Advanced Geomatics

http://publish.mersin.edu.tr/index.php/geomatics/index

e-ISSN: 2791-8637

Creating Climate Change Scenarios Using Geodesing Method: Pütürge District Example

Büşra Köksal*[1], Fred Barış Ernst[1]

[1]Harran University, Department of Geomatics Engineering, 63000, Şanlıurfa, Türkiye; (busrakoksal29@gmail.com; f.b.ernst@harran.edu.tr)

Keywords

Geodesing,
Climat change,
Deforestation.

Research Article

Received : 29.12.2022
Revised : 07.07.2023
Accepted : 11.09.2023
Published : 30.09.2023

* **Corresponding Author**
busrakoksal29@gmail.com

Abstract

At the beginning of the problems brought by the climate change that threatens our world, there are some negative situations due to temperature increases. At the beginning of these negativities, increases in natural greenhouse gas levels cause some problems such as drought and deforestation. In this study, alternative scenarios that will adapt to climate change will be produced. The Geodesign approach, which contributes to the production of alternative scenarios and plans for the future with an innovative perspective, will be used. Geodesing 6 question model and process will be applied in three repetitions in Pütürge District, which was chosen as the study area.

1. Introduction

One of the most important problems we are experiencing in the globalizing world is temperature extremes caused by climate change.

İncrease of greenhouse gases in the atmosphere results in an increased frequency of droughts and forest fires. Taking the district of Pütürge as a reference, which has not yet been studied in relation to climate change, the region's agriculture, animal husbandry, forestry and scenarios will be examined in its potential for development of tourism and the processes it will undergo in the future 20-30 years will be analyzed and alternative plans will be prepared. In the master thesis related to this paper the national and international literature review on the above-mentioned subject, i.e. studies on climate change in the world and especially Turkey, has been undertaken.

In fact, Turkey is one of the countries in the world most affected by climate change already now. In addition, it is also among the countries that will be most affected by many changes that may occur to the regional climate in the future.

Turkey is estimated to be a country that will be affected and may experience major problems (Kanat & Keskin, 2018). To promote climate adaptation to climate change combining spatial information with stakeholder values in response to climate change management planning, the joint use of 4 geographical designs has been tested in an interactive environment. This climate adaptation process planning was based on consensus, with the views and suggestions of many stakeholders influencing the decision (Eikelboom & Janssen, 2017).

Cite this;

Demez, K., & Ernst, F.B. (2024). Creating Climate Change Scenarios Using Geodesing Method: Pütürge District Example. Advanced Geomatics, 4(1), 01-08.

2. Method

Initially, a literature search was conducted on the subject of the study and the studies related to the Geodesign method were utilized. The works of scientists such as Hrishikesh Ballal, Carl Steinitz and Brian A Orland, Jack Dangermond, Ming-Chun Lee, who are considered as the founders of the Geodesign method, were utilized. Carl Steinitz, who is considered as the founder of the Geodesign method, defines Geodesign as "changing geography by design" (Dangermond, 2010). The fact that geodesign is both an old and a new idea emphasized that geodesign means design with nature (Şenöz, 2013). As the second stage, fieldwork, field trips and observations were made in the district center of Pütürge and the planning study was directed. In this study, primary and secondary data sources were utilized. These data were used in Arcgıs, a geographic information systems software, and maps were created. Then, Geodesign method, which is a place design process, was applied. Since Geographic Information Systems are included in the process part of the Geodesign method, it contributes to faster and more robust execution by saving time and labor in the planning and decision parts (Yavaş et al., 2021). The Geodesign method plays a role in realizing the most appropriate scenario among different alternatives and in decision making.

Geodesign is a multidisciplinary method that facilitates the production of alternative scenarios for the future with an innovative approach by combining geography and design processes (Karadeniz, 2016). In this article, scenarios are created by using Geodesign method for Pütürge District by taking climate change into consideration. Maps were prepared with the criteria determined in accordance with Geodesign Hub (www.geodesignhub.com), the internet-based software of the Geodesign method. These maps are slope, aspect, elevation, precipitation, distance to rivers, geology map, land use map and precipitation map. Separate criteria were determined for each map and the data in accordance with these criteria were digitized in Arcgıs environment, one of the GIS software.

Data used in this study;

- Photographs taken from Pütürge district center,
- TÜİK, taken from population data
- Master development plan for Pütürge District
- 1/25.000 scale l40c2,l41 a3, b1,b2,b3,b4, c1,c2,c3,c4,d1,d2,d3,d4,l42 d1, d4, sheets
- Forest data obtained from Elazığ General Directorate of Forestry, Pütürge Forest Management Directorate
- The map taken from the General Directorate of Mapping
- Digital Terrain Model (DTM)
- Precipitation data received from Elazığ 13th Regional Directorate of Metrology.

2.1. Study Area

Pütürge District, which is the study area, is located in the Upper Euphrates Region of the Eastern Anatolia Region, within the southeastern borders of Malatya Province, to which it is administratively connected. The total population is 12,976 people (Eşiyok, 2021).

It is 1,250 meters above sea level and consists of 1 sub-district, 1 town, 2 municipalities, 62 villages and 325 hamlets.

The elevation difference in the research area can reach up to 1000-1500 meters in short distances. The slope exceeds 30% in some places. Due to the geographical location of Pütürge District, it has gained a climate characteristic of Mediterranean-Continental transition climate due to planetary factors and landforms. Under these geographical conditions, "Şiro Stream Basin Local Climate" was formed. The average annual temperature of Pütürge is 12.4°C (Özdemir, 1994).

Figure 1. A view in Pütürge District center.

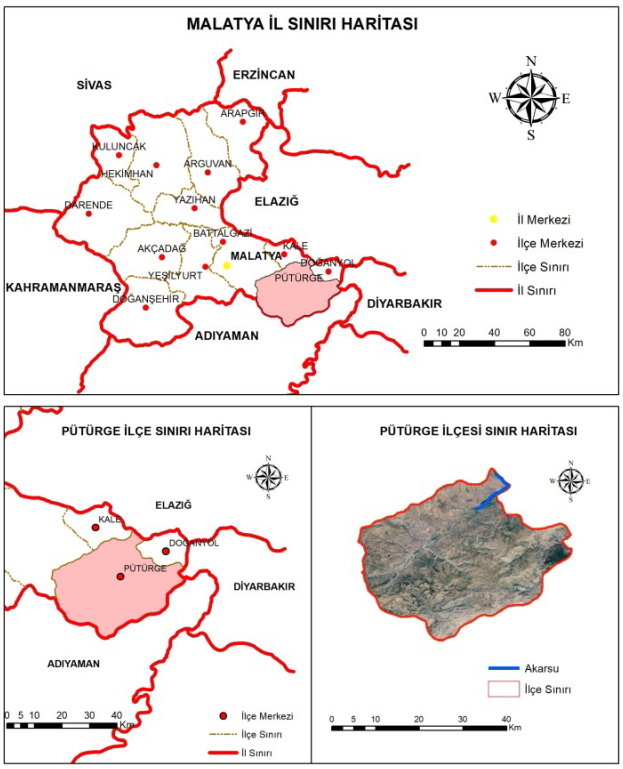

Figure 2. Location map of the study area.

2.1.1. Impact of Climate Change on Endemic Plant Species; Pütürge District Example

In the observations made in the study area, it was revealed that climate change, which has a global impact, affects regional areas the most and has an accelerating effect on climate change, and adaptation and mitigation studies are carried out in order to minimize the effects of climate change and the vulnerability of rural areas to climate change (Kahraman, 2018). The negative impacts of climate change have no boundaries and these negative impacts spread rapidly to all areas unless they are given enough importance.

Plants, which are important for the life of all living things, will cause us to face many problems in the future as a result of geographical variability such as temperature parameters and precipitation parameters due to climate change (Aydın, 2017). Therefore, it is necessary to predict the geographical distribution of plants under the possible effects of climate change in the future. In order to protect the distribution area of Tulipa Armena tulip species, which is one of the endemic plant species in Pütürge district, the location information was determined by geolocating with Gps (Global Positioning System) device in the study site investigation.

Figure 3. Endemic plant species Tulipa Armena mountain tulip.

Table 1. Geographic coordinates of the endemic plant species Tulipa Armena

Items	Y	X
1	38°43’47.162’’	38°06’57.922’’
2	38°43’47.133’’	38°06’57.971’’
3	38°43’47.109’’	38°06’57.065’’

2.1.2. Studies Conducted with Geodesign Method

Geodesign theory was first mentioned at the ESRI Users' meeting held by ESRI in 1981 with the participation of 16 people, and then at the Geodesign Summit in 2010, and summits were regularly organized by GIS users in the following years (Değerliyurt & Çabuk, 2015).

The Cape Code peninsula, located in Massachusetts, USA, was selected as a pilot project area to examine the consequences of climate change. In this region, scenarios were produced using the Geodesign method in 2011, taking into account sea level rise and coastal erosion due to climate change, land use, transportation networks, high-density and low-density settlement areas. The main purpose of generating land planning scenarios is to reduce greenhouse gas emissions that occur while carrying out transportation services and to reveal the impact of climate change on land use and transportation infrastructure (McElveney, 2012).

Another study is the Singapore Lake Jurong Region Sustainable Development Plan. Due to the limited water resources and natural resources around Lake Jurong, long-term land use strategies are reviewed every ten years to meet the needs arising from the increasing population and developing economy without harming the nature. This study was conducted in 2012 using the Geodesign method and alternative scenarios were presented based on the needs of the economy, society and the environment.

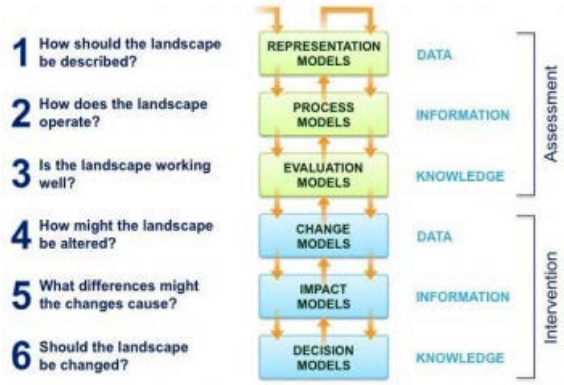

Figure 4. Six Models of the Geodesign Process Created by Carl Steinitz (Foster, 2016).

2.2. Maps and criteria created for the study area

2.2.1. Geology of the Study Area and the Near Environment

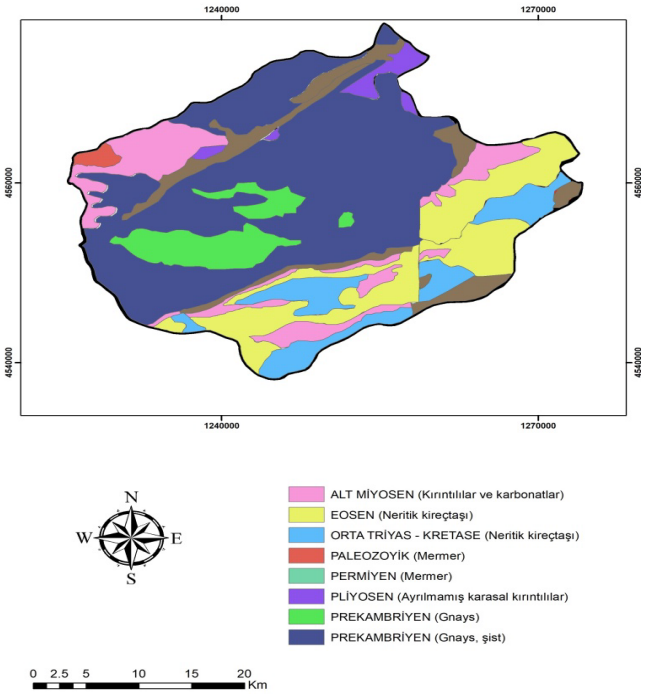

Figure 5. Geology Map of Pütürge District.

2.2.2. Map of Distance to Stream

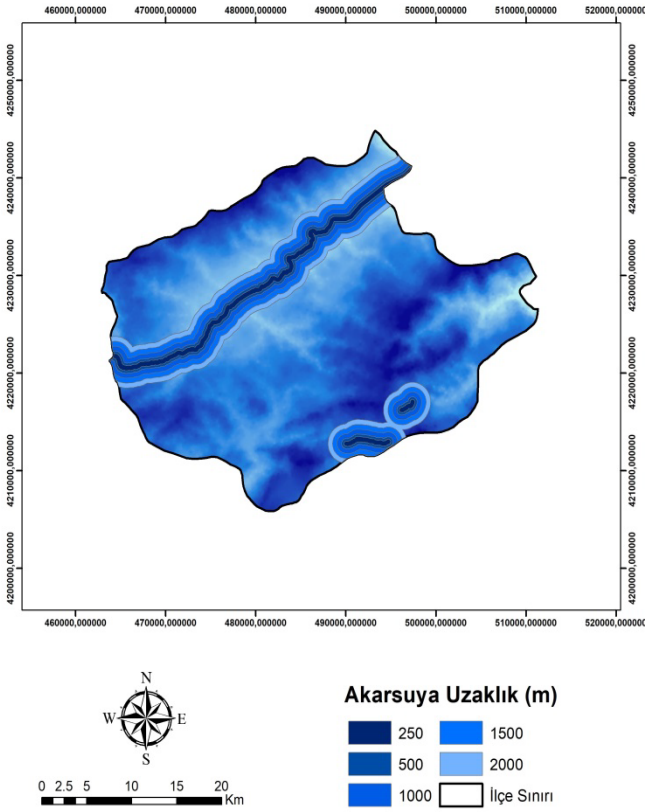

Figure 6. Map of distance to streams in Pütürge District.

2.2.3. Slope Map

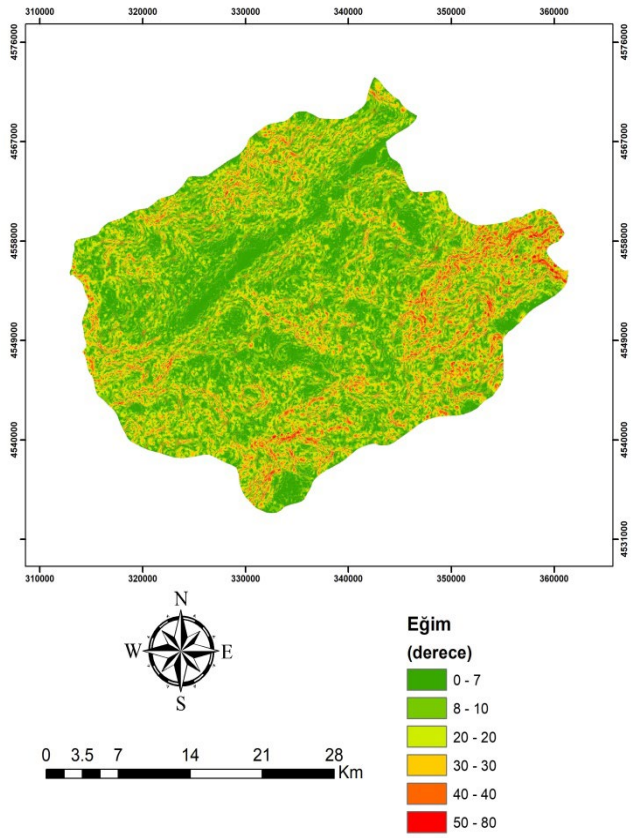

Figure 7. Slope map of Pütürge District.

2.2.4. Aspect Map

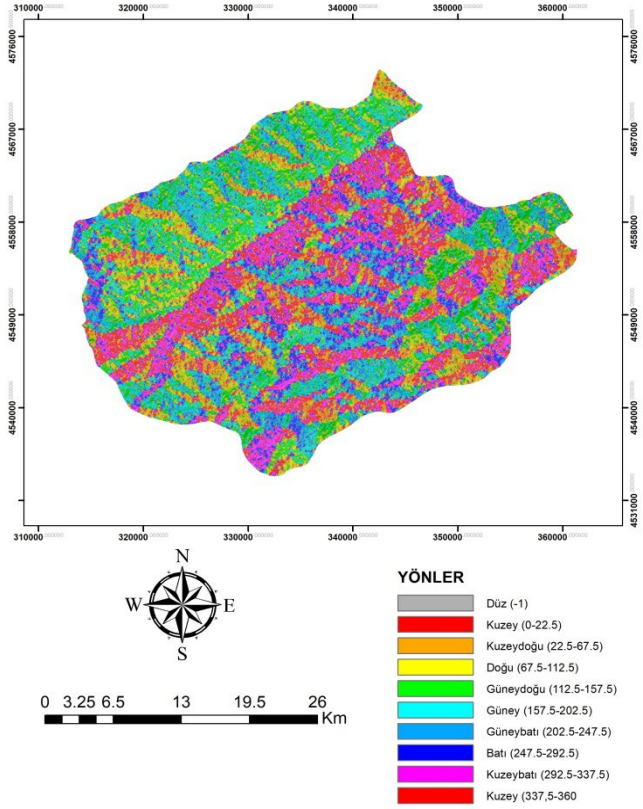

Figure 8. View map of Pütürge District.

2.2.5. Elevation Map

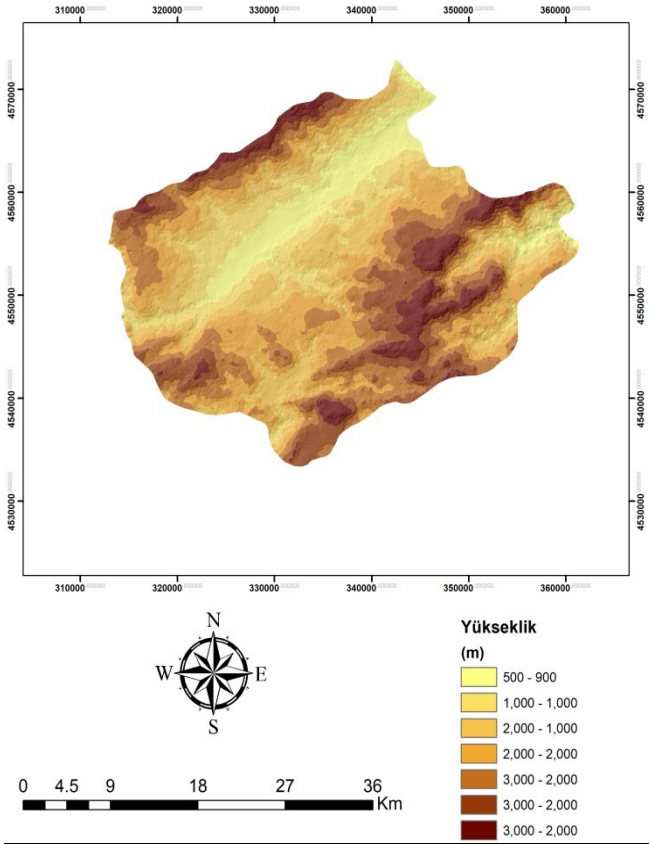

Figure 9. Elevation map of Pütürge District.

2.2.6. Land use Map

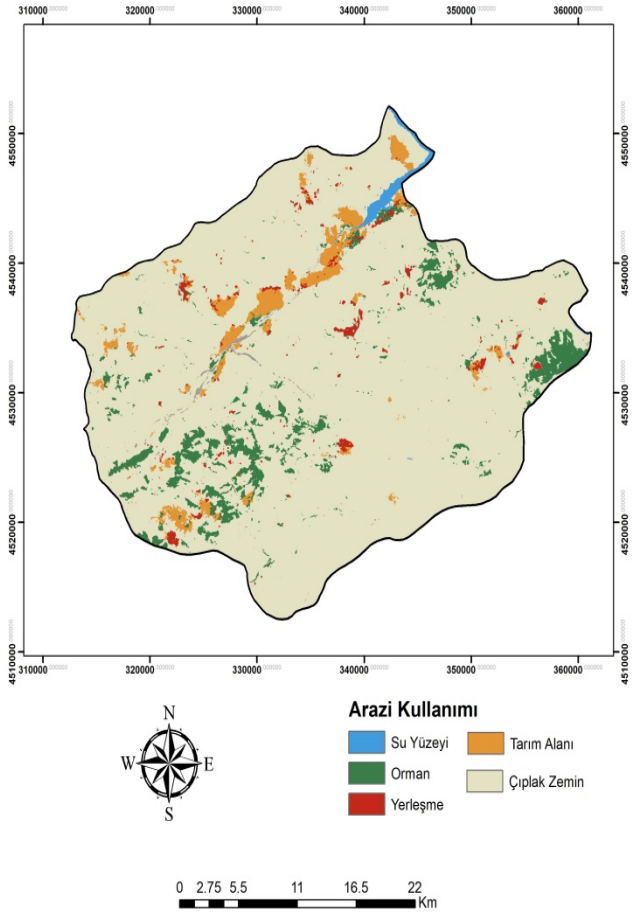

Figure 10. Land use map of Pütürge District.

2.2.7. Temperature Map

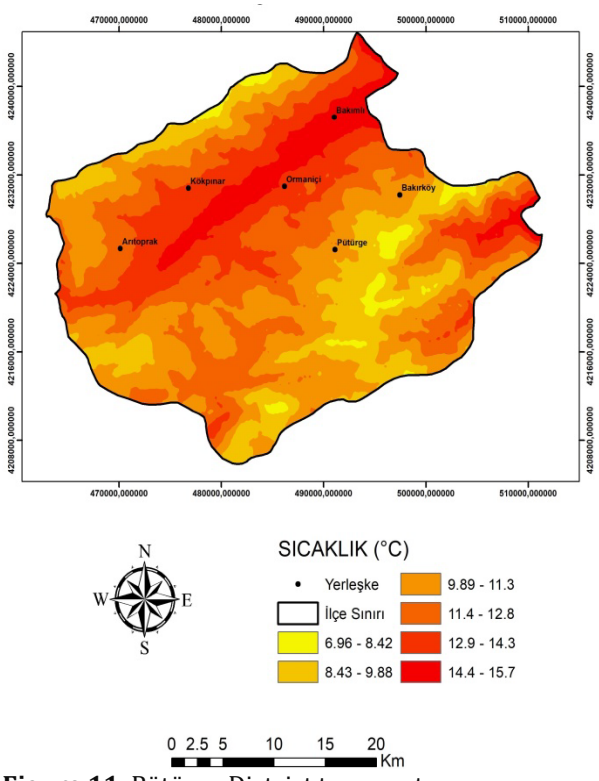

Figure 11. Pütürge District temperature map.

2.2.8. Rainfall Map

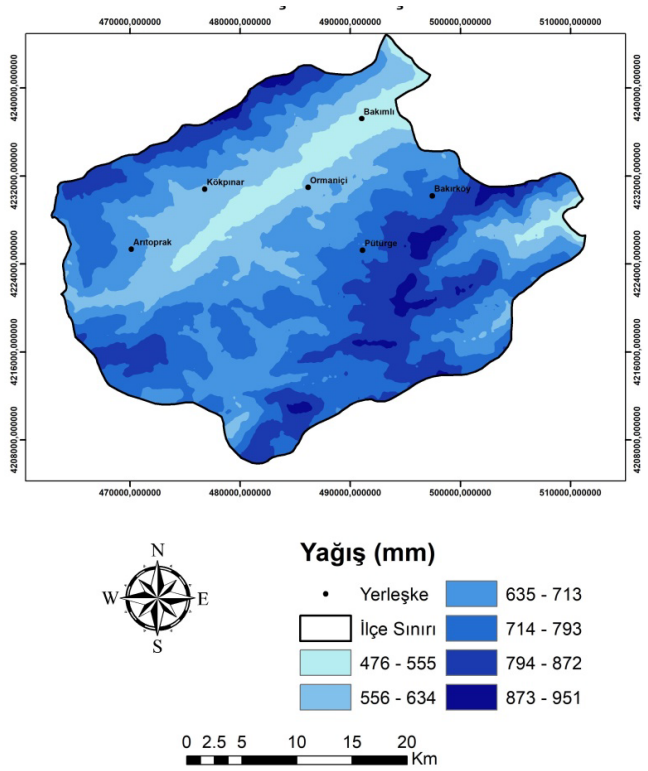

Figure 12. Rainfall map of Pütürge District.

2.3. Climate Change

Climate change is defined as the global climate change problem caused by the warming caused by greenhouse gas emissions in the last thirties. The transition of society to the global climate system has been the most dominant force of warming and climate change with the negative consequences of the industrial revolution.

The global warming observed to date has led to large-scale changes in systems, including increases in some weather events such as drought, floods and loss of biodiversity (Türkeş, 2014).

Reducing the problems caused by climate change, which is one of the main problems of our lives, continues to be a problem that concerns many institutions such as politicians, urban planners, geographers, engineers, non-governmental organizations.

These problems bring about changes and transformations in the natural environment. According to the IPCC report published in 1992, it was revealed that some gases such as greenhouse gases have potentially more impact on climate change than others. According to the IPCC 1992 report, carbon dioxide has more than half of the effectiveness of other greenhouse gases and this effect will continue in the future (IPCC, 1992). According to IPCC2013 (Intergovernmental Panel on Climate Change), the global average temperature increased by 0.85 °C between 1880 and 2012, while the global average temperature increased by approximately 1.1 °C between 2010 and 2019 (IPCC, 2021ab).

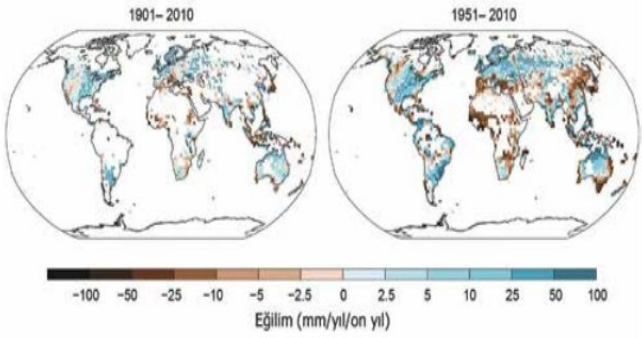

Figure 13. 1901-2010 and 1951-2010 areal distribution patterns of observed precipitation changes (IPCC, 2013).

3. Results

Global climate change causes negativities in rural areas as in every aspect of our lives. An important climate agreement in Paris in 2015 aimed to reduce the negative impacts of global climate change, increase political momentum and expand transformative action in all countries to reduce greenhouse gas emissions (Öztürk et al., 2019).

For this reason, multidisciplinary and participatory planning-design processes need to analyze the data in a realistic and reliable way, taking advantage of the advantages of the Geodesign method in planning climate change mitigation scenarios, to determine what kind of risks determine us in the coming years as a result of temperature increases in future global climate change scenarios and what kind of planning should be done in areas such as academic, economic and tourism for these adverse conditions, what kind of planning should be done in areas such as academic, economic and tourism, and what kind of planning should be done for these negative conditions, and what kind of planning should be done in areas such as academic, economic and tourism in the future(Yavaş & Ulukan, 2021).

4. Discussion

Making climate projections for future periods is very important in predetermining the destructive effects of climate change and taking measures accordingly. The most important work that can be done for the detection of climate change is the modeling of climate change. As a result of the analysis of the maps, when the inferences of the alternative scenarios produced for climate change are compared with other studies, the results of various studies; The results of the various studies carried out; The General Directorate of Meterology (MGM), (IPCC) 5. Assessment Report (AR5), computer-aided scenarios such as Global Circulation Models (GCM), Regional Climate Models (RCM) and HadGem2, according to RCP4.5 scenarios and RCP8.5 scenarios, RCP4.5 Scenario is an equilibrium scenario.

It plans that the total radiative forcing may reach 4.5 W/m^2 by 2100 despite all precautions with greenhouse gas emissions, and according to the RCP 8.5 Scenario, considering a continuous increase in greenhouse gas emissions, the radiative forcing will reach 8.5 W/m^2 by 2100 (Turp, 2014). According to computer-aided (HadGem2) scenarios, it is predicted that by 2100, CO_2 in the atmosphere will reach 538 ppm according to the RCP 4.5 scenario, 670 ppm according to the RCP 4.5 scenario and 936 ppm according to the RCP 8.5 scenario, while temperature values may increase by 1.8 C°, 2.2 C° and 3.7 C° (Shresta and Lohpaisankrit, 2017). This result is the same with the result of the article, and at this point, the main criteria and their sub-criteria were determined by considering the literature and the geographical characteristics of the study area by creating alternative scenarios that adapt to climate change with the Geodesign method and sustainable scenarios with 6 different models in 3 repetitions (Steinitz, 2012).

5. Conclusion

In this study, in which the administrative boundaries of Pütürge district were selected as the research area, the slope, aspect, elevation, geological structure, land use areas, land use areas, distance distances to rivers were tried to be determined and the outputs obtained with precipitation and temperature maps were taken into account when climate change was taken into consideration. In the report of the General Directorate of Metrology "Temperature and Precipitation Assessment in River Basins according to Climate Projections", it was determined that there is an increase in temperatures and precipitation amounts tend to decrease in the Euphrates-Tigris Basin, which includes Malatya province.

Although cities occupy less than 2 percent of the world's surface, they consume approximately 78 percent of the world's energy and produce more than 60 percent of the world's carbon dioxide, and these regional and urban areas have the least resistance to climate change (Kahraman ve Şenol, 2018).

It is accepted that climate change and cities are in a mutual interaction. Research shows that climate change, which has a global impact, affects regional areas the most and has an accelerating effect on climate change (Arslan, 2019).

Author contributions

Fred Barış ERNST: Methodology, Validation and Control. Büşra KÖKSAL: Data curation, Writing-Original Draft Preparation, Validation, Control and Validation, Methodology

Conflicts of interest

There is no conflict of interest between the authors.

Statement of Research and Publication Ethics

Research and publication ethics were complied with in the study.

References

Abdullah, K., Sedat, B., & Fred, E. (2021). Planning of Eyyübiye District Center (Şanlıurfa) Using the

Geodesign Method. *Journal of Geography*, (42), 251-269.

Akarsu, V. (2005). Geometride Uzay, Düşey Ve Yatay Açılar Arasındaki Fonksiyonel İlişki. *Selcuk University Journal of Engineering Sciences*, *4*(3), 134-142.

Akçakaya, A., Sümer, U. M., Demircan, M., Demir, Ö., Atay, H., Eskioğlu, O., & Gürkan, H. Yazıcı B, Kocatürk A, Şensoy S, Bölük E, Arabacı H, Açar Y, Ekici M, Yağan S, Çukurçayır F. 2015. *Yeni Senaryolarla Türkiye İklimProjeksiyonları ve İklim Değişikliği. Ankara: Meteoroloji Genel Müdürlüğü Yayını. Report No.: TR2015-CC*.

Akpınar, A. (2014). Peyzaj tasarımda yeni bir süreç: GeoTasarım. *Turkish Journal of Forestry*, *15*(2), 189-195.

Aksay, C. S., Ketenoğlu, O., & Latif, K. U. R. T. (2005). Küresel Isınma ve İklim Değişikliği. *Selçuk Üniversitesi Fen Fakültesi Fen Dergisi*, *1*(25), 29-42.

Arslan, E. S. (2019). İklim değişimi senaryoları ve tür dağılım modeline göre kentsel yol ağaçlarının ekosistem hizmetleri bağlamında değerlendirilmesi: Robinia pseudoacacia L. örneği. *Turkish Journal of Forestry*, *20*(2), 142-148.

Carey, B. (2013). Climate change on pace to occur 10 times faster than any change recorded in past 65 million years, Stanford scientists say. *online]. Stanford Report*, *1*.

Change, I. C. (2013). The physical science basis. *(No Title)*.

Crooks, A. T.& Heppenstall, A. J. (2012). Introduction to Agent-Based Modelling. Chapter 5. Heppenstall, A., J., Crooks, A., T., See, L., M., Batty, M., (Editors). Agent-Based Models of Geographical Systems. ISBN 978-90-481-8926-7 e-ISBN 978-90-481-8927-4, DOI 10.1007/978-90-481-8927-4, Springer Dordrecht Heidelberg London New York.

Çabuk, S. N. (2014). Coğrafi bilgi sistemleri ile tasarlamak: Geotasarım kavramı. *Harita Teknolojileri Elektronik Dergisi*, *6*(1), 37-54.

Çömert, R., Bilget, Ö., & Çabuk, A. (2015). Kyoto Protokolüne İmza Atan G20 Ülkelerinin Yıllara Göre Karbon Salınımlarının (1990-2012) Coğrafi Bilgi Sistemleri Yardımı İle Analizi. *Anadolu Üniversitesi, Yer ve Uzay Bilimleri Enstitüsü*, 883-891.

Çömert, R., Bilget, Ö., Olcay, F., Aksoy, T., Şenöz, E., & Çabuk, A. (2016). Geotasarımın Tarihsel Gelişimi Ve Coğrafi Bilgi Sistemleri İle İlişkisi. *Eastern Geographical Review/Doğu Coğrafya Dergisi*, *20*(35).

Dangermond, J. (2010). Geodesign and GIS–designing our futures. *Proceedings of Digital Landscape Architecture*, 502-514.

Değerliyurt, M., & Çabuk, S. (2015). Coğrafyayi Coğrafi Bilgi Sistemleri İle Tanimlamak. *Doğu Coğrafya Dergisi*, *20*(33), 37-48.

Eikelboom, T., & Janssen, R. (2017). Collaborative use of geodesign tools to support decision-making on adaptation to climate change. *Mitigation and Adaptation Strategies for Global Change*, *22*, 247-266.

Erdem, M. S., & Yenilmez, F. (2017). Türkiye'nin Avrupa Birliği çevre politikalarına uyum sürecinin değerlendirilmesi. *Optimum Ekonomi ve Yönetim Bilimleri Dergisi*, *4*(2), 91-119.

Erkan, N., Abdulğaffar, K. A. Y. A., & Kalkan, B. (2021). Sarıçamın (Pinus Silvestris L.) Doğal Yayılış Alanı Dışında Gösterdiği Bir Performans: Pütürge Örneği. *Ağaç Ve Orman*, *2*(1), 15-21.

Ernst, F. (2023). Geodesign For Designing The Future Of Our Cities GSI Journals Serie C: Advancements in Information Sciences and Technologies (AIST), 6 (2): 1-19

Eşiyok, Ş. (2021). *2645, 2646, 2647 nolu (H. 1262-1263/M. 1846-1847) nüfus defterlerine göre Pütürge (Şiro) kazasının nüfusu* (Master's thesis, Karamanoğlu Mehmetbey Üniversitesi).

Foster, K. (2016). Geodesign parsed: Placing it within the rubric of recognized design theories. *Landscape and Urban Planning*, *156*, 92-100.

Güner, B. (2012). Pütürge ilçesinin (Malatya) beşeri ve ekonomik coğrafyası. doi: 10.1501/Cogbil_0000000177

Güner, B., & Çitçi, M. D. (2013). Pütürge İlçesi'nde (Malatya) Cumhuriyet Döneminde Nüfusun Gelişimi Ve Göç. *Fırat Üniversitesi Sosyal Bilimler Dergisi*, *23*(2).

http://www.climatechange2013.org/images/report/WG1AR5_ALL_FINAL.pdf

İlke, V. (2016). Kentsel ekolojik altyapı tasarımına yönelik ilişkisel peyzaj analiz yöntemi: Kuzey İstanbul örneği.

Kahraman, S., & Şenol, P. (2018). İklim değişikliği: Küresel, bölgesel ve kentsel etkileri. *Akademia Sosyal Bilimler Dergisi*, 353-370.

Kalonya, D. H. İklim Değişikliği Azaltım Ve Uyum Süreçlerinde Mera Alanlarının Önemi. *Çevre Şehir ve İklim Dergisi*, *1*(1), 128-157.

Karabulut, A. I., Benek, S., & Ernst, F. (2021). Geodesign yöntemi kullanılarak sürdürülebilir kentsel büyüme analizi: Eyyübiye ilçe merkezinden (Şanlıurfa) bir örnek çalışma. *Coğrafya Dergisi*, (42), 251-269.

Karadeniz, N., Otçu, İ. K., Cüre, C. T., Şenöz, E., & Ceylan, S. K. (2016). Peyzaj planlama senaryolarının geodesign yaklaşımı ile geliştirilmesi: İmrahor Vadisi örneği. *Coğrafi Bilimler Dergisi*, *14*(2), 135-156.

Keskin, A., & Kanat, Z. (2018). Dünyada iklim değişikliği üzerine yapılan çalışmalar ve Türkiye'de mevcut durum. *Atatürk Unıversıty Journal Of Agrıcultural Faculty*, *49*(1).

Malatya-Elazığ-Bingöl-Tunceli Planlama Bölgesi 1/100.000 Ölçekli Çevre Düzeni Planı Açıklama Raporu

McElvaney, S. (2012). *Geodesign: Case studies in regional and urban planning*. Environmental Systems Research Institute.

Moss, R. H., Babiker, M., Brinkman, S., Calvo, E., Carter, T., Edmonds, J. A., ... & Zurek, M. (2008). Towards new scenarios for analysis of emissions, climate change, impacts, and response strategies.

Özdemir, M. A. (1994). Örmeli Çayı Havzasının (Pütürge-Malatya) Genel ve Uygulamalı Jeomorfolojisi. *FÜ Sos. Bil. Enst. Doktora Tezi (Yayınlanmamış)*.

Öztürk, M., & Öztürk, A. (2019). Bmidçs'den Paris Anlaşması'na: Birleşmiş Milletler'in iklim değişikliğiyle mücadele çabaları. *Ömer Halisdemir Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, *12*(4), 527-541.

Sever, R., & Doğanay, H. (2014). Çamlıdere Köyü (Pütürge) çevresindeki bazı güncel doğal çevre sorunları. *Türk Coğrafya Dergisi*, (34), 581-596.

Shrestha, S., & Lohpaisankrit, W. (2017). Flood hazard assessment under climate change scenarios in the Yang River Basin, Thailand. *International Journal of Sustainable Built Environment*, *6*(2), 285-298.

Steinitz, C. (2012). A framework for geodesign: Changing geography by design.

Steinitz, C., Anderson, R., Arias, H., Bassett, S., Flaxman, M., Goode, T., ... & Shearer, A. (2005). Alternative futures for landscapes in the Upper San Pedro River basin of Arizona and Sonora. *USDA Forest Service General Technical Report PSW-GTR-191*.

Şenol, H. İ., Ernst, F. B., & Akdağ, S. (2018). Kentsel dönüşüm alanlarının geotasarım yöntemi ile planlanması: Eyyübiye örneği. *Harran Üniversitesi Mühendislik Dergisi*, *3*(3), 63-69.

Turp, M. T., Öztürk, T., Türkeş, M., & Kurnaz, M. L. (2014). RegCM4. 3.5 bölgesel iklim modelini kullanarak Türkiye ve çevresi bölgelerin yakın gelecekteki hava sıcaklığı ve yağış klimatolojileri için öngörülen değişikliklerin incelenmesi. *Ege Coğrafya Dergisi*, *23*(1), 1-24.

Türkeş, M. (2017). Türkiye'nin İklimsel Değişkenlik Ve Sosyo-Ekolojik Göstergeler Açısından Kuraklıktan Etkilenebilirlik Ve Risk Çözümlemesi. *Ege Coğrafya Dergisi*, *26*(2), 47-70.

Üzülmez, M. (2019). Coğrafi Bilgi Sistemleri ile Morfometrik Analize Bir Örnek: Suat Uğurlu Baraj Gölü Çevresi. *Amasya Üniversitesi Sosyal Bilimler Dergisi*, (6), 225-253.

Yıldız, Z. (2016). Küresel Isınma Ve Alternatif Turizme Yönelim Üzerine Etkileri. *Süleyman Demirel Üniversitesi Vizyoner Dergisi*, *1*(1), 77-91.