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Evaluation of urban infrastructure policies in Turkey for climate resilience and adaptation

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ABSTRACT

Turkey is a country vulnerable to the negative effects of climate change. In urban areas where most of the population lives, floods occur due to sudden, short-term but heavy rains caused by climate change. Infrastructure deficiencies have also caused considerable loss of life and property. I have discussed policies and practices of public administration formed by central government and local administrations focusing on climate change resilience and adaptation. I have also evaluated policy areas that need further development. This study can contribute to finding solutions to problems faced by cities in Turkey and other nearby countries. Findings show that participatory processes involving scientific and local knowledge can play a key role. Green and blue infrastructure with grey infrastructure and associated engineering solutions should also be used. Legislation should be updated to expand the use of nature-based solutions and green infrastructure, which should form a key focus of urban policy development.

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1. Introduction

There have been considerable changes in the Earth's climate over time. Although natural processes have caused these changes, it has been highlighted by the Intergovernmental Panel on Climate Change (IPCC) reports that the main cause of contemporary climate change is anthropogenic activities (IPCC, 2014, 2022). Greenhouse gases in the atmosphere have increased and this has caused changes to the climate system (Türkeş, 2021). In the World Meteorological Organization (WMO) Global Climate Update Report, it was stated that the probability of the global average temperature increasing by more than 1.5°C in a five-year period before 2026 has now reached 50% and this rate continues to rise (WMO, 2022a, 2022b).

In the IPCC 6th Assessment Report (AR6) Working Group (WGs) reports, it was stated that the number, frequency, and severity of climate-related adverse effects will increase. This will also create an environment that makes it difficult to achieve the United Nations (UN) 2030 Agenda and the Sustainable Development Goals (SDGs). Larger-scale social, technological, and economic transformation must be undertaken across all sectors to build resilience to climate impacts and reduce the associated risks to tolerable levels (IPCC, 2021, 2022).

At the centre of this transformation are the cities where the population and economic activities are concentrated. It

is essential to ensure that cities adapt and are become resilient to climate change (Buis, 2019; IPCC, 2014). This is also needed due to the changing nature of extreme weather events and other disasters associated with climate change. According to UN figures, approximately 90% of disasters over the last 20 years are related to climate change and their number, frequency and severity are increasing (UNDRR. & CRED, 2020). This situation has already caused substantial loss of life and property in cities. Floods are the most common climate change driven disaster worldwide, leading to an economic loss of \$46 billion in 2019 (WEF, 2022a).

Adapting to climate change and ensuring resilience of human settlements is a highly important issue for Turkey. Extreme weather events and disasters are experienced intensively in Turkey and cause substantial loss of life and property. The main reason why I have chosen Turkey in this study is that it is in a geographical location that is open to vulnerabilities arising from climate change. Short-term heavy rainfall events are one of the main climate-related extreme weather events in Turkey, and floods from excessive precipitation occur because of inadequate urban infrastructure. Therefore, in this study, I have emphasized the importance of developing urban water infrastructure. The World Bank's assessments have shown similar results. Public

administration in Turkey has important investments to ensure successful adaptation and urban resilience in the face of disasters from changing climate. However, this does not yet meet the needs of cities due to the high finance requirements of these investments in infrastructure revision (World Bank, 2022). Use of nature-based solutions (NbS) and green infrastructure (GI) are cost-effective urban infrastructure solutions for providing urban resilience and adaptation and disaster risk reduction (DRR) in Turkey. However, as a developing country, Turkey is not yet in the position it deserves in terms of public policies. Local administrations have limited budgets for infrastructure investments and it is important that these solutions are more widely implemented to cope with changing climatic conditions and disasters and to ensure urban resilience (Coşgun & Özdemir, 2017; Hepcan & Hepcan, 2018; Tuna & Bostancı, 2021).

This study clarifies public administrations' policies and projects focusing on resilience, climate change adaptation and evaluates policy areas where further development is needed in Turkey. The following questions are addressed within this scope of research: (1) How does climate change affect Turkish cities and what adaptation needs does it highlight, especially in terms of urban infrastructure? (2) What are the policies and practices to be developed by central government and local administrations to ensure adaptation and resilience to climate change in cities, and what should be included in future policies?

2. Materials and methods

In this study, a relational research model was used to evaluate the relationship between resilience and adaptation to climate change and urban infrastructure in Turkey. I focused on policy documents and project studies undertaken by public administrations in these areas as reference material in the study. To conduct these analyses, I collected the necessary research data and examined relevant sources through desk research and a literature review. I also used various books, journals, articles, national statistical data, and web resources. Although there is important literature from Turkey on resilience, adaptation and disaster management, urban processes are predominantly affected by the decisions, policies, and practices of public administration.

This study aims to identify policy gaps that need to be developed to ensure resilience, adaptation and DRR in Turkish cities. Key solutions are suggested for the realization of investments with lower financing for urban infrastructure revision required, especially to address problems derived from flooding. In this study, I aim to highlight the importance of developing physical and

human infrastructure through implementation of participatory processes.

This study comprises three different parts (Figure 1). I have focused on a conceptual framework that includes climate change, urban resilience, adaptation and DRR. I examined these concepts alongside the effects of climate change in Turkish cities. I have also explored current efforts of central government and local administrations to achieve climate resilience and undertake successful adaptation in urban areas in the context of urban infrastructure. I then discussed future-oriented approaches and policies for climate resilience and adaptation.

2.1. Conceptual framework

Climate change is defined in the UN Framework Convention on Climate Change (UNFCCC) as 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods' (UNFCCC, 1992). The first scientific report in which it was emphasized with 95% certainty that climate change is human driven is the IPCC (2014). In the IPCC (2021), it was stated that anthropogenic climate change has reached the level of crisis, and some regions worldwide are more vulnerable to adverse effects of climate change. Turkey is relatively vulnerable to natural disasters due to its geographical location. According to IPCC Reports, the Mediterranean Basin, which includes Turkey, is one of the regions that will be most affected by climate change. Average temperatures in the region are expected to increase by 2.5–4°C by 2100 (IPCC, 2018). In the 7th National Communication presented within the scope of UNFCCC, it was stated that the number of hot days has increased throughout the country and that precipitation has become irregular (MoEUCC, 2018).

In the fight against climate change, taking measures to mitigate greenhouse gas emissions alone is insufficient and it is necessary to adapt to the effects of climate change. Adaptation to climate change is defined by the IPCC as 'In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities' (IPCC, 2018). Cities are one of the most appropriate administrative scales for implementing climate change adaptation initiatives. Given that population, economic activities and infrastructures are concentrated in cities, it is vital to ensure climate resilience for cities and this issue has also been emphasized in the UN SDGs (Gu, 2019).

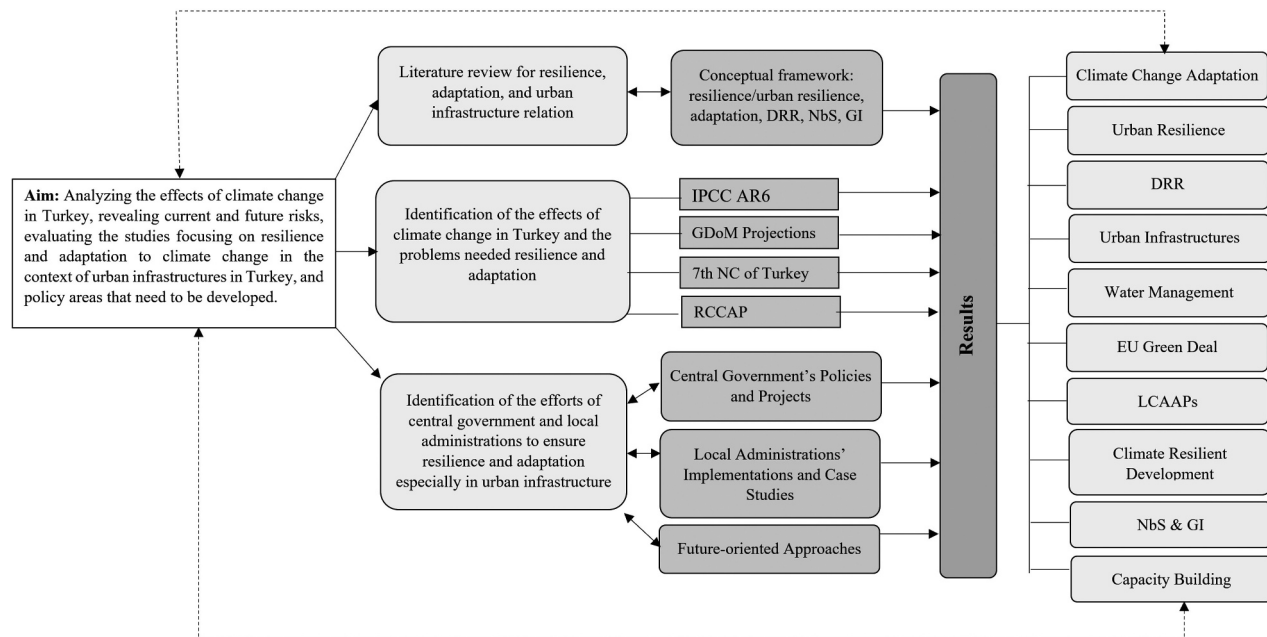


Figure 1. Conceptual method flowchart.

According to official statistics announced by the Turkish Statistical Institute (TurkStat) in 2022, 93.2% of the population of Turkey lives in urban areas (TurkStat, 2022). Therefore, it is highly important to evaluate the results of climate-related extreme weather events and disasters at the city scale, as well as the results of studies undertaken at national and regional levels.

The highest-level policy documents in Turkey are the Development Plans. The 11th Development Plan (2019–2023) highlights that efforts to reduce greenhouse gas emissions and adapt to climate change continue in Turkey, where drought, floods and sudden precipitation are experienced due to climate change. The effects of climate change on different sectors would be evaluated during the period of implementation for the plan. Under the title of ‘Liveable Cities and Sustainable Environment’, it was stated that studies should be undertaken on infrastructure, disaster management, transportation, integrated urban planning and design, climate-sensitive housing, protection of the environment and biodiversity, and urban economic development in line with ensuring urban sustainability and resilience. Under the title of ‘Protection of the Environment’, it was stated that Climate Change Action Plans would be prepared for seven geographical regions of Turkey, especially the Black Sea Region, to take the necessary measures at the local scale against climate change. Regional Climate Change Action Plans have been prepared by the Ministry of Environment, Urbanization and Climate Change (MoEUCC)

according to the General Directorate of Meteorology (GDoM) data. The effects of climate change shown in Table 1 are expected to have considerable impacts on seven geographical regions of Turkey (Birpınar & Tuğaç, 2021; CSBB, 2019; MGM, 2022; MoEUCC, 2021).

While these negative effects are expected at the regional scale, urban resilience is also considerably affected in the cities in these regions. Urban resilience is the capacity to survive in the face of shocks and stresses (Chelleri, 2012; Figueiredo et al., 2018; Galderisi, 2014). It refers to the social, economic, and environmental capacity of the urban system that enables it to adapt, respond and transform to sustain its basic functions in the face of disasters (IPCC, 2014). However, this is relatively difficult in Turkish cities, predominantly due to the inadequacy of infrastructure. Turkey is located in an area with high seismicity and this has led to damages to the infrastructure and superstructure of many cities. Short-term, sudden, and heavy rainfall events driven by climate change have added to this effect. Urban flooding has resulted from these severe rainfall events and the loss of life and property has highlighted the inadequacy of infrastructure, constituting an important risk area.

In Turkey, the Meteorological Disasters Assessment Report is prepared annually by GDoM. According to the report from 2010–2021, Turkey is among the countries in the risk group in terms of the effects of climate change. Increases in forest fires, storms and floods,

Table 1. Effects of climate change in seven geographical regions of Turkey (Birpınar & Tuğaç, 2021; MGM, 2022; MoEUCC, 2021).

Location	Regions	Findings
	The Aegean Region	The region has a Mediterranean climate and the main problem is water stress. Consecutive dry days are increasing. Floods due to short-term, sudden, and heavy rains are the most common disaster type in this region. It is a priority to protect the region's rich underground water resources from the effects of sea level rise.
	The Black Sea Region	This region receives the most precipitation in Turkey and there is precipitation in all seasons, causing floods, overflows, and landslides. GI solutions such as permeable surface coatings and the conversion of riverbeds to their natural state can play a key role.
	The Central Anatolia Region	This region receives the least rainfall and is a closed basin. Consecutive dry days and sinkhole formations are increasing. The most common disaster type in the region is storms. Short-term heavy rain causes floods and occurs in all months together with storms. Rainwater harvesting is important in the region.
	The Eastern Anatolia Region	Storms are the most common disaster type in this mountainous region, which has the highest altitude. While an increase in sudden and heavy rains is expected, it is predicted that there will be long periods without precipitation. Drought and floods will become problems for the region. Considering the high avalanche risk, infrastructure solutions including climate resilient and permeable ground cover become important.
	The Marmara Region	Temperatures and precipitation irregularities are gradually increasing. Floods, overflows, and storms are seen almost every month of the year. Hybrid infrastructure solutions (green-blue-grey) should be urgently addressed to provide resilience to flooding.
	The Mediterranean Region	The most common disaster type is storms. A decrease in annual precipitation and an increase in short-term sudden precipitation are expected. This can lead to flooding. The decrease in annual precipitation has made rainwater harvesting and the protection of wetlands increasingly important.
	The South-Eastern Anatolia Region	High temperatures bring about severe evaporation. This leads to drought and desertification. Sudden and short-term heavy rains cause floods. Rainwater harvesting is a key requirement.

hail, heat waves, landslides and avalanches are predicted because of climate change. The GDoM Report has stated that irregular, sudden and heavy rains in Turkey have caused floods, landslides, and erosion. The provinces of Antalya, Balıkesir, İzmir, İstanbul, Konya, Mersin, Ordu, Van, Muğla, Aksaray, Çorum, Bursa, Elazığ, Kayseri, Manisa, Kastamonu, Nevşehir and Aydın were most affected in the 8,274 meteorological events that occurred from 2010–2021, respectively (MGM, 2022). On 24–26 January 2019, the disaster experienced due to flooding in Antalya caused life and property losses (AFAD, 2020). Hundreds of citizens were affected by the flood because of all-day rains in the Araklı district of Trabzon on 18 June 2019, and then in the Akçakoca

district of Düzce on 17 July 2019. (AFAD, 2020). On 26–27 June 2022, a strong precipitation warning was issued for the Western Black Sea Region by GDoM. An average of 100 kg of precipitation per square meter fell in different provinces in the region within 24 hours. Loss of life and property occurred in the floods, and a red alert was issued for the provinces of Zonguldak, Bartın, Karabük, Kastamonu, and Sinop. Citizens were warned using the short message service (SMS) and Commercial Mobile Alerts System (CMAS). A total of 47 million Turkish Liras (₺) (approximately \$2.6 million) aid was sent from the Bank of Provinces, an affiliate of the Ministry of Environment, Urbanization and Climate Change (MoEUCC), the Ministry of Family and Social

Services, and the Disaster and Emergency Management Presidency (DEMP), to compensate for the loss and damage in the region (AFAD, 2022a).

It has been emphasized by GDoM that while there has not been a substantial change in the number of geological and geophysical disasters in Turkey in recent years, there has been a substantial increase in the number of meteorological, climatological and hydrological disasters under global climate change. Some types of disasters that have not previously been seen in Turkey have started to occur (MGM, 2020). According to GDoM data, the most common disaster in Turkey in 2010–2021 was storms with 2,645 events occurring. This was followed by heavy rainfall and flooding with 2,486 events and hail with 1,427 events reported, respectively (MGM, 2022).

According to data from the International Disaster Database (EM-DAT), \$ 2.5 billion were lost due to floods in Turkey from 1948–2020 and 1,401 people lost their lives. This is because of urbanization, increases in impermeable surfaces alongside decreasing green areas, insufficient infrastructure, illegal construction, and riverbed narrowing (Aslan, 2022).

The effects of extreme weather events and disasters related to climate change across all sectors, ecosystems, human health, and social structure in Turkey requires urgent action, especially in urban areas. In a study conducted by the World Bank (2022) on vulnerabilities due to climate factors, Turkey's vulnerability was found to be 9 of 10. It was highlighted that this is a relatively high level of vulnerability compared to the average of other OECD countries of 2 of 10. In the DEMP evaluation in the Global Risk Management Index, Turkey is in the group of high-risk countries for humanitarian crises and disasters with an index score of 5.0 in 2019 (AFAD, 2020).

To ensure the resilience of cities, climate change adaptation measures have been developed and DRR studies have been carried out. DRR studies are systematic approaches that aim to reduce the effects of climate change in urban areas and prioritize the necessary strategic planning and implementation (Etinay et al., 2018). Today, the importance of establishing a relationship between DRR studies and climate change adaptation has been understood and these two approaches are now considered in an integrated manner, which is important in developing countries such as Turkey (Abeygunawardena et al., 2003; Figueiredo et al., 2018; Prasad et al., 2009). Urban resilience can be supported by transferring the financial resources for separate allocation for studies on infrastructure transformation, which is one of the main requirements for Turkish cities. The World Bank (2022) has underlined that policies and plans involving different sectors have been developed to achieve transformation in Turkey through adaptation and resilience. However, the integration of climate change

adaptation and DRR processes into national development processes is an area that requires improvement.

Local administrations need cost-effective solutions in making urban infrastructure climate resilient, adapting to climate change in cities and DRR. As stated in many UN documents, especially the UN Habitat New Urban Agenda, which is also a signatory of Turkey, this solution appears as NbS and GI (UN Habitat, 2016; IUCN, 2019). GI has been defined by the European Commission as 'a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services' (EC, 2013). GI in cities include natural elements such as coastal areas, wetlands, reeds and swamps, and forest areas, as well as open and green areas such as city parks, urban agricultural areas, urban forests, street trees, sports fields, green wall and green roof applications. GI solutions are considered along with the blue infrastructure water bodies encompassing rivers, lakes, seas and oceans (BISE, 2022; Hepcan & Hepcan, 2018). GI reduces the heat island effect and contributes to DRR in cities, and offers opportunities for flood risk reduction, rainwater harvesting, ensuring water and food security in cities, and creating a sink for greenhouse gas emissions (BISE, 2022; WEF, 2022b). Handling green and blue infrastructure solutions alongside grey infrastructure, namely engineering solutions, is a cost-effective strategy in ensuring city resilience (Boland et al., 2021). However, storms and flash floods are the most common disasters in Turkish cities and there are negative practices in Turkey in terms of GI facilities where rainwater can be transferred before it causes flooding (Akman, 2021; Dinç, 2019; Kirmencioğlu, 2015).

Regulations on urban green spaces within the scope of GI in Turkey are shaped by the 'Regulation on Construction of Spatial Plans', which was published in the Official Gazette dated 14.06.2014 and numbered 29,030. The purpose of the regulation is: 'To the construction of spatial plans, which are prepared to protect and develop physical, natural, historical and cultural values, to ensure the balance of protection and use, to support sustainable development at the country, region and city level, to create healthy and safe environments with high quality of life, and which bring land use and construction decisions, and to determine the procedures and principles regarding its implementation'. However, this regulation has insufficient clarity on how to protect and develop ecological services and strengthen ecological connections during planning processes. Coastlines, transportation networks, and nature-based protected areas, which are stated as being planned at separate levels, are GI components and should be considered holistically in planning processes (Demiroğlu et al., 2019).

Conserving wetlands in their current condition at the peripheries of the cities, preserving stream beds and undertaking rehabilitation of degraded areas, are important in terms of their contribution to resilience as GI elements. However, in Turkey, the marshes have been drained, stream beds are frequently intervened and there has been illegal construction on the floodplains. Although Turkey is party to international conventions on the protection of natural areas and wetlands, especially the Ramsar Convention, the examples of restoration and rehabilitation of wetlands included in these documents are not common in Turkey. Rapid urbanization in Turkish cities has increased pressure and intervention on river and stream beds. Inadequate urban infrastructure services from rapid urbanization and urban sprawl have become even more inadequate in the context of changing climate conditions (Altundağ & Canlı, 2019; Kirmencioğlu, 2015). NbS and GI solutions are still an area requiring development and have applications in providing resilience, adaptation, and DRR in cities and in providing cost-effective infrastructure (Birpınar ve Tuğaç, 2021).

3. Results

3.1. Current studies in Turkey in the context of climate resilience and adaptation

Flooding in Turkey requires revision of urban infrastructure in line with urban resilience and climate change adaptation. In the following sub-titles, examples of the projects carried out by the central government in Turkey and the practices carried out by the local administrations are presented. Evaluation of these will shed light on what should be the future approaches.

3.1.1. Central government policies and projects for urban resilience and climate change adaptation

Due to Turkey's vulnerable position against climate impacts, studies for combating climate change are gradually increasing. This has led to the consignment of the co-leadership task of Infrastructure, Cities and Local Climate Action, one of the thematic transformation areas determined by the UN within the scope of the UN Climate Action Summit held in New York in 2019, to Turkey, together with Kenya and UN Habitat (UN Habitat, 2019).

While Turkey actively participates in international climate change negotiations within the scope of the UNFCCC and the Paris Agreement, to which it is a party, the following documents have also been prepared. However, MoEUCC is currently updating these documents (CSB, 2018):

- National Climate Change Strategy in 2010
- Climate Change Action Plan (2011–2023), which includes actions in areas such as energy, building, industry, transportation, waste, agriculture, land use and forestry, as well as water resources management, the agriculture sector and food security, ecosystem services, and biodiversity in 2011.
- Climate Change Adaptation Strategy and Action Plan (2011–2023), which focuses on forestry, natural disaster risk management and human health in 2011.

Another important project carried out by the central government is the Impact of Climate Change on Water Resources in Turkey Project, completed by the Ministry of Forestry and Water Affairs in 2016. The effects of climate change on surface and underground water resources were studied, and climate, hydrology, hydrogeology, and hydraulic projections were made for 25 hydrological basins in Turkey. One of the important outputs of the project was the determination of drinking and utility water, rainwater harvesting, and water pricing, which falls within the working area of municipalities. Suggestions were also made for climate change adaptation in the agriculture and industry sectors (OSB, 2016).

Technical Assistance to Enhance the Capacity of AFAD in the Adaptation and Reduction of Disaster Risks Resulting from the Climate Change in Turkey Project was initiated by DEMP in 2020. The project aims to develop technical and human capacity against climate-related risks, to prepare local action plans for disasters in selected pilot provinces, and to develop local capacity, resilience, and public awareness (MFA, 2020).

Another study carried out by DEMP on disasters is the Provincial Disaster Risk Reduction Plans (PDRRP). In these plans, while the effects of disasters are detailed at the provincial level, strategies for minimizing them are also put forward. DEMP guidelines have been taken as a basis in the preparation of documents that require the participation of all provincial level stakeholders. The plans include the current situation in each province, hazard and risk assessments, current situation analysis, DRR targets and actions, and scope for monitoring and evaluation (IRAP, 2022). Based on PDRRPs prepared for 81 provinces, DEMP also prepared a Turkey Disaster Risk Reduction Plan. Within the scope of the plan, measures and strategic actions to be taken against many different types of disasters such as climate change and earthquake were included. The strategic priorities of the Sendai Framework for DRR (SFDRR) were also considered in the selection of these strategic actions (AFAD, 2022b).

MoEUCC has announced that ₺37 billion (\$2 billion) will be allocated to climate-friendly projects in 2022 through the Bank of Provinces for the design and financing of infrastructure and other investment needs of local administrations. Priority will be given to greenhouse gas mitigation, adaptation, and disaster prevention. A total of 17 flood control projects have been prepared in the basins where the floods started, to prevent flooding from reaching cities and to minimize loss and damage (TRT News, 2022).

The Bank of Provinces has implemented 3,169 projects from July 2018–September 2021. A total of ₺22 billion (\$1.3 billion) of finance was transferred for 485 wastewater projects, 454 drinking water projects, 770 superstructure projects, 345 urban investments and 1,115 other infrastructure investments (Bank of Provinces, 2022a).

Studies on the preparation of the Climate Law in Turkey are also ongoing. To ensure participation of all stakeholders, the Climate Council was organized by MoEUCC from 21–25 February 2022. Separate working groups were formed within the Council on climate change adaptation and local administrations, and climate sensitive urban planning, resilient infrastructures, NbS and GI were discussed by these groups (İklimSura, 2022a; TRT News, 2022).

On 22 October 2021, the World Bank Memorandum of Understanding (MoU) was signed between the Ministry of Treasury and Finance of Turkey, the World Bank, and other stakeholders. With the MoU, approximately \$3.5 billion concessional loan and \$12.5–66.5 million grant support will be provided to Turkey. A substantial portion of the financial package is to be allocated to Bank of Provinces for infrastructure projects to provide climate resilience to local administrations (Bank of Provinces, 2022b; İklimSura, 2022b).

At present, there is no complete integration between climate change and DRR studies in projects carried out by central government. However, addressing these issues in an integrated manner will provide economic and administrative benefits. Steps have been taken to realize climate change governance by including actors such as NGOs and local administrations after Turkey became a party to the UNFCCC in 2004 and public administration reforms were undertaken with the influence of EU accession negotiations. An understanding in line with the governance approach in which all stakeholders are involved, such as joint project construction, project meetings or strategy determination, especially with EU projects, has become widespread in Turkey. However, the traditional approach has been maintained by central government in decision-making and implementation processes and the development of

participatory processes should be carried to the next level (Ocaklı, 2021; Özişik, 2020).

3.1.2. Implementation and studies of local administration for climate resilience and adaptation

Local Climate Change Action Plans (LCCAPs) are prepared by local administrations on a voluntary basis in line with low-carbon, sustainable, and climate-resilient development in cities. LCCAPs are documents that serve to understand the current situation and risks locally and to develop consistent policies and strategies for the future (Damsø et al., 2016; Tang et al., 2010). However, the adaptation component in the LCCAPs either does not exist or has not been discussed in sufficient detail (Tuğaç, 2021). Therefore, it is necessary to strengthen the adaptation component of LCCAPs and address them with the inclusion of NbS and GI. Implementation of LCCAPs is as essential as preparation and to facilitate this, the financial capacities of local administrations should be developed. Although the NbS Catalogue for local administrations has been prepared by MoEUCC, it has not yet been made available to local administrations (İklimiDuy, 2021b).

There are also projects developed by local administrations in Turkey aimed at urban resilience and adaptation by focusing on water management, NbS and GI, albeit at an early stage. The following examples include local case studies.

- İzmir-Balçova/Green re-vision/ A framework for the resilient cities project: This project benefited from the EU IPA funds in 2019 and was jointly carried out by the İzmir Metropolitan Municipality and the Landscape Research Association. Climate models with 500 metre resolution were created under the RCP 4.5 and RCP 8.5 scenarios of the HadGEM2-ES Global Circulation Model (GCM), which has also been used in the CMIP5 project included in IPCC AR5, to reveal the climate model of İzmir Province. Changes in land cover in the pilot area in Balçova District were analysed and projections were made for 2050–2100. Ecosystem services, retention of precipitation, and sink potentials provided by natural-semi-natural green areas in Balçova were calculated. The temperature increases in the low parts of Balçova have been projected to be high from 2050–2100, and precipitation, humidity, and evaporation will increase. In the light of these findings, evaluations were made for the composition and configuration of the urban GI. It was determined that there were 15 different GI element classes in Balçova. The natural vegetation covers the largest area (32%)

and its location close to the settlements provides a considerable advantage. However, a substantial proportion of the GI comprises parks, refuges, private and corporate gardens, and built areas covering approximately $\frac{1}{4}$ of Balçova. Stormwater and sewerage systems in Balçova are not currently separate, and because of the project, applications for stormwater management, which will ensure the collection of stormwater in a separate system should be handled together with the parks. Agricultural land should be protected to benefit from urban flood prevention by taking advantage of the high rainfall water holding capacity. Suitable plants should be chosen in urban landscaping that are adapted to high levels of precipitation. Urban resilience can be contributed by replacing the impermeable surfaces that cause stormwater to flow faster on permeable surfaces by rearranging the borders that prevent the flow of flood waters to the green areas where they can be absorbed. In this context, urban renewal has been proposed (Berberoğlu et al., 2019).

- Ankara–Çankaya/Adaptation to climate change through rainwater harvesting project: Within the scope of the EU–Turkey Civil Society Dialogue Program, the project, co-beneficiary of Çankaya Municipality and Portuguese Association for a Humanitarian World, was realized with a grant from EU IPA funds. The goals of the project are to strengthen relations between Turkey and the EU on climate change adaptation. Capacity development in line with application of rainwater harvesting methods to create an alternative to the traditional water management approach in Çankaya is also a key priority. Training has been provided in Portugal and a Rainwater Harvesting Guidebook was prepared. To support participation of stakeholders, an international congress was held with 185 participants (Coşgun & Özdemir, 2017; PAD, 2019).
- İzmir metropolitan municipality/Water supply project: According to an assessment made among global metropolitan cities in 2018, İzmir was one of the cities with the fastest growing economy in Turkey between 2014 and 2016 (Bouchet et al., 2018). İzmir receives a high rate of immigration, leading to urban expansion, and the urban ecosystem is being damaged. Another problem area in the context of urban resilience is infrastructure. To eliminate problems related to water supply and quality, the main strategy was development of integrated water management plans, development of water and treatment infrastructure projects, and

creation of a circular economy. İzmir Metropolitan Municipality together with the municipality's water administration IZSU, cooperated with the World Bank–IFC to expand the water service in the growing city. Thanks to these investments, water services have been provided to 97.7% of the citizens. With four wastewater treatment plants established, a circular economy has been created along with reuse of water (IFC, 2018).

3.2. Future-oriented approaches to climate resilience and adaptation

Studies have been carried out by central government and local administrations, and international cooperation is being established. There are important data infrastructure creation and modelling studies carried out by GDoM, General Directorate of Water Management, and General Directorate of State Hydraulic Works in line with the assessment of climate and disaster risks at the basin and region scales (World Bank, 2022).

The negative effects of climate change in Turkey will affect sustainable development and efforts towards the realization of the SDGs. All these make adaptation and resilience studies a priority and these studies should be developed at all administrative scales. Almost every city in Turkey is affected by different types of disasters, especially flooding caused by climate change, which necessitates adaptation financing for urban infrastructure and developing cost-effective resilience solutions. It is especially important for local administrations to have sufficient finance, technical capacity, and technological support in their work, to ensure urban resilience and to realize infrastructure investments, which are urgent for climate change adaptation.

However, where the negative effects of climate change are predicted to continue, it is necessary to take efforts to the next level, to ensure the contribution of all local administrations and to monitor them. Disaster management and efforts to combat climate change, which are carried out separately in Turkey, should be addressed and integrated. As a developing country, Turkey's economic resources will be used more effectively (Aslan, 2022).

Developing the human, administrative and financial capacities of local administrations, which is the closest administrative scale to the citizens is another issue that Turkey should emphasize in providing climate resilience.

It is highly important to encourage local administrations to become members of national and international city networks. These networks will support information sharing and good practice examples. Through these

memberships, it will be possible to attract climate resilient infrastructure investments to cities, to provide financing opportunities, to cooperate with the private sector as important stakeholders, and to provide green employment opportunities (Kern & Alber, 2009).

The use of local knowledge as well as scientific knowledge and encouraging participatory processes play a key role in the fight against climate change in cities. In the traditional approach in Turkey, NGOs, citizens, and public administrations come together, especially in EU projects, but it is vital to improve governance at the local level.

Protection of natural resources that provide ecosystem services and GI in cities within the scope of NbS is another important issue. However, legal gaps on this should be filled. This is also an obligation for international agreements to which Turkey is a party. NbS and GI should be disseminated and actively used in local administrations to reduce life and property losses due to climate change-related extreme weather events and disasters, and to ensure sustainability and resilience of cities because NbS costs at least 50% less than grey infrastructure (WEF, 2022a).

Turkey suffers from flood disasters due to sudden and heavy rains. However, ensuring water security in Turkish cities is a problem that needs to be addressed. The annual amount of water per capita in Turkey is around 1,346 cubic meter (m^3) and Turkey is a country that suffers from water stress. The water sector needs special attention to ensure climate resilience as well as water and food security in Turkey (DSI, 2022). The use of NbS and GI with engineering solutions is a prominent strategy. According to World Bank figures, 2/3 of Turkey's river basins are home to metropolitan cities such as Ankara, İstanbul, İzmir, and Antalya and cover important agricultural areas such as the Konya Plain, which creates water scarcity in these basins. The World Bank forecast for 2023 is that total water consumption in Turkey will be 112 billion m^3 , and 72 billion m^3 of this will be used for irrigation, 18 billion m^3 for domestic use, and 22 billion m^3 for industry (World Bank, 2022).

As the demand for irrigation water grows, the groundwater level has decreased. In 2020 and 2021, the amount of water decreases in the metropolitan water reservoirs at the drought level. Warming due to climate change in the Sea of Marmara has highlighted the problem of mucilage together with wastewater being discharged into the sea without treatment. This has negatively affected sectors such as tourism and fisheries. It is necessary to make integrated basin management planning for water management and infrastructure, to prevent water losses with engineering solutions such as NbS or floating solar panels and to ensure

sustainable water storage. Drainage and irrigation systems should be reviewed and wastewater should be reused. Rainwater harvesting should be expanded in local administrations and infrastructure and separate collection from the sewer system should be developed (Çaltı & Somuncu, 2019; Öztürk et al., 2021; World Bank, 2022; Yılmaz, 2010).

Resilience to climate change plays a key role in urban renewal activities. Climate change should be taken into consideration in planning and design activities and infrastructure design, and illegal construction should not be allowed by local administrations. By implementing a compact form of urban development, the spread of cities to natural areas should be prevented. (Tuğaç, 2019).

According to the World Bank, although Turkey's need for infrastructure investment is high compared to other OECD countries, the gain to be obtained because of the investment will also be high. The World Bank emphasized that transportation infrastructure is open to climate-related effects and should be built according to higher standards. Although this approach increases the initial investment cost by 11%, it brings greater gains through resilience and reduces annual maintenance and repair costs (World Bank, 2022).

The most effective method for developing adaptation capacity, which has also been emphasized in the Paris Agreement, is to support urban resilience. In this way, it will also be possible to implement the SFDRR, New Urban Agenda, and UN SDGs accepted by Turkey.

4. Conclusion

Cities worldwide are faced with many different natural and human-induced shocks and stresses. Being the places where population and economic activities are focused increases the vulnerability of cities, making it essential to provide urban resilience. In the face of climate change, it has become critical to carry out adaptation actions and to establish climate-resilient cities.

Due to its geographical location, Turkey is in a highly vulnerable position to the effects of climate change. According to IPCC reports, the negative effects of climate change and related extreme weather events and disasters in the region will increase in number, frequency, and severity.

Turkey has become a party to the Paris Agreement as of November 2021 and has also announced its net zero emission target for 2053 and its green development policy. However, Turkey needs to reduce greenhouse gas emissions, and adapt to the effects of climate change and ensure resilience, especially in urban areas. Turkey is currently experiencing substantial loss of life and property in its cities, predominantly due to storms and floods.

DRR and climate change adaptation studies in Turkey should be handled using a holistic approach. DRR studies should be developed with effective adaptation actions and policies, and adaptation to climate change should be considered in sustainable DRR studies. This approach should be considered in all policies, strategies, and practices developed by central government and local administrations to ensure urban resilience.

In management of climate-related disasters in Turkey, it is important that understanding on providing humanitarian aid after a disaster is replaced by proactive approaches before a disaster occurs. Integrated DRR and climate change adaptation studies should be a key focus to manage risk rather than crises.

Dissemination and effective use of early warning systems in cities and development of citizens' awareness levels are another important dimension. Local administrations should focus on capacity building and projects that will raise the awareness among citizens about disaster preparedness.

Investing in resilient urban infrastructure and services and regular maintenance by local administrations is an important strategy. Insurance systems developed in sharing climate-related risks will also be an effective tool.

Evaluation of the unique conditions of the city in providing urban resilience is an important step in determining which adaptation actions to choose against risks and disasters. For this, impact, vulnerability, and risk analysis should be made at the local level.

A multi-stakeholder participatory governance process should be operated in understanding and reduction of disaster risk and implementation of adaptation. An approach should be implemented that ensures that no one is left behind and that all segments of society are included.

Financing is a key requirement for increasing resilience in cities and for implementing DRR and adaptation actions. Efforts should be made to attract public and private financial resources to the city. The production of disaster risk information, land use planning, studies for the protection of critical infrastructure, including transportation and energy infrastructure, disaster risk management and water-related risks, adaptation needs, investments related to disaster risks constitute the priority areas. Policies to be developed by the public are important in making investments in these areas attractive for the private sector. Development of climate-sensitive standards for infrastructure and buildings will contribute to this area.

Although LCCAPs play a key role in ensuring climate resilience and planning transformation, strategies, and actions needed in cities, LCCAPs need to be prepared

for Turkish cities and updated to include mitigation and adaptation actions based on accurate data.

A GI system should be established with high ecological qualities and a balanced distribution in the urban texture, and to develop a holistic approach to improve the ecological characteristics of open green areas.

Implementation of the master plans of the local administrations needs to be meticulous and plans must be climate sensitive, considering the local climatic conditions. To prevent further increase in loss and damage in climate-related disasters and extreme weather events, it is necessary to prevent unauthorized construction.

Its location adjacent to the EU requires Turkey to prepare for development and transformation in bilateral relations with the Union, where 40% of its commercial relations are undertaken in line with the Green Deal document. Although the Green Deal Action Plan has been prepared, it is important for Turkey to determine the policies that consider the EU New Adaptation Strategy announced in 2021 as a pioneering action of the Green Deal. This issue should be considered, especially in the National Climate Change Adaptation Strategy and Action Plan, which is one of the national documents being revised by MoEUCC for 2053 Green Development targets.

Holistic planning and implementation of these actions, which are important within the scope of different administrative scales in Turkey, will provide urban resilience and adaptation and contribute to a resilient and sustainable economy. The potential of these efforts to create green jobs, sectors and new employment areas is highly important for a developing country like Turkey. The climatic conditions we live in necessitate the implementation of climate-resilient development.

As UN Secretary-General António Guterres has stated, 'Disasters inflict horrendous suffering and can wipe out decades of development gains in an instant. In the coming decade, the world will invest trillions of dollars in new housing, schools, hospitals, and other infrastructure. Climate resilience and disaster risk reduction must be central to this investment.' (UN, 2019).

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