most of our planet is made up of water. 2-3% of this water, that is very little, is fresh water. Living things can only use fresh water. Water is polluted in the city we live in, in Turkey and in the world. Our water is polluted when we use non-biodegradable detergents, when we pour waste oil into sinks, when we empty our waste into the sea, when we unconsciously use pesticides, that is, when we act harmful to the environment. For example, frying oils constitute about 25% of the pollution load of municipal wastewater. When we pollute the waters, this water mixes with the stream or river in our city, the seas in our country, and the oceans of the world. All living things in the world can be affected by this pollution. Water pollution can also cause other environmental problems, such as soil pollution. It poses a great threat to the lives of all peoples of the world. The return of water pollution is very difficult. Since the water resources we have are limited, they should be used very carefully. So how can water pollution be prevented? As a nature friend, can you stop water pollution? Can you design a model that we will use in our homes to prevent water pollution? You will be given some materials for this design. The cost of your design must be economical, your resources are limited.



1. Identifying the Problem

1. What is the problem with the big design task?

2. What should be done to solve the problem successfully?

3. What limitations exist in solving the problem?

2. Researching Possible Solutions

You identified the problem. What kind of design do you intend to make that can protect the environment and prevent water pollution? What do you need to learn for your design? Please research.

The criteria for this design are:

• There must be at least two different wastewater routes.

• Accumulation of water containing contaminants (such as oil) should be ensured.

• The hose at one end of the double outlet faucet apparatus should be at least 20 cm, and the one at the other end should be at least 70 cm.

• Maximum cost of your design is 60 ₺

• Your design should be able to hang somewhere.

• Attention should be paid to the connections to prevent leakage.

Materials:

• 1 meter garden hose (1m 4 ₺)

• 1 piece of funnel (1 piece 10 ₺)

• 1 double outlet faucet apparatus (1 x 30 ₺)
Scissors (1 piece 10 ₺)

• 1 piece 5-liter waste plastic bottle or 1 piece waste liquid detergent bottle (0 ₺)

• 1 meter waste rope (0 ₺)

• Repair tape (1 m 0.5 ₺)

(Water, oil and detergent to be used jointly between groups to test the model)

Material to be used	Amount
Total	

You can communicate and discuss designs with other groups. Draw and explain what kind of design you intend to make.

3. Choosing the best solution

As eco-friendly engineers, you chose your materials and thought about the design to prevent water contamination. Draw your design below.

4. Making and Testing the Model

Make your design the way you planned. Test your model with oil and water.

5. Evaluating the Model

Evaluate your tested design with the help of the table below.

Criteria	Should be improved (1 point)	Moderate (2 points)	Good (3 Points)	Very Good (4 Points)
Did your model have the features you wanted?	**1**	**2**	**3**	**4**
Can your model separate water containing contaminants?	**1**	**2**	**3**	**4**
Is your model economical?	**1**	**2**	**3**	**4**
Is your model original?	**1**	**2**	**3**	**4**
Is your model useful?	**1**	**2**	**3**	**4**
Does your model protect nature?	**1**	**2**	**3**	**4**
Can your model be improved?	**1**	**2**	**3**	**4**
Total				

What concepts did you use in your design? What environmental concepts did you use?

Has your model been useful for protecting the environment? What environmental problems can it be used to solve? Please explain.

What are the differences and similarities of your model when you compare it with the models of other groups? Evaluate your own model when you compare it with other groups in showing environmentally beneficial behavior, ie protecting the environment.

What changes should you make in your model to increase environmental protection? Please explain.

References:

Hynes, M., Portsmore, M., Dare, E., Milto, E., Rogers, C., Hammer, D., & Carberry, A. (2011). Infusing engineering design into high school STEM courses.. https://files.eric.ed.gov/fulltext/ED537364.pdf

Ministry of National Educaion [MoNE] (2018a). Fen bilimleri dersi öğretim programı (İlkokul ve ortaokul 3, 4, 5, 6, 7 ve 8. sınıflar). http://ttkb.meb.gov.tr/www/guncellenen-ogretimprogramlari/icerik/151

Ministry of National Education [MoNE] (2018b). Matematik dersi öğretim programı (ilkokul ve ortaokul 3, 4, 5, 6, 7 ve 8. sınıflar). https://mufredat.meb.gov.tr/Dosyalar/201813017165445-MATEMATİK%20ÖĞRETİM%20PROGRAMI%202018v.pdf

Ministry of National Education [MoNE] (2018c). Teknoloji ve tasarım dersi öğretim programı (ortaokul 7 ve 8. sınıflar). https://mufredat.meb.gov.tr/Dosyalar/2018124112937511-TEKNOLOJİ%20TASARIM%20ÖĞRETİM%20PROGRAMI%207-8.pdf

Wendell, K. B., & Rogers, C. (2013). Engineering design-based science, science content performance, and science attitudes in elementary school. Journal of Engineering Education, 102(4), 513–540.

E→STEM and Project-Based Learning

Project-based learning (PBL) is a learning approach that has an old history, but has gained a place in educational environments in the 20th century and remains up-to-date (Korkmaz & Kaptan, 2001). Project-based learning puts the student at its center, but makes it active in the process by assigning responsibilities not only to the student but also to other stakeholders of education. Content-specific learning, active participation of the student and sharing what has been learned are among the principles of PBL (Krajcik, 2006).

Within the scope of PBL (also known as PjBL in the literature), there are five criteria for determining whether a project is an example or not. These are centrality, driving question, constructive investigations, autonomy and realism (Thomas, 2000). Along with the concepts of learning to learn and lifelong learning, it also serves for competences such as decision making, self-evaluation and evaluation (Tonbuloğlu et al., 2013).

Project-based learning can be used effectively in many educational levels. Taking responsibility for learning, discipline and freedom are the products of PBL (Bell, 2010). The center of PBL is pedagogy and it is not carried out within the scope of a program (Sepahkar et al., 2015). The main differences between a normal project process and PBL can be listed as follows (Sepahkar et al., 2015):

- The teacher guides the students to be on the right path during the project process. The teacher's expertise in the research subject is as important as his field knowledge.
- There are no separate tasks set for group members in the project. During the project, they experience the same experience in different ways at the relevant stage.
- Planning can be stretched in time. Progress in a certain timeline may distract from the target because students think of different ways and mistakes are considered as learning experiences.

PBL consists of stages. Until one of these stages is completed, the next stage should not be passed. It is possible to proceed with the following steps in PBL (Bell, 2010):

- The problem is determined. This problem is chosen in a way that is free from various factors.
- Requirements are determined by brainstorming about the research process.
- It is decided how the learning will be transformed as a project.

- The group, community (e.g. classmates, school administrators, parents) to whom the project will be presented is selected in accordance with the scope of the project.

The interconnection of the design processes of STEM and PBL is clearly seen. There are studies on STEM-PBL (Han et al., 2016; Han et al., 2016; Lou et al., 2017; Özçakır-Sümen & Çalışıcı, 2019), these studies have found positive effects on success and skill. STEM-PBL stages can be carried out in seven steps as identifying the problem, researching the problem, deciding on the design, analyzing ideas, making the project, testing and redesigning, communication and presentation (Çepni, 2017). PBL, whose research process is similar to STEM, can also be easily carried out with the E→STEM approach.

- In this context;
- The problem can be determined for environmental problems. In the selection of this environmental problem, the selection of the immediate environment can create effectiveness in the research process.
- Research on the problem has the potential to bring about change/development in environmental knowledge and environmental literacy.
- At the stage of turning it into a project, the criteria for creating a product and solving a problem for the environment should be observed.
- The point of sharing the beneficial behavior that will be shown as a result of the product with the target audience is in a structure that can create positive results in terms of environmental education

E→STEM and Project Based Learning Sample Activity

Zero Waste Project

Grade Level: 7th and 8th Grade
Duration: 10 weeks
Goals and Relation with E→STEM Disciplines:

Environment	Performs the Reduce Reuse and Recyle stages of the Waste Hierarchy. Realizes efficient resource usage. Prevents wastage. Carries out applied environmental activities for the development of environmental awareness.
Science	F.7.4.5.2. Designs a project for the recycling of domestic solid and liquid wastes. F.7.4.5.4. Pays attention to waste control in its immediate surroundings. F.8.6.4.1. Takes care to be economical in the use of resources. F.8.6.4.2. Designs projects for the efficient use of resources.
Technology	TT.7.B.1.3. Shares the solution proposal he/she has developed for the problem he/she has determined. TT.7.B.2.1./ TT.8.B.1.1. Makes draft drawings for design. TT.7.D.1.3. Prepares the design plan. TT.7.D.1.4. Creates the model or prototype of the design. TT.7.D.1.6. Restructures the designed product according to the evaluation results. TT.8.C.3.4. Designs a product using the engineering design process TT.8.D.2.1. Prepares promotional materials for the product to be exhibited.
Engineering	Makes a product prototype. Applies engineering design processes.
Mathematics	M.7.1.1.5. Solves problems that require operations with integers. M.7.2.2.3. Solves first-order equations with one unknown.
21st Century Skills	Creativity and Innovation Critical Thinking and Problem Solving Collaboration Communication

Questioning Phase

Rotting and crushing of food leads to wastage of food. This is called food waste. Not only in places where food is produced, but also excessive food orders, excess bread and excessive food intake are the causes of food waste in restaurants. The biggest food waste occurs in our homes.

- 1/3 of the food produced in the world is wasted every year.
- 45% of vegetables and fruits produced in the world and 20% of animal foods are wasted.
- Of the 33 million tons of garbage collected every year in our country, 14.5 million consists of food.

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Food waste means wastage of energy and water during production. This increases our ecological, carbon and water footprint. Waste pollutes the environment and causes environmental problems. Along with our resources, their access to resources is endangered for future generations. In addition to wise and planned shopping, it is also beneficial to extend the shelf life of foods in preventing this waste.

Based on this information, develop a project suitable for the question given below.

Problem Status

You opened a restaurant. As an operator, after a while, you realize that 3 kg of food is thrown away every day in the restaurant kitchen. To prevent this, you made a planned shopping by calculating the average daily consumption of vegetables, fruits and meat. However, you have seen that this is not a solution to food waste, that the food in the restaurant kitchen gets moldy and continues to be thrown away. When you investigated the reason, you learned that there is a decay related to the storage life of the food, so 1 kg of it is thrown away every day. You also calculated that you suffered financial damage because you had to buy new ones instead of these rotting foods. You know that increasing the cooling levels of the refrigerator cabinets that provide storage will also cause energy consumption and it is not an environmental-friendly behavior. You need to find a solution that will prolong the decay time of foods. How do you come up with a solution?

Students will carry out this project in the following stages:

1. Identifying the problem

It is necessary to determine the beginning of the project and to define the problem clearly.
Causes of food waste

1. (When the restaurant was first opened) No planned shopping
(21 kg of food was wasted per week due to this problem) (After the planned shopping)
Not extending the shelf life (7 kg of food was wasted per week due to this problem)

2. When the levels of the coolers to prevent food waste are increased,
it causes more energy consumption.

2. Investigation of the Problem

Research is done about the problem, solutions are developed.

In your first problem, you explored the possibility that you may still be making unplanned shopping related to spoilage of food. You have found that your purchase and need are equal, that you have made a planned shopping, and that the problem is the deterioration of the food. What should you do to reduce food waste?

Regarding your second problem, you have done research to delay the deterioration of foods, to extend their shelf life. You talked to refrigerator cabinet companies. They suggested that you can buy coolers that cool more powerfully and consume more energy. You have calculated that this will cause an increase in the invoice price due to both cost and energy consumption. You knew it was an environmentally damaging behavior that also increased the ecological and carbon footprint. In order to find an environmentally friendly solution proposal, you have searched for a substance, plant or method that will not harm health in contact with food in nature and will prevent organisms that cause decomposition. As a result of your research, you learned that oak tree leaves delay the deterioration of food and this leaf has been used in the countryside since ancient times. You have decided to produce boxes for storing foods that can be placed in the refrigerator cabinet using oak leaves.
Determine the materials needed, the cost and the work schedule.

At this stage, information such as decay, living things that realize decay, organic wastes and how they should be removed are also questioned.

3. Deciding on the design

With the necessary material, cost and work schedule research, the students determine what should be related to the prototype they will make. At this stage, students stay in touch with their friends and can brainstorm. The target audience to which the design will be presented is determined. Cost, durability, functionality, efficiency and materials to be used are determined.
In determining prototypes, the following can be discussed:

- What processes should oak leaves be made into a box?
- What is the decay time of oak leaves?
- Do oak leaves have the same effect when shredded or should they be used as a whole leaf?
- What is the environmental impact of the use of oak leaves?

4. Analyzing ideas

Prototype design is decided according to the way the project is done individually or with a group. At this stage, theoretical knowledge of STEM disciplines is used. The prototype design plan is finalized. The criterion of the prototype being environmentally friendly is also taken into account.

5. Construction phase

Prototype construction is carried out.

6. Testing and redesign

The designed prototype is tested and improvement studies are carried out in line with the results. The testing process under this project will be long-term.

7. Communication and presenting

This solution, which will prolong the decay time of foods, will not harm the environment, is environmentally friendly also economical, is presented to the target audience. As a result of all the presentations, the students communicate and share their thoughts on the designs. As a result of this sharing, the design is finalized by making changes/corrections in the design when necessary.

This design can be examined by the teacher with the performance evaluation scale.

PROJECT ASSESSMENT SCALE

Criteria	Weak (1point)	Acceptable (2 points)	Medium (3 points)	Good (4 points)	Very Good (5 points)
The work plan	1	2	3	4	5
Identifying needs	1	2	3	4	5
Doing research	1	2	3	4	5
Distribution of tasks (if with a group)	1	2	3	4	5
Project execution according to plan	1	2	3	4	5
Material use	1	2	3	4	5
Originality	1	2	3	4	5
Usefulness	1	2	3	4	5
Affordability	1	2	3	4	5
Environmental protection	1	2	3	4	5
Attention to detail	1	2	3	4	5
Completion of the project	1	2	3	4	5
Communication	1	2	3	4	5
Creativity	1	2	3	4	5
Presentation	1	2	3	4	5
Total					

Students can evaluate themselves on the following scale in the STEM-PBL activity:

Criteria	Should be improved (1)	Medium (2)	Good (3)	Very Good (4)
Did your project have the features you wanted?	1	2	3	4
Were you able to realize your project according to your plan?	1	2	3	4
Was your research sufficient?	1	2	3	4
Does your project prevent food rot/spoilage?	1	2	3	4
Is your project economical?	1	2	3	4
Is your project original?	1	2	3	4
Is your project useful?	1	2	3	4
Does your project protect nature?	1	2	3	4
Did you work in harmony with your friends? (if with group)	1	2	3	4
Was your presentation effective?	1	2	3	4
Can your project be improved?	1	2	3	4
Total				

References:

Çepni, S. (Ed.).(2017). Kuramdan uygulamaya STEM eğitimi. Ankara: Pegem Akademi.
Ministry of National Educaion [MoNE] (2018a). Fen bilimleri dersi öğretim programı (İlkokul ve ortaokul 3, 4, 5, 6, 7 ve 8. sınıflar). http://ttkb.meb.gov.tr/www/guncellenen-ogretimprogramlari/icerik/151
Ministry of National Education [MoNE] (2018b). Matematik dersi öğretim programı (ilkokul ve ortaokul 3, 4, 5, 6, 7 ve 8. sınıflar). https://mufredat.meb.gov.tr/Dosyalar/201813017165445-MATEMATİK%20ÖĞRETİM%20PROGRAMI%202018v.pdf
Ministry of National Education [MoNE] (2018c). Teknoloji ve tasarım dersi öğretim programı (ortaokul 7 ve 8. sınıflar). https://mufredat.meb.gov.tr/Dosyalar/2018124112937511-TEKNOLOJİ%20TASARIM%20ÖĞRETİM%20PROGRAMI%207-8.pdf
URL: https://gidaisrafi.com

Conclusion

Education is a process that is constantly evolving and seeking the best, and for this purpose, it has been determined that combining different paths rather than following a single path provides both comprehensive and effective education. With this partnership of different disciplines, interdisciplinary education approaches have emerged. The STEM approach, which is one of the current trends of interdisciplinary education, has expanded its field of application by integrating with many disciplines and has taken a place in environmental education. Since the practice-oriented structure of the STEM approach coincides with the environmental education's goal of beneficial behavior, a partnership has been established that is pleasing to both sides. It is very important to turn the goals into action in environmental education and this is met with STEM applications. The E→STEM approach enables STEM to evolve with a deeper philosophy that considers the future rather than its economic, political or competitive bases. E→STEM, which can be applied at every level with every educational theory, approach and method in which STEM is applied, has the feature of a current approach to environmental education. At the point where environmental problems come, international agreements, sanctions or individual efforts create effects far from desired, and it is thought that nature education, namely E→STEM, will be a hope for the environment in the axis of STEM structuring the professions of the future.

References

African Union Commission. (2015). Agenda 2063: The Africa we want. Addis Ababa, Ethiopia. Retrieved June 04, 2021, from https://www.un.org/en/africa/osaa/pdf/au/agenda2063.pdf

Ah-Namad, L. & Osman, K. (2018). Integrated STEM education: Promoting STEM literacy and 21st Century learning. In M. Shelley & S. A. Kıray (Eds.), *Research highlights in STEM education (*pp. 66-80). Ames, Iowa: ISRES Publishing.

Amabile, T. M. (2012). *Componential theory of creativity.* Boston, MA: Harvard Business School.

Apedoe, X. S., Reynolds, B., Ellefson, M. R., & Schunn, C. D. (2008). Bringing engineering design into high school science classrooms: The heating/cooling unit. *Journal of Science Education and Technology, 17*(5), 454-465.

Artvinli, E. & Demir, Z. M. (2018). A study of developing an environmental attitude scale for primary school students. *Journal of Education in Science, Environment and Health (JESEH), 4*(1), 32-45. DOI:10.21891/jeseh.387478

Aydos, E. H. & Yağcı, E. (2015). Examination of the teacher candidates' environmental attitudes via NEP scale in terms of different variables. *Journal of Education in Science, Environment and Health (JESEH), 1*(1), 20-27.

Bamberger, Y. M. & Cahill, C. S. (2013). Teaching design in middle-school: Instructors' concerns and scaffolding strategies. *Journal of Science Education and Technology, 22*(2), 171–185. doi: 10.1007/s10956-012-9384-x

Barnett, M. Connolly, K. G., Jarvin, L., Marulcu, I. Rogers, C., Wendell, K. B., & Wright, C. G. (2008). *Science through LEGO engineering design a people mover: Simple machines*. Retrieved July 21, 2021, from http://www.legoengineering.com/wp-content/uploads/2013/05/LEcom_Compiled_Packet_Machines_LowRes.pdf

Bell, S. (2010). Project-based learning for the 21st century: Skills for the future. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas, 83*(2), 39-43. https://doi.org/10.1080/00098650903505415

Breiner, J. M., Harkness, S. S., Johnson, C. C., & Koehler, C. M. (2012). What is STEM? A discussion about conceptions of STEM in education and partnerships. *School Science and Mathematics, 112*(1), 3-11. https://doi.org/10.1111/j.1949-8594.2011.00109.x

Brundtland, G. H. (1987). Our common future: The World Commission on Environment and Development. Retrieved August 04, 2021, from https://digitallibrary.un.org/record/139811#record-files-collapse-header

Bozkurt, E. (2014). *Mühendislik tasarım temelli fen öğretiminin fen bilgisi öğretmen adaylarının karar verme becerisi, bilimsel süreç becerileri ve sürece yönelik algılarına etkisi* [Unpublished doctoral dissertation]. Gazi Üniversitesi.

Cansoy, R. (2018). Uluslararası çerçevelere göre 21.yüzyıl becerileri ve eğitim sisteminde kazandırılması. *İnsan ve Toplum Bilimleri Araştırmaları Dergisi, 7*(4), 3112-3134.

Claire, C. (2017). What is this thing called education?. *Qualitative Inquiry, 23*(9), 649-655. https://doi.org/10.1177/1077800417725357

Colebrook, C. (2017). What is this thing called education?. *Qualitative Inquiry, 23*(9), 649-655.

Çepni, S. (Ed.).(2017). *Kuramdan uygulamaya STEM eğitimi.* Ankara: Pegem Akademi.

Derman, M. & Gurbuz, H. (2018). Environmental education in the science curriculum in different countries: Turkey, Australia, Singapore, Ireland, and Canada. *Journal of Education in Science, Environment and Health (JESEH), 4*(2), 129-141. DOI:10.21891/jeseh.409495

Dieser, O. & Bogner, F. X. (2016). Young people's cognitive achievement as fostered by hands-on-centered environmental education. *Environmental Education Research, 22*(7), 943-957. https://doi.org/10.1080/13504622.2015.1054265

Dikmenli, Y. (2017). Preservice teachers' perception levels concerning consumer environmental consciousness. *Journal of Education in Science, Environment and Health (JESEH), 3*(2), 157-164. DOI:10.21891/jeseh.326741

European Union (2010). 2010 joint progress report of the council and the commission on the implementation of the 'education and training 2010 work programme'. Official Journal of the European Union. Retrieved August, 22, 2021 from https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2010:117:0001:0007:EN:PDF

Erten, S. (2005). Okul öncesi öğretmen adaylarında çevre dostu davranışların araştırılması. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 28*, 91-100.

Erten, S. (2012). Türk ve Azeri **öğretmen** adaylarında **çevre** bilinci. *Eğitim ve Bilim, 37*(166), 88-100.

Erten, S. (2019). Çevre ve çevre bilinci. In C. Aydoğdu & S. Kıngır (Eds.), *Fen öğretimi* (pp. 305-343). Ankara: Nobel Yayıncılık.

Fraser, J., Gupta, R., Flinner, K., Rank, S., & Ardalan, N. (2013). *Engaging young people in 21st century community challenges: Linking environmental education with science, technology, engineering and mathematics*. New York: New Knowledge Organization Ltd.

Goodland, R. (2002). Sustainability: Human, social, economic and environmental. In T. Munn (Ed.), Encyclopedia of Global Environmental Change (pp. 1-3). New York: John Wiley & Sons Ltd.

Gupta, R., LaMarca, N., Rank, S. J., & Flinner, K. (2018). The environment as a pathway to science learning for K–12 learners-A case study of the E-STEM movement. *Ecopsychology, 10*(4), 228–242. https://doi.org/10.1089/eco.2018.0047

Han, S., Capraro, R. ve Capraro, M.M. (2015). How science, technology, engineering, and mathematics (STEM) project-based learning (PBL) affects high, middle, and low achievers differently: The impact of student factors on achievement. *International Journal of Science and Mathematics Education, 13*, 1089–1113.

Han, S., Roslı, R., Capraro, M. M., & Capraro, R. M. (2016). The effect of science, technology, engineering and mathematics (STEM) project based learning (PBL) on students' achievement in four mathematics topics. *Journal of Turkish Science Education, 13*(Special Issue), 3-29.

Harris, J. (2000). Basic principles of sustainable development. In K. S. Kawa & R. Seidler, *Encyclopedia of life support systems: Dimensions of sustainable development* (Volume 1) (pp. 21-41). UNESCO

Hollweg, K. S., Taylor, J. R., Bybee, R. W., Marcinkowski, T. J., McBeth, W. C., & Zoido, P. (2011). *Developing a framework for assessing environmental literacy*. Washington, DC: North American Association for Environmental Education. Retrieved August, 01, 2021 from http://www.naaee.net

Hynes, M., Portsmore, M., Dare, E., Milto, E., Rogers, C., Hammer, D., & Carberry, A. (2011). Infusing engineering design into high school STEM courses. Retrieved July, 01, 2021 from https://files.eric.ed.gov/fulltext/ED537364.pdf

Ilomäki, L., Kantosalo, A., & Lakkala, M. (2011). What is digital competence? European schoolnet. Retrieved August 03, 2021, from https://helda.helsinki.fi/bitstream/handle/10138/154423/Ilom_ki_etal_2011_What_is_digital_competence.pdf

Kılıç, S. (2012) Sürdürülebilir kalkınma anlayışının ekonomik boyutuna ekolojik bir yaklaşım. *İstanbul Üniversitesi Siyasal Bilgiler Fakültesi Dergisi, 47*, 201-226.

Kınık-Topalsan, A . (2018). Sınıf öğretmenliği öğretmen adaylarının geliştirdikleri mühendislik tasarım temelli fen öğretim etkinliklerinin değerlendirilmesi. *Yüzüncü Yıl Üniversitesi Eğitim Fakültesi Dergisi, 15*(1), 186-219.

Kolodner, J. L., Camp, P. J., Crismond, D., Fasse, B., Gray, J., Holbrook, J., Putnam, S., & Ryan, M. (2003). Problem-based learning meets casebased reasoning in the middle schools science classroom: Putting learning by designTM into practice. *Journal of the Learning Sciences, 12*(4), 495–547.

Korkmaz, H. & Kaptan, F. (2002). Fen eğitiminde probleme dayalı öğrenme yaklaşımı. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 20*(20), 185-192.

Krajcik, J. S. (1994). Enacting project-based science: Experiences of four middle grade teachers. *Elementary School Journal, 94*(5), 517-538.

Kuvaç, M. & Koç-Sarı, I. (2018). *E-STEM STEM öğretmenleri için çevre konularına yönelik ortaokul etkinlik kitabı.* Ankara: Anı Yayıncılık.

Levin-Goldberg, J. (2012). Teaching generation techX with the 4Cs: Using technology to integrate 21st century skills. *Journal of Instructional Research, 1*(1), 56-66.

Lou, S.-J., Chou, Y.-C., Shih, R.-C., & Chung, C.-C. (2017). A study of creativity in CaC_2 steamship-derived STEM project-based learning. *Eurasia Journal of Mathematics, Science and Technology Education, 13*(6), 2387-2404. https://doi.org/10.12973/eurasia.2017.01231a

Martín-Páez, T., Aguilera, D., Perales-Palacios, F. J., & Vílchez-González, J. M. (2019). What are we talking about when we talk about STEM education? A review of literature. *Science Education, 103*(4), 799–822.

McKenzie, S. (2004). *Social sustainability: Towards some definitions*. Hawke Research Institute Working Paper Series No 27, Hawke Research Institute University of South Australia Magill, South Australia. Retrieved August 01, 2021, from https://unisa.edu.au/SysSiteAssets/episerver-6-files/documents/eass/hri/working-papers/wp27.pdf

Ministry of National Educaion [MoNE] (2018a). *Fen bilimleri dersi öğretim programı (İlkokul ve ortaokul 3, 4, 5, 6, 7 ve 8. sınıflar).* Retrieved August 11, 2021, from http://ttkb.meb.gov.tr/www/guncellenen-ogretimprogramlari/icerik/151

Ministry of National Education [MoNE] (2018b). *Matematik dersi öğretim programı (ilkokul ve ortaokul 3, 4, 5, 6, 7 ve 8. sınıflar).* Retrieved August 11, 2021, from https://mufredat.meb.gov.tr/Dosyalar/201813017165445-MATEMATİK%20ÖĞRETİM%20PROGRAMI%202018v.pdf

Ministry of National Education [MoNE] (2018c). Teknoloji ve tasarım dersi öğretim programı (ortaokul 7 ve 8. sınıflar). Retrieved August 11, 2021, from *https://mufredat.meb.gov.tr/Dosyalar/2018124112937511-TEKNOLOJİ%20TASARIM%20ÖĞRETİM%20PROGRAMI%207-8.pdf*

The National Aeronautics and Space Administration. [NASA]. (2015). *Engineering design process*. Retrieved August 02, 2021, from https://www.nasa.gov/sites/default/files/files/EDC-02_Let_It_Glide_Facilitation_Guide_FINAL.pdf

North American Association for Environmental Education [NAAEE]. (2013). *Engaging young people in 21st century community challenges: Linking environmental education with STEM.* Retrieved August 13, 2021, from https://cdn.naaee.org/sites/default/files/eepro/resource/files/estem_report_0.pdf

OECD (2018). *The future of education and skills. Education 2030.* Retrieved July 13, 2021, from https://www.oecd.org/education/2030/E2030%20Position%20Paper%20(05.04.2018).pdf

Okulu, H. Z., Oguz Unver A., & Arabacioglu, S. (2019). MUBEM & SAC: STEM based science and nature camp. *Journal of Education in Science, Environment and Health (JESEH), 5*(2), 266-282. DOI:10.21891/jeseh.586326

Özçakır-Sümen, Ö. & Çalışıcı, H. (2019). STEM proje tabanlı öğrenme ortamında sınıf öğretmeni adaylarının geliştirdikleri matematik projelerinin incelenmesi. *Ondokuz Mayıs Üniversitesi Eğitim Fakültesi Dergisi, 38*(1), 238-252.

Partnership for 21st Century Skills [P21]. (2012). *P21 framework definitions.* Retrieved July 11, 2021, from https://files.eric.ed.gov/fulltext/ED519462.pdf

Partnership for 21st Century Skills [P21]. (2019). *Framework for 21st Century Learning*. Retrieved July 11, 2021, from http://static.battelleforkids.org/documents/p21/P21_Framework_Brief.pdf

Perkins, D. N. (1994). *The intelligent eye: Learning to think by looking at art*. Santa Monica, CA: The Getty Center for Education in the Arts.

Roth, C. E. (1992). Environmental literacy: Its roots, evolution and directions in the 1990s. ED 348235. ERIC database.

Sepahkar, M., Hendessi, F., & Nabiollahi, A. (2015). Defining Project Based Learning steps and evaluation method for software engineering students. *International Journal of Computer Science and Information Security, 13*(10), 48-55.

Shanahan, M.-C., Carol-Ann Burke, L. E., & Francis, K. (2016). Using a boundary object perspective to reconsider the meaning of STEM in a Canadian context. *Canadian Journal of Science, Mathematics and Technology Education, 16*(2), 129–139. https://doi.org/10.1080/14926156.2016.1166296

Siekmann, G. & Korbel, P. (2016). Defining 'STEM' skills: Review and synthesis of the literature-support document 1 NCVER. Retrieved August 11, 2021, from https://files.eric.ed.gov/fulltext/ED570655.pdf

Silva, E. (2009). Measuring skills for 21st-century learning. *Phi Delta Kappan, 90*(9), 630–634.

Şen, C., Sonay, Z., & Kıray, S. A. (2018). STEM skills in the 21st century education. In M. Shelley & S. A. Kıray (Eds.), *Research highlights in STEM education* (pp. 81-101). USA: ISRES Publishing.

Takeuchi, M. A., Sengupta, P., Shanahan, M.-C., Adams, J. D., & Hachem, M. (2020) Transdisciplinarity in STEM education: A critical review. *Studies in Science Education, 56*(2), 213-253. doi: 10.1080/03057267.2020.1755802

Thomas, J. W. (2000). *A review of research on PBL*. Retrieved July 5, 2021, from https://tecfa.unige.ch/proj/eteach-net/Thomas_researchreview_PBL.pdf

Tonbuloğlu, B., Aslan, D., Altun, S., & Aydın, H. (2013). Proje tabanlı öğrenmenin öğrencilerin bilişüstü becerileri ve öz-yeterlik algıları ile proje ürünleri üzerindeki etkisi. *Mustafa Kemal Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 10*(23), 97-117.

Uzun, N., Gilbertson, K. L., Keles, O., & Ratinen, I. (2019). Environmental attitude scale for secondary school, high school and undergraduate students: Validity and reliability study. *Journal of Education in Science, Environment and Health (JESEH), 5*(1), 79-90. DOI:10.21891/jeseh.491259

Yılmaz, E. & Sünbül, A. M. (2009). Üniversite öğrencilerine yönelik girişimcilik ölçeğinin geliştirilmesi. *Selçuk Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 21*, 195-203.

Yılmaz, E., Ural, O., & Güven, G. (2018). The development and analysis of reliability-validity of social problem solving skills scale for 48-72 month old children. *Kastamonu Education Journal, 26*(3), 641-652.

Wendell, K. B., Connolly, K. G., Wright, C. G., Jarvin, L., Rogers, C., Barnett, M., & Marulcu, I. (2010, June, 20-23). Poster, incorporating engineering design into elementary school science curricula. In *Think outside the box! K-12 engineering* [Symposium]. Curriculum American Society for Engineering Education Annual Conference & Exposition, Louisville, Kentucky, USA.

Wendell, K. B., & Rogers, C. (2013). Engineering design-based science, science content performance, and science attitudes in elementary school. *Journal of Engineering Education, 102*(4), 513–540.

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CHAPTER 9

Early Childhood Environmental Education and Current Trends

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Introduction

Environmental education is also important in terms of creating value for the environment by developing an attitude towards the environment and teaches respect for the environment. Environmental education has a very important place in early childhood because it is known that the child develops a positive attitude towards the environment in this period. Value judgments and attitudes formed in early childhood and at a young age have a very important place in the development of empathy and love for nature in relations with nature at an early age. Considering the period, we live in, children are born into an environment where environmental disasters are experienced and strengthened by human hands, and vital diversity decreases. For this reason, it is expected that children, who are our future, will be more conscious and sensitive individuals about the environment. The first thing to be done for the purpose of creating environmental awareness in children is to give children the opportunity to communicate with their environment. In this regard, activities that will make children move, interact with the environment and explore the environment should be included in the child's life rather than activities that will keep children at home and immobilize them.

Although environmental education differs according to age groups, it has some common points: *Consciousness, knowledge, attitude, skills* and *participation* express these common aspects. In environmental education, which is shaped by common points, it is aimed that individual become conscious about the environment and its problems, have basic knowledge about the environment and its problems, develop an attitude based on protecting, improving and beautifying the environment, gaining skills to identify problems and develop solution proposals, and actively participate in environmental situations. In addition, enabling children to understand the environment in early childhood also enriches human-environment relations.

Environmental education addresses all cognitive, affective and psycho-motor learning areas of children. These developmental stages will be the learning in the affective field that should be taken into account and will later help the development of environmentally beneficial conscious behaviors in individuals. Within the scope of environmental education, children should be played games that make them love nature and they should gain experiences in nature. With these games and experiences, children acquire positive emotions and learn to be environmentally friendly. Children, who learn that nature is a value, become aware of its beauty with all their sense organs and make an effort to protect it. There are many approaches used in parallel with this dimension in early childhood education and some of these approaches attract global attention such as Montessori, Reggio Emilia, High Scope, Forest Schools and Waldorf. It can be said that 'environment' is the most striking of some of the points where these approaches are combined.

In addition to these early childhood programs, which have been carried out for many years, the need, place and importance of technology use in environmental education is increasing day by day. Especially in the technologies used in pre-school education, there are criteria such as supporting the development of the child, using it for multiple purposes and independently. When computer technologies are used in accordance with the development of children, they are an important tool that facilitates learning and allows me to explore. Technology must be physically present in the classroom and open to children's active use. While the activities are being implemented during the day, it should be ensured that children benefit from technology and how they will benefit from it should be determined.

Technological tools used in early childhood education are generally; music players, televisions, computers, overhead projectors, data projectors, electronic storybooks and other electronic devices. These tools, which are used, affect the motivation of children because they attract the attention of children and attract their attention. Technological tools should be used consciously to support children's cognitive, social, emotional, physical and language development opportunities and to enable them to learn, and should be appropriate for early childhood development. There are many examples where these tools also support environmental education in children.

The Child's Environmental Perception and Sensitivity

The perception of the environment in which people live is an important prerequisite for the development of environmental awareness. In the development of this sensitivity in humans, the perception that will be created through environmental education, especially in childhood, and the sensitivity that will be revealed by the perception will make people feel responsible for the environment they live in in the future (Rejeski, 1982). Awakening this sense of responsibility is more needed in the age of technology and unplanned urbanization. While technology immobilizes us more and more and limits our communication with the environment, unplanned structures narrow the environment we can communicate with. In this sense, environmental perception and sensitivity should be instilled in individuals from childhood in order to raise individuals who are aware of the environment and its elements, sensitive to and responsible for their environment (Yoleri, 2012).

Environmental Perception in Children

Children are curious and can be curious about almost anything. It is known that this curiosity arises when they open their eyes to the world and they try to understand what is going on around them. One of the subjects that this curiosity has turned to over time is the environment (Çabuk, 2019). When children encounter the environment, they realize that there is a life outside of them, and this triggers their sense of curiosity at a very high level since in the preschool period, the child has an egocentric mindset. Therefore, the environment they perceive is limited to the things they communicate with, and every new living-inanimate being they come into contact with creates an element of curiosity for them (Durmaz, 2019).

Figure 1. Environment and World

The concept of 'environment' begins to form in childhood; Children communicate with their environment through their 5 basic senses (Düzenli et al., 2018). The concept of environment has found meaning in children in different ways according to the environment, age, gender and social dynamics in which they are brought up. For example, a child growing up in the city may see the environment as consisting of houses, apartments and similar elements. On the other hand, the child growing up in the countryside uses the environment as trees, flowers, insects, etc. can perceive with its concepts (Taşkın & Şahin, 2008). These examples can be reproduced according to the following statistical data in terms of other variables (Haktanır & Çabuk, 2000):

- It has been observed that children who have siblings have less environmental perception than those who do not.
- The perception of the environment in the children of families with higher socioeconomic level in the upper stratum of the society is less than that of the lower socioeconomic level children in the lower strata of the society.
- It is observed that children with higher level of parental education can perceive the environment significantly more.

As a result, the concept of environment for the child has a wide definition in terms of meaning. When it comes to environmental perception in children, although the natural environment often comes to mind due to the period in which children live, it would be useful to consider other elements of the environment if it is desired to reach healthy inferences about children's environmental perception.

Environmental Sensitivity in Children

Considering the period, we live in, children are born into an environment where environmental disasters are experienced and strengthened by human hands, and vital diversity decreases. For this reason, it is expected that children, who are our future, will be more conscious and sensitive individuals about the environment (Ahi & Alisinanoğlu, 2016). Environmental education is also important in terms of creating value for the environment by developing an attitude towards the environment and teaches respect for the environment (Gärling & Golledge, 1989).

A large number of studies document that children differ in the degree they are shaped by their developmental context with some being more sensitive to environmental influences than others (Plues et al., 2018). Multiple theories suggest that Environmental Sensitivity is a common trait predicting the response to negative as well as positive exposures. The term 'environmental sensitivity' appears to have emerged in the 1970s and, in particular, following the 1977 Conference on Environmental Education in Tbilisi which resulted in the International Tbilisi UNESCO declaration (Canosa et al., 2020). This was the first international declaration linking education with the environment, whereby educators were passionate to instill a sense of awareness and 'sensitivity' to the environment in the early years (Chawla, 1998). According to Chawla (1998), there is evidence that 'the roots of environmental concern may lie in young children's initial fusion of their own feelings with their sensations of the world, thus forming the basis for a sense of the world as a living being to which they are attached'.

The first thing that needs to be done for the purpose of creating environmental awareness in children is to give children the opportunity to communicate with their environment (Çukur, 2011). In this regard, activities that will make children move, interact with the environment and explore the environment should be included in the child's life rather than activities that will keep children at home and immobilize them (Ärlemalm-Hagsér, 2013). The child's awareness of the things growing, happening and going on around her will enable him to ask questions about the environment, and these questions and the answers the child receives will form the basis of environmental sensitivity and awareness in the child.

Another issue that is as important as interacting with the environment in raising children who are sensitive to their environment is environmental education. Environmental education is the one that will complete the sensitivity of children with their curious nature by transforming them into a building (Gülay, 2011). Since it is known that perception is interpretation of sensation; Interacting with the environment creates sensation, and making sense of the environment being interacted with creates perception. Since the child begins to receive environmental education, he/she will make his/her perception first an attitude and then a value and will complete his/her awareness of the environment and become environmentally sensitive (Nazlıoğlu, 1988).

Figure 2. The Relationship Between Sensitivity-Perception and Environmental Awareness in Children

Another dimension of environmental awareness is family involvement. The general acceptance in the society is that the basic education of the child begins with the pre-school period. However, even before that, the foundation of child education begins to be laid in the family, albeit informally. In this sense, the duty of the family is to take their children outside, to take them for a walk, to interact with the natural environment and other environments. Since the child is constantly curious due to the period he is in, he will start this process by himself.

Figure 3. Family Involvement for Environmental Awareness

Although the children of the technology age we live in spend more time at home, this situation poses a danger for the healthy development of children. It is not possible for a child who does not interact with the environment to develop environmental perception and environmental sensitivity. For this reason, parents should introduce and interact with their children, taking into account the situations that their children may encounter in their future lives (Scrimin et al., 2018).

The benefits of raising an environmentally conscious child can be cited as:

- ✓ A child who is raised sensitive to his environment and educated in this way will first learn to respect the existence of a world outside himself (Torquati, 2013).
- ✓ The child, who realizes that he is a part of the environment when he communicates with the environment, will develop awareness to protect it through environmental education. For example, he will know that he should not throw garbage on the ground and that he will damage his own living space when he throws it.
- ✓ Children who are sensitive to their environment will have knowledge and awareness about environmental disasters.
- ✓ Since respect for the right to life, which is the most fundamental right of all life forms, goes beyond being sensitive to the environment, individuals who are sensitive to the environment also become sensitive to the right to life.
- ✓ It will be easier for children who grow up sensitive to their environment to understand the limits of their own freedom and the freedoms of other individuals and to act accordingly (Ärlemalm-Hagsér, 2013).
- ✓ A child who is sensitive to his environment will react to the harm that children who have not yet gained environmental awareness are trying to cause to the environment.
- ✓ A child who has reached environmental awareness before due to individual differences will be able to gain environmental awareness through peer teaching to children who have not yet reached it (Gärling & Golledge, 1989).
- ✓ The child who becomes sensitive to the environment will know that he has to contribute to the environment. For example, behavioral patterns that can be acquired in early childhood, such as planting saplings, saving water, and sorting waste, which are taught to children through environmental education, are important for the protection of the future environment.
- ✓ The child who grows up with environmental awareness will turn this sensitivity into an attitude and value in his future life and transfer it to the next generations. This will ensure continuity in environmental protection (Scrimming et al., 2018).
- ✓ The child, who is sensitive to the environment, will realize that his country is an

environmental factor in the learning he will do at the next level. He will understand that he has a civic duty to protect the environmental elements in his country.

Considering all these issues, the child who has environmental awareness at an early age will know that the planet earth he lives in has a place in the cosmic environment in his later years, and he will realize that he needs to take individual precautions to protect the planet by not limiting environmental awareness to the environment he lives in.

As in every education type and level, some approaches, methods and techniques are used in order to carry out educational activities in environmental education and pre-school level. In order to create environmental awareness in children, methods such as games, creative drama, field trips, and simulation are frequently preferred especially in preschool education (Akbayrak & Turaşlı, 2017; Aysu, 2019). The reason why these methods are preferred is that they can be applied according to the developmental stages and age ranges of children in all areas. Looking at the approach part, the Forest Schools Approach, which provides direct contact with nature, the Waldorf approach that prioritizes interaction with natural materials, and the Project Approach with its structure suitable for field trips stand out. However, it is clear that the environment is not just about the natural environment; For this reason, it should not be forgotten and ignored that all the approaches, methods and techniques in early childhood education can be beneficial if they are arranged in accordance with the level of children and in a way that takes them to the center.

The Impact of The Environment and Nature on The Development of The Child

Environment is defined as ‘area or place to live’. The concept of nature is broader than the concept of environment. Nature is a broad concept that includes natural and artificial environments as well as physical and social environment. Being a multidimensional concept, the environment has been the subject of research for many child development professionals (Baum, 2005; Chawla & Cushing, 2007; Dillon, 2003; Rickinson, 2006; Schnack, 2008). These studies revealed that the environment has two dimensions in the development of the child; social environment and physical environment.

Social environment is defined as the environment in which people interact in all kinds of social, economic, political, physical environment is the environments in which people live, exist and develop. The physical environment is divided into titles and plays an important role in the development of the child, both natural and artificial (Faber Taylor et al., 1998). Artificial environment, as the name suggests, is a ready-made, structured artificial space created entirely by humans. The natural environment, on the other hand, is the environment that occurs spontaneously, without human influence. These; all inanimate beings such as humans, animals, plants, soil, water and air. Both the social and physical environment are components that need to be addressed for environmental education in early childhood.

As a holistic approach to child development, a development support model that focuses on simultaneously developing all developmental areas (see Figure 4) of the child (language-cognitive, emotional, fine-gross motor, vestibular, proprioceptive, self-care, social) should be implemented. Solomon and Heide (2005) emphasize that interacting with the environment positively affects the holistic development of individuals and can help them cope with stress.

Figure 4. Elements of Child Development that Can be Affected by Environmental Education

Beyond the five senses traditionally taught, those of visual, auditory, gustatory, olfactory, and tactile, there are at least two more senses early childhood educators should be aware of: proprioceptive sense and vestibular sense. “Proprioception is the ability to sense what different parts of your body are doing without even looking at them. The vestibular sense is your awareness of where your body is in space; it determines your ability to effectively navigate your environment with ease and control” (Hanscom, 2016, p. 44). Within the scope of this development elements of child, all kinds of activities and practices for the environment will greatly contribute to the development of these senses.

Environmental education has a very important place in early childhood since it is known that the child develops a positive attitude towards the environment during this period.

A growing body of research also argued that nature has deep effects on well-being, above all for children because of their greater neuronal plasticity (Wells & Evans, 2003). Value judgments and attitudes formed in early childhood and young ages have a very important place in the development of empathy and love for nature in relations with nature at an early age (Erten, 2004). At this age, children are brought to life by playing nature-oriented games. Again, children during this period are curious and inquisitive. They are good observers of the environment and natural events they live in. Due to the developmental characteristics of preschool children, teaching by doing and playing is more effective in this period, so games and activities should be given more place in preschool education. While doing these, it is very effective to introduce concepts such as environmental education, sustainability and environmental protection through games and fun activities in this period (McClain & Vandermaas-Peeler, 2015).

Within the environmental education that the child receives at a young age, he or she goes on the way to become a conscious individual in the following years, and children who grow up with this awareness behave environmentally sensitive and love nature. The environment has positive and negative effects on the development of the child. For example, in underdeveloped and developing countries, a child may consume unhealthy drinking water, die due to environmental pollution, common diseases, or be born with a disability in the womb (UN, 2013). The environment after birth is the closed environment where the child lives with his mother. Sanitation, insufficient ventilation, overcrowding, low environment and socioeconomic level negatively affect this environment. In this case, factors such as the increase in the education level of the mother, the use of essential drugs, and immunization prevent adverse environmental conditions.

In the family environment, if there are parents who smoke, the probability of pneumonia and bronchitis in these babies is doubled. The external environment of the child, namely the mesosystem, causes adverse conditions due to many factors such as water pollution, air pollution, chemical pollution, destruction of forests and so on. However, environmental awareness and controlling pollution at an early age, increasing educational opportunities and expanding forest areas are the most important interventions in this regard. The child's macro environment, as well as the distant environment, is affected by the gradual warming of the climate, the thinning of the ozone layer, the melting of glaciers, the rise of the seas and water scarcity, etc. In short, the world in which the child lives is affected.

Children are more sensitive to environmental conditions than other individuals. Children are in holistic development during this period. Environmental awareness in children starts at a very young age, and by gaining experience in natural environments freely at these ages, the child should be able to absorb his environment. However, the exploration of the environment is important for children at an early age. Children also need to integrate their senses, and the outdoors is a wonderful place for this. Exploring natural materials and the natural environment allows us to engage in all of our senses effortlessly as natural materials often come with their own scents, visual stimuli, sounds, tastes, and textures in a way that is far different from a classroom filled with manufactured products with its windows shut to the birds and other natural noises outdoors (Rothmeyer, 2019).

In this period, children's perceptions are not limited to what they see in their environment or gain experience. On the contrary, the education-teaching process of the child and the home environment should be enriched. Today, adverse environmental conditions have imprisoned children in artificial environments, but children rarely meet with nature. These, on the other hand, are usually artificial environments, which inhibit the child's assimilation of his environment. However, the child's interaction with nature, touching, smelling, examining and researching ensures the child's full development, as the child discovers, his sense of curiosity increases and he wants to be more intertwined with nature (Barber et al., 2013; Pyle, 2002; Wells, 2000).

In educational environments, when it is not possible to bring children together with nature, albeit unintentionally, activities are enriched and children need an environment in the classroom that will activate their all senses. This is the responsibility of the teacher. The teacher has an important place in the interaction of the child with the environment and in the formation of environmental awareness. In some cases, depriving the child of nature may cause affective development disorders (Basile, 2000). In order to avoid such problems, the child should be brought together with nature at regular intervals. Most of the models applied in the educational environment are criticized because they empower children in a limited and specific development area, but cannot support them holistically.

Considering the other effects of the environment and nature on the development of the child, it can be said that living close to nature and having daily contact with nature have positive effects on intelligence and focus. This is evidenced by the fact that schools that use nature as part of their school curriculum do better in mathematics, social sciences, science and arts than others. In addition, the incidence of attention deficit and hyperactivity decreases in children of countries with long recess periods in schools. It is known that the benefits of being in contact with nature in child development are not limited to the cognitive domain (Kaplan & Kaplan, 1994). It has been determined that these children are more physically active and more respectful to each other in their peer relations in social areas. Also, nature and environmental activities have highly curative effects to children immune system.

> Healthy bodies and immune systems are vital in education and both are supported by time outdoors. According to microbiologist Mary Ruebush, "What a child is doing when he puts things in his mouth is allowing his immune response to explore his environment. Not only does this allow for

> ‘practice’ of immune responses, which will be necessary for protection, but it also plays a critical role in teaching the immature immune response what is best ignored” (As cited in Rothmeyer, 2019).

If the environment in which children live is intertwined with nature, the risk of experiencing anxiety and depression in children is less than other children (Taylor et al., 2001). However, nature is also good for the sleep problems that exist in the child, and the child spends all his energy in nature, observes and researches his surroundings, and sometimes grows his own products in his garden. Thus, the child can overcome all his negative feelings with nature. Value judgments and attitudes formed especially in childhood and young ages are very important in the development of empathy and love for nature in relations with nature at early ages. Environmental education addresses children’s cognitive, affective and psycho-motor learning areas. The formation of these values means showing environmentally friendly behaviors for the protection of the environment (Erten, 2004). These developmental stages will be the learning in the affective field that should be taken into account and will later help the development of environmentally beneficial conscious behaviors in individuals.

Within the scope of environmental education, children should be played games that make them love nature and they should gain experiences in nature. With these games and experiences, children acquire positive emotions and learn to be environmentally friendly. Children, who learn that nature is a value, become aware of its beauty with all their sense organs and make an effort to protect it. In the following sections, the effects of environment and nature on different developmental areas of children will be discussed.

Effect of Environment on Cognitive Development of Children

Children are born with a natural curiosity and desire to explore. Horwitz (1996) states that interest in the environment and association with nature begin at an early age. From the moment he was born, he conducts research through his senses to explore his environment and nature. As children grow older, they become interested in the natural environment they live in, the characteristics of living and non-living things in this environment, ask questions and begin to conduct experiments and observe the results of experiments (Güler, 2004; Akman, 2003). For example, he understands the seasonal changes by observing nature and monitors the changes in the surrounding trees and can draw conclusions.

Children who spend time in nature having meaningful hands-on experiences understand the world around them more fully. As they take in all the information in the environment, they are building their skill in sensory processing (discussed more in the next section), connecting deeply to the environment around themselves, and building cognitive skills such as attention, concentration, memory, reasoning, and understanding (Hanscom, 2016, p. 58; Louv, 2008, p. 105). Children with unstructured outdoor time become better problem solvers through developed skills in analysis, synthesis, and evaluation as well showing more mental flexibility (or creativity), engagement, and social skills (Hanscom, 2016, p. 93 and 168; Louv, 2008, p. 124).

Piaget (cited in Ültanir, 2012) proposed that children's thinking progresses through a series of four discrete stages. By "stages," he meant periods during which children reasoned similarly about many superficially different problems, with the stages occurring in a fixed order and the thinking within different stages differing in fundamental ways. The four stages that Piaget hypothesized were the sensorimotor stage (birth to 2 years), the preoperational reasoning stage (2 to 6 or 7 years), the concrete operational reasoning stage (6 or 7 to 11 or 12 years), and the formal operational reasoning stage (11 or 12 years and throughout the rest of life).

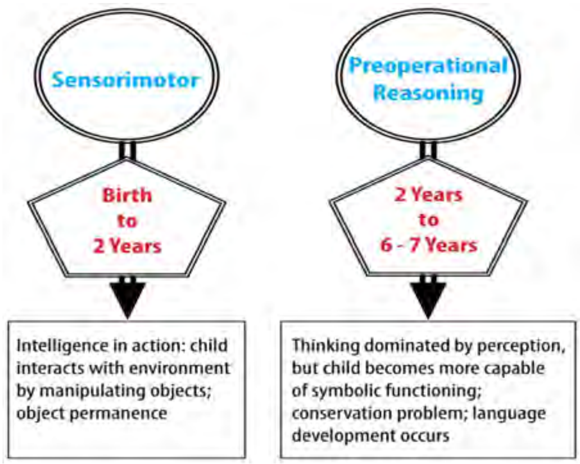


Figure 5. Piaget's Sensorimotor and Pre-Operational Reasoning Stages

Starting from the earliest ages, in sensorimotor and preoperational stage, children can learn much faster and more actively in an environment where they can see, touch, hear, use their senses, wonder, observe and test (Erentay & Erdoğan, 2009). Environments outside the classroom offer great opportunities for learning in this sense. According to Froebel, a relationship should be established between the child and nature from the first ages, because this is necessary for the child's body, mind and moral development (Akyüz, 1979).

Cognitive development is also an area of development that includes understanding and learning about the environment and what is happening around us. The child develops his/her abilities such as establishing cause-effect relationships, paying attention to details, estimating and problem solving. As a result of children's interaction with nature and their environment, scientific thinking skills such as observation, examination, research, inference and evaluation develop. Many researchers suggest that children have a tendency to observe and think about nature and this tendency should be developed by offering effective science learning opportunities in the preschool period (French, 2004; Ginsburg & Golbeck, 2004; Kallery & Psillos, 2001; Patrick et al., 2009; Watters et al., 2000).

There is strong evidence that the ever-changing and evolving nature of nature increases intelligence. Nature inspires creativity, can increase intelligence, stimulates children with its ever-changing and developing structure and contributes to their cognitive development (Tai, 2006). Kaplan and Kaplan (1994) studies have shown that being in nature greatly improves performance on attention, memory and cognitive tests compared to being in the city or at home. Surprisingly, these benefits can also be observed through artificial things like looking at houseplants or even nature photos (Brainfit, 2017).

As a result, nature can be defined as an open classroom that supports the cognitive and physical development of children. For example, seasonal differences can give children the opportunity to examine how the living things around them change. It can be found in leaves, trees, soil, water, etc. differences can be observed and discussed in the classroom environment. By organizing field trips, children can be introduced to different living spaces.

The Effect of Environment on Language Development in Children

The child's experiences through observations; It supports cognitive, physical, social and language development. Activities done in nature in childhood, such as playing, hiking, camping, climbing; environmental attitudes of families, teachers and other role models affect children's environmental behaviors (Chawla & Flanders Cushing, 2007). When nature, which offers unlimited learning opportunities to human beings, is used as a learning environment, children will have the opportunity to learn many words by experiencing and discovering (Kınık et al., 2016).

Children, who are quite curious due to their developmental characteristics, try to explore the environment by asking questions about the world around them and by doing research. These characteristics of children form the basis for them to acquire sufficient knowledge about the environment and develop positive attitudes and behaviors (Yaşar et al., 2012). While spending time in nature and outdoor games support the development of children's physical and motor skills, they can also contribute to their cognitive and language development by providing many learning opportunities.

The most effective cognitive development in the 3-6 age period is in the language area. The child quickly learns concepts and tries to understand his environment. Observation, experiment, etc. made within the framework of science and nature activities. In addition to improving the ability of self-expression, expressing, and comparison in the child, it also awakens the child's feelings of curiosity. As a result, the child learns about objects, events and living things why?, how?, why? begins to ask questions containing the words

(Uysal, 2007).

The Effect of the Environment on the Social Emotional Development of Children

Spending time outdoors and building a connection with the environment has positive effects on psychosocial wellbeing. In simple terms, social and emotional learning (SEL) is the capacity to recognize and manage emotions, solve problems effectively, and establish positive relationships with others, competencies that clearly are essential for all students. Thus, SEL targets a combination of behaviors, cognitions, and emotions. The Collaborative for Academic, Social, and Emotional Learning offers a summary construct with five interrelated groups of competencies that together encompass the areas typically considered to be part of social and emotional competence (see Figure 6).

Self-awareness: The ability to accurately recognize one's emotions and thoughts and their influence on behavior. This includes accurately assessing one's strengths and limitations and possessing a well-grounded sense of confidence and optimism.

Self-management: The ability to regulate one's emotions, thoughts, and behaviors effectively in different situations. This includes managing stress, controlling impulses, motivating oneself, and setting and working toward achieving personal and academic goals.

Social awareness: The ability to take the perspective of and empathize with others from diverse backgrounds and cultures, to understand social and ethical norms for behavior, and to recognize family, school, and community resources and supports.

Relationship skills: The ability to establish and maintain healthy and rewarding relationships with diverse individuals and groups. This includes communicating clearly, listening actively, cooperating, resisting inappropriate social pressure, negotiating conflict constructively, and seeking and offering help when needed.

Responsible decision-making: The ability to make constructive and respectful choices about personal behavior and social interactions based on consideration of ethical standards, safety concerns, social norms, the realistic evaluation of consequences of various actions, and the well-being of self and others.

Figure 6. Elements of Social and Emotional Competence for Children.

Environment and nature have an impact on all these dimensions of social emotional development. There are two main reasons that make environmental education necessary for children: First, environmental education is the most effective solution to increasing environmental problems. Secondly, it is the speed of development and learning in the preschool period. Environmental education to be given to young children will enable them to know and love their environment and develop a conscious perspective towards protecting the environment (Gülay, 2011). The inactivity of the children growing up within the four walls of the city life in a restricted area not only restricts the physical development of the children, but also negatively affects the emotional and social development of the child. (Sweet Kids, 2019). On the other hand, children who have good social relationships have greater self-esteem than those who do not and are less likely to experience mental health problems including depression and anxiety.

Children's interest in plants and animals teaches them to know them and to love and protect them. With the development of environmental awareness in children, their fear of animals decreases and their love and interest increase instead. In order for a child to feel responsible for the environment, first of all, he must love nature, and in order to love it, he must smell and touch plants, play with the soil, watch animals and clean the environment, in other words, he must experience and learn many things in nature. Especially in the pre-school period, children will certainly carry the attitudes and behaviors they have acquired to the future. This period has an important place in the child's life as the first socialization period, the learning period of permanent behaviors and the period in which he progresses in many ways. It is important to give children information about the environment in nature. A school garden can be designed for this purpose, or if the school does not have a suitable garden, regular trips can be organized outside the school (Plant Magazine, 2020).

People protect their loved ones, so making children love animals and plants should be one of the most basic aims of environmental education. From this point of view, it can be said that the love of animals gives the child empathy. The love of animals, which plays an important role in the moral development of the child and prevents him from being an absolute egocentrist, also instills responsibility in children. Nurturing the animal, loving it, not harming it, thinking about its well-being not only nurtures the child's positive feelings towards animals, but also reminds him that the existence of others is as valuable as his own. As he gives love and attention, he realizes the virtue of love and realizes that love is a reciprocal relationship, as he sees how animals, especially creatures with a sense of loyalty, such as dogs, respond to him. The bond established with animals also contributes to the development of children's sense of friendship. Thanks to this relationship, the child can develop a more tolerant, more giving, more sharing, more understanding, more open personality (Echoschools, 2021). In addition to this, allowing children to experience risky situations in nature helps them build understanding of how to navigate unpredictability and challenges, building persistence, entrepreneurship, self-knowledge, and problem solving (Rothmeyer, 2019).

As a result; the environment and nature contribute greatly to the social and emotional development of children. During the time spent in the environment and nature, children develop a love and awareness of the environment and nature. Children learn to observe and discover new things with their friends when they actively spend time in nature with their peers. Children create a rich learning environment in groups with their peers, activities and discoveries in the environment and nature. Children learn to share with their friends in nature, cooperate, take responsibility, respect their friends, compete with them, etc. finds the opportunity to learn many experiences thanks to the environment and nature interaction with her/his friends. Thus, the child's having different experiences with his friends contributes to his social and emotional development. The self-confidence of children who play in nature with their friends also increases. Children's shyness in the group decreases. The communication of children who spend time in nature with their friends increases. Thus, their social adaptation becomes easier.

Effect of Environment on Children's Motor Development

In terms of environmental education, critical periods in the first years of life are evaluated and children get to know their environment and gain sensitivity towards the environment. Practices during environmental education support children's cognitive, physical, social and emotional development. A motor skill is a learned ability to cause a predetermined movement outcome with maximum certainty. Motor learning is the relatively permanent change in the ability to perform a skill as a result of practice or experience. Performance is an act of executing a motor skill. During environmental training, running, jumping, walking, etc. large muscle skills are supported with movements, small muscle skills are supported with skills such as holding, throwing and carrying.

Motor learning is a relatively permanent skill as the capability to respond appropriately is acquired and retained (Adams, 1971). It includes movements such as small and large muscle development, holding small objects, jumping with both feet and one foot, crouching, and running on tiptoe in children aged 3-6 years (Yapıcı & Yapıcı, 2006). Games such as climbing, hiding leaves and collecting flowers that children can play with plants will help them complete their motor development (Lee & Schmidt, 1999). Gross and fine motor skills vary and develop during ages of infancy and young children (see Figure 7).

Changes in Gross- and Fine-Motor Skills During Early Childhood

Age	Gross-Motor Skills	Fine-Motor Skills
2–3 years	• Jumps, hops, throws, and catches with rigid upper body • Pushes riding toy with feet; little steering	• Puts on and removes simple items of clothing • Uses large zippers • Uses spoon effectively
3–4 years	• Jumps and hops, flexing upper body • Throws and catches with slight upper-body involvement • Pedals and steers tricycle	• Fastens and unfastens large buttons • Serves self food without help • Uses scissors • Draws first picture of person
4–5 years	• Runs more smoothly • Gallops and skips • Throws with increased body rotation	• Uses fork effectively • Cuts with scissors following line • Copies shapes and some letters
5–6 years	• Increases running speed • Mature throwing, catching • Rides bicycle with training wheels	• Uses knife • Ties shoes • Draws more detailed person • Copies numbers and simple words

Figure 7. Changes in Gross and Fine Motor Skills During Early Childhood

When we look at the effects of environmental and nature activities on physical and psycho-motor development; the basic element that helps the child to examine the differences in the external world is perception. The basic sense organs that provide perception are the eyes, ears, tongue, nose and skin. Environmental and nature activities improve the coordination between these organs and the brain of the child, give them the ability to use their sense organs more effectively and help the development of the sense organs (Demiriz et al., 2011). It enables the child to use large and small muscles and to move in a balanced way. It develops hand skills, gives the ability to provide hand-eye coordination. The ability to use tools and equipment in daily life (magnifying glass, stethoscope, etc.) develops. It enables the child to provide physical coordination, to use his body more effectively, and helps him to establish control over his body. With these activities, the child's need for movement is met (Demiral, 1986; Dirim, 2004; Şahin, 2000).

Children gain concrete experiences with their senses in the natural environment and have the opportunity to get to know life. Games played in playgrounds support children's creativity and independence. These areas allow various activities such as running, jumping, jumping, throwing, swinging, climbing, digging, riding, sliding, and catching, and concepts and skills arising from movement are acquired Ünal (2009). Natural play tools that can be used in ecologically based playgrounds have developmental importance in children. Plants are a game tool where children can develop many physical skills such as climbing, hiding and jumping that will support their muscle development.

In addition to these environments, water containers of different shapes and volumes can be used for different age groups in early childhood. While water games help children relax, they also help develop their emotional and motor skills. For example, a child who builds a pool with soil and water or tries to create a dam by piling sand in front of the water will see the effect of water pressure. Children who build towers with complex blocks made of water and sand or mud will be able to learn balance and carrying capacity. Helicopter beetles, ants, butterflies, worms, fireflies, birds, rabbits, lambs and many more are just a few of the creatures that arouse children's interest when they encounter them in the natural environment. The most important part of growing is having the opportunity to experience the world, to change it, to see the results of these changes and to learn from all this experience. Children need to be able to change their environment. For this reason, materials and space should be provided for the child to establish new structures with materials such as sand and gravel in playgrounds. Sand is essential for children's ability to change and shape their environment.

They can be used as a toy, sometimes as a slide, sometimes as a climbing wall, sometimes as a small waterfall with the fall of the water, with small interventions without spoiling the natural slopes. According to Öztan (2002) children enjoy the feeling of acceleration and the change of motor coordination. From the tools that provide this, for example, on slides, the slope affects the degree of difficulty. On slopes of 30 degrees or less, the child can control their speed. Research on behavioral patterns shows that sitting and talking in playgrounds are major functions. Seating areas account for a quarter of children's outdoor activities. Suitable places for ecological children's playgrounds should be chosen and the points of interest of children should be highlighted without interfering with nature too much. With the necessary small interventions, places should be created for climbing, running, playing with water and making observations (Turgut & Yılmaz, 2010).

Objectives of Environmental Education in Early Childhood Period

The main purpose of environmental education is to enable the individual to perceive the natural environment, to improve the awareness of protecting and using the natural environment by positively affecting the values and behaviors related to the environment (Tahiroğlu et al., 2010). For this purpose, environmental education studies at all education and training levels will make a great contribution to the training of individuals who have sufficient environmental awareness, are sensitive, protect and protect the environment they live in. According to Başal (2005); The general objectives of environmental education are given below.

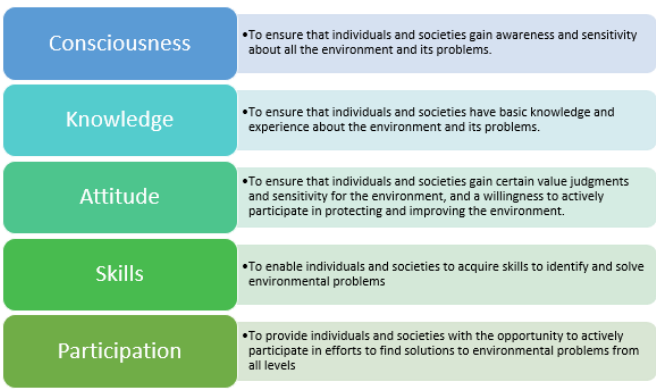


Figure 8. Objectives of Environmental Education

It would not be wrong to say that the education process for the environment, which should last a lifetime, should start from the early stages when the personality of the individual begins to take shape. In this sense, "early childhood education" is a period in which the basis of the attitudes and behaviors of the adult person is laid. The attitudes and behaviors acquired by the child in the early childhood period form the permanent personality structure of the future adult. Researchers state that environmental knowledge and attitudes towards the environment begin to take shape in the pre-school period, and environmental awareness gained in the pre-school period has an important place in developing a positive attitude towards the environment in the following years (Smith, 2001). For this, it can be said that the implementation of well-prepared environmental education programs from an early age is of great importance. The importance of environmental education in preschool education programs can be summarized as follows (Başal, 2005; Büyüktaşkapu et al., 2011):

- ✓ Developing an interest and curiosity about various objects and experiences around them through contact with nature and being able to recognize similarities in the environment that surrounds them,
- ✓ Interacting with their immediate environment and enjoying making new discoveries and thinking,
- ✓ Help children understand the nature of objects, concepts of quantity and number, written words, etc. enrich their perceptions by observing, thinking about, and dealing with objects and experiences around them.
- ✓ Leading a life in close contact with nature; to be aware of the miracle, beauty and grandeur of nature,
- ✓ To come into contact with various objects in their lives and develop an interest and curiosity in the nature and organization of these objects,
- ✓ Noticing the changes in nature and people's lives with the seasons,
- ✓ Developing an interest in objects around them, such as nature,
- ✓ Recognizing the importance of living, appreciating and respecting life through the experiences of recognizing the animals and plants around it,
- ✓ To behave carefully and attentively to the objects around,
- ✓ Developing an interest in surrounding objects and play tools by thinking about them and seeking ways to make the most of them,
- ✓ Developing an interest in diagrams, numbers and quantities in daily life,

- ✓ Developing curiosity towards simple signs and written words in daily life,
- ✓ Developing curiosity about environmental knowledge and skill through play, which has an important role in their lives.

According to Handler and Epstein (2010), maintaining the environmental awareness gained at an early age in the following years of life can be achieved by gaining experience freely and in natural environments at these ages. It is known that environmental education programs implemented in informal education environments contribute to children's environmental awareness (Erdoğan & Uşak, 2009), environmental awareness and being responsible for the environment, and these situations are effective in developing positive attitudes and behaviors towards the environment. It is an approach that has attracted attention in recent years that environmental education can be carried out with field trips to informal educational environments such as parks, museums, zoos, aquariums, forest / woodland or nature centers, apart from formal education environments (Aktaş-Arnas, 2019). Bento and Dias (2017) describe how the outdoor environment allows for open-ended use of materials such as sticks, rocks, flowers, soil, and water, in order to utilize children's imagination, divergent thinking, creativity, and problem-solving skills. This same process also builds children's connection to nature while drawing their attention to its richness and diversity.

Environmental education programs implemented outside of school are more attractive to children than practices related to environmental education in the classroom; because children have the opportunity to explore the environment intensively and gain different experiences in out-of-school environments. These experiences often support the emotional development of the child. The fact that teachers, as those who ensure the implementation of environmental education, think that children's learning about the environment and taking action to solve environmental problems is not easy and meaningful in formal school environments also reveals the effectiveness of environmental education practices in the aforementioned out-of-school learning environments (Stevenson et al., 2013).

To summarize, although environmental education differs according to age groups, it has some common points: Consciousness, knowledge, attitude, skills and participation express these common aspects. In environmental education, which is shaped by common points, it is aimed that individual become conscious about the environment and its problems, have basic knowledge about the environment and its problems, develop an attitude based on protecting, improving and beautifying the environment, gaining skills to identify problems and develop solution proposals, and actively participate in environmental situations. In addition, enabling children to understand the environment in early childhood also enriches human-environment relations. Spending time in the outside environment can reduce anxiety and stress in children as in adults. The basic points of environmental education in the pre-school period are to introduce and endear the environment (Kabaş, 2004). Family involvement studies are another element that shapes the environmental education to be given to young children. Parents should also be educated about the environment and their awareness should be increased. Environmental education programs should be evaluated in a multi-faceted way, parents should be reinforced, as well as teaching all subjects and concepts, promoting the environment and creating environmental awareness. For this reason, early childhood educators should both inform their parents with family participation studies and make them the providers of the continuity of the education process.

Popular Early Childhood Approaches and Environmental Education

In the world, environmental problems have reached serious dimensions in recent years and have led people to seek solutions in this regard. In order to protect the environment, it is necessary to raise individuals with environmental awareness and environmental sensitivity. Developing environmental awareness in the society and bringing environmental awareness and responsibility to individuals can only be possible with an effective environmental education. The development of environmental awareness and environmental awareness begins in early childhood years. Today, the increase in environmental pollution and the threat of the future have caused the adequacy of the current environmental education to be questioned.

The basis of environmental problems lies in human behavior and the level of consciousness that naturally causes people to engage in these behaviors. In this context, as long as people's intellectual and moral consciousness does not change, their sensitivity to the environment will not change and existing problems will continue in a vicious circle (Atasoy, 2005; Dikicigil & Gülersoy, 2020; Gülersoy, 2019b; Gümüş et al., 2017; Pruneau et al., 2009). For this reason, especially in recent years, there has been a search for new and contemporary environmental education approaches that can meet the needs of society by producing solutions to existing environmental problems, and scientists are constantly suggesting new approaches to environmental education.

There are many approaches used in parallel with this dimension in early childhood education and some of these approaches attract global attention such as Montessori, Reggio Emilia, High Scope, Forest Schools and Waldorf. It can be said that 'environment' is the most striking of some of the points that these approaches have in common. The Reggio Emilia approach states that the environment is the third teacher, and states that the most important element that prepares the child for life after the parent and the teacher is the environment. In the Montessori approach, attention is drawn to the concept of the structured environment; this structured environment is a miniature of real life and prepares the child for life. Waldorf, on the other hand, is an educational approach based entirely on the natural environment. Respect for nature and harmony are very important and Waldorf is known to support eco-friendly toys. It is almost impossible for children who receive education in such programs to remain insensitive to the environment. In particular, the Waldorf program teaches young children to respect nature, to be in touch with nature, and to get along well with nature. The following parts describe how these some common approaches in early childhood involve environmental aspects.

Waldorf Approach and Environmental Elements

The Waldorf education approach was developed by Rudolf Steiner in 1919. This approach aims to transform education into an art. It also takes into account the holistic and balanced development of children. According to Steiner, the child has a potential and this potential emerges in the appropriate conditions and environment, so it should be waited patiently and should not be rushed. Steiner likens this to the gardener waiting for a flower to bloom. If the seeds of learning are planted in fertile soil, a rich harvest will come as no surprise. The teacher has an important place in the Waldorf approach; the teacher is not only an educator but also a thinker, scientist, poet, artist, musician and environmentalist. In addition, the most important job of the Waldorf teacher is to ensure that the child adapts to his existence, worldly existence and spiritual reality. The colors of the walls and furniture are very important in Waldorf classrooms. Plain and light colors that do not tire the eyes are preferred. Furniture made of natural and solid materials is used. In the classroom, natural materials are included (gourd, cones, branches, pebbles, wooden toys, etc.) in order to recognize and unite with nature. As can be understood from these features, the Waldorf approach is based on respect and integration with nature.

Figure 9. Waldorf Schools and Environment)

The basic motto of the Waldorf approach is ‘Education of body, mind and spirit’. Music is very important in the Waldorf approach. Children listen to music with five voices, called pentatonic music. The reason for the use of this music is that it causes a kind of trance by increasing the frequency of alpha and theta waves in the human brain. This situation, which is observed through scientific research, is explained as the functioning of nerve cells that cannot be used normally, thus increasing the perception capacity of human beings.

In Waldorf education, it is aimed to train the child's brain, heart and hands. Concrete examples are important in teaching and what to learn should be demonstrated concretely when necessary. The importance of the environment in the Waldorf approach begins here. There is an understanding that education should be in harmony and intertwined with nature and the student should be given the opportunity to progress at his own pace. According to the theory developed by Steiner, the child is accepted as a part of nature and children are offered activities that will allow them to discover themselves in nature. For this reason, activities parallel to classroom activities are carried out in open spaces in Waldorf schools (Toran, 2015).

Dahlin (2021) explains the ideational ground and practical-concrete elements of Waldorf curriculum as;

> The views of Herder and Novalis, the participatory view of learning, and the experience of Earth as a living being are all "romantic" elements that can be found in Steiner's anthroposophy. They are also in agreement with the principles of ecospirituality (Smith, 2009). The postponement of cognitive judgment to higher grades goes together with awakening interest in the world in the same grades. These latter points are important contributions of Waldorf education to a fruitful ecospiritual approach to environmental education. Without them, what is possibly achieved in lower grades may be undone in higher grades through "early closure".

The classroom environments of Waldorf schools differ from classrooms of other approaches. Waldorf schools are established in places where one can be intertwined with nature and benefit from the opportunities offered by nature. While arranging the classroom environment, great attention is paid to creating an aesthetic and natural environment. The beauty in nature and in the classroom will enable the child to develop a love of nature and to perceive natural harmony; It is thought to create happiness because it is a part of nature.

Figure 10. Waldorf Classroom Environment

The classroom is organized in the closest way to the natural environment, and the child is tried to perceive and live the cycle and rhythm of nature. In Waldorf education, since the person is seen as a being of nature, it is thought that the integrity of the person can only be achieved through integration with nature. Again, it is thought that the natural cycle, the rhythm of the seasons, affects the rhythm of the human being and that humans exist within this rhythm. For all these reasons, the classroom environment is full of natural assets. There is a nature table in the classroom in kindergarten and primary school. Thanks to this table, the child is informed about the beauty and rhythm of nature. Seasonal objects are placed on the nature table. Children can contribute to this table (Kotaman, 2009). Considering the environmentalist role assigned to the teacher, the importance of the role of the teacher in environmental education of the Waldorf approach was emphasized. According to Waldorf, imitation means more than the child learning by observing a model. In other words, the environmentalist teacher has the responsibility of being a good role model for children (Koca & Ünal, 2018).

Forest Schools

The forest schools, which emerged in Scandinavia in the 1950s with the aim of teaching children about the natural world, are very important institutions in which educators and parents play an active role in the process in terms of improving environmental awareness in children and ensuring its sustainability. Forest schools are a system built on basic dynamics all over the world. By adopting the play pedagogy as a principle, the forest school has brought a unique dimension to contemporary outdoor education by focusing on young children. The concept of play, which puts children at the center and considers the active participation of the child, is seen as a new and potential principle and it not only brings a new breath to educators, but also opposes the current understanding of education (Leather, 2016).

Figure 11. Forest Schools

In forest schools, it is ensured that children are in close contact with the soil (Knight, 2017). In addition, children in this school have equal opportunities in all nature studies. Forest schools aim to provide environmental education to children permanently and in touch with nature, and by removing the studies carried out in traditional kindergartens, they enable educators and parents to play an active role in children's environmental awareness through out-of-class education. Planning, adaptation, observation and examination are integral elements of the forest school. It also provides children with respect for nature and sustainable lifestyle education. Six basic principles of forest schools stand out;

Forest School is not a one-time process. Time is spent frequently and regularly in natural environments.

1. Forest Schools are established in environments intertwined with nature.
2. Forest Schools aim at the holistic development of the individual.
3. Forest Schools offer children the opportunity to take risks and responsibility.
4. Forest School practitioners have sufficient qualifications and training.
5. Forest Schools put the student at the center

Forest schools have been an environment that not only supports children's development with a multidimensional and holistic perspective, but also offers them the opportunity to become self-confident and aware of their competencies (Tantekin & Yalçın, 2017). The determining factor behind forest schools is that children learn more outside the classroom than in unconventional environments. The target audience of these schools is especially aimed at kindergartens and primary school children (MacEachren, 2013). Moreover, forest schools help to establish long-term environmentally viable behaviors and child-nature relationship through children's experiences. It is seen that this nature-based education approach is adopted and examples are seen in different countries around the world.

Forest school is defined as an inspiring practice in which the active participation of individuals is ensured in the forest or wooded area, and they are supported in self-confidence and decision-making (Dilek, 2019). Rousseau, Pestalozzi, Froebel, J. Dewey, M. Montessori, J. Piaget, L. Vygotsky, and Csikszentmihalyi are the pioneers of the forest schools, which include the concept of learning outside, education outside the classroom, in other words, education without walls. The forest schools, which emerged in Scandinavia in the 1950s with the aim of teaching children about the natural world, are very important institutions in which educators and parents play an active role in the process in terms of improving environmental awareness in children and ensuring its sustainability (Koyuncu, 2019). Forest schools aim to support holistic development areas such as self-confidence, independent and creative thinking, and flexibility. Forest schools do not mean only training in the forest. Any environment where children learn by using nature in an open environment can be a forest school. Forest schools are a system based on certain principles all over the world. We can summarize them as follows: Forest schools are a long-term process involving long and regular sessions rather than a one-time visit to the woodland or natural environment. Planning, adaptation, observation and examination are integral elements of the forest school. The forest school should regularly visit the natural environment with the students in the same group, at least once a week for a long time (Koyuncu, 2019). The reason why forest areas are especially chosen is that it is the most ideal environment that can meet the needs of the program and the student and provides the most suitable environment for them to explore and get to know.

Outdoors reinforces the sense of independence and confidence once again, as children learn about themselves and the world around them in a way that is often not tolerated in a classroom setting, because the forest school environment provides children with spaces to move freely. Basic forest school activities such as cave diving, navigating with a compass and using a knife in woodworking are just a few of the activities that instill a sense of confidence and independence in children (Koyuncu, 2019).

To sum up, this approach which was born especially in Scandinavian countries is in demand in many countries of the world today. Forest Schools is a progressive and developmental learning path that nurtures students from childhood through adolescence and beyond. Forest Schools are taught by qualified leaders who are both compassionate and caring while nurturing a child’s determination that adds tools for life to support resilience, responsibility, resourcefulness and self-confidence. It is defined as nature is a permanent gift to childhood (Blackwell, 2015).

The Child and Its Environment in Reggio Emilia Approach

The foundations of the Reggio Emilia approach began to be laid in Italy after the Second World War (Thurton & Brunton, 2009). Loris Malaguzzi (1920-1994) graduated from educational sciences and started her career as a primary school teacher. He was later qualified as an educational psychologist and founded “Reggio Emilia’s Municipal Psycho-Pedagogical Medical Center”. He is also known as the founder and pioneer of the Reggio Emilia approach. In Emilia schools, the appearance of the classroom is given importance because the environment is considered the third teacher. The concept of project is very important in these schools. Children produce projects that are suitable for their interests, needs and development. Children learn to express themselves through art and creative ways. The most crucial point of this approach is the concept of ‘The child’s 100 languages’, this concept states that there are many ways in which the child expresses himself not only verbally and in writing. Children can express their learning with light, sound, dance, music, drawing and many more languages. The important thing is to be able to see and make sense of children’s expressions. In this case, teachers and families play a big role.

The works of children during field trips, the plants they collect and their collections are exhibited in a place where both children and adults can see them. There is a common area for all children at the school, called the ‘atelier’. It is the ‘common space and workshop’ areas, which are unique to the Reggio Emilia approach, are particularly important here. Children from different classes and groups gather here to set up play or study groups. Reggio Emilia schools have an entrance, common areas, gardens, workshops, music rooms, dining halls and archive rooms.

Figure 12. An Atelier in Reggio Emilia

Reggio Emilia approach is an education approach that emerged as an important freedom movement in Italy and pioneered innovations in the field of education all over the world. This approach was born in the city of Reggio Emilia, where it is named, and Louris Malaguzzi was the biggest supporter of this approach. It has become increasingly widespread with the participation of families and has become one of the most used alternative approaches in early childhood.

Being one of the most important elements in the Reggio Emilia approach, the environment should be prepared to be the teacher himself. For this reason, the preparation of the environment is very important for the successful realization of children’s learning activities. A good environment is one where the child has many alternatives to choose from and can motivate him/her to engage in a relationship. It is stated that not only the physical environment but also the social environment is important in Reggio Emilia (Basic, 2018). In this respect, giving due importance to the social environment as well as the physical environment can be easier and more effective for the child to interact with the environment.

An interesting environment has been prepared with different stimulating materials to encourage children to think, use their emotions, be a good observer and develop their creativity. Another remarkable feature of Reggio schools is the arrangement of the environment in accordance with the project subjects (Basic, 2018). For instance, in order for the child to see himself from different angles, triangular mirrors can be given. Seeing himself from different angles with mirrors will contribute to the development of the child's observation and thinking skills. It will also contribute to the child's potential to make inferences. However, the child will be able to recognize his own body thanks to the mirrors, and this will be an important and first step in terms of creating an identity in the future. In addition, the environment should be arranged in a way that will attract the attention of children and reinforce their sense of curiosity.

Matte, calming colors, natural and natural materials, illuminated tables, mirrors, essential incense, candles are the remarkable elements in the schools. The windows extending from floor to ceiling, the presence of windows between the rooms provide brightness and flow, importance is given to light (Bennett, 2001). In the kindergarten environment, there are products of children's work that are usually hung on ceilings and on the wall. (Basic, 2018). In this way, children will be able to see each other's work, gain different perspectives and come to the conclusion that everyone's world of thought and emotion can be different

.

Figure 13 . Classroom environment in Reggio Emilia

Most of the materials used are natural and recyclable. There are wooden blocks in each center, and behind these wooden blocks is an overhead system that reflects pictures and colors on the wall. In some centers, there are hand puppets and puppet scenes made by families (Pekdogan, 2016). Preferring recyclable materials is important in terms of creating environmental awareness in children. It will be possible for children who begin to be conscious of the environment they live in, to develop environmental awareness and to continue this in their future lives. In addition, puppets created from waste materials or fabrics will also support their ability to design new materials that will serve their purposes. The external environment of the Reggio Emilia schools has been enriched with a wide variety of materials, from areas for water play to climbing hills, mazes of child-sized trees planted by families, picnic tables, camellias with canvases, paints and various material boxes (Bennett, 2001).

In the education program of Reggio Emilia schools, activities such as project work and working with waste materials are also included, including for the environment. These activities are held at random times from waste materials at hand that children are familiar with in their daily life. It is seen that the environmental arrangement of this approach, which puts the child in the center, contributes to the child in every aspect. Mirrors, the preferred colors and shapes, the materials used and the raw materials of the materials, the children's own works, provide the formation of a certain level of aesthetic environmental awareness as well as the learning of many concepts in children.

Environmental Understanding in Montessori Approach

Montessori founded Casa dei Bambini (Children's House) in 1907, where she could work with more than 50 normal children aged 3-7, with some of the educational materials she developed, toys and child-sized furniture. Montessori has saved the knowledge from rote, concretized it at a level that children of all ages can understand, and has developed a series of methods and materials to convey it in integrity. In the Montessori approach, the environment should give freedom to the child. Older and younger children are together, because it is to provide learning by modelling.

Montessori points out the deep and absolute respect for the individual and the environment as an important element. The love for nature and the world around us are also some of the main elements in the methodology of Maria Montessori (Stanislava, 2020). In *The Discovery of the Child*, she wrote, regarding how actual experience leads to building a child's empathy toward animals, "A feeling for nature grows with exercise. We certainly do not communicate it by a pedantic description or exhortation made to a listless and bored child shut up within the walls of a room" (cited in Rothmeyer, 2019; Montessori, 1909/1972, p. 70)

Figure 14. Basics of Montessori Philosophy and Environmental Education

In Montessori classrooms, all materials are within the reach of children. There is one of each material in Montessori classrooms, so if a child wants to use a material, he should wait for his friend to finish. This gives the child characteristics such as patience, respect and harmony with the social order. There is error checking in Montessori materials so that the child can evaluate his own learning. Montessori materials are nature-friendly materials created from natural materials such as wood. Montessori education supports the social and sensory development of children and contributes to their future lives as individuals who respect others, their environment, themselves, are responsible, and lead their lives in harmony with the society. The first concept that comes to mind when Montessori is mentioned is the ‘Absorbent Mind’, the absorbent mind absorbs the information around the child without effort. Therefore, if a suitable environmental environment is presented to the child, a sensitive natural life will contribute to environmental education.

There are features that must be found in Montessori classrooms. It is suggested that each classroom should have a small garden that will allow children to work in the garden, observe nature, and work in the open air whenever they wish, and a door that opens to the outside that will allow them to enter and exit the garden freely (Seldin, 2002). Children interact with the environment using all their senses. Therefore, sensory education, which is of great importance in all areas of life, is designed to help children focus more carefully on the physical world and to perceive the diversity of objects in detail with their senses (Seldin & Epstein, 2003).

The Montessori environment assumes the role of a “teacher” for the child. In Montessori school, the child will learn by himself with specially developed Montessori materials. These are attractive, often simple, small, self-correcting materials. If the child makes a mistake, he or she can correct the mistake by looking at the material itself. Thus, an adult does not hurt the child by telling him to correct his mistake. In other words, specially designed materials including error control are used in Montessori education. In Montessori school, the child learns by himself and with his friends. He learns to follow the classroom rules and even warns his friends to follow them. The child is more likely to succeed, as he/she chooses and adjusts the work to be done according to his/her own system. The Montessori classroom is a non-competitive environment. Here, the child also recognizes plants and animals, learns to care for and help them (Mallory, 1989). Since the physical environment of the classroom is designed in accordance with the child, it provides autonomy.

Reality and naturalness are of great importance in the Montessori environment. Tools in the classroom are tools that are used in real life to make it easier for the child to face the facts. Real glass cups are used to drink something, a real heatable iron is used for ironing, and a sharp knife is used to cut vegetables (Temel, 2018). This classroom is an attractive environment where the child can explore his/her own world, develop his/her mind and body, away from adult management and pressure (Mallory, 1989). In addition to this, in Montessori program, outdoor times provide to develop social skills as well. Children at different ages come together in outdoor environmental activities and they communicate, help and give each other materials.

The characteristics of the eighth intelligence of Gardner known as naturalist intelligence seems to match very well with Montessori early childhood classrooms with their emphasis on supporting children: in training the senses; in spending time with concrete, natural phenomena; in searching for and discriminating between patterns; in caring for plants and animals; by respecting the sensitive period for the sense of order; creation of books, booklets, and nature journals; by seeding the prepared environment with real plants and animals, realistic models of plants and animals, and realistic books about the same; and by providing many opportunities to categorize and distinguish between plants and animals from the natural world (Rothmeyer, 2019).

Environment in High Scope Program

Daily order in the High Scope approach are cleaning, plan-do-evaluate, small-large group activities and outdoor games. In terms of being relevant here, the content of outdoor games is as follows: It is the time period when children go out to the garden and play various games, and are physically active by running, climbing, swinging, crawling, researching. Children continue the games they play indoors, in a larger environment, by getting to know their natural environment and the region they live in, by experiencing the changing weather conditions and seasons. Adults also actively participate in children, talk to them about what they are doing, get more information about their interests and skills, and talk to parents who come to collect their children (Bilaloğlu, 2004). Thus, children gain knowledge about the environment by exploring and learning, and for students who did not receive education until the early childhood period, first information is formed and they gain their first impressions. The more effectively they use their environment, the more permanent learning can become, and they find the opportunity to learn by doing and living in the environment.

The physical environment has a strong influence on children's behavior. Therefore, in the High Scope approach, children are provided with constant opportunities to make decisions and make choices. Children are encouraged to make choices about activities and materials throughout the day. Children explore, ask and answer questions, solve problems, and interact with classmates and adults as they pursue their choices and plans. In such an environment, children naturally acquire basic experiences by engaging in activities that develop developmental skills and abilities (Bilaloğlu, 2004: 46). Again, since the physical environment significantly affects the behavior of children and adults and the experiences of children as a result of their one-to-one relationships with their physical environment have an important place in their learning, how to organize the physical environment in the High Scope system has an educational importance. It is one of the basic elements of the High Scope system to provide educational materials rich in quality and quantity for the child to recognize, interact and explore, and to organize the school in a way that will encourage independence and provide different options for the child to explore (Schweinhart, 2002). The more information children have about their environment, the more sensitive they can become. This means that if we consider how fast learning is in the preschool period, they can have the opportunity to have in-depth knowledge for preschool children.

One of the most important tasks of the teacher in the High Scope approach is to organize the environment in a way that will allow the child's education and support the child's development in the best way possible. It is the teacher's responsibility to create an environment that will enable the formation of experiences appropriate to the child's maturity level. Since the child will feel safe in a familiar environment and can act and take initiatives more freely on the basis of this trust, radical changes should not be made in the environment and classroom arrangement. In order to prevent the child's mind from becoming lazy by constantly being exposed to the same stimuli, the teacher can add different materials to the environment when appropriate. All this landscaping is also carried out by considering the maturation stages of the child in line with the framework provided by the key experiences. The child realizes how much importance is given to him through the environment that is formed as a result of the environmental arrangement and that surrounds the child. In addition, he understands what skills he should have in order to better understand the environment (Kotaman, 2009). As a result, pre-school children's awareness of the environment has an important task in the High Scope approach, as it is an educational topic. These trainings are given both in the classroom environment and in the form of the application of outdoor games. Thus, it is ensured that the gains to be gained are given in the best way.

The Use of Technology and Modern Methods in Early Childhood Environmental Education

It is inevitable that children are exposed to these technologies, as computer technologies are increasingly becoming a part of many tools we use in our daily life. In fact, with the widespread use of embedded systems, children are faced with digital technology-based products other than computers before the preschool age. Toys that contain various forms of interaction such as a singing violin, a book that plays a different music on each page, a broom with human characteristics, and a car steering wheel that approximates the experience of driving on the street are often offered to children. In addition, dealing with computer technologies today requires developing new literacy skills. Children encounter visual, auditory and textual communication environments and forms as a part of daily life. At the same time, tools and methods are intertwined, making it difficult for traditional literacy skills to be sufficient to "read" computer technologies. Skills such as knowing the structure and use of electronic texts, determining where to find the necessary information and accessing this information, and understanding images become necessary at an earlier age (Stephen & Plowman, 2003).

Educational technologies, the use of which has become widespread in recent years, has begun to bring a new perspective to education. Computers, one of the most frequently used educational technologies, offer educators the opportunity to prepare and use materials at different levels that can be used in education. Computer animations prepared in the computer environment create multimedia environments that increase students' understanding of the problems in environmental education, provide a better understanding of the connection points in the ecosystems, and can easily see how the problem at any stage will reflect on the future. Accordingly, computer animations can be used to increase student success. (Arıcı and Dalkılıç, 2006; Hede, 2002; Kara, 2007; Karaçöp et al., 2009; Kraidy, 2002).

Today, technology, which is an indispensable part of a child's life, takes place in children's lives with many technological tools such as television, smart phone, digital camera, tablet, computer, and children learn to use them easily (McManis & Gunnewig, 2012: 14). Children start school having witnessed many technologies. It can be exemplified that children live together with technology, such as traveling by car or plane, withdrawing money from the bank with a family member, turning the TV on and off, operating the washing machine or observing all these (Dodge & Colker, 1995; cited in Akkoyunlu & Tuğrul, 2002: 12) . It is necessary to ensure that children use these tools in a way that supports their development and learning, rather than preventing the technology in their lives from early childhood.

In education, which is one of the fields in which technology is used that has an importance to direct the future of society in many parts of our lives, the selection of methods-techniques and tools-equipment suitable for the purpose of the subject to be transferred affects the clarity of the transferred subject and the permanence of the information (Collier et al., 1971; Fisher, 2000; cited in Altınsoy, 2018: 27). The use of technology in appropriate conditions has a positive effect on the physical, emotional, linguistic and cognitive development of early children. When students experience the information first hand and use appropriate technologies that support abstract concepts visually, difficult to understand topics can be easily understood (İlhan Agan, 2004: 25). One of the fields where technology is used in education is environmental education. Matthews and Riley (1995) emphasized the importance of using interactive methods in an effective environmental education and stated that methods such as small group discussions, case studies, films or slides in which an ethical scenario is indicated, interactive videos, role playing, digital story and project can be used. It is noteworthy that applications such as slides, interactive videos and digital stories among the methods mentioned by the researchers are technology supported.

Environmental education materials created with interactive multimedia technologies enrich the previously used materials and deepen learning and understanding. Simulations in computer aided education have a great contribution to environmental education. The multimedia that will be created with computer-aided education will enable students to better understand the problems and support a better understanding of the connection points in the environment and ecosystems. How the problem experienced at any stage will reflect on the future will be easily seen by the students. Computer-assisted instruction to be used in environmental education will increase students' desire to learn, as well as provide a better understanding of complex ecological relationships and the opportunity to observe what harm can be done by humans to nature. Through computers and the internet, children will be able to visit virtual zoos and museums. While they can watch documentary programs and learn about animals, the digital camera will provide the opportunity for children to re-learn from these experiences by recording and re-watching their experiments, observations, study trips. When children have limited access to the natural environment, technology can provide a realistic, interactive supplement or the opportunity to directly experience the natural world through simulation. It can also enable children to reach people, animals and places that they do not have the opportunity to encounter in their normal lives and encourage them to go out and experience the environment (Willis et al., 2014).

In traditional teaching methods, the teacher teaches the lesson and the student is a passive listener. Since this method is teacher-centered, lessons are more boring. For this reason, environmental education is not realized at the desired level in the traditional teaching method. Students should be at the center of environment or nature education (Özbuğutu et al., 2014: 405). Thanks to technology-supported education, students will be involved in the process interactively and as a result, they will learn both by having fun and by doing. In this context, Ruchter et al. (2009: 1062) in their research comparing the effects of mobile devices and traditional approaches on environmental education, revealed that mobile guide devices are as effective as traditional methods. They also concluded that computers, as mobile guides, can increase environmental knowledge and increase students' motivation to engage in environmental education activities. Although the use of technology seems like a distant option in environmental education, integrating technology into environmental education from early childhood will increase the efficiency of the education given, since it has an important place in the lives of students in today's conditions.

Modern Methods in Child and Environmental Education by Using Technology

Early childhood period 0-6 is the age of curiosity of children and children want to know what is going on around them. Therefore, the concept of technology at this age satisfies their curiosity to the extreme. With the rapid development of technology in today's world, children are somehow exposed to technology and media and learn to use them, even if they do not meet in educational environments.

Technically speaking, children should not be introduced to any technological device before the age of 3. For instance; while the computer harms children before the age of 3, it contributes to some developmental areas of the child with an appropriate use in the preschool period. Children encounter and easily use many technological tools such as television, smart phone, tablet, computer in their environment. These tools deeply affect children's daily lives, shape their communication with their environment, their understanding of entertainment and learning. For this reason, it is necessary to ensure that children use technological tools as a support for their development and learning, rather than preventing them from using them. Technology gives children the opportunity for immediate feedback. It supports children's independent learning. According to Lim and Tay (2003), the use of technology and media in education helps children acquire knowledge in many different formats, gain fun learning experiences, organize information, and communicate more easily and effectively with their teachers or peers in expanding their learning.

There are also studies that examine the effects of technology on children and determine that it is not developmentally appropriate. These studies indicate that children should meet their learning needs with concrete materials, especially at a young age, and that excessive exposure to the screen causes attention, concentration, social skills, language development and physical development problems in young children (Cordes & Miller, 2000; Duch et al., 2013; Schmidt et al., 2009; Tomopoulos et al., 2010). At the same time, technology provides environments for children to solve problems and share ideas. The question that comes to mind here is how technology is used in educational programs. Since when technology is integrated into educational processes in a developmentally appropriate manner, it increases children's early literacy skills and positive approaches to learning, and supports children's social skills (Blackwell, 2013; Blackwell et al., 2014; Plowman et al., 2012).

There are also some other studies examining the relationship between the use of technology in education and learning. In these studies, it was found that the use of technology supports and increases their phonological awareness, develops a positive attitude towards learning, increases their problem solving and analysis skills, and supports their learning in tasks and activities that are meaningful to them (Edwards et al., 2000). Especially in the technologies used in pre-school education, there are criteria such as supporting the development of the child, using it for multiple purposes and independently.

Information and communication technologies also play an important role in early childhood environmental teaching and learning (Ikoh & Nwankwo, 2013). Possible ICT tools to be used in early childhood education; computers, digital cameras, digital video cameras, communication software and tools, internet, telephones, fax machines, mobile phones, voice recorders, digital stories, computer games, programmable robot toys and control technologies, video conferencing technologies and closed-circuit televisions, projectors are expressed as electronic smart boards (Bolstad, 2004). Information and communication technologies have started to be used effectively in education and training environments and have reached much different dimensions with the widespread use of the internet.

When the pre-school education programs of OECD countries are examined, it is seen that most of them add ICT skills to meet the changing needs, lifestyles and preferences of today's society (OECD, 2015). Educators' widespread use of information technologies and their interest in this have increased the quality of the education they offer in the school environment and has become more remarkable for students.

Computer and audio-visual education tools based on technological developments should be used easily, effectively and efficiently in the classroom environment for educational purposes. The correct use of technology for children in the pre-school period can be achieved with the knowledge and competencies of educators. For this reason, the educator's ability to prepare, organize and use pre-school education programs is considered important.

If there is an unconscious excess between technology and the child, this may have negative consequences for the child. Just in this period, if these curiosities of children are turned into interaction with the environment, environmental awareness can be provided to children. If we consider this awareness under the title of pre-school environmental education, Akçay (2006) defines environmental education; the acquisition of values, attitudes and concepts related to the biological, social and physical environment of individuals. There are two basic information on which environmental education is based in the preschool period; "The first of these; to ensure the interaction of the child with the outside world, and the other is to support the healthy development of the child. It is necessary to direct children's sense of curiosity and discovery in the best way possible. Apart from the existing life, there are many environmental factors that will attract the attention and interest of children.

It can give children both technology and environmental education by running it in a mixed way. For example; In a simple environment day event, children can be prevented from using technology for any other purpose by using any technological tool. Because when technology is used properly and appropriately, it will provide cognitive and psychomotor benefits to children. With such an activity, both the teacher creates a suitable classroom environment and the children develop themselves in more than one area by carrying out environment + technology processes together, make their learned knowledge permanent and gain sensitivity towards the environment. In short, curiosity in children can be supported by a mix of environmental and technology activities.

Figure 15. Technology for Children Education

Use of technology in environmental education; within environmental activities, technology offers children research opportunities on many subjects. Especially the use of the internet provides opportunities to find direct answers to children's questions about the environment and nature concepts. In the researches to be carried out under the guidance of teachers, children satisfy their curiosity about the environment and nature and learn by exploring. Through the internet, children can watch documentary programs about the beauty of nature or the damage to the environment, how to keep the environment clean, and provide information about the environment. On the other hand, the digital camera allows children to re-learn from these experiences by recording and re-watching their experiments, observations, study trips. Apart from this, children cannot create their environmental awareness and enrich their perspectives due to the unplanned and excessive exposure of children to technology in environmental education.

Artificial Intelligence in Early Childhood Environmental Education

Intelligence is the structure that helps us make cognitive features such as comprehension, learning, problem solving, planning. Although artificial intelligence logically overlaps with the concept of intelligence, it is programming the data to be used using the most accurate mechanism, since it is an intelligence managed by the computer (Baştanlar, 2018). Artificial intelligence also affects the environment. Artificial intelligence is an application that responds to environmental problems.

Learning in nature; it is through direct experiences that an effective development is achieved, mental and social learning takes place, and that covers the principles of thinking, feeling and acting. Attention can be drawn to environmental education by making use of artificial intelligence in museums, botanical gardens and science centers. As an example, we can take the system used in traffic usage. With this system, transportation time from one place to another, traffic jam estimation, etc. can be calculated. situations are taken under control thanks to artificial intelligence (Tektaş et al., 2002). Thanks to this system, a problem that may occur in traffic has been prevented. It can be used to create awareness and implement the necessary strategies and policies for the use of artificial intelligence in daily life, especially for the prevention of environmental problems.

In early childhood environmental education, environmental awareness can be created by making children watch animations, cartoons and documentaries about the use of artificial intelligence or computer environmental problems. Or, how many problems affect the environment can be shown to children by using modern methods such as artificial intelligence and computers. Environmentally friendly robots can be shown to children and attract their attention. Robots that are respectful and beneficial to the environment, collecting plastic and foreign materials, and energy-related robots that are suitable for these features and can be beneficial to the ecosystem can be shown to children. Since we are dealing with the early childhood period, we can only show and make children understand. Robots or other methods using artificial intelligence enable children to think creatively and affect children in this regard, artificial intelligence or modern methods used on the environment raise awareness of children and enable them to think creatively.

Eco-friend Activity for Early Childhood Children

Activity Name:	**Subject Area**	**Age:**
Our Species Are In Danger Of Extinction!	Science-Environmental Education	5-6 years
Purpose of the Activity: • Recognize endangered animals. • To raise awareness of the impact of environmental problems on animal life. • To ensure that children gain environmental awareness at a young age. • To ensure respect for the life of other living things • To warn children when they see someone polluting nature in their daily life. • Helping to protect animals in their daily life.	**Learning Objectives:** • Cognitive Development • Pays attention to the object/situation/event. • Makes a prediction about the object/situation/event. • Groups objects or entities according to their properties. • Generates solutions to problem situations • Linguistic Development • Understands the meaning of what they listen/watch. • Motor Development	**Materials:** • Large cardboard figures of endangered animals, clipboard, animal cards, felt, scissors, glue, plastic bottle, floating eyes, cotton, endangered animal pictures, colorful background cards, double sided tape. **Concepts:** Caretta Caretta, Lynx, Javanese Rhinoceros, Sumatran Orangutan, Penguin, Polar Bear, Panda, Figure

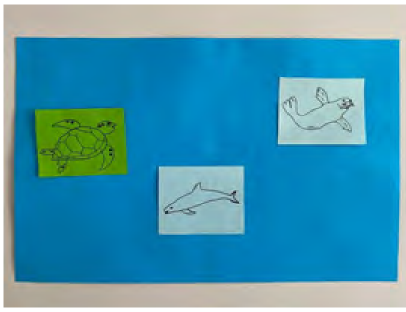
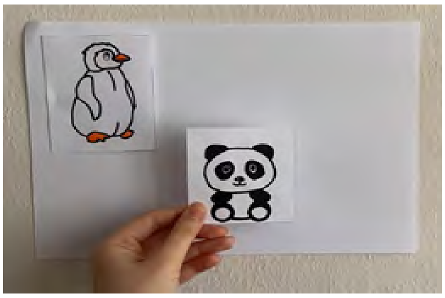
• It warns those who violate the living rights of living things.	• Performs movements that require the use of small muscles	Mexican Dolphin, Mediterranean Seal, Cheetah, Black Vulture, Striped Hyena, Animal, Endangered Animals, Habitat, Water, Desert, Polar.

Learning Process:
DAY 1
The teacher enters the classroom with large cardboard figures of endangered animals (Caretta Caretta, Lynx, Javanese Rhinoceros, Sumatran Orangutan, Penguin, Polar Bear, Panda, etc.) Among these figures, some extinct animals take place. Ask the children, 'Why do you think I brought these animal pictures? Do you know these animals? Have you seen these animals before in your life? What and how do these animals feed? Where do they live? It creates an atmosphere of discussion in the classroom by asking questions such as: In this way, children make predictions about the subject using their previous knowledge. After predictions, the teacher explains the names of these animals one by one, where they live and what the concept of extinction means.
Afterwards, (s)he explains to children that these animals are endangered, even that some of them are extinct, what should be done to protect these animals, what environmental problems caused this problem, in a way that children can understand, so that children have an idea about this issue. Then, what do you think we can do to protect these animals? he asks again, taking the guesses of the children. After the predictions, the teacher checks whether a documentary about endangered animals is available on the internet so that the children can understand it better and shows the children to watch the video found. After the documentary, do you think we can make a model of one of the animals we watched in the documentary with the materials in our class? Which animal would you like to figure out? (s)he asks.
In order for the children to learn about endangered animals fully, the teacher takes the cards with the pictures of endangered animals and extinct animals on them, which he has prepared beforehand. The teacher puts these cards in a place where the children can see them and asks them to examine these cards carefully. Then he divides the class into two groups and asks the children to group these pictures as endangered or extinct animals and to create a table by sticking these cards on the boards they brought (One group will create a painting from endangered animal cards, while the other group will create a painting from extinct animal cards).
In addition, the teacher asks each child to say the name of the animal on the card he/she holds and what environmental problem caused the death of this animal (such as polar bears dying due to the melting of glaciers, caretta carettas dying due to garbage thrown into the sea). The game is repeated several times until the children separate these animals completely, and at the end of the game these two boards are hung in a corner of the classroom. In this way, children will constantly be able to see pictures of endangered and extinct animals. Thanks to this issue, they will have gained awareness of the danger of extinction of species, which is one of our current environmental problems, and the environmental problems that cause it.

DAY 2
The teacher asks the children how they are feeling today, what they did before they got to school, and what animals they saw on the way. After the teacher listens to the children, he shows the children the various animal puppets he has in hand and asks questions about whether they know these animals and starts the activity by drawing the attention of the children. After watching a short-animated film about endangered animals and giving information, the children are divided into three randomly formed groups after asking questions about where these animals live, their colors, the sounds they make, and why they are going extinct. Each group sits at a table. Each group is given white, yellow and blue background cardboard and scissors on which a large rectangle was drawn beforehand. The names of the colors and the names of the living things in these colors are asked. Each group cuts out the rectangles from their cardboard. The teacher collects the cut rectangles. Children sit on the floor in a semicircle.
The children introduce the endangered animal pictures they found with their families the day before to their friends. It is talked about the characteristics of animals (size, color, diet, sounds they make, where they live, etc.) and the necessity of purifying our environment from wastes and chemicals regarding the protection of these endangered animals. It is talked about that the deterioration in the natural balance can harm people and environmental awareness is created. Each child is given a picture of an animal. (Polar Bear, Panda, Penguin, Caretta Caretta, Mexican Dolphin, Mediterranean Seal, Cheetah, Black Vulture, Striped Hyena) Children hold the pictures in their hands. Rectangles of three colors are separated according to their colors and placed in three different corners in the classroom.
The teacher tells the children that they will dance freely around the classroom when the music starts. When the music stops, the children place their picture on the background cardboard (yellow-desert, blue-water, white-polar) showing where the creature they are holding lives (desert, water, pole). When a child goes to the wrong habitat, he is taken to the right habitat by his friends in the habitat he went to. Children who get to the correct rectangle are applauded. Ask the children what other creatures can live in these habitats. Then the teacher collects the pictures in the children's hands. This time he takes out the endangered animal pictures he brought himself. Tell the children the names of the animals in these pictures in turn. When children hear the names, they go to the corner where the living space of that creature is. Children who go to the wrong corners can go to the right corner by saying the name of a creature found in the living areas in the rectangles they go to. The event ends after all living things are placed in their habitats

Assessment and Evaluation:	Family Involvement:
At first, the teacher starts a conversation in line with the children's ideas about the subject by asking questions about the activity. At the end of the conversation, he ends the activity by asking the children to draw a picture of one of their favorite animals that they saw in the documentary.	Families participated in the beginning of the activity by finding pictures of endangered animals with their children the day before. After the activity is completed, the children take pictures of other living things to their homes, apart from the ones they brought their pictures from. The parents talk and chat about the creature and the features of the living thing in the picture that the child brings.

• Which creatures were present in the documentary we just watched?	
• How did you feel just watching the documentary? How did the extinction of these animals make you feel?	
• Do you have an animal in your house that you keep?	
• Which animals do you see on your way to and from school? Do you think these animals are also endangered?	
• What can we do to protect the life of living things?	
• Which animals do you think harm the garbage we throw into the sea or ashore?	
• How does the garbage we throw in nature harm animals?	
• How can we protect glaciers for the survival of polar bears and penguins?	
Penguin model made with students in the classroom and animal drawings becoming extinction:	

References

Adams, J.A. (1971). A closed-loop theory of motor learning. *Journal of Motor Behaviour, 3* (2), 111–49. https://doi.org/10.1080/00222895.1971.10734898

Ahi, B., & Alisinanoğlu, F. (2016). Okul öncesi eğitim programına kaynaştırılan çevre eğitimi programının çocukların "çevre" kavramı hakkındaki zihinsel model gelişimine etkisi. *Kafkas Üniversitesi, Sosyal Bilimler Enstitüsü Dergisi* (18), 305-329.

Akbayrak, N., & Turaşlı, N. K. (2017). Oyun temelli çevre etkinliklerinin okul öncesi çocukların çevresel farkındalıklarına etkisinin incelenmesi. *Erken Çocukluk Çalışmaları Dergisi*, *1*(2), 239-258.

Akçay, İ. (2006). *Farklı ülkelerde okul öncesi öğrencilerine yönelik çevre eğitimi* [Yayınlanmamış yüksek lisans tezi]. Uludağ Üniversitesi, Sosyal Bilimler Enstitüsü.

Akkoyunlu, B., & Tuğrul, B. (2002). Okulöncesi çocukların ev yaşantısındaki teknolojik etkileşimlerinin bilgisayar okuryazarlığı becerileri üzerindeki etkisi. *Hacettepe* Üniversitesi *Eğitim Fakültesi Dergisi, 23*(23).

Akman, B., Üstün, E. Y., & Güler Yıldız, T., (2003). 6 yaş çocuklarının bilim süreçlerini kullanma yetenekleri. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 24,* 11-14.

Aktaş-Arnas, Y. (2019). (Ed.). Çocuk merkezli öğrenme ortamları: Okul öncesi çocuklar için bir okul tasarla. Pegem Akademi.

Altınsoy, F. (2018). *Okul* öncesi *dönem* çocuklarında çevre *kirliliği farkındalığı oluşturmada geleneksel* öğretim *ve teknoloji destekli yöntemlerin karşılaştırılması* [Yayınlanmamış yüksek lisans tezi]. Necmettin Erbakan Üniversitesi, Eğitim Bilimleri Enstitüsü.

Arıcı, N. & Dalkılıç, E. (2006). Animasyonların bilgisayar destekli öğretime katkısı: bir uygulama örneği. *Kastamonu Eğitim Dergisi, 14*(2), 421-430.

Ärlemalm-Hagsér, E. (2013). Respect for nature-a prescription for developing environmental awareness in preschool. *Center for Educational Policy Studies Journal*, *3*(1), 25-44.

Atasoy, E. (2005). Çevre *içi eğitim: ilköğretim* öğrencilerinin çevresel *tutum ve* çevre *bilgisi* üzerine *bir* çalışma [Yayınlanmamış Doktora Tezi]. Uludağ Üniversitesi, Sosyal Bilimler Enstitüsü.

Aysu, B. (2019). *Drama temelli çevre eğitiminin çocukların çevre farkındalık düzeylerine etkisinin incelenmesi* (Yüksek lisans tezi, Ankara Üniversitesi).

Barber, S. E., Jackson, C., Akhtar, S., Bingham, D. D., Ainsworth, H., Hewitt, C., & Wright, J. (2013). Pre-schoolers in the playground: An outdoor physical activity intervention for children aged 18 months to 4 years old. Study protocol for a pilot cluster randomised controlled trial. Trials, 14, 326. doi: 10.1186/1745-6215-14-326

Basile, C. G. (2000). Environmental education as a catalyst for transfer of learning in young children. *Journal of Child and Adolescent Psychiatric Nursing, 10*(1), 17–24.

Basile, C. G. (2000). Environmental education as a catalyst for transfer of learning in young children. *The Journal of Environmental Education, 32*(1), 21–27.

Başal, H. A. (2005). *Okul öncesi eğitiminde uygulamalı çevre eğitimi, erken çocuklukta gelişim ve eğitimde yeni yaklaşımlar 2.* Morpa Kültür Yayınları.

Baştanlar, Y. (2018). *Yapay zekâ ve yapay öğrenme*. Bilim Genç.

Baum, W.M. (2005). *Understanding behaviorism: Behavior, culture, and evolution* (2nd ed.). Malden, MA: Blackwell.

Bennett, T. (2001). Reactions to visiting the infant-toddler and preschool centers in reggio emilia, ttaly. *Early Childhood Research and Practice*, *3*(1), 2-9.

Bento, G., & Dias, G. (2017). The importance of outdoor play for young children's healthy development. *Porto Biomedical Journal, 2*(5), 157-160 doi: 10.1016/j.pbj.2017.03.003

Bilaloğlu, G. (2004). Okul öncesi dönemde high scope yaklaşımı. Çukurova Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 13(2), 41-56.

Blackwell, C. (2013). Teacher practices with mobile technology ıntegrating tablet computers into the early childhood classroom. *Journal of Education Research, 7,* 231-255.

Blackwell, C., Lauricella, A. R., & Wartella, E. (2014). Factors influencing digital technology use in early childhood education. *Computers and Education, 77,* 82-90. http://dx.doi.org/10.1016/j.compedu.2014.04.013

Blackwell, S. (2015b). The archimedes forest schools model. *Archimedes Earth Press.*

Bolstad, R. (2004). *The role and potential of* ıct *in early childhood education: A review* *of new zealand and* ınternational *literature.* New Zealand Council for Educational Research.

Brainfit. (2017). Doğanın bilişsel faydaları. (27.06.2021). https://brainfit.com.tr/doganin-bilissel-faydalari/

Büyüktaşkapu, S., Koçyiğit, S., Öztürk Samur, A., & Özenoğlu Kiremit, H. (2011). Çocuk ve çevre. Vize Yayıncılık.

Canosa, A., Graham, A., & Wilson, E. (2020). Growing up in a tourist destination: developing an environmental sensitivity. *Envıronmental Educatıon Research, 26* (7), 1027-1042. https://doi.org/10.1080/13504622.2020.1768224

Chawla, L. & Flanders Cushing, D. (2007). Education for strategic environmental behaviour. *Environmental Education Researc*h, *13*(4), 437-452.

Chawla, L. (1998). Significant life experiences revisited: a review of research on sources of environmental sensitivity. *The Journal of Environmental Education, 29*(3), 11–21.

Cordes, C., & Miller, E. (2000). *Fool's gold: A critical look at computers in childhood.* Maryland, MD: Alliance for Childhood.

Çabuk, B. (2019). Çevre farkındalığı, erken çocukluk döneminde çevre eğitimi ve sürdürülebilirlik. (1. Baskı).

Çukur, D. (2011). Erken çocukluk döneminde görsel algı gelişimine uygun 25 mekan tasarımı. *Sosyal Politika Çalışmaları Dergisi*, *24*(24), 25-36.

Demiriz, S., Karadağ, A., & Ulutaş, İ. (2011). *Okul* öncesi *eğitim kurumlarında eğitim ortamı ve donanım.* Anı Yayıncılık.

Dikicigil, Ö., & Gülersoy, A.E. (2020). Social studies pre-service teachers' awareness of environmental ethics. *Elementary Education Online, 19*(3), 1579-1591. http://dx.doi.org/ 10.17051/ilkonline.2020.734482

Dilek, Ö. (2019). Orman okulu uygulamalarının çocukların gelişimine yönelik katkısının değerlendirilmesi. *Kastamonu Üniversitesi Sosyal Bilimler Enstitüsü Dergisi.*

Dillon, J. (2003). On learners and learning in environmental education: Missing theories and ignored communities. *Environmental Education Research, 9*(2), 215–26.

Duch, H., Fisher, E.M., & Ensari, I. et al. (2013). Screen time use in children under 3 years old: A systematic review of correlates. *Int J Behav Nutr Phys Act 10, 102*. https://doi.org/10.1186/1479-5868-10-102

Duhlin, B. (2021). The Bildung of Humanity and Earth; The ecospiritual potential of Waldorf education. *Research on Steiner Education, 12* (special issue), 15-26.

Düzenli, T., Işık, B. & Yılmaz, S. (2018). *Çocukların Hayallerindeki Çevre Algısı*.

Edwards, V., Monaghan, F., & Knight, J. (2000). Books, pictures and conversations: Using bilingual multimedia storybooks to develop language awareness. *Language awareness 9*(3), 135-146.

Ekookullar. (2021). *Okul öncesinde çevre eğitimi.* http://www.ekookullar.org.tr/ckfinder/userfiles/files/Antalya_Halide%20Edip%20Ad%C4%B1var%20Anaokulu_Okul%20%C3%96ncesinde%20%C3%87evre%20E%C4%9Fitimi%20ve%20Eko-Okul%20Uygulamalar%C4%B1.pdf

Erdoğan, M., & Uşak, M. (2009). Curricular and extra-curricular activities for developing environmental awareness of young students:A case from Turkey. *Odgojne ZnanostiEducational Sciences, 11*(1), 73-85.

Erentay, N. & Erdoğan, M. (2009). *22 Adımda Doğa Eğitimi*. ODTU Yayıncılık.

Erten, S. (2004). Çevre eğitimi ve çevre bilinci nedir, çevre eğitimi nasıl olmalıdır. Çevre ve İnsan Dergisi, (6566).

Faber Taylor, A., Kuo F.E., & Sullivan, W. C. (1998). Growing up in the inner city: Green spaces as places to grow. *Environment and Behaviour, 30,* 3-27.

French, L. (2004). Science as the center of a coherent, integrated early childhood curriculum. *Early Childhood Research Quarterly, 19*(1), 138-149.

Gärling, T., & Golledge, R. G. (1989). Environmental perception and cognition. *In Advance In Environment, Behavior and Design,* (203-236).

Ginsburg, H. P., & Golbeck, S. L. (2004). Thoughts on the future of research on mathematics and science learning and education. *Early Childhood Research Quarterly*, *19*(1), 190– 200.

Gülay, H. (2011). Ağaç yaş iken eğilir: yaşamın ilk yıllarında çevre eğitiminin önemi. *TÜBAV Bilim Dergisi*, *4*(3). 240-245.

Güler, T. (2009). Ekoloji temelli bir çevre eğitiminin öğretmenlerin çevre eğitimine karşı görüşlerine etkileri. *Eğitim ve Bilim, 34*(151).

Gülersoy, A.E. (2019b). Mekân-insan etkileşiminin ıslahına bâtıni bir yorum: Rıza şehri (kâmil toplum). Gönençgil, B. (Ed.). *1. İstanbul Uluslararası Coğrafya Kongresi Bildiri Kitabı*. İstanbul Üniversitesi. https://doi.org/10.26650/PB/PS12.2019.002.009

Gümüş, N., Gülersoy, A. E. & Avcı, G. (2017). Arazi kullanım bilincinin üniversite öğrencileri açısından değerlendirilmesi. *The Journal of Academic Social Science Studies, 56*, 351- 368. http://dx.doi.org/10.9761/JASSS7006

Haktanır, G., & Çabuk, B. (2000). *Okul öncesi dönemdeki çocukların çevre algıları.* Kongre bildirisi, 4. Fen Bilimleri Eğitim Kongresi.

Handler, D., & Epstein, A. (2010). Nature education in preschool. *Extensions Curriculum Newsletter from Highscope, 25*(2), 1-7.

Hanscom, A. J. (2016*). Balanced and barefoot*. Oakland, CA: New Harbinger Publications, Inc.

Hede, A. (2002). An integrated model of multimedia effects on learning. J. Ed. *Multimedia Hypermedia, 11*, 177–191.

Horwitz, W. A. (1996). Developmental origins of environmental ethics: The life experiences of activists. *Ethics and Behavior, 6*(1), 29-54.

Ikoh, N.F., & Nwankwo, F.M. (2013). Teacher resourcefulness: A key to improving ICT learning in primary schools. *Journal of OMEP. 10*(1). 115-121.

İlhan Agan, Ş. (2004). Öğretim *teknolojileri ve materyal destekli yabancı dil (*İngilizce*)* öğretimin*, ilköğretim okul* öncesi *eğitimi anasınıfı* öğrencilerinin öğrenme *ve hatırlama düzeyleri* üzerindeki *etkisi* (Yüksek lisans tezi, Muğla Üniversitesi).

Kallery, M., & Psillos, D. (2001). Pre-school teachers content knowledge in science: Their understanding of elementary science concepts and of issues raised by children's questions*. International Journal of Early Years Education, 9*(3), 165-179.

Kaplan, R., & Kaplan, S. (1994). The experience of nature: A psychological perspective. *Cambridge University Pres.*

Kara, Y. (2007). Mitoz ve mayoz bölünme konularında öğrenci başarıları, kavram yanılgıları ve biyolojiye karşı tutumlara öğretim amaçlı bilgisayar yazılımlarının etkisi. *Buca Eğitim Fakültesi Dergisi, 21,* 49-57.

Karaçöp, A., Doymuş, K., Doğan, A., & Koç, Y. (2009). Öğrencilerin akademik başarılarına bilgisayar animasyonları ve jigsaw tekniğinin etkisi. *Gazi Eğitim Fakültesi Dergisi, 29*(1), 211-235.

Kınacı, B., Albuz Pehlivan, N., & Seyhan, G. (2011). *Turizm ve çevre (Çevre koruma)*. Pegem Akademi.

Kınık, B., Okyay, Ö., & Aydoğan, Y. (2016). 24-36 aylık çocuklarda aile katılımlı çevre eğitiminin dil gelişimine etkisinin incelenmesi. *Kastamonu Eğitim Dergisi*, *24*(5), 2143-2456.

Knight, S. (2017). *Forest School for the early years in England*. T. Waller, E. Arlemaalm-Hagser, E. B. H. Sandseter, L. Lee-Hammond, & K. L. S. Wyver (Eds.) In The Sage handbook of out- door play

Koca, C., & Ünal, F. (2018). Türkiye'deki bir waldorf anaokulunun misyon, vizyon ve diğer anaokullarından farklı yönlerine ilişkin görüşlerin incelenmesi. *Eğitimde Nitel Araştırmalar Dergisi , 6*(3) , 185-206.

Kotaman, H. (2009). Okul öncesi dönemde high scope modeli. *Pamukkale Üniversitesi Eğitim Fakültesi Dergisi* (26), 31-41.

Kotaman, H. (2009). Rudolf Steiner ve Waldorf Okulu. Yüzüncü Yıl Üniversitesi, Eğitim

Koyuncu, M. (2019). Orman okullarında öğretmen, veli ve yönetici görüşlerinin incelenmesi. *Ankara Yıldırım Beyazıt Üniversitesi Sağlık Bilimleri Enstitüsü Dergisi.*

Kraidy, U. (2002). Digital media and education: Cognitive impact of ınformation visualization. *Journal of Educational Media, 27*(3), 95–106.

Leather, M. (2016). A critique of forest school: Something lost in translation. *Journal of Outdoor and Environmental Education, 4.*

Lee, T.D. & Schmidt, R.P. (1999). Motor control and learning: a behavioral emphasis. *IL: Human Kinetics.* ISBN 0-88011-484-3.

Lim, C.P., & Tay, L.Y. (2003). Information and communication technologies (ICT) in an elementary school: Engagement in higher order thinking. *Journal of Educational Multimedia and Hypermedia, 12*(4), 425-451.

Louv, R. (2008). *Last child in the woods: Saving our children from nature-deficit disorder* (updated ed.). Chapel Hill, NC: Algonquin Books of Chapel Hill.

MacEachren, Z. (2013). The canadian forest school movement, Queen's University Learning. *7*(1).

Mallory, J. P. (1989). *In search of the indo-europeans: Language, archaeology and myth*. Thames and Hudson.

Matthews, B. E., & Riley, C. K. (1995). *Teaching and evaluating outdoor ethics education programs*. Vienna, VA: National Wildlife Federation. (ED 401 097).

McClain, C., & Vandermaas Peeler, M. (2015). Social contexts of development in natural outdoor environments: children's motor activities, personal challenges and peer interactions at the river and the creek. *Journal of Adventure Education and Outdoor Learning, 16*(1), 31–48. doi: 10.1080/14729679.2015.1050682

McManis, L.D., & Gunnewig, S.B. (2012). Finding the education in educational technology with early learners. *Young Children, 67*, 14-24.

Nazlıoğlu, M. (1988). Çevre bilincinin oluşmasında çevre eğitiminin rolü (Yüksek lisans tezi, Hacettepe Üniversitesi).

OECD. (2015). *Enabling the next production revolution.* OECD Publishing.

Özbuğutu, E., Karahan, S. & Tan, Ç. (2014). Çevre eğitimi ve alternatif yöntemler–literatür taraması. *Mustafa Kemal* Üniversitesi *Sosyal Bilimler Enstitüsü Dergisi, 11* (25), 393-408.

Öztan, Y. (2002). Çocuklarda oyunla ilgili içgüdüsel eğilimler ve eylemler. *Aylık Anne Baba Eğitimci Dergisi.*

Patrick, H., Mantzicopoulos, P., & Samarapungavan, A. (2009). Motivation for learning science in kindergarten: Is there a gender gap and does integrated inquiry and literacy instruction make a difference. *Journal of Research in Science Teaching, 46*(2), 166- 191.

Pekdoğan, S. (2016). Reggio emilia yaklaşımı üzerine bir çalışma. Amasya Üniversitesi.

Plant Dergisi. (2020). Çocuklara çevre bilinci (27.06.2021). https://www.plantdergisi.com/dr-ogr-uyesi-sima-pouya-3/cocuklara-cevre-bilinci.html

Plowman, L., & Stephen, C. (2003). A 'Benign addition ?' research on ICT and pre-school children. *Journal of Computer Assisted Learning, 19*, 149-164. https://doi.org/10.1046/j.0266-4909.2003.00016.x

Plowman, L., Stevenson, O., McPake, J., & Stephen, C. (2012). *Computers and Education, 59*(1), 30-37. https://doi.org/10.1016/j.compedu.2011.11.014

Pluess, M., Assary, E., Lionetti, F., Lester, K. J., Krapohl, E., Aron, E. N., & Aron, A. (2018). Environmental sensitivity in children: Development of the Highly Sensitive Child Scale and identification of sensitivity groups. *Developmental Psychology*, *54*(1), 51–70. https://doi.org/10.1037/dev0000406

Pruneau, D., Freiman, V., Barbier, P.V., & Langis, J. (2009). Helping young students to better pose an environmental problem. *Applied Environmental Education and Communication, 8*, 105-113. https://doi.org/10.1080/15330150903133678

Pyle, R. M. (2002). *Eden in a vacant lot: Special places, species, and kids in the neighbourhood of life.* In P. H. Kahn & S. R. Kellert (Eds.), Children and nature: Psychological, sociocultural and evolutionary investigations (pp. 305–327).

Rejeski, D. W. (1982). Children look at nature: Environmental perception and education. *The Journal of Environmental Education*, *13*(4), 27-40.

Rickinson, M. (2006). Researching and understanding environmental learning: Hopes for the next ten years. *Environmental Education Research, 12*(3–4), 445–58.

Rothmeyer, J. (2019). *Interaction of environmental education and montessori pedagogy.* (Unpublished Master's Thesis). University of Wisconsin.

Ruchter, M., Klar, B., & Geiger, W. (2010). Comparing the effects of mobile computers and traditional approaches in environmental education. *Computers and Education, 54,* 1054-1067. http://dx.doi.org/10.1016/j.compedu.2009.10.010

Schmidt, M.E., Pempek, T.A., Kirkorian, H.L., Lund, A.F., & Anderson, D.R. (2008). The effects of background television on the toy play behavior of very young children. *Child Dev, 79* (4). 1137-1151. 10.1111/j.1467-8624.2008.01180.x.

Schnack, K. (2008). *Participation, education, and democracy: Implications for environmental education, health education, and education for sustainable development.* In Participation and learning: Perspectives of education and the environment, health and sustainability, Edited by: Reid, A., Jensen, B.B., Nikel, J. and Simovska, V. 181–96.

Schweinhart, Larry. (2002). The high scope preschool curriculum: What is it? Why use it?. *The journal of at risk issues; a joint publication of National Dropout Prevention Center and Network, 8*, 13-16.

Scrimin, S., Osler, G., Pozzoli, T., & Moscardino, U. (2018). Early adversities, family support, and child well-being: the moderating role of environmental sensitivity. *Child: Care, Health And Development*, *44*(6), 885-891.

Seldin, T., & Epstein, P. (2003). *The Montessori way*. The Montessori Foundation Press.

Seldin, T.D. (2002). *Maria Montessori's biography*. Gale Encyclopedia of Education. http://www.answers.com/topic/maria-montessori.

Smith, A. (2001). Early childhood a wonderful time for science learning. *Australian Primary & Junior Journal, 17* (2), 52–55.

Solomon, E. P., & Heide, K. M. (2005). The biology of trauma: Implications for treatment. *Journal of Interpersonal Violence, 20,* 51-60.

Stanislava, M. (2020). Cultıvatıon of envıronmental educatıon by the Montessorı method. *Section Education and Accreditation in GeoSciences, 20*(5.2).

Stevenson, B., Dillon, J., Wals, A. E. J., & Brody, M. (2013). The Evolving Characteristics of Environmental Education Research. In R. B. Stevenson, M. Brody, J. Dillon, & A. E. J. Wals (Eds.), International Handbook of Research on Environmental Education (pp. 512-517). Routledge.

Tahiroğlu, M., Yıldırım, T., & Çetin, T. (2010). Değer eğitimi yöntemlerine uygun geliştirilen çevre eğitimi etkinliğinin, ilköğretim 7. sınıf öğrencilerinin çevreye ilişkin tutumlarına etkisi. *Selçuk* Üniversitesi *Ahmet Keleşoğlu, Eğitim Fakültesi Dergisi 30*, 231-248.

Tai, L., Haque, M.T., McLellan, G.K., & Knight, E.J. (2006). *Designing Outdoor Environments for Children*. McGraw-Hill.

Tantekin, F., & Yalçın, F. (2017). E. Aktan Acar (editör), *Doğanın kalbinde oyun temelli eğitim: orman okulu yaklaşımı içinde: erken çocukluk eğitimi mozaiği*. Nobel Yayıncılık.

Taşkın, Ö., & Şahin, B. (2008). "Çevre" kavramı ve altı yaş okul öncesi çocuklar. *Pamukkale Üniversitesi Eğitim Fakültesi Dergisi*, *1*(1), 1-12.

Tatlı Çocuklar. (2019). Doğa ve çocuklar (27.06.2021). https://www.tatlicocuklar.com/blog/doga-ve-cocuklar/

Taylor, A. F., Kuo, F. E., & Sullivan, W. C. (2001). Coping with add: The Surprising Connection to Green Play Settings. *Environment and Behavior*, *33*(1), 54–77. https://doi.org/10.1177/00139160121972864

Tektaş, M., Akbaş, A. & Topuz, V. (2002). Yapay zeka tekniklerinin trafik kontrolünde kullanılması üzerine bir inceleme. *Marmara Üniversitesi Teknik Bilimler MYO.*

Temel, F. (2018). *Okul öncesi eğitimde alternatif yaklaşımlar*. Hedef Yayıncılık.

Thornton, L., & Brunton, P. (2015). Understanding the reggio approach: early years education in practice (3rd ed.). *Routledge*. https://doi.org/10.4324/9781315744018

Tomopoulos, S., Dreyer, B.P., Berkule, S., Fierman, A.H., Brockmeyer, C., & Mendelsohn, A.L. (2010). Infant media exposure and toddler development. *Arch Pediatr Adolesc Med, 164* (12). 1105-1111. 10.1001/archpediatrics.

Toran, M. (2015). *Steıner Pedagojisi ve Waldorf Okulları.* (Ed. Fulya Temel). Okul Öncesi Eğitimde Alternatif Yaklaşımlar. Hedef Yayıncılık.

Torquati, J., Cutler, K., Gilkerson, D., & Sarver, S. (2013). Early childhood educators' perceptions of nature, science, and environmental education. *Early Education & Development*, *24*(5), 721-743.

Turgut, H. & Yılmaz, S. (2010). *Ekolojik temelli çocuk oyun alanlarının oluşturulması.* III. Ulusal Karadeniz Ormancılık Kongresi, IV,1618-1630.

UNWater. (2013). *Water Quality.* http://www.unwater.org/fileadmin/user_upload/unwater_new/docs/water_quality.pdf

Uysal, D. (2007). *Okulöncesi eğitim kurumlarında uygulanan fen ve doğa etkinliklerinin işlevselliğine ilişkin öğretmen görüşleri* (Yüksek lisans tezi, Anadolu Üniversitesi).

Ültanir, E. (2012, July). An epistemological glance at the constructivist approach: Constructivist learning in Dewey, Piaget, and Montessori. *International Journal of Instruction, 5*(2), 195-212.

Ünal, M. (2009). Çocuk gelişiminde oyun alanlarının yeri ve önemi. İnönü Üniversitesi Eğitim Fakültesi Dergisi, 10(2), 95-109.

Watters, J.J., Diezmann, C.M., Grieshaber, S.J., & Davis, J.M. (2000). Enhancing science education for young children: A contemporary initiative. *Australian Journal of Early Childhood, 26*(2), 1-7.

Wells, N. M. (2000). At home with nature, effects of 'greenness' on children's cognitive functioning. *Environment & Behavior, 35*(6), 775–795.doi: 10.1177/00139160021972793

Wells, N.M., & Evans, G.W. (2003). Nearby nature: A buffer of life stress among rural children. *Environment & Behavior, 35*(3), 311–330. http/doi. 10.1177/0013916503035003001

Willis, J., Weiser, B., & Kirkwood, D. (2014). Bridging the gap: Meeting the needs of early childhood students by integrating technology and environmental education. *International Journal of Early Childhood Environmental Education, 2*(1), 140-155.

Yapıcı, Ş. & Yapıcı M. (2006). Çocukta Bilişsel Gelişim. *AKÜ Eğitim. Eğitim Fakültesi Dergisi. 6*(1).

Yaşar, M. C., İnal, G., Kaya, Ü. Ü., & Uyanık, Ö. (2012). Çocuk gözüyle tabiat anaya geri dönüş. *Eğitim ve Öğretim Araştırmaları Dergisi, 1*(2), 30-40.

Yoleri, S. (2012). Çocuk ve çevre: okul öncesi çocuklar arasında çevre bilinci oluşturma. *Dokuz Eylül Üniversitesi Buca Eğitim Fakültesi Dergisi*, (34), 100-111.

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Chapter 10

Environmental Knowledge

Sevcan CANDAN HELVACI
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Introduction

In our world where change is inevitable, besides the positive results of the variations that arise, negative situations can also be encountered. The most universal situation in which these negativities affect everyone without discrimination is environmental problems. People are getting worse day by day by using nature rudely and consuming it without thinking (Atasoy, 2015), and their living spaces are exposed to strong environmental problems with vital effects (Duan et al., 2018). The impact of education in understanding, preventing and solving environmental problems has been known internationally since 1970 (Shobeiri et al., 2006). Education has a great importance in the construction of a future different from the present (Colebrook, 2017) and environmental issues have started to gain a more important place in education (Gola, 2017). Environmental education directs individuals to raise awareness about the environment and to take beneficial actions (Stevenson, 2019).

In this context, environmental education has three main aims (Geray, 2002):

1. To enable people to understand the environment and their place in it,
2. To develop the necessary attitude for individuals to live in peace with the world,
3. To be able to act with a sense of responsibility towards the environment and to protect the environment.

The first article in these aims of environmental education is very important. It is possible for individuals to get to know the environment and to understand all the concepts and variables related to it. Environmental knowledge, which also creates environmental awareness and can be accepted as the first step in the formation of environmental awareness, is the basic step of environmental education. Knowing ecological concepts will support the formation of attitudes and behaviors will provide an effective understanding of the ecological threat that affects all humanity, regardless of country, race and religion. A branching environmental knowledge education is required at the origin of the definition of the environment.

Environment

Although the concept of environment has abstract or subjective connotations in the minds, it is a deeper concept than this. The environment can have definitions that are specialized in different areas and it has a complex structure that we directly experience. It is formed by environmental conditions (İncedayı, 2002) and shaped by the interaction between biotic and abiotic factors (Rosalino et al., 2014). In other words, the environment is the habitat in which biotic and abiotic factors interact and balance (Figure 1). The environment, which has conditions that surround and affect living things in many ways (Sharma, 2012), makes these systematically occurring conditions a part of their development (Lewontin & Levins, 1997).

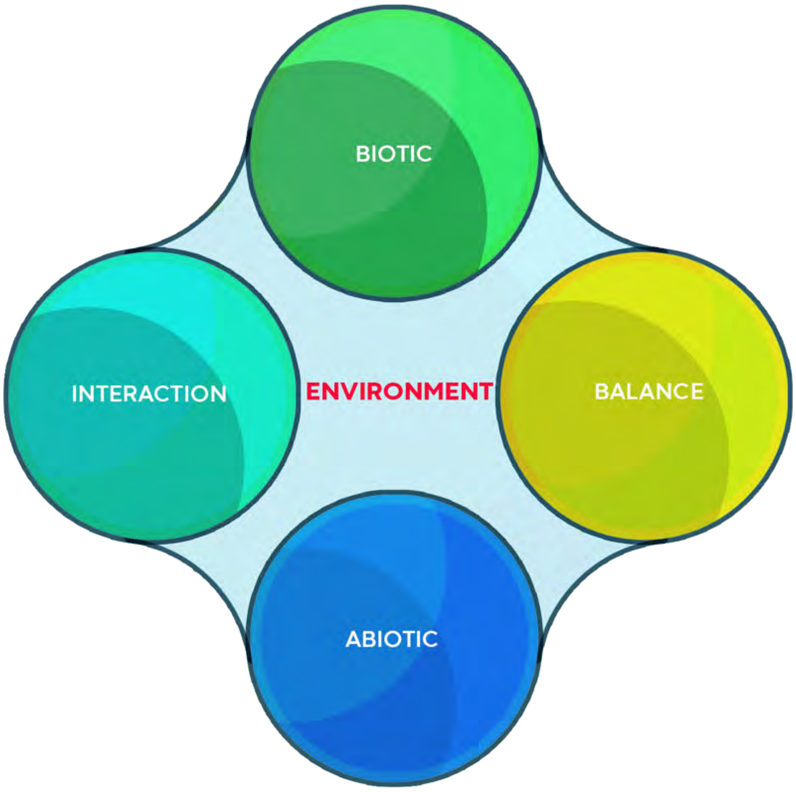


Figure 1. Environment

There is a physical world outside of organisms, and this world goes through certain transformations that are autonomous. Volcanoes erupt, the earth moves on its own axis of rotation. However, the physical world is not an environment, only the conditions under which environments can be created. The environment is divided into two as artificial and natural environment. While the natural environment defines an unmodified environment without human intervention, the artificial environment defines the environment created by interventions throughout human history (Görmez, 2015).

Basic Concepts of Environment

Ecology

The concept of ecology was used in 1866 by the German biologist Ernst Haeckel in his book *Generelle Morphologie der Organismen*. It is derived from the Greek words oikos (home, residence, family) and logos (language, language of mind) (Schwarz & Jax, 2011). Haeckel is accepted as the founder of ecology (Egerton, 2013) and is defined as the study of animals' interrelationships with their environment. Tansley (1935), who made a broader definition, stated that ecology is the science that studies the function of living things in their natural habitats. One of the most accurate definitions of ecology is that it is a science that provides a more intense explanation of the relationship between human and nature and aims to preserve the balance and integrity of the environment. It can be diversified such as physiological ecology, physiographic ecology, ecological phytogeography, as well as branching out such as population ecology, forest ecology, chemical ecology by taking the research object as a forename. Ecology types are grouped into 4 groups by Dodson (1998):

1. Types of ecology defined by subject or approach (such as landscape, ecosystem, physiologist, behaviorist, socialist)

2. Types of ecology defined by living things (Plant, animal, lichen, human, deer, tree etc.)

3. Types of ecology defined by habitat (such as land, lakes and rivers, ocean, rainforest, city)

4. Types of ecology defined by practice (such as theorist, management, reclamation)

Ecosystem

The ecosystem, which has common aspects with the definition of the environment, is defined as the whole formed by the living things living in a certain area and constantly interacting with each other, and their inanimate environment. The key phrase here is "a specific area". This situation, which expresses limitation, is decisive for the ecosystem. Ecosystems can be very large or small scales. Earth ecosystem and Sahara Desert ecosystem can be given as examples.

Biosphere

The concept of the biosphere, which was first mentioned in the work of biologists Lamark and Geologist Suess in the 19th century, took a wide place in the studies of the 20th century (Budyko, 1986). The biosphere is one of the components that make up the climate system. The biosphere can be expressed as the layer where life on earth is. It includes biotic life. At the intersection of the atmosphere, lithosphere and hydrosphere is the biosphere. The atmosphere, lithosphere and hydrosphere are abiotic while the biosphere is biotic.

Community

Community, which means the unity of life in the ecosystem, is a concept that includes living things. There is a balanced interaction among the living things in the community. Sharing the same physical environment is one of the defining features of the community.

Population

There are many approaches to describe the population (Berryman, 2002). It is possible to have different ecological and evolutionary perspectives, and population is at the basis of ecology (Waples & Gaggiotti, 2006). In the simplest sense, organisms of the same species living in a particular area are called population. People in Ohio and apple trees in Cambridge are examples of populations. The most important factor affecting the population size is the face measurement in which they are defined.

Species

As in all ecological concepts, there are definitions for the species that vary with different perspectives and there are many different perspectives (such as biological, racial, morphological). From a biological point of view, the definition of a species can be defined as a community that occupies a certain place, reacts equally to common chemical and physical conditions, and can produce fertile offspring among themselves under natural conditions (Demirsoy, 2018). Although the number of defined species is 1.4 million, it is thought that there are 12 million species excluding microorganisms (Swanson, 1997). People, deer, larch are examples of species.

Organism

A living being is called an organism. It is a biotic structure that shows physical, biological and chemical activities.

Dominant species

The species that stands out in terms of number and action in the community is called the dominant species.

Habitat

The place where a species lives is called habitat. Its "address" is where the species will be found when searched. Just like Columbia is the address for coffee trees.

Ecological Niche

The responsibility and role of the organism in the ecosystem is called the ecological niche. The ecological niche is also concerned with the communication of the species with the region in which it lives. The ecological niche model, which sheds light on the possible location and density of the species as a model, has an important place in ecology.

Flora

It refers to the plant species in the ecosystem.

Fauna

It refers to the animal species in the ecosystem.

The image explaining this basic concept of environment is in Figure 2.

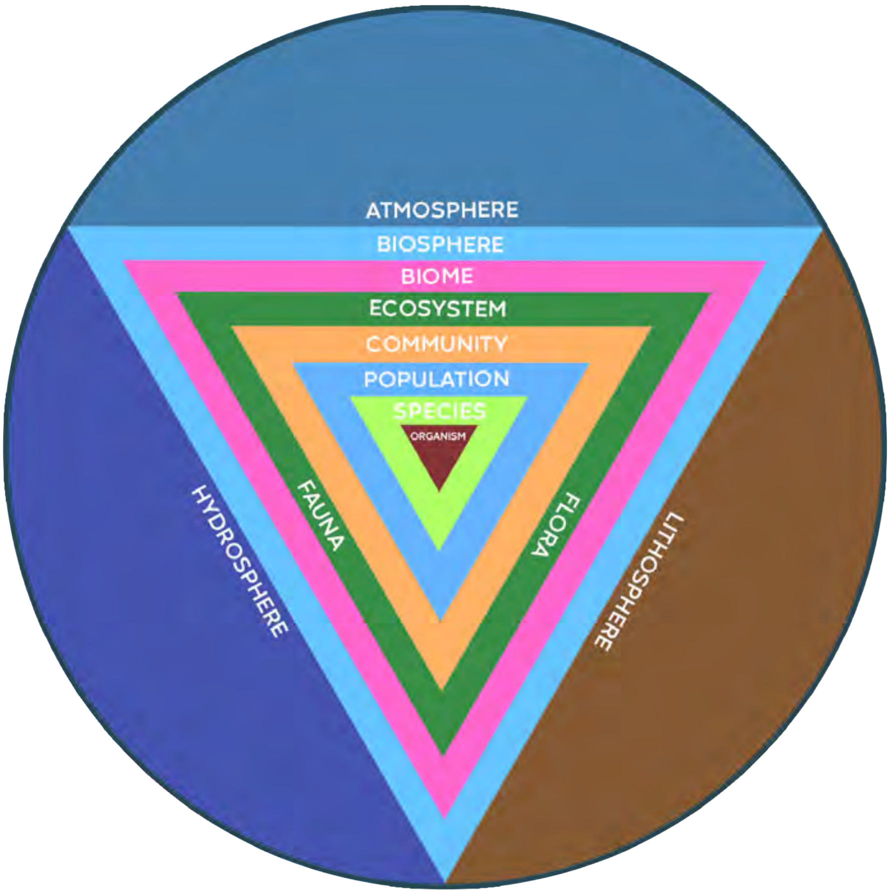


Figure 2. Basic Concepts of Environment

Biotic

The concept of biotic, which is one of the main dimensions of the environment, can be approached from two different perspectives. The first of these is the taxonomy of living things. The second is nutritional relationships. Biotic factors can be examined as shown in Figure 3.

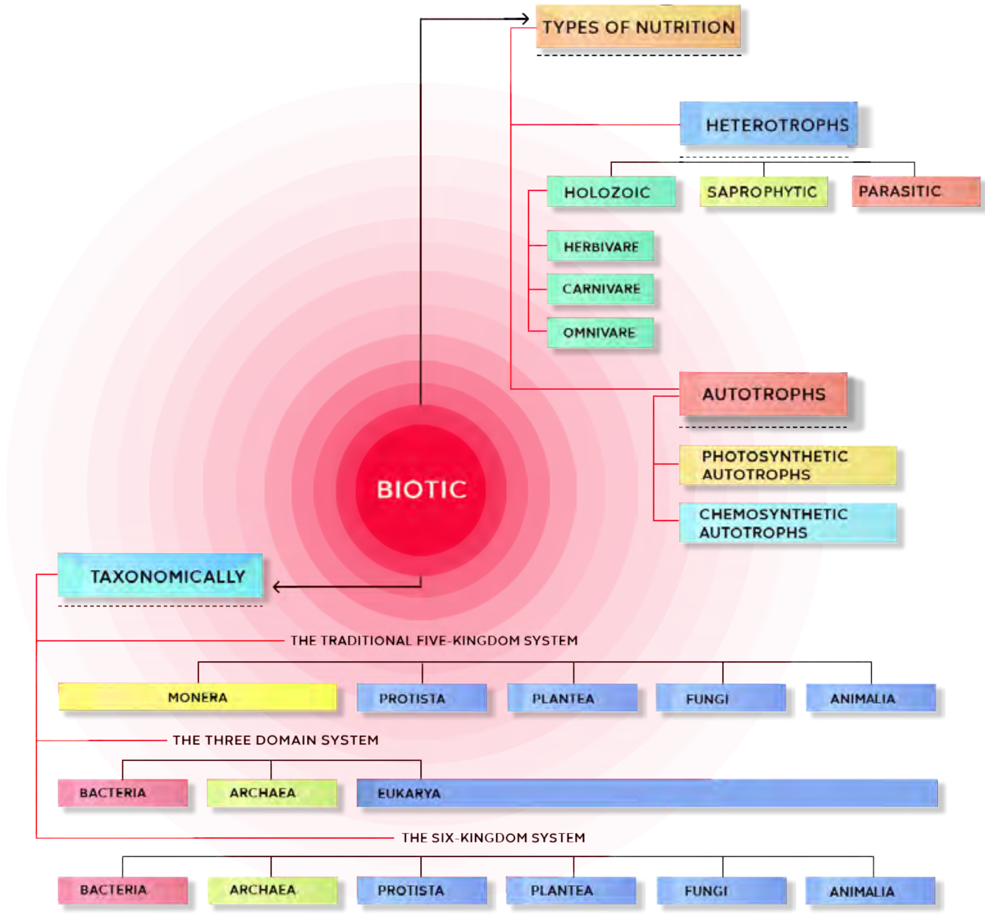


Figure 3. Biotic Factors

Taxonomy

The basis of taxonomy, which is the classification of living things, is based on ancient Greece, and Linnaeus' binary classification has been used for 250 years, which is still valid today (Godfray, 2002). In the process, living things were categorized by two, three and four classifications (The two-kingdom system of classification of Linnaeus, The three-kingdom system of classification of Haeckel, The four-kingdom system of classification of Copeland) (Verma, 2016). This classification is based on characteristics such as physiological, morphological, ecological, ethological or geographical. With The Five Kingdom System Ecologist Whittaker (1969), tries to eliminate the question marks in the previous classifications by categorizing living things according to their diet, cell structure, phylogenetic, body organization and reproduction systems (Verma, 2016). According to this classification, living things are examined in five realms. These are Monera, Protista, Fungi, Plants and Animals.

With the advances in molecular biology, the determination of DNA sequences has revealed new features (Nicol & Prosser, 2016) and some disadvantages have emerged in the Five Kingdom System classification. Woese et al. (1990) developed a three domain system that regulates biodiversity through evolutionary relationships. According to this system, living things are divided into domains as Archaea, Bacteria, and Eucarya and classified by the six-kingdom system. The concept of domain is hierarchically superior to the concept of kingdom.

Nutritional Relationships

Nutritional relationships emerge when biotic factors that affect the environment (or ecosystem when we limit it to an environment) are categorized according to their ecological niches. According to their nutritional relationships, living things are classified as autotrophs and heterotrophs.

Autotrophs

Autotrophs, which make their own food, synthesize organic matter from inorganic substances. Autotrophs, which are indispensable elements of the ecosystem, produce the chemical energy necessary for all living things. In this way, the energy necessary for the continuation of the vitality of living things is provided (Kışlalıoğlu & Berkes, 2014). According to the energy source they use, they are examined in two groups as photosynthetic and chemosynthetic autotrophs.

> Photosynthetic Autotrophs: They contain chlorophyll and synthesize organic matter from inorganic substances such as $C0_2$ and H_2O with light energy. Plants and cyanobacteria can be given as examples.
>
> Chemosynthetic Autotrophs: They do not have chlorophyll and they synthesize organic matter from inorganic substances such as $C0_2$ and H_2O with the help of chemical energy. Archaebacteria can be given as example.

Heterotrophs

They do not produce their food and feed on autotrophs or other creatures that feed on it (Erten, 2019). While heterotrophs are divided into three as holozoic, saprophytic and parasitic; holozoics are grouped as herbivores, carnivores and omnivores according to the type of food they consume.

Holozoic

They feed on solid foods. Holozoic is classified as herbivore, carnivore and omnivore.

> Herbivores are creatures that feed directly on autotrophs (Zooplankton, rabbit, cow).

Carnivores feed on by eating other heterotrops (hyena, lion)

Omnivores are creatures that feed on both autotrophs and heterotrops (bear, mouse, human)

Saprophytic

Saprophytes undertake the task of making various chemical substances in plant, animal dead and residues in soil or water usable for living things (Erten, 2019). Saprophytes generally consist of bacteria and microscopic fungi (Kışlalıoğlu & Berkes, 2014). Saprophytes are small-scale grinders that do very large-scale works that enable material cycles to take place.

Parasitic

Parasitics obtain some or all of their food from another living thing and harm that living thing. The organism in which the parasite lives is called the host. If the parasite is inside the host, it is an internal parasite, if it lives outside, it is an external parasite (Dinç & Aslan, 2009).

Abiotic

Biotic factors are affected by the amount of light in the environment, water supply, temperature change and soil composition, and these factors form abiotic components. Abiotic factors determine what kind of organisms can live in a particular environment (Suri, 2018). The abiotic factor, which is one of the main dimensions of the environment, is light, temperature, water and soil, can be examined as shown in Figure 4.

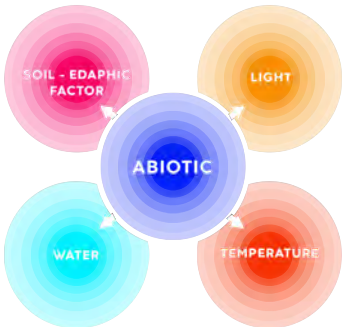


Figure 4. Abiotic Factors

Light

Light is the energy source of plants (Roeber et al., 2020) and the main environmental factor affecting their growth (Skalak et al., 2021). It significantly influences the way autotrophs adapt to changes (Janda et al., 2020). Changes in the quality and amount of light can affect the components in plants (Roeber et al., 2020). Considering that plants play a leading role in producing chemical energy in the ecosystem with photosynthesis, it is seen that light is the primary energy source in the ecosystem. Light provides energy to components and stages in the biosphere (Norton et al., 2017). When we customize it for humans, it is known that light has behavioral, cognitive, psychological and physiological effects (Münch et al., 2017) and plays key roles in vitamin D synthesis.

Since light is necessary for photosynthesis, its intensity, quality, duration, wavelength and period are important factors. 5% of the light reaching the earth, which provides the continuation of the ecological balance and life, consists of UV (UVA, UVB and UVC) rays (Bayramgürler, 2005). This type of light, which is harmful to humans, can cause cancer, aging and burns (Çayırlı et al., 2013). It is known that some insect species develop a chitin layer to protect them from these rays.

Temperature

Temperature, which is associated with sunlight from abiotic factors, has a strong effect on the environment. Regional temperature differences are seen on earth due to the sunlight coming from different angles. These different temperatures directly affect the habitat distribution of living things. Plants and animals live in the range of 0-50 ^{0}C, and there are differentiating optimum values for each species. Temperature, which is so effective on biotic factors, is at the center of one of the important environmental problems. The increase in temperature, which is the cause of global warming and climate change, affects all components of the environment. It is predicted that the temperature on earth will increase by 0.2 ^{0}C every ten years, and it may increase up to 4 ^{0}C in 2100 (The Intergovernmental Panel on Climate Change [IPCC], 2007), and there is even concern that this 4 ^{0}C threshold will be exceeded.

Water

Water is the main natural resource (Akın & Akın, 2007; Poonam et al., 2013). With its content, water plays an important role in the biochemical activities of living things (Akın & Akın, 2007). As it is known that it creates a suitable ground for biological activities and that life will cease when there is no water, a life without water is unthinkable. One of the proofs of this is that the importance of water has been known even from ancient times, civilizations have been established near the waters (Erten-Bilgiç & Abdelhamid-Hosny, 2019). From oceans to deserts, all living things live on water. Every living thing contains water in different proportions. 70% of the human body, about 75% of succulents and 95% of a jellyfish is water. With its solvent feature, water is also an important part of the substance cycles (Abreu, 2005).

Water resources are classified as fresh and salt water resources. Our planet contains ¾ of water, 97-97.5% of this water is salt water source, while only 2.5-3% is fresh water source (Cassardo & Jones, 2011). Today, there is a dramatic decrease in fresh water resources due to the rapid increase in population and related reasons, and the decrease in surface waters increases the need for groundwater (Poonam et al., 2013). In addition, agricultural activities consume 5 times more water than economic activities (Walczak, 2021) and it is predicted that this fresh water problem will increase with increasing food production activities. In addition, it causes problems such as detergents that harm nature, industrial residues, pesticides chemically polluting groundwater.

Soil-Edaphic Factor

Soil is a complex structure consisting of solid part (organic components and minerals), soil water and air (Turgut et al., 2010). While about half of the soil consists of solid part, air and water share the other half (Malkoç, 2018). Soil-related factors, in other words, edaphic factors refer to the effects of soil on biotic factors. It is such a sensitive structure that it can be said that it is impossible to revert when the soil loses its properties. It is known that a quarter of the world consists of land and 12% of its surface is agricultural land (Verma et al., 2005). Compared to plants, soil contains twice as much carbon as plants (European Environment Agency, 2019) and can hold much more water than its own mass. The soil consists of different layers, and the Soil Organic matter (SOM) part contains biotic factor corpses, which are of great importance for productivity (Stevenson, 1994). Many variable effects such as the living things living on the properties of the soil, the organic substances that occur with the activities of the living things, and the temperature (Kışlalıoğlu & Berkes, 2014). Soil works as a ground, a recycling stage, where organic-inorganic matter transformation takes place.

Interaction

The concept of interaction, which is one of the main components of the environment, consists of ecological relations between living and non-living things. The relationships between living and non-living things are divided into three groups. The effect of the non-living things on the living things is called action, the effect of living things on the non-living things is called reaction, and the relations of living things with living things are called coaction (biological relations) (Malkoç, 2018). The image explaining this interaction is in Figure 5.

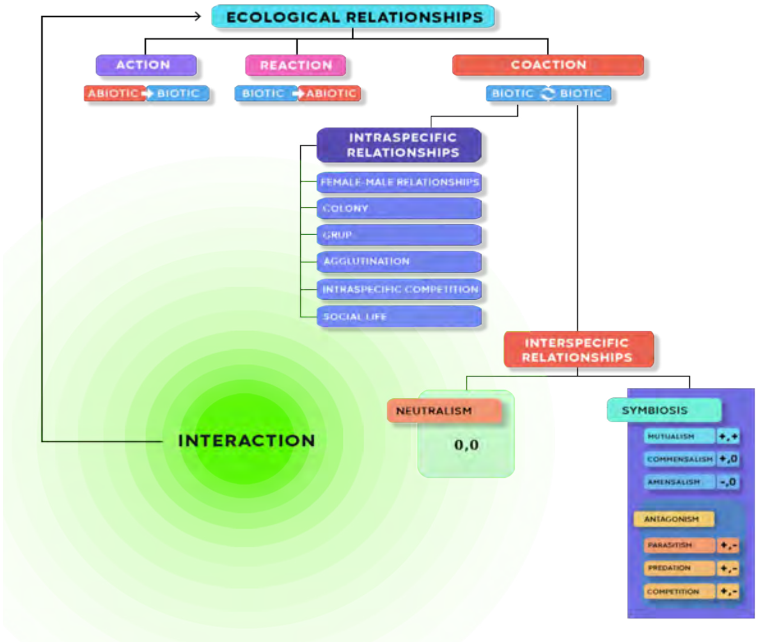


Figure 5. Interaction (Ecological Relations) Factors

Action

It is the non-living factors that make up the environment affect living things. (Dinç & Aslan, 2009; Erten, 2019). The change that occurs in a plant with temperature change, and the shedding of leaves with climate change are examples of action. Against the effects of non-living factors, biotic elements tend to adapt (Kışlalıoğlu & Berkes, 2014).

Reaction

It is the modification of non-living factors by living things and their products in order to survive (Erten, 2019). The effects of humans on the environment, the secretion of plants and the change of the organic-inorganic structure of the soil can be given as examples.

Coaction

It covers all kinds of interactions between living things (Erten, 2019). When we consider the taxonomies of living things, the relations of all categories with others and with each other means coaction, that is, biological interaction. Male and female offspring care, migration, leadership struggle are examples of coaction/biological interaction. Coaction is examined in two groups as intraspecific relationships and interspecific relationships.

Intraspecific Relationships

Six different relationships can occur between individuals belonging to the same species (Malkoç, 2018):

Male-Female Relationships: It is the union of males and females for reproduction and care of offspring.

Colonies: A community that comes together by asexual reproduction.

Groups: Individuals of the same species coming together for a specific time and purpose. It's like flying together to migrate.

Clustering: Clustering that occurs as a result of the inadequacy of the facilities in the habitat of the species for the number of individuals in the environment can create a negative situation for individuals.

Intraspecific Competition: It is the struggle between individuals of the same species (Gilad, 2008).

Social Life: It is the division of labor by organized species members (Erten, 2019).

Interspecific Relationships

The following relationships can occur between at least two different species:

Neutralism: It is the type of relationship in which order is seen most concretely in the relationship between species and it is a coincidental situation. It is the situation in which two species do not affect each other and there is no relationship between them (Srinivas et al., 2014).

Mutualism: It is the unity of interspecies coexistence and mutual benefit (Erten, 2019). e.g.: Lichens, which are formed by the partnership of fungi and algae and are a fresh air indicator.

Commensalism: It is the coexistence between species, where one of the species benefits and the other does not benefit or harm (Srinivas et al., 2014). For example: Vultures eating lion's prey residues.

Parasitism: It is the situation in which a species harms that species by benefiting from another species and cannot continue its non-species life with interspecies cohabitation (Price, 2002).

Predation: It is the use of one species as a food source by interspecies cohabitation (Price, 2002).

Amensalism: A condition in which secretion of one species suppresses the growth and development of another species. It does this by nature. e.g.: It is the suppression of the growth of other plants around it with the secretion (juglone) of the walnut tree.

Competition: Competition between species for food, shelter and space (Dhondt, 2012).

Symbiosis: It is the state of mutual long-term coexistence in interspecies relations. Mutual benefit can be provided, as well as harming (Roossinck, 2008).

Antagonism: It is the situation in which another species is damaged by effects such as protection, obtaining food or chemical secretions in interspecies relations (Price, 2002).

Balance

When viewed with the environment or its restricted state, the balance for the ecosystem means balancing the interactions of biotic and abiotic factors and maintaining the system's order without being disturbed. The continuation of the photosynthesis reaction, the blooming of flowers, the fruiting of the trees, the breathing of people, the nourishment of living things, the complete and uninterrupted fulfillment of every imaginable life-related event, such as rain, is ensured by an ecological balance. In order to achieve this balance, a transformation takes place in which the biotic and abiotic factors in the environment are involved. After the inorganic substances are taken from the abiotic environment and transferred between the biotic factors, they are returned to the abiotic environment (Kışlalı & Berkes, 2014) and this transformation is called the biogeochemical cycle. Substance cycles, which are the movement of substances between biotic and abiotic factors, provide the balance between the elements of the environment. Thanks to cycles, we give back what we borrowed for others to use, and this continues systematically. This cycle is the expression of the balance of elements with its most basic definition (Exley, 2003). Cycles are a movement that ensures the continuation of life.

The term biogeochemical consists of the concepts of biology, geology and chemical (O'Neill, 1998). Water, Carbon, Oxygen, Nitrogen, Sulfur and Phosphorus are found in organic molecules in various forms and circulate between living and non-living things with the biogeochemistry cycle.

Water Cycle Water/Hydrological Cycle

The water cycle, which is one of the most basic cycles, is also called the hydraulic cycle. The amount of water on our planet is constant, it remains in balance with the completion of the circulation of water on and below the earth. Understanding the water cycle is also important in understanding the other processes of the earth (Gleick et al., 2013). The water cycle is the condensation of water that goes to the atmosphere through evaporation and perspiration under the influence of the sun and its return to the earth as precipitation. This continues as a systematic process, forming the water cycle.

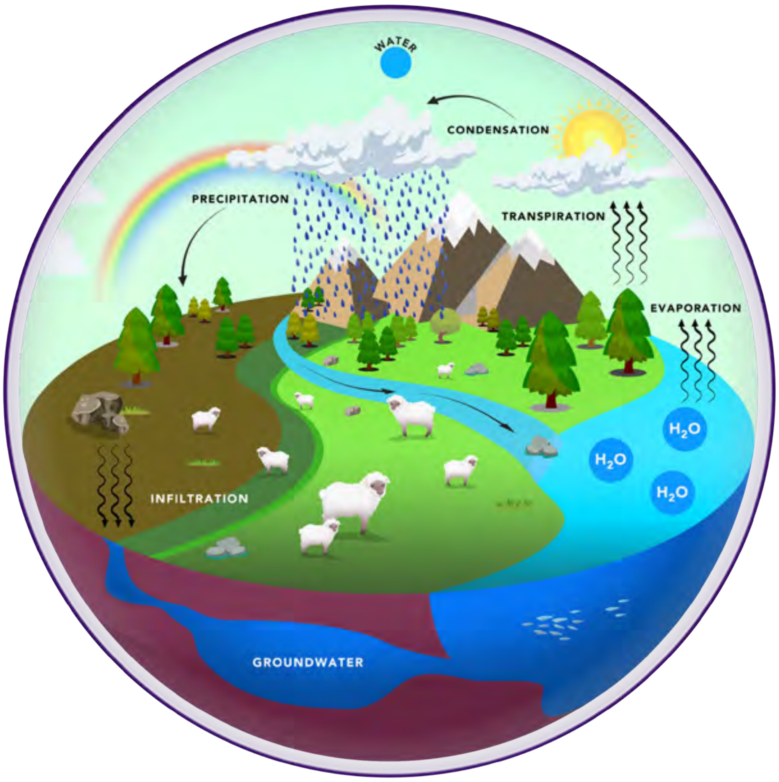


Figure 6. Water/Hydrological Cycle

The water cycle consists of five stages: condensation, precipitation, infiltration, runoff, and evapotranspiration (Gupta, 2016).

Condensation: It is the process in which water turns into water droplets in vapor form. This is when the clouds appear.

Precipitation: It is the return of water to the earth as downfall. It can take different forms such as rain, hail, snow.

Infiltration: It is the process of water infiltrating from the soil and going to underground water resources.

Runoff: It refers to the flow of water that is not absorbed by the soil and does not infiltrate into groundwater.

Evapotranspiration: It is a combination of transpiration in plants and vaporization from the earth.

Oxygen Cycle

The oxygen cycle is an important part of the functioning of the earth (Kasting & Canfield, 2012). It is the first element according to the density in the earth's crust and the second element according to the density in the atmosphere (Huang et al., 2021). Ozone form of oxygen (O_3) takes place in the stratosphere layer and filters UV rays (Gupta, 2016). The oxygen cycle consists of the stages of oxygen production and consumption. Green plants, algae and water play a role in the production of oxygen.

Figure 7. Oxygen Cycle

While green plants and algae take CO_2 and produce O_2 with the photosynthesis reaction, O_2 comes out with the decomposition of water with sunlight. Fossil fuel use and respiration play a role in oxygen consumption, and O_2 is taken and CO_2 is produced. This continues in a cycle. As can be seen, the photosynthesis reaction and respiration play a role in the oxygen cycle.

Carbon Cycle

There is an important connection between the carbon cycle and the oxygen cycle in terms of its effects on the realization of biotic activities (Schimel, 1995). The carbon cycle is important for three reasons (Houghton, 2003):

1. Carbon is the basis of life and constitutes an important part of living things.

2. Carbon is converted into chemical energy by plants and this energy feeds the energy flow in the ecosystem.

3. The use of fossil fuels increases carbon dioxide (CO_2) and methane (CH_4), which are the forms of greenhouse gases released into the atmosphere, and this causes warming. In

this respect, warming is linked to the carbon cycle.

Carbon carries out its cycle by moving between fossil resources, atmosphere, ocean and terrestrial ecosystem (Schimel, 1995). This cycle takes place in two processes.

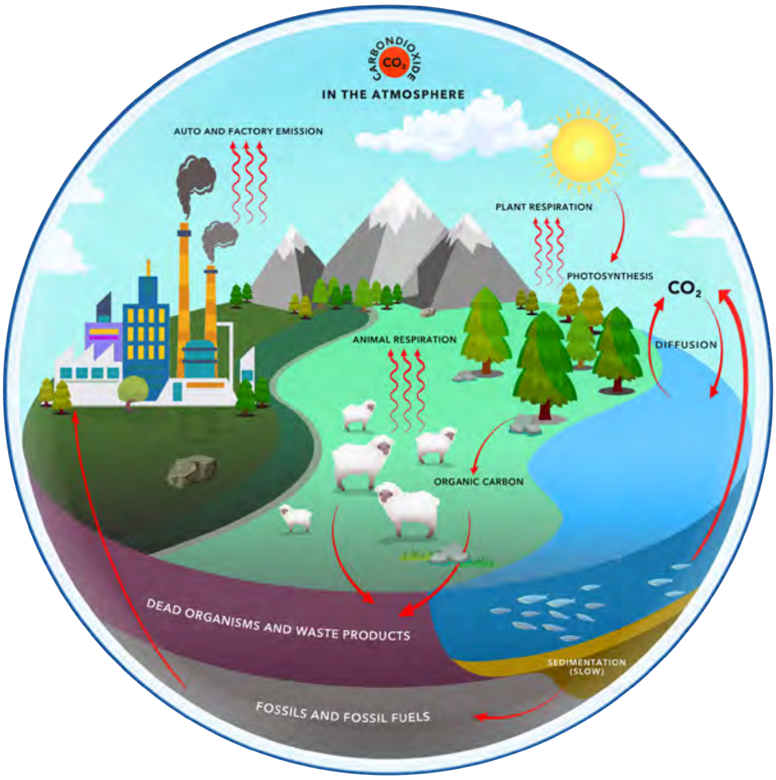


Figure 8. Carbon Cycle

1. In the first carbon cycle process between biotic factors, autotrophs convert CO_2 into carbon-containing organic compounds through photosynthesis, and these compounds are broken down by cellular respiration by heterotrophs fed with autotrophs. At the end of this process, CO_2 is released. Plant and animal dead and residues are transformed with decomposers, resulting in the formation of organic compounds and CO_2 release.

2. The second longitudinal process of the carbon cycle takes place in three different ways. Over millions of years, carbon accumulates with fossilization and CO_2 is released with their use. CO_2 in the lower layers of the earth is released by volcanic eruptions. Carbon dioxide dissolves in the oceans, and as a result of the reactions, it first combines with carbonate and then with calcium, turns into calcium carbonate and takes part in the shell formation of sea creatures. With the death of these creatures, it accumulates at the bottom and is stored with the formation of limestone over time.

Nitrogen Cycle

Nitrogen, which is a very small amount in living things when compared to other elements in the structure of living things, is of vital importance. Nitrogen (found in the form of

N_2 in the atmosphere), which is the most abundant element in the atmosphere with a rate of 78%, is required for protein synthesis in the molecule that stores genetic information, and is taken as nitrogenous compounds from foods that cannot be used directly by most organisms. Plants cannot use nitrogen in the atmosphere directly and they need nitrogen-fixing bacteria (Smil, 1997). Nitrogen turns into many forms during the cycle.

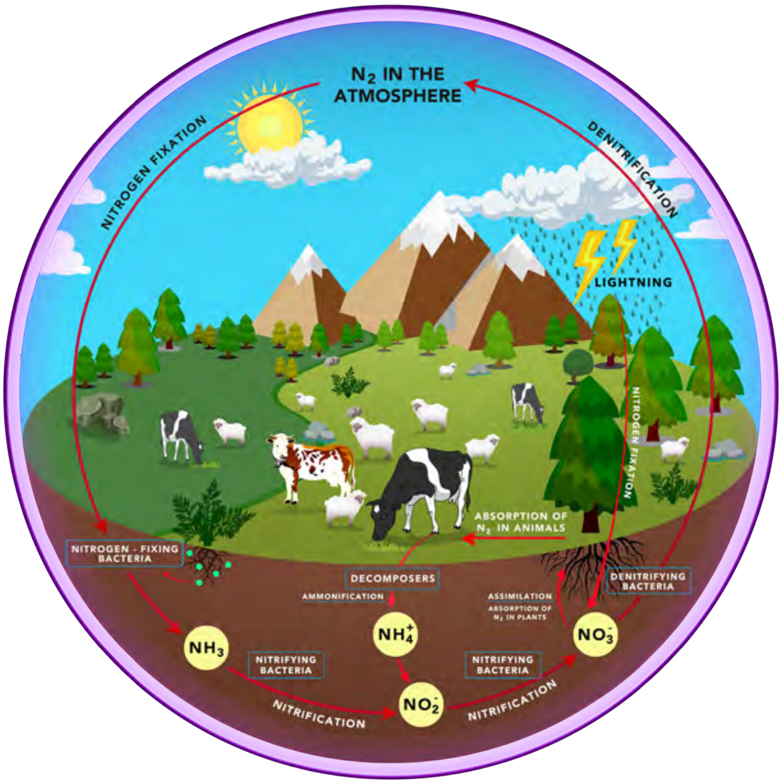


Figure 9. Nitrogen Cycle

N_2 in the atmosphere can react with O_2 in events such as thunderbolt and lightning and can pass into the soil as ammonia (NH_3), nitrate (NO_3^-), ammonium (NH_4^+), and this is called abiotic nitrogen fixation. The conversion of N_2 in the atmosphere to NH_3 by some bacteria is called biotic nitrogen fixation.

Rhizobium bacteria living in the roots of legumes convert the N_2 in the atmosphere to ammonia (NH_3) $\rightarrow$ nitrite (NO_2^-) $\rightarrow$ nitrate (NO_3^-). This phenomenon is called nitrification. The plant, which uses nitrate in amino acid and protein synthesis, incorporates nitrogen into its body. Nitrogen continues its movement between living things through the food chain.

The conversion of NO_3^- to N_2 and release to the atmosphere by denitrifying bacteria, which is the opposite of nitrification, is called denitrification.

The nitrogen, which returns to the soil with the residues and dead of plants and animals, turns into NH_3 by the saprophytes and the cycle continues.

Sulfur Cycle

Although sulfur is of great importance in life, it is the building block of amino acids such as cysteine and taurine (Brosnan & Brosnan, 2006). Sulfur is found in nature in different forms and during the sulfur cycle, there is a transition between the hydrosphere, lithosphere, atmosphere and biotic.

In its cycle on land, sulfur in the atmosphere in the form of sulfur dioxide (SO_2) turns into weak sulfuric acid (H_2SO_4) with rain (Kocataş, 2008). It can fall directly from the atmosphere with the name of sulfur spray, or it can mix with the soil from rocks containing sulfur. These sulfates (SO_4^{2-}) taken from the soil by plants reach living things through the food chain and are decomposed as a result of the death of the plants and released as hydrogen sulfide (H_2S).

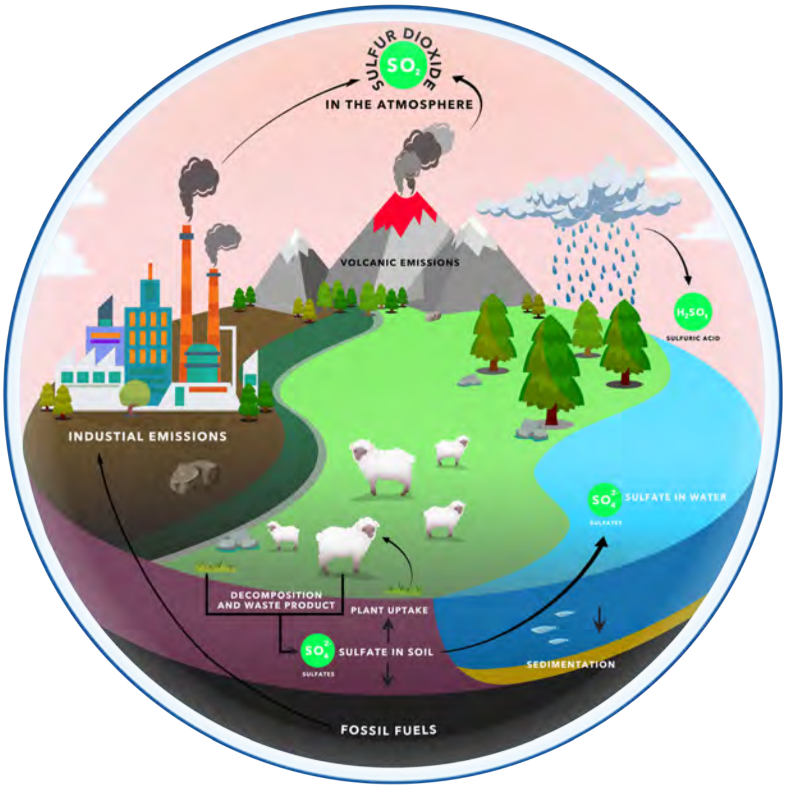


Figure 10. Sulfur Cycle

In the oceans, sulfur entering the environment from land, fallout and geothermal crevices is found in marine ecosystems in the form of SO_4^{2-}. Sulfur dioxide (SO_2), which increases with the use of fossil fuels, turns into weak sulfuric acid (H_2SO_4) and harms this ecosystem (Fisher, 2017).

Phosphorus Cycle

The phosphorus cycle is a cycle that moves from land to sea and from sea to land (Nebel & Wright, 1996). Phosphorus also differs due to its absence in the atmosphere. It is present as orthophosphate ions (HPO_4^{2-}) in the form of phosphoric acid salt during the cycle

(Beiras, 2018). Phosphorus has a tendency to form compounds that do not dissolve easily in water (Gupta, 2016). Phosphorus in phosphate rocks dissolves and is taken by plants as inorganic form orthophosphate (N_2PO_4) and converted to organic form. Phosphorus, which moves between the food chain and living things, is converted into inorganic form by decomposing wastes and dead (Kocataş, 2008). Phosphorus transforms into different forms in the hydrosphere and undergoes the stages of decomposition, precipitation and rock formation.

Figure 11. Phosphorus Cycle

Energy Flow: Food Chain, Food Web, and Food Pyramid

The ecosystem consists of organized producers, consumers and decomposers and abiotic factors affecting this organization. Abiotic factors include the flow of energy and the transformation of substances. Energy circulates between species and provides the energy flow in the ecosystem, which is associated with biodiversity. All the energy in the ecosystem comes from the sun. The first law of thermodynamics (conservation of energy in the ecosystem) and the second law (energy is lost as energy is transformed and lost as heat energy) form the basis of energy flow.

Energy transfers of living things take place in the form of feeding steps and each feeding step is called the trophic level. Living things settle in trophic levels in the ecosystem according to their energy production and consumption status (Cebrian, 2015). One of the important concepts in energy flow is biomass. It is all the unfossilized biological contents of living and recently lived organisms (Öztürk, 2013). During the energy flow, the energy transferred by biomass is lost at each step or level. While about 80-90% of it is given to the environment as heat, 10% of it can be transferred to the next step. Bioaccumulation is the accumulation process when the chemical uptake of the organism is greater than its excretion from the organism (Popek, 2018). Accordingly, the concentration of the energy flow in the food chain and the accumulation in the upper steps is called biomagnification. Bioaccumulation and biomagnification create negativities for ecosystem health.

In the first trophic level of the energy flow in the ecosystem, green plants, that is, producers, produce chemical energy by photosynthesis by using sunlight. While some of this energy is used in metabolic activities, some of it is lost with heat. This energy, which is transferred to the second trophic level with the living things that feed on plants, is transferred to the third trophic level by being used in metabolic activities and undergoing heat losses at this level. The same processes take place at this level as well.

At each trophic level, very little of the energy taken is converted into biomass. In this energy flow, 10% of the energy used in the metabolic activities of the living thing, excluding the energy lost as heat, is transferred to the living thing at the upper trophic level. This is called the 10-percent rule.

Figure 12. Food Chain

Figure 13. Food Web

Energy flow, which is the interdependence of species with energy and matter flow, can be shown in three different ways. The energy flow that continues in a straight line, which is formed by the use of another living thing as a nutrient, refers to the food chain. Since it does not consider other species in the environment (Fontefrancesco & Sidsaph, 2019), it offers limited energy flow information. The energy flow representation, which is a more complex structure consisting of food chains and presents the flow of nutrients between living things more realistically, is called the food web (Fontefrancesco & Sidsaph, 2019).

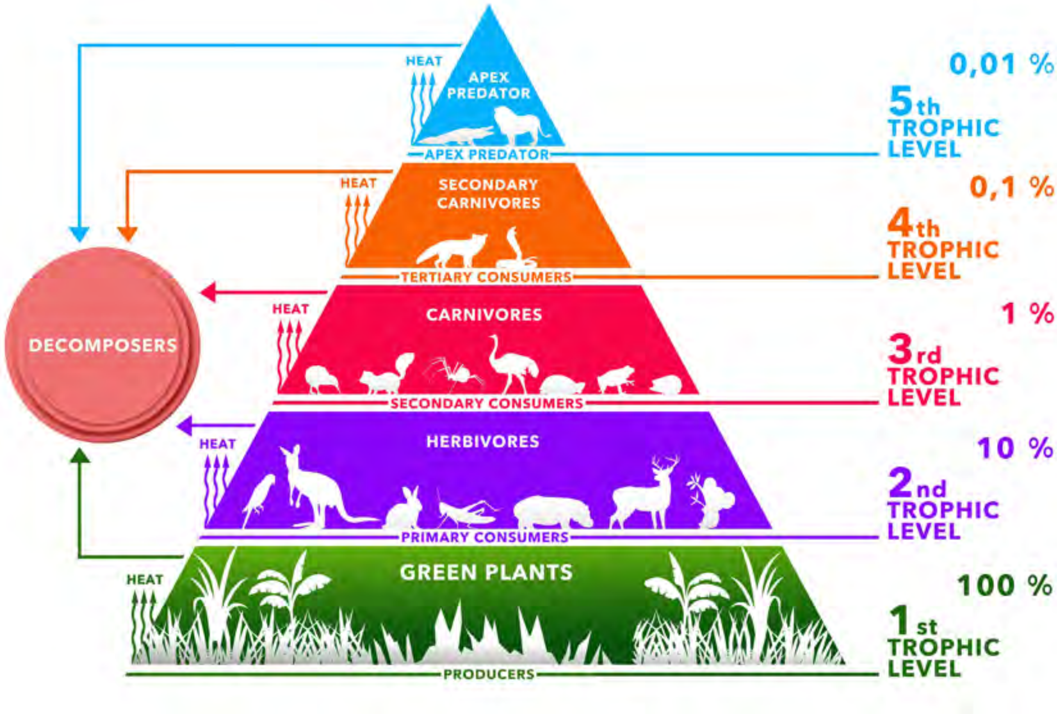


Figure 14. Food Pyramid

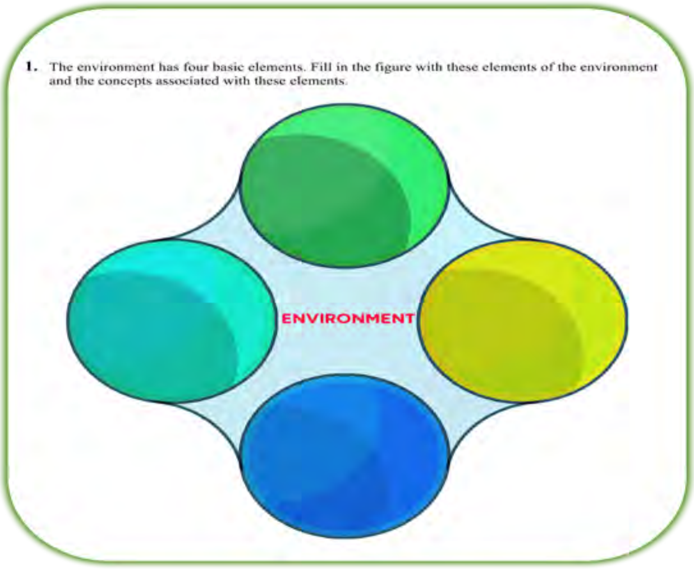
The system that the energy flow creates vertically with trophic levels is called the food pyramid.

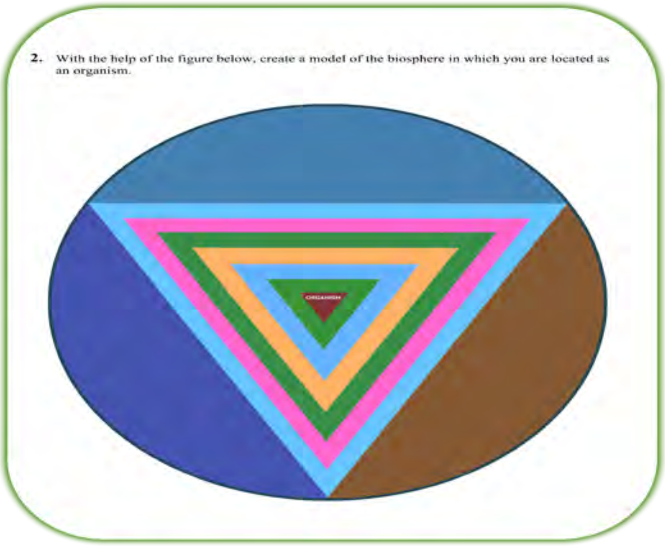
Conclusion

Environmental education is an indispensable education and its basic pillar is to know ecological knowledge. Individuals who know the basic information about the environment have feelings for the environment and take actions for the environment. Environmental knowledge is a prerequisite for concrete steps to be taken towards the environment and for the formation of environmental awareness. For example, there is a big difference from an environmental awareness perspective between an employee who is responsible for collecting garbage, separating waste suitable for recycling due to his job, and a student using waste recycling bins, considering the environmental benefits and knowing the effects on the environment, although the behaviors are the same. Environmental consciousness wants the actions and feelings towards the environment to be "conscious" and environmental information provides the knowledge required for this awareness.

Within the scope of environmental education, it is thought that basic ecological information at the point of developing environmental awareness will be a reference point in the journey of the individual to perform environmental-friendly behaviors. The borderless environment is fed by its own nature and is full of complex and comprehensive information and research. With new questions, directions, and advances in science, this body of knowledge is open to development.

Activities





References

Abreu, F. A. M., Duarte, A. M., Ribeiro, M. R., Lima, A. R. C., & Sousa, W. J. (2005). The hydrologic cycle: an open or a closed system?. *Revista Geográfica, 137*, 109-122.

Akın, M. & Akın, G. (2007). Suyun **ö**nemi, Türkiye'de su potansiyeli, su havzalari ve su kirliliği. *Ankara **Üniversitesi** Dil ve Tarih-Coğrafya Fakültesi Dergisi, 47*(2), 105–118.

Atasoy, E. (2015). *İnsan-doğa etkileşimi ve çevre eğitimi*. İstanbul: Sentez.

Bayramgürler, D. (2005). Güneş koruyucular ve güneşten korunma. *Türkiye Klinikleri Journal of Internal Medical Sciences, 1*(48), 180-184.

Beiras, R. (2018). *Marine pollution: Sources, fate and effects of pollutants in coastal ecosystems.* Amsterdam, The Netherlands: Elsevier.

Berryman, A. A. (2002). Population: A central concept for ecology?. *Oikos, 97*(3), 439-442.

Brosnan, J. T. & Brosnan M. E. (2006). The Sulfur-containing amino acids: An overview. *The Journal of Nutrition, 136*(6), 1636S–1640S.

Budyko, M. I. (1986). *The evolution of the biosphere.* Dordrecht: D. Reidel Publishing Company.

Cassardo, C. & Jones, J. A. A. (2011). Managing water in a changing world. *Water, 3,* 618-628.

Cebrian, J. (2015). Energy flows in ecosystems. *Science, 349*(6252), 1053-1054.

Colebrook, C. (2017). What is this thing called education?. *Qualitative Inquiry, 23*(9), 649-655.

Çayırlı, M., Tunca, M., & Açıkgöz, G. (2013). Güneşten korunma ve güneşten koruyucular. *TAF Preventive Medicine Bulletin, 12*(2), 193-198.

Demirsoy, A. (2018). Tür tanımında ve filogenetik soy ağacında bitmeyen tartışma. *Kafkas Üniversitesi Fen Bilimleri Enstitüsü Dergisi, 11*(2), 58-64.

Dhondt, A. A. (2012). *Interspecific competition in birds.* New York: Oxford University Press.

Dinç, M. & Aslan, O. (2009). Canlılar ve çevre. In M. Aydoğdu & K. Gezer (Eds.), *Çevre bilimi* (pp. 12-34). Ankara: Anı Yayıncılık.

Dodson, S. I. (1998). What is ecology? Looking at nature from different perspectives. In S.I. Dodson (Ed.), *Ecology* (pp. 1-24). New York: Oxford University Press.

Duan, J., Wang, Y., Fan, C., Xia, B., & de Groot, R. (2018). Perception of urban environmental risks and the effects of urban green infrastructures (UGIs) on human well-being in four public green spaces of Guangzhou, China. *Environmental Management, 62,* 500–517.

Egerton, F. N. (2013). History of ecological sciences, part 47: Ernst Haeckel's ecology. *The Bulletin of the Ecological Society of America, 94*(3), 222-244.

Erten, S. (2019). Çevre ve çevre bilinci. In C. Aydoğdu & S. Kıngır (Eds.), *Fen öğretimi* (pp. 305-343). Ankara: Nobel Yayıncılık.

Erten-Bilgiç, D. & Abdelhamid-Hosny, E. (2019). Din ve inançlarda suyun önemi̇ ve mimariye yansimasi El Hamra Sarayı örneği̇. *The Journal of Turk & Islam World Social Studies, 6*(20), 59-76.

Exley, C. (2003). A biogeochemical cycle for aluminum?. *Journal of Inorganic Biochemistry, 97*(1), 1-7.

Fisher, M. R. (2017). Environmental biology. Retrieved August 01, 2021, from https://openoregon.pressbooks.pub/envirobiology/

Fontefrancesco, M. F. & Sidsaph, H. (2019). Food web and food network: Role of food system ecological interconnectedness in achieving the zero hunger goal. In W. L. Filho, A. M. Azul, L. Brandli, P. G. Özuyar & T. Wall (Eds.) *Zero hunger.* Springer, Cham

Geray, C. (2002). *Halk eğitim.* Ankara: İmaj.

Gilad, O. (2008). Competition and competition Models. In S. E. Jørgensen & B. D. Fath (Eds.), *Encyclopedia of ecology* (pp. 707-712). Elsevier Science. Retrieved August 10, 2021, from https://www.sciencedirect.com/science/article/pii/B9780080454054006662

Gleick P.H., Cooley, H., Famiglietti, J.S., Lettenmaier, D.P., Oki, T., Vörösmarty, C.J., & Wood, E.F. (2013). Improving understanding of the global hydrologic cycle. In G. R. Asrar & J. W. Hurrell (Eds.), Climate science for serving society (pp. 151–184). Dordrecht: Springer.

Godfray, H. C. J. (2002). Challenges for taxonomy. *Nature, 417*, 17-19.

Gola, B. (2017). Is formal environmental education friendly to nature? Environmental ethics in science textbooks for primary school pupils in Poland. *Ethics and Education, 12*(3), 320-336. https://doi.org/10.1080/17449642.2017.1343619

Görmez, K. (2015). *Çevre sorunları.* Ankara: Nobel Akademik Yayıncılık.

Gupta, O. P. (2016). *Elements of environmental pollution control*. New Delhi: Khanna Book Publishing.

Houghton, R. A. (2003). The contemporary carbon cycle. In K. K. Turekian & H. D. Holland (Eds.), *Treatise on geochemistry* (pp. 473- 513). Dordrecht: Elsevier. doi:10.1016/B0-08-043751-6/08168-8

Huang, J., Liu, X., He, Y., Shen, S., Hou, Z., Li, S., Li, C., Yao, L., & Huang, J. (2021).

The oxygen cycle and a habitable Earth. *Science China Earth Sciences, 64*, 511–528. https://doi.org/10.1007/s11430-020-9747-1

İncedayı, D. (2002). *Çevre tümdür, çok boyutlu bir olguya bütüncü bakış*. İstanbul: Bağlam Yayıncılık.

Janda, T., Hideg, É., & Vanková, R. (2020). Editorial: The role of light in abiotic stress acclimation. *Frontier in Plant Science, 11*, 184. https://doi.org/10.3389/fpls.2020.00184

Kasting, J. F. & Canfield, D. E. (2012). The global oxygen cycle. In A. H. Knoll, D. E. Canfield, K. O. Konhauser (Eds.), *Fundamentals of geobiology* (pp. 93-104). Chichester, UK: John Wiley & Sons.

Kışlalıoğlu, M. & Berkes, F. (2014). *Çevre ve ekoloji.* İstanbul: Remzi Kitabevi.

Kocatas, A., (2008). *Ekoloji çevre biyolojisi.* İzmir: Ege Üniversitesi Basımevi.

Lewontin, R. & Levins, R. (1997). Organism and environment. *Capitalism Nature Socialism, 8*(2), 95-98. https://doi.org/10.1080/10455759709358737

Malkoç, S. (2018). Ekolojinin genel ilkeleri. In A. S. Koparan (Ed.), *Ekoloji ve çevre bilgisi* (pp. 2-35). Eskişehir: Anadolu Üniversitesi Açıköğretim Fakütesi Yayını.

Münch, M., Brøndsted, A. E., Brown, S. A. Gjedde, A., Kantermann, T., Martiny, K., Mersch, D., Skene, D. J., & Wirz-Justice, A. (2017). The effect of light on humans. In S. Sander & J. Oberst (Eds.), *Changing perspectives on daylight: Science, technology, and culture* (pp. 16-23). Science/AAAS Custom Publishing Office

Nebel, I.B. & Wright, R.T. (1996). *Environmental science.* New Jersey: Prentice Hall.

Nicol, G. W. & Prosser, J. I. (2016). *Ecology of archaea*. New York: Oxford University Press. doi: 10.1093/OBO/9780199830060-0160.

Norton, B., Balick, M., Hobday, R., Fournier, C., Scartezzini, J. L., Solt, J., & Braun, A. (2017). Daylight: contexts and concepts. In S. Sander & J. Oberst (Eds.), *Changing perspectives on daylight: Science, technology, and culture* (pp. 4-8). Science/AAAS Custom Publishing Office.

O'Neill, P. (1998). *Environmental chemistry*. London: Blackie Academic and Professional Publisher.

Öztürk, H. H. (2013). Yenilenebilir enerji kaynakları. İstanbul: Birsen Yayınevi.

Poonam, T., Tanushree, B., & Sukalyan, C. (2013). Water quality indices-important tools for water quality assessment: A review. *International Journal of Advances in Chemistry (IJAC), 1*(1), 15-28.

Popek, E. P. (2018). *Sampling and analysis of environmental chemical pollutants a complete guide* (2nd Ed.). Amsterdam, Netherlands: Elsevier.

Price, P.W. (2002). Species interactions and the evolution of biodiversity. In C.M. Herrera & O. Pellmyr (Eds.), *Plant–animal interactions: An evolutionary approach* (pp. 3-25). Blackwell: Oxford.

Roeber, V. M., Bajaj, I., Rohde, M., Schmülling, T., & Cortleven, A. (2020). Light acts as a stressor and influences abiotic and biotic stress responses in plants. *Plant, Cell & Environment, 44*(3), 645-664. https://doi.org/10.1111/pce.13948

Roossinck M. J. (2008). Symbiosis, mutualism and symbiogenesis. In Roossinck M. J. (Eds.), *Plant virus evolution* (pp 157-164). Berlin: Springer.

Rosalina, L. M., Verdade, L.M., & Lyra-Jorge, M. C. (2014). Adaptation and evolution in changing environments. In L.M. Verdade, M.C. Lyra-Jorge & C. I. Piña, (Eds.), *Applied ecology and human dimensions in biological conservation* (pp. 53-71). Heidelberg: Springer.

Tansley, A. G. (1935). The use and abuse of vegetational concepts and terms. *Ecology 16*(3), 284-307.

The European Environment Agency (2019). Soil. Retrieved August 01, 2021, from https://www.eea.europa.eu/themes/soil/intro

The Intergovernmental Panel on Climate Change [IPCC]. (2007). Climate change 2007 synthesis report. Retrieved August 11, 2021, from https://www.ipcc.ch/site/assets/uploads/2018/02/ar4_syr_full_report.pdf

Turgut, B., Öztaş, T., & Aksakal, E. L. (2010). Bazı toprak özelliklerinin penetrasyon direnç değerlerine doğrudan ve dolaylı etkileri. *Süleyman Demirel Üniversitesi Ziraat Fakültesi Dergisi, 5*(2), 45-53.

Schimel, D. S. (1995). Terrestrial ecosystems and the carbon cycle. *Global Change Biology, 1*(1), 77–91.

Schwarz, A. & Jax, K. (2011). Etymology and original sources of the term “Ecology”. In A. Schwarz & K. Jax (Eds.), *Ecology revisited.* Dordrecht: Springer.

Shobeiri, S. M., Omidvar, B., & Prahallada N. N. (2006). Influence of gender and type of school on environmental attitude of teachers in Iran and India. *International Journal of Envi-ronmental Science and Technology, 3*(4), 351-357.

Skalak, J., Nicolas, K. L., Vankova, R., & Hejatko, J. (2021). Signal integration in plant abiotic stress responses via multistep phosphorelay signaling. *Frontier in Plant Science, 12*, 1-19. doi: 10.3389/fpls.2021.644823

Smil, V. (1997). Global population and the nitrogen cycle. *Scientific American 277*(1), 76–81.

Srinivas, M.N., Reddy, K.S., Das, K., Sabarmathi, A., & Das, P. (2014). Stochastic effects on an ecosystem with predation, commensalism, mutualism and neutralism. *Journal of Advanced Research, 6*(3), 62-78.

Stevenson, C. (2019). Adressing the sustainable goals through environmental education. In L. Wilson, & C. Stevenson (Eds.), *Building sustainability through environmental education* (pp. 121-148). Hershey: IGI Global.

Suri, L. (2018). Planlamada doğal eşik değerlendirme kriterlerï. *Istanbul Commerce University Journal of Science, 17*(34), 47-67.

Swanson T.M. (1997). *Global action for biodiversity, An international framework for implementing the convention on biological diversity*. London: Earthscan.

Walczak, A. (2021). The Use of world water resources in the irrigation of field cultivations. *Journal of Ecological Engineering, 22*(4), 186–206. doi:10.3390/w3020618

Waples, R. S., & Gaggiotti, O. (2006). What is a population? An empirical evaluation of some genetic methods for identifying the number of gene pools and their degree of connectivity. *Molecular Ecology, 15*(6), 1419-1439. https://doi.org/10.1111/j.1365-294X.2006.02890.x

Whittaker, R. H. (1969). New concepts of kingdoms of organisms. *Science, 163*(3863), 150-160. DOI: 10.1126/science.163.3863.150

Woese, C., Kandler, O., & Wheelis, M. (1990). Towards a natural system of organisms: proposal for the domains archaea, bacteria, and eucarya. *Proceedings of the National Academy of Sciences of the United States of America, 87*(12), 4576–4579. https://doi.org/10.1073/pnas.87.12.4576

Verma, A. K. (2016). Evolution, merits and demerits of five kingdom system. *Flora and Fauna, 22*(1), 76-78.

Verma, S.B., Dobermann, A., Cassman, K.G., Walters, D.T., Knops, J.M., Arkebauer, T. J., Suyker, A.E., Burba, G.G., Amos, B., Yang, H.S., Ginting, D., Hubbard, K.G., Gitelson, A.A., & Walter-Shea, E.A. (2005). Annual carbon dioxide exchange in irrigated and rainfed maize-based agroecosystems. *Agricultural and Forest Meteorology, 131*(1-2), 77-96.

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Chapter 11

Environmental Understanding in Turkish-Islamic History

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Environmental Understanding in Turkish-Islamic History

Living and non-living beings that create the environment are in harmony naturally. Like every living creature, humans need nature and balance of nature in order to continue with their lives. The Industrial Revolution, which started in England in the second half of the 18th century, affected not only humanity but also the environment. While this great revolution accelerated scientific and technological developments that facilitated human life, it caused an increase in environmental issues. In addition to industrialization, people's unconscious use of natural resources in their daily lives also causes a global environmental destruction.

The "Environmental Movement", which was created to prevent environmental issues, showed its first effects in Western Europe and America in the 1800s, and has left an impact in the second half of the 20th century (Duru, 1995). However, centuries before the environmental movement was formed, the understanding of protecting the environment and living in harmony with nature was adopted in the old Turkish communities and states. Moreover, the balance of nature and the importance given to the environment were frequently mentioned in the holy books. The importance given to the environment in the verses of the Qur'an, which is the holy book of Islam religion, and in the life of the prophet Muhammad specially attract the attention.

In this section, subjects such as the environment according to the Islamic belief, the importance given to the environment, the interaction of human and environment, the balance of nature, animal rights will be examined in the light of verses of the Qur'an and hadiths. Then, the understanding of environment in Turkish-Islamic history will be explained by giving examples from Turkish states. It is suggested that mentioned environmental understanding can guide people towards preventing environmental problems and for a sustainable environment.

Environment in Islam

As social being, humans are affected by the conditions and culture of the period they live in. Moreover, they create a consciousness mechanism belongs the period they live. Therefore, humans evaluate the lives of humans and other living being in the world, and the events and issues that occur in the world, with this consciousness mechanism.

When we look at environmental issues, it is seen that environmental issues such as air, water, soil, noise pollution, global warming and climate change, which have reached a very important level today, did not exist in past centuries. Until this era, which is called Modern Age, humans have lived in constant exchange with the environment since their first days on earth (Özdemir & Yükselmiş, 1997).

Increasing human population, their growing and diversifying needs and accordingly the production of advanced technologies, consumption and destruction of limited natural resources, and construction of settlements in agricultural lands can be cited as the reasons why environmental problems have increased so much in the 21st century compared to the past (Türküm, 1998). To prevent environmental issues, global agreements, government policies and scientific studies are carried out. However, in order for these large-scale measures to be effective and permanent, "human behaviour" must be taken to centre.

The human beings were created with a willpower. They decide on the basis of the guide they have adopted and act according to it. There is a significant effect of religious belief on human actions (Cebeci, 2008). According to the Islamic belief, holy book Qur'an, was sent down as a guide to people, and the prophet Muhammad was assigned to warn, guide and herald with good news under the guidance of the Qur'an. This situation is described in the following verses in the Qur'an:

> "…Say: "It is a guide / And a healing to those / Who believe; and for those / Who believe not, there is / A deafness in their ears,/ And it is blindness in their (eyes): / They are (as it were) / Being called from a place / Far distant!" (The Holy Qur'an, Surah Fussilat/41: 44).

> "A similar (favour / Have ye already received) / In that We have sent / Among you a Messenger / Of your own, rehearsing to you / Our Signs, and purifying / You, and instruction you / In Scripture and Wisdom, / And in new Knowledge." (The Holy Qur'an, Surah Al-Baqarah/2: 151).

In order to prevent environmental issues and for a sustainable environment, it is very important to determine the environmental understanding of the Islamic belief, which has a tremendous impact on human behaviour, in the light of the Qur'an and hadiths.

In this chapter, the phenomenon of environment in Islam, the verses of the Qur'an sent down as a guide to people and the importance of the environment within the framework of the life of the prophet Muhammad, are examined under the subjects of human and environment, balance in nature, animal rights.

Importance of Environment

In order to prevent environmental pollution, which is one of the biggest problems of our age, it would be correct to examine the conceptual content of it. Environmental pollution can occur as air, water, soil, noise and visual pollution. (Atabek Yiğit, 2009). This situation causes the extinction of vegetation and animal species (Çelikkıran, 1997). In other words, caring and protecting air, water, soil and living things is the basic principle in preventing environmental pollution. In order for the plants and especially the trees that make up the forests to grow in a healthy way, the soil must not be polluted and it must be well taken care of. Also, water is as important as soil for living beings. Moreover, forests that grow with clean soil and clean water ensure that the air is clean (Durkaya & Durkaya, 2016). As can be seen from here, there is a strong bond between soil, water and air. Pollution in one affects all others. In short, the environment is the habitat in which living and non-living being coexist in balance. Therefore, both biotic and abiotic factors are negatively affected by the pollution. The natural balance is disrupted, and environmental issues begin to occur.

In order to find an answer to the question of what is in the essence of living beings according to Islam, it would be correct to look at what object or matter Allah created living things from. According to the Qur'an, jinn were created from fire, humans from earth, and living things in general from water (Yeniçeri, 2009). Knowing that human, whom Allah has declared to be the highest among His creations, is essentially soil, shows how important soil is in Islam. In addition, with the hadith of Prophet Muhammed "When any of you treads with his shoes upon something unclean, they will be purified with the earth." (Sunan Abi Dawud, Kitab Al-Taharad, 1, 386), it is emphasized that the soil is not a dirt, but a cleansing matter. The soil, which is considered very valuable in Islam, is unfortunately exposed to soil erosion by wrong agricultural practices done by humans and heavy rains. One of the most effective solutions to prevent this problem is to plant trees (Morgan, 2009).

Although there is no command to "plant a tree" in the Qur'an, it is seen that there are trees and other plants in many sections. The word "secer", which is the equivalent of the word tree, is mentioned in 26 places in the Qur'an. The word heaven, which is the equivalent of the vineyard and garden formed by the coming together of trees, is seen 70 times in the singular and 76 times in the plural. In addition, the words date, date palm, grape, olive, pomegranate, fig are also mentioned in many verses. In the surah At-Tin, by saying "By figs and olives..." an oath made to these two trees (Canan, 1986). The fact that trees and plants are mentioned many times in the Qur'an, the paradise promised to people is depicted with trees, and Allah's oath to figs and olives shows the importance Islam gives to trees and plants. In addition, the importance Prophet Muhammad gave to plants and trees in hadith sources is seen in the following hadiths:

> "If the Final Hour comes while you have a shoot of a plant in your hands and it is possible to plant it before the Hour comes, you should plant it," (Al-Adab Al-

Mufrad, 27, 479).

"There is none amongst the Muslims who plants a tree or sows seeds, and then a bird, or a person or an animal eats from it, but is regarded as a charitable gift for him." (Sahih al-Bukhari, 42, 1).

"'Eat (olive) oil, and anoint with it, for it is from a blessed tree!" (Ash-Shama'il Al-Muhammadiyah, 25, 7).

When the hadiths above are examined, it is reported that the Prophet Muhammad encouraged people to plant trees and that planting trees is charity defined as material and moral aid given to gain Allah's approval (Emsal & Şentürk, 2021: 85). Again, the Prophet Muhammad stated that it is wrong to damage trees and that those who intentionally harm trees will be cursed and punished with the following hadith:

"If anyone cuts the lote-tree, Allah brings him headlong into Hell." (Sunan Abi Dawud, Kitab Al-Adab, 43, 467).

When the verses and hadiths in the Qur'an are examined, it can be said that the Islamic faith gives importance to plants, encourages people to plant plants and trees, and there are deterrent provisions against harming plants. In the Qur'an, it is explained that the environment is important for both humans and animals, and that countless blessings created are put at the service of man. The most remarkable and important of these blessings is water, which is the main source for the continuation of life (Chaplin, 2001). The importance of water, which is essential for the life of living things and the environment, is seen in some verses of the Qur'an:

"Do not the Unbelievers see / That the heavens and the earth / Were joined together (as one / Unit of Creation), before / We clove them asunder? / We made from water / Every living thing. Will they / Not then believe?" (The Holy Qur'an, Surah Al-Anbiya/21: 30).

"And We send down water / From the sky according to / (Due) measure, and We cause is / To soak in the soil: / And We certainly are able / To drain it off (with ease). With it We grow for you / Gardens of date palms / And vines; in them have ye / Abundant fruits: and of them / Ye eat (and have enjoyment)-" (The Holy Qur'an, Surah Al-Mu'minun/23: 18-19).

"It is He Who sendeth down / Rain from the skies: / With it We produce / Vegetation of all kinds: / From some We produce / Green (crops), out of which / We produce grain, /Heaped up (at harvest); / Out of the date palm / And its sheaths (or spathes) / (Come) clusters of dates / Hanging lowand near: / And (then there are) gardens / Of grapes, and olives, / And pomegranates, / Each similar (in kind) / Yet diferent (in variety): / When they begin to bear fruit, / And the ripeness thereof. / Behold! In these things / There are Gigns for people / Who believe." (The Holy Qur'an, Surah Al-An'am/6: 99).

As stated in the verses, plants, greenery and trees grow from the soil with water. In other words, water is a very important resource for living things. However, water should be used with caution, like any other resource. The Prophet Muhammad's action to someone who uses a lot of water while performing ablution and saying don't waste it (Özdemir & Yükselmiş, 1997) shows his attitude towards preventing water waste (Koop & Leeuwen, 2017), which is one of the important problems of our age.

Clean air as well as soil and water affect the growth of plants. With the change in the ratio of the gases in the air, the air becomes polluted and as a result, acid rains occur. When acid rains reach the soil, the pH level drops and the toxic effect can be seen on the plants grown in the soil with the enrichment of Al^{3+} and Mn^{2+} cations (Tolunay, 1992). In general, one of the most important sources for cleaning the air polluted due to human behaviour is forests (Durkaya & Durkaya, 2016). The importance of plants and trees in the Islamic faith was mentioned with the verses of the Qur'an and examples of hadiths. In addition, it is seen in the following verses in the Qur'an that one of the elements that ensure a healthy life is the wind:

"Among His Signs is this, / That He sends the Winds, / As heralds of Glad Tidings, / Giving you a taste / Of His (Grace and) Mercy- / That the ships may sail / (Majestically) by His Command / And that ye may seek / Of His Bounty: in order / That ye may be grateful." (The Holy Qur'an, Surah Al-Rum/30: 46).

"And He it is Who sends / The Winds as heralds / Of glad tidings, going before / His Mercy, and We send down / Pure water from the sky- That with it, We may give / Life to a dead land, / And slake the thirst / Of things We have created- / Cattle and men in great numbers." (The Holy Qur'an, Surah Al-Furqân/25: 48-49).

Winds have negative effects as well as positive effects on our lives. Severe hurricanes and tornadoes can cause great destruction in the region. In addition, it is a well-known fact that toxic gases causing air pollution damage human health. The following verses describe how people are punished with polluted air and storms in the Qur'an:

"For We sent against them / A furious wind, on a Day / Of violent Disaster" (The Holy Qur'an, Surah Al-Qamar/54: 19).

"And the 'Ad- / They were destroyed / Bya terrible Storm / Of thunder and lightning!" (The Holy Qur'an, Surah Al-Hâqqah/69: 6).

"Then watch thou / For the Day / That the sky will / Bring forth a kind / Of smoke (or mist) / Plainly visible, Enveloping the people: / This will be a Penalty / Grievous." (The Holy Qur'an, Surah Al-Dukhân/44: 10-11).

"On you will be sent / (O ye evil ones twain!) / A flame of fire (to burn) / And a smoke (to choke): / No defence will ye have" (The Holy Qur'an, Surah Al-Rahmân/55: 35).

In the 21st century, it is predicted that there will be an increase in the number of hurricanes due to climate change which is the result of air pollution and global warming (Alper & Anbar, 2007). The verses that explain that Allah punished people with smoke and hurricanes in the past are warnings about future disasters if air pollution and global warming are not prevented.

Human and Environment

When the Qur'an is looked at as a whole, it can be said that human beings appear in a central position among all living and non-living beings. The fact that Allah has put all the blessings He has created into the service of humans also supports the idea. This situation is revealed in the following verses in the Qur'an:

"It is He Who hath created for you / All things that are on earth: / Then He turned to the heaven / And made them into seven firmaments. / And of all things / He hath perfect knowledge." (The Holy Qur'an, Surah Al-Baqarah/2: 29).

"It is Allah Who hath created / The heavens and the earth / And sendeth down rain / From the skies, and with it / Bringeth out fruits wherewith / To feedyou: it is He / Who hath made the ships of service / To you, that they may sail / Through the sea by His Command; / And the rivers (also)hath He / Made of service to you. And He hath made of service/ To you the sun and the moon. / Both diligently pursuing/ Their courses: and the Night / And the Day hath He (also) / Made of service to you." (The Holy Qur'an, Surah Ibrâhîm/14: 32-33).

As it is understood from the verses, the earth, the sky, the sun, the moon, the seas, night and day, the crops grown on the earth, olives, dates, grapes and all kinds of plants were created for humans. However, people can only benefit from these blessings by protecting the environment (Akgündüz, 2009). The fact that Allah has put all the blessings He has created into the service of man does not mean that man can exhibit unconscious and arbitrary behaviour towards the environment. People, who must live in harmony with other living things in nature, are responsible for the environment they live and benefit from. The connection between human and nature, and between natural sciences and religion is clearly seen in the Qur'an (Nasr, 1988/2019).

Balance of Nature

There is a balance between living and non-living beings in nature. It is explained in the following verses that Allah created the entire universe and the planet we live on in a balance:

> "Verily, all things / Have We created / In proportion and measure." (The Holy Qur'an, Surah Al-Qamar/54: 49)

> "And the earth We have spread out / (Like a carpet); set thereon / Mountains firm and immovable; / And produced therein all kinds / Of things in due balance." (The Holy Qur'an, Surah Al-Hijr/15: 19)

According to the Islamic belief, Almighty Allah has created everything in itself flawlessly. There is a magnificent order and balance in the universe. Humans should live in harmony and protect the ecological balance in the environment they live in. In addition, attitudes and behaviours that will disrupt this balance should be avoided (Akgündüz, 2009).

Unlike the creatures that live in harmony with each other in their natural environment, humans can engage in behaviours that disrupt this balance. Waste of water and food, unconscious tree cutting as well as agricultural practices and animal hunting activities are the most striking of these behaviours. A person who wastes the blessings bestowed on her or him and uses it unconsciously is warned in the Qur'an as follow:

> "(Saying) 'Eat of the good' / Things We have provided / For your sustenance, but / Commit no excess therein, / Lest My Wrath should justly / Descend on you: and those / On whom descends My Wrath / Do perish indeed!" (The Holy Qur'an, Surah Tâ hâ/20: 81).

> "O Children of Adam! / Wear your beautiful apparel / At every time and place / Of prayer: eat and drink: / But waste not by excess, / For Allah loveth not the wasters." (The Holy Qur'an, Surah Al-A'râf/7: 31).

Animal Rights

The individual should not destroy the environment in line with their own interests and should think that the actions they take will affect the lives of other living beings around them. Not only humans but also animals need environmental resources such as water, plants, fruits on trees, and clean air in the world. In the Qur'an, Allah reveals that animals also benefit from these resources found in nature:

> "And do they not see / That We do drive Rain / To parched soil (bare / Of herbage), and produce therewith / Crops, providing food / For their cattle and themselves? /

Have they not the vision?" (The Holy Qur'an, Surah Al-Sajdah/32: 27).

"It is HeWho sends down / Rain from the sky. / From it ye drink, / And out of it (grows) / The vegetation on which / Ye feed your cattle. With it He produces / For you corn, olives, / Date palms, grapes, / And every kind of fruit: / Verily in this is a Sign / For those who give thought." (The Holy Qur'an, Surah Al-Nahl/16: 10-11).

When we look at the environmental understanding in Islam in general, it is possible to see that there is a balance in nature, but since humans disrupt this balance with their behaviours, they are warned against it. The fact that there are so many blessings offered to the service of humans does not mean that they can consume natural resources as they wish. On the contrary, it imposes responsibility to them on the topic. Thus, it is seen that the right to life of animals and other living beings is also protected. The understanding that people who harm the environment and natural resources they live in will be punished encourages people with Islamic belief to protect nature. As a result, it can be said that the belief in Islam has a positive effect on people's understanding of the environment.

Environmental Awareness in Turkish-Islamic States

It is very important to examine the relationship of the Turkish states, which rule in different geographies around the world, with the environment they live in. The Turks, who ruled in different regions as many empires, states, khanates and beyliks from the 8th century BC to the present, adopted different lifestyles in different periods of history (Çeçen, 2021). Before the settled life, Turks were nomadic and mostly engaged in animal husbandry (Balaban, 2006). After adopting settled life, they have started doing agricultural practices and building permanent shelters. In addition to the geography they live in, the belief systems of the Turks have also affected their lifestyles and especially their understanding of the environment.

In this section, the Turkish states established before and after accepting Islam are briefly mentioned, and then the environmental understanding in Turkish history is explained under sub-titles.

Turkish States Before Islam

In the pre-Islamic periods, when the Shamanism belief was practised more intensely, Turks saw nature as the essence of life rather than benefiting humanity. While believing in shamanism, the sky, mountains, hills, rivers, trees and land are considered sacred (Özdemir, 2003), and in this way, Turks were firmly attached to their homeland and the environment they lived in (Yörükhan, 2016). In addition, shamans performed various religious practices to make these saints happy (Radloff, 2009). All these show that the

Turks do not pollute the natural resources that they consider sacred in the belief of Shamanism and that they are very careful about using these resources.

Figure 1. A Shaman and her Drum

Before Islam, Tengri (Sky) and the land called Yer-Sub (Earth-Water) were worshipped majorly in the old Turkish belief. However, the real power in this holy couple was the Sky. Khans were given names such as “Sky-like” or “Born in Sky” and according to their beliefs, these khans were in power at the wish of Heaven (Klyashtorny & Sultanov, 2013).

Today, there are Duhka Turks (Dukhas) living within the borders of Mongolia. Dukha Turks, who have Tengrism belief, believe that lakes and mountains have souls. That’s why they won’t wash their dirty things in lakes. They will do the washing outside the lake with the water taken from lake. However, lately, there are those who believe that these spirits are angry because of some people’s polluting lakes and mountains, unnecessary hunting and plant-gathering behaviour. According to their belief, nature gives people plants and animals as a gift to share with others. However, people believe that nature spirits will be angry if they use them as if they belong only to themselves (Küçüküstel, 2012). As horses and donkeys cannot adapt to cold climatic conditions, Dukha Turks generally use deer as mounts. They also use the meat, milk and offal of deer. At the same time, Dukha Turks, who make clothes from deer skin; and knives, necklaces and bracelets from antlers, can earn money by selling these to tourists. Milk milked from deer is placed in a closed container and fixed in cold flowing rivers. Thus, milk can be stored for a long time without spoiling. Thereby, Duhka Turks avoid waste by making use of every part of the animal that is most suitable for the geography and climate they live in, and by using appropriate techniques (Rotasız Seyyah, 2021).

It is possible to collect the beliefs of Steppe Turks under three headings. These are belief in the forces of nature, the cult of ancestors and the religion of Sky-God (Kafesoğlu, 2016). The Turks, who believed in the existence of some secret forces in nature, viewed the sky, mountain, stone and tree as the manifestation of the Creator and regarded them as sacred (Tazebay & Akpınar, 2010). They were also considered spirits.

The cult of ancestors was considered as a belief of respect for deceased elders and ancestors. Asian Huns, Tuobas and Göktürks offered sacrifices to their ancestors in front of the sacred caves and severely punished the attacks made to the Turkish tombs. While some nations with ancestor cults sometimes see powerful people as demigods and sacrifice human beings for them and other gods, this is not the case for Turks. In the Sky-God religion, which is accepted as the original religion of the steppe Turkish community, Tengri (God) was the Creator, who was seen as the highest being, and was considered almighty. It was also believed that Tengri punished immoral behaviour with drought (Schmidt, 1964). Apart from these belief systems, some Turkish communities affected by different cultures in different geographies have been influenced by different religions such as Shamanism, Judaism, Christianity, Buddhism, Manichaeism. However, since the religion of Islam is compatible with the ancient beliefs of the Turks in many respects, it is a widespread religion among Turks and at the same time reinforcing Turkishness (Kafesoğlu, 2016).

The term Tengri (God), which can be considered at the centre of the belief system of the ancient Turks, first appeared in the Huns (200 BC), continued its existence in all Turkish dialects and preserved its place in the religions accepted by the Turks (Roux, 2021). The Huns had a nomadic lifestyle. Animal products were plentiful, but they were in dire need of land crops as they were engaged in animal husbandry. They met these needs with trade or what they had obtained from their raids. However, the successes of the Huns in the wars improved the nomadic animal husbandry and led to the reduction of internal conflicts for the unification of the tribes (Gumilev, 2013). The main food item of the steppe Turks was meat. Turks, who produce plenty of meat, learned how to canned meat in order not to spoil it and to preserve it for a long time (Kafesoğlu, 2016).

Nomadic livestock was generally practised in the Oghuz tribes. However, there were also groups engaged in farming and fishing in settled and semi-settled tribes (Agacanov, 2015). Turks were quite competent in animal husbandry and after adopting settled life they started to do to agricultural activities. As in animal husbandry, they improved in agriculture and used the most appropriate methods and techniques of the period. So much so that many irrigation channels were opened for agricultural purposes during the Göktürks period. One of them, Tötö Canal, whose length is close to 10 kilometres, was built with such high technical knowledge that the Russians decided to use this canal exactly in 1935 (Ögel, 1945).

When we look at the Turkish states before they accepted Islam in general, it is possible to say that people's religious beliefs led them to protect nature and not to harm living things and animals. Considering the elements in nature sacred, preventing the waste of meat by canning technique and preserving deer milk in cold river water, creating irrigation channels with the right techniques, using deer which is resistant to cold climate conditions as mounts and benefiting from their meat, milk, leather, offal and horns show that even before accepting Islam, the Turks led a life in harmony with the environment they lived in and used natural resources efficiently.

Turkish States After the Acceptance of Islam

The acceptance of Islam by the Turks took place in the 7th and 8th centuries. Itil Bulgars (7th-10th century) and Karakhanids (840-1212) are known as the first Turkish states to accept Islam. In addition, the first state founded by Muslim Turks was Tulunids (868-905) (Alican, 2018). Among the Oghuz, Çanak Khan, who became the head of the tribe after Salur Khan, the ancestor of the tribe, accepted Islam. Other Turkish tribes, clans and families nearby also accepted Islam and they were called Türk-i Îmân (Believed Türk). This expression took the form of Türküman and Türkmen over time. Today, Oghuz Turks who accept Islam are called Türkmen (Maksudoğlu, 2018). Since then, different Turkish states have been founded and generally adhered to the Islamic faith. The foundation of the Seljuk Empire, which has an important place in Muslim Turkish history, was laid in 1020 and was officially established after the victory against the Ghaznavids in the Battle of Dandanaqan (Yenigün, 2020). The Ottoman Empire, which was founded in 1289 by tribal leader Osman, is another Muslim Turkish state that ruled until 1922 (Maksudoğlu, 2018). The Republic was proclaimed by Mustafa Kemal Atatürk in 1923 and the Republic of Turkey has existed since then. Today, there are Turks in other Turkish states outside the Republic of Turkey who practices different religions such as Shamanism, Buddhism, Tengrism, Burkhanism, Christianity in addition to the belief in Islam ("List of Turkic dynasties and countries," 2021).

Respect and Love for Animals

Wolf and Eagle had an important place in Old Turkish Mythology. According to the old belief, it was believed that the "Sky Wolf" lived with the Turkish ancestors and led them. (Candan, 2013). The wolf was considered a sacred animal, a symbol of freedom and independence (Aydoğan, 2019). The eagle had an important role in the shamanistic rites performed in Yakut, Altai, Kazakh-Kyrgyz and Bashkirs. According to the Yakuts, the greatest oath was the oath taken with the name of the eagle. If a person saw an eagle near their house, they would owe it to themselves to offer it a meat feast (Radloff, 2009). While wolves and eagles are seen as sacred animals, horses also have a special place in Turkish states. The Turks living in the steppe culture are the first nation in the world to domesticate horse. (Kafesoğlu, 2016).

While it is seen that some animals were considered sacred and the horse was domesticated in the pre-Islamic period, the feeling of compassion towards animals came to the fore after the adoption of Islam. It is seen that stray animals and horses are shown mercy during the Ottoman Empire period. Du Loir, who came to Turkey in the 17th century, describes in his travel book Les voyages du sieur Du Loir (sieur Du Loir'in Seyahatleri) that there are buildings dedicated to cats in Turkey, foundations are allocated for their food, stewards and butlers are attained to their care. He also states that the Turks do not put too much weight on their horses and that they punish the people who does by making them carry those loads on their backs (Danishmend, 1982). In addition, it was forbidden to put too much weight on the horses, as well as to carry them without shoes and to leave them neglected (Altınay, 1987).

Importance of Forest and Trees

While Turks believed in shamanism, trees and forests were considered sacred by them. It was believed that trees had spirits and these creatures, which they considered sacred, were not harmed unnecessarily (Özdemir, 2003). Steppe Turks, on the other hand, accepted the tree as the manifestation of the Creator and would not harm it (Tazebay & Akpınar, 2010). Likewise, they believed that every tree had a spirit. Nature spirits were called "Yer-Su (Earth-Water)" in the time of the Göktürks. The same term was used as "Yer-Suv" in Uyghurs. Like trees, forests had a very important place in Turkish culture. Otuken forests were considered sacred in the time of the Göktürks and Uyghurs. In the Qara Qoyunlu Alevi Turkmens, there was a sacred forest around one of the villages. They called this forest "Karaoğlan" and it was forbidden to touch these trees. Qara Qoyunlu women used to tie flowers to these trees when spring came and bury the bones of sacrificed animals in this forest (Radloff, 2009).

In the old Turkish belief, a great tree was a symbol of eternity and power due to its roots going deep into the ground and branches reaching to the sky. In that period, when they pass by an old and great tree, they would pay respect by tying their hands together and kneeling down (Aydoğan, 2019).

After the adoption of Islam, the importance given to trees and forests continued. Special measures were taken to protect trees and forests in the Ottoman Empire. Those who cut trees, graze animals and hunt without permission were fined. In 1559, a decision was taken to prohibit cutting trees from the Eşme, Dikme and Sapanca mountains (Çolak, 2019).

The founder of the Republic of Turkey, the Great Leader Mustafa Kemal Atatürk, did not allow the willow trees in the construction site to be cut down, and had these trees moved to a different place. Atatürk, in the Opening Speeches of the Turkish Grand National Assembly on March 1, 1922, "It is one of our important rules to improve, expand and provide the highest benefit to our forests with modern measures, since they are of certain importance in terms of both agriculture and the existence and general health of the country," used the expression (TBMM, 1922). This thought of Atatürk can be accepted as an indication of his far sightedness on sustainable agricultural practices and afforestation, which have an important place today.

Atatürk went to Yalova in 1929 and asked for a mansion to be built near the plane tree in which he rested in its shadow. After the mansion was built, those who worked there told Atatürk, who went back to Yalova in 1930, that the elongated branches of the plane tree damaged the roof and walls of the mansion. When they said that these branches should be cut, Atatürk did not allow. He wanted the mansion to be moved a little further with tram tracks. Thereupon, the tram rails brought from Istanbul were placed on the floor of the mansion as a result of long efforts, and the building was moved about five meters further. After this event, which was one of the greatest examples of Atatürk's love of trees, the name of the mansion began to be known as "Walking Mansion". The mansion is currently exhibited as a history museum ("Yürüyen Köşk," 2021).

Environmental Cleaning and Environmental Regulations

The importance given to the environment in the Seljuk State is striking. In this period, more environmentalist practices were carried out with the foundations established. Some of the environmentally friendly practices made during the Seljuk State are as follows (Yenigün, 2020):

- Limited resources have been used correctly, thanks to the large number of foundations created.
- In addition to being treated in hospitals, the students who grew up in the district were trained on environmental cleaning and precautions against epidemics that may occur after drought.
- Birdfeed was left where the birds could reach so that they would not starve in case of heavy rainfall.
- Drinking and utility water is provided in accordance with the needs of people. For this purpose, aqueducts, water reservoirs, cisterns, wells, pools, waterways and fountains were built. In addition, snow chutes have been made, which allowed the falling snow of winter to be compressed and used as ice in the summer heat.
- With the sewage system formed from soil pipes, permanent solutions that prevent environmental pollution are presented.

7th sultan of the Ottoman Empire, II. Mehmet (Mehmed the Conqueror) Han (Figure 2), also known as Fâtih, ruled first between 1444-1446 and then between 1451-1481. At the age of 21, he conquered Istanbul and ended the Eastern Roman Empire. Fâtih, one of the most important sultans of the Ottoman Empire, was cultured, educated and had a broad vision. He wanted the environment to be neat and clean in the lands he ruled. So much so that after the conquest of Istanbul, he wrote an edict to prevent the Golden Horn from being polluted and filled with soil and ensured that necessary measures were taken in this regard (Akgündüz, 2009). In a will that is said to belong to him, He wants the street-side officials to punish these offenders and the street to be disinfected with lime in order to prevent the environmental damage caused by those who spit on the streets (Şeker, 1992).

Figure 2. Sultan Mehmed II, 1480; Oil on Canvas; National Gallery, London.

Another important sultan of the Ottoman Empire, Süleyman I (Suleiman the Magnificent) Han (Figure 3) prepared the Nizamnâme (Regulations), which can be considered the world's first environmental law. The Nizamnâme, which was given to Edirne garbage Soubashi in 1539, continue to be relevant in today's world.

Figure 3. Portrait of Suleiman I by Titian c. 1530.

In the Nizamnâme, there are environmental regulations such as cleaning houses and shops, cleaning dirty places, cleaning the baths, not spilling bleach containing detergents on the road, removing animal carcasses from the places where people live, closing open graves, putting cars in private parking spaces. Based on this Nizamnâme, it is possible to show the principles of the Ottoman Empire on environmental cleaning and regulation in items (Akgündüz, 2009):

- Every individual or institution is primarily responsible for the environmental cleanliness of the area they are in. The control of these is provided by the Soubashi.
- Who threw out the garbage in the neighborhoods, streets and bazaars will be determined by the Soubashi and this garbage will be cleaned by those who caused it.
- Wastewater of businesses that discharge wastewater into the environment is controlled, and these roads are arranged in a way that does not prevent people from passing through.
- Who throws the garbage on the ground is investigated, first of all, those closest to this garbage is held responsible. Even if it is understood that these people did not do it, they are asked to help find the person who is responsible,
- It is ordered that waste liquids such as bleach, blood, paint and other garbage should never be thrown into places where people walk and should be taken to desolate and secluded places away from people in a way that will not disturb anyone.
- Particular attention is paid to the cleanliness of places that produce and sell food products.
- It is requested that the animals should not be fed in public places unless it is necessary, and that the feed residues and animal excrement should be cleaned by the owners when they need to be fed.
- It is ordered that the coachmen tie up their oxen in places that will not disturb people, and that the garbage and excrement formed in the places where these animals are tied are cleaned by the animal owners.
- It is ordered to keep the cemeteries clean and not to throw garbage and animal carcasses in this area.
- Those who pollute the environment with the rubbish and dead animals they leave and resist to cleaning them are informed that they will be disgraced in the city with those animal heads.

The punishment of displaying the dead animal can be seen as a severe punishment in today's conditions, which damages human dignity. However, the aim here is not to damage human dignity, but to prevent crime and ensure that honourable people stay away from these behaviours. Because fines do not have the same deterrence for all people (Akgündüz, 2009).

Considering the decisions taken in this Regulation, it is seen that an excellent auto control system was established in the Ottoman Empire for environmental cleaning. Considering the damage caused by liquid wastes such as bleach, dye and detergent water to nature, the restrictions made in this direction still carry great importance today. The rules applicable to passenger animals of that time shed light on the rules established for today's motor vehicles. It is emphasized that auto repairs and maintenance are carried out in a way that does not disturb people (auto industries), and the necessity of parking the vehicles in the places reserved for them without hindering the movement of people. Keeping the cemeteries clean shows the value given to human beings and reveals that the environment of the dead as well as the living should be kept clean.

In the 16th century, garbage was collected in certain places in Istanbul in order to prevent environmental pollution. The rubbish of the chambers of the Janissaries and the Sekban chambers, which constituted an important part of the military power of the Ottoman Empire, was dumped into the sea on the Langa side designated for this purpose. When it was discovered that these wastes were poured into the sea from Yenikapı in 1585, it was decided to dump them again from the Langa side (Altınay, 1987).

The environmentalist personality of Mustafa Kemal Atatürk (Figure 4), the founder of the Republic of Turkey, has an important place in reflecting the environmental consciousness of Turkish history. After the proclamation of the republic in 1923, some of Atatürk's decisions within the borders of Turkey reveal his environmentalist personality and his aim to bring this environmental understanding to the Turkish nation. Some of the decisions Atatürk took for this purpose are as follows (Köroğlu, 2009):

- Declaring Ankara capital and building Atatürk Forest Farm, Youth Park, Hippodrome, Güvenpark and Victory Park, and working on the dimensions of Ankara streets and forestation,
- Producing fruits, vegetables, milk and dairy products on farms and generating income from these products and producing seeds for farmers,
- Not giving permission to the cutting of willow trees that need to be cut due to the construction in the Söğütözü, and making responsible people move these trees to another place,
- Opening canals in swamps and barren lands, making these lands suitable for

agriculture,

- Reminding the importance Islam gives to planting trees and expressing that some people forget or abuse this rule,
- Greening around Yalova Thermal Springs and planting pine trees in this area,
- Not allowing the plane tree, which is said to have damaged the roof and walls of the mansion he had built in Yalova, to be cut down, and to have the mansion changed using a rail system.

Figure 4. Mustafa Kemal Atatürk

There has been an increase in environmental problems globally since the 1970s, and Turkey, like other countries, has followed policies aimed at reducing these problems and preventing them. These problems have been addressed in the development plans and studies have been made and continue to be done to create a sustainable environmental understanding (Sezik, 2018).

Conclusion

In the belief of Islam, factors such as advising people to use environmental resources without wasting and sharing these resources with animals, depicting the paradise promised to people with water resources such as trees and rivers, explaining that there is a balance between living and non-living beings in nature reveal the importance given to the environment. When we look at Turkish history, it is seen that natural structures such as the sky, mountains, forests, trees and some animals were considered sacred in the pre-Islamic period, while in the post-Islamic period, animals were treated with mercy and afforestation was given importance. In addition, it is understood that environmental regulations have been made because of increasing population and environmental pollution, and measures have been taken for environmental cleaning.

As a result, it is possible to say that there was an advanced and positive environmental understanding in Turkish states before and after the acceptance of Islam. It is seen that the Turkish states lived in harmony with their environment and had a positive environmental understanding even before they accepted Islam. After the acceptance of Islam, it is understood that this positive environmental understanding was dominated by the understanding of showing mercy to animals and meeting their needs instead of seeing animals as sacred. In addition, in Islam, "rightful due", which is abusing the rights of others is prohibited. In this respect, it can be thought that the person may be taking special care not to abuse the rightful due, in other words, not to disturb others, especially in environmental cleaning. In other words, this provision of Islam may have had an effect on the measures taken by the Turks for environmental cleaning and regulations after they accepted Islam. It can be said that Islam has an impact on the environmental understanding of the Turks, in terms of compassion for animals and animal rights.

Environmental Understanding Activity

Let's Picture the Understanding of Environment in Turkish-Islamic History

Aims of the activity:

- To help students comprehend the environmental understanding in Turkish states.

Activity time: 2 hours

Materials needed for the activity**:** Colored crayons, drawing paper, symbols.

Activity content: Blank drawing papers and crayons are distributed to the students. Students are asked to draw the environmental understanding of Turkish states. During the activity, it may be requested to show these features in the picture by giving guiding tips such as "environmental arrangements, environmental cleanliness, importance of animals, balance in nature, trees and forests, efficient use of natural resources." While drawing the picture, elements such as the lifestyles, sanjaks and religions of the Turkish states can be expressed.

References

Agacanov, S. G. (2015). *Oğuzlar* (7th ed.) (E. N., Necef, & A., Annaberdiyev, Trans.). Selenge Yayıncılık.

Akgündüz, A. (2009). *İslam ve Osmanlı çevre hukuku*. Osmanlı Araştırmaları Vakfı Yayınları.

Al-Adab Al-Mufrad, Book 27, Hadith 479. https://sunnah.com/adab/27/4

Alican, M. (2018, March 30). İlk Müslüman Türk devleti hangisidir? *Beyaz Tarih*. https://www.beyaztarih.com/sorularla-tarih/ilk-musluman-turk-devleti-hangisidir

Alper, D., & Anbar, A. (2007). Küresel ısınmanın dünya ekonomisine ve Türkiye ekonomisine etkileri. *Dokuz Eylül Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 9*(4), 15-54.

Altınay, A. R. (1987). Onuncu asr-ı hicrîde İstanbul hayatı (A. Uysal, Ed.). Kültür ve Turizm Bakanlığı Yayınları.

Ash-Shama'il Al-Muhammadiyah, Book 25, Hadith 7. https://sunnah.com/shamail:156

Atabek Yiğit, E. (2009). Çevre sorunları. In V. Sevinç (Ed.), *Eğitim fakülteleri için genel çevre bilimi*. Maya Akademi.

Aydoğan, M. (2019). *Antik Çağ'dan küreselleşmeye yönetim gelenekleri ve Türkler*. İnkılap Yayınları.

Balaban, A. (2006). *İskit, Hun ve Göktürklerde sosyal ve ekonomik hayat*. [Unpublished master dissertation]. Gazi University.

Canan, İ. (1986). *İslam'da çevre sağlığı*. Cihan Yayınları.

Candan, E. (2013). *Atalarımızın Gök Tanrı dini*. Sınır Ötesi Yayınları.

Cebeci, S. (2008). Milli kimlik bağlamında din-kültür ilişkisi. *Akademik İncelemeler, 3*(2), 1-11.

Chaplin, M. F. (2001). Water: its importance of life. *Biochemistry and Molecular Biology Education, 29*, 54-59.

Çeçen, A. (2021). *Türk devletleri* (5th ed.). Astana Yayınları.

Çelikkıran, A. (1997). *Çevre sorunları ve eğitim: çevre konusunda formatör öğretmen eğitimi kursu uygulama örneği*. [Unpublished doctoral dissertation]. Ankara University.

Çolak, İ. (2019, June). Osmanlı Devleti›nde dünyanın ilk mükemmel çevre düzenlemesi. *Zafer, 510*. https://www.zaferdergisi.com/makale/11121-osmanli-devletinde-dunyanin-ilk-mukemmel-cevre-duzenlemesi.html

Danişmend, İ. H. (1982). Garb Menba'larına göre eski Türk seciyye ve ahlakı (3rd ed.). İstanbul Kitabevi.

Durkaya, B., & Durkaya, A. (2016, November 4-6). *Hava kirliliğinin önlenmesinde orman biyokütlesi* [Conference presentation abstract]. 3rd International Symposium on Environment and Morality, Alanya, Turkey. http://www.i-sem.info/PastConferences/ISEM2016/ISEM2016/papers/3-ISEM2016ID59.pdf

Duru, B. (1995). *Çevre bilincinin gelişim sürecinde Türkiye'de gönüllü çevre kuruluşları*. [Unpublished doctoral dissertation]. Ankara University.

Emsal, M., & Şentürk, H. (2021). Kur'an ve sünnette empatik yaklaşımın yeri. *Anadolu Akademi Sosyal Bilimler Dergisi, 3*(1), 77-92.

Gentine Bellini. (2021, July 7). In *Wikipedia*. https://en.wikipedia.org/wiki/Gentile_Bellini

Gümilev, L. M. (2013). *Hunlar* (5th ed.) (D. A., Batur., Trans.). Selenge Yayınları. (1997)

Kafesoğlu, İ. (2016). *Türk milli kültürü* (40th ed). Ötüken Yayınları.

Klyashtorny, S. G., & Sultanov, T. İ. (2013). *Kazakistan Türkün üç bin yılı* (3rd ed.) (D. A., Batur., Trans.). Selenge Yayınları.

Koop, S. H. A., & van Leeuwen, C. J. (2017). The challenges of water, waste and climate change in cities. *Environment, Development and Sustainability, 19*, 385-418. https://doi.org/10.1007/s10668-016-9760-4

Köroğlu, V. (2009). Environmentalist Atatürk. *Cag University Journal of Social Sciences, 6*(2), 57-69.

Küçüküstel, S. (2012, December 13). Moğolistan / kayıp Türkler-2, yerleşik Dukhalar. Atlas, 237. https://www.atlasdergisi.com/kesfet/kultur/mogolistan-kayip-turkler-2-yerlesik-dukhalar.html

List of Turkic dynasties and countries. (2021, July 19). In *Wikipedia*. https://en.wikipedia.org/wiki/List_of_Turkic_dynasties_and_countries

Maksudoğlu, M. (2018). *Osmanlı tarihi 1289-1922* (5th ed.). Salon Yayınları.

Morgan, R. P. C. (2009). Soil erosion & conversation (3rd ed.). Blackwell. https://books.

google.com.tr/books?hl=tr&lr=&id=j8C8fFiPNOkC&oi=fnd&pg=PR7&dq=erosion&ots=wpK8IWVeFg&sig=kbin1YJdaLWnyrES22TBA-rqWNM&redir_esc=y#v=onepage&q=erosion&f=false

Mustafa Kemal Atatürk. (2021, July 17). In *Wikipedia*. https://tr.wikipedia.org /wiki/Mustafa_Kemal_Atat%C3%BCrk

Nasr, S. H. (2019). *İnsan ve tabiat* (N. Avcı, Trans.). İnsan. (Original work published 1988).

Ögel, B. (1945). Gök-Türk yazıtlarının "Apurım"ları ve "Fu-lin" problemi. *Belleten, 33*, 63-87.

Özdemir, D. (2003). The development of environmental consciousness in modern Turkey. In R. Foltz (Ed.), *Environmentalism in the Muslim world*. MIT Press.

Özdemir, İ., & Yükselmiş, M. (1997). *Çevre sorunları ve İslam* (2nd ed.). Diyanet İşleri Başkanlığı Yayınları.

Radloff, W. (2009). *Türklük ve Şamanlık* (2nd ed.) (A. Temir, T. Andaç, N. Uğurlu, Trans.). Örgün Yayınevi.

Rotasız Seyyah. (2021, July 25). *Dukha Türkleriyle geçirdiğim 3 gün – Moğolistan* [Video]. Youtube. https://www.youtube.com/watch?v=loqeJNS07oE

Roux, J. P. (2021). *Türklerin ve Moğolların eski dini* (A. Kazancıgil, Trans.). Dergah Yayınları.

Sahih al-Bukhari, Book 41, Hadith 1. https://sunnah.com/bukhari:2320

Schmidt, P. (1964). Eski Türklerin dini. *İstanbul Üniversitesi Edebiyat Fakültesi Türk Dili ve Edebiyatı Dergisi, 13*, 75-90.

Sezik, M. (2018). Türkiye'nin çevre politikaları. In I. Arpacı, & O. Ağır (Eds.), *Türkiye'de devlet politikaları*. Nobel.

Suleiman the Magnificent. (2021, July 7). In *Wikipedia*. https://en.wikipedia.org/wiki/Suleiman _the_Magnificent

Sunan Abi Dawud, Kitab Al-Taharad, Book 1, Hadith 386. https://sunnah.com/abudawud:386

Sunan Abi Dawud, Kitab Al-Adab, Book 43, Hadith 467. https://sunnah.com/abudawud:5239

Şeker, M. (1992). Osmanlı vakfiyelerinde çevre bilinci ve örnekleri. *Ekoloji, 4*, 26-30.

Tazebay, İ., & Akpınar, N. (2010). Türk kültüründe bahçe. *Bilig, 54*, 243-253.

TBMM (1922, March 1). Türkiye Büyük Millet Meclisi 1. dönem 3. yasama yılı açış konuşmaları. *Millet Meclisi Tutanak Dergisi* D. 1, C. 18. https://www.tbmm.gov.tr/tarihce/ataturk_konusma/1d3yy.htm

The Holy Qur'an. Publications of the Presidency of Religious Affairs, Amana Publications, 2018.

Tolunay, D. (1992). Toprak kirlenmesi ve yanlış arazi kullanımının yarattığı sorunlar ile çözüm önerileri. *İstanbul Üniversitesi Orman Fakültesi Dergisi, 42* (1-2), 155-167.

Türküm, S. (1998). *Çağdaş toplumda çevre sorunları ve çevre bilinci*. Can G. (Ed.). Çağdaş yaşam çağdaş insan. Anadolu Üniversitesi Açık Öğretim Fakültesi İlköğretim Öğretmenliği Lisans Tamamlama Programı, 165-181.

Yeniçeri, C. (2009). *Hz. Peygamber'in çevreciliği: spor etkinlikleri ve Kur'an'da çevrecilik*. Çamlıca Yayınları.

Yenigün, İ. (2020). Selçuklularda çevreci yaklaşımlar. *TURAN-SAM Uluslararası Bilimsel Hakemli Dergisi, 12*(45), 85-88.

Yörükan, Y. Z. (2016). *Müslümanlıktan evvel Türk dinleri: Şamanizm* (T. Yörükhan, Ed.). Ötüken Neşriyat.

Yürüyen Köşk. (2021, July 21). In *Wikipedia* https://tr.wikipedia.org/wiki/Y%C3%BCr%C3%BCyen_K%C3%B6%C5%9Fk

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Chapter 12

Environmental Problems

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Environmental Problems

The perception that the earth is a living planet emerged with the Gaia theory. According to the Gaia theory, all living things are physically interconnected through air, oceans, fresh waters and all fluids on Earth. Accordingly, trees, lakes, seas, animals, plants in the world are in constant interaction with each other. The existing energy is in a continuous cycle in the world. For this reason, the change of each part that interacts with the world will affect each other and therefore the whole. It is possible to explain this with the butterfly effect. We can explain the butterfly effect with an example in terms of environmental problems. Developed countries sell their waste to less developed countries. Even at the other end of the world, harmful gases such as carbon dioxide and methane are released into the atmosphere due to this garbage in countries that take this garbage. As it is known, carbon gas is one of the most important gases that cause the greenhouse effect. In other words, the damage caused by garbage extends to water, soil, plants, animals and people, with the increase of the greenhouse effect, global warming, drought, famine, deforestation and decrease in biodiversity. With the increase in the mentioned effects, nowadays people started to have anxiety for the future. The world is now alarming because of these effects. If we look at the emergence of these effects, it can be thought that the consumption of nature started with the emergence of humanity. Since ancient times, people have begun to consume nature for purposes such as nutrition, shelter and safety. The habit of consuming nature, which started as a natural process only for survival, has deviated from its purpose day by day. Today, the consumption rate of nature has increased thoroughly in order to meet the needs of the increasing population and to increase the living standards continuously. Due to this speed, nature cannot find enough opportunity to renew itself. Nature started to give people the message that "I can no longer catch up". Some other messages of nature are "I cannot keep up with the pace you consume me", "It cannot be renewed and I am being used up by the day", "I do not think I can be enough for future generations". It is very important to evolve into a society that can read these messages, internalize them and regulate their living habits by accepting that nature and human beings and all living things are an inseparable whole. Despite all the work done, no habitable planet has been found in the universe. So, planet earth is one in the universe, unique and fascinating. And we need it forever.

Therefore, in this chapter, ecology and environmental concepts, environmental pollution, types of environmental pollution, the effects of environmental pollution and the popular environmental problems of 2020 will be discussed.

Ecology and Environment

The term ecology, one of the fields of environmental sciences, was first used by Ernst Haeckel in 1869. It is extracted from the Greek "oikos" which means house or dwelling (Plutynski, 2018). According to McIntosh (1985) ecology is a "polymorphic" discipline because of being so diverse in its subject matter. It consists of many sub-disciplines; behavioral ecology; physiological ecology, community ecology, population ecology, ecosystem ecology, and evolutionary ecology. Ecology is a research field that investigates interactions of organisms (including human beings) with their environments. So ecologists are interested in not only how humans live, but also how they should relate to their environment (Kingsland, 1995; Mitman, 1992). The components of our environment are shown in Figure 1.

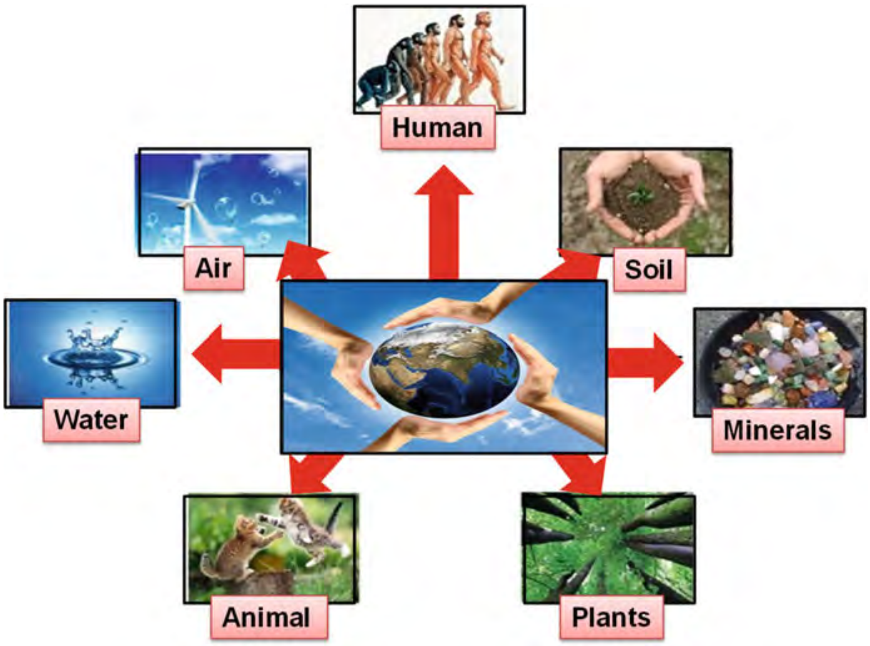


Figure 1. The Components of our Environment

The term environment means all the things around us. It explains organisms' all physical and biotic conditions. The natural environment consists of four basic components called; atmosphere, lithosphere, hydrosphere and biosphere. These four systems are both affected by human activities in constantly changing situations and also are affecting human activities. First of all, hydrosphere is the component that includes oceans, seas, lakes, streams and groundwater on land (Demirtaşlı, 1967; Singh & Singh, 2017). It covers 71% of the earth. The composition of the hydrosphere is shown in Figure 2.

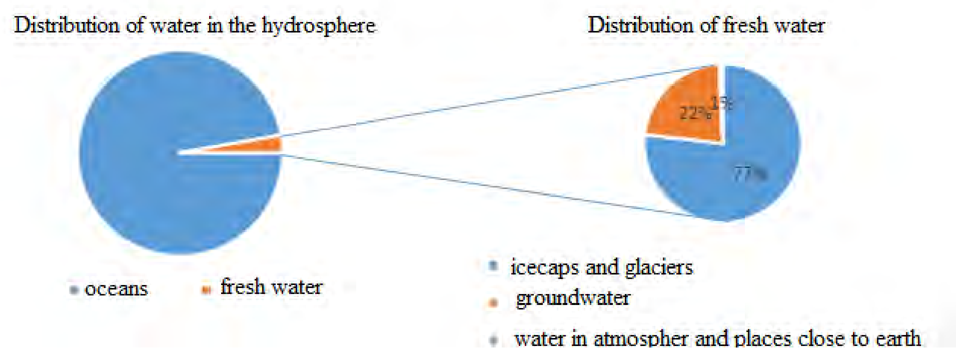


Figure 2. The composition of hydrosphere

The second component of the environment is the lithosphere and it is the solid part of the earth, composed of various rocks, 54 million square miles of which are above water and 143 million square miles are under water. The above water part of the lithosphere forms the continents. The gas cover that surrounds the whole earth is the atmosphere which is the third component of the environment. It contains gases like carbon dioxide, oxygen, helium, nitrogen, hydrogen, argon and ozone etc. The atmosphere consists of five layers. These are stratosphere, troposphere, thermosphere, mesosphere and exosphere. Last component is the biosphere which may also be named as the zone of life on Earth. It covers all organisms that exist in the world and their interactions with water and air. The biosphere is the total of all ecosystems, including all microorganisms, plants and animals from the smallest microscopic organisms to the largest creatures in nature (Singh & Singh, 2017). If there is a change in the quality or quantity of any of these natural environmental components it will affect living things negatively, an environmental problem will arise (Khan & Ghouri, 2011; Singh & Singh, 2017). The main environmental issues are pollution, ozone layer, acid rain, global warming, overpopulation, deforestation, waste disposal, plastic pollution and loss of biodiversity (Johnston, 1989; Mäler, 1990; Steinberg, 2007).

Pollution

Any liquid, solid or gaseous substance in any concentration that may pose a hazard or harm to the environment is called pollution. Pollution is a global problem and has serious effects on the health of individuals (Fereidoun et al., 2007). It occurs mostly in the urban and industrial areas of developed countries (Kromm, 1973). Recent studies show that global concern for pollution is increasing in public health (Kimani, 2007). It is believed that today’s exposure to pollution is higher than any other time (Schell et al, 2006). The main reasons for the pollution are natural and man-made reasons. There are two different pollution types called point source (PS) and non-point source (NPS) pollution. PS pollution is a pollution originating from a fixed location or a fixed facility where pollutants are dumped. NPS is a type of pollution that cannot be easily traced back to its source. Common NPSs are; mining, agriculture, forestry and construction activities, urban, dams, canals, city streets and land disposal (Singh & Singh, 2017).

Environmental Pollution

Before settling down in ancient times, people used nature for their needs such as eating and sheltering. When they consumed their environment and decreased its efficiency, they migrated to new places where they can reach new resources. In this process, nature had enough time to renew itself to overcome the damage caused by humans. However, with the increase in population, rapid urbanization and industrialization nowadays, nature cannot find the time to renew itself. In this case, the constantly accumulating waste and the resulting destruction cause irreversible environmental problems that result from several pollution types. Those environmental pollution types are; solid, air, water, sound, light and electromagnetic pollution.

Soil Pollution

The soil is a material that covers the outside of the earth and consists of a mixture of various decomposition products of rocks and organic materials, containing and feeding countless living things. So it is a well-formed chemical, biological and physical material that has a significant role in the life of humans and other living things (Güler & Çobanoğlu, 1997). Surface soil is the most important part of the soil in terms of vital activities of living things. Human beings cultivate and consume the surface soil for purposes such as shelter, agricultural, industrial activity and recreational arrangement in the period from the beginning of living life to the present day (Karaca & Turgay, 2012). There are nine reasons for soil pollution. These are erosion, stoniness, aridity, fertilization, pesticide use, open pit mining, domestic and industrial wastes, use of agricultural land for non-agricultural activities and nuclear pollution. As a result of soil pollution, harmful pollutants in the soil can pass to the human body by nutrients through the plants. Some of these harmful pollutants have toxic effects when taken at high doses, while others can reach toxic amounts due to the accumulation effect even if taken in low doses (Güler & Çobanoğlu, 1997).

Air Pollution

Clean air is very important for a healthy life. However, air pollution is widespread especially in developed countries. The major pollutants in the air that living beings breathe include, sulphur oxides (SO_x), nitrogen oxides (NO_x), carbon monoxide (CO) emitted from industrial facilities and motor vehicles. Some other pollutants are methane, xylene, toluene, chlorofluorocarbon (CFC), peroxyacetyl nitrate, ozone (O_3), odours, metals etc (European Public Health Alliance, 2009; Singh & Singh, 2017). The increase of these substances in the air to a level that is harmful to other living things and non-living things is defined as air pollution. Although there are many causes of air pollution, it is possible to investigate the causes in two main categories as air pollution caused by natural causes and as a result of several activities performed by people. Forest and vegetation fires, volcano eruptions and dust storms are natural causes. Industrialization and urbanization are the main causes of air pollution resulting from human activities. Industrialization is effective in air pollution as it is responsible for the release of pollutants into the atmosphere without taking the necessary precautions (Sümer, 2014). Air pollution causes global warming, acid rains and ozone depletion, it also brings many health problems like, bronchitis, cancer, asthma, heart disease, respiratory infections, premature mortality (Khomenko et al., 2021; Manisalidis et al., 2020; Miri et al., 2018; WHO, 2009).

Water Pollution

Water pollution occurs as a result of the pollution of water bodies such as oceans, seas, lakes and groundwater in the world. A chemical, physical or biological change in water resources is considered as water pollution, and this pollution adversely affects living things (Dojlido & Best, 1993). These changes occur as a result of industrial wastes (Eckenfelder, 2000), sewages (Ashraf et al, 2010), agricultural (Moss, 2008) or household wastes (Khan & Ghouri, 2011; Singh & Singh, 2017). As most of these activities lead to water pollution with various synthetic and geogenic natural chemicals, it is not surprising that chemical pollution in natural water has become a major public issue almost anywhere in the world. In the USA, research revealed that drinking water pollution is the primary environmental problem (Saad, 2009). There are two types of water pollution sources. First one is natural and the other is man-made. Natural sources of water pollution are minerals leaching from rocks, erosion and decayed organic matter. Man-made sources of water pollution are toxic chemical wastes such as detergents, heavy metals and fertilizers, agricultural wastes (pesticides), micro plastics and sewage water. The quality of soils and vegetation is affected by water pollution. So it affects the environment and public health (Singh & Singh, 2017). There are many researches that shown polluted water causes death of human beings and health hazards (Ashraf et al, 2010; Çağlar Irmak & Hepçimen, 2010; Jepsen & De Bruyn 2019; Mato et al. 2001; Scipeeps, 2009; Thiel et al. 2018; Varol, Davraz, & Varol, 2008).

Noise Pollution

The word noise, derived from the Latin word “nousea”, can be defined as an unwanted unpleasant or unexpected disturbing sound (Firdaus & Ahmad, 2010). It can usually be referred to as high energy sound waves (Akman, Ketenoğlu, Evren, Kurt & Düzenli, 2000). Noise pollution is an important environmental pollution in developed and developing countries (EPA, 2016) and reduces people’s quality of life (Firdaus & Ahmad, 2010).

Unlike air, soil and water pollution, noise pollution does not stay in the environment for a long time and does not accumulate. Besides, its effects occur in the short term (Cohen & Weinstein, 1981; Schulz, 1978). WHO Guideline on Community Noise reported health effects of noise in six categories (Berglund & Lindvall, 1995). These categories are; disturbances in mental health, negative social behavior and annoyance, interference with spoken communication, hearing impairment, sleep disturbances and cardiovascular disturbances. On the other hand, according to Hunashal and Patil (2012), the effects of noise on human health and quality of life depend on the duration and intensity of the noise. These effects are presented in four categories.

1) Hearing loss and headache due to prolonged exposure to noise,

2) Increased blood pressure, heart rhythm irregularity and ulcer,

3) Irregular sleep, insomnia, going to bed late, excessive irritability, being stressed and depression,

4) Misunderstanding of what you hear, decrease in production due to decreased work efficiency.

Light Pollution

Light pollution that negatively affects lives, is an important global problem that concerns the whole world and all individuals very closely. Using more light than needed, in the wrong direction and at an unsuitable time can be defined as light pollution (Aslan et al., 2011). The International Dark-Sky Association defined light pollution as "*any adverse effect of artificial light including sky glow, glare, light trespass, light clutter, decreased visibility at night, and energy waste*". Light pollution can be classified as annoying light and excessive light. It can also be classified as indoor and outdoor light pollution (Rajkhowa, 2014). The effects of light pollution are seen in the observation difficulties experienced in astronomy studies. In many urban areas with light pollution, the visibility of stars has decreased. Another effect of light pollution is the damage it caused to the ecosystems. Many nocturnal animals such as moths, beetles, spiders and crickets lose their ability to navigate due to light pollution. In addition, reproductions of caretta carettas are affected by light pollution (Longcore & Rich, 2004).

Electromagnetic Pollution

The Earth is surrounded by static electromagnetic fields varying between 25-65µT. It means that the Earth has a natural electromagnetic field (Feychting, Ahlbom, & Kheifets, 2005). The sources of the natural electromagnetic field are known as the sun, stars and lightning (Uygunol & Durduran, 2008). Natural electromagnetic waves are a part of the natural world and it is in our lives from the existence of the world to the present day.

However, with various technological devices produced by human beings, the amount of electromagnetic waves in their lives increases and as a result electromagnetic pollution occurs (Köklükaya, 2013; Köklükaya & Selvi, 2015; Köklükaya, Güven Yıldırım & Selvi, 2017; Önder & Güven Yıldırım, 2020). The sources of electromagnetic pollution that humans frequently use in their daily life are base stations, laptops, wireless modems, hair dryers, microwave ovens, mobile phones, televisions, radios etc (Ahldom & Feychting, 2003; Jin, Li, Zhou, & Ni, 2005; Redl, 2001). The effects of electromagnetic pollution depend on some variables. These variables are the frequency, intensity of the electromagnetic field, the distance of the electromagnetic field and lastly the duration of the electromagnetic field which is the most important variable (Ermol, 2008). Electromagnetic pollution has two types of effects on human health. The first of these are the effects that occur as a result of short-term exposure to electromagnetic pollution, and the second is the effects that occur as a result of long-term exposure. Short-term effects are weakness, dizziness, tiredness, burning in the eyes, eye pain, headache and etc (Wilén, Johansson, Kalezic, Lyskov, & Sandström, 2006). Long-term effects are the effects on molecular and chemical bond structures in living things, on the cell and on the body's defense system (Graham, Cook, Cohen, & Gerkovich, 1994; Kang et al., 1997).

Effects of Environmental Pollution

The environmental pollution mentioned above has some negative effects on the world (Singer, 1970). These effects are ozone layer depletion, global warming, loss of biodiversity and acid rain.

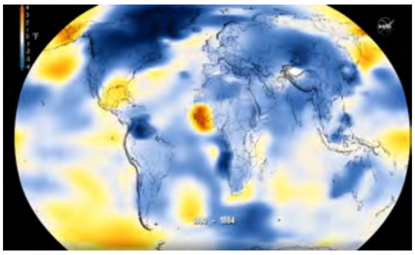
Global Warming and Climate Change

Global warming and climate change are seen as the most important problems of the 21st century all over the world. Global warming and climate change are interrelated so it is not possible to separate these two problems. The climate changes that all are beginning to witness are happening due to global warming (NRC, 2010). Global warming is a term used to refer to the average temperature increase in the Earth's atmosphere and oceans (Singh & Singh, 2017; Yazdanparast et al., 2013). It is possible to express the difference between global warming and climate change as follows. The concept global warming indicates increase in temperature on a global scale, while climate change refers to the change of weather and natural events that are not related to heat (Widiyawati, 2020).

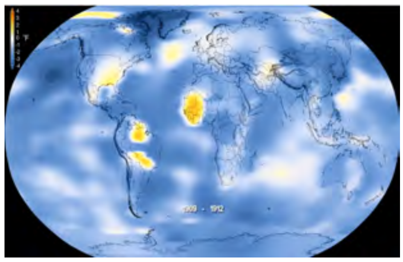
As with many environmental problems, global warming has both natural and man-made reasons. Natural causes such as volcanic movements in the world and changes in the sun cause changes in global temperature. Moreover, the world's climate system contains many internal variations such as El Niño- Southern Oscillation and the Atlantic Multidecadal Os-cillation (Ring, Lindner, Cross, & Schlesinger, 2012; Schlesinger & Ramankutty, 1994). On the other hand, according to the assessment reports in the Intergovernmental

Panel on Climate Change, the impact of humans on climate change and global warming is greatly increasing (Ring, Lindner, Cross, & Schlesinger, 2012).

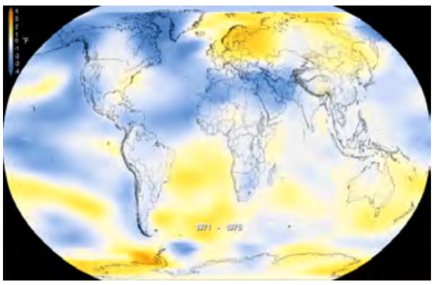
The industrial revolution can be regarded as the milestone of global warming and climate change problems. Before the industrial revolution, the emission of gases that caused global warming to the atmosphere was low and the atmosphere of the world was in balance. However, after the industrial revolution, the increase of harmful gases in the atmosphere, the increase in the use of fossil fuels, changing agricultural activities and deforestation started to disrupt the balance of the world (Singh & Singh, 2017). These gases are called greenhouse gases and the effect created by greenhouse gases is called the greenhouse effect. The increase in global warming over the years is shown in Figure 3.



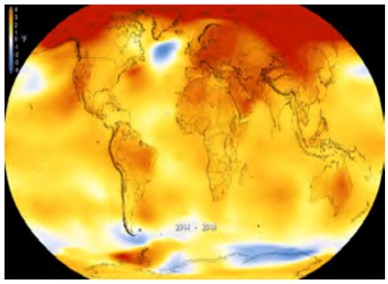
1880-1884



1909-1912



1971-1975



2014-2018

Figure 3. Global Climate Change

The graphic prepared according to the NASA data is given in Figure 4. It shows the change of the temperature of the Earth by months from 1880 to 2020.

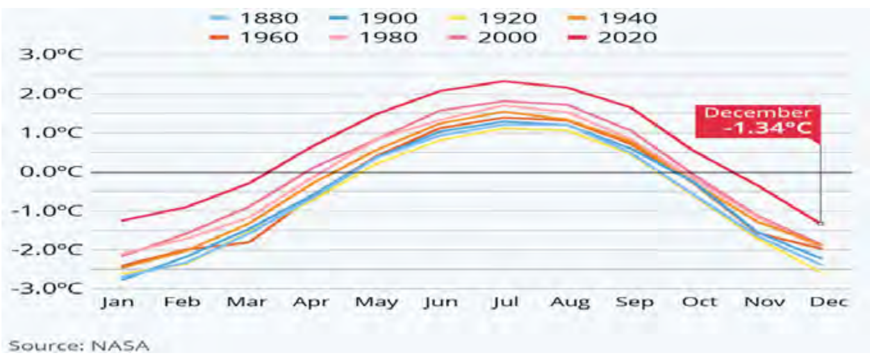


Figure 4. The Change of the Temperature of the Earth by Months (1880-2020)

Changes in climate have been observed since ancient times. However, when climate change is evaluated in terms of the time of change, it was taking place in a much longer period of time compared to today. The long period of change enabled the living creatures on Earth to adapt to this change. However, global warming is happening very quickly today and it becomes difficult for living creatures to adapt to the effects of this warming. The faster the climate change, the more harmful its effects will be. The major effects of global warming are rise in global temperature, rise in sea level, retreat of glaciers, decreasing crop yield, disease outbreaks (Singh & Singh, 2017).

Greenhouse Gasses and Greenhouse Effect

Greenhouse gasses are chlorofluorocarbons, water vapor, carbon dioxide, ozone, methane, and nitrogen oxides (U.K. Met Office, 2011). The most important greenhouse gas causing global warming is carbon dioxide. Carbon dioxide is generally released into the atmosphere through anthropogenic activities such as fossil fuels (coal, oil and natural gas), wood and solid waste burning (Bayar & Bahrend, 1994; Singh & Singh, 2017). Chlorofluorocarbons (CFCs) also make a significant contribution to global warming, even though they are present in very small amounts. The effects of greenhouse gasses on global warming are presented in Figure 5.

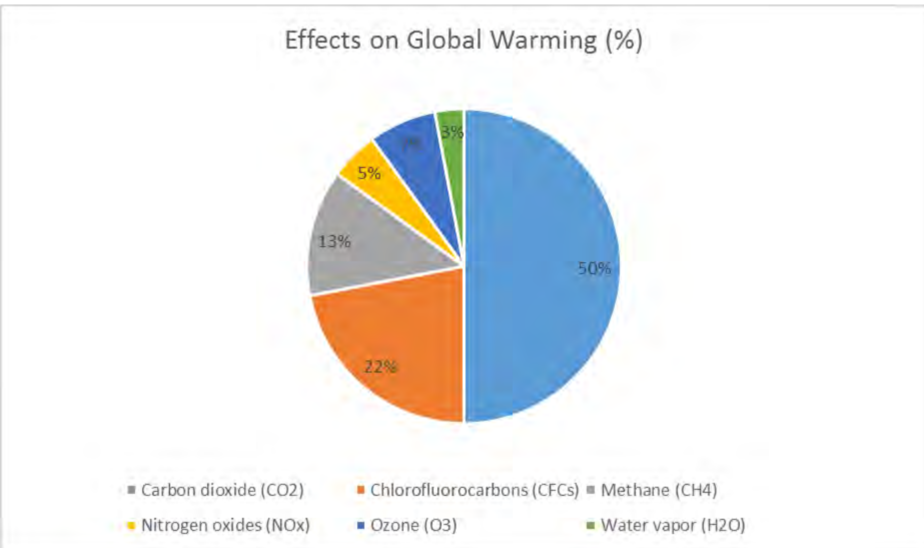


Figure 5. The Effects of Greenhouse Gasses on Global Warming

These greenhouse gases, which are present at high rates in the atmosphere, cause the Earth's temperature to increase by trapping the heat in the atmosphere. Therefore, the ability of greenhouse gases to keep the heat causes the greenhouse effect (The Royal Society, 2010). When solar radiation reaches the Earth, part of it is reflected back. Absorbed part of the solar radiation heats up the Earth. Thus, the Earth's temperature depends on how much sunlight is absorbed by the land, ocean, and atmosphere, and how much heat the Earth radiates into space. If the flow of incoming solar energy is balanced by an equal flow of heat into space, the earth reaches radiative equilibrium, and then resulting in a fairly constant average global temperature (Figure 4). Known as the greenhouse effect, this makes the earth's average surface temperature around 286K or 13°C. If there was no greenhouse effect, the world would be an uninhabitable place. The surface temperature would be about -17°C and it would be impossible to find water in liquid form at this temperature. In other words, greenhouse gases make a cover effect in the lower layers of the Earth's atmosphere and keep the Earth's temperature at a livable level. However, elements that increase or decrease the amount of energy coming to and leaving the Earth will disrupt the Earth's radiative balance. In this case, the global temperature will either increase or decrease. Unfortunately, as a result of human activities, the amount of greenhouse gases in the atmosphere is increasing and as a result of these increasing greenhouse gases, global warming is constantly increasing (Singh & Singh, 2017).

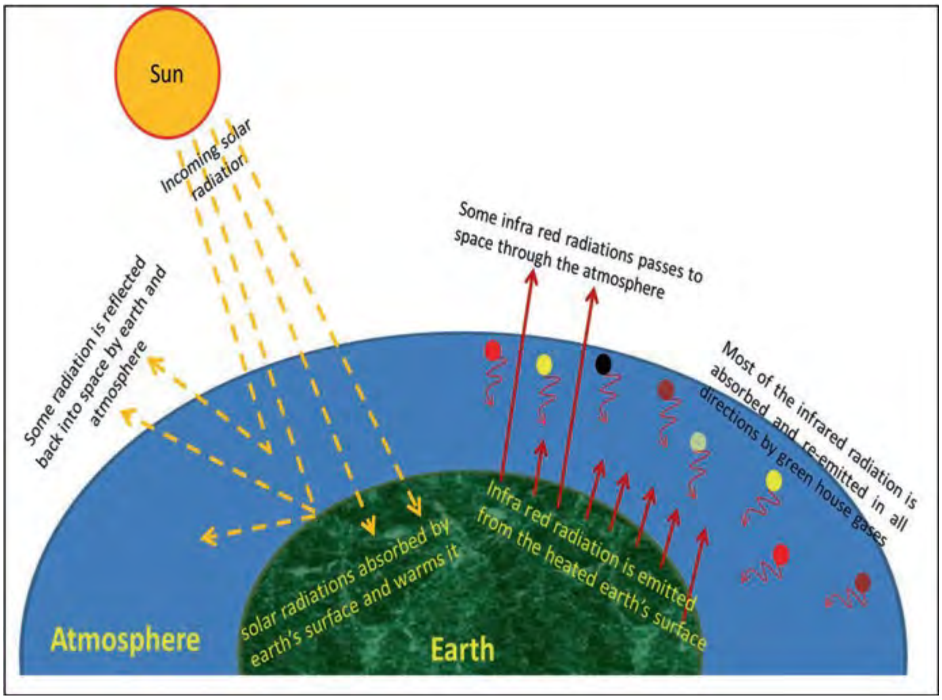


Figure 6. Greenhouse Effect

Ozone Layer Depletion

The atmosphere consists of 3 layers: mesosphere, stratosphere and troposphere. The ozone (O_3) layer is located in the stratosphere, which is 10-50 km from the Earth's surface. It is formed as a result of the natural accumulation of ozone particles in the stratosphere (Rye & Rubba, 2000). In other words, its formation is a natural process as well as its degradation. There is a balance between its formation and its natural extinction. Therefore, the total amount of ozone remains constant. Ozone occurs mostly at the equator where there is maximum solar energy and its concentration is highest between 19 and 23 km of atmosphere (Xiong et al., 2014). Ozone protects the world from harmful ultraviolet radiations (Singh & Singh, 2017). Ultraviolet (UV) wavelength is slightly shorter than the wavelength of violet light and when it passes into the atmosphere, it is absorbed by living organisms and damages their proteins and DNA molecules. If all the UV radiation falling into the stratosphere could reach the Earth's surface, all organisms in the Earth would be greatly damaged. Here ozone absorbs most of the UV radiation and hence the ozone layer is mostly known as the UV radiation shield. Ozone is formed by the combination of UV-B radiation and oxygen (O_2) molecules in the stratosphere (Singh & Singh, 2017).

$$O_2 \xrightarrow{\text{UV-B}} O + O \text{ (atomic oxygen)}$$

$$O + O_2 = O_3 \text{ (ozone)}$$

Sometimes, free oxygen atoms can combine with ozone molecules to form two oxygen molecules:

$$O + O_3 = O_2 + O_2 \text{ (molecular oxygen)}$$

Lastly, ozone absorbs UV-B radiation again and turns into free oxygen:

$$O_3 \xrightarrow{\text{UV-B}} O + O_2$$

It means there is a balance between ozone's formation and extinction.

Some compounds released as a result of human activities cause damage to the ozone layer. The two important atoms released from these compounds are chlorine and bromine. When chlorine and bromine atoms in the stratosphere encounter ozone, they destroy the ozone atoms. The compounds that release chlorine and bromine are called ozone-depleting substances (ODS) (Newman, Daniel, Waugh, & Nash, 2007). Other ODS are chlorofluorocarbons (CFCs), halons, hydro chlorofluorocarbons (HCFCs), carbon tetrachloride, methyl bromide, chlorobromomethane, hydro bromofluorocarbons, dichloromethane and methyl chloroform (Cameron & Ward, 2020; Roy, 2020). The main uses of ODS include refrigerators and air conditioners, cleaning solvents, aerosol propellants, plastic blowing agents and refrigerants freon.

CFC is released to the atmosphere and reaches the stratosphere with other normal gasses and destroys the ozone. These CFC's come across the UV-B radiation in the stratosphere and break apart. Successive reactions are given below (Singh & Singh, 2017). Reactions (2) - (3), are called "chlorine catalytic cycle". Chlorine constantly reacts with ozone, which reduces the amount of ozone and as a result causes damage to the ozone layer.

$$CFCl_3 \xrightarrow{UV\text{-}B} Cl + CFCl_2 \quad (1)$$

$$Cl + O_3 \longrightarrow ClO + O_2 \quad (2)$$

$$ClO + ClO \longrightarrow 2Cl + O_2 \quad (3)$$

Ozone depletion has several effects on living organisms such as cataracts, skin cancer, sunburn, weakening of the immune system and rapid aging as a result of overexposure to strong UV light. Meanwhile, many products that are vulnerable to UV light, such as corn, wheat, oats, broccoli, rice, cauliflower and tomatoes are damaged. At the same time, non-living materials such as plastic, wood, fabric and rubber are greatly degraded by too much UV radiation (Cameron & Ward, 2020).

Acid Rain

Acid rain was first mentioned by pharmacist Ducros in 1845, but the first detailed studies were done by Robert Angus Smith in 1870's (Menz & Seip, 2004; Smith, 1872). The sources that cause acid rains can occur as a result of both natural and human activities. Natural sources are volcanoes and various aquatic creatures that emit these gases as a result of their biological processes (Abbasi, Poornima, Kannadasan & Abbasi, 2013). However, as with all environmental problems, human-induced causes constitute the main problem. Acid rain consists of SO_2 and NO_x released into the atmosphere due to the largely use of fossil fuels. When these oxides dissolve in the atmosphere and react with H_2O, they form H_2SO_4 (sulfuric acid) and HNO_3 (nitric acid). In this case, the acidity of the rain increases and acid rain occurs. The reactions by which sulfuric acid and nitric acid are formed are given below (Singh & Singh, 2017).

$$2\,SO_2 + O_2 \longrightarrow 2SO_3$$

$$SO_3 + H_2O \longrightarrow H_2SO_4 \text{ (Sulfuric acid)}$$

$$2NO + O_2 \longrightarrow 2NO_2$$

$$4NO_2 + 2H_2O + O_2 \longrightarrow 4HNO_3 \text{ (Nitric acid)}$$

Acid rains have enormous effects on the living and non-living environment. First of all, acid rains falling on oceans, seas, lakes and rivers change the pH value of the water. It increases the acidity. This is a fatal situation for the eggs of many fishes. In addition, aquatic plants and invertebrates, which are food for fish, are also damaged by this acidity which results in decrease in fish feed. Moreover, the acidity damages the gills of the fish and prevents oxygen intake. It also causes bone calcification. Acid rains also damage forest ecosystems and results in nutrients such as calcium and phosphorus to leach from the soil. This decreases the productivity in that soil so plants cannot grow. In acidic groundwater, substances such as aluminum dissolve and make the water toxic. Finally, acid rains erode old and valuable buildings such as open-air museums and ruins over time and damage them irreparably (Singh & Singh, 2017).

Loss of Biodiversity

Biodiversity is a field that contains the diversity of living organisms, the communities and ecosystems in which they originate, the genetic differences between them, and the ecological and evolutionary processes that are constantly changing and adapting (Noss & Cooperrider, 1994). Shortly, biodiversity contains the diversity within species, among species and ecosystems (Singh & Singh, 2017). Also Heywood and Watson (1995) explained the composition of biodiversity in three parts. First one is ecological diversity that contains; biomes, ecosystems, habitats, bioregions landscapes and populations. Second is genetic diversity that contains; nucleotides, genes, chromosomes, individuals and populations. Lastly organismal diversity that contains; kingdoms phyla families, genera, species and populations.

2.1 million species are believed to be currently known today, but this includes only a small part of the total amount of species that exists (Heywood & Watson, 1995). According to the UNEP data, the number of living species by taxonomic group is given in Table 1.

Table 1. Number of Living Species by Taxonomic Group

Group Estimated	Identified species	Total
Bacteria and viruses	5,800	10,000
Fungi	80,000	1,500,000
Protozoa and algae	100,000	250,000
Nonvascular plants	150,000	200,000
Vascular plants	250,000	300,000
Invertebrates	1,500,000	7–50 million
Fishes	20,000	23,000
Amphibians and reptiles	12,000	13,000
Birds	9,100	9,200
Mammals	250,000	300,000
Total	2,125,300	9–52 million

The world is in danger about biodiversity (Wilson, 2002). In 2021, the International Union for Conservation of Nature (IUCN) reported that 37,400 of 112,432 species were threatened with extinction (IUCN, 2021). There are many reasons for the decrease in biological diversity. The biggest cause of this extinction is habitat loss. The destruction of forests, wetlands and other ecosystems has caused the extinction of millions of species on Earth. The other reasons for the decrease in biological diversity are invasive species, hunting, pollution and diseases (Díaz, Fargione, Chapin, & Tilman, 2006). Therefore, there are many causes of global species losses that cannot be predicted in advance. It has been determined that at least 480 animals and 654 plant species have disappeared since the 17th century (Heywood & Watson, 1995). This number includes only the species that have been diagnosed. In fact, many more species disappeared. While it took 300 years for a species to disappear in nature under normal conditions, this period was shortened by the influence of humans.

The Biggest Environmental Problems of 2020

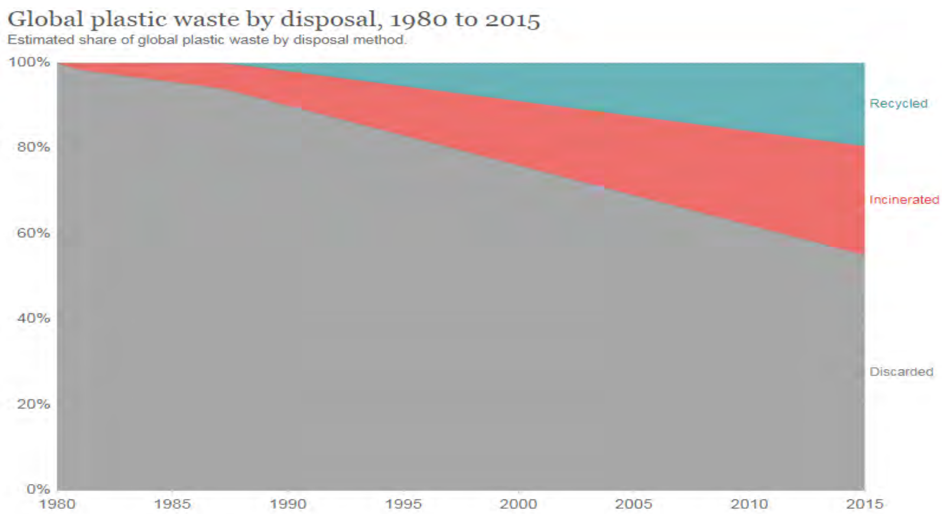
In addition to the above mentioned problems the biggest environmental problems of 2020 can be classified as food waste, plastic pollution, deforestation, melting ice caps (https://earth.org/the-biggest-environmental-problems-of-our-lifetime/). Also overpopulation and waste disposal can be added to these problems.

Food Waste

It is known that 1/3 of food is wasted today. This value corresponds to approximately 1.3 billion tons. 3 billion people can be feed by this wasted food. Food waste occurs in different ways in developed and developing countries. While 40% of food waste occurs at retail and consumer stages in developed countries, 40% of food waste occurs at post-harvest and processing levels in developing countries. An interesting reason for wasting food is aesthetics. At the retail level, therefore, huge amounts of food are wasted. In the US, it is known that more than 50% of trashed products are wasted because they are too "ugly" to be sold to consumers. This means that approximately 60 million tons of fruit and vegetables are wasted (https://earth.org/the-biggest-environmental-problems-of-our-lifetime/). Other food waste reasons are poor infrastructure and transportation, poor storage facilities, lack of refrigeration, poor packaging, inadequate market facilities, poor environmental conditions during display, quality standards, lack of planning, best-before-dates, limited focus on waste and leftovers. To prevent food waste, the following can be done. For low income countries it is recommended to pay attention to local investments, cooling chain when possible, education improved market facilities and improved packaging. For high income countries it is recommended to pay attention to education, awareness, improved communication in supply chains, improved purchase and consumption planning and consumer power (https://www.madr.ro/docs/ind-alimentara/risipa_alimentara/presentation_food_waste.pdf).

Plastic Pollution

While more than 2 million tons of plastic was produced annually in the world in the 1950's, this number increased to 419 million tons as of 2015. According to a report from the scientific journal Nature, about 11 million tons of plastic are thrown into the oceans every year and it is harming animals there. It is predicted that this value will increase to 29 million metric tons in 2040 if no precaution is taken. If micro plastics are included in this value, the total amount of plastic in the oceans could reach 600 million tons (https://earth.org/the-biggest-environmental-problems-of-our-lifetime/). When the disposal methods of plastic thrown in between 1980 and 2015 are examined in Figure 7 (Geyer, Jambeck, & Law, 2017), it is seen that a very small portion of it is recycled. However, the increase in this value from year to year can be considered as hopeful.



	1980	2015
Discarded	%100,00	%55,00
Incinerated	%0,00	%25,50
Recycled	%0,00	%19,50

Figure 7. Global Plastic waste by Disposal from 1980 to 2015

Recycling is the process of separating usable products and parts from the used products and using and utilizing them in the production of the new products (Kumar et al., 2016). In the recycling process, the material is recovered without preserving the structure of the product (Fleischmann, 2003). In terms of wastes; it is the reuse of wastes for original purposes or for other purposes, including organic transformation, excluding energy recovery, by subjecting them to a production procedure. With recycling, recyclable materials in waste are brought back to the economy.

Stages of Recycling System

Collection; The recycling process of waste starts when the products are consumed. Recyclable components in solid waste require the waste to be collected regularly and economically at a specific location. Two basic collection methods are used; the first is the consumer to bring, the other is to reach and buy from the consumer. A collection system developed recently especially for the collection of packaging wastes is milk run. In this system, the vehicle that takes the products to one place picks up other wastes from the same place. In this way, the company can transform most of the packaging material used in production (Erdal et al., 2008).

Separation; The materials collected for recycling must be separated in the form and meticulousness required by the selected evaluation method. Also, undesirable substances are also eliminated at this stage from collected materials.

Evaluation; It is the economic recycling process of separated, cleaned and reprocessed materials. While this process, products are changed physically and chemically and return to the economy as new products.

Bringing the new product to the economy; It is the stage of bringing the recycled product to re-use (Şengül, 2010).

Deforestation

Deforestation means destroying forest areas to use them for other purposes like urban development or grazing (Van Kooten & Bulte, 2000) and agriculture. The amount of tropical forests decreases due to deforestation day by day and causes extinction of living creatures in these areas (Barraclough & Ghimire, 2000). This means that living things are left homeless, either to die or to look for other houses. Thus, biological diversity is decreasing. In addition, the greenhouse effect increases with deforestation (Angelsen & Kaimowitz, 1999). Myers says that half of all tropical forests on earth still exist (Myers, 1992). However, this situation is alarming. For this reason, efforts to save forests and rainforests continue in the world. In order for these efforts to be carried out efficiently, the main reasons for deforestation should be determined well. Pearce and Brown (1994) explained two basic factors affecting deforestation as follows.

- Human competition for ecological niches in land and coastal areas. Deforestation of fertile coastal and land regions and marketing them with various constructions such as hotels, facilities and houses.

- Failure in the functioning of economic systems. Forests are basically not given due importance by the governments and their real value and benefits are not marketed.

Under these two main factors, some direct causes of deforestation are given as follows.

Expansion of farming land: 60% of deforestation is for agricultural settlement (Myers, 1994). This value makes agricultural settlement the main source of deforestation. Millions of people live very cheaply in the rainforests. Most of these people are estimated to be foreign settlers. Increasing life in these areas causes the destruction of forest lands. As deforestation occurs, people migrate to find new forests, damaging new forests (Amor, 2008; Amor & Pfaff, 2008; Wilkie et al., 2000). This cycle goes on like this.

Logging and fuel wood: Fuel wood collection is common in degraded forest areas and tropical dry forests (Repetto, 1988; Rowe, Sharma & Bowder, 1992). Firewood is not usually the primary cause of deforestation in humid tropics, but it can happen in some populated areas.

Overgrazing: Although overgrazing is seen in some parts of the tropics, the main problem arises in dry areas when trees are cut down for grazing and natural vegetation. Soil erosion occurs because of overgrazing (Hays, 2008).

Fires: Although fire has benefits such as clearing forests and improving grasslands, when abused, fire may be a major reason of deforestation (Repetto, 1988; Rowe, Sharma & Bowder, 1992). According to the data of 118 countries representing 65 percent of the forests in the world, it is known that one percent of all forests which is an average of 19.8 million hectares is significantly affected by fires each year (Anon., 2010).

Mining: Mining is an activity that leaves intense destruction in nature and has destructive effects (Mather, 1991; Sands, 2005). It is not seen as a primary cause of deforestation as it is carried out on relatively small land. However, mining is seen as a gainful activity as it encourages people to settle in this area after deforestation (Staff, 2010).

20 football field sizes of forests are cut down every minute in the world. In 2030, it is predicted that only 10% of the current forests will exist. If deforestation is not prevented, all forests are in danger of extinction in less than 100 years. In this case, more erosion and landslides will occur in the world. In addition, there will be no more carbon emission by forests. Thus, the greenhouse effect will increase. Countries with the highest rates of deforestation are the Democratic Republic of Congo, Brazil and Indonesia (https://earth.org/the-biggest-environmental-problems-of-our-lifetime/).

Melting Ice Caps

The cryosphere (ice sphere), which consists of snow and glaciers in the world, reflects almost half of the rays coming from the sun to the earth and plays a fundamental role in the formation and protection of the energy (heat) balance of the Earth. Because of this property of the snow, soils outside the Polar Regions do not freeze easily. In this way, many plant species have the opportunity to live in areas where it snows (Akın, 2013). Also glaciers are water (Akhtar et al., 2008; Xu et al., 2010) and energy (Sternberg, 2010; Zimmermann, 2001) source. For example, the city of La Paz, which has a population of more than one million in Bolivia, provides 85% of its water needs from glaciers. But unfortunately it is known that global warming causes the temperature of both ocean waters and the atmosphere to rise. This temperature rise results in glaciers to melt faster than ever before (Akın, 2013; Barnhart et al., 2016; Day et al., 2012; Kay et al., 2011). It has been documented that this melting occurs continuously (Comiso, 2012; Kinnard et al., 2011; Rodrigues, 2008) and this process has been going on for centuries. Recent satellite observations show that the melting rate is much higher than predicted (Kattsov et al., 2010; Rampal et al., 2011). Glaciers and interglacial periods that occur in geological times result from the cycle of the solar system. In other words, it is a natural event that takes place within nature's own cycle. However, today's glacial melting is one of the events triggered by Global Warming, which is caused by overpopulation and excessive greenhouse gas emissions as a result of industrialization (Dedegil, 2007; Gibbard & Cohen, 2008; Lowe & Walker, 1999). At the end of the current century (in the year 2100), an increase of one meter in sea level is expected according to the most optimistic estimates. Three factors will cause a one-meter rise in sea level.

1. Global warming will cause about 30 cm rise by heating the water of the oceans.
2. Glaciers in mountains such as the Himalayan, Alpine, Andean and Rocky Mountains will melt with the effect of global warming. It is estimated that it will provide 30 cm rise in the oceans.
3. Also with the melting of the glaciers in Greenland, Alaska, the Arctic and Antarctica 30-40 cm rise is expected.

As stated above the most optimistic forecast is that by the end of this century, sea level will increase by about one meter as the glaciers in the North and South poles and high mountains melt. The extent of the danger can be better understood if one is remembered that more than a hundred million people around the world live along the continental coast at levels one meter above sea level. If the sea level rises by one meter, the people living there have to move to other settlements and the population of the migrated places will increase more than necessary. Therefore, as the land for agriculture in the migrated areas will be reduced, there will be drought and there will be no clean environment. Thirst, hunger and infectious diseases will cause problems in human life. If people living on the shores one meter above sea level want to live there, they will have to spend trillions of money to protect the sea shores by building concrete barriers. As a result of global warming, the coasts of countries such as Vietnam, Bangladesh, Egypt, Denmark, the Netherlands, America (Florida coasts) will become uninhabitable and some of the island states in the oceans will be removed from the map (Akın, 2013).

Overpopulation

The ability of living things to reproduce is one of their most basic common characteristics. The ability of living things to reproduce is different from each other. When evaluated in terms of reproduction number, although humans are one of the least reproducing creatures, the population of humans in the world is increasing rapidly. The average growth rate of the world population in recent years is around 1.7%. While the doubling time of the world's population occurred in 2000 years, the doubling time decreased to 40 years between 1950-1990 (Çamurcu, 2005). The main causes of overpopulation are lack of family planning, immigration, and a decrease in mortality. The rapid increase in the human population has increased the demand for development and caused environmental degradation by increasing the consumption of various natural resources. Global overpopulation causes many environmental problems. These problems are; global warming and climate change, environmental degradation, land / soil degradation, habitat destruction, depletion of natural resources, loss of biodiversity, air pollution, water pollution, water scarcity, food scarcity and health problems (Singh & Singh, 2017). According to the report published by the United Nations, the world population is expected to exceed 10 billion in 2050. Due to this dense population, it will be almost impossible for people to live in cities, and besides, there will be no clean water for drinking and communication tools will become inoperable. According to a study conducted by the National Academy of Sciences of the USA, if the population growth in the world continues to increase at today's rate, the number of population to be reached in 2075 will be 30 billion (Çamurcu, 2005).

Waste Disposal

Waste can be categorized according to various characteristics such as consumption, production, chemical and physical properties. One of these classifications is solid liquid and gaseous wastes. Waste of whatever source (commercial, domestic or industrial) can be defined as losing its usefulness after the use of raw materials, fuel and water and thus losing its economic value for the individual (Read, 1999). According to the United Nations Environment Program (UNEP), waste is defined as "substances that the owner does not want, need, do not use, that needs to be treated and disposed of" (Öztürk, 2010). Wastes are substances that are undesirable for human and environmental health and therefore must be disposed of regularly. The wastes in the waste cycle are in direct or indirect interaction with people and environment from the time they are produced to the time they are disposed of. Solid wastes can affect environment and people health directly with pathogenic substances or indirectly because of being a source of nutrition and reproduction for other creatures such as mice and flies. Since it is a source of nutrition and reproduction for other living things, it can indirectly affect the environment and human health negatively (Güler & Çobanoğlu, 1996; Tokgöz & Sarmaşık, 1982). The effects of wastes on the environment and people could be biological, chemical and physical. While diseases such as plague, leprosy, malaria, cholera, tuberculosis, dysentery, rabies that can be transmitted directly or by intermediate animals are examples of biological negativities, leakage waters and gases that occur in landfill sites cause biological and chemical adverse effects and wastes left in the environment irresponsibly can cause physical adverse effects to individuals. The relationship between the environment and human health and poor sanitation and waste management practices is evident in developed and developing countries (Palabıyık, 2001).

Solution Suggestions for Environmental Problems

It has been observed that human beings, who did not give sufficient importance to the environmental issue until the 1970s, began to notice these problems from the beginning of the 1970s with the increasing ecological problems. During this period, the existing economic system was questioned in various books, international conferences and meetings. It was stated that a new system that does not disrupt the functioning of the environment should be developed. For example, in 1972, in the capital city of Sweden, Stockholm, at the UN Conference on Environment and Development, the view “we have only one world” was adopted and some solution proposals were discussed in this conference (Karalar & Kiracı, 2011). One of the solutions of environmental problems discussed in this conference is sustainable development. Sustainable development means meeting the needs of today’s generations without eliminating the possibilities of meeting the needs of future generations (United Nations, 1987). The concept of sustainable development is based on two main ideas: 1- basic requirements, 2- reconciling the needs of current and future generations, taking into account the renewal capacity of the environment (Conca & Geoffrey, 2004). Sustainable development is important for the protection of natural resources. Since the possibility of self-renewal of the natural resources stock has disappeared with human activities today, a decrease in the natural resources stock is inevitable. Here, the basic philosophy of sustainable development is to stop this decrease in natural resources stock and help nature to renew itself (Ergün & Çobanoğlu, 2017). For this reason, it is necessary to have the awareness of sustainable development both as managers and as society in order to prevent the environmental problems that we encounter. Another solution to environmental problems is to stop using fossil fuels. Fossil fuels emit large amounts of carbon to the atmosphere and this carbon release causes many environmental problems. So we should use clean renewable energy sources instead of fossil fuels. The term “renewable energy” is energy that is based on self-renewing energy sources such as wind, sunlight, earth’s internal heat, flowing water and biomass such as energy crops, industrial and agricultural waste. These resources can be used for electrical energy in all economic sectors, but also for fuel in transport and heat generation in buildings and industrial activities (Bull, 2001). Other solutions can be sorted as the emergence of minimalist lifestyles, a tendency to live with zero waste, the necessity of using recycled products while producing new products, the environmentally friendly products of cleaning products to be produced and the increase in organic farming efforts (Erten, 2020). In addition, education has an important role in preventing environmental problems. With environmental education, it is ensured that individuals both gain ecological knowledge and develop positive attitudes towards the environment. Then, these attitudes can be transformed into a positive behavior towards the environment. Environmental education addresses cognitive, affective and psychomotor learning areas of individuals. Therefore, environmental education is a process that includes the development of knowledge and skills, the formation of value judgments and attitudes, the demonstration of environmentally friendly behaviors and the results of these in individuals, in order to protect the environment (Erten, 2004; Erten, 2020). This education should be given to all levels of society, regardless of age, profession and gender.

Eco-friendly person activity

How Eco-Friendly Person You Are?

Aims of the activity: - To help students gain environmentally friendly habits.

- To help students be aware of themselves in terms of being an eco-friendly person.

Time: 30 days

Activity content: The eco-friendly behaviors chart given in Table 2 will be distributed to students. Students will perform the behaviors in the chart within 30 days and will prove them with photographs or explanations. As a result of each behavior performed, they will obtain the specified score. If students perform the specified activities more than once, they will earn points as many times as they have done. After completing the activities, students will get eco-friendly person total points. The activity period will be repeated every 30 days and an eco-friendly person of each month will be declared.

Table 2. Eco-Friendly Behaviors Chart

Activity no	Activity information	Photos and explanations of activity	Score
1	Storing household wastes in the form of plastic-glass-paper separately for recycling		10
2	Delivering glass, plastic or paper to recycling units		10
3	Planting a total of five tree saplings		10
4	Providing information to a friend or a family member about environmental problems		10
5	Using recycled products		10

6	Turning off wireless, laptop and mobile phone before going to sleep at night		10
7	Using public transport to go anywhere		10
8	Growing flower(s) in the house		10
9	Collecting garbage found in a park		10
10	Preparing a poster that will take attention to the melting of the glaciers and sharing it on a social media account		10
11	Following news regarding current environmental issues from the Internet / newspapers / scientific journals		10
12	Preparing a poster to take attention of the endangered animals and sharing them on a social media account		10
13	Preparing a poster to take attention of the endangered plants and sharing them on a social media account		10
14	Using environmentally friendly cleaning products (detergent, toothpaste and body spray etc.)		10
15	Using reusable non-plastic bags instead of plastic ones in shopping		10

References

Abbasi, T., Poornima, P., Kannadasan, T., & Abbasi, S. A. (2013). Acid rain: past, present, and future. *International Journal of Environmental Engineering*, *5*(3), 229-272. https://doi.org/10.1504/IJEE.2013.054703.

Ahldom, A. & Feychting, M. (2003). Electromagnetic radiation: Environmental pollution and health. *British Medical Bulletin*, *68*, 157-165. https://doi.org/10.1093/bmb/ldg030

Akhtar, M., Ahmad, N., & Booij, M. J. (2008). The impact of climate change on the water resources of Hindukush–Karakorum–Himalaya region under different glacier coverage scenarios. *Journal of Hydrology, 355*(1), 148–163. https://doi.org/10.1016/j.jhydrol.2008.03.015

Akın, G. (2013). Yüzyılımızın temel sorunlarından biri; buzulların erimesi. *Antropoloji*, (25), 9-27. https://doi.org/10.1501/antro_0000000027

Akman, Y., Ketenoğlu, O., Evren, H., Kurt, L., & Düzenli, S. (2000). Çevre *kirliliği*. Ankara: Palme Yayıncılık.

Amor, D. (2008). *Road impact on deforestation and jaguar habitat loss in the Selva Maya*. Ph. D. dissertation. Ecology Department, Nicholas School of the Environment, Duke University.

Amor, D., & Pfaff, A. (2008). *Early history of the impact of road investments on deforestation in the Mayan forest*. Working Paper, Nicholas School of the Environment and Sanford School of Public Policy, Duke University, Durham, NC, USA.

Angelsen, A., & Kaimowitz, D. (1999). Rethinking the causes of deforestation: lessons from economic models. *The world bank research observer*, *14*(1), 73-98. https://doi.org/10.1093/wbro/14.1.73

Anonymous, (2010). *Global Forest Resources Assessment*, 2010-Main Report. FAO Forestry Paper 163. Rome, Italy.

Ashraf, M. A., Maah, M. J., Yusoff, I., & Mehmood, K. (2010). Effects of polluted water irrigation on environment and health of people in Jamber, District Kasur, Pakistan, *International Journal of Basic & Applied Sciences*, *10*(3), 37-57.

Aslan, Z., Gölbaşı, O., Koçer, D., Tunca, Z., Işık, E., Yelkenci, A., Bağdaş, D., Devlen, A., Özdemir, T., Yelkenci, K., Demirciler, T., İkizler, U., Karamahmutoğlu, A., Koçer, M., Mutlu, M., Özyar, Ü., & İpek, H., (2011). *Türkiye'de gece gökyüzü parlaklığının* ölçülmesi, 8. Ulusal Aydınlatma Kongresi, 14-15 Nisan Bildiri Kitabı s:69.4.

Barnhart, K., Miller, C., Overeem, I., & Kay, J. (2016). Mapping the future expansion of Arctic open water. *Nature Climate Change, 6*(3), 280–5. https://doi.org/10.1038/nclimate2848

Barraclough, S. L., & Ghimire, K. B. (2000). *Agricultural expansion and tropical deforestation: Poverty, international trade, and land use*. London: Earthscan.

Bayar, A. B., & Bahrend. H. (1994). *Küresel* çevre *problemleri*. Ankara: Özkan matbaası

Berglund, B., & Lindvall, T. (1995). (eds.) Community noise. *Archives of the center for sensory research, 2*(1), 1-195.

Bull, S. R. (Aug.-2001). Renewable energy today and tomorrow. In *Proceedings of the IEEE*, 89(8), 1216-1226. https://doi.org/10.1109/5.940290

Çağlar Irmak, N., & Hepçimen, A. Z. (2010). Ağır metal toprak kirliliğinin gıda zinciri ve insan sağlığına etkisi. *Akademik Gıda*, *8*(2), 31-35.

Cameron, Z., & Ward, J. S. (2020). Ozone layer depletion: Overview. *INOSR Experimental Sciences 6*(1), 36-42.

Çamurcu, H. (2005). Dünya nüfus artışı ve getirdiği sorunlar. *Balıkesir Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, *8*(13), 87-105.

Cohen, S., & Weinstein, N. (1981). Non-auditory effects of noise on behavior and health: *J Social Issues, 37*(1), 36–70. https://doi.org/10.1111/j.1540-4560.1981.tb01057.x

Comiso, J. C. (2012). Large decadal decline of the Arctic multiyear ice cover. *Journal of Climate, 25*(4). 1176–1193. https://doi.org/10.1175/JCLI-D-11-00113.1

Conca, K., & Geoffrey, D. D. (2004). *Green planet blues, environmental politics from Stockholm to Johannesburg*. Colorada: Westview Pres.

Day, J. J., Hargreaves, J. C., Annan, J. D., & Abe-Ouchi, A. (2012). Sources of multi-decadal variability in Arctic sea ice extent. *Environmental Research Letters, 7*(3). http://dx.doi.org/10.1088/1748-9326/7/3/034011

Dedegil, Y. (2007). Dünya ısınıyor mu? Buzullar eriyor mu? Denizler yükseliyor mu? Gerçekse neden ve ne kadar? *EMO Enerji 3*,30-33.

Demirtaşlı, E. (1967). Jeolojinin ana prensipleri ve temel konuları. *Bilimsel Madencilik Dergisi, 6*(4), 259-267.

Díaz, S., Fargione, J., Chapin III, F. S., & Tilman, D. (2006). Biodiversity loss threatens human well-being. *PLoS Biol, 4*(8), 1300-1305. https://doi.org/10.1371/journal.pbio.0040277

Dojlido, J., & Best, G. A. (1993). *Chemistry of water and water pollution*. Ellis Horwood Limited.

Eckenfelder, W. (2000). *Industrial water pollution control*. McGraw-Hill.

Environmental Protection Agency. (2016). Noise pollution. Retrived from https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=2000U8Y1.txt at 01.05.2021.

Erdal, M., Görçün, Ö. F., Görçün, Ö., & Saygılı, M. S. (2008). *Entegre lojistik yönetimi*. İstanbul: Beta yayınları.

Ergün, T., & Çobanoğlu, N. (2017). Sürdürülebilir kalkınma ve çevre etiği. *Ankara Üniversitesi Sosyal Bilimler Dergisi*, *3*(1).

Ermol, C. (2008). *900 ve 1800 mhz mobil telefonların oluşturduğu elektromanyetik alanın tendon iyileşmesine etkisi: ratlard*a deneysel çalışma. Yüksek Lisans Tezi. Süleyman Demirel Üniversitesi, Tıp Fakültesi, Isparta.

Erten, S. (2004). Çevre eğitimi ve çevre bilinci nedir, çevre eğitimi nasıl olmalıdır? Çevre *ve* İnsan *Dergisi,* Çevre *ve Orman Bakanlığı Yayın Organı, 65*-66.

Erten, S. (2020). *Fen ve teknoloji uygulamalarının* çevreye *etkileri. Teknoloji ve elektromanyetik dalgalar*. Güven Yıldırım, E. & Önder, A. N. (Ed.) *Senaryolarla desteklenmiş fen ve teknoloji uygulamaları*. Ankara: Anı Yayıncılık.

European Public Health Alliance, (2009). *Air, Water Pollution and Health Effects*. Retrieved from http://www.epha.org/r/54 at 30.04.2021.

Fereidoun, H., Nourddin, M. S., Rreza, N. A., Mohsen, A., Ahmad, R., & Pouria, H. (2007). The effect of long-term exposure to particulate pollution on the lung function of Teheranian and Zanjanian students. *Pak J Physiol, 3*(2), 1–5.

Feychting, M., Ahlbom, A., & Kheifets, L. (2005). EMF and health. *Annu Rev Public Health, 26*, 165-189. https://doi.org/10.1146/annurev.publhealth.26.021304.144445

Firdaus, G., & Ahmad, A. (2010). *Noise pollution and human health: a case study of municipal corporation of Delhi*. Indoor and Built Environment, Sage Publications.

Fleischmann, M. (2003). Reverse logistics network structures and design. *Available at SSRN 370907*.

Geyer, R., Jambeck, J. R., & Law, K. L. (2017). Production, use, and fate of all plastics ever made. *Science advances*, *3*(7), e1700782. https://doi.org/10.1126/sciadv.1700782

Gibbard, P., & Cohen, K. M. (2008). Global chronostiatigraphical correlation table for the last 2,7 million years. *Episodes Journal of International Geoscience, 31*(2), 243-247. http://dx.doi.org/10.18814/epiiugs/2008/v31i2/011

Graham, C., Cook, M. R., Cohen, H. D., & Gerkovich, M. M. (1994). Dose response study of human exposure to 60 hz electric and magnetic fields. *Bioelectromagnetics, 15*, 447–463. https://doi.org/10.1002/bem.2250150508

Güler, Ç., & Çobanoğlu, Z. (1996). *Sağlık açısından* çöp. Ankara: Tıbbi Dokümantasyon Merkezi Toplum Sağlığı Dizisi, 14.

Güler, Ç., & Çobanoğlu, Z. (1997). *Toprak kirliliği*. TC Sağlık Bakanlığı *Çevre* Sağlığı Temel Kaynak Dizisi, *40*.

Hays, J. (2008). Deforestation and desertification in China. Retrived from http://

factsanddetails.com/china.php?itemid=389&catid=10&s ubcatid=66 at 04.05.2012.

Heywood, V. H., & Watson, R. T. (1995). *Global biodiversity assessment*. 1140. Cambridge: Cambridge university press.

https://earth.org/the-biggest-environmental-problems-of-our-lifetime/

https://ourworldindata.org/plastic-pollution?utm_source=newsletter

https://www.madr.ro/docs/ind-alimentara/risipa_alimentara/presentation_food_waste.pdf

Hunashal, R. B., & Patil, Y. B. (2012). Assessment of noise pollution indices in the city of Kolhapur, India‖. *Procedia - Social and Behavioral Sciences. 37*, 448 – 457.

IUCN. (2021). The IUCN Red List of Threatened Species. Retrived from https://www.iucnredlist.org/ in 03.05.2021.

Jepsen, E. M., & De Bruyn, P. N. (2019). Pinniped entanglement in oceanic plastic pollution: A global review. *Marine Pollution Bulletin, 145*, 295-305. https://doi.org/10.1016/j.marpolbul.2019.05.042

Jin, G., Li, G., Zhou, M., & Ni, Y. (2005). Research on allocation of gross electromagnetic pollution emission right in power quality markets. *IEEE, (1),* 320-325. *https://doi.org/10.1109/PES.2005.1489325*

Johnston, R. J. (1989). *Environmental problems: nature, economy and state*. Belhaven Press, Pinter.

Kang, G. H., Lee, C. H., Seo, J. W., Sung, R. H., Chung, Y. H., Lee, S. K., Suh, Y. H., & Chi, J. G. (1997). In vivo study on the harmful effect of the extremely low frequency unipolar pulsating magnetic field in mice. *Korean Medical Science, 12*(2), 128–134. https://doi.org/10.3346/jkms.1997.12.2.128

Karaca, A., & Turgay, O. C. (2012). Toprak kirliliği. *Toprak Bilimi ve Bitki Besleme Dergisi*, *1*(1), 13-19.

Karalar, R., & Kiracı, H. (2011). Çevresel Sorunlara karşı bir çözüm önerisi olarak sürdürülebilir tüketim düşüncesi. *Dumlupınar Üniversitesi Sosyal Bilimler Dergisi*, (30), 63-76.

Kattsov, V. M., Ryabinin, V. E., Overland, J. E., Serreze, M. C., Visbeck, M., Walsh, J. E., Meier, W., & Zhang, X. (2010). Arctic sea ice change: a grand challenge of climate science, *Journal of Glaciology, 56*(200), 1115–21.

Kay, J. E., Holland, M. M., & Jahn, A. (2011). Inter-annual to multi-decadal Arctic sea ice extent trends in a warming World. *Geophysical Research Letters, 38*(15), L15708. https://doi.org/10.1029/2011GL048008

Khan, M. A., & Ghouri, A. M. (2011). Environmental pollution: its effects on life and its remedies. *Researcher World: Journal of Arts, Science & Commerce*, *2*(2), 276-285.

Khomenko, S., Cirach, M., Pereira-Barboza, E., Mueller, N., Barrera-Gómez, J., Rojas-Rueda, D., ... & Nieuwenhuijsen, M. (2021). Premature mortality due to air pollution in European cities: a health impact assessment. *The Lancet Planetary Health*, *5*(3), e121-e134. https://doi.org/10.1016/S2542-5196(20)30272-2

Kimani, N. G. (2007). Environmental pollution and impact to public health. *Implication of the Dandora Municipal Dumping Site in Nairobi, Kenya. A pilot study report In cooperation with The United Nations Environment Programme (UNEP)*.

Kingsland, S. (1995). *Modeling nature: Episodes in the history of population ecology*. Chicago: University of Chicago Press.

Kinnard, C., Zdanowicz, C. M., Fisher, D. A., Isaksson, E., de Vernal, A., & Thompson, L.G. (2011). Reconstructed changes in Arctic sea ice over the past 1450 years. *Nature, 479*(7374), 509–512. https://doi.org/10.1038/nature10581

Köklükaya, A. N. (2013). Öğrencilerin *elektromanyetik kirliliğe sebep olan bazı teknolojik cihazların bilinçli kullanımına ilişkin farkındalık düzeylerinin incelenmesi ve geliştirilmesi.* Yüksek Lisans Tezi, Gazi Üniversitesi Eğitimm Bilimleri Enstitüsü, Ankara.

Köklükaya, A. N., & Selvi, M. (2015). Elektromanyetik kirliliğe sebep olan teknolojik cihazların bilinçli kullanımına ilişkin farkındalık ölçeğinin geliştirilmesi. *Ahi Evran Üniversitesi Kırşehir Eğitim Fakültesi Dergisi*, *16*(3), 105-121.

Köklükaya, A. N., Yıldırım, E. G., & Selvi, M. (2017). The relationship between pre-service teachers' awareness levels of electromagnetic pollution and other environmental problems. *Eurasian Journal of Educational Research, 16*(67), 17-35. http://dx.doi.org/10.14689/ejer.2017.67.2

Kromm, D. E. (1973). Response to air pollution in Ljubljana, Yugoslavia. *Annals of the Association of American Geographers*, 63(2), 208-217. https://doi.org/10.1111/j.1467-8306.1973.tb00919.x

Kumar, A., Sivakumar, R., Reddy, Y. S. R., Raja, B., Nishanth, T., & Revanth, V. (2016).

Preliminary study on marine debris pollution along Marina beach, Chennai, India. *Regional Studies in Marine Science*, *5*, 35-40. http://dx.doi.org/10.1016/j.rsma.2016.01.002

Longcore, T., & Rich, C. (2004). Ecological light pollution. *Front Ecol Environ, 2*(4), 191–198. https://doi.org/10.1890/1540-9295(2004)002[0191:ELP]2.0.CO;2

Lowe, S. S. & Walker M. S. C. (1999). *Reconstructing quaternary environments*. England: Longman Group.

Mäler, K. G. (1990). International environmental problems. *Oxford Review of economic policy*, *6*(1), 80-108.

Manisalidis, I., Stavropoulou, E., Stavropoulos, A., & Bezirtzoglou, E. (2020). Environmental and health impacts of air pollution: A review. *Frontiers in public health*, *8 (14)*. https://doi.org/10.3389/fpubh.2020.00014

Mather, A. S. (1991). *Global forest resources*. International Book Distributors, Dehra Dun.

Mato, Y., Isobe, T., Takada, H., Kanehiro, H., Ohtake, C., & Kaminuma T. (2001). Plastic resin pellets as a transport medium for toxic chemicals in the marine environment, *Environmental Science and Technology, 35*(2), 318-324. https://doi.org/10.1021/es0010498

McIntosh, R. P. (1985). *The background of ecology*. Cambridge: Cambridge University Press.

Menz, F. C., & Seip, H. M. (2004). Acid rain in Europe and the United States: an update. *Environmental Science & Policy*, *7*(4), 253-265. https://doi.org/10.1016/j.envsci.2004.05.005

Miri, M., Alahabadi, A., Ehrampush, M.H., Rad, A., Lotfi, M.H., Sheikhha, M.H., & Sakhvidi, M. J. Z. (2018). Mortality and morbidity due to exposure to ambient particulate matter. *Ecotoxicol. Environ. Saf. 165*, 307–313. https://doi.org/10.1016/j.ecoenv.2018.09.012

Mitman, G. (1992). *The state of nature: Ecology, community and American social thought, 1900–1950*. Chicago: University of Chicago Press.

Moss, B. (2008). Water pollution by agriculture. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *363*(1491), 659-666. https://doi.org/10.1098/rstb.2007.2176

Myers, N. (1992). *The primary source: Tropical forests and our future*. New York: Norton.

Myers, N. (1994). *Tropical deforestation: rates and patterns*. In: Brown, K., Pearce, D.W. (Eds.), *The Causes of Tropical Deforestation*., London: University College London Press.

Newman, P. A., Daniel, J. S., Waugh, D. W., & Nash, E. R. (2007). A new formulation of equivalent effective stratospheric chlorine (EESC). *Atmospheric Chemistry and Physics*, *7*(17), 4537-4552. https://doi.org/10.5194/acp-7-4537-2007

Noss, R. F., & Cooperrider, A. (1994). *Saving nature's legacy: protecting and restoring biodiversity*. Washington: Island Press.

NRC. Advancing the Science of Climate Change. (2010). *National research council*. The National Academies Press: Washington, DC, USA.

Önder, A. N. & Güven Yıldırım, E. (2020). *Teknoloji ve elektromanyetik dalgalar*. Güven Yıldırım, E. & Önder, A. N. (Ed.) *Senaryolarla desteklenmiş fen ve teknoloji uygulamaları*. Ankara: Anı Yayıncılık.

Öztürk, İ. (2010). Katı atık yönetim ve AB uygulamaları. İstanbul: İSTAÇ Teknik Kitaplar Serisi 2.

Palabıyık, H. (2001). *Belediyelerde kentsel katı atık yönetimi: İzmir Büyükşehir Belediyesi* Örneği. DEÜ Sosyal Bilimler Enstitüsü, Doktora Tezi, İzmir.

Pearce, D., & Brown, K. (1994). S*aving the world's tropical forests. In the causes of tropical of tropical deforestation*. Brown, K., & Pearce, D. (eds.). *The economic and statistical analysis of factors giving rise to the loss of the tropical forest*, UCL Press.

Plutynski, A. (2018). *Ecology and the Environment*. The Oxford Handbook of Philosophy of Biology (Ed: Michael Ruse). Retrived from https://core.ac.uk/download/pdf/295732117.pdf 30.04.20201.

Rajkhowa, R. (2014). Light pollution and impact of light pollution. *International Journal of Science and Research*, *3*(10), 861-867.

Rampal, P., Weiss, J., Dubois, C., & Campin, J. M. (2011). IPCC climate models do not capture Arctic sea ice drift acceleration: Consequences in terms of projected sea ice thinning and decline. *Journal of Geophysical Research: Oceans*, *116*(C8). https://doi.org/10.1029/2011JC007110

Read, A. D. (1999). A weekly doorstep recycling collection, I had no idea we could!: Overcoming the local barriers to participation. *Resources, Conservation and Recycling, 26*, 217 -249. https://doi.org/10.1016/S0921-3449(99)00008-7

Redl, R. (2001). Electromagnetic environment impact of power electronics equipment. *Proceedings of the IEEE, 89*(6), 926-938. http://dx.doi.org/10.1109/5.931490

Repetto, R. (1988). *The forest for the trees? Government policies and the misuse of forest resources*. World Resource Institute, Washington DC.

Ring, M. J., Lindner, D., Cross, E. F., & Schlesinger, M. E. (2012). Causes of the global warming observed since the 19th century. *Atmospheric and Climate Sciences*, *2*, 401-415. http://dx.doi.org/10.4236/acs.2012.24035

Rodrigues, J. M. (2008). The rapid decline of the sea ice in the Russian Arctic. *Cold Regions Science and Technology. 54*(2),124–142. http://dx.doi.org/10.1016/j.coldregions.2008.03.008

Rowe, R., Sharma, N. P., & Bowder, J. (1992). *Deforestation: problems, causes and concern*. In: *Managing the world's forest: looking for balance between conservation and development*, ed. Sharma, N. P. Pp 33-46. Kendall/Hunt Publishing Company, Iowa.

Roy, S. (2020). Ozone depletion and global environment. *Adv Earth & Env Sci. 1*(1), 1-5.

Rye, J., & Rubba, P. (2000). *Student understanding of global warming: Implications for STS education beyond 2000*. Kumar, D., & Chubin, K. (Ed). *Science, Technology, and Society: A Sourcebook on Research and Practice* New York: Plenum 193-230.

Saad L. (2009). Water pollution Americans' top green concern. Retrived from http://www.gallup.com/poll/117079/waterpollution-americans-top-green-concern.aspx at 01.05.2021.

Sands, R. (2005). *Forestry in a global context*. CABI Publishing.

Schell, L. M., Gallo, M. V., Denham, M., & Ravenscroft, J. (2006). Effects of pollution on human growth and development: An introduction. *Journal of Physiological Anthropology*, *25*(1), 103-112. https://doi.org/10.2114/jpa2.25.103

Schlesinger, M. E., & Ramankutty, N. (1994). An oscillation in the global climate system of period 65-70 years. *Nature, 367*, 723-726. https://doi.org/10.1038/367723a0

Schulz, T. J. (1978). Synthesis of social surveys on noise annoyance: *J Acoust Soc Amer, 64*, 377–405. https://doi.org/10.1121/1.382013

Scipeeps, (2009). *Effects of water pollution*. Retrieved from http://www.scipeeps.com/ at 01.05.2021.

Şengül, Ü. (2010). Atıkların geri dönüşümü ve tersine lojistik. *Paradoks Ekonomi, Sosyoloji ve Politika Dergisi*, 6(1), 73-86.

Singer, S. F. (1970). Global effects of environmental pollution. *Eos, Transactions American Geophysical Union*, *51*(5), 476-478. https://doi.org/10.1029/EO051i005p00476

Singh, R. L. & Singh, P. K. (2017). *Global environmental problems.* Singh, R. L. (Ed.). *Principles and applications of environmental biotechnology for a sustainable future*. (E-Book). Singapore: Springer.

Smith, R. A. (1872). *Air and rain. The beginnings of chemical climatology*. London: Longmans, Green.

Staff, S. (2010). *Mining deforestation nearly tripled between 2000-08*. Archives, Wednesday October 13 2010.

Steinberg, F. (2007). Jakarta: Environmental problems and sustainability. *Habitat International*, *31*(3-4), 354-365. https://doi.org/10.1016/J.HABITATINT.2007.06.002

Sternberg, R. (2010). Hydropower's future, the environment, and global electricity systems. *Renewable and Sustainable Energy Reviews, 14*(2), 713–723. https://doi.org/10.1016/j.rser.2009.08.016

Sümer, G. Ç. (2014). Hava kirliği kontrolü: Türkiye'de hava kirliliğini önlemeye yönelik yasal düzenlemelerin ve örgütlenmelerin incelenmesi. *Uluslararası İktisadi ve İdari İncelemeler Dergisi*, (13), 37-56.

The Royal Society. (2010). *Climate change: A summary of the science*. London: The Royal Society Science Policy Centre.

Thiel, M., Luna-Jorquera, G., Álvarez-Varas, R., Gallardo, C., Hinojosa, I. A., Luna, N., Urbina- Miranda, D., Morales, N., Ory, N., Pacheco, A. S., Portflitt-Toro, M., & Zavalaga, C. (2018). Impacts of marine plastic pollution from continental coasts to subtropical gyres—fish, seabirds, and other vertebrates in the SE Pacific. *Frontiers in Marine Science, 5*(238). https://doi.org/10.3389/fmars.2018.00238

Tokgöz, M., & Sarmaşık, N. (1982). Çöp *sorunu ve sağlık*. Çevre 82 Sempozyumu. İzmir.

U.K. Met Office. (2011). *Warming: A guide to climate change*. Exeter, U.K.: Met Office Hadley Centre.

United Nations General Assembly. (1987). Report of the World Commission on Environment and Development: Our Common Future. https://sustainabledevelopment.un.org/

content/documents/5987our-common-future.pdf

Uygunol, O., & Durduran, S. S. (2008). Elektromanyetik kirlilik haritalarının coğrafi bilgi sistemi (cbs) yardımıyla oluşturulması. *TMMOB Harita ve Kadastro Mühendisleri Odası Ankara Şubesi I. CBS Günleri Sempozyumu.* Ankara.

Van Kooten, G. C., & Bulte, E. H. (2000). *The economics of nature: managing biological assets*. Blackwells

Varol, S., Davraz, A., & Varol, E. (2008). Yeraltı suyu kimyası ve sağlığa etkisinin tıbbi jeoloji açısından değerlendirilmesi. *TAF Prev Med Bull, 7*(4), 351-356.

Widiyawati, Y. (2020, April). Global warming & climate change: integration of socio-scientific issues to enhance scientific literacy. In *Journal of Physics: Conference Series* (Vol. 1511, No. 1, p. 012071). IOP Publishing. https://doi.org/10.1088/1742-6596/1511/1/012071

Wilén, J., Johansson, A., Kalezic, N., Lyskov, E., & Sandström, M. (2006). Psychophysiological tests and provocation of subjects with mobile phone related symptoms. *Bioelectromagnetics, 27*, 204-14. https://doi.org/10.1002/bem.20195

Wilkie, D., Shaw, E., Rotberg, F., Morelli, G., & Auzels, P. (2000). Roads, development and conservation in the Congo Basin. *Conservation Biology 14*(6),1614-1622.

Wilson, E. O. (2002). *The future of life*. New York: Alfred A. Knopf.

World Health Organization. WHO (2009). Global Health Risks: Mortality and Burden of Disease Attributable to Selected Major Risks. *World Health Organization*, Geneva. https://apps.who.int/iris/handle/10665/44203

Xiong, X., Maddy, E. S., Barnet, C., Gambacorta, A., Patra, P. K., Sun, F., & Goldberg, M. (2014). Retrieval of nitrous oxide from Atmospheric Infrared Sounder: Characterization and validation. *Journal of Geophysical Research: Atmospheres*, *119*(14), 9107-9122. http://dx.doi.org/10.1002/2013JD021406

Xu, C., Chen, Y., Yang, Y., Hao, X., & Shen, Y. (2010). Hydrology and water resources variation and its response to regional climate change in Xinjiang. *Journal of Geographical Sciences, 20*(4), 599–612. http://dx.doi.org/10.1007/s11442-010-0599-6

Yazdanparast, T., Salehpour, S., Masjedi, M. R., Seyedmehdi, S. M., Boyes, E., Stanisstreet, M., & Attarchi, M. (2013). Global warming: Knowledge and views of Iranian students. *Actan Medica Iranica, 51*(3), 178-184.

Zimmermann, M. (2001). Energy situation and policy in Switzerland. *International Journal of Ambient Energy, 22*(1), 29–34. https://doi.org/10.1080/01430750.2001.9675384

Zoray, F., & Pır, A. (2007). *Küresel* ısınma *problemi: sebepleri, sonuçlar,* çözüm *yolları*. Yıldız Teknik Üniversitesi Çevre Mühendisliği Bölümü. İstanbul.

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Chapter 13

Energy Resources and Energy Conservation

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Energy and the Importance of Energy

Human and environment are inseparable parts of a continuous whole and the balance between human and environment has been going on for millions of years. However, especially since the 19^{th} century, with the transition from the living conditions provided by nature to the living conditions created in line with human needs, many problems have been encountered in the relationship between human and environment. With the globalization of environmental problems, human beings have realized that they are rapidly consuming natural resources and have searched for different energy resources.

The word energy is derived from the Greek words en (in) and ergon (work). In its most general form, the ability of a substance or system of substances to work is defined as energy (EIA, 2020a; Spurgeon & Flood, 2014). In the scientific literature, energy is defined in different ways because it is an interdisciplinary concept. According to chemistry, energy is stored in the chemical bonds of atoms and molecules and occurs due to the arrangement of the molecules in the matter. Energy for physics; It causes objects to move or change and is the capacity of matter to do work. According to biology, energy is a cycle between living beings that take its source from the sun (Karaca & Göktan, 2007; Kurnaz, 2007; Spurgeon & Flood, 2014; Trefil & Hazen, 2004). Energy is seen as one of the most basic needs of all societies today and is accepted as one of the most important indicators of development by the world countries.

Today's rapid population growth, changing technology and development processes in industrial activities rapidly increase the energy needs of all countries. The concept of energy, which is closely related to the economic and political development level of countries, is seen as one of the basic inputs of all systems that a nation will establish for its economic and social development. Energy, which is seen as a basic need, has become one of the most important factors in determining the policies that countries should follow. But today, a significant part of the energy production in the world is obtained from non-renewable energy sources, most of which are fossil fuels. However, the fact that fossil fuels will be depleted in the near future, causing serious damage to the environment, and the encouragement of environmentally friendly and innovative technologies in accordance with the Kyoto Protocol, directs countries to renewable energy resources

(Boz, 2020; Fırat, Sepetçioğlu, & Kiraz, 2012). Therefore, clean, renewable, continuous and quality energy sources are needed to ensure a sustainable development and to prevent foreign dependency in energy.

Types of Energy

Energy appears in different forms in our daily life. According to the I. law of thermodynamics, the total amount of energy in a system remains constant. This law that states energy cannot be created or destroyed but may be changed from one form to another. Taking advantage of this law, energy is produced in different forms such as heat, light, nuclear, chemical and electrical energy in order to continue our daily activities. However, energy is generally examined under two headings, potential and kinetic. Potential energy is the energy an object has due to its position. Kinetic energy is defined as the energy that the object has due to its motion. The sum of the kinetic energy and potential energy of a system is called mechanical energy (Çengel, Boles, & Kanoğlu, 2019; TÜRÇEV, 2014). According to another classification, while potential energy is stored energy and positional energy, kinetic energy is defined as the energy resulting from the movement of waves, electrons, atoms, molecules, substances and objects. Potential and Kinetic energy types are summarized in Figure 1 (EIA, 2020b).

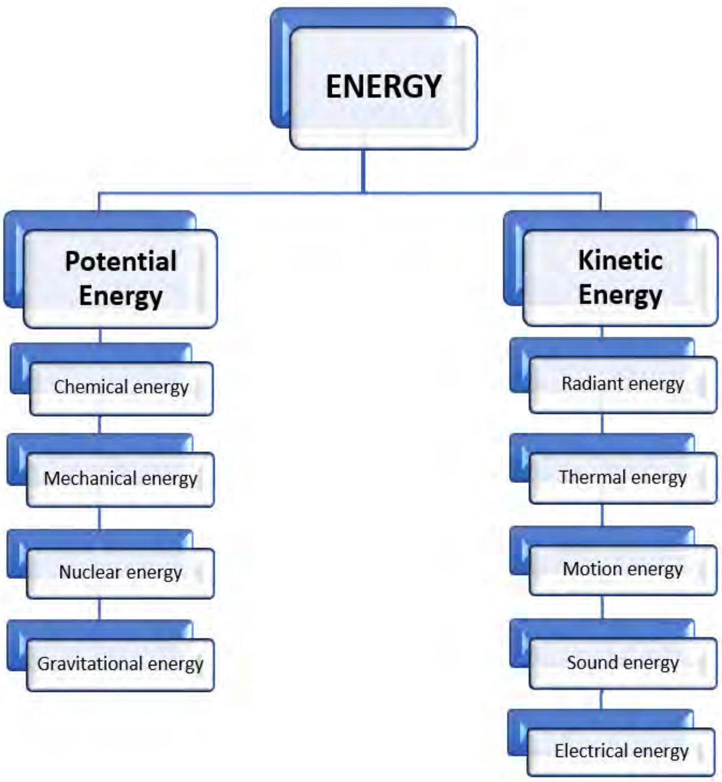


Figure 1. Types of Energy

One of the potential energy types is chemical energy. This energy is stored in the bonds of atoms and molecules. Mechanical energy is stored in objects by tension and Nuclear energy is stored in the nucleus of an atom the energy that holds the nucleus together. Gravitational energy is energy an object has because of its position or height. One of the kinetic energy types, Radiant energy, is explained as electromagnetic energy that travels in transverse waves. Thermal energy is the energy that comes from the movement of atoms in a substance. Motion energy is energy stored in the movement of objects and Sound is the movement of energy through substances in the form of compression waves. Electrical energy is provided by tiny charged particles called electrons, typically moving through a wire (EIA, 2020b).

Energy Literacy

Partnership for 21st Century Learning (P21), a strategic education project, explains the skills that individuals are expected to acquire in the 21st century. Energy literacy skills are among the main topics of 21st century skills in this project (Gelen, 2017). The concept of energy literacy is basically based on the Theory of Planned Behavior first put forward by Fishbein and Ajzen (1975) and developed by Ajzen (1985; 1991).

Energy literacy describes the awareness and competence individuals need to make conscious choices and pay attention to energy conservation. This concept also expresses a broad content knowledge about affective and behavioral dimensions (DeWaters, Qaqish, Graham, & Powers, 2013; Lay, Khoo, Treagust, & Chandrasegaran, 2013). Energy literacy is defined as making conscious choices about energy in daily life, both affectively and behaviorally. Energy literacy; to understand the role of energy in the universe and our lives, to find answers to questions about energy with this understanding, to solve problems related to energy (Boz, 2020; DeWaters & Powers, 2011; Öykün & Abbasoğlu, 2017). Energy literacy is also to pay attention to the efficient use of energy resources, to have knowledge about the production and consumption of energy, and to realize the environmental, social and global effects of energy use (Fah, Hoon, Munting, & Chong, 2012).

Classification of Energy Resources

Resources that obtain energy economically with different methods are named as energy resources. Energy resources are examined under two separate titles according to their convertibility and usability (Figure 2). Energy sources are classified as primary and secondary energy sources according to their convertibility, and as non-renewable and renewable energy sources in terms of their use (Koç & Şenel, 2013).

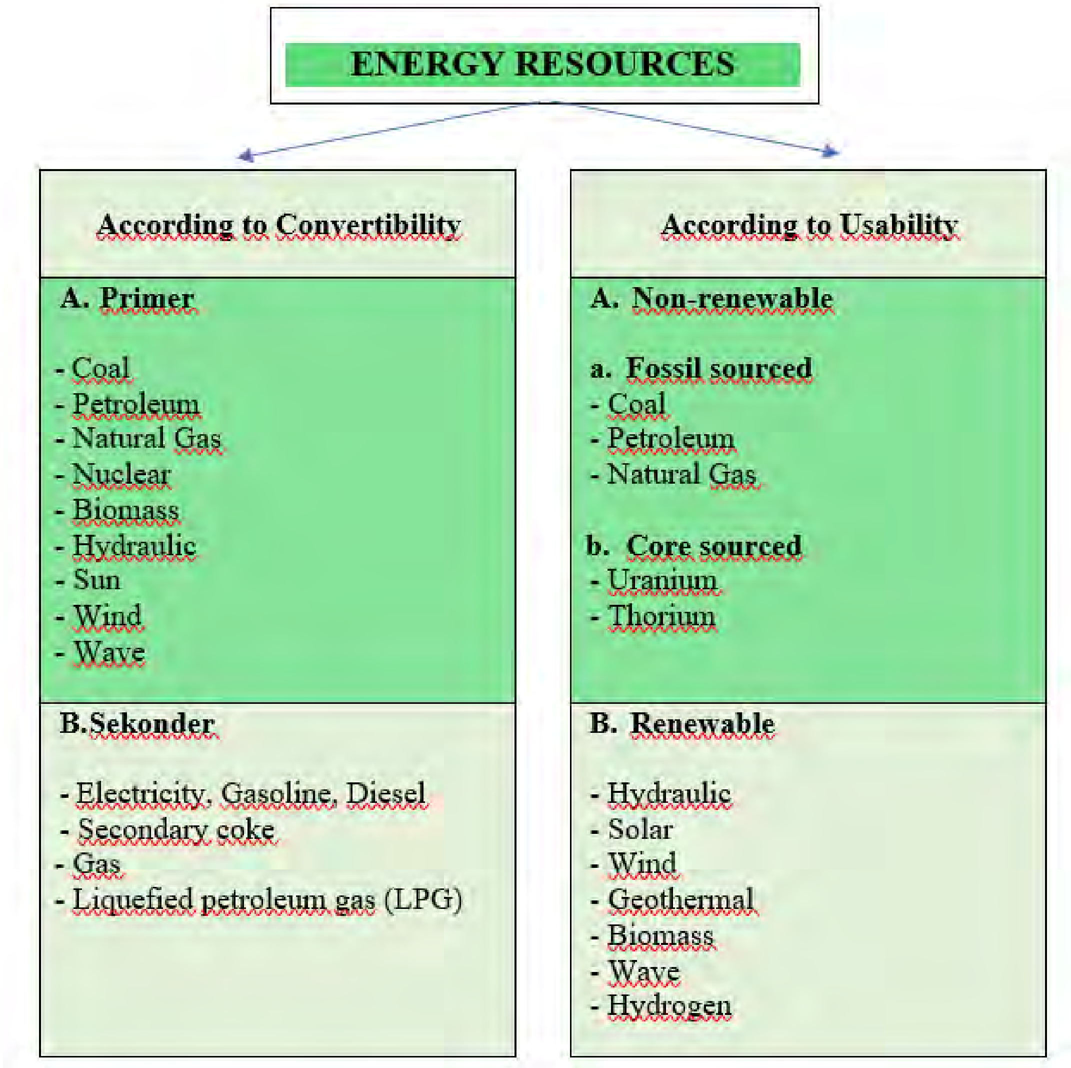


Figure 2. Classification of Energy Resources

Primary and Secondary Energy Sources

The form of energy that has not undergone any change or transformation is defined as primary energy (Koç & Şenel, 2013). Primary energy is the resources that occur due to various chemical reactions, occur within the functioning of nature itself, and can be used without any cycle other than separation and cleaning. Examples of these resources are coal, petroleum, sunlight, natural gas, nuclear energy, biomass energy, tidal energy, wind energy and stream energy. Secondary energy is the energy obtained by transforming the primary energy. For example, electricity, gasoline, diesel oil, coke, petroleum coke and liquefied petroleum gas are secondary energy sources, which are made available for use as a result of the conversion of primary resources such as coal, petroleum, natural gas, sun, water and wind (Aydın, 2014; Koç & Şenel, 2013).

Non-Renewable and Renewable Energy Sources

In another classification of energy resources, the existing reserves or stocks of the resources in nature are taken into account. In this classification, resources are classified considering their exhaustibility or renewability at the end of use. According to this classification, energy resources that do not renew themselves when used are defined as non-renewable energy resources. Unlike non-renewable energy resources, energy resources that do not decrease despite being used and that can remain in a natural cycle process without being exhausted are called renewable energy resources (Koç & Şenel, 2013; Koç & Kaya, 2015).

Non-Renewable Energy Resources

There is no type of energy that cannot renew itself in nature. However, as a result of the ways in which some energy resources are formed, it takes a very long time to be renewed. These resources, which take a long time to renew and are rapidly exhausted, are called non-renewable energy resources (Soral, 2020). Non-renewable energy sources are divided into two as fossil-sourced and core-sourced. Coal, petroleum and natural gas are fossil-based non-renewable energy resources and uranium and thorium are core-sourced non-renewable energy sources (Koç & Şenel, 2013; Koç & Kaya, 2015).

a. *Coal*

Coal is a sedimentary rock consisting mostly of carbon (C), less hydrogen (H), oxygen (O), sulfur (S) and nitrogen (N) elements, composed of vegetable origin organic substances and inorganic components. It is formed as a result of the accumulation of plant and tree residues in the swamps and the chemical and physical changes over millions of years. Coal occurs as a result of physical (pressure, precipitation, etc.) and chemical events (heat, decay and transformation, etc.) called the carbonization process (TKİ, 2020).

Coal, one of the oldest known energy sources in the world, has increased its use with the invention of steam machines after the industrial revolution. Nowadays, with the increase in the use of natural gas and petroleum, the use of coal is decreasing day by day. On the other hand, coal is still widely used in Turkey for electricity generation and heating purposes (Özkan, 2020). A very small part of our country's coal resources are considered as reserves. The exploration and reserve development studies conducted in recent years have yielded results and the coal resources have increased significantly. The total coal resource in Turkey is approximately 20.84 billion tons (MTA, 2020; TKİ 2020).

Coal is an inexpensive energy source that is relatively easy to discover and extract compared to other energy sources. Another advantage of coal is its reserves spread over a wide area around the world. It is stated that the proven coal reserves in the world are much more than the sum of both petroleum and natural gas reserves. Despite these advantages, when coal is burned, it releases more carbon dioxide than all other fuels. In addition to causing intense air pollution and playing an important role in global warming, coal is an energy source that has negative aspects such as expensive filter systems and an extensive transportation network (Torunoğlu Gedik, 2015). As a result, although coal is a fossil fuel that offers a financial advantage, it cannot be ignored that it has negative environmental effects. Although these problems are reduced with the help of better technologies, they cannot be eliminated completely (Kerimoğlu, 2020).

b. *Petroleum (Oil)*

Petroleum occurs naturally from animal and vegetable wastes in deep sediment deposits. It is a generally dark, viscous and foul-smelling hydrocarbon substance (McLeroy & Caudle, 2019). The word petroleum is a combination of the Latin words petra, meaning stone, and oleum, meaning oil. Refers to unprocessed crude oil extracted from underground (Öztürk, 2013). The term "crude" in the expression of crude oil indicates that it is a raw material and has not yet been distilled. Crude oil is distilled in refineries and transformed into many intermediate products and fuel oil products we use in daily life (Akpınar, 2007). Dead plants, algae, and plankton are subjected to intense heat and pressure among tons of rocks and sediment with virtually no oxygen. The organic matter here becomes a waxy substance called kerogen. With more heat, time, and pressure, kerogen is converted into hydrocarbons through a process called catagenesis. Different combinations of heat and pressure create different hydrocarbon forms. Fossil fuels such as coal, natural gas and petroleum emerge with the drying of the seas and the remaining dry basins (National Geographic, 2018). Crude oil is found in liquid form under the earth's crust in underground pools, reservoirs, small areas in sedimentary rocks and tar sands. In addition, most of the petroleum deposits are trapped in natural rock pores at depths between 150 and 7600 meters above the ground surface. After the petroleum is extracted from underground, it is sent to the refinery for separation into different petroleum products such as gasoline, diesel fuel, jet fuel, petrochemical raw materials, waxes, petroleum and asphalt (EIA, 2021; McLeroy & Caudle, 2019).

Petroleum, one of the most valuable fuels in the world, contributes to the increase of social welfare by facilitating the transportation of people and goods. In addition, petroleum products such as gasoline, diesel, LPG contain more energy than other fossil fuels, and are more easily stored and transported (Onur, 2006). Therefore, petroleum and petroleum products have a very important place in human life as an energy source (The World Bank, 2009). However, since petroleum is a fossil fuel, it causes environmental pollution in exploration, extraction, transportation and use processes. Threats the ecological balance by accelerating the global warming process (Mosbech, 2002). As another disadvantage, petroleum reserves are limited in the world. The concentration of these reserves in a certain region brings security problems for the countries of that region (Kerimoğlu, 2020).

c. Natural Gas

Natural gas is a mixture of hydrocarbons mainly composed of saturated light paraffins such as methane and ethane. It is a flammable, colorless and odorless gas mixture that also contains other hydrocarbons such as propane, butane, pentane and hexane. It is formed as a result of bactericide, kerogenization and thermal decomposition in organic materials in the lower layers of the earth. Generally, natural gas contains significant amounts of hydrogen sulfide or other organic sulfur compounds. It is known as "sour gas" for this reason. However, after desulfurization, a small amount of fragrance is added to the natural gas to ensure that any leakage that may occur in transport or use is detected (Carruthers, Solomon, Atwater, Riva, & Waddams, 2019; Devold, 2013). The formation of natural gas requires a similar process to petroleum and natural gas is a derivative of oil. But the geological conditions that create natural gas are more difficult than petroleum. While liquid petroleum can be found at a certain depth, there is no depth limitation for gas reserves. Natural gas is usually found dissolved in petroleum at high pressures in a reservoir. It emerges as a gas layer on top of petroleum (Carruthers, Solomon, Atwater, Riva, & Waddams, 2019).

Natural gas is seen as one of the most important energy sources used almost all over the world today with industrial development, urbanization and increase in population. Natural gas is the most energy efficient fossil fuel. It is a cleaner energy source due to its lower carbon content. Natural gas offers significant advantages to users in terms of efficiency and cost (Bayraç, 2009). As a result of its use, carbon dioxide (CO_2) and sulfur dioxide (SO_2) gases, which are composed of basic polluting gases, are not released (Hayhurts & Lavrance, 1992). In addition, natural gas does not have a serious effect if it is inhaled for a short time. Because it is lighter than air, it tends to rise in the atmosphere. With this feature, it rises to the air in case of leakage and does not pollute the underground water resources (Akpınar & Başıbüyük, 2011). However, although it is cleaner than other fossil fuels, when natural gas is burned, it emits greenhouse gases that cause global warming. Another disadvantage of natural gas is its limited reserves. As a result of the increase in demand for natural gas, it is predicted that natural gas reserves will be depleted in a shorter time than expected (Kerimoğlu, 2020; Montgomery, 2014).

d. Nuclear Energy

Nuclear energy is a type of energy produced from atomic nuclei. By bombarding heavy radioactive elements with neutron, atomic nuclei are fragmented (fission) or light atomic nuclei are combined (fusion). As a result of these events, a significant amount of energy is released. This energy is called nuclear energy or core energy (Altın, 2004; Doğanay & Coşkun, 2017). Nuclear energy is called as an alternative source in some documents. However, nuclear energy is a non-renewable energy source whose raw materials are radioactive elements such as uranium, plutonium, thorium and which are limited in the world (Gezer, 2013). Uranium and thorium are the main raw materials of nuclear energy. These radioactive elements are not found freely in nature and form different compounds (Mahmutoğlu, 2013). During the reaction, a neutron strikes the nucleus of Uranium and a typical fission reaction takes place in the nucleus. The fission products emerging as a result of this first stage collide with other atoms and most of the motion energy is converted into heat energy. This heat is used to generate electricity (TAEK, 2010).

Today, nuclear power plants are seen as a cheaper, reliable and sustainable energy source compared to other energy sources and they are preferred by many countries. Nuclear power plants can generate electricity by operating continuously without being affected by weather conditions. One of the most important features of nuclear power plants is that they do not emit greenhouse gases. Therefore, electricity generation from nuclear energy helps to eliminate the accelerating effects of global warming caused by fossil fuels (T.C. Enerji ve Tabii Kaynaklar Bakanlığı, 2021a). In addition, Uranium reserves are found in many different parts of the world. Therefore, nuclear energy offers significant advantages in terms of fuel supply, cost, amount of use and storage facilities (Montgomery, 2014). Nuclear power plants reduce a country's dependence on foreign sources in terms of energy. Because when only renewable energy sources are used, energy production is disrupted in some cases, while nuclear energy is a sustainable resource (Pipe, 2013). The biggest disadvantage of nuclear energy is the threats to life in case of accident and the problems that nuclear wastes may cause. In case of contact of these wastes with the external environment, irreversible problems arise. In order to eliminate these problems, nuclear wastes are buried in special warehouses built 500 meters to 1,200 meters below the ground. Nuclear waste is degrading extremely slowly. If these wastes come into contact with groundwater, they can cause the poison to come to the earth (Kerimoğlu, 2020; Palabıyık, Yavaş, & Aydın, 2010). On the other hand, the technical life of a nuclear power plant is approximately 30-40 years and at the end of this period it is dismantled. Reactor dismantling is a very expensive process. The process time can approximately correspond to the time required to build the reactor (Kerimoğlu, 2020; Yarman, 2011).

Renewable Energy Sources

As a result of global environmental problems, the concepts of sustainable and renewable energy have come to the fore as an alternative to fossil and nuclear fuels. These resources are seen as a promising solution to environmental problems due to their sustainable and environmentalist nature. However, it is not enough for energy sources to be renewable only. Resources must also be sustainable for ecological balance (Aykal, Gümüş, & Akça Özbudak, 2009). Renewable energy sources are energy sources that are in a continuous cycle, can exist in the same way the next day in nature's own evolution, can renew themselves faster than the depletion rate of the resource and can be used again and again (Gezer, 2013). Renewable energy sources are classified as hydraulic energy, solar energy, wind energy, geothermal energy, biomass energy, wave energy, hydrogen energy (Koç & Şenel, 2013; Koç & Kaya, 2015). Renewable energy types and their sources are summarized in the table below (TEİAŞ, 2021).

Table 1. Renewable Energy Types and Their Sources

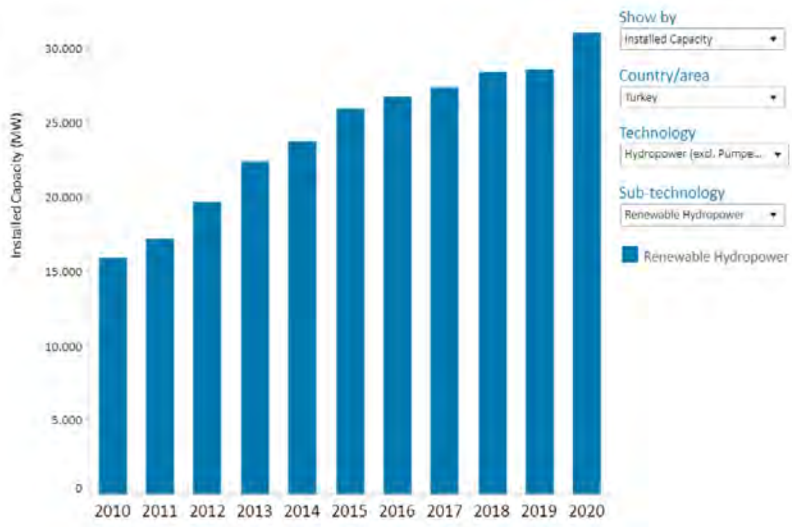
Renewable Energy Source	Source
Hydraulic Energy	River
Solar Energy	Sun
Wind Energy	Wind
Geothermal Energy	Groundwater
Biomass Energy	Waste
Wave Energy	Ocean and Sea
Hydrogen Energy	Water and Hydroxides

a. Hydraulic energy

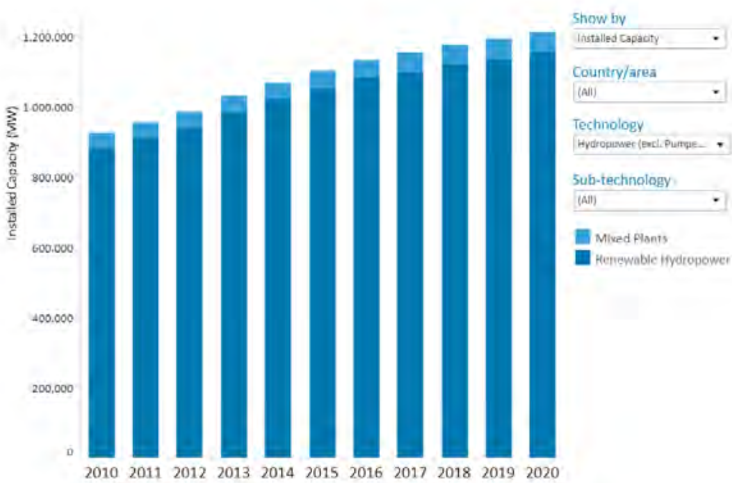
Hydraulic energy is energy produced from water. While this energy is produced, the potential energy between the two points where the water source is located is converted into kinetic energy. Then energy is this converted into mechanical energy and finally into electrical energy (Öztürk, 2013). In this respect, hydraulic power plants must be installed not where they are needed, but where water resources are located (Erdoğan, 2016). The water accumulated in dam-type power plants gains potential energy. Kinetic energy is generated by dropping this water from a height. This energy turns the water turbines and turns the generator that provides electricity (Kocaeren, 2016).

Figure 3. Hydraulic Energy

Hydraulic power plants are frequently preferred because of their environmentally friendly, clean, efficient, long-lasting and low cost. In addition, these power plants do not have fuel expense and high risk potential. Turkey's hydraulic potential corresponds to approximately 1% of the world's total hydraulic potential (T.C. Enerji ve Tabii Kaynaklar Bakanlığı, 2020b). The installed capacity of hydroelectric energy in the World and Turkey until 2020 is shown in Graph 1 and Graph 2 (IRENA, 2021a).



Graph 1. Installed Capacity of Hydroelectric Energy in Turkey



Graph 2. Installed Capacity of Hydroelectric Energy in the World

The basic element in the release of hydroelectric energy is water. For this reason, it does not cause any gas emission that causes global warming and environmental pollution during the electricity generation phase. These power plants are very long-lasting and highly efficient. In addition to electricity generation, these power plants undertake important functions in meeting the water needs of the region, reducing flood and overflow risks and irrigation of agricultural lands. The development of these power plants that generate electricity with domestic resources reduces the problem of external dependency in the field of energy and contributes to the economic security of the country (Başkaya, 2010; Yıldız, 2011). Along with these advantages, there are some criticisms that hydroelectric power plants also cause environmental and social devastating consequences by blocking rivers through large dams. Dams can cause drying of soils and deterioration of natural structure by creating large reserves. In addition, some lands, villages or historical areas may be submerged under the dam waters during the dam construction (Union of Concerned

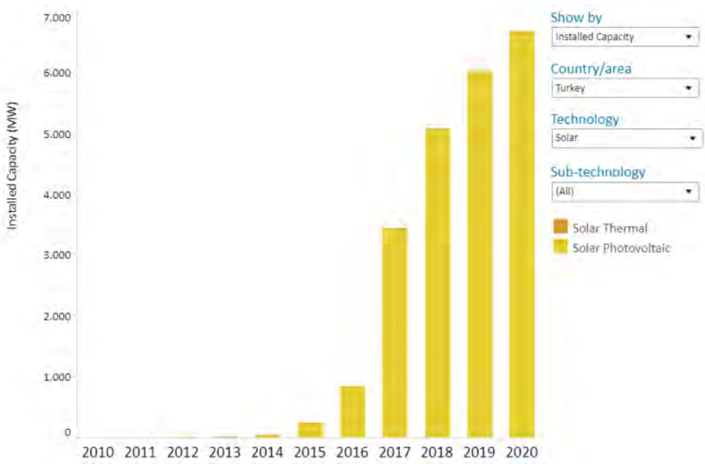
Scientists, 2013). Construction works may also have some negative consequences for the wildlife living in the region. Species living in the region may be extinct. However, the decaying of plants in submerged areas can lead to the emergence of large amounts of carbon dioxide and methane gas (Atak & Öztok, 2013; Kerimoğlu, 2020).

b. Solar Energy

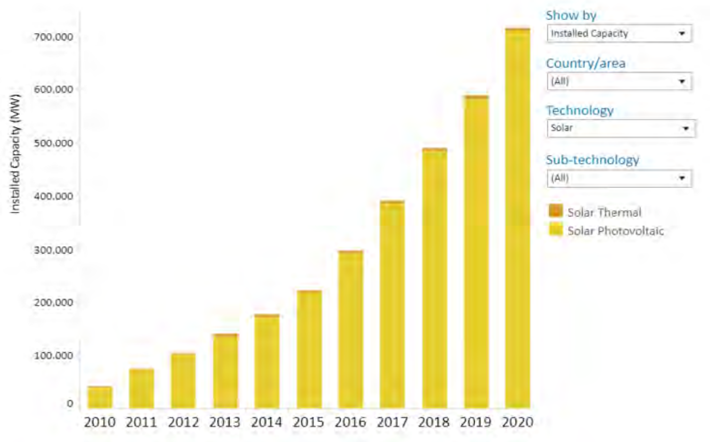
The sun is the main source of energy. For this reason, it is an important requirement for both electricity generation and other energy sources. Heat and light emerge as a result of massive nuclear reactions in the core of the sun. In the solar core, a powerful energy

Figure 4. Solar Energy

Solar energy is a clean and continuous energy source. It has no fuel problem, it is easy to operate, it works smoothly for many years (Çakırlar, 2015). Today, many different technologies are used to benefit from the sun's rays. Some of these technologies use energy directly, such as heat or light energy, while others use solar energy to generate electricity (Aydın, 2014). The installed capacity of solar energy in the World and Turkey until 2020 is shown in Graph 3 and Graph 4 (IRENA, 2021b).



Graph 3. Installed Capacity of Solar Energy in Turkey



Graph 4. Installed Capacity of Solar Energy in the World

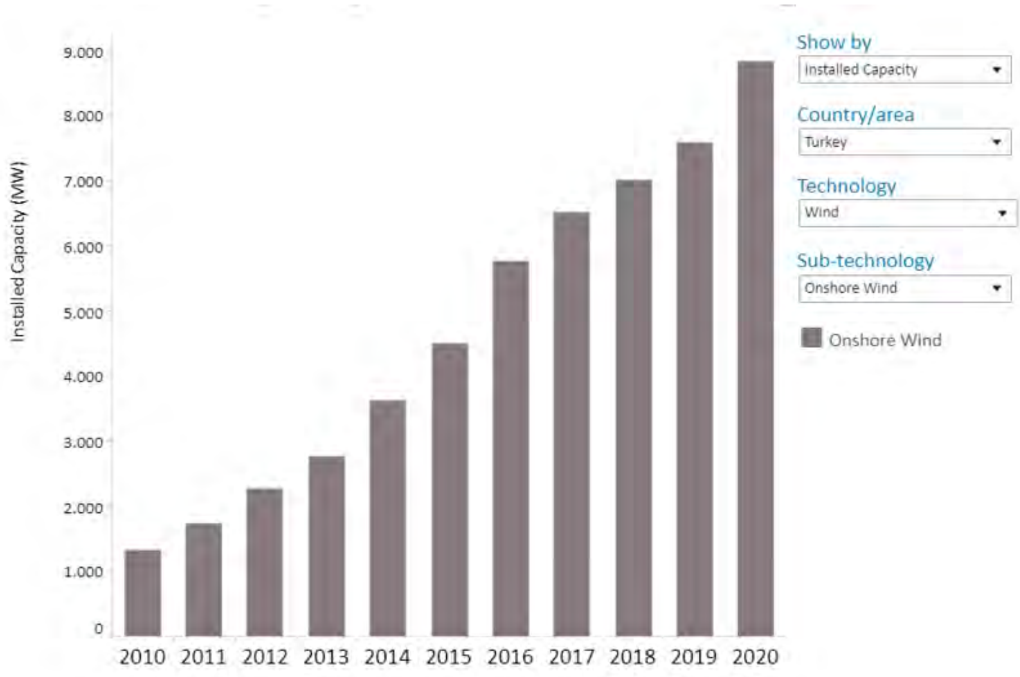
The most important advantage of solar energy is that it is seen as limitless. Solar energy is a renewable, environmentally friendly and clean energy source (Köroğlu, Teke, Bayındır, & Tümay, 2010). The cost of electricity generation with solar energy is decreasing day by day and its usage area is gradually expanding. On the other hand, solar heating / cooling, industrial applications and electricity production can be easily performed without requiring fuel costs (Akova, 2008). The most important disadvantage of solar energy is the high initial investment cost. Large surfaces are needed to collect solar energy. It is not possible to produce enough electricity from solar energy on cloudy days and at night. This problem makes it inevitable to store the energy obtained during the day. Storage is possible thanks to accumulators, but the high cost of accumulators also increases the energy cost (Akova, 2008; Kerimoğlu, 2020).

c. Wind Energy

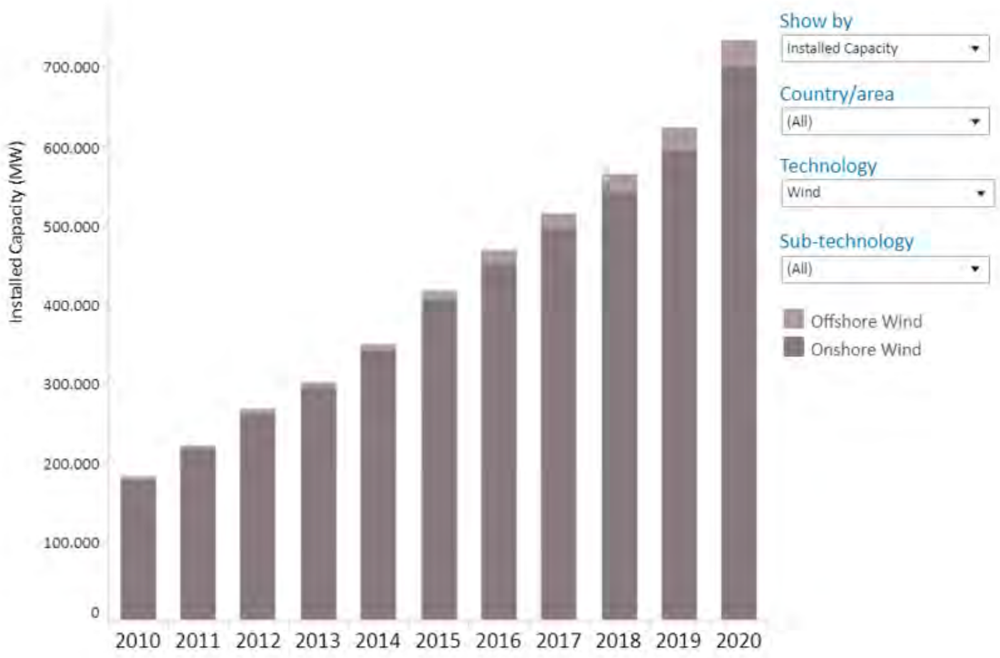
The heat energy reaching the Earth from the sun is used by gravity and electromagnetic forces, and approximately 2% of this energy is converted into wind energy (Öztürk, 2013). The wind emerges from the mutual interaction of low and high pressure centers, which are formed as a result of not heating every region of the earth equally (Doğanay & Coşkun, 2017). Wind, which is a natural phenomenon, is converted into wind energy by means of wind turbines.

Figure 5. Wind Energy

As a result of the increase in technology and industrial activities worldwide, the demand for wind energy is increasing day by day. The installed capacity of wind energy in the World and Turkey until 2020 is shown in Graph 5 and Graph 6 (IRENA, 2021c).



Graph 5. Installed Capacity of Wind Energy in Turkey



Graph 6. Installed Capacity of Wind Energy in the World

The most important advantage of wind energy is that it is an environmentally friendly and clean energy source. In addition, wind power provides continuous generation and reduces foreign dependency. The installation and operating costs of wind turbines are low and they allow agriculture in the land where they are established (İlkılıç, 2009).

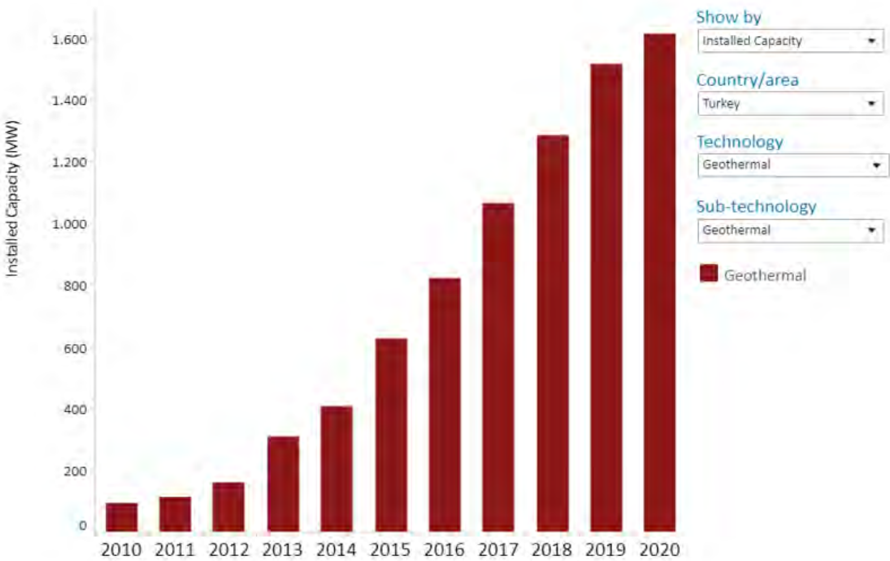
There are some disadvantages of wind energy. The biggest problem is that the wind does not blow continuously. Therefore, it is very difficult to produce the desired amount of energy at the desired time. At the same time, wind turbines cause a certain amount of noise, pose a danger to birds during migration, and create interference in communication (Kerimoğlu, 2020; Koçaslan, 2010).

d. Geothermal Energy

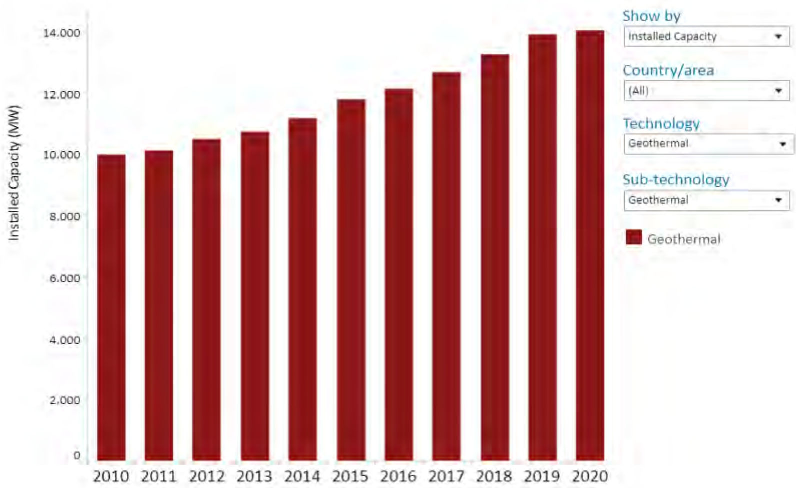
Geothermal energy is the energy generated by the heat in the depths of the earth. There are two main sources of heat that releases geothermal energy. The first of these sources is the temperature that is carried and spread with the magma rising towards the earth's surface. The other is the earth's own temperature, which increases as one goes deeper

Figure 6. Geothermal Energy (IRENA, 2021d)

The importance of geothermal energy is increasing due to its cheap and environmentally friendly nature. Turkey is rich in geothermal energy resources due to its location (T.C. Enerji ve Tabii Kaynaklar Bakanlığı, 2021c). The installed capacity of geothermal energy in the World and Turkey until 2020 is shown in Graph 7 and Graph 8 (IRENA, 2021d).



Graph 7. Installed Capacity of Geothermal Energy in Turkey



Graph 8. Installed Capacity of Geothermal Energy in the World

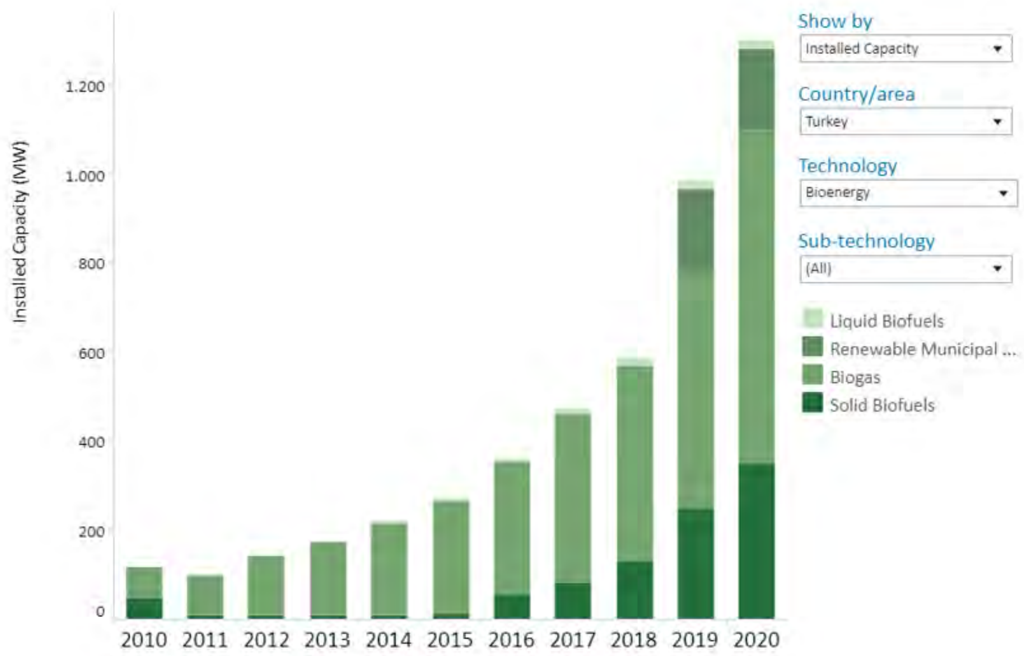
Geothermal energy is a highly efficient, stable, sustainable and environmentally friendly energy source. The cost of electricity generated from geothermal energy is lower than other sources. In addition, this energy is not affected by weather events such as solar and wind energy. Geothermal power plants do not occupy large areas, nor do they require any storage or transportation process. Risk factors such as explosion, fire and poisoning are extremely low during use (Aksoy, 2007; Kerimoğlu, 2020). The most important disadvantage of geothermal systems is that the total power obtained from power plants decreases as the source temperature does not increase. In addition, hot groundwater can also contain arsenic, mercury, boron, lithium and some types of bacteria. It can also be toxic and lethal if it is drunk (Montgomery, 2014).

e. Biomass Energy

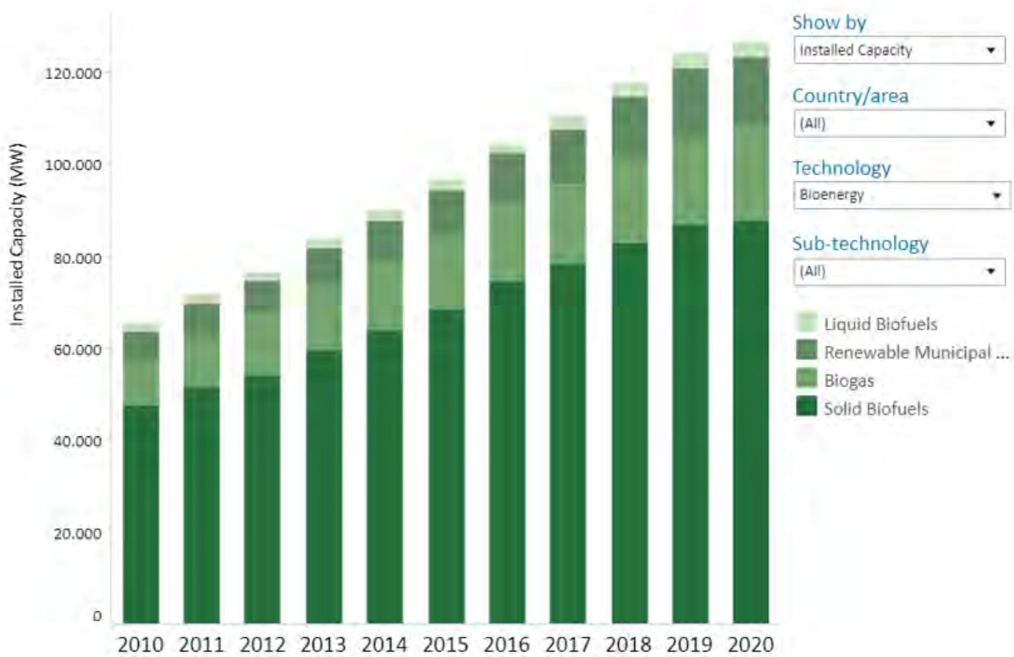
Biomass energy is energy produced from materials originating from biomass. Bioenergy use falls into two basic categories. The first of these is traditional use and refers to the burning of biomass in forms such as wood, animal waste, coal. Modern bioenergy includes liquid biofuels derived from plants, wood heating systems and other technologies (IRENA, 2021e).

Figure 7. Biomass Energy

Nowadays, with the development of technology, the usage areas of biomass energy have expanded and the production cost has decreased (Doğanay & Coşkun, 2017). The installed capacity of biomass energy in the World and Turkey until 2020 is shown in Graph 9 and Graph 10 (IRENA, 2021e).



Graph 9. Installed Capacity of Biomass Energy in Turkey



Graph 10. Installed Capacity of Biomass Energy in the World

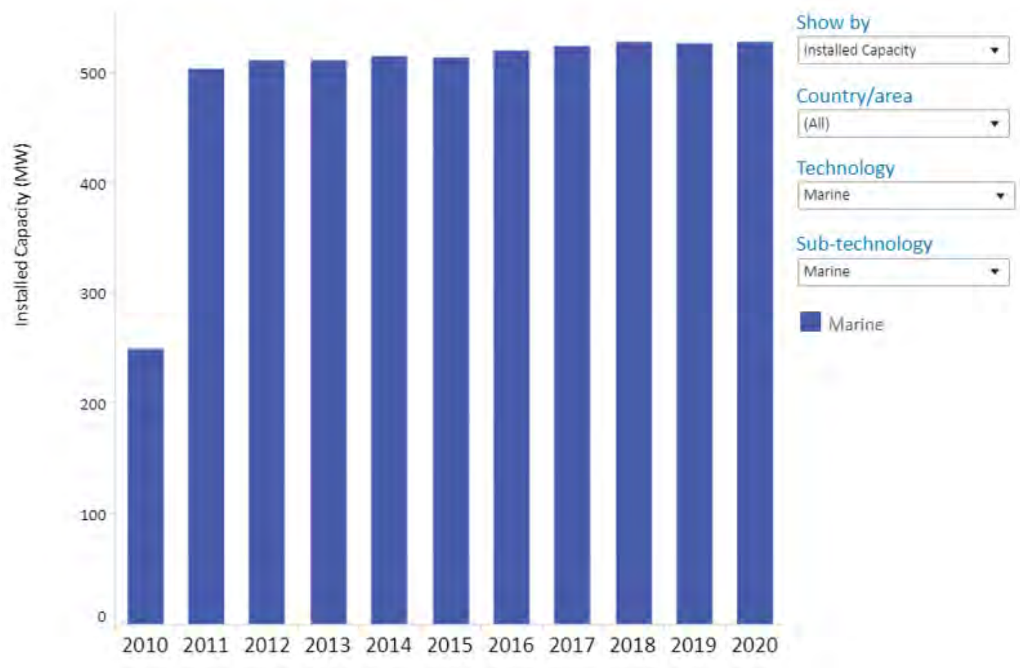
Biomass is seen as a clean and inexhaustible energy source. Since animal and forest wastes are disposed of in the production of this energy, environmental pollution is also decreasing. Therefore, biomass energy creates positive results in terms of reducing environmental pollution, reducing carbon dioxide emission, reducing expenses related to health problems, improving water-air-soil quality and increasing biodiversity (Jenkins, Baxter, Miles Jr., & Miles, 1998). Biomass production facilities can work for very long hours. And as long as the fuel is available, it can produce at high capacity continuously. In addition, production facilities contribute positively to the employment and income level in the region where they are established. As it creates an additional demand for agricultural work, it creates new job areas in rural areas and reduces the desire to migrate from the village to the city. Thus, biomass energy production facilities support regional development. The most important disadvantage of biomass energy is that it has lower calorific value and fuel quality compared to fossil fuels. Another disadvantage is the need for very large cultivation areas for growing plants that form the basic raw material of biomass energy resources. However, in case of focusing on growing these plants, the production amount of other grains decreases. This situation is reflected in the price of food products. At the same time, large-scale biofuel production can lead to soil erosion, extinction of endemic plant species and loss of natural forest areas (Christy, 2008; Duygu, 2009; Kerimoğlu, 2020).

f. Wave Energy

Wave energy is the energy obtained from the pressure created by the wave motion in the seas. Earthquakes, wind, tides and collapses in the sea bottoms cause the formation of sea waves. Dams are built at the mouth of the bays suitable for wave energy production and the incoming water is kept here. Then, electricity is produced with turbines by using the difference in height of the water (Bayraç, Çildir, & Çelikay, 2018; Kerimoğlu, 2020).

Figure 8. Wave Energy

Although wave energy is not a major energy source, it is seen as the most reliable among renewable energy sources. Considering that 2/3 of the world is water, it is thought that when the necessary importance is given, a significant part of the energy need can be met from wave energy (Bayraç, Çildir, & Çelikay, 2018). The installed capacity of wave energy in the World until 2020 is shown in Graph 11 (IRENA, 2021f).



Graph 11. Installed Capacity of Wave Energy in the World

The global sea current resource potential of wave energy is quite high. This energy has high energy densities, highly predictable power outputs. It is also independent from extreme atmospheric fluctuations and has no negative visual effects (TÜRÇEV, 2014).

g. Hydrogen Energy

Hydrogen is the main energy source of the universe. Hydrogen is defined as the type of energy that has the highest energy potential in terms of unit mass. It can be used in all areas that require heat and explosion energy. In addition, in energy systems where this energy source is used as fuel, the product emitted into the atmosphere is only water or water vapor (Özkan, 2020).

Figure 9. Hydrogen Energy

Hydrogen gas is considered as the most important clean energy source due to its high unit energy and environmental friendliness. It can be used as a fuel instead of petroleum in vehicles and as a fuel instead of natural gas in homes and factories. And it allows electrical energy to be obtained (Dabanlı & Uyumaz, 2010). In addition, hydrogen does not remain as a puddle on the ground during a leak and is dispersed in the atmosphere due to its low density. For this reason, the security of the environment can be ensured. While obtaining hydrogen energy, fossil fuels are used due to their cheapness and this is seen as the most important disadvantage of hydrogen energy. In addition, there are some problems that require solutions in the production, storage, transportation and burning of this energy (Kocaeren, 2016; Ün, 2003).

Current Situation of Turkey in Terms of Energy Resources

Energy is an indispensable input for almost all processes that are necessary for us to continue our lives. It is one of the most fundamental elements of economic and social development of all countries. As a result of the increasing population growth, a great increase in energy demand is observed all over the world. According to the data of the International Energy Agency (IEA, 2020), global share of total energy supply of the world, which was 6,098 Mtoe in 1973, reached 14,282 Mtoe in 2018 with a big increase. Again, according to IEA (2018), it is thought that the energy demand will increase by 60% in 2030 and 100% in 2050 compared to today (IEA, 2018; 2020). The energy need in our country is increasing day by day.

Today, Turkey meets a significant part of its energy needs from fossil fuels. With the increasing population, urbanization and industrialization, there is a big increase in energy demand. Although our country is not rich in terms of non-renewable energy resources that it provides most of its energy needs, it is more fortunate in terms of renewable energy resources due to its geographical location and geopolitical structure. Our country is in a very favorable position especially in terms of hydraulic, geothermal, biomass, wind and solar energy potentials. However, Turkey cannot meet the energy it needs from renewable energy sources and imports energy (Kılıç, 2011; Koç & Şenel, 2013). Hydroelectric energy is currently used in Turkey. In addition, it is thought that resources such as wind energy and solar energy will contribute significantly to meeting the energy needs of the country. The fact that these resources contain low costs and the view that they can make the country more independent in terms of external dependency increases the expectations for these resources (Özev, 2017).

In our country, thermal and hydraulic resources are mostly used to meet the electricity needs. The share of installed power capacity of renewable energy sources in Turkey has increased significantly in the last 10 years. At the end of September 2019, the installed power of our country has reached 90,720 MW. In 2018, electricity energy consumption in Turkey increased by 2.2% compared to the previous year and reached 304.2 billion kWh. On the other hand, electricity generation increased by 2.2% compared to the previous year and reached 304.8 billion kWh. Electricity consumption is expected to reach 375.8 TWh in 2023 with an annual average increase of 4.8%. According to the data published by ETBK, the distribution of our installed power according to resources as of the end of September 2019; 31.4 percent hydraulic energy, 28.6 percent natural gas, 22.4 percent coal, 8.1 percent wind, 6.2 percent solar, 1.6 percent geothermal and 1.7 percent is in the form of other sources (T.C. Enerji ve Tabii Kaynaklar Bakanlığı, 2021d). Again, according to the information published by TEİAŞ (2021), the data showing what percentage of our country's daily energy needs are met from renewable resources is given in the following figure (Figure 10).

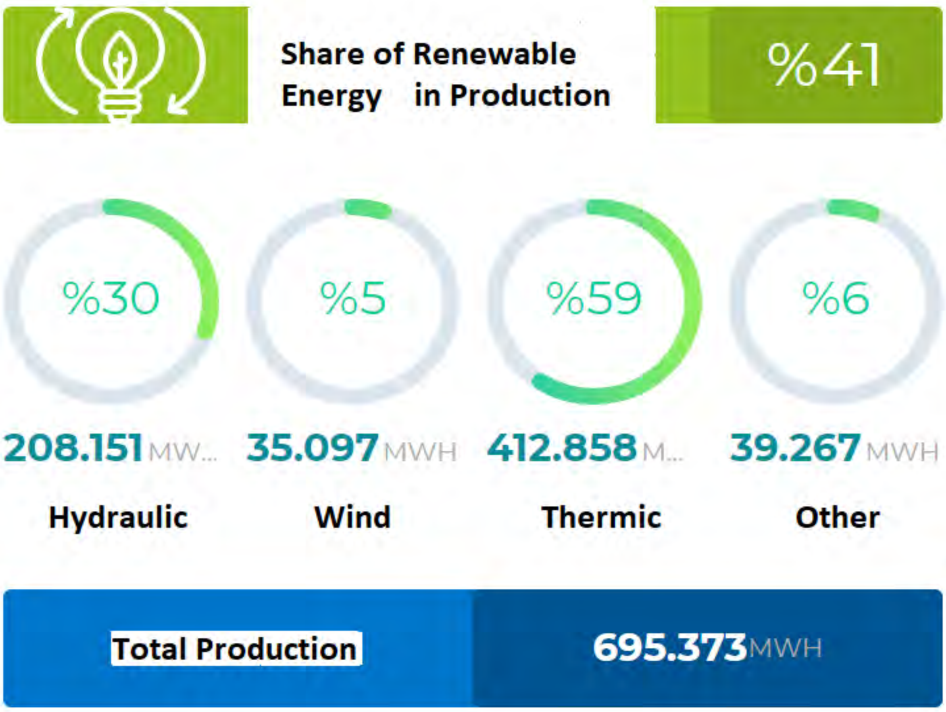


Figure 10. Share of Renewable Energy in Meeting Daily Energy Needs

According to the data in the figure, 30% of Turkey's daily energy needs are met from hydraulic energy, 5% from wind energy, 59% from thermal power plants and 6% from other energy sources. 41% of the daily electricity produced in our country is met by renewable energy sources. This ratio is expected to increase in the coming years (TEİAŞ, 2021).

Energy Conservation

One of the most important factors in energy efficiency is energy conservation. While energy consumption is mostly explained by socio-demographic characteristics, energy conservation is predominantly influenced by personal factors (Abrahamse & Steg, 2009). The most general definition of energy saving is the consumption of less energy and all behaviors that prevent existing energy losses (EIA, 2020c). Energy saving is explained by factors such as a sense of responsibility, environmental awareness, and the urge to get approval from the society. At this point, the personal components of the behavior become important (Karlin, Davis, Sanguinetti, Gamble, Kirkby, & Stokols, 2012).

Sometimes energy conservation is confused with energy efficiency. In fact, energy efficiency tells what to buy, while energy conservation shows how to behave. Energy conservation refers to the reduction of total energy demand, while energy efficiency refers to the regulation of energy saving behaviors of individual consumers (EIA, 2020c; Gillingham, Newell, & Palmer, 2009). In this context, energy conservation behaviors are considered as adopting some behavioral patterns such as turning off unused electronic devices to reduce energy use, turning off the light when leaving the room, and using less electrical appliances (Karlin et al., 2014). Energy saving is considered as the focal point of incentive programs like other environmental behaviors. Methods applied to reduce the energy consumption of households have been tried and successful for years (Sintov, Desario, & Prescott, 2010).

The methods used for the dissemination of energy conservation on a global scale are based on technological developments. This situation causes to move away from the awareness that energy conservation is a behavior and to neglect the psychological dimension of this concept (Stern, 1992). However, it is stated that environmental knowledge, attitude, values and other psychological variables are effective in saving energy (Haron, Paim, & Yahaya, 2005). Many studies in the field of energy conservation psychology highlight the importance of informational strategies in promoting saving behavior. These strategies are generally used to encourage energy conservation activities where there are few contextual barriers to saving behavior and that do not require much time and cost effort (Steg, 2008). In raising awareness of saving, it is adopted that the primary step is to access scientific information. Therefore, the question of how the environmental knowledge levels of energy consumers in Turkey will affect this behavioral scheme comes to mind. Especially environmentalist behavior is a prerequisite for energy conservation in our country. In this context, behaviors such as the dissemination of environmentally friendly green products, saving in the consumption of natural resources, preferring public transportation, saving energy and water in houses and workplaces are evaluated within the scope of environmentally friendly behaviors (Koçak, 2020; Larson, Stedman, Cooper, & Decker, 2015; Steg, Lindenberg, & Keizer, 2015).

Saving energy is an extremely important requirement in order to leave a livable world to future generations. In this context, it is believed that we have to fulfill our duty by taking individual responsibility in accordance with sustainability, contributing to the continuity of natural resources and ending unnecessary consumption habits.

Zero Waste

With the increase of the world population, the amount of waste and carbon emissions are increasing rapidly. However, energy and raw materials are wasted, natural resources are consumed excessively and underground / surface water resources become unusable due to pollution. The pollution of the air, the increase in epidemic diseases and the accumulation of waste on the soil appear as problems that need to be solved urgently (Erten, 2020). The environmental problems encountered in the last century and the rapid increase in carbon emissions and waste materials have brought the question of how to solve these problems. Human beings are making an intense effort and carrying out studies regarding a solution. Undoubtedly, one of the biggest studies done is zero waste applications (Maxwell, 2006).

Zero waste is defined as the recovery of all resources and materials from waste materials that can be reused or recycled without creating any waste residue. It is to systematically eliminate the volume and toxicity of waste materials. It means systematically designing and managing products and processes to conserve, recover, incinerate or bury all resources. Zero waste does not mean recycling. Zero waste is the prevention of waste even during production. It means reducing the production of all kinds of waste and garbage (Erten, 2019; ZWIA, 2018). Zero Waste aims to prevent waste, to use resources efficiently, to examine the causes of waste and to prevent them. In addition, it is a waste management process that expresses the collection and recycling of waste by separating it at the place where it is formed (Çalışkan, 2020).

Zero waste is used as an approach for the first time in the article published by George Washington Carver in 1893 and wastes are defined as other sources in disguise. In 1930, Henry Ford researched the industrial use of farm and forest resources with a zero waste approach and obtained products such as car horns and gear levers from soybeans. The term zero waste was first used in the name of Zero Waste Systems (ZWS), which was founded by Chemist Paul Palmer in the 1970s. It was realized in 1996 when New Zealand adopted the zero waste strategy by targeting 2010 (Yaman & Olhan, 2010). In recent years, zero waste studies have become widespread all over the world. Most of the research on this topic has mainly focused on cities' transition to zero waste management (Zaman & Lehmann, 2013). As in the whole world, population, industrialization, urbanization and consumption increase in Turkey, while natural resources are rapidly depleted accordingly. These developments are also reflected in consumption activities. The amount of waste increases rapidly and causes air, water and soil pollution. In addition, these wastes cause climate change and bring problems that will threaten life at the global level. Disposal of wastes without recycling causes serious resource losses. In this respect, the sustainable and efficient management of resources is seen as a necessity (T.C. Çevre ve Şehircilik Bakanlığı, 2017).

The Zero Waste Project in Turkey was announced in a publicity in 2017. It was introduced under the auspices of the Presidency and under the leadership of the Environment and Urbanization Presidency. The project was implemented for the first time in the

Presidential Complex and the Ministry of Environment and Urbanization. With the project, it is aimed to use resources efficiently, prevent waste, reduce the amount of waste, and ensure the recycling of wastes with an efficient waste collection system (Erdur, 2019). Following the introduction made in 2017, the Zero Waste Regulation was published in the Official Gazette dated 12 July 2019 and numbered 30829. The regulation is based on the effective management of raw materials and natural resources, the protection of the environment and human health. In addition, the regulation covers the principles regarding the establishment, dissemination, development, monitoring, financing, recording and certification of the zero waste system (T.C. Çevre ve Şehircilik Bakanlığı, 2019). The main objectives of the zero waste project are listed as follows: (Erdur, 2019);

- Awareness of the concept of waste in daily life,
- Prevention of waste,
- Reducing the amount of waste thrown away,
- Reducing the disposal costs of our garbage,
- Reuse of qualified wastes as raw materials,
- Raising environmental awareness of individuals,
- Extending the life of existing resources,
- Enabling all living things to live in healthier environments.

In this context, it is predicted that with the Zero Waste Project, both economic gain will be achieved and more livable cities will be left for future generations by protecting our environment. Zero waste practices make a great contribution to the environment and human health by eliminating the wastes at the source before they are formed. It provides great savings in terms of both energy and cost. Zero waste practices ensure the effective use of the resources owned by controlling the wastes. Adoption of the zero waste principle together with the sustainable development approach makes a great contribution to the economic and environmental development of Turkey, as well as transferring a livable world to future generations (Önal, Kaya, & Çalışkan, 2019; T.C. Çevre ve Şehircilik Bakanlığı, 2017). In this respect, the subject of zero waste should be included in the primary and secondary education curriculum. While this subject is included in the programs, support should be obtained from the experts of the subject. In order to understand this issue, training should be given to the whole society, especially teachers (Erten, 2019).

Activities

Activity 1. Below is a sample poster for energy saving. Considering the features in this poster, prepare an original poster for one of the topics you learned in this section.

Activity 2. Let's find the difference between an insulated house and an uninsulated house in terms of energy savings!

Please complete the activity by following the steps below.

- Build two simple houses from plywood.

- Glue foams on plywood to the wall of one of these houses.

- Then carefully put candles inside both houses.

- Place thermometers inside both houses to measure the temperature.

- After a certain time interval, measure the interior temperature of the houses with two thermometers.

- By looking at the difference, explain which house is more energy efficient and how much energy it saves.

References

Abrahamse, W., & Steg, L. (2009). How do socio-demographic and psychological factors relate to households' direct and indirect energy use and savings? *Journal of Economic Psychology, 30*(5), 711-720. https://doi.org/10.1016/j.joep.2009.05.006

Ajzen, I. (1985). *From intentions to actions: a theory of planned behavior*. In J. Kuhl & J. Beckman (Eds.), Action-control: From cognition to behavior. Heidelberg: Springer.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Akova, İ. (2008). *Yenilenebilir enerji kaynakları*. Ankara: Nobel Yayınevi.

Akpınar, A. (2007). *Dünya, Avrupa Birliği ve Türkiye'nin toplam elektrik ve hidroelektrik enerji üretim projeksiyonu*. Yüksek Lisans Tezi. Karadeniz Teknik Üniversitesi, Fen Bilimleri Enstitüsü, Trabzon.

Akpınar, E., & Başıbüyük, A. (2011). Jeoekonomik önemi giderek artan bir enerji kaynağı: doğalgaz. *Turkish Studies, 6*(3), 119-136. http://dx.doi.org/10.7827/TurkishStudies.2640

Aksoy, M. (2007). Jeotermal kaynaklardan elektrik üretimi. *Elektrik Mühendisler Odası Bilim Dergisi, 19*, 56-59.

Altın, V. (2004). Yeni ufuklara, nükleer enerji. *TÜBİTAK Bilim ve Teknik Dergisi*, 4-6.

Atak, E., & Öztok, D. (2013). 10 soruda hidroelektrik santraller. Doğal Hayat Koruma Vakfı Yayını.

Aydın, L. (2014). *Enerji ekonomisi ve politikaları/kuram ve kavramlarpiyasalar-modeller-politikalar.* Ankara: Seçkin Yayıncılık

Aykal, F. D., Gümüş, B., & Özbudak Akça, Y. B. (2009). Sürdürülebilirlik kapsamında yenilenebilir ve etkin enerji kullanımının yapılarda uygulanması. V. *Yenilenebilir Enerji Kaynakları Sempozyumu,* Diyarbakır, Türkiye.

Başkaya, Ş. (2010). Hidroelektrik Santralleri ve rüzgâr enerjisi santrallerinde çevresel etki değerlendirmesi. *III. Ulusal Karadeniz Ormancılık Kongresi,* Artvin, Türkiye

Bayraç, H. N. (2009). Küresel enerji politikaları ve Türkiye: petrol ve doğal gaz kaynakları açısından bir karşılaştırma. *Eskişehir Osmangazi Üniversitesi Sosyal Bilimler Dergisi. 10*(1)*,* 115-142.

Bayraç, H. N., Çelikay, F., & Çildir, M. (2018), *Küreselleşme sürecinde sürdürülebilir enerji politikaları.* Bursa: Ekin Yayınevi.

Boz, V. (2020). *Enerji kaynaklarına ilişkin öğrenci görüşleri ve enerji okuryazarlığı: durum çalışması*. Yüksek Lisans Tezi. Yıldız Teknik Üniversitesi, Fen Bilimleri Enstitüsü, İstanbul.

Carruthers, J. E., Solomon, L. H., Atwater, G. I., Riva, J. P., & Waddams, A. L. (2019). Natural gas. Retrieved April 23, 2021, from https://www.britannica.com/science/natural-gas/Shale-gas

Christy, A. D. (2008). *Bioenergy from agricultural wastes.* Ohio: The Ohio State University.

Çakırlar, E. (2015). *Ortaöğretim öğrencilerinin yenilenebilir enerji kaynakları konusundaki farkındalık düzeylerinin belirlenmesi.* Yüksek Lisans Tezi. Hacettepe Üniversitesi, Eğitim Bilimleri Enstitüsü, Ankara.

Çalışkan, Y. (2020). *Sosyal medyada sıfır atık hareketi: instagram örneği*. Yüksek Lisans Tezi. İstanbul Okan Üniversitesi, Sosyal Bilimler Enstitüsü, İstanbul.

Çengel, Y., Boles, A. M., & Kanoğlu, M. (2019). *Thermodynamics: an engineering approach.* New York: Mc Graw Hill.

Dabanlı, İ., & Uyumaz, A. (2010). Hidrojen enerjisi ve Türkiye'nin potansiyeli. *VIII. Ulusal Temiz Enerji Sempozyumu, Yenilenebilir Enerji ve Yerel Yönetimler*, Bursa, Türkiye.

Devold, H. (2013). *Oil and gas production handbook*. Oslo: ABB Oil and Gas.

DeWaters, J. E., & Powers, S. E. (2011). Energy literacy of secondary students in New York State (USA): A measure of knowledge, affect, and behavior. *Energy Policy, 39*(3), 1699-1710. https://doi.org/10.1016/j.enpol.2010.12.049

DeWaters, J., Qaqish, B., Graham, M., & Powers, S. (2013). Designing an energy literacy questionnaire for middle and high school youth. *Journal of Environment Education, 44*(1), 56–78. https://doi.org/10.1080/00958964.2012.682615

Doğanay, H., & Coşkun O. (2017). *Enerji kaynakları*. Ankara: Pegem Akademi.

Duygu, E. (2009). Ekolojik ve sosyoekonomik sorunlara çözüm arayışında biyokütle enerjisi ve biyorafineriler. *Kimya Mühendisliği Dergisi, 173,* 22-26.

EIA- U.S. Energy Information Administration, (2020a). What is energy? Retrieved April 13, 2021, from https://www.eia.gov/energyexplained/what-is-energy/

EIA- U.S. Energy Information Administration, (2020b). What is energy? Forms of energy. Retrieved April 13, 2021, from https://www.eia.gov/energyexplained/what-is-energy/forms-of-energy.php

EIA- U.S. Energy Information Administration, (2020c). Use of energy explained energy efficiency and conservation. Retrieved May 17, 2021, from https://www.eia.gov/energyexplained/use-of-energy/efficiency-and-conservation.php

EIA- U.S. Energy Information Administration, (2021). Oil and petroleum products explained. Retrieved April 19, 2021, from https://www.eia.gov/energyexplained/oil-and-petroleum-products/

Erdoğan, S. (2016). *Arz güvenliği bakışı ile Türkiye'de enerji politikaları*. Ankara: Orion Kitapevi.

Erdur, E. (2019). *Türkiye'de sıfır atık projesi ve projenin kamu kurumlarında uygulanması; Süleymanpaşa Belediyesi örneği.* Yüksek Lisans Tezi. Gazi Üniversitesi Fen Bilimleri Enstitüsü, Ankara.

Erten, S. (2019). Sıfır Atık Projesi'nin ilköğretim fen programlarına uygulanabilirliği. *International Conference on Science and Education*, Antalya, Turkey.

Erten, S. (2020). *Fen ve teknoloji uygulamalarının çevreye etkileri.* In Güven Yıldırım, E. & Önder, A. N. (Eds.), Senaryolarla desteklenmiş fen ve teknoloji uygulamaları. Ankara: Anı Yayıncılık.

Fah, L.Y., Hoon, K. C., Munting, E. T., & Chong, C.A. (2012). Secondary school students' energy literacy: Effect of gender and school location. *OIDA International Journal of Sustainable Development, 3*(7), 75- 86.

Fırat, A., Sepetçioğlu, H., & Kiraz, A. (2012). Öğretmen adaylarının yenilenebilir enerjiye ilişkin tutumlarının incelenmesi. *Hacettepe* Üniversitesi *Eğitim Fakültesi Dergisi, 1*, 216-224.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: An introduction to theory and research.* Reading: Addison-Wesley.

Gelen, İ. (2017). P21- 21st century skill frameworks in curriculum and instruction (USA practices). *Journal of Interdisciplinary Educational Research, 1*(2), 15-29.

Gezer, E. H. (2013). *Yenilenebilir enerji kaynakları ve Türkiye*. Yüksek Lisans Tezi. Gazi Üniversitesi, Sosyal Bilimler Enstitüsü, Ankara.

Gillingham, K., Newell, R. G., & Palmer, K. (2009). Energy efficiency economics and policy. *Annual Review of Resource Economics, 1(*1), 597-620. https://doi.org/10.1146/annurev.resource.102308.124234

Haron, S. A., Paim, L., & Yahaya, N. (2005). Towards sustainable consumption: an examination of environmental knowledge among Malaysians. *International Journal of Consumer Studies, 29*(5), 426-436. https://doi.org/10.1111/j.1470-6431.2005.00460.x

Hayhurts, A. N., & Lawrence, D. (1992). Emissions of nitrous oxide from combustion sources. *Progress in Energy and Combustion Science, 18*(6), 529-552. https://doi.org/10.1016/0360-1285(92)90038-3

IEA- Internatıonal Energy Agency, (2018). World energy statistics and balances. Retrieved May 7, 2021, from https://enerji.mmo.org.tr/wp-content/uploads/2018/11/Key_World_ energy-statistics-2018.pdf

IEA- Internatıonal Energy Agency, (2020). Key world energy statistics 2020. Retrieved May 7, 2021, from https://www.iea.org/reports/key-world-energy-statistics-2020

IRENA- International Renewable Energy Agency, (2020). Green hydrogen could compete with fossil fuel produced varieties by 2030. Retrieved April 27, 2021, from https://www.pv-tech.org/irena-green-hydrogen-could-compete-with-fossil-fuels-by-2030/

IRENA- International Renewable Energy Agency, (2021a). Hydropower. Retrieved April 27, 2021, from https://www.irena.org/hydropower

IRENA- International Renewable Energy Agency, (2021b). Solar energy. Retrieved April 27, 2021, from https://www.irena.org/solar

IRENA- International Renewable Energy Agency, (2021c). Wind energy. Retrieved April 27, 2021, from https://www.irena.org/wind

IRENA- International Renewable Energy Agency, (2021d). Geothermal energy. Retrieved April 27, 2021, from https://www.irena.org/geothermal

IRENA- International Renewable Energy Agency, (2021e). Bioenergy. Retrieved April 27, 2021, from https://www.irena.org/bioenergy

IRENA- International Renewable Energy Agency, (2021f). Ocean energy. Retrieved April 27, 2021, from https://www.irena.org/ocean

İlkılıç, C. (2009). Türkiye'de rüzgar enerjisi potansiyeli ve kullanımı. *Mühendis ve Makine Dergisi, 50*(593), 26-32.

Jenkins, B.M., Baxter, L.L., Miles Jr., T.R., & Miles, T.R. (1998) Combustion properties of biomass. *Fuel Processing Technology, 54,* 17-46. https://doi.org/10.1016/S0378-3820(97)00059-3

Karaca, G., & Göktan, S. Ö. (2007). *Ortaöğretim Kimya 10. sınıf ders kitabı*. Ankara: Paşa Yayıncılık.

Karlin, B., Davis, N., Sanguinetti, A., Gamble, K., Kirkby, D., & Stokols, D. (2012). Dimensions of conservation: exploring differences among energy behaviors. *Environment and Behavior,46*(4), 423-452. https://doi.org/10.1177/0013916512467532

Kerimoğlu, K. (2020). *Yenilenebilir enerji ile ekonomik büyüme arasındaki ilişki bağlamında Türkiye'nin enerji politikalarının değerlendirilmesi.* Yüksek Lisans Tezi. Selçuk Üniversitesi, Sosyal Bilimler Enstitüsü, Konya.

Kılıç, F. Ç. (2011). Türkiye'deki yenilenebilir enerjilerde mevcut durum ve teşviklerindeki son gelişmeler. *Engineer & The Machinery Magazine, 52*(614), 103-115.

Kocaeren, A. (Ed.) (2016). Çevre ve enerji. Ankara: Nobel Yayıncılık.

Koç, E., & Kaya, K. (2015). Enerji kaynakları–yenilenebilir enerji durumu. *Mühendis ve Makina, 56*(668), 36-47.

Koç, E., & Şenel, M. C. (2013). Dünyada ve Türkiye'de enerji durumu - genel değerlendirme. *Mühendis ve Makina Dergisi, 54*(639), 32-44.

Koçak, E. (2020). *Tüketicilerin hane içi enerji tasarrufu davranışına etki eden faktörlerin incelenmesi.* Yüksek Lisans Tezi. Hacettepe Üniversitesi, Sosyal Bilimler Enstitüsü, Ankara.

Koçaslan, G. (2010). Sürdürülebilir kalkınma hedefi çerçevesinde Türkiye'nin rüzgâr enerjisi potansiyelinin yeri ve önemi. *Sosyal Bilimler Dergisi, 4,* 53-61.

Köroğlu, T., Teke, A., Bayındır, K. Ç., & Tümay, M. (2010). Güneş paneli sistemlerinin tasarımı. *Elektrik Mühendisliği Dergisi, 439,* 98-104.

Kurnaz, M. A. (2007). *Enerji kavramının üniversite 1. Sınıf seviyesinde öğrenim durumlarının analizi.* Yüksek Lisans Tezi. Karadeniz Teknik Üniversitesi, Fen Bilimleri Enstitüsü, Trabzon.

Larson, L. R., Stedman, R. C., Cooper, C. B., & Decker, D. J. (2015). Understanding the multi-dimensional structure of pro-environmental behavior. *Journal of Environmental Psychology, 43,* 112-124. https://doi.org/10.1016/j.jenvp.2015.06.004

Lay, Y. F., Khoo, C. H., Treagust, D. F., & Chandrasegaran, A. L. (2013). Assessing secondary school students' understanding of the relevance of energy in their daily lives. *International Journal of Environmental and Science Education, 8*(1), 199-215.

Mahmutoğlu, M. (2013). *Türkiye elektrik sektöründe yenilenebilir enerjinin rolü.* Yüksek Lisans Tezi. Gazi Üniversitesi, Fen Bilimleri Enstitüsü, Ankara.

Maxwell, S. (2006). *Strategies for zero waste in the fraser valley regional district.* Masters Thesis. Royal Roads University, Victoria, BC.

McLeroy, P. G., & Caudle, B. H. (2019). Petroleum production. Retrieved April 21, 2021, from https://www.britannica.com/technology/petroleum-production/Surface-methods

Montgomery, S. L. (2014). *Küresel enerjiye yön veren güçler: 21. yüzyıl ve sonrası* (Translate Evra Günhan Şenol). Ankara: Türkiye Bilimsel ve Teknolojik Araştırma Kurumu.

Mosbech, A. (2002). *Potential environmental impacts of oil spills in Greenland*. NERI Technical Report. Denmark: National Environmental Research Institute.

MTA- Maden Tetkik ve Arama Genel Müdürlüğü, (2020). Kömür arama araştırmaları. Türkiye'nin önemli linyit havzaları ve sahaları. Retrieved April 17, 2021, from https://www.mta.gov.tr/v3.0/arastirmalar/komur-arama-arastirmalari

National Geographic, (2018). Fossil fuels, explained. Retrieved April 21, 2021, from https://www.nationalgeographic.com/environment/article/fossil-fuels

Onur, M. (2006). Petrol ve doğal gazın Dünya'da, Türkiye'de durumu ve İTÜ'deki çalışmalar. Retrieved April 19, 2021, from https://inis.iaea.org/collection/NCLCollectionStore/_Public/41/103/41103136.pdf

Önal, H., Kaya, N., & Çalışkan, T. (2019). Çevre eğitiminde sıfır atık politikası ve mevcut ders kitaplarındaki görünümü. *Milli Eğitim, 48*(221), 123-140.

Öykün, T., & Abbasoğlu, S. (2017). Energy literacy survey at high schools in Northern Cyprus. *International Journal of New Trends in Arts, Sports & Science Education, 6*(2), 1-16.

Özev, M. H. (2017). *Küresel denklemde Türkiye'nin enerji güvenliği*. İstanbul: Turkuaz Haberleşme ve Yayıncılık A.Ş.

Özkan, K. (2020). *Enerji güvenliği ve Türkiye'de enerji güvenliğinin geleceği.* Yüksek Lisans Tezi. Niğde Ömer Halisdemir Üniversitesi, Sosyal Bilimler Enstitüsü, Niğde.

Özmen, E. (2018). *Yenilenebilir enerji kaynaklarının kullanımında bir model olarak güneş şehirler: Manisa örneği.* Yüksek Lisans Tezi. İstanbul Teknik Üniversitesi, Fen Bilimleri Enstitüsü, İstanbul.

Öztürk, H. H. (2013). *Yenilenebilir enerji kaynakları*. İstanbul: Birsen Yayınevi.

Palabıyık, H., Yavaş, H., & Aydın, M. (2010). *Nükleer enerji ve sosyal kabul*. Ankara: Usak Yayınları.

Pipe, J. (2013). *Doğal gaz temiz bir fosil yakıt mı?* (Translate Ezgi Ertuğrul). Ankara: TÜBİTAK Popüler Bilim Kitapları.

Sintov, N. D., Desario, G., & Prescott, C. (2010). Effectiveness of a competition-based intervention in promoting pro-environmental behavior in a university residential setting. *ACEEE Summer Study on Energy Efficiency in Buildings,* 322-336.

Soral, Ç. (2020). *Türkiye'deki enerji ve enerji verimliliği çalışmalarının tarihsel değişim süreci.* Yüksek Lisans Tezi. Osmaniye Korkut Ata Üniversitesi, Fen Bilimleri Enstitüsü, Osmaniye.

Spurgeon, R., & Flood, M. (2014). *Enerji ve güç.* (Translate: Zehra Sönmezler). Ankara: TÜBİTAK Popüler Bilim Kitapları.

Steg, L. (2008). Promoting household energy conservation. *Energy Policy,36*(12), 4449-4453. https://doi.org/10.1016/j.enpol.2008.09.027

Steg, L., Lindenberg, S., & Keizer, K. (2015). Intrinsic motivation, norms and environmental behaviour: the dynamics of overarching goals. *International Review of Environmental and Resource Economics, 9*(1-2), 179–207. http://dx.doi.org/10.1561/101.00000077

Stern, P. C. (1992). What psychology knows about energy conservation. *American Psychologist, 47*(10), 1224-1232. https://doi.org/10.1037/0003-066X.47.10.1224

T.C. Çevre ve Şehircilik Bakanlığı, (2017). 2016-2023 ulusal atık yönetimi eylem planı. Retrieved May 19, 2021, from https://webdosya.csb.gov.tr/db/cygm/haberler/ulusal_at-k_yonet-m--eylem_plan--20180328154824.pdf

T.C. Çevre ve Şehircilik Bakanlığı, (2019). Sıfır atık yönetmeliği. Retrieved May 19, 2021, from https://sifiratik.gov.tr/sifir-atik/mevzuatlar

T.C. Enerji ve Tabii Kaynaklar Bakanlığı, (2021a). Nükleer enerji. Retrieved April 27, 2021, from https://enerji.gov.tr/bilgi-merkezi-enerji-nukleer-enerji

T.C. Enerji ve Tabii Kaynaklar Bakanlığı, (2021b). Hidrolik enerji. Retrieved April 27, 2021, from https://enerji.gov.tr/bilgi-merkezi-enerji-hidrolik

T.C. Enerji ve Tabii Kaynaklar Bakanlığı, (2021c). Jeotermal. Retrieved April 27, 2021, from https://enerji.gov.tr/bilgi-merkezi-enerji-jeotermal

T.C. Enerji ve Tabii Kaynaklar Bakanlığı, (2021d). Elektrik. Retrieved May 9, 2021, from https://enerji.gov.tr/bilgi-merkezi-enerji-elektrik

TAEK- Türkiye Atom Enerjisi Kurumu, (2010). *Günümüzde nükleer enerji*. Ankara: Türkiye Atom Enerjisi Kurumu.

TEİAŞ- Türkiye Elektrik İletim AŞ., (2021). Enerjinin gücü. Retrieved April, 2021, from https://www.teias.gov.tr/

The World Bank, (2009). *The petroleum sector value chain*. Washington: The International Bank for Reconstruction and Development/The World Bank.

TKİ- Türkiye Kömür İşletmeleri, (2020). Enerji ve kömür. Retrieved April 17, 2021, from https://www.tki.gov.tr/tr-TR/enerji-ve-komur

Torunoğlu Gedik, Ö. (2015). *Türkiye'de yenilenebilir enerji kaynakları ve çevresel etkileri.* Yüksek Lisans Tezi. İstanbul Teknik Üniversitesi, Fen Bilimleri Enstitüsü, İstanbul.

Trefil, J., & Hazen, R. M. (2004). *Physics matters: an intraduction to conceptual physics.* New Jersey: John Wiley & Sons Inc.

TÜRÇEV- Türkiye Çevre Eğitimi Vakfı, (2014). Uluslararası eko-okullar programı enerji el kitabı. Retrieved April 17, 2021 from http://www.turcev.org.tr/turcevCMS_V2/files/files/enerji_el_kitabi_net.pdf

Union of Concerned Scientists, (2013). Environmental impacts of hydroelectric power. Retrieved April 30, 2021, from https://www.ucsusa.org/resources/environmental-impacts-hydroelectric-power

Ün, T. Ü. (2003). Hidrojen enerjisi: depolanması, güvenliği, çevresel etkisi ve dünyadaki durumu. *Mühendis ve Makine Dergisi*, 525, 17-22.

Yaman, K., & Olhan, E. (2010). Atık yönetiminde sıfır atık yaklaşımı ve bu anlayışa küresel bir bakış. *Biyoloji Bilimleri Araştırma Dergisi, 3*, 53-57.

Yarman, T. (2011). *Geçmişte ve bugün nükleer enerji tartışması*. İstanbul: Okan Üniversitesi Yayınları.

Yıldız, D. (2011). Hidroelektrik enerji politikaları ve HES projeleri. *Elektrik Mühendisliği Dergisi, 442*, 25-29.

Zaman, A., & Lehman, S. (2013). The zero waste index: a performance measurement tool for waste management systems in a 'zero waste city'. *Journal of Cleaner Production, 50*, 123-132. https://doi.org/10.1016/j.jclepro.2012.11.041

ZWIA- Zero Waste International Allience, (2018). Zero waste definition. Retrieved May 15, 2021, from https://zwia.org/zero-waste-definition/

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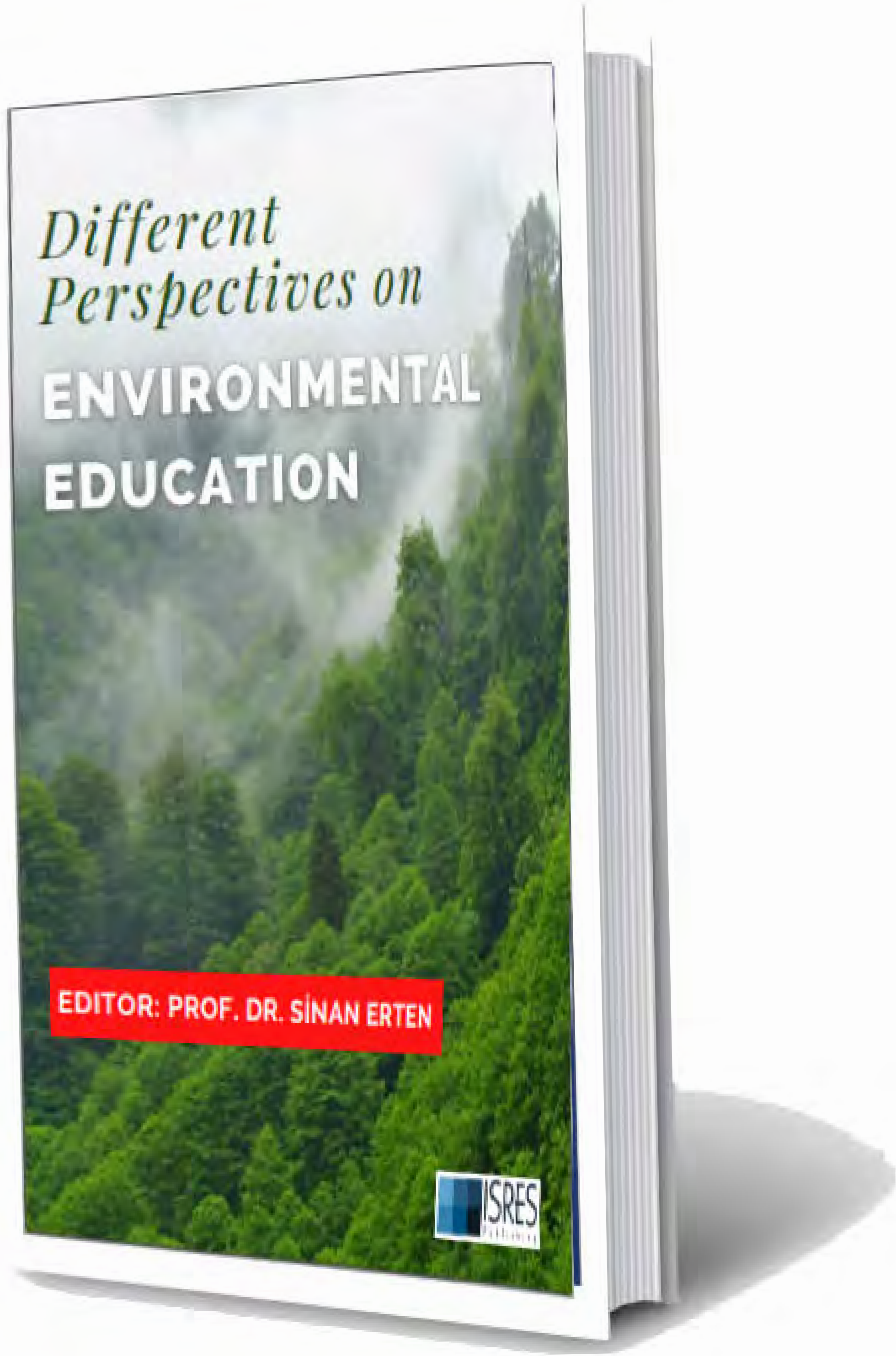

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