DOI: 10.26650/JGEOG2022-1093425

COĞRAFYA DERGİSİ
JOURNAL OF GEOGRAPHY
2022, (44)

https://iupress.istanbul.edu.tr/en/journal/jgeography/home

Exploring Traditional Ecological Knowledge (TEK) as an Urgent Action to Combat Climate Change in Turkey

Türkiye'de İklim Değişikliğiyle Mücadelede Acil Bir Eylem Olarak Geleneksel Ekolojik Bilgiyi (GEB) Keşfetmek

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ABSTRACT
The aim of this paper is to determine the role of traditional ecological knowledge (TEK) in coping with climate change and adapting to projected climate changes in the case of Turkey. In order to accomplish this research objective, we have set out to present TEK examples on themes such as (1) local climate information, (2) understanding climate change, (3) coping with climate change and developing adaptation strategies, and (4) correct management and protection of natural resources. This paper uses the qualitative research design of ethnographic research. The data were collected using qualitative data collection methods such as observations and interviews between 2018-2021, with the data analysis using the descriptive analysis technique. The purposeful sampling method of convenience sampling was used to select the places to be observed and the study group. This paper reveals the local communities to have developed TEK practices and strategies against climate change and the problems that arise as a result in Turkey. Integrating these TEK examples with scientific knowledge in Turkey is believed to be able to play an important role in climate change adaptation and mitigation.
Keywords: Local community, Local climate information, Adaptation strategies

ÖZ
Bu makalenin amacı, Türkiye örneğinde iklim değişikliği ile başa çıkmada ve öngörülen iklim değişikliklerine uyum sağlamada Geleneksel Ekolojik Bilginin (GEB) rolünü belirlemektir. Bu amaca ulaşmak için Türkiye'de GEB'in; (1) yerel iklim bilgisi, (2) iklim değişikliğini anlama, (3) iklim değişikliğiyle başa çıkma ve uyum stratejileri geliştirme, (4) doğal kaynakların doğru yönetimi ve korunması gibi konulardaki rolü nitel araştırma desenlerinden kültür analizi (etnografya) yöntemiyle belgelenmeye ve karakterize edilmeye çalışılmıştır. Çalışma verileri, 2018-2021 yıllarını kapsayan bir süreçte gözlem ve görüşme gibi nitel veri toplama yöntemleriyle toplanmış ve elde edilen verilerin analizinde betimsel analiz tekniği kullanılmıştır. Gözlem yapılacak yerlerin ve çalışma grubunun seçiminde ise amaçlı örnekleme yöntemlerinden kolay ulaşılabilir durum örneklemesi kullanılmıştır.
Çalışma, Türkiye'de iklim değişikliği ve iklim değişikliği sonucu ortaya çıkan sorunlara karşı yerel halkın yöresel farklılıklar gösterebilen GEB uygulama ve stratejileri geliştirdiğini ortaya koymaktadır. Türkiye'de GEB örneklerinin bilimsel bilgiye entegre edilmesinin iklim değişikliğiyle başa çıkma ve iklim değişikliğine uyum stratejileri geliştirmede önemli bir rol oynayabileceğine inanılmaktadır.
Anahtar kelimeler: Yerel halk, Yerel İklim Bilgisi, Uyum Stratejileri

Submitted/Başvuru: 25.03.2022 • **Revision Requested/Revizyon Talebi:** 13.05.2022 • **Last Revision Received Son Revizyon:** 19.05.2022 • **Accepted/Kabul:** 30.05.2022 • **Published Online/Online Yayın:** 00.00.0000

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Citation/Atıf: Gul, S. (2022). Exploring Traditional Ecological Knowledge (TEK) as an urgent action to combat climate change in Turkey. *Cografya Dergisi*, *44*, 289-306. https://doi.org/10.26650/JGEOG2022-1093425

1. INTRODUCTION

Climate change is one of the determinative issues being debated in this era on how to struggle with its reasons and outcomes on an international scale. The Intergovernmental Panel on Climate Change (IPCC) uses climate change to refer to any change in climate over time, whether due to natural variability or as a result of human activity (Parry et al., 2007, p. 21). Significant long-term changes regarding global climate can be composed dependently of natural internal process and factors within the climate system (i.e., significant natural or human-induced changes upon the composition of the atmosphere and surface characteristics of the Earth) or changes regarding the factors originating from natural or external forces (plate tectonics or changes in the solar activities and astronomical relations between the Earth and Sun) (Türkeş, 2008, p. 27). Human activities are accepted as the primary propulsive force regarding climate change as these have a 95% contribution to the rapid increase in temperature, particularly through the use of fossil fuels, deforestation, and land use that emits greenhouse gases (Cook et al., 2016; Hosen et al., 2020, p. 1). Climate change's negative impacts over the next decades are expected to be centered upon such things as food security, socioeconomic sectors, and human health (Forster et al., 2020; Soroye et al., 2020; Türkeş et al., 2020). Although all national and international partners (e.g., specialists, scientists, politicians, and citizens) are generally in agreement about the need to prevent climate change, they still have different opinions on who is in charge of preventing it, how to set targets for preventing climate change, and which methods will be used throughout the process. The importance of issues such as reducing greenhouse gas emissions, conserving energy, preventing deforestation, reducing carbon footprints, and enhancing carbon sinks have been particularly emphasized in the struggle against climate change.

What this means is that national and international policies are more focused on mitigation (Measham et al., 2011; Pielke et al., 2007), and the requirement of handling climate change with local knowledge and local adaptation generally go unnoticed (Ingty, 2017, p. 42). At this point, the study's focus is on whether traditional ecological knowledge (TEK) can be an alternative in the struggle against global climate change.

TEK is defined as the cultural inheritance that has been preserved and transmitted for generations by the public over a wide range of social, cultural, and environmental contexts (Berkes, 1993, p. 3). TEK can be qualified as the unwritten laws, means, abilities, attitudes, beliefs, and practices local communities have obtained through direct contact with the environment over hundreds and even thousands of years (Gül, 2020, p. 304). Berkes (1999) separated TEK into three complex components: knowledge (e.g., about plants, animals, and animal behaviors), implementations (applying knowledge to their livelihood as hunters, fishermen, or shepherds), and beliefs (belief systems that nominally interpret events).

Integrating TEK and science are extremely important with regard to the conservation and sustainable administration of natural resources, wetlands, and biodiversity alongside the fight against global climate change. This is because TEK has the characteristic of being able to contribute a lot on the subjects of struggling with climate change, validating beneficial data for scientific research, describing the effects of climate change, making seasonal estimations, and understanding how to adapt to climate change (Berkes, 2009; Lemi, 2019; Hosen et al., 2020; Türkeş, 2020; Vinyeta & Lynn 2013).

1.1. The Current Study

Important literature exists that explains TEK's perspective on climate change and how it copes with it. This study generally focuses on a set of local TEK samples with regard to TEK's conceptual dimension, its use in resource management, the similarities and differences between modern techniques with regard to comprehending climate change, and local communities' perspectives regarding how to struggle against and adaptation to climate change. Riedlinger and Berkes (2001) in particular determined five fields where science and TEK are able to communicate and cooperate with one another regarding climate change (i.e., expertise on the local scale, climate history and basic data sources, composing research questions and hypothesis, community effects and adaptations, and community-based long term monitoring). According to Salick and Rose (2009), TEK is an invaluable actor in assessments related to climate change, how to deal with the negative impacts of climate change, and adaptation strategies connected to climate change. Meanwhile, Parker et al. (2016) described locals as the first communities experiencing the effects of climate change through TEK and viewed them as the most coherent and durable communities against climate change. According to Lemi (2019, p. 28), using TEK to correspond the impact of climate change to the integration of scientific information is important. Also, some TEK strategies that the local community of Hawaii used to cope with socio-ecological changes were relatively low, yet it demonstrated that increasing the locals' resistance to environmental changes and in particular their adaptation to climate change in areas such as

diversification of livelihoods, information transfer, food stockpiling, composing a common information repository, and cultural identity are vitally important (McMillen et al., 2017).

One of the fields where TEK is used to prevent the effects of climate change is natural resource management. In addition, TEK is a valuable tool with regard to fire control; protection of bio-diversity, land use, and wetlands; and managing water resources. For example, controlled burns were a TEK implementation that had been carried out each year by the local Aborigines of Australia and the Native North Americans before Europeans came to those continents (Bird et al., 2005; Gillies, 2019; Gottesfeld, 1994). Because these indigenous people repeated these burns periodically with the intention of managing vegetation, it turned into an ecological phenomenon, and most of the pastural vegetation adapted to periodic burns. This implementation not only prevented greater forest fires but also reduced carbon emissions due to the burns within this period and formed plant communities more resistant to insects, illness, and the inevitable forest fires (Gillies, 2019). However, due to the arrival of European settlers who substantially prevented this practice and Western culture's land administration techniques, many devastating forest fires have occurred from the accumulation of foliage, such as the forest fire that took place in Australia in 2019. Hatfield et al. (2018) showed global climate change to have an effect upon the migration time of fish in India and the locals there to have detected this situation. Research has shown that TEK notices changes to natural resources much more quickly, and the potential exists for cooperation between climate scientists and those who have TEK. TEK makes an important contribution to dealing with climate change on issues such as weather forecasting, understanding climate change, and reinterpreting meteorological data. Perhaps the best-known example of weather forecasting done by observing animal movements was made by Dolbear (1897), an American physicist who determined air temperature by the buzzing of North American male crickets. By virtue of his formula based upon observations of the increase of the North American male cricket's chirping, he was able to make very accurate temperature forecasts based on the correlation between the speed of the chirps and temperature. Riseth et al. (2011) concluded that Sámi (a local community of Northern Scandinavia) reindeer herders have important information on estimating grazing conditions in winter by observing the changes in snow and ice, in other words, reading nature, and significant harmony exists between Sámi terminology and scientific meteorological measurements. In 2004, unusual fish movements showed consistent relationships with recirculating currents at the sea bottom in the Indian Ocean immediately before a tsunami came ashore. However, the Moken and Urok Lawai peoples of the Thailand coasts and islands, the Onge of India's Andaman Islands, and Indonesia's Simeulue community all predicted the tsunami thanks to TEK and quickly went inland to escape from the tsunami's destructive effects; these local communities remained alive despite terrible losses of around 80,000 casualties elsewhere in Indonesia (Elias et al., 2005). Undoubtedly, scientific research and project reports on interpreting climate change are valuable knowledge sources for decision makers to use in understanding and estimating the broad scale impacts of climate change . However, in addition to these, new climate change knowledge also emerges by integrating new information into TEK and is able to narrow down geographic sensibility, increase cultural awareness, and above all, lend assistance to designing effective adaptation strategies (Ignatowski & Rosales, 2013).

In the Turkish literature, although no studies are found to have directly involved subjects such as directly preventing climate change or the negative effects it causes using TEK, some studies are found on the positive effects TEK has had in protecting wetlands (Arı & Derinöz 2011; Gül, 2020), the constructive role of TEK in agricultural production and food security problems caused by climate change (Türkeş, 2020), and the preservation of TEK within the context of the cultural and environmental relationships in pastoral communities (Büyükşahin, 2017).

1.2. Purpose and Scope

An increase in the human-induced greenhouse gases that have been accumulating since the Industrial Revolution has reached significant levels in recent years, and the inadequacy in precautions taken/to be taken to reduce the current and potential effects of climate change have made new solution suggestions and development strategies obligatory for preventing climate change. Although the literature has underlined the significance of TEK with regard to the struggle against and prevention of climate change, TEK has unfortunately not received the necessary attention from the scientific world, governments, or communities with regard to the issue of solutions.

This study focuses on an in-depth analysis of the role TEK has in themes such as (1) local climatic knowledge, (2) understanding of climate change, (3) coping with climate change and developing coping strategies, and (4) how to properly administer and protect natural resources. The research findings are thought to help in submitting practical information to national

governments, the scientific world, and other stakeholders about how to struggle with climate change. The study assumes that TEK is especially important in dealing with climate change and developing adaptation strategies in environments such as Turkey, which has a variety of natural environmental conditions and cultural diversity.

To achieve these goals, this study seeks answers to research questions such as "Which methods do local communities use to forecast the weather?", How do local communities understand climate change?", "Which strategies have they developed to cope with it?", and "How do local communities use TEK to manage and protect natural resources?"

2. METHOD

This study uses the qualitative research technique of cultural analysis (ethnography). Qualitative research is defined as research that collects qualitative data using methods such as observations, interviews, and/or document analyses and follows a qualitative process to realistically and holistically reveal perceptions and events in a natural environment (Yıldırım & Şimşek, 2018, p. 41). As such, qualitative studies attempt to understood the causes underlying social reality and human behaviors (Gürbüz & Şahin, 2014, p. 106). The cultural analysis design is commonly used for searching within cultures and human communities as it provides researchers with the tools to allow them to study cultural groups (Gürbüz & Şahin, 2014, p. 368). This method has been preferred for interpreting and identifying the TEK practices local communities use in the face of climate change with respect to the data collected between 2018-2021 in Turkey.

2.1. Study Area

The Mediterranean Basin where Turkey is found is one of the most delicate areas on the Earth with respect to global climate change (World Wildlife Fund [WWF], 2021). According to the WWF report, Turkey will face many negative consequences such as unexpected weather events, heat waves, increases in the number and impact of forest fires, drought, and the resultant loss of biodiversity and agricultural productivity due to a temperature increase of 2°C in the Mediterranean Basin. Even though Turkey is found in the Mediterranean climate zone, its geographical formations, the direction of its mountain ranges, elevations, slopes, conditions of slope erosion, its location near the sea, and its continentality over short distances all cause Turkey to experience a variety of different climates. Alterations in these factors simultaneously cause local communities to respond to climate change (i.e., they have different examples of TEK implementations). Turkey has hosted many cultures and civilizations and has cultural elements that bear the traces of these civilizations. This cultural diversity in combination with its natural environmental conditions supports the addition of many different elements to different TEK practices. In addition, the rural population in Turkey, despite being only 20% of the total population, resides near protected areas rich in biodiversity. A large part of the rural population earns their livelihood through agriculture and livestock breeding and prefers traditional practices in their daily activities. Although the rural population has a very low impact on global climate change, these people perhaps constitute the group most adversely affected by climate change among the total population. As a result and when taking into account the arguments presented above, different TEK practices from almost every region of Turkey have been attempted to be put forth over a wide range of areas with regard to combating and adapting to climate change.

2.2. Data Collection Tool

In culture analytical research, data sources generally involve the behaviors and actions that compose a culture as well as the individuals or groups affected by that culture. Therefore, the data has mostly been collected through qualitative data collection methods such as observations, interviews, metaphors, and document analyses (Yıldırım & Şimşek, 2018, p. 67). This study collected the data using the techniques of nonparticipant observations and face-to-face interviews. According to Gürbüz and Şahin (2014, p. 318), interviews are a data collection technique that tries to understand people and relate situations to them by the means of verbal communication. A semi-structured interview form was used for the interviews. Ssemi-structured interview forms help at finding the opportunity to examine local community's subjective judgments, feelings, and thoughts about global climate change. The development of the semi-structured interview form took advantage of the works from Berkes (1993), Gül (2020), Hosen et al. (2020), Ingty (2017), Lemi (2019), Riedlinger and Berkes (2001), and Vinyeta and Lynn (2013). The semi-structured interview form consists of two sections and has questions involving personal information such as age, gender, and residence in the first section and open-ended questions in the second section regarding local climate information, climate change perceptions of the local community, how TEK contributes to protecting and managing natural resources and to adapting to climate change. Before proceeding to the data acquisition phase, one face-to-face interview was

conducted using the semi-structured interview form developed according to the literature with an individual possessing TEK but who was not included in the study group. After this application, the necessary changes were made to the interview form based on the opinions taken from an expert studying in the field of TEK; this was done to validate the form. Non-participant observations were preferred as another data collection technique as it provides the opportunity to access the data first hand and to describe the behaviors that occur in any environment in detail. However, the broad study area did not permit interviews and observations everywhere.

2.3. The Participants

The purposive sampling method of convenience sampling was used to select the study group and the places to be observed. Thus, the research gained speed and practicality by selecting subjects, places, and materials possessing certain characteristics of the broad study area that are considered suitable for the research problem. In this context, the interviews and observations were made in places the researcher could easily access (**Table 1**).

2.4. Data Collection

Field studies and a lengthy data collection process are required in order to understand the culture, individuals, and groups researched in a cultural analysis study (Yıldırım & Şimşek, 2018, p. 67). Thus, this study involved a long process occurring between 2018-2021. Face-to-face interviews were conducted in the common areas of a residence or settlements by going to the settlements where the individuals who'd be culturally examined were living. Interviews were recorded with a voice recorder upon receiving their approval, with videos and photos also being taken. The interviews lasted between 20 minutes to 1 hour. After the interviews were digitalized in an electronic environment, 47 pages of data were acquired. When analyzing the data, the names of the interviewed individuals were not used; instead, codes such as Sp1, …, Sp21 were used.

2.5. Data Analysis

The descriptive analysis technique was used to analyze the data obtained as a result of the interviews and observations. Description analysis is a process that involves the researcher handling and explaining the data in the context of the characteristics, causes, and results of the subject being examined (Gürbüz & Şahin, 2014, p. 384). Descriptive analysis is a technique where the researcher summarizes and interprets the obtained data according to the themes the researcher previously determined (Yıldırım & Şimşek, 2018, p. 239). The data acquired by descriptive analysis are first reduced to codes, then organized into themes in second stage; results are reached in the third stage, and lastly the findings are summarized (Mason, 2002; Yıldırım & Şimşek, 2011). The TEK applications in the obtained data set, the examples formed regarding local climate knowledge, and the understanding of and adaptation to climate change were subjected to descriptive analysis according to the previously created categories and themes. The participants' points of view

Table 1: Brief Information About the Participants.

Rank	Source Person (Sp)	Province-Municipality (village)	Age	Gender
1	Sp 1	Rize-Güneysu	85	F
2	Sp 2	Gümüşhane-Kürtün	67	M
3	Sp 3	Çorum-Mecitözü	81	F
4	Sp 4	Ordu-Ünye	60	F
5	Sp 5	Samsun-İlkadım	52	M
6	Sp 6	Yozgat-Boğazlıyan	68	F
7	Sp 7	Kayseri-Yahyalı	58	M
8	Sp 8	Ordu/Korgan	67	M
9	Sp 9	Kars Digor	40	M
10	Sp 10	Muş Bulanık	72	F
11	Sp 11	Tokat-Turhal	69	M
12	Sp 12	Bitlis-Güroymak	52	M
13	Sp 13	Muğla-Milas	51	M
14	Sp 14	Kayseri-İnecik Bağları	57	M
15	Sp 15	Tekirdağ-Marmaraereğlisi	60	M
16	Sp 16	Şanlıurfa-Germüş (Dağeteği)	69	M
17	Sp 17	Balıkesir-Erdek	57	M
18	Sp 18	Nevşehir- Ortahisar	68	M
19	Sp 19	Manisa- Akhisar	72	F
20	Sp 20	Malatya –Şire Pazarı	63	F
21	Sp 21	Amasya-Merzifon	75	F

on some themes are given in block quotations without any changes made apart from the translation in order to present the existing situation as is. This study used Miles and Huberman's (1994) formula, where reliability equals the number of agreements divided by the sum of the number of agreements plus the number of disagreements, for the reliability analysis of the qualitative data. According to this reliability formula, the data were divided into themes by two field experts well-versed on the subject. Thus, sub-themes were created. Miles and Huberman (1994) suggested an inter-rater reliability (IRR) value of 80% among 95% of the codes to be sufficient agreement among multiple coders. The reliability formula values are given for the four themes in **Table 2**.

When examining **Table 2** as a result of this process to determine the reliability of the data analysis, the reliability formula values for each theme were determined to be higher than 86%. This shows the researcher's coding to be reliable.

3. RESULTS

When taking into account the data provided by the interview form and observations, the traditional strategies the local communities apply against climate change and the problems that arise as a result of climate change in Turkey are seen to be structured under four dimensions (**Table 3**).

3.1. Local Climate Information

The local communities in Turkey forecast the weather and climate using conventional techniques such as observing the sun, moon, and sky as well as plants, animals, and their movements (**Table 4**).

"If ants raise their anthill to the north, the year will be cold, if they are raised to the south, the year will be warm" (Sp8, Sp21). *"If the birds are flying close to the ground, it will rain, if they are flying high, the weather will be clear"* (Sp6, Sp8, Sp19, Sp21). *"If the frogs croak too much in lakes, it will rain."* (Sp5, Sp6, Sp11, Sp13). *"If the rabbit's hair is thick, the winter will be harsh that year"* (Sp3, Sp21). *"If the northern pike (*Esox Lucius*) stays still at the bottom of the river, there will be wind or rain"* (Sp5). *"If there are lots of cricket (*Acheta Assimilis*) and crickets chirping at night, it will be hot the next day"* (Sp13, Sp21). *"If crickets chirp too much at night, it will be hot the next day"* (Sp13, Sp21). *"If*

Table 2: Miles & Huberman Reliability Formula Values for Themes.

Themes	M&H Reliability Formula Values (%)
Local climate information	[23 / (23+3)] * 100 = 88.46
Traditional land use and management	[15 / (15+2)] * 100 = 87.5
Conservation of natural resources and biodiversity	[20 / (20+3)] * 100 = 86.95
Strategies for adapting to climate change	[35 / (35+5)] * 100 = 87.5

Table 3: Themes and Activities.

Themes	Categories
Local climate information	• Observing animals and their movements • Observing the sun, moon and sky • Observating plants
Traditional land use and management	• Agro-ecosystems • Mud pond • Fish ponds • Windbreak • Shade plant • Product selection • Tillage • Postponement of crop planting time
Conservation of natural resources and biodiversity	• Protecting animals and trees • Protecting medicinal plants • Protecting fresh water • Protecting wetlands
Adaptation strategies to climate change	• Local architecture • Natural disaster risk management • Water resources management • Sustainable food production • Food security

Table 4: TEK Categories and Codes; Quotations on the Theme of Local Climate Information.

TEK Categories	Codes	Contribution of TEK	Problems that may arise when TEK is not implemented
Observing animals and their movements	• Flight altitudes of birds • Anthill • Croaking of frogs • Rabbit hair thickness • Movements of the fish • Cricket chirping • Movements of squirrels • Movements of bees • Movements of sheep • Number of field mice • Movements of housefly • Number of molehills	• Providing weather forecast data in cases where meteorological data is insufficient. • Detection of climate change by supporting meteorological data with local climate information	• Late recognition of climate change. • Inadequate food production. • The problem of adaptation to climate change
Observing the sun, moon and sky	• Color of the sky at sunrise • Shape of the clouds • Cold of the rime • Movement of the clouds • Color of the clouds • Air temperatures increase suddenly. • Shape of the moon		
Observing plants	• Thickness of onion peels • Pine cones • Large numbers of certain fruit • Carpinus betulus or Populus albapoplar leaves		

the squirrels collect a lot of walnuts, the winter will be very harsh" (Sp8, Sp21). *"If the bees do not come out of their hives early in the morning, it will be rainy, and if they move uneasily by tracing a circular path, it will hail"* (Sp3, Sp11, Sp21).

"If the sheep suddenly run away while grazing, there will be a storm" (Sp3, Sp7, Sp21). *"If the field mice show up, the weather will be nice"* (Sp3, Sp6, Sp21). *"If a housefly enters a covered space or home and bites people a lot, it will rain heavily"* (Sp6, Sp9, Sp10, Sp21). *"If the molehills are frequent and grouped, the winter will be harsh, but if they are sparse or in rows, the winter will be mild"* (Sp3, Sp6). *"A red sky at dawn forecasts a storm, and a red sundown forecasts beautiful weather."* (Sp14, Sp21). *"If the clouds are like mountains in the morning, they will be like a fountain (sheet) in the evening"* (Sp5, Sp21). *"The cold of the rime descends from the night"* (Sp19, Sp21). *"Turn your back on the wind, look at the clouds. If the clouds are stable, the weather will be stable. If the clouds are going from left to right the weather will get worse, if the clouds are going from right to left, the weather will be better* (northern hemisphere)*"* (Sp21). *"If the evening cloud turn red, just keep your mind on nice weather; if the morning cloud turns red, just keep your mind on your back getting wet"* (Sp11, Sp16, Sp21). *"If the sun suddenly gets too hot, it will rain with thunderstorms"* (Sp4, Sp5, Sp8, Sp21). *"If the moon is just past new and its open part faces upward, it will rain soon"* (Sp5, Sp21). *"If the onion peels are thick, winter will be cold, if thin, it will be temperate"* (Sp5, Sp21, Sp19). *"If the weather is humid or rainy, pine cones close to protect their seeds, and if the weather is dry, they open to spread their seeds"* (Sp19, Sp21). *"If Quercus ithaburensis, Mespilus germanica, Castanea sativa, Prunus spinosa, Rosa Canina, Berberis vulgaris and Cydonia oblonga abundantly bear fruit, the winter will be cold"* (Sp1, Sp3, Sp4, Sp5, Sp6, Sp8, Sp11, Sp21). *"If the leaves of Carpinus betulus or Populus albapoplar begin to fall from the top, the winter is cold, if they start to shed their leaves from the bottom, the winter will be temperate"* (Sp1, Sp5, Sp6, Sp11).

3.2. Traditional Land Use and Management

Local communities in Turkey have developed some traditional land use applications and land administration strategies for sustainable food manufacture and responding to climate change. Agro-ecosystem usage, terracing, soil pools, shelter belts, and product selection come into prominence among the land use strategies hidden in TEK (**Table 5; Figures 1 & 2**).

The developments that emerged in the weaving industry with the proclamation of the Republic increased the need for raw materials. Cotton began being cultivated in the clayey, calcareous soils with high groundwater and semi-swampy coastal areas of

Table 5: TEK Categories and Codes and Excerpts Related to the Theme of Traditional Land Use and Management.

TEK Categories	Codes and Quotation	Contribution of TEK	Problems that may arise when TEK is not implemented
Agro-ecological zone (AEZs)	• Local people divide the land into agro-ecological areas (belts) in rugged and water-scarce areas (Sp 7, Sp 11, Sp 14) • While orchards and vineyards are common on high south-facing slopes and terraces, some more frost-resistant grains and horticultural crops are grown on valley floors and low terraces with more favorable soil and water conditions. (Sp 4, Sp 5).	• Sustainable food production. • Reduction of energy consumption. • Land acquisition that can be cultivated • Reducing soil erosion • Increase in efficiency	• Increase in energy consumption due to fossil fuels • Wind erosion • Decreased soil fertility due to barrenness and salinization • Food shortage. • Decreased productivity due to lodging of plants
Mud pond	• Rice has a high water demand while growing, and needs water from mud pools and rain water (Sp 13, Sp 19). • Use of water and wind power in processing rice (Sp 13, Sp 19).		
Fish ponds	• Making aquaculture on lands that have become unproductive due to barrenness and water salinization (Sp 13, Sp 19).		
Windbreak	• Planting high and low trees parallel to the prevailing wind direction to protect from the wind (Sp 5, Sp 14). • Making a windbreak with tall plants or plant remains (Sp 5, Sp 14).		
Shade plant	• Reduce plants' water needs by planting tall plants such as corn and sunflower, which prevents the sun from reaching vegetables at other times except high noon (Sp 14, Sp 20).		
Product selection	• Planting short crops on a windswept slope (Sp 5, Sp 11). • Sow products that need high temperatures on south slopes, and products that need high humidity in sunless areas. (Sp 11, Sp 21). • Plant crops (e.g., chickpeas, lentils, wheat, barley) that need less water on barren land and plant crops that need a lot of water at mountain foothills and valley bottoms (Sp 11, Sp 14, Sp 17, Sp 18).		
Postponement of crop planting time	• Crops such as beans and corn are not planted during the new moon (Sp 5, Sp 21).		
Tillage	• Make the land suitable for agriculture by using terraces on slopes to prevent erosion (Sp 1, Sp 11). • Cultivate deep (2-3 times) and till more for crops such as sunflowers and sugar beets (Sp 3, Sp 6, Sp 11). • Deep-plow fields and till more (2-3 times) for crops such as sunflowers and sugar beets; but do not deep-plow for products such as wheat, barley, oats. Deep-plow sandy soils and plant tubers (Sp 7, Sp 11).		

Figure 1: a) Olive and grape terraces in Artvin, Oruçlu (Sirya) Village (URL1), b) Tea terraces in Rize-Güneysu.

Figure 2: a) Hizan district's (Bitlis) paddy fields, b & c) Paddy harvest (Photo by A. İhsan Öztürk).

the Mediterranean and Aegean regions, where climate and soil characteristics are suitable. Agricultural productivity has decreased due to soil salinization and barrenness due to irrigation in cotton-grown lands in previous years in Milas, the Güllük-Dalyan region of Muğla. In addition, the decreased economic returns in recent years have led the local community to new (actually old) land use methods. Field fishery is carried out in pools established on lands that had previously been cotton fields.

"Since the soil is not permeable, our fields became barren and sod-like after cotton planting. Also, our water got salty. Because of this situation, growing agriproduct has been precluded, and our lands remain unproductive. We knew that our ancestors were breeding and hunting fish in small ponds made of reeds. We began to raise fish again in the soil ponds we made with this knowledge. These numbers have increased over time, and we've become a cooperative. The number of families interested in this business around Milas is in the hundreds. We are marketing the fish we produce, such as sea bass and sea bream both domestically and overseas" (Sp13).

3.3. Protecting Natural Resources and Biodiversity

The local communities in Turkey have developed a number of practices and strategies for protecting natural resources and biodiversity, such as for medicinal plants, fresh water, and wetlands (**Table 6**).

Examples are seen where some animals are protected because they are considered sacred in many parts of the Anatolian territories. For example, those who spoil bird nests are believed will be punished by God. On this subject, Sp5 conveyed the following:

"We build nests for many bird species such as pigeons and storks around the Bafra Kızılırmak Delta (bird sanctuary). The nests of birds are never damaged. It is also thought that the birds whose nests are destroyed say the following behind the people:
'I will go and I will come
I will see you plump
Your bloody shirt
I will see on the fence'
Let me add something as my own memory: When we realize that there is a sparrow's nest on a branch while harvesting hazelnuts, we just leave the branch in place and don't collect it, there are too many bird nests on the hazelnut branches."

Another natural element that is consecrated in Anatolia is plants. Some intense beliefs such as sacred trees, wish trees, and sacred forests in Anatolia have allowed monumental trees to survive from past to present. Also, the Anatolian geography has an important folk medicine culture. Various plants and animals constitute the main sources of folk medicine. These animals and plants that are believed to be able to cure are mostly held sacred for medical purposes: They are allowed to grow without being harvested prematurely and are protected in certain areas. Fresh water is also considered sacred in Anatolian culture. Water is a referenced healing source in Anatolian culture in the case of any illness, nuisance, or difficulty in addition to being a source of

Table 6: TEK Categories and Codes and Excerpts Related to the Theme of Conservation of Natural Resources and Biodiversity.

TEK Categories	Codes and Quotation	Contribution of TEK	Problems that may arise when TEK is not implemented
Protecting animals and trees	• Breaking a bird's nest is considered a sin (Sp 5, Sp 21). • Don't hunt birds that are incubating. • Cloth is tied to sacred trees, their branches are not cut, their fruits are not collected or eaten (Sp 2, Sp 32, Sp 5, Sp 20, Sp 21). • In the second week of February every year in Sırçalı Mountain (Yozgat), hang bread on the trees, leave apples in the bushes, and spill wheat on the ground for the animals in nature (Sp6, Sp7). • For each child born, a tree is planted and the life of the child is expected to be as long as the tree's (Sp 13, Sp 19).	• Conservation of monumental trees and biodiversity • Protection of fresh water resources • Conservation of wetlands	• Decreased biodiversity • Reduction of fresh water resources • Flash floods • Global warming • Aridity
Protecting medicinal plants	• Some plants are believed to be good against diseases, so protect and do not harvest these plants early (Sp 2, Sp 32, Sp 5, Sp 20, Sp 21).		
Protecting fresh water	• Throwing garbage or other pollutants into clean water is considered a sin (Sp 5, Sp 6, Sp 7, Sp 14, Sp 19, Sp 21).		
Protecting wetlands	• Do not hunt fish or birds in wetlands (Sp 5, Sp 7). • Do not cut or burn plants such as *Phragmites australis* and *Juncus acutus* in wetlands (Sp 5). • Do not disrupt the channels that connect lakes with the sea or with each other (Sp 5).		

life. A culture of protecting clean water is also present in Turkish culture, where it is considered a sin to place garbage, ash, or urine into clean water.

3.4 Adaptation Strategies of Climate Change

The local community in Turkey has developed a number of practices and strategies for adapting to climate change, such as local architecture (**Table 7**), natural disaster risk management (**Table 8**), water resource management (**Table 9**), sustainable food production (**Table 10**), and food security (**Table 11**).

"Waterways which provide natural air conditioning in streets and rooms are also natural landscape elements. The soğukluk [coldroom] *is located in the back part of the lowest floor of Kemaliye houses, which are generally three floors. This room has the function of cold storage. The soğukluk is cooled naturally by the waterways passing through it* [**Figure 3**]. *There is also a seki* [platform] *reserved for people in the barn. This platform is called the ahır sekisi. The sitting plane that is the seki is separated into a platform and divided by wooden posts. During the long winter days, people sit in the seki and chat"* (Sp 9).

In the village of Germüş (Dağeteği) in Şanlıurfa, although the number of households has been decreasing, the water needs of approximately 900 households and 500 decares of agricultural land were once supplied by the *kariz*, which the local community call water tunnels. Due to the geological structure of Eocene neritic limestone, most of the precipitation and surface water in

Table 7: Codes and Quotations Related to the Local Architecture Categories.

TEK Categories	Codes and Quotation	Contribution of TEK	Problems that may arise when TEK is not implemented
Local architecture	• **Long roofs:** Making roofs with long eaves in cold and rainy regions (Sp 1, Sp 4, Sp 5). • **Seasonal room:** Summer room-anteroom (north) and winter room (south) practice (Sp 5, Sp 9, Sp 10, Sp 12, Sp 14, Sp 21). • **Ahır sekisi [Platform]:** The area reserved for humans in the barn (Sp 3, Sp 6, Sp 9, Sp 10, Sp 21). • **Waterway in street:** Spring water is circulated through the streets with waterways for the natural air-conditioning of the streets.	• Energy-saving. • Reducing the use of fossil fuels.	• Increasing the need to use fossil fuels. • Depletion of natural resources • Air pollution.

Table 8: Codes and Quotations Related to the Natural Disaster Risk Management Categories.

TEK Categories	Codes and Quotation	Contribution of TEK	Problems that may arise in case of non-implementation of TEK
Natural disaster risk management	• **Pile dwelling:** Construct pile dwellings on plains and valley floors where there is a risk of flooding (Sp 5). • **The stone roof cover in wooden rural houses:** To prevent wooden roof flying due to wind by increasing the weight of houses built with wooden materials or prevent the house from slipping in a landslide by increasing the weight of the house (Sp 5). • **Footpath:** Goats reduce the risk of forest fire by reducing the underbrush and creating paths in the forest (Sp 5). • **Collecting pine cones:** Cones and leaves can cause new fires if they are carried by the wind (Sp 5). • **Observing animal behaviors:** • Mice digging holes in valley slopes before flooding (Sp 9, Sp 10). • Fish splashing on the water before a storm (Sp 9, Sp 10). • Leeches come out of the water before a storm and hide under plants (Sp 5, Sp 8). • Seagulls stop flying before a storm and perch on the beach (Sp 4, Sp 5). • Turtles ascend taller hills before prolonged rains and storms (Sp 21). • Cows ruminate in the direction of continuous flooding before the flood (Sp 3, Sp 21). • Incessant barking of dogs before earthquakes, and sheep do not lie down but stamp their feet (Sp 3, Sp 5, Sp 21). • Thinking that there will be an earthquake after very suffocating weather (Sp 3, Sp 5, Sp 6, Sp 11, Sp 21).	• Energy-saving • Protection of the natural environment • Reduction in loss of life and loss of property • Reducing the risk of fire	• Increasing loss of life and property loss • Rapid spread of forest fire

Table 9: Codes and Quotations Related to the Water Resources Management Categories.

TEK Categories	Codes and Quotation	Contribution of TEK	Problems that may arise when TEK is not implemented
Water resources management	• **Cisterns and draw wells:** Rainwater flowing from the roofs of the houses or from the streets is collected by channels and pipes into barrels or cisterns placed under or near the house. (Sp 11, Sp 14). • **Kariz (qanat):** Transportation of surface or ground water in mountainous areas through horizontal underground channels to agricultural areas by gravity without leakage and evaporation in semi-arid or arid-climatic regions (Sp 11, Sp 16). • **Swales and sluiceways:** Creating discharge systems to purify rainwater and increase water seepage into the ground (Sp 3, Sp 5, Sp 6). • **Snow wells:** The snow falling in winter is buried in pits to be used in the summer, and the snow filled into natural pits in high mountain areas is used as animal watering or drinking water in summer (Sp 7, Sp 14).	• Sustainable food production • Energy-saving • Protection of the natural environment • Combat drought and desertification	• Increasing loss of life and property loss • Drought • Famine • Food insecurity

Table 10: Codes and Quotations Related to the Sustainable Food Production Categories.

TEK Categories	Codes and Quotation	Contribution of TEK	Problems that may arise when TEK is not implemented
Sustainable food production	• **Pigeon loft (Boranhane):** Obtain pigeon manure (Sp 7, Sp 14, Sp 16). • **Grazing:** Feeding grasses such as kangal (*Silybum marianum*), nettle (*Urtica dioica*), and spurge (*Euphorbia cyparissias*) to increase milk yield (Sp 5, Sp 7, Sp 11, Sp 14). • ***Water buffalo* hot springs:** Non-pregnant *Anatolian* water buffaloes are washed in hot springs in cold winter months, and their blood circulation is accelerated so that increase milk yield (Sp 12). • **Transhumance:** Increase animal yield by taking advantage of the plant diversity that occurs depending on the altitude and the change in the growth times of plants (Sp 1, Sp 2, Sp 4, Sp 8, Sp 5, Sp 7, Sp 11). • **Migratory beekeeping:** Bi-seasonal practice and transport of bees with wheeled beehives (Sp 5, Sp 8). • **Germination:** Timely germination of seeds with winter and spring precipitation (Sp 5, Sp 11, Sp 14). • **Early irrigation or water spraying:** Irrigate trees in cold weather or by spraying small granules of water on the tree crown in order to delay flowering during a false spring (Sp 7, Sp 18). • **Seed storage in ash:** To prevent seed moisture (Sp 20).	• Conservation of biodiversity • Sustainable food production and food security • Protection of the natural environment • Reduction in loss of life and loss of property • Decreased use of artificial fertilizers and chemical pesticides	• Increasing need for use of fossil fuels • Increasing loss of life and loss property • Drought • Famine • Soil, air and water pollution • Food insecurity

Germüş seeps into the soil. The local community has great difficulty in reaching clean water resources, yet have solved this problem thanks to the TEK example.

"Although it is not known exactly when it was built, the underground water (aquifer) descends through two 30-meter-deep wells drilled on the southern slopes of Germüş Hill. These two wells are the farthest and deepest wells from the exit point. Most of the water going to the tunnel is supplied from these two wells. The clean water collected in the main well is transported through channels called kariz, which are approximately 60 cm wide by 1 meter high (in some areas, the height decreases to 60 cm) and merges in a well called Köybaşı. After this well, there are ventilation wells about 30-40 meters apart that were sunk along the tunnel to connect the surface to the tunnels. The depth, which is 30 meters in the main well, gradually decreases to 25, 20, 15, 10, and 5 meters in the ventilation wells as it moves away from the main well. The clean water, which is transported with the help of channels called kariz, reaches the outlet pool after three water wells called springs in the village center. While drinking water is needed from the water wells called Pınar, the water accumulated in the outlet pool is sent to the agricultural areas with the help of channels and used to irrigate the agricultural areas. Until recently, the water needs of Şanlıurfa had also been distributed to other parts of the city with a system called the water clock from the place called Su Meydanı [Water Square] *through underground water channels called keriz"* (Sp 16; **Figure 4**).

"Our region has a long winter season and is also rich in hot water resources. The small lake created around the hot water

Table 11: Codes and quotation related to the food security categories.

TEK Categories	Codes and Quotation	Contribution of TEK	Problems that may arise when TEK is not implemented
Food security	• **Bait plant:** Plant figs between olive trees to reduce the damage done by the olive fly to olives, and plant roses around vineyards to prevent flies from laying larvae on the vines (Sp16, Sp17, Sp19). • **Wood ash pouring:** Prevents mold disease and insect infestation on plant leaves (Sp 1, Sp 3, Sp 4, Sp 5, Sp 6, Sp 11, Sp 19). • **Planting a fig branch:** Prevents the mole beetle from eating plant roots (Sp3, Sp4). • **Ice cave:** Keeps meat from spoiling (Sp 7, Sp 18, Sp 20). • **Storage pits:** Protects vegetables and fruits from rodents or frost, rot, and worms (Sp 5, Sp 6, Sp 18, Sp 21). • **Putting a flax bag on a tree trunk:** Protects the trunks of peanut trees from extreme heat, also protects from fungal diseases that may occur due to excessive moisture in the root collar (Sp 16). • **Wooden or earth tank storage:** Put grains in wooden or earthen tanks to protect it from moisture and humidity (Sp 16, Sp 18). • **Pour pomegranate peels underneath walnuts:** Prevents walnut anthracnose (Sp 16). • **Wasp trap:** Make a trap by placing molasses or meat products in the box to protect the beehives (Sp 6, Sp 11, Sp 18). • **Plant almonds and cannabis on field borders:** The wheat-damaging *Aelia rostrata* beetle is disturbed by the odor of these plants and does not come (Sp 4, Sp 18). • **Ash container:** Put eggs in ash to prevent spoilage (Sp 3). • **Human hair:** Sprinkle human hair around the field to protect the fields from pigs and various wild animals (Sp 3, Sp 11). • **Plant fruit trees:** Plant fruit trees in the forests and pastures around the villages so that wild animals do not starve and damage agricultural products (Sp 2). • **Takilik (bear repellant):** protects cornfields and beehives from wild animals by making a sound using hydraulics (Sp 1, Sp 2, Sp 8). • **Garlic:** Put garlic in nests to protect garden and field crops from moles and *Gryllotalpa Gryllotalpa* (Sp 1, Sp 6).	• Conservation of biodiversity • Sustainable food production and food security • Energy-saving • Protection of the natural environment • Reduction in loss of life and loss of property • Combat drought • Decreased use of chemical pesticides	• Increasing use of fossil fuels • Increasing loss of life and loss property • Famine • Soil, air and water pollution • Food insecurity

Figure 3: a, b, & c) Waterways in Kemaliye district.

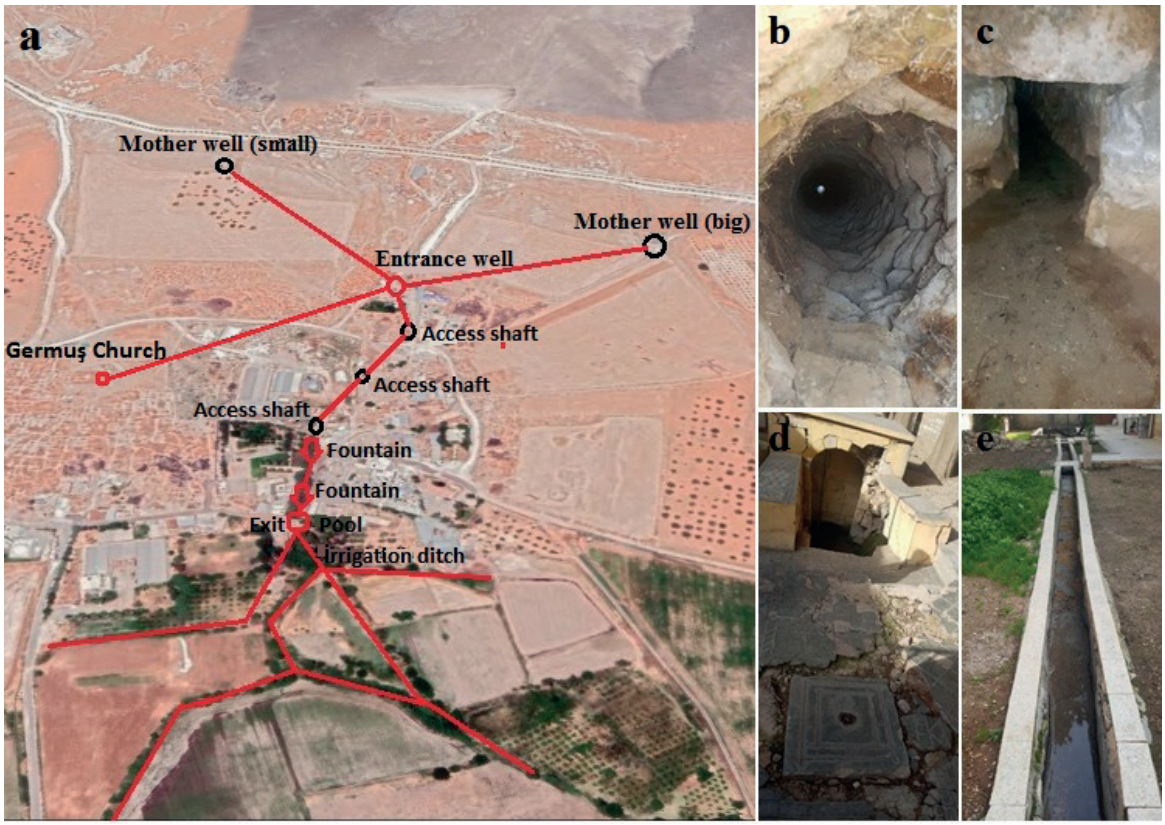

Figure 4: a) Kariz system in Şanlıurfa province, Germüş village, b) access shaft, c) kariz tunnel, d) fountain, e) water distribution channel.

spring near our village turns into water buffalo spas in winter. The temperature drops down to -20 C◦ on many days of the long winter season. During the cold winter days, the buffaloes wait in the barns and get dirty because they cannot be taken outside. During the winter months, we bathe the buffaloes in hot spring water at certain intervals (several days a week, 2-3 hours) in order for them to get clean, be healthier, and increase their milk yield, and the buffaloes spend part of the day there. We learned this practice from our ancestors and we continue it just as we saw it from them. In our observations, we saw that the milk yields of milkable buffaloes that were taken to the spa and cleaned there were higher than the days when they were not taken to the spa. However, there is a risk of miscarriage when pregnant buffaloes enter hot water. For this reason, we do not take pregnant buffaloes to the spa" (Sp12; **Figure 5**).

Extreme importance is had in the local community saving the seeds for the crops that they will plant in the coming years. Storing seeds in ash is one of the traditional seed storage methods, which Sp 20 describes as follows:

Figure 5: a & b) Water buffalo hot springs in Güroymak district, Budaklı village (Photo by Ö. Olcay).

"We take the seeds from the previous year's crop. Even when the product is of good quality, we sometimes separate and store enough seeds for two years from this product. We use ash of oak tree for storage. We wait for the fire to go out and become ash. Ashes are collected in the chamber and seeds are stored in this ash chamber for a two-year planting period according to the unit area. The ashes prevent the normal moistening of the seed and them from sticking together. In addition, when these seeds touch the soil, the active substances in the ash also provide a nitrogen source" (Sp 20).

The method of planting fig trees between olive trees in order to increase olive production, especially in the Mediterranean, Aegean and Marmara regions where olive production is important in Turkey, is a TEK practice that has been continued from the past to the present. Sp 17 earns his keep from olive growing in the Erdek region and expressed the importance of fig trees in olive groves for food security, describing this method as follows:

"The olive fruit fly is one of the most damaging factors for olive production. But they cut down the fig trees inherited from our ancestors in olive groves and planted olive trees in their place because they don't know the importance of these fig trees. This decreased the yield of the olives. Because the period when the fruits of the fig tree ripen coincides with the pollination period of the olive tree. Olive fruit fly is one of the most significant enemies of the olive and head towards the fruits of the ripening fig trees during the periods when it will damage the olive fruit. So, the sweetened figs allure the olive fruit fly. Besides, fig has the ability to kill olive fruit fly. Thus, it is possible to get rid of the olive fruit fly without using chemicals. In the past, there were several fig trees in almost every olive garden. Unfortunately, there are none or only a few of them now" (**Figure 6**).

While some agricultural products produced in season such as potatoes, radishes, onions, and carrots are kept in pits, grains in particular are stored in wooden or soil grain warehouses to protect them from moisture. The easily shaped volcanic land in the Central Anatolian Region (Aksaray, Kayseri, Kırşehir, Nevşehir, Niğde) was put into a functional shape and used according to the needs of the local community in their daily life. The citrus fruits of Çukurova in particular, which is close to the region, and products such as apples and potatoes grown in the region were stored in these earthen warehouses.

"There are chimneys on these warehouses where the products grown in the region were stored in the past. The peels of the lemons are thinned and watered thanks to these chimneys. Since the products put into the warehouse are watered, their taste and weight increase at the same time" (Sp 18).

A variety of grains are stored in wooden warehouses in places such as the Central Black Sea and Central Western Anatolia, which have richer forest assets compared to Central Anatolia. These structures are placed on large stones, absorb the moisture from the soil from below, and ensure that the grains remain unharmed. The entrance to these structures, which have no windows to prevent the entry of insects, is provided through small narrow wooden doors. One of the issues especially emphasized in previous sections was local communities' responses with regard to adapting to climate change. Hot weather can damage watermelon crops, which are the livelihoods of the local community engaged in agriculture in Çukurova, an important watermelon production area of Turkey. The method of wrapping watermelons with newspapers is an example of TEK

Figure 6: a) Fig bait planted for the olive fruit fly in Aydın province, b) Takilik or Çaçuka (bear repellant) in Bayburt province.

that was developed by the Anatolian community on food safety and is new compared to others.

> *"The watermelon, which should be collected quickly and presented to the market, especially in the ripening period; are forced to wait in the field due to factors such as transportation, marketing, and labor. Farmers in Çukurova protect the watermelons from the sun by wrapping them in newspaper without plucking them so that the watermelons in the field are not damaged by the heat. In this way, the product is stored in the field for about a month without spoiling. Thus, both the watermelon preserves its freshness and additional time is provided for the producer to present it to the market"* (Sp 15).

4. DISCUSSION

This study was conducted to document and characterize strategies for coping with and adapting to climate change in the case of Turkey. In many regions of Turkey, TEK practices have been determined related to strategies for coping with and adapting to climate change. The TEK applications were determined to mostly focus on defining, understanding, and developing strategies to cope with climate change, and TEK can play a key role in how a local community adapts to climate change. Berkes (2009), Lemi (2019), Hosen et al. (2020), Robinson and Herbert (2001), and Vinyeta and Lynn (2013) also stated TEK to be able to help develop effective strategies for adapting to climate change by contributing to solving problems about the conservation and sustainable management of natural resources, biodiversity, and wetlands. Traditional weather forecasting practices are still used in different geographies of Turkey by observing plants; certain animal behavior patterns; and the sun, moon, and sky. Berkes and Jolly (2001), Egeru (2012), and Dolbear (1897) also pointed out the existence of weather forecasting applications where local communities in different parts of the world observe plant and animal behaviors. However, the data also show the use of TEK in weather forecasting to have decreased significantly in Turkey due to reasons such as easier access to meteorological data using mass media and young people's decreased interest in TEK. Local communities in Turkey who earn their living through primary economic activities such as agriculture, animal husbandry, hunting, forestry, or fishing are clearly faced with a series of problems stemming from climate change. This is because local communities are the first to be affected by ecological and environmental changes (Berkes, 2009). On the other hand, local communities that are largely dependent on the climate and maintain agricultural and animal husbandry practices with extensive methods benefit more from TEK practices at overcoming these intertwined problems. Among the TEK applications identified in the study, most are focused on traditional land use and management and applications related to protecting natural resources and biodiversity. Thanks to traditional land use methods such as terracing, land that is difficult to cultivate due to rough topography and steep slope are brought into a suitable condition for agriculture, while the variety of products to be planted are chosen among those suitable for the climate. Also, soil characteristics of fields are measured without the use of agro-ecosystems, any meteorological data, or soil tests thanks to TEK, which has been accumulated throughout history and transferred to future generations without resorting to analysis, and the appropriate product is selected. TEK practices in Turkey especially have also created a protective shield in preventing pressure on natural resources and biodiversity. This shield of protection sometimes appears in the form of sacred ecology cases and sometimes in the form of myths and legends in Anatolia. However, Egeru (2012) drew attention to the weakness TEK has in its ability to cope with problems such as animal diseases, uncertain seasons, and short response times of climate variability events. In this context, understanding TEK and integrate it into scientific knowledge is extremely important. Berkes (2009), de Echeverria and Thornton (2019), Gómez-Baggethun et al. (2013), Granderson (2017), Lefale (2010), Vinyeta and Lynn (2013), Hatfield et al. (2018), and Hosen et al. (2020) also emphasized the importance of integrating TEK and scientific knowledge when developing strategies for coping with and adapting to climate change. Undoubtedly, local communities are the ones who are in constant contact with the natural environment and are the first to benefit from it. For this reason, local communities are the first to understand changes in the natural environment and climate, sometimes by observing the movements of plants and animals mentioned above or the changes in atmospheric events, and other times with signals such as decreased agricultural and/or animal food production. After all, local communities are the ones who adapt to the negative effects of climate change by developing new adaptation strategies. Findings demonstrate that local communities in Turkey have developed a set of adaptation strategies such as substitutions, and water resource management and to adopt practices such as natural disaster risk management, local architecture, sustainable food production, and traditional foods to fight against the effects of climate change as seen in higher summer temperatures, less precipitation in winter, lower water levels both on the surface and underground, drought, infertile soil, coastal erosion, and floods. In particular, different TEK

applications related to accessing and protecting clean water and managing water resources are frequently encountered in almost every part of Anatolian geography.

One should not forget that accessing clean water, protecting clean water, and properly managing water resources are not a problem that the Anatolian geography is likely to face in the near future. The Anatolian community has faced great water issues in the past and have significant knowledge and experience in developing strategies to cope with this problem. Common TEK examples developed for collecting and using precipitation when needed are found around the settlements and traditional structures in many parts of Anatolia in particular. The Anatolian community has developed traditional solutions and adaptation methods to the water problems that arise from climate change thanks to the methods they've developed to collect rain, surface water, and snow runoff. However, the TEK samples obtained in the study also show significant similarities as well as contrasts based on the regional variations in climate, topography, and culture. In fact, these variations, which occur even across short distances with regard to TEK, offer extremely important opportunities to local communities for adapting to climate change in Turkey. Ingty (2017) also emphasized that different TEK applications have emerged in areas with rough topography and that these applications are important in terms of creating alternatives while adapting to climate change.

4.1. Theoretical Inferences

This study contributes to the literature in several ways. First of all, it reveals the bidirectional relationship between TEK and climate change in a geography such as Turkey's, where cultural diversity and TEK examples are found in high concentration. Researchers can adapt this study to examine the impact TEKs have on climate change in different geographies by making use of the theories and practices of different researchers such as Berkes (2009), de Echeverria and Thornton (2019), Gómez-Baggethun et al. (2013), Granderson (2017), Hatfield et al. (2018), Hosen et al. (2020), Lefale (2010), and Vinyeta and Lynn (2013).

4.2. Practical Inferences

The study also has some practical implications. First of all, observing, reading and understanding nature is an art. Perhaps the local communities are the ones who observe, study, and understand nature best. This study provides basic data that contributes to solutions regarding the problem of climate change by examining four structures local communities have developed to cope with climate change: local climate information, understanding of climate change, proper management and protection of natural resources, and adaptation strategies. In addition, the TEK examples detected in the research area are seen to have varied over short distances and to offer alternative solutions to the same problem. Lastly, the TEK local communities have developed against disasters such as global warming and drought present strategic data. Moreover, invaluable examples of TEK have been identified for understanding the changes and interactions between natural and human systems in Turkey as well as for sustainably managing natural resources.

4.3. Limitations and Future Research

As with any other study, this study has some limitations. First of all, the sample size was 21 participants in a geographically broad and culturally diverse geography such as Turkey's. The semi-structured interview form that was used only had six questions that were developed to identify local communities' TEK examples and strategies regarding climate change, and the participants were not evenly distributed over all regions of Turkey. In addition, due to the conditions of the pandemic, some participants could only be interviewed online. Future studies can investigate the impact TEK has in being able to understand and solve the climate change problem using larger samples. In addition, integrating the TEK examples obtained in this study into scientific knowledge and practices may yield some fruitful results in developing strategies for coping with and adapting to climate change. In other words, theses, projects, and research can be done to learn the validity of TEK applications. Studies may also be carried out with regard to accepting TEK as a cultural heritage and integrating this heritage into school curricula in order to transfer it to future generations.

Peer-review: Externally peer-reviewed.
Conflict of Interest: The author has no conflict of interest to declare.
Grant Support: The author declared that this study has received no financial support.

Hakem Değerlendirmesi: Dış bağımsız.
Çıkar Çatışması: Yazar çıkar çatışması bildirmemiştir.
Finansal Destek: Yazar bu çalışma için finansal destek almadığını beyan etmiştir.

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