KADEM
Kadın Araştırmaları Dergisi
ARAŞTIRMA MAKALESİ / RESEARCH ARTICLE

DOI: 10.21798/kadem.2024.146
https://kadinarastirmalari.com

Gönderilme Tarihi: 19.01.2024
Son Revizyon: 03.06.2024
Yayın Tarihi: 27.06.2024

Impact Chain Analysis on Determining the Vulnerability Levels of Women to Climate Hazards and Risks: A Case Study of Türkiye

İklim Tehlike ve Risklerinden Kadınların Etkilenebilirlik Düzeylerinin Belirlenmesine Yönelik Türkiye Örneğinde Etki Zinciri Analizi

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Abstract

The case studies in the literature and the reports prepared by international organizations indicate that the vulnerability level of women to climate change-related hazards and risks is considerably high. In addition, it is mentioned in the literature that women's participation in both the development and implementation of mitigation and adaptation actions to be taken against climate change will yield more positive outcomes. It is seen when considered the impact chain analyses described in the reports of the Intergovernmental Panel on Climate Change (IPCC) that there is still a need to propose methods and data sets which involve the transformation of the required parameters to be used for the determination of women's vulnerability levels to climate change under specific factor groups into data and the determination of the vulnerability levels through concrete indicators by weighting these data. Therefore, the aim of this study is to propose parameters, data, and data sources that can be used in the impact chain analysis of women's vulnerability in Turkey using the methodology developed to analyse the vulnerability of various sectors and themes to climate change. For this purpose, a methodology combining the PESTEL technique, initially used in the external environmental analysis of private sector companies, with the impact chain analysis conducted within the scope of climate change to determine the parameter classes in the most comprehensive way and a data set is described to contribute to the modelling studies that provide concrete and comparative insights into the women's vulnerability to climate change.

Keywords: Climate Change, Impact Chain Analysis, PESTEL Analysis, Vulnerability, Women.

Öz

İklim değişikliği kaynaklı tehlike ve risklerden kadınların etkilenebilirlik seviyesinin yüksek olduğu literatürdeki vaka çalışmalarından ve özellikle uluslararası kurumlarca hazırlanan raporların içeriğinden anlaşılmaktadır. Bunun yanında, yine literatürde iklim değişikliğine karşı alınacak azaltım ve uyum önlemlerinin hem geliştirilmesinde hem de uygulanmasında kadınların katılım sağlamasının daha olumlu sonuçlar vereceğinden de bahsedilmektedir. Hükûmetlerarası İklim Değişikliği Paneli (Intergovernmental Panel on Climate Change, IPCC) raporlarında tarif edilen etki zinciri analizleri dikkate alındığında belirli faktör grupları altında kadınların iklim değişikliğinden etkilenebilirlik seviyelerinin belirlenmesinde kullanılabilecek parametrelerin veri haline getirilmesini ve bu verilerin ağırlıklandırılarak somut göstergelerle etkilenebilirliğin belirlenmesini içeren metot ve veri seti önerisinde bulunmaya ihtiyaç olduğu görülmektedir. Bu nedenle bu çalışmanın amacı, çeşitli sektör ve temaların iklim değişikliğinden etkilenebilirliğini analiz etmek amacıyla ortaya konulmuş metodolojiden yararlanarak Türkiye'de kadınların etkilenebilirlik analizine ait etki zincirinde kullanılabilecek parametrelerin, bunlara ait verilerin ve veri kaynaklarının önerilmesidir. Bu amaçla parametre sınıflarının en kapsayıcı şekilde belirlenmesi için başlangıçta özel sektör firmalarının dış çevre analizinde kullanılan PESTEL tekniğinin iklim değişikliğine uyum kapsamında yapılan etki zinciri analizi ile birleştirilmesinden oluşan bir metodoloji tercih edilmiş ve kadınların iklim değişikliğinden etkilenebilirliklerine dair somut ve karşılaştırmaya olanak verecek modelleme çalışmalarına katkı sağlaması açısından bir veri seti tarif edilmiştir.

Anahtar Kelimeler: Etki Zinciri Analizi, Etkilenebilirlik, İklim Değişikliği, Kadın, PESTEL Analizi.

Atıf/Citation: Eren, Z., & Toy, S. (2024). Impact Chain Analysis on Determining the Vulnerability Levels of Women to Climate Hazards and Risks: A Case Study of Türkiye. *KADEM Kadın Araştırmaları Dergisi*, *10*(1), 55-84.

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Extended Abstract

Climate change caused by anthropogenic activities leads to meteorologically extreme weather events that have never been measured, observed or experienced on Earth before. Further warming of the atmosphere, oceans and land surfaces results in a global increase in average sea level, and an increase in the frequency and severity of extreme weather events such as heat waves, excessive precipitation, drought and tropical cyclones. On the other hand, the effects of climate change on humans vary depending on the socioeconomic development of countries, the characteristics of the places they live in, and the economic sectors they are engaged in. Hazards and risks arising from climate change may increase the magnitude of existing risks that individuals are exposed to, as well as cause new risks - throughout the entire ecosystem. For example, while risks increase for individuals, assets, economies, and ecosystems in urban areas, the inadequate infrastructure, and services for those living in the areas exposed to these risks further increase the magnitude of the risks. In rural areas, such risks affect access to water and water resources, food security, infrastructure and agricultural income. The impacts of climate change do not only depend on the effects of extreme weather events with the increasing severity and frequency but also vary according to regions, sectors, and social and economic groups. From this perspective, climate change has different impacts depending on gender. Therefore, the impacts of climate change may contribute to the exacerbation of existing high gender inequalities. In many countries of the world, women still bear a disproportionate responsibility for domestic services, food, fuel and water supply. More than half of agricultural production in the world is still carried out by women. Therefore, when dangers and risks such as drought, heat waves, and extreme meteorological events caused by climate change affect the agricultural sector, it is inevitable that women will be the most affected group by this situation. Women, who work in sectors whose sustainability depends on the health of ecosystems, such as agriculture, animal husbandry and fishing, are most affected by the devastating consequences of climate change. One of the most important problems caused by climate change is the increase in urban migration due to declining employment in rural areas. The groups most affected by migration are women and girls. Climate change and the disasters it causes are seen as a threat multiplier to the health of women and children. It is seen that there are also qualitative studies based on field data and observations, especially the methods obtained from the general framework presented in the Intergovernmental Panel on Climate Change (IPCC) 4th Assessment Report (AR4) and 5th Assessment Report (AR5), on determining women's vulnerability levels to climate hazards and

risks. Addressing the literature on women living in rural areas in developing countries being affected by climate change, the main reasons for the high level of women's vulnerability to climate change include poverty, gender inequality, lack of women's property and other social rights, and women's participation in agricultural production. It has been determined that the economic dependency is higher among women while their opportunities to access education and information sources are limited. This level of vulnerability also increases because women have insufficient financial resources, experience social marginalization, face limited mobility, and are excluded from decision-making processes in the face of disasters. In the last three assessment reports prepared by the IPCC (AR4, AR5 and AR6), the concept of vulnerability has been addressed and evolved in different ways. In the AR4 Report, exposure to the effects of climate change, sensitivity and adaptive capacity are discussed within the framework of vulnerability, while in the AR5 Report, vulnerability is defined only as one of the components that constitute the risk, covering only the components of sensitivity and adaptive capacity. In addition, the concepts of hazard and exposure have also been included as components in the concept of risk. For this reason, the concept of risk began to be used instead of vulnerability. Therefore, the aim of this study is to suggest the parameters, data and data sources that can be used in the impact chain analysis of the climate change vulnerability of women in Turkey, by using the methodology put forward to analyze the vulnerability of various sectors and themes to climate change. At this point, it is the most comprehensive indicator class that can be used in the development of the climate impact chain, the framework of which was created by the IPCC, for women. It is very important to determine it accurately. For this reason, it is expected that combining the PESTEL analysis, which was initially developed for the external environmental analysis of private sector companies, with the impact chain analysis will contribute to obtaining concrete and comparable results regarding women's vulnerability to climate change. PESTEL analysis is defined as a framework or tool used to identify, analyse and monitor important macro-environmental factors that affect the performance of an organization. PESTEL is the abbreviation of the first letters of Political, Economic, Social, Technological, Environmental and Legal factors. PESTEL, as a tool, generally leads to a better understanding of a situation or the relevant internal and external factors when used in conjunction with other tools such as strengths, weaknesses, opportunities and threats (SWOT) or the impact chain analysis discussed in this study. Especially in developing countries, women become more sensitive to the dangers and risks caused by climate change for different social, economic and cultural reasons and have higher levels of vulnerability. The two primary issues are women's low socioeconomic level and limited access to opportunities that would increase their adaptation capacities.

Introduction

The hazards and risks related to climate change have the potential to cause the biggest global disasters for humanity in the 21st century. With the impact of anthropogenic activities, significant and rapid physical, chemical, and biological changes occur in the system known as the 'climate system', which consists of the atmosphere, oceans, land surfaces, glaciers, and biosphere, forcing the climate system to change (IPCC, 2018). Anthropogenic climate change leads to the experience of unprecedented and unobserved meteorological values and events (extreme values and extreme weather events) globally and regionally. The warming of the atmosphere, ocean waters, and land surfaces, along with the global average sea level rise of approximately 0.20 (0.15-0.25) meters between 1901 and 2018, has made climate hazards more striking, including increased frequency and intensity of extreme weather events such as heatwaves, heavy rainfall, droughts, and tropical cyclones (IPCC, 2023). While climate change affects every individual on Earth due to all these hazards, the impact does not occur at the same level for everyone (UNFCCC, 2023a). The countries and societies that have become the most sensitive and have the highest level of vulnerability to such situations, causing significant adverse effects, losses and damages on the environment and people, are those that have the lowest contribution to climate change (UNFCCC, 2023a). Since the Industrial Revolution, the primary historical responsibility for the climate crisis has belonged to the global North countries, particularly the United Kingdom and the United States. However, due to their climate conditions and geographical locations, populations living in Small Island Developing States, which historically have used almost no fossil fuels, are facing the threat of losing their lands due to the rising sea levels caused by climate change (İklimin, 2019). The impacts of climate change on individuals vary depending on the socioeconomic development status of countries resulting from the economy policies and governmental systems they adopted (Mavisakalyan & Tarverdi, 2019), as well as the characteristics of the geographical locations and environment in which they reside, and the economic sectors they are engaged in (IPCC, 2019).Economic losses such as lower production and income rates are observed as risks in the leading sectors exposed to the impacts of climate

change like agriculture, forestry, fisheries, industry/energy and tourism, and such risks are followed by social impacts such as losses in per capita gross domestic product, unemployment, poverty, and hunger. The extent of climate impacts, which cause physical problems like damages to housing areas and infrastructure, economic losses like the destruction of assets and income sources and social problems like the worsening public health, reduced food security and the decrease in employment rate, can vary depending on individual characteristics such as gender, social and economic status, living places, income level, age, education, ethnic origin and disability status. (Elasha, 2012; UNFCCC, 2022). Climate hazards and risks may enlarge the extents of the existing risks that individuals are exposed to as well as lead to the emergence of new risks throughout the entire ecosystem (FAO & UNDP, 2020). For instance, in urban areas, while risks increase for individuals, assets, economies, and ecosystems, the inadequacy of infrastructure and services for those living in the areas exposed to these risks, further increases the magnitude of risks. In rural areas, such risks affect access to water resources, food security, infrastructure, and agricultural income (IPCC, 2014). Mitigation and adaptation strategies need to be developed and implemented to mitigate and manage climate change-related risks. It is required that mitigation strategies reduce greenhouse gas emissions while adaptation strategies increase the adaptive capacity of socioeconomic systems to minimize the negative impacts of climate change and create new opportunities (IPCC, 2014).

The Vulnerability Levels of Women to Climate Change

The term sustainability was first introduced in the Our Common Future Report (UN, 1987) published by the United Nations (UN) in 1987. The Millennium Development Goals (MDGs: 8 goals), announced by the UN General Assembly in September 2000 and valid until 2015, and subsequently the Sustainable Development Goals (SDGs: 17 goals) announced in 2015 and valid until 2030, primarily address environmental and social sustainability. They prioritize issues such as poverty reduction, hunger eradication, improvement of education, and immediately after, address gender equality. There are qualitative studies based on field data and observations, especially the methods derived from the general

framework presented in IPCC's AR4 and AR5 reports on how to determine the levels of women's vulnerability to climate hazards and risks. As gender equality is inherently more social and cultural than biological in nature, gender differs from birth-assigned sex. The relationships between women and men in the family, workplace, or public sphere reflect notions of appropriate abilities, characteristics, and behaviors for women and men. The gender qualities, which encompass the roles played by men and women and the expectations associated with them, vary greatly among societies and evolve over time. Gender roles, which include the responsibilities, duties, and tasks in society, cannot be equally standardized for women and men in every society. UN reports still indicate that no country has truly achieved gender equality. It is noted that the social and economic repercussions of the COVID-19 pandemic have further complicated this situation. In countries where gender inequality is noticeable, threats to the lifestyles, livelihoods, socio-economic rights, health, safety, and security of women and girls are increasing. Therefore, the empowerment of women and girls, which is considered a driving force for development in such societies, is of paramount importance (UNFPA, 2005; UN, 2023). The climate crisis, which has become a global threat because of climate change, has deepened gender inequality and led to a shortfall in global goals in this regard. The effects of climate change are not only limited to the increasing severity and frequency of extreme weather events but also vary according to regions, sectors, social, and economic groups. From this point of view, climate change affects genders differently. Therefore, the effects of climate change can contribute to the exacerbation of existing gender inequalities (UNCTAD/LDC, 2015). In many countries, women still bear a disproportionate responsibility for household services, food, fuel and water supply. 45-90% of agricultural production in the world is still carried out by women (UN Women, 2024). Therefore, when climate change affects the agricultural sector with hazards and risks such as drought, heatwaves, and extreme weather events, it is inevitable that women will be the most affected group. Women, who earn their livelihoods in sectors such as agriculture, livestock, and fisheries, which depend on the health of sustainable ecosystems, are most affected by the devastating consequences of climate change. One of the most important problems caused by climate change is the increasing migration to urban

areas due to declining employment in rural areas. Once again, women and girls are the most affected groups in these migrations. Climate change and the disasters it causes are seen as exacerbating threats to women's and children's health (Talu, 2017).

Women worldwide are more dependent on natural resources but have less access to them. In low- and lower-middle-income countries where agriculture accounts for a significant share of sectoral employment, women work more as agricultural laborers and primary providers for their families during droughts and irregular rainfall periods to generate income and resources. This often puts pressure on girls, who are generally forced to drop out of school to help manage their mothers' increasing burden. Other services especially water, food and healthcare services, which are not accessible because of climate hazards and risks, increase the vulnerability of women and girls. Moreover, the emergence of new disease types due to climate change and their exacerbation of existing ones result in worse outcomes for mothers and newborns (Tatgın, 2019; UN Women, 2022). In spite of all the negative effects of climate change, it is observed that women contribute more to adaptation and mitigation efforts and to generating nature-based and sustainable solutions (UNFCCC, 2023b). At the 27th Conference of the Parties (COP 27) held in Egypt by the UNFCCC in November 2022, there was an emphasis for the first time on empowering women and girls, increasing women's participation in decision-making mechanisms, and focusing on women and girls for effective climate planning and management, acknowledging their delicate positions and significant missions. In a review of the impacts of climate change on women living in rural areas of developing countries (Yadav & Lal, 2018), it was found that the high level of vulnerability of women to climate change is attributed to factors such as poverty, gender inequality, lack of women's property and other social rights, women's intensive dependence on agricultural production, and limited access to education and information. This level of vulnerability is further increased by women's inadequate financial resources, social marginalization, restricted mobility, and exclusion from decision-making processes in the face of disasters. In a study examining the vulnerability of

women to climate change in coastal communities in Nigeria (Akinsemolu & Olukoya, 2020), it was determined that women's vulnerability levels are influenced by factors such as economic status, education level, intangible cultural elements (patriarchal norms and traditions), political factors (power and power relations), and gender inequalities in different domains. Additionally, literature reviews indicate that women are not only passive recipients affected by climate change but also serve as active human resources capable of contributing to adaptation and mitigation efforts against the effects of climate change. Women are able to mitigate the negative effects of climate change through their contributions to the preparation and implementation of adaptation and mitigation strategies thanks to their experiences and expertise gained in various fields (FAO & UNDP, 2020; Türkeş, 2023; Yadav & Lal, 2018). In the literature, there are examples of women's organizations worldwide playing important roles in climate change adaptation, resilience-building, and mitigation efforts, despite women's positive roles as agents of change and their contributions to livelihood strategies being ignored (Dankelman, 2010). Renowned environmental activist Dr. Vandana Shiva has highlighted that women's grassroots collective initiatives create needs-based economies, emphasize collaboration, reflect diversity, and form the foundation of future economies. Moreover, emphasizing that women possess knowledge and practices that create resilient systems, she has underscored the need for women to be leaders in climate action (SEWA, 2022).

Vulnerability and Risk Methodology

In the latest three assessment reports of the IPCC (AR4, AR5, and AR6), the concept of vulnerability has been addressed and evolved differently. In the AR4 report, exposure, sensitivity, and adaptive capacity to the impacts of climate change were considered within the framework of vulnerability. However, in the AR5 report, vulnerability was defined only as one of the components that constitute risk, encompassing sensitivity and adaptive capacity. Furthermore, the concept of hazard and exposure was also included within the framework of risk concept. Therefore, the term "risk" has started to be used instead of vulnerability. IPCC's Sixth Assessment Report (AR6), which is the latest assessment report, differs from previous

reports in that it addresses the relationships and interactions between climate and ecosystems/biodiversity and human communities (Figure 1). Therefore, compared to previous reports, information produced by natural, ecological, social, and economic sciences has been more integrated into the analyses. Additionally, in the analysis of the impacts of climate change and resulting risks, the effects of global trends such as biodiversity loss resulting from non-climatic factors but affected by climate change, unsustainable consumption of natural resources, land and ecosystem degradation, rapid urbanization, demographic changes, social and economic inequalities, and pandemics are also addressed. In the mentioned report, terms such as adaptation, vulnerability, exposure, resilience, equity and justice, and transformation have been evaluated within the framework of the analysis of climate risks (IPCC, 2022).

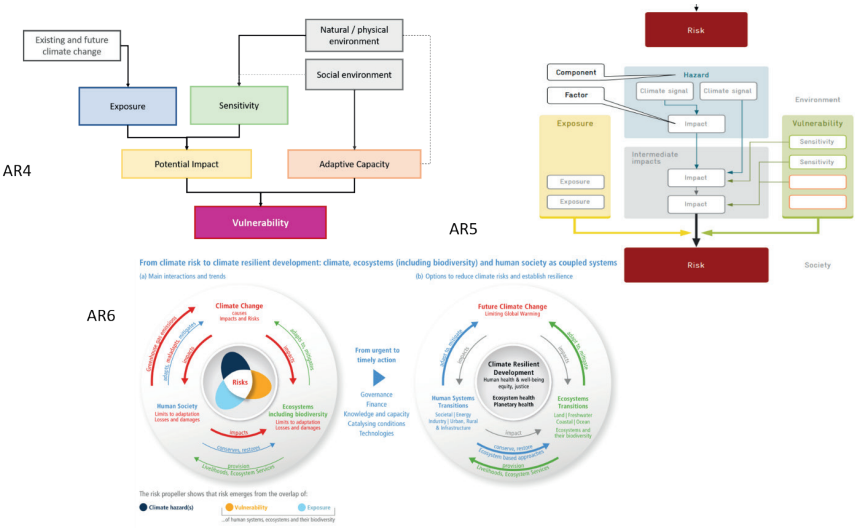

Figure 1. *Differences in vulnerability approaches for IPCC AR4, AR5 and AR6*

The hazard component refers to the potential negative effects of a natural or human-induced physical event or trend. This event or trend can result in loss of life or damage to human life, injury, or other health issues, as well as damage and loss to immovable property, infrastructure, livelihoods, service supply systems, ecosystems, and environmental resources (IPCC, 2022).

The exposure component refers to the presence of humans, their livelihoods, other species, or ecosystems in areas that could be adversely affected by climate hazards, including environmental functions, ecosystem services, natural resources, infrastructure, or economic, social, and cultural assets (IPCC, 2022).

Vulnerability refers to the level of impact on human-made and natural systems exposed to climate hazards. According to the IPCC, vulnerability encompasses various concepts and elements such as susceptibility to harm (sensitivity) and the lack of coping mechanisms and adaptive capacity, and it indicates a tendency for negative effects. Approaches to analyzing and assessing vulnerability have been addressed and developed in IPCC assessment reports. Vulnerability may vary across communities, regions, countries, and over time.

While adaptation refers to the process of adjusting to climate impacts in human-made systems to reduce existing or future damages caused by climate change and to seize emerging opportunities; 'adaptation in natural systems' refers to the process of adjusting to current climate conditions and impacts (IPCC, 2022). Enhancing the capacity for adaptation to climate change plays a key role in reducing exposure and vulnerability. Adaptation in ecological systems can occur spontaneously through ecological and evolutionary processes. In human-made systems, adaptation can be achieved through proactive actions or reactive responses, either through gradual transitions or transformative changes initiated when the impact occurs. Adaptation is generally defined as the capacity of a system to return to its original state after disturbances caused by intervention, often referred to in conjunction with the concept of resilience (IPCC, 2022).

There is no standard method for conducting climate risk and vulnerability assessments. However, various handbooks and guides have been developed. For instance, "the Vulnerability Sourcebook" (GIZ, 2017) provides a standardized approach that covers a wide range of sectors and topics (such as water, agriculture, fisheries, and different ecosystems), narrowing down the spatial (community, national, and international) and temporal (current and short to medium-term vulnerabilities) scope for

vulnerability and risk analysis. Another example is the ISO standard (ISO/DIS 14091:2021), which aims to provide a standard document applicable to any type of organization seeking to develop adaptation strategies, regardless of scale, type, or structure (ISO, 2021).

In order to create an index based on specific variables for vulnerability and risk analysis, quantitative approaches are more commonly adopted. Risk methodology commonly focuses on assessing sectoral and thematic risks by considering the current and future state of climate hazards. Disasters such as droughts, heatwaves, heavy rainfall, forest fires, and severe winds resulting from increasing temperatures and changing precipitation patterns and regimes are examined within this framework. As shown in Figure 2, risk analysis generally involves: 1) Establishing sectorial and thematic impact chains, 2) Identifying indicators (parameters) associated with factors within these chains, 3) Identifying data headings and sources for these indicators, 4) Normalizing the data for format and unit consistency, and 5) Weighing and balancing the normalized indicators with the participation of subject matter experts and stakeholders, ultimately leading to the calculation of risks (GIZ, 2017).

The terminology and conceptual foundation of the impact chain are based on the climate risk concept established in the IPCC's latest three assessment reports. A climate risk (such as damage to agricultural production due to drought) arises from the interaction between climate-related hazards (drought), those exposed (such as agricultural areas or farmers), and the vulnerability of human-made and ecological systems (the drought resistance of crops, the presence of irrigation). Adaptation capacity can reduce climate risks, vulnerability levels, exposure, and climate hazards.

Within this context, the fundamental concepts that constitute the evolving terminology of vulnerability analysis in IPCC reports, namely risk, hazard, exposure, vulnerability, and adaptive capacity (Figure 1), are defined as follows:

Risk is defined within the analytical framework as potential negative outcomes for human-made and ecological systems due to climate change (IPCC, 2014; IPCC, 2022). In the analysis of climate-related risks (climate risks), the escalating, interconnected, and often irreversible effects of

climate change on ecosystems, biodiversity, and human systems, both current and future, are addressed across regions, sectors, and societies. Climate risks arise from climate-related hazards, along with the vulnerability of humans and ecosystems to these risks. In the IPCC AR6 Report, a new concept of risk arising from new conditions resulting from human responses to climate change (such as maladaptation) has also been incorporated into risk analysis (IPCC, 2022). While there are some terminological differences in the IPCC's latest three reports, it is evident that the basic assumptions follow a similar logic. Common aspects include the general framework of risk and vulnerability analysis (impact chain) (IPCC, 2023).

Figure 2. *Steps to be Taken for Risk Analysis*

There are studies on determining the levels of vulnerability of women to climate hazards and risks, including the methods obtained from the general framework presented primarily in IPCC's AR4, AR5, and AR6 reports, as well as qualitative studies based on field data and observations. Considering impact chain analyses described in IPCC reports, there is a need for the development of a methodological framework for determining the vulnerability levels of women to climate change under specific factor groups, by transforming various characteristics into parameters, indicators, and data. Therefore, the aim of this study is to propose parameters, their data, and data sources that can be used in the impact chain analysis of women's vulnerability to climate change in Türkiye, using the methodology to analyze the vulnerability to climate change of various sectors and themes. At this point, it is important to determine indicator classes that can be used for the development of the IPCC-framed climate impact chain for women in the most comprehensive way possible. Thus, the integration of the PESTEL analysis, initially developed for external environmental analysis by private sector companies, with impact chain analysis is expected to contribute to obtaining concrete and comparable results regarding women's vulnerability to climate change.

Methodology

Climate Vulnerability Assessment and Impact Chain Analysis

Similar to other fields, vulnerability and risk analyses of women to climate change are based on information about current extreme weather events' intensity and frequency changes and future changes depending on scenarios. Furthermore, data on effective factors and trends unrelated to climate characteristics and projections should also be used in these analyses. These data groups include spatial characteristics and data classes related to the political, economic, social, technological, environmental, and legal conditions of communities on the ground, along with factors affecting ecosystems. Also, the classification of this data is crucial for identifying the impacts of climate risks. Impact chains prepared to identify climate risks for specific scopes (sectoral, spatial, thematic) are based on a cause-and-effect chain covering all main factors and processes constituting these risks. These factors and processes are considered as gradual effects under the risk components of hazard, exposure, or vulnerability in the medium term. Impact chains are generally developed through a participatory approach (GIZ, 2017). When analyzing climate risks based on the subject and scope, stakeholders and experts ensure the identification of root causes. Moreover, efforts are made to obtain information on suitable local, regional, and national indicators and data from similar groups for analysis. This data often relates to stakeholders' own institutional responsibilities (such as meteorology) or is acquired through individual work and experience (GIZ, 2017).

In this study, it is recommended to use a comprehensive and inclusive approach, such as the PESTEL analysis, in the stages of identifying factors and indicators, as well as determining data headings and sources for the impact chain and risk analysis created to assess women's vulnerability to climate change. The PESTEL analysis is defined as a framework or tool used to identify, analyze, and monitor significant macro-environmental factors that affect an organization's performance (de Bruin, 2016).

PESTEL consists of the initials of Political, Economic, Social, Technological, Environmental, and Legal factors in English. As a tool, PESTEL is generally used in conjunction with other tools such as Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis or other tools, such as the impact chain analysis addressed in this study, to provide a better understanding of a situation or relevant internal and external factors.

The Impact Chain in Analyzing Women's Climate Vulnerability Using PESTEL

Within the scope of the PESTEL analysis, political factors can include indicators related to national policies and legal regulations in areas such as education, environment, and health. Economic factors can include indicators such as economic growth rate, exchange rates, inflation rate, unemployment rate, and per capita income. Indicators related to demographic characteristics, cultural norms, traditions, and societal values, as well as data on population growth rates, age distribution, income distribution, educational status of the population, security, health, quality of life, and other social issues can be included under social factors. Parameters related to the technological and innovation development level of the organization or the target group are analyzed for technical/technological factors. This also includes data on investments and incentives for technology, innovation, and R&D, the ability to track and utilize technological developments, and technological awareness. Environmental factors can be analyzed economically and socially in this analysis. For economic sectors, issues such as raw materials, pollution, trade-offs, carbon footprint, and topics affecting main sectors like industry, agriculture, and tourism are considered, along with the growing societal sensitivity and awareness towards environmental issues. Even though legal factors sometimes intersect with political factors; specific legal regulations are considered within the analysis, such as laws against discrimination based on gender, race, and religion; trade and competitiveness laws; labor laws; consumer protection laws; intellectual property rights and patent laws; health and social security laws (Table 1).

Table 1. *The parameters and indicators under the PESTEL analysis*

P (political)	E (economic)	S (social)	T (technological)	E (environmental)	L (legal)
National policies, Political trust, Institutionalization, Foreign trade policy, Tax policy, Labor law	Economic development, Exchange rates, Interest rates, Income per capita, Unemployment rate	Population growth rate, Age distribution, Career tendencies, Security, Health, Social security, Life quality, Cultural barriers	Technology, innovation and R&D investment, Openness to technological innovations	Weather events and climate, Environment policies, Climate change, Consciousness and awareness	Laws against discrimination, Trade and competitiveness laws, Intellectual property rights and patent laws, Labor and social security laws, Consumer protection laws

Developing an approach that combines the PESTEL method with risk/impact chain analysis to analyze women's vulnerability to climate change will contribute to a comprehensive analysis, ensuring that all relevant parameters and data are considered. Thus, the PESTEL analysis combined with the impact chain analysis is considered as an effective method for determining which factors to consider when analyzing women's vulnerability to climate change.

The PESTEL analysis can be adapted to gender-specific conditions for analyzing climate risks for women. Even though this analysis is traditionally used to understand external macro-environmental factors affecting an organization, it can also be adapted to identify climate risks affecting specific groups such as women. In this sense, political factors might include the presence and scope of national policies on climate change and gender, specific initiatives indicating women's vulnerability to climate change, and the willingness to implement gender-sensitive climate policies. The impact of climate change on women's livelihoods or income sources can be analyzed for economic factors. This also includes the effects of extreme weather events on women employed in climate-

sensitive sectors such as agriculture and the assessment of economic opportunities in climate-resilient sectors for women. Social factors might include social norms, cultural practices, gender role distribution, and access to resources, which either increase or decrease women's vulnerability to climate change. Technological factors might include contributions to increasing women's resilience to climate change. Smart agriculture applications, early warning systems, and the rate at which women adopt innovations such as internet access and online shopping, helping them adapt to the evolving world and societal order might also be involved in this. Legal factors might include the presence of a legal framework related to gender and climate change, laws/regulations protecting women's rights in cases of loss and damage due to extreme weather events, and legal mechanisms ensuring women's participation in decision-making processes. Environmental factors might involve direct and indirect environmental impacts of climate change on women, such as access to water, loss of biodiversity, and the spread of diseases, including specific indicators related to these issues.

Moreover, it is believed that using the PESTEL analysis in stages 2 and 3, as shown in Figure 3, will contribute to a more comprehensive and thorough identification of indicators and a consistent and accurate description of data sources when analyzing the vulnerability of women to climate change specifically in Türkiye within the framework of vulnerability and risk analysis.

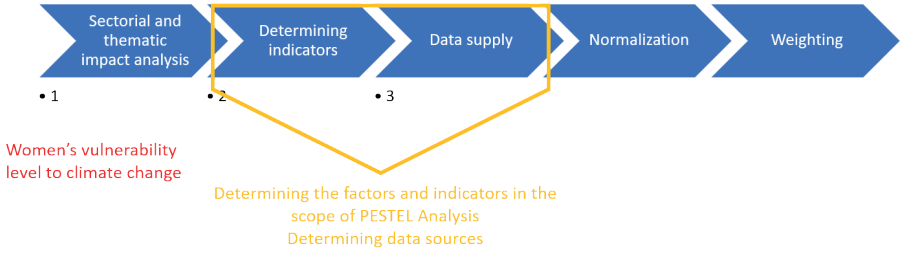

Figure 3. *Stages from the PESTEL analysis in vulnerability analysis*

Results

Türkiye is considered among the regions expected to be most affected by climate change-related hazards and risks. It is noted that the frequency and severity of extreme weather events have been on an upward trend, especially in the last twenty years (MGM, 2022). In 2021, 1024 extreme meteorological events were recorded, while this number increased to 1030 in 2022. The recorded extreme meteorological events included storms/tornadoes, heavy rain/floods, landslides, hail, severe snow, lightning strikes, frost, avalanches, forest fires triggered by extremely high temperatures, fog, and dust storms. Figure 4 shows the long-term annual number and distribution of extreme meteorological events in our country (MGM, 2023).

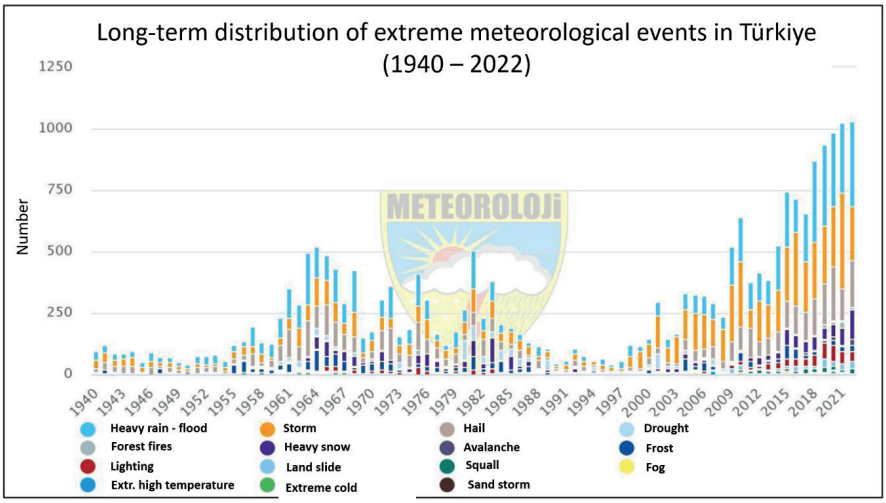

Figure 4. *The distribution of numbers and weather conditions*

The population segments exposed to, sensitive to, and affected by the hazards and risks caused by the increasing frequency and severity of meteorological events in Türkiye, are also increasing and the groups primarily affected by it are women and disadvantaged groups.

It is stated that human groups already highly vulnerable to other risks (due to inequalities such as income, gender, ethnicity, etc.) will be more significantly affected by climate change-induced hazards and risks (IPCC, 2023). From the perspective of women, the trends or relative status of indicators obtained within the framework of the PESTEL analysis over the years are crucial for providing insights into the magnitude of the risks. In this context, Table 2 shows the parameters that can be used to assess women's vulnerability to climate change and the data headings available in Türkiye. In Table 2, the indicators and data sources that can be used in the vulnerability and risk analyses of women to climate change in our country are primarily derived from the Turkish Statistical Institute (TÜİK) Gender Statistics and Statistics on Women reports and are based on risk components (TÜİK, 2023a; TÜİK, 2023b).

In Türkiye, particularly women and disadvantaged groups, exposed to the dangers and risks caused by meteorological events, which increase in frequency and severity every year, are also increasing. It is stated that human groups, which are already highly vulnerable to other risks (due to inequalities experienced based on income, gender, ethnicity, etc.), will be more significantly affected by climate change-related dangers and risks (IPCC, 2023). From the perspective of women, the trend or relative status of indicators obtained within the scope of the PESTEL analysis over the years is crucial in terms of providing insight into the magnitude of risks. In this context, Table 2 shows what parameters can be used in evaluating the vulnerability of women to climate change and which data headings can be obtained in Türkiye. In Table 2, indicators and data sources that can be used in the vulnerability and risk analyses of women specific to Türkiye are mostly derived from the Turkish Statistical Institute (TÜİK) Gender Statistics and Statistics on Women reports and are based on risk components (TÜİK, 2023a; TÜİK, 2023b).

Table 2. Transforming the factors for the analysis of women's vulnerability to climate change into parameters and indicators, and data sources

Impact Chain Components			
Hazard: Heatwave, Drought	**Exposure**	**Vulnerability Sensitivity / Adaptive capacity**	**Risk**
Factors	**Sample Indicators**	**Sample Indicators**	**Data source**
Political	Population by gender and age Women population in rural and urban and by age group	Participation in decision-making processes and administration (the rates of women governors, district governors, mayors, members of parliament, ministers, ambassadors), The proportion of women in higher education jobs as instructors/professors The proportion of women in upper and mid-level management positions, The number of top policy documents on gender equality. International agreements supporting women's rights and gender equality.	TÜİK (Turkish Statistical Institute), YÖK (The Council of Higher Education, Information System of Regulations
Economical	Women's employment in agricultural / non-agricultural sectors	Labour force by gender and education level Employment rate by gender and living places The proportion of part-time employees in employment by gender Individuals responsible for housework by gender Annual average incomes of family members out of their main jobs The Proportion of employment in agricultural/non-agricultural sectors Income satisfaction The proportion of women below the poverty line	TÜİK (Turkish Statistical Institute),

Based on the sample indicators in Table 2, the annual changes in indicators that could fall under economic, social, and technical factors, such as the rate of internet usage by gender (1; male and female-%), the proportion of individuals in upper and mid-level management positions by gender (2; male and female-%), and the annual average primary job income of household members by their primary job status (3; female/male-%), are shown in Figure 5.

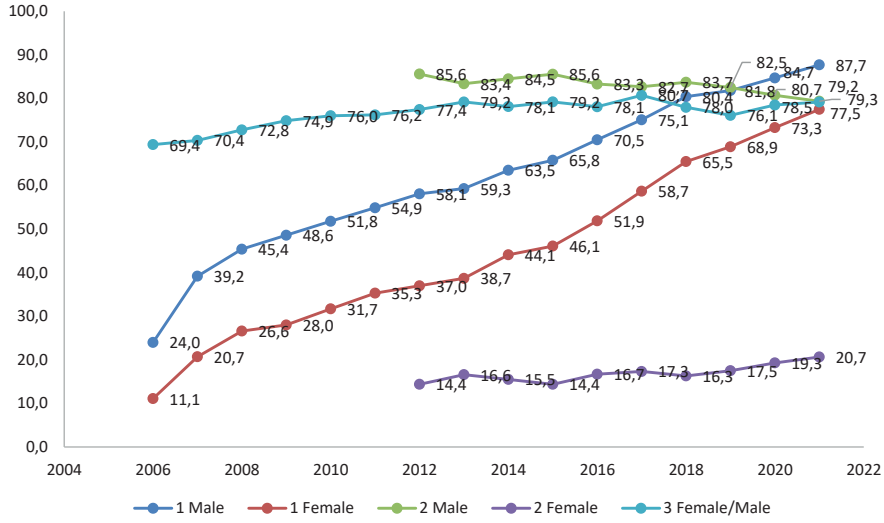

Figure 5. *Comparison of men and women in Türkiye in some economic, social and technical indicators*

According to Figure 5, although there has been an increase in internet usage over the years, the rate of internet usage among women is still lower when compared to men. Regarding the proportion of upper and mid-level management positions, even in the best scenario, women are significantly behind men (20.7% compared to 80.7%). In terms of job income, women also show a declining trend compared to men. According to the Turkish Statistical Institute (TÜİK) reports on Gender Statistics and Women in Statistics (TÜİK, 2023a; TÜİK, 2023b), the employment rate of women is less than half that of men, the labor force participation rate of women with higher education is higher than other education levels (65.6%), the part-time employment rate, and the rates of women ambassadors, parliament

members, professors, and managers are much lower than those of men. Additionally, only 15.4% of women have higher education levels than their spouses, and 40.3% of women order or purchase products online. Even when evaluating a very small number of indicators based on data, it is evident that the vulnerability levels of women to climate change in Türkiye are increasing due to various negative factors. In fact, efforts to improve such indicators that can enhance women's adaptation and resilience to climate change should be supported. Moreover, the participation of women as decision-makers and participants in decision-making processes will enhance the appropriateness and implementation of legal regulations and strategies related to climate change.

Results and Conclusion

Women become more sensitive to climate change-related hazards and risks due to various social, economic, and cultural reasons, and they have higher levels of vulnerability especially in developing countries.

Two primary issues for women to have higher vulnerability levels are that women are at lower socioeconomic status and they have limited access to opportunities that could increase their adaptive capacity (Nellemann et al., 2011). The IPCC reports on the climate impacts, adaptation, and vulnerability (IPCC, 2007) emphasized gender inequality, and this brought attention to the need for identifying vulnerability factors related to women. Studies have shown that women's employment in economic sectors being highly dependent on natural resources increases their vulnerability to climate change (GIZ, 2017). Extreme weather events restrict women's access to food, water, and energy, and they do not have as much access to alternative income opportunities as men, which exposes them to a higher risk of poverty (UNFPA, 2005). Furthermore, it is indicated that women's access to information about disaster risks is limited, making them less able to benefit from early warning systems compared to men (71% versus 51%; Brown et al., 2019). Women's greater vulnerability to climate hazards is also due to their limited participation in the control and decision-making processes regarding the use of resources and the distribution of benefits and income. In addition,

their limited time for formal education, job training, skill development, and income generation, as well as restricted mobility, further contribute to their increased vulnerability to climate hazards.

However, it is also crucial to understand the vital role women play in adaptation and mitigation efforts related to climate change (UNFCCC, 2023a). Considering that women make up half of the world's population, their participation at all levels, from all regions and sectors, should be expected in the implementation of actions aimed at adapting to and mitigating the effects of climate change. Women are noted for increasing productivity in the economic sectors they are involved in, especially agriculture. It is foreseen that women will contribute more significantly to sustainable production activities and the conservation of natural resources when they are provided with appropriate technology and financial resources (UNFCCC, 2023a). Thus, investments in the personal and professional development of women are expected to yield high long-term benefits. Research shows that countries with higher representation of women in parliament have a higher rate of implementation of international environmental agreements (Women Deliver, 2019). Women's participation in planning processes is crucial for building climate-resilient societies, taking timely action against natural disasters, reducing pre-disaster risks, and helping families recover post-disaster (UNDRR, 2023a). It is noted that supporting activities aimed at increasing gender equality and the effectiveness and power of women in society will provide social benefits such as environmental protection, poverty reduction, and the achievement of Sustainable Development Goals (SDGs) (UNFCCC, 2023a; Women Deliver, 2019; Yadav & Lal, 2018). Therefore, action plans at every scale for adaptation and mitigation of climate change should ensure the strengthened participation of women as beneficiaries and implementers of the proposed actions. Many countries, including Türkiye, describe how they prioritize gender equality and women in the implementation of their National Adaptation Plans (NAPs)

and Nationally Determined Contributions (NDCs) (UNFCCC LDCEG, 2015; UNFCCC, 2023b; UNFCCC, 2023c). Furthermore, the Gender Action Plan adopted by governments under the UNFCCC calls for the full, equal, and meaningful participation and contribution of women in decision-making and implementation of actions related to climate change (UNFCCC, 2023d). Addressing climate change adaptation actions with a gender-sensitive approach will strengthen societal resilience.

There is a need for an objective and data-driven methodology to determine the vulnerability levels of women to climate change. In this study, using Türkiye as an example, it is suggested that such a methodology can be developed by combining two methodological approaches. The impact chain used for this approach helps assess the level of women's exposure to climate risks, while the PESTEL analysis is used to comprehensively address the characteristics of women that need to be evaluated in terms of climate hazards and risks. Accordingly, it is observed that some of the parameters and data required for assessing the vulnerability of women to climate hazards and risks in Türkiye are included in official statistics, can be tracked annually, or are determined through periodic special reports. It is also noted that, besides the published official statistics, some parameters are monitored by institutions but not published as statistics. In addition, some parameters necessary for the analyses, for which data are not available, can be represented using different data. Based on the data and trends of all these parameters, it appears that the most prominent reason for the higher vulnerability levels of women compared to men in Türkiye to climate change is the difference in income levels and the widening of this gap. Besides economic indicators, it is believed that all indicators related to women's contributions and participation in life in a social sense could also impact the level of vulnerability to climate change in Türkiye. However, even though women lag behind men, their use of technological products, especially the Internet, is increasing. This contributes positively to women's knowledge and awareness of issues with environmental and

social impacts, such as climate change. In the context of Türkiye, there is a need for data that can be used in vulnerability analyses, including women's vulnerability, to be prepared for specific sectors and themes or to facilitate access to this data.

In conclusion, sustainable development, one of the most important issues, cannot be achieved without the participation and contribution of women. While women are seen as vulnerable to climate hazards, they also constitute the local and national human resource capacity and driving force that can actively work on adaptation and mitigation. Women's solidarity, ability to act collectively, organization, collaboration skills, and determination to contribute to society also enhance their adaptative capacity to climate change. In developing countries, including Türkiye, women will gain the skills and capabilities to contribute to both mitigation and adaptation through education, awareness-raising, R&D, and innovation activities as qualified human resources. Efforts and investments to ensure that women have equal pay and income opportunities, access to financial resources, education and extension services, and access to information and technology with men will have a higher multiplier effect in the long term. It is particularly necessary to develop strategies that address the needs and priorities of women and direct funding in local, regional, national, and sectoral development plans. Special headings for women and greater support for female entrepreneurship should be included in funding and investment programs for adaptation and mitigation.

Acknowledgement: N/A.

Conflict of Interest: Authors have no conflict of interests.

Peer Review: Double blinded peer review.

Financial Support: This study has been supported by no institutions.

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