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Visual Images about Climate Change**

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Examination of Secondary Students' Visual Images about Climate Change

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Abstract

In this study, it was aimed to examine the perceptions of secondary school students about climate change. The study was planned according to the phenomenological design. The research was carried out with the participation of 131 students selected according to the criterion sampling. Students were asked to draw pictures about climate change and the collected pictures were subjected to content analysis. Since 12 of the pictures could not be evaluated under any theme, they were excluded from the data set and coding were done on 119 drawings. As a result of the data analysis, three themes were determined as temperature increase and its effects, change in thermal and precipitation regime, and extreme weather events. Under these three themes, subcategories were created based on the drawings that were similar to each other. As a result of the research, it has been determined that secondary school students have a high awareness of climate-related events and the directly observable effects of climate change in the city they live in.

Introduction

Climate change refers to statistically significant changes in meteorological parameters, such as temperature or precipitation that persist for decades or more (Kahraman & Şenol, 2018). Climate change in early Earth's history was often the result of natural factors. In the process from the industrial revolution to the present, the most determining factor of climate change has been human (anthropogenic factors) activities. (IPPC, 2007; Türkeş, 2008). After the industrial revolution, with the use of fossil fuels, a significant amount of greenhouse gases [carbon dioxide (CO₂), methane (CH₄), nitrogen oxide (N₂O), ozone (O₃) and fluorinated gases] began to accumulate in the atmosphere (Demir, 2009; Türkeş, 2012), and the increase in greenhouse gas accumulation has led to changes in the climate system. These changes were manifested most clearly by the increasing trend in air temperatures (Erlat & Ölgen, 2008). So much so that the global temperature increase has increased **1.09** [0.95 to 1.20] °C higher in 2011–2020 than 1850–1900 (IPCC, 2021). Moreover, The IPCC (2001) predicts that the global average surface temperature will rise between 1.4 and 5.8 °C by 2100.

As a result of anthropogenic climate change, changes occur in the frequency, duration, severity and timing of extreme weather events (Erlat & Avşar, 2020). Due to the melting of glaciers and thermal expansion of ocean waters, the global sea level is rising, the start/end dates of phenological events in the biosphere are changing, and many species are on the facing of extinction. Extreme weather events such as drought, heavy rain, landslide, tornado, hurricane, frost and sandstorm are among the observed effects of climate change in daily life (Gezer & İlhan, 2021). In Figure 1, the possible effects of global climate change on living spaces are summarized (TEMA, n.d.). As seen in Figure 1, climate change makes itself felt in every aspect of life.

Climate Change in Turkey

Turkey is one of the countries most affected by climate change due to being surrounded by sea on three sides, being on a fragmented topography and orographic characteristics (Öztürk, 2002). The western and southern parts of Turkey belong to the Mediterranean climate, which is one of the most vulnerable regions to global warming and climate change (Sanchez et al., 2004). Along with the global temperature increase, a significant temperature increase is experienced in Turkey and the duration of the cold air waves is decreasing. For example, between 1950 and 2017 in Turkey, the duration of the warm period showed a tendency to lengthen; the cold period shortened considerably in the period from 1998 to 2017 (Erlat & Güler, 2018). In addition, since the mid-1980s in Turkey, there has been an increase in the number of tropic night and minimum temperature values. This increase causes a decrease in the daily temperature range and changes in the start and end dates of phenological events.

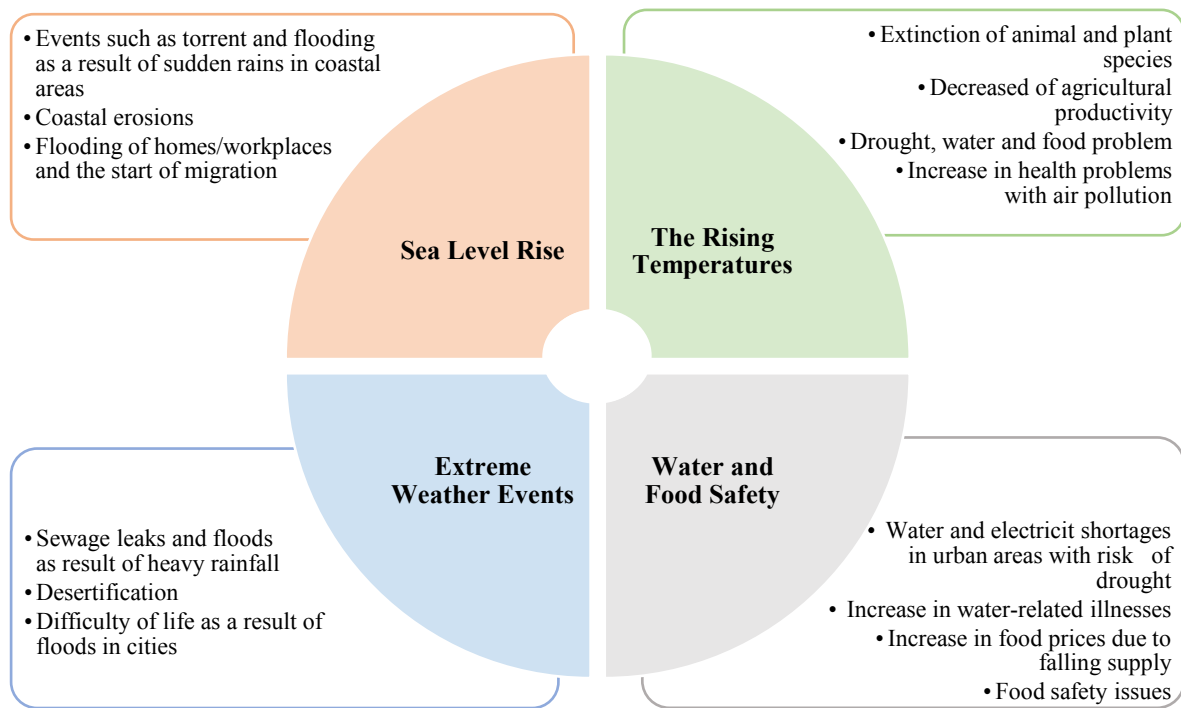


Figure 1. Possible effects of global climate change on habitats

Accordingly, differentiations are observed in the reproduction and survival times of agricultural pests and pathogens. The increase in night temperatures negatively affects human comfort, especially the population in big cities, and causes an increase in the number of cooling days and energy consumption (Erlat & Türkeş, 2017). Again in Turkey, with the increase in temperature, snow melts begin earlier and earlier shifts were observed in the current rivers fed by snow. It has been determined that Turkey's glaciers retreated an average of 10 m each year in response to the temperature increase. Measurements on the coast indicate that the sea level is rising by about 6 mm per year (Şen et al., 2013). It is forecasted that the recharge of groundwater will gradually decrease between 2015 and 2100, the snows will go into the melting phase more quickly in parallel with the increasing temperatures, and this situation will increase the water stress in the related regions in the late spring and summer months. In addition, it is thought that there may be an increase in snow avalanches and floods due to fusing and melting in areas covered by seasonal snow and permanent snow-ice cover (Kadioğlu et al., 2017). Considering the precipitation regime of Turkey, it is seen that there are changes from the normal and a decrease in the precipitation amount. For instance precipitation, which is 631 mm on average in Turkey, decreased by 15% in 1999 and 7% in 2000 (Türkeş, 1999). It is predicted that the total precipitation in Turkey, especially in the Aegean and Mediterranean coasts and the East and Southeast regions, will decrease further as of 2050. On the other hand, it is expected that extreme precipitation events and flood risk in parallel are expected to increase in the Eastern Black Sea Region (Kadioğlu et al., 2017).

Climate change; in recent years, in Turkey have also triggered hydro meteorological disasters such as heavy rains, storms, heat waves, forest fires, floods and tornado (Şen et al., 2013). According to the Turkey climate assessment report, 2020 is the year in which extreme weather events are experienced the most with 984 extreme events. Most of the extreme events recorded in 2020 were heavy rain/flood with 30%, storm with 27% and hail with 23%. Other events were lightning with 7%, snow with 5%, landslide with 2%, and frost, avalanche forest fire, sandstorm, high temperature and fog with 1% and less. Also in the same report, it was emphasized that there has been an increasing trend in extreme weather events, especially in the last two decades (Ministry of Agriculture and Forestry General Directorate of Meteorology, 2021). When all these are taken into account, as in the rest of the world, climate change can affect water resources, agriculture, industry, biodiversity, health, tourism, energy resources, etc. in Turkey profoundly affected many areas, and it's an undeniable the acceleration of this effect will increase day by day (Yılmaz & Imteaz, 2014).

Social Studies and Climate Change

As climate change becomes a more serious issue, climate literacy has turned into one of the skills that take place under the umbrella of scientific literacy (Dupigny-Giroux, 2010). As citizens of the world, all people should

have advanced climate literacy in order to better understand the impact of global climate change and its consequences (Harrington, 2008). Climate literacy is defined as the understanding the effects of the person on the climate and the effects of the climate on the person. Making sense of the basic concepts and principles related to climate, establishing meaningful connections between climate change and climate, and being able to make scientifically conscious decisions about climate are among the climate literacy skills (Yakar & Karakuş, 2020). Yakar and Karakuş (2020) collected climate literacy competencies that secondary school students should have in six categories: *i*) climate-related concepts, *ii*) basic climate information, *iii*) national and local climate information, *iv*) climate and life relationship, *v*) skills, and *vi*) attitudes and values.

Competencies expected from secondary school students regarding climate literacy, also included in the curriculum. When the curricula are examined, it is seen that the social studies program has an important place in providing students with the necessary knowledge, skills and behaviors about the human impact on climate change and the negative consequences that this effect possible to cause (Özkaral, 2019; Yakar & Karakuş, 2020). The love of nature, sensitivity to the natural environment and responsibility values, as well as the ability to perceive space and environmental literacy skill in the social studies program can be associated with climate change. Although there is no learning area, unit or subject that directly deals with climate change in the social studies program, some learning areas indirectly include concepts related to climate, climate elements and climate change. Table 1 shows the objectives that deal with climate change in the social studies curriculum (MoNE, 2018).

Table 1. Objectives about climate change in the social studies curriculum

Learning Area	Grade Level	Objectives
<i>People, Places and Environments</i>	4th grade	Observing the weather events occurring around her/him, he/she transfers her findings to illustrated graphics. Makes necessary preparations for natural disasters.
	5th grade	Explain the effect of the climate seen in the living environment on human activities by giving examples from her daily life. Questions the causes of disasters and environmental problems in the environment they live in. Explains the effects of natural disasters on community life with examples.
	6th grade	Examines the main physical geography features of Turkey, landforms, climatic features and vegetation on the relevant maps. Analyzes the effects of unconscious consumption of resources on live life.
<i>Global Connections</i>	7th grade	Together with her/his friends, she/he develops ideas for the solution of global problems.

The explanations made for these objectives in the curriculum have been effective in thinking that the achievements in Table 2 are related to climate change. That is, it was determined that the concept of global climate change was included in the explanation of the "Develops ideas suggestions for the solution of global problems with their friends" objective in the 7th Grade Global Connections learning area. In the objective of "Explains the effect of the climate seen in the environment in which they live, on human activities by giving examples from their daily lives", student is asked to examine the effect of the climate in the region they live in on human life. However, climate change is not mentioned in this objective. Again, in the objectives of "Analyze the causes of disasters and environmental problems in the environment they live in" and "Explains the effects of natural disasters on community life with examples", students were expected to evaluate human-environment interaction in terms of disasters and environmental problems in their region.

Nevertheless, the connection of these objectives just mentioned with climate change was not touched upon. In the objective of "Analyzes the effects of unconscious consumption of resources on living life", the effect of unconscious consumption of natural resources on human life is taught to the student, but its connection with climate change is not taken into account. The concepts of global warming and drought, which are directly related to climate change, were included in Social Studies textbooks (5th and 6th grades). The concepts of climate change, greenhouse gases, deforestation, desertification and global warming are also mentioned in the 7th grade social studies textbook.

Purpose and Importance of the Research

Its effects, which reach life-threatening dimensions by disrupting the ecological balance, show that it is insufficient in the fight against climate change. The need is for well-equipped individuals who can cope with the uncertainty of the environmental, economic and political future that will be created by global climate change (Bangay & Blum, 2010). For this reason, the necessity of training climate literate citizens have emerged today (Arndt & LaDue, 2008). As a matter of fact, it is emphasized in the United Nations Framework Convention on Climate Change (United Nations Department of Public Information, 1994) that climate change education should be promoted and people's awareness of climate change should be increased (Barak & Gönençgil, 2020). Climate is influenced by both natural and anthropogenic elements on atmospheric composition, this situation making it difficult for students to understand climate change (Hansen, 2010). This understanding of students is critical because the younger generation will be faced with far more difficult choices and possible solutions regarding climate change mitigation and adaptation than today (Bodzin et al., 2014). It is very important to provide individuals with a planned education at an early age regarding global-scale problems such as climate change. With the objectives in the secondary school social studies curriculum, it was aimed to teach the subject of climate change, albeit partially. Coping with the problems stemming from climate change primarily depends on knowing how well the curriculum objectives are understood by the students. Therefore, it is important to determine the perceptions of secondary school students about the causes and possible consequences of climate change.

The issues climate change education and climate literacy are newly developing fields. Hence, research on climate change is limited in our country as well as in the world. There are studies in the literature that examine climate change theoretically. For example, Özkara (2019) examined social studies curricula in Turkey, Canada (Ontario) and Hong Kong in terms of global warming and climate change. Yakar and Karakuş (2019) investigated the social studies programs between 1968 and 2018 in terms of climate literacy competencies. Demir (2019) scrutinize the 2018 social studies curriculum and textbooks in terms of climate change. Barak and Gönençgil (2020) compared in terms of climate change education the secondary school education programs implemented in high-achieving countries according to PISA 2015 results and Turkey. Furthermore, Görgülü Arı and Aslan (2020) developed a climate literacy scale for secondary school students. Atik and Doğan (2019) conducted a study to determine the opinions of high school students about climate change. However, no study has been found in the literature focusing on the perceptions of secondary school students about climate change. In this context, the present research, it is aimed to examine the drawings of secondary school students and thus to reveal their visual images about climate change.

Method

Research Model

The study is in the phenomenological design, which is one of the qualitative research models. In phenomenological research, it is aimed to evaluate the experiences of individuals regarding an event or phenomenon in detail (Yıldırım & Şimşek, 2011). Events such as earthquake, war, migration, and psychological-based situations such as racism, aggression, sexual abuse, addiction encountered in daily life can be the subject of phenomenological research (İlhan & Gezer, 2021). Meteorological parameters in the direction of increase and decrease were recently recorded in Diyarbakır. It has been determined that there is an increase in average temperatures and a decrease in total precipitation in Diyarbakır (Çelik & Toprak, 2016; Kınık, 2020; Özdel, 2020). Therefore, it can be said that secondary school students have common experiences regarding the observed effects of climate change in Diyarbakır. In this respect, it is thought that the study is suitable for the phenomenological design.

Table 2. Distribution of participants by their gender and grade level

	Female	Male	Total
7th grade	38	36	74
8th grade	18	27	45
Total	56	63	119

Study Group

The criterion sampling method, which is one of the purposive sampling techniques, was used to determine the participants. With the idea that the perception of climate change would be portrayed more clearly, secondary

school 7th and 8th grade students were determined as the study group. A secondary school in which families are homogeneous in terms of their socio-economic level was selected in the central district of Kayapınar in Diyarbakır province. The research was carried out with the participation of a total of 131 students. However, 12 forms were excluded from the study, and the coding was done on the drawings of 119 students. In the research, codes such as P1, P2, ... P119 were used instead of participant names, and the distribution of participants according to gender and class levels is given in Table 2.

Data Collection and Analysis

Before collecting the research data, an application was made to the ethics committee about whether the study was in accordance with scientific ethics and ethics committee approval was obtained. Then, the data collection tool was distributed to the students and an explanation was given about the purpose of the research and it was stated that the participation was based on the principle of voluntariness. Besides, the students were reminded that the collected drawings would not be shared with third parties or institutions, and their names would be kept confidential. After the necessary reminders were made, they were asked to mark the information on the class and gender variables on the form and draw a picture about climate change in the area below. It took 40 minutes for the students to complete their drawings.

After collecting the research data, the data analysis phase was started. Data analysis in phenomenological research is carried out by content analysis. The aim is to conceptualize the data and reveal themes that can describe the phenomenon. Content analysis is mostly used in the analysis of data collected by written and visual methods. Primarily, words and pictures with close meanings are determined and categories related to the subject are developed in line with these (Batdı, 2021). Then, data with similar trends are placed in appropriate categories. The purpose of content analysis is to discover the concepts and connections that can explain the collected data, that is, to reveal the patterns hidden in the data (Yıldırım & Şimşek, 2011). Data analysis was carried out by the researcher. In order to ensure the reliability of the coding made in content analysis, it is recommended that the coding process be done by more than one person. However, in cases where there is no such possibility, the same person repeating the coding several times at different times also helps to achieve correct results (Batdı, 2021). The coding made in this context was reviewed by the researcher twice within 15 days and no difference was found between the coding's. In the study, three themes were determined as temperature increase and its effects, change in thermal and precipitation regime, and extreme weather events. Sub-categories were created based on the drawings that were similar to each other under the themes in question.

Results

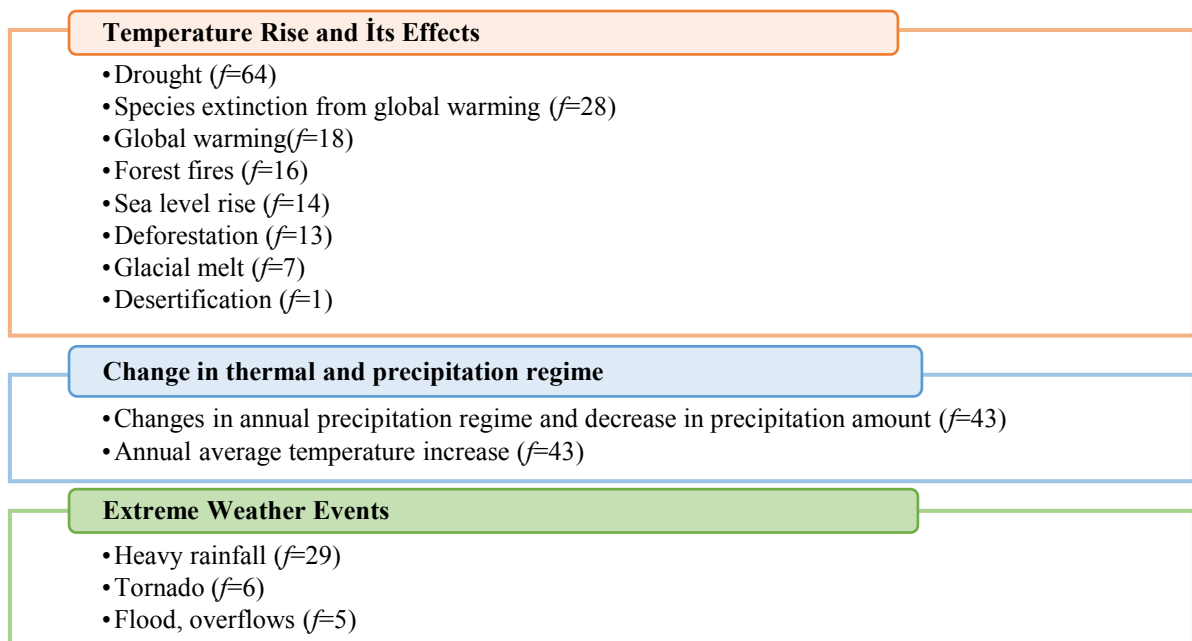


Figure 2. Themes and subcategories of participant opinions

As a result of the content analysis, the perceptions of secondary school students about climate change were gathered under three themes. These themes and subcategories of each theme are presented in Figure 2. As seen in Figure 2, the first theme is related to the temperature increase and its effects. This theme consists of the categories of drought, species extinction from global warming, global warming, forest fires, rise in sea level, deforestation, glacier meltdowns and desertification, respectively, according to the frequency of repetition. Examples of participant drawings for some of these categories are presented in Figure 3.

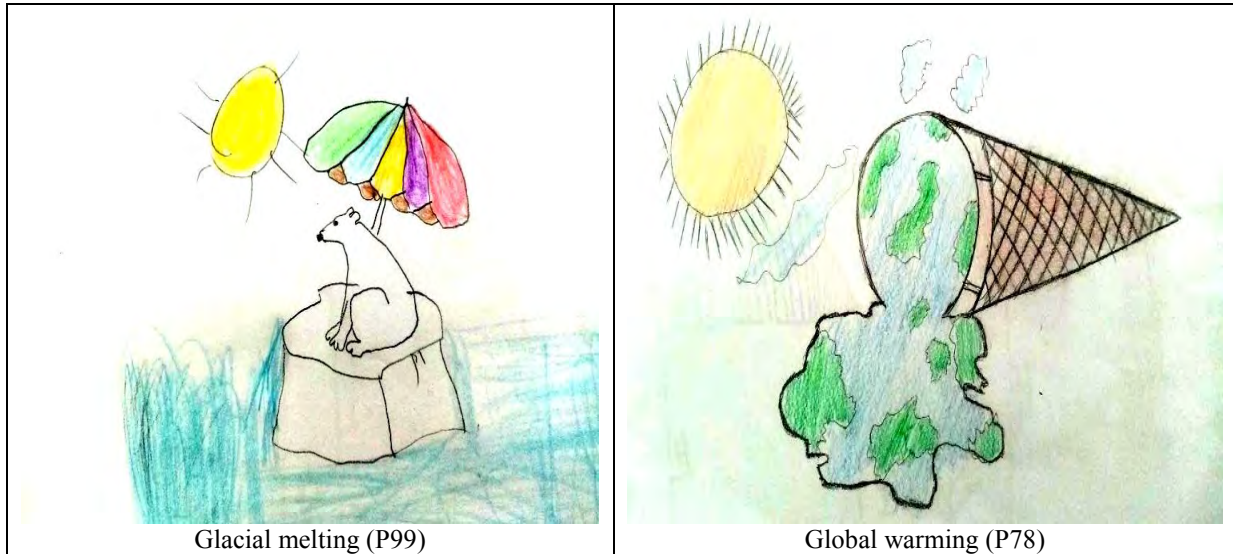


Figure 3. Drawings of the theme of temperature increase and its effects

Participants reflected the results of climate change in their drawings, such as changes in the average temperature values and precipitation patterns according to the seasons, hotter summer, drier spring and autumn seasons, and reduced snowfall in winter. Since it includes the effects of climate change on temperature and precipitation regime, the label of change in thermal and precipitation regime are used for this theme. Under this theme, there are the categories of changes in the annual precipitation regime, decrease in precipitation and annual average temperature increase. Examples of participant drawings for this theme are presented in Figure 4.



Figure 4. Drawings on the theme of change in thermal and precipitation regime

The last theme that emerged as a result of the content analysis is the theme of extreme weather events. Under this theme, there were heavy rainfall, flood and flooding, tornado subcategories, respectively, according to the frequency of repetition. Examples of participant drawings for each of the listed categories are presented in Figure 5.



Heavy rainfall and flood (K13)

Heavy rainfall and tornado (K55)

Figure 5. Drawings on the theme of extreme weather events

Conclusion and Discussion

As a result of the research, it was determined that the students' perceptions of climate change were gathered under three themes: temperature increase and its effects, change in thermal and precipitation regime, and extreme weather events. Under the theme of temperature increase and its effects, respectively, took place in drought, species extinction from global warming, global warming, forest fires, rise in sea level, deforestation, glacier melting's and desertification. These categories include the current reflections of climate change due to temperature increase. Although there is no study in the literature that directly overlaps with this finding, there are studies that indirectly support the research result.

Punter et al. (2011) found that secondary school students are knowledgeable about the physical consequences of climate change, such as melting, high temperature, drought, and sea level rise in the Polar Regions. Gezer and İlhan (2018), in their study in which they adapted the climate change knowledge test into Turkish, concluded that the knowledge of pre-service teachers about climate change is mostly related to the actual aspect of the subject. Similarly, Özdemir Özden and Özden (2015) and Özsoy (2012) revealed in their research that the environmental problems that children include in their drawings are mostly related to the problems that they can directly observed. Demirbaş and Pektaş (2009), on the other hand, examined primary school students' level of realization of basic concepts related to environmental problems and revealed that students mostly have knowledge about environmental problems they encounter in daily life.

When the student drawings were analyzed, the second theme was named as the changes in thermal and precipitation regime. Under this theme, the categories of increase in summer temperature, temperatures above seasonal norms in autumn and spring, decrease in precipitation in spring and autumn, decrease in snowfall in winter took place. Climate change studies conducted in Diyarbakır province (Çelik & Toprak, 2016; Kınık, 2020; Özdel, 2020) have proven that the changes in the annual total precipitation, number of rainy days, snow depth and number of snowy days in Diyarbakır are in the direction of decrease. In this sense, it is possible to say that students' awareness of climate-related events in the city they live in is high.

Regarding the third theme of the research, extreme weather events, the students mostly included heavy rainfalls, floods, overflows and tornadoes in their drawings. In recent years, it is seen that the effect of extreme weather events has increased in Turkey as in the world. For example, recent heavy rains in the Black Sea region have caused sea level rise and triggered extreme weather events such as floods and overflows. According to the 2020 climate assessment report of the General Directorate of Meteorology, 30% of the extreme events recorded in 2020 were heavy rainfalls and floods. In the last 10 years, there has been a significant increase in the frequency of tornado events compared to previous years. A notable example of this is the Çeşme tornado (February 11, 2021) has left deep traces in the memory of many people in the region. All of the listed effects are directly observed consequences of climate change today. It is not surprising that students have knowledge of these

effects. Because students are faced with the news in social media or in the written/visual media about the threat of drought, forest fires, desertification, etc. almost every day.

Indeed, when the word "climate change" is searched on Google, 45300 news are found in the last year. When the words climate change, drought and flood are scanned together, more than 1000 news items are encountered. When searching for climate crisis news, there are 21100 results for the last year. Therefore, it can be said that public perception is tried to be strengthened by including news such as climate change and climate crisis. As a matter of fact, there are studies in the literature that show parallelism with this finding (Boyes et al., 1993; Hansen 2010; Hestness et al., 2019). Hestness et al., (2019) examined the drawings of middle school students about climate change in their study. 75% of the students in the research group stated that local television news, internet tools such as google, wikipedia and publications such as books, magazines, newspapers, and articles were the sources of their learning about climate change. This indicates the importance of having digital literacy skills for students to acquire climate literacy skills.

In the study, it was observed that the theoretical aspect of climate change was not given much space in student drawings. For example, fossil fuels and the resulting greenhouse effect have little place in the drawings. Indeed, many studies in the literature (Boyes et al., 1993; Koulaidis & Christidou, 1999; Shepardson et al., 2012) indicate that students lack knowledge about global warming, greenhouse gases, the combination of greenhouse gases in the atmosphere, greenhouse effect, and climate system. In a similar vein, İlhan and Gezer (2018) found in their study that prospective teachers' actual knowledge about climate change is high, but their theoretical knowledge is limited. In other words, the elements that are not included in the drawings, such as the elements in the student drawings regarding climate change, are on the same axis with the studies in the literature.

Recommendations

Considering that students will be affected by the consequences of climate change throughout their lives, it is extremely important that they better understand its effects on humans and ecosystems. The main factor that will enable students to take action to reduce the potential consequences of climate change is their awareness of this issue. In this respect, it is imperative to develop students' climate literacy skills. Therefore, climate change education should be made a part of formal education and integrated into curricula. It is seen that learning experiences that will serve this purpose are not adequately addressed in the social studies curriculum. It is thought that the preparation of a curriculum that includes well-rounded learning about climate change will contribute to the development of literacy skills about climate change.

Scientific Ethics Declaration

I, the author, declare that the scientific ethical and legal responsibility of this article published in JESEH journal belongs to the author.

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Appendices-1

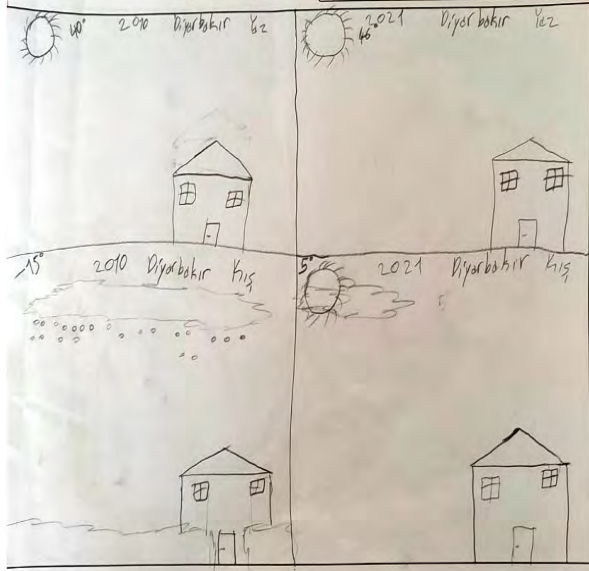


Figure 6. Change in annual temperature averages (P119)



Figure 7. Glacier melting/ Extinction of animal and plant species (P87)

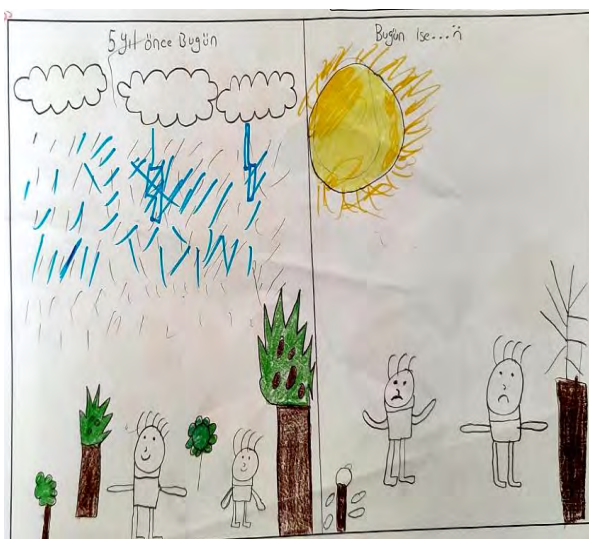


Figure 8. Change in thermal and precipitation regime(P105)

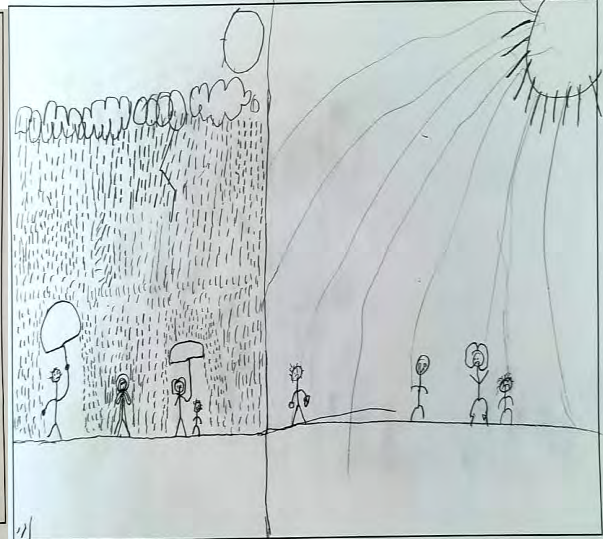


Figure 9. Decreased amount of precipitation (P35)



Figure 10. Fossil fuels (P30)



Figure 11. Forest fires (P21)

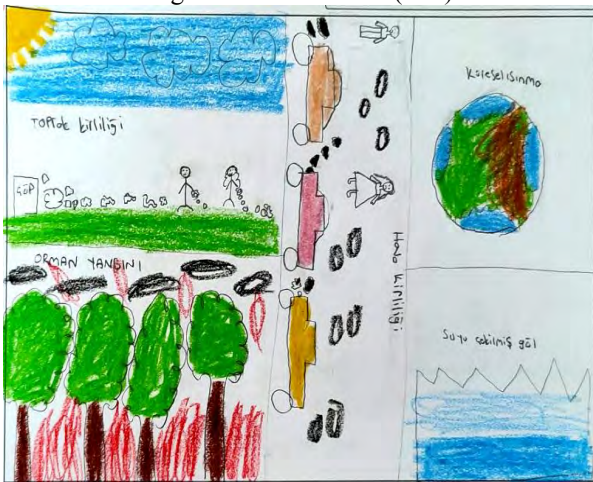


Figure 12. Enviromental pollution / Global warming

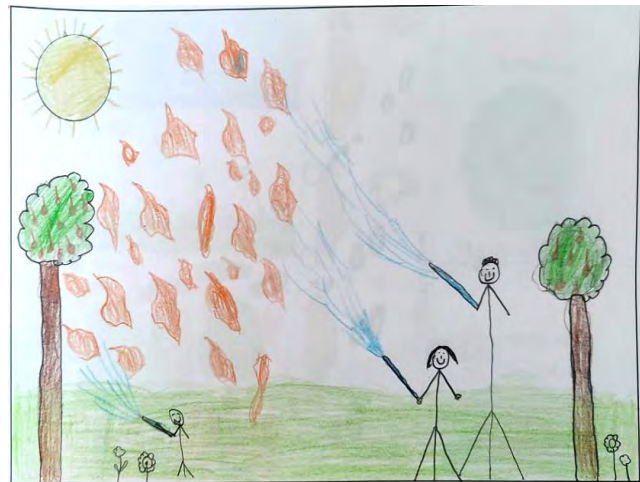


Figure 13. Forest fires (P38)

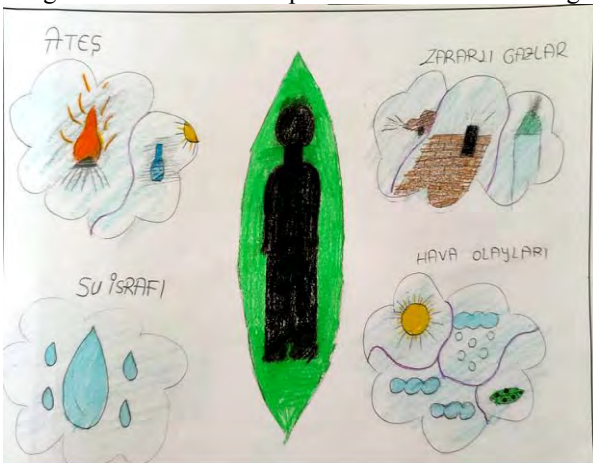


Figure 14. Fossil fuels (P89)



Figure 15. Drought (P108)