

CATS Centre for Applied
Turkey Studies
NETWORK

**OVERCOMING GLOBAL PROBLEMS
THROUGH LOCAL COOPERATION:
THE CASE OF THE ISTANBUL
METROPOLITAN MUNICIPALITY**

CLIMATE CHANGE ADAPTATION AND
ITS IMPACT ON VULNERABLE GROUPS:
BERLIN MUNICIPALITY CASE STUDY



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SABANCI ÜNİVERSİTESİ
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I. INTRODUCTION¹

“Climate Change Adaptation and Its Impact on Vulnerable Groups: Berlin Municipality Case Study” is the second report to emerge from the three-stage joint project “Overcoming Global Problems through Local Cooperation: The Case of the Istanbul Metropolitan Municipality,” conducted by the Economic Development Foundation (IKV), Istanbul Policy Center (IPC), and the Economic Policy Research Foundation of Turkey (TEPAV). The report includes an in-depth inventory of the Berlin Municipality’s current policies to adapt to climate change, the best practices carried out by the municipality in this context, and the measures to be taken. It addresses governance challenges in implementing climate change policies and the protection of vulnerable groups in the city (refugees, women, children, and those living below the poverty line). In this framework, the research team focused on Berlin’s local climate action plans and the effects of climate change on vulnerable groups (especially women and refugees) living in Berlin. The research team employed qualitative research methods, conducting an extensive literature review of international, national, and local research and news articles on climate change and vulnerability.

The effects of climate change are already being seen in many regions of the globe. The global mean temperature (GMT) has been steadily increasing since the start of industrialization. The increasing concentration of greenhouse gases in the atmosphere is one of the primary causes of global warming. Methane (CH₄) and carbon dioxide (CO₂) are two of the most well-known greenhouse gases. Increasing levels of these gases worsen the greenhouse effect, which results in a considerable amount of solar radiation being absorbed by the atmosphere rather than being reflected into space from Earth’s surface.

Humans are primarily responsible for the release of greenhouse gases through the burning of fossil fuels like coal, oil, and natural gas, extensive livestock farming, agriculture, and deforestation. Polar ice caps and glaciers are melting as a result of increasing temperatures, and irrigation patterns are also changing. As a result, there are more extreme weather occurrences,

rising sea levels, and excessive rainfalls. The first ten years of the 21st century have been among the hottest on record since systematic meteorological records have been kept. Significant cuts in greenhouse gas emissions are required to combat anthropogenic climate change.

Cities are crucial to this as they hold more than 50% of the world’s population, and this number is rising. Though cities only cover 3% of the world’s surface, around 70% of greenhouse gas emissions worldwide are produced by cities. Giving cities a unified voice when it comes to climate protection is one of the goals of worldwide and European city networks like C40 Cities, the EU Covenant of Mayors, and the Climate Alliance. Major cities, like Berlin, have relatively more responsibility than small cities when it comes to climate protection. Additionally, they are particularly impacted by climate change due to local warming that is significantly higher than in the nearby countryside, which is exacerbated by elements like building structure density, decreased condensation, and numerous air exchange barriers. The urban heat island effect is another name for this phenomenon. Furthermore, severe rainfalls represent a bigger threat to cities, since the amount of water that the wastewater system can absorb is smaller, and large amounts of water cannot easily drain out of an enclosed space.

The United Nations (UN) has held the annual Framework Conventions on Climate Change since the mid-1990s. The parties to these conventions agreed to legally binding CO₂ emission limits for the first time in 1997 at their conference in Kyoto. In 2015, a follow-up pact was negotiated in Paris, which came to be known as the Paris Agreement. The parties’ shared goal, as outlined in the agreement, is to keep the rise in the average world temperature below 2 degrees Celsius (°C), ideally below 1.5°C, compared to pre-industrial levels.

Over the past century, the average world temperature has increased by roughly 0.8°C. Over the same period, Europe has warmed by about 1.3°C. The hottest years on record have been 2014 and 2015. By 2100, if this trend continues the global mean temperature might rise by 2–6°C. The years 2015 and 2018 have been the hottest years on record in Germany since the introduction of instrumental measurements in 1881, while the hottest days on record were recorded in 2003 and 2015. Over the past years, Berlin has also experienced more

¹ The Centre for Applied Turkey Studies (CATS) at Stiftung Wissenschaft und Politik (SWP) in Berlin is funded by Stiftung Mercator and the Federal Foreign Office. CATS is the curator of CATS Network, an international network of think tanks and research institutions working on Turkey. “Overcoming Global Problems through Local Cooperation: The Case of the Istanbul Metropolitan Municipality” is a project of CATS Network.

heat waves and extreme weather events, which can be expected to intensify in the future.

There are significant variances in precipitation fluctuations in Germany, particularly by season but also by location. Over the years, summer rainfall averages have stayed roughly similar; however, winter conditions have become more humid. The annual mean precipitation has increased by 8.7% overall in Germany compared to the surface area mean between 1881 and 2018. The winter season has so far been associated with the most obvious changes. According to 2019 Monitoring Report, since the winter of 1881, the average precipitation surface area has increased by 25%.

Germany's largest and capital city, Berlin, has played an important role in the country's efforts to combat climate change. The local government welcomed the idea of becoming a leader in the modern industrial field as an opportunity to secure competitive, well-paying jobs after a protracted period of economic stagnation following the city's reunification. With the help of the European Regional Development Fund (ERDF), Berlin has been financing some initiatives for the protection of the environment and the climate for more than 20 years. The government adopted a smart city strategy in 2015 that outlines how it intends to assist the digitization of many aspects of urban life in the coming years. Since then, a less structured digital agenda that describes the city's approach to addressing the so-called digitization challenge has been added to this strategy. The municipal administration also ordered two studies to be carried out in 2014 and 2015, Climate-Neutral Berlin 2050 and New Energy for Berlin.

The first part of this report examines the Berlin Energy and Climate Protection Programme (BEK) 2030, which was adopted in 2018 with a strong emphasis on Berlin's unique potential and requirements. The program is another step toward accomplishing the city's 2050 climate-neutral goals. The 2015 final report *Draft for a Berlin Energy and Climate Protection Programme* (BEK) and the report *Adapting to the Impacts of Climate Change in Berlin* (AFOK) both contain scientific background research and outline the city's integrated strategy to address both climate change reduction and protection. This section will outline Berlin's climate action plans related to energy, recycling, health human and civil protection, urban development, and water resource management.

The second part of this report explains Berlin's vulnerability in the context of climate change and examines findings on how vulnerable groups living in Berlin are

affected by climate change. Considering these findings, it is seen that Germany, and therefore Berlin, lags behind other EU member states in terms of protection for vulnerable groups. The report identifies refugees, women, and children as the most important vulnerable groups living in Berlin. Especially after the COVID-19 pandemic as the child poverty has increased, child refugees was the most affected by the issue.

Due to changing climate conditions, many people are migrating to Berlin, which is seen as an economically prosperous city. These people, defined as climate refugees, are included among the vulnerable groups in Berlin. Therefore, the increase in the problems of vulnerable groups is directly related to climate change. People experience disruptions in their work due to changing, unfavorable climatic conditions and disasters. These individuals, whose working conditions are adversely affected, become impoverished over time, and as a result, significant vulnerabilities emerge in many cities, such as Berlin.

There are certain deficiencies despite the fact that local governments and civil society in Berlin carry out or participate in numerous projects on the issue of climate change and vulnerable groups. While climate change, difficulties in participation in the economy and the low female representation in politics all over the world in the pre-pandemic period affected advances in gender equality, the COVID-19 pandemic, which created a global shock, underlined the dependence of society on women in the fight against the virus. The curfews imposed with the addition of the COVID-19 pandemic to the climate crisis we are in, restrictions applied in many areas, quarantines, social distance rules, changing working styles and hours have caused significant changes especially in the life and health of women. The barriers to women's participation in the economy and their inclusion in decision-making mechanisms in local or international organizations have not been completely overcome. To address the issues faced by vulnerable groups as a result of climate change, various communities must participate in decision-making processes within NGOs and local governments. Although the efforts of Berlin's civil society are growing day by day, women are notably missing from these decision-making processes.

2. BERLIN'S CLIMATE CHANGE ACTION PLAN

2.1. ENERGY

Germany's federal government began laying the groundwork for the transition to sustainable energy sources before the Paris Agreement was signed. The goals set forth in Paris are explicitly mentioned in the Climate Action Plan 2050, which also outlines implementation plans and imposes obligations on the state of Berlin. Federal states, cities, and municipalities within Germany are all expected to provide their own implementation plans. This objective has been established as legislation for the aforementioned purposes: According to the Berlin Energy Turnaround Act,² automotive emissions must be reduced by 40% by 2020 compared to the base year of 1990. By 2030, this percentage rises to 60%, and by 2050, it must reach a minimum of 85%.

With a budget of over EUR 274 million, the Berlin Program for Sustainable Development (BENE)³ implements climate and environmental protection projects in Berlin. Cofinanced with funds from the ERDF, this project promotes energy efficiency, the use of renewable energies, sustainable mobility, and environmental and the nature conservation in Berlin. BENE is thus the most important and financially strongest program in Berlin to support sustainable climate and environmentally friendly urban development. More than 165 projects are running and should be completed by the end of 2023.

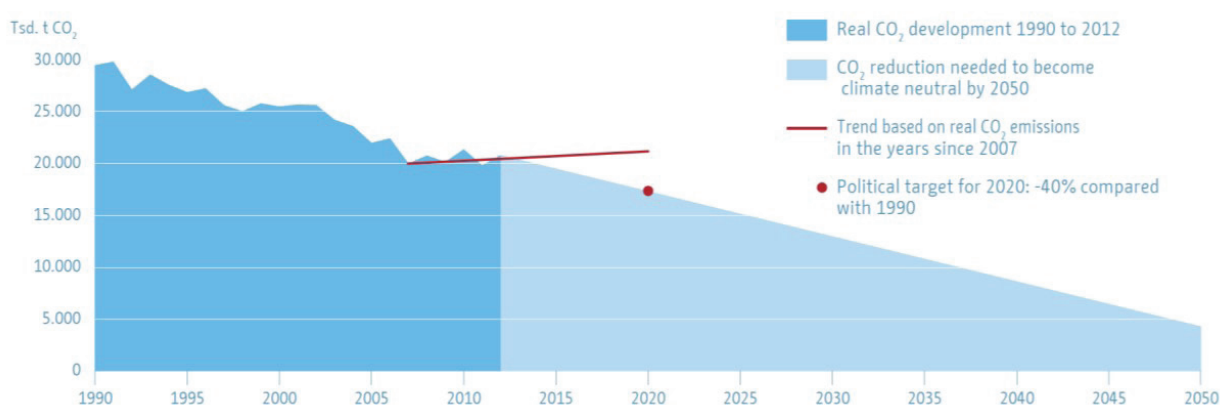
Since 2015, BENE has supported investments and initiatives to reduce greenhouse gas emissions in the private and public sectors. The major areas of concentration are the development of sustainable mobility, the improvement of energy efficiency, and the addition of new green spaces. Through BENE-funded initiatives, almost 38,000 tons of CO₂ emissions have already been reduced annually.

For lowering CO₂ emissions and preparing the city for the effects of climate change, the Federal State of Berlin has set particular targets in the BEK 2030.⁴ The greatest potential for reducing CO₂ has been identified in the "Energy Supply" and "Buildings and Urban Development" areas of action, as well as the transportation sector.

Calculations show that the "Buildings and Urban Development" area of the BEK 2030 offers great potential for energy savings. In 2012, this industry sector accounted for about 59% of all energy use.

The energy requirements of buildings can be decreased through efficient heating, ventilation, and cooling systems. Other areas of activity are also significantly impacted by the adoption of more efficient technologies. Household appliances, efficiency in energy generation, and automobile energy efficiency are just a few examples.

Figure 1: Berlin's CO₂ emissions since 1990, trend and action required by 2050



Source: Climate-Neutral Berlin 2050 Recommendations for a Berlin Energy and Climate Protection

2 Climate-Neutral Berlin 2050 Recommendations for a Berlin Energy and Climate Protection Programme (BEK) https://www.berlin.de/sen/uvk/_assets/klimaschutz/publikationen/broschuere_bek_en.pdf

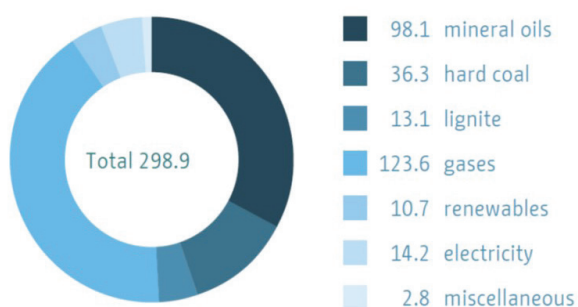
3 BENE- Berlin Program for Sustainable Development <https://www.berlin.de/sen/uvk/umwelt/foerderprogramme/berliner-programm-fuer-nachhaltige-entwicklung/>

4 Berlin Energy and Climate Protection Programme 2030 <https://www.berlin.de/sen/uvk/en/climate-action/berlin-energy-and-climate-protection-programme-2030-bek-2030/>

Berlin's renewable energy requirements are expected to be met in large part by solar power and photovoltaic installations. To this end, Berlin must develop its own renewable energy sources as well as discover ways to store the extra electricity produced by wind and solar systems. When the supply of power from solar systems exceeds demand on days with high solar radiation, excess electricity is generated. Intelligent power and heat storage devices must be connected to this weather-dependent electrical supply. This is significant since it will enable future flexible power utilization. The shift of Berlin's centralized energy supply system to environmentally friendly sources will be accompanied by an increase in decentralized energy generation. The distance to the consumer will be reduced as a result. The buildings in which the energy is consumed can be directly connected to solar power systems and other renewable energy sources.

Solar energy, being a particularly clean form of energy, plays a key role in the city's energy turnaround. The Federal State of Berlin is creating a "Masterplan Solarcity"⁵ in response to this. In the long term, solar energy is expected to fulfill 25% of Berlin's electricity needs. The Federal State of Berlin will become a model city as a result of this. One of the goals of the BEK 2030 is to have solar panels installed on every appropriate roof surface of state-owned buildings by the year 2030. An essential collaborator in the execution of this initiative is the public utility business Berliner Stadtwerke (BSW), which provides Berlin's households with locally produced green power.

Figure 2: Primary Energy Consumption in Berlin in 2012 in Petajoules (1 quadrillion Joules)



Source: Climate-Neutral Berlin 2050 Recommendations for a Berlin Energy and Climate Protection, brochure

Figure 2 shows that over 90% of Berlin's energy is sourced from fossil fuels. To reach its climate goals, Berlin must first phase out fossil fuels, especially coal and oil, then boost renewable energy sources and combined heat and power (CHP), and finally, dramatically cut overall energy usage by launching an offensive on savings and efficiency.

Berlin's Energy Agenda to Combat Climate Change contains the following plans:

- the phase-out of coal and significantly reducing oil consumption
- expanding gas-based flexible CHP
- intensifying and converting district heating network, heat storage facilities
- massively expanding solar power
- expanding heat pumps and geothermal energy
- using excess energy from renewables (P2X), virtual power stations, flexibility
- promoting urban energy transition innovations and business models

The BEK's recommendations call for a total of 30 actions that, if taken, would cut primary energy use and CO₂ emissions in half by 2050 compared to 2012 levels. By 2020 and 2030, respectively, lignite and hard coal must be phased out to accomplish this. Gas-based CHP⁶ plants that produce both electricity and local or district heating will be developed to replace coal-fired power plants when they are decommissioned.

Further measures will ensure that infrastructure is updated in a forward-thinking manner, for example, by decreasing heating network temperature levels and progressively incorporating thermal energy storage. Although the gas network will continue to be crucial, district heating is also a crucial component. The development of district heating and the decentralized energy supply of buildings, as well as the replacement of fossil natural gas with renewable gases, will all have a significant impact on the long-term viability of the gas network. Therefore, it is advised that the thermal infrastructure sector engage in a different approach and conduct more research.

⁵ Masterplan Solarcity- <https://www.berlin.de/sen/energie/erneuerbare-energien/masterplan-solarcity/>

⁶ Berlin's new combined heat and power plant <https://www.siemens-energy.com/global/en/news/magazine/2021/urban-decarbonization-berlins-new-chp-plant.html>

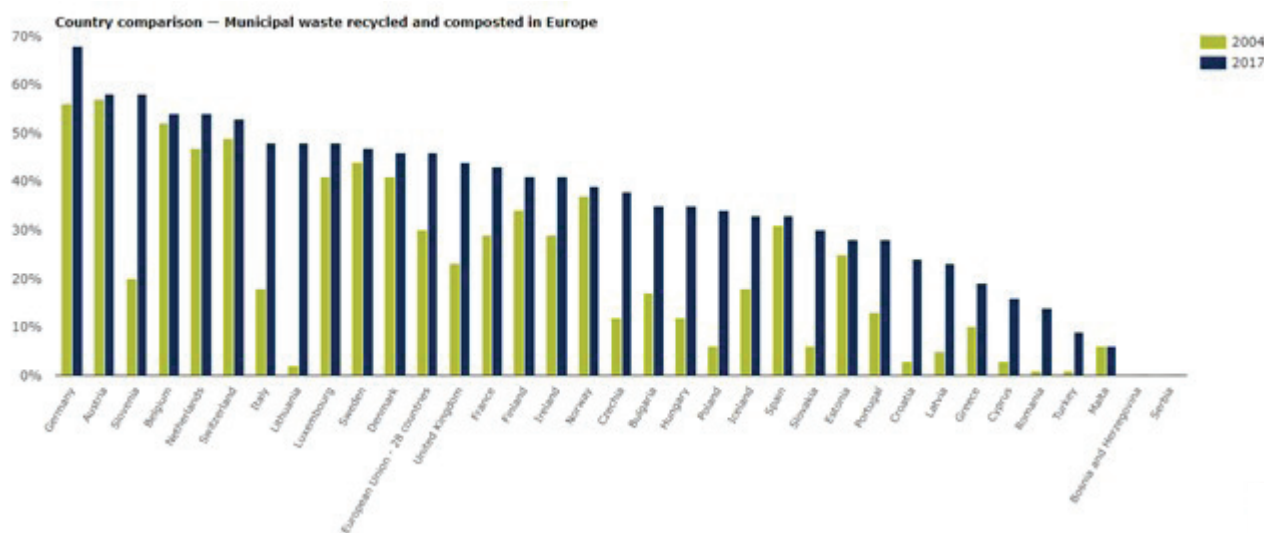
2.2. RECYCLING AND WASTE MANAGEMENT

Recycling is a core part of implementing a circular economy. Recycling is under the waste management section of the latest report on Berlin's adaptation to climate change, *Anpassung an die Folgen des Klimawandels in Berlin* (AFOK), along with waste management, street cleaning, and winter services.^{7,8} Berlin Waste Management (*Abfallwirtschaftskonzept*) 2010–2020,⁹ the waste management concept for the state of Berlin for the planning period between 2010 and 2020 that was approved on May 12, 2011, has been the backbone of these previous strategies and action plans regarding combating climate change. Berliner Stadtreinigungsbetriebe (BSR),¹⁰ a statutory body owned 100% by Land Berlin, is the unit responsible for the city of Berlin's waste management. The city of Berlin generated around 1,350,457 tons of solid waste in 2016.¹¹ BSR collects

59% of paper and packaging waste with an estimated recycling rate of 54%. In 2017, BSR recycled 76,000 tons of organic waste, of which 69,000 tons were converted to biogas in a fermentation facility to be utilized as fuel in the BSR's fleet of vehicles.¹² Overall, Berlin Waste Management reduced CO₂ by 1.2 million Mg/a through retiring landfills used to dispose of municipal waste, launching an ecological procurement system at Berlin's municipal institutions, fostering sustainable usage of the recovery potential of waste, and creating a waste prevention program.¹³

While transitioning from a linear economy to a circular economy, the Berlin Municipality has been updating its recycling and waste management strategies. Berlin's waste management strategy is one important reason for the country's success in this field.

Figure 3: Municipal waste recycled and composted in Europe¹⁴



Source: European Environment Agency, 2017¹⁵

7 Berliner Energie- und Klimaschutzprogramm 2030 (BEK 2030) Umsetzungszeitraum 2017 bis 2021, Konsolidierte Fassung; Änderungen gem. AH Drucksache 18/0423 und AH Drucksache 18/0780, https://www.berlin.de/sen/uvk/_assets/klimaschutz/klimaschutz-in-der-umsetzung/das-berliner-energie-und-klimaschutzprogramm-bek/bek-2030-beschlussfassung.pdf

8 Reusswig, F.; Becker, C.; Lass, W.; Haag, L.; Hirschfeld, J.; Knorr, A.; Lüdeke, M. K.B.; Neuhaus, A.; Pankoke, C.; Rupp, J.; Walther, C.; Walz, S.; Weyer, G.; Wiesemann, E. (2016): *Anpassung an die Folgen des Klimawandels in Berlin* (AFOK). Klimaschutz Teilkonzept. Hauptbericht. Gutachten im Auftrag der Senatsverwaltung für Stadtentwicklung und Umwelt, Sonderreferat Klimaschutz und Energie (SRKE). Potsdam, Berlin. https://www.berlin.de/sen/uvk/_assets/klimaschutz/anpassung-an-den-klimawandel/programm-zur-anpassung-an-die-folgen-des-klimawandels/afok_zusammenfassung.pdf

9 *Abfallwirtschaftskonzept für das Land Berlin – Planungszeitraum 2010 bis 2020*. (2011). https://www.berlin.de/sen/uvk/_assets/umwelt/kreislaufwirtschaft/strategien/abfallwirtschaftskonzepte/awkberlin2010-2020.pdf

10 Berliner Stadtreinigungsbetriebe (BSR), <https://www.bsr.de/>

11 Case Study-Berlin, 2020 Collectors Project, https://www.collectors2020.eu/wp-content/uploads/2020/08/Case_Integration_Summary_Berlin.pdf

12 Berlin Energy and Climate Protection Programme 2030. (2017), https://www.berlin.de/sen/uvk/_assets/klimaschutz/publikationen/bek2030_broschuere_en.pdf

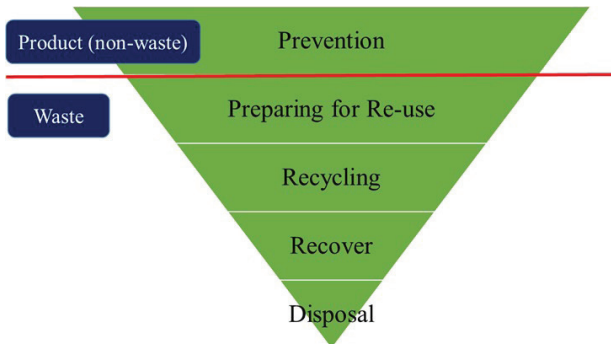
13 Padalkina, D. (2020). Project “Circular Berlin”. https://circulareconomy.europa.eu/platform/sites/default/files/circular_berlin_project_-_report_copy.pdf

14 Recycling rates indicate the percentage of municipal waste generated that is recycled, composted, and anaerobically digested, and might also include that prepared for reuse. Changes in reporting methodology mean that 2017 data are not fully comparable with 2004 data for Austria, Belgium, Croatia, Cyprus, Estonia, Lithuania, Italy, Norway, Malta, Poland, Romania, Slovakia, Slovenia and Spain; 2005 data were used instead of 2004 data for Poland because of changes in methodology. On account of limited data availability, instead of 2004 data, 2003 data were used for Iceland, 2007 data for Croatia, 2006 data for Serbia and 2008 data for Bosnia and Herzegovina. For the EU-28, 2004 data were based on 2007 data for Croatia, and 2016 data were used for Iceland and Ireland instead of 2017 data. The 2017 data for Cyprus, Germany, France, Luxembourg, Poland, Slovenia, Spain, Switzerland, Turkey and the EU-28 include estimates.

15 European Environment Agency, 2017 <https://www.eea.europa.eu/data-and-maps/indicators/waste-recycling-l/assessment-1>

According to Figure 3, municipal waste recycling rates differ widely between European countries, ranging from 68% in Germany to 0.3% in Serbia in 2017. In 2017, three countries recycled 55% or more of their municipal waste. In 2017, 28 countries recycled 55% or more of their packaging waste, and 15 countries recycled 65% or more of their packaging waste. These improvements have been partly driven by EU targets introduced in 1994 and 2008 and later by circular economy packages. The Berlin waste management strategy demonstrates the success of Germany in this field. As the state of Berlin enforced the legal framework for a circular economy and bioeconomy, the waste management concept for municipalities was also revised in 2021 by including a zero-waste strategy for Berlin,¹⁶ emphasizing waste avoidance, reuse, and recycling. The new waste framework was developed according to the Waste Directive of the EU¹⁷ with the intention to conserve resources and avoid emissions. This framework follows the EU's waste hierarchy from the avoidance of waste, preparation for reuse of waste, recycling of waste, recovering waste, and the disposal of waste.¹⁸ The waste hierarchy can be seen in Figure 3 below. The figure helps to display Berlin's adoption of an integrative framework for waste management concerning the circular economy.

Figure 4: The Waste Hierarchy



Source: European Commission¹⁹

16 Abfallwirtschaftskonzept Für Siedlungs- und Bauabfälle Sowie Klärschlämme Planungszeitraum 2020 Bis 2030 - Zero Waste Strategie Des Landes Berlin- (2021). https://smart-city-berlin.de/fileadmin/user_upload/PDFs/awkberlin2020-2030.pdf

17 The European Parliament and the Council of the European Union, (2008), DIRECTIVE 2008/98/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 19 November 2008 on waste and repealing certain Directives, Official Journal of the European Union, <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0098&from=EN>

18 Empfehlung Zur Weiterentwicklung Des Berliner Energie- Und Klimaschutzprogramms 2030, Umsetzungszeitraum 2022 bis 2026, (2022), https://www.berlin.de/sen/uvk/_assets/klimaschutz/klimaschutz-in-der-umsetzung/das-berliner-energie-und-klimaschutzprogramm-bek/bek-abschlussbericht_2022-2026.pdf

19 European Commission, (n.d.), Waste prevention and management, *The waste hierarchy*, https://ec.europa.eu/environment/green-growth/waste-prevention-and-management/index_en.htm#:~:text=The%20Directive%20defines%20a%20hierarchy,be%20the%20very%20last%20resort.

2.3. HUMAN HEALTH AND CIVIL PROTECTION IN BERLIN

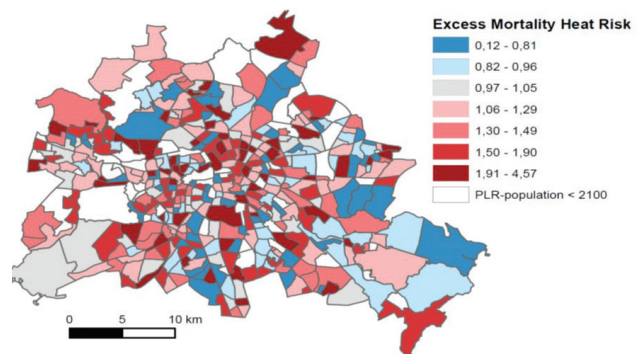
According to 2022 IPCC Report, climate change is the largest global health issue of the 21st century, including biodiversity loss.²⁰ Climate change will also have an impact on the health of Berlin's population due to both gradual changes in weather conditions and an increase in the frequency of extreme weather events (e.g., heavy rain, heat waves).

Hot days and heat waves can cause dehydration, incidences of cardiovascular crises (e.g., heat strokes), sleep disturbances, and decreased labor productivity, among other minor issues (e.g., chronic obstructive pulmonary disease).

The presence of numerous hot days in succession, when no meaningful cooling happens even at night and most individuals cannot fully recover, is particularly upsetting for the human organism.

According to studies, heat stress increases the risk of death, particularly for people with chronic respiratory diseases.²¹ The elderly, the ill, and small children are particularly vulnerable. Demographic predictions for Berlin show heightened future vulnerability due to the growing elderly population. Deaths (i.e., mortality) and hospital admissions (i.e., morbidity) have risen as a result. Studies show that from 2001 to 2010, there were an additional 1,400 heat-related fatalities in Berlin per year.²²

Figure 5: Heat mortality in Berlin (spatial variability at the neighborhood scale, excess mortality, calculated as relative risk)



Source: Schuster et al., 2014.²³

20 IPCC Report 2022- <https://www.ipcc.ch/2022/02/28/pr-wgii-ar6/>

21 Gasparini et. al., "Mortality risk attributable to high and low ambient temperature: a multicountry observational study" (2015)

22 Deutsches Ärzteblatt 26/2022 "Heat-Related Mortality in Germany Between 1992 And 2021" <https://www.aerzteblatt.de/archiv/225954/Hitzebedingte-Mortalitaet-in-Deutschland-zwischen-1992-und-2021>

23 "Schuster et al. "Heat mortality in Berlin - Spatial variability at the neighborhood scale" (2014)

When life circumstances for plants, animals, and microbes progressively alter due to climate change, there are also long-term health risks. This also enables new pathogens to colonize regions that had previously been closed to them by unfavorable meteorological conditions. These newer pathogens are often transmitted by native or new disease carriers, or “vectors,” such as mice, mosquitoes, or ticks. Although ticks, which may spread Lyme disease, have not been a huge issue in Berlin up until now, they may start to appear more often as a result of the warmer winters.

Common ragweed, *Ambrosia artemisiifolia*, is another issue in Berlin. This plant, an invasive species from North America, generates pollen that causes extreme allergic reactions and thrives better as a result of climate change. Similarly, allergy-inducing insects such as the oak processionary have become an issue in Berlin. These caterpillars have venomous hairs on their back that release an urticating toxin that can irritate the skin and trigger asthma attacks. The oak processionary is a forest insect that thrives in hot, dry weather conditions. Finally, it is important to remember that more sun exposure increases the risk of skin cancer. Between 2000 and 2014, skin cancer was among the top ten deadliest diseases in Berlin, and its prevalence is likely to rise as the effects of climate change continue to be seen.²⁴

2.4. URBAN DEVELOPMENT IN BERLIN

Cities are substantially warmer than the rural areas they surround because of their dense construction volume, limited evaporation, and numerous barriers to air exchange. Due to rising temperatures, particularly during the summer, increasingly developed urban surfaces raise health risks for urban populations. Urban parks are put under stress by intermittent dry spells. The rise in severe rain events is expected to cause greater flooding in densely populated areas, putting underground tunnels at risk and putting segments of roads and basements under water. Cities’ sewer capacities will also be tested. Berlin is currently expanding by roughly 40,000 people annually, partially as a result of international migration processes. Building new homes is a top priority, and it is also necessary to develop schools, workplaces, and other facilities. Two projects carried out by Berlin Municipality, “Sponge City Berlin” and “Green Moabit,” which will be outlined in more detail below, aim to mitigate the effects of this situation.

Within its borders, about 40% of Berlin’s total land area is composed of green (parks, forests, etc.) and blue

(rivers, channels, lakes, ponds, etc.) areas.²⁵ The city seeks to build a “green belt” around the city to serve as a limit to urban growth and as protection against urban sprawl.

Berlin Municipality has a particular multi-level administrative system that controls how various governmental levels interact and how funds are allocated. In the German federal system, the city of Berlin performs the duties of both the municipal and the state governments. It is organized into districts (*Bezirke*), some of which are in charge of environmental and land use planning. Creating green solutions and infrastructure is a common goal shared by all levels of planning in Berlin, and it is embedded in most urban planning documents.

A planning initiative called the Urban Development Concept Berlin 2030²⁶ aims to define future-oriented policies and objectives. It encourages the integration of institutional stakeholders and urban society for the growth of Berlin. As a result, the idea generates opportunities for participants to contribute to ongoing engagement and cooperation.

Berlin’s Urban Development Agenda to Combat Climate Change contains the following provisions:

- Protecting climate relief areas
- Creating qualified green and open spaces, a systematic strategy of roof and facade greening
- Increasing the resilience of urban green spaces
- Climatic decoupling of new construction projects
- Increasing the resilience of the city’s surfaces to extreme weather conditions
- Climate adaptation strategies at the neighborhood level
- Pilot projects on climate adaptation

While there are many pilot projects in Berlin focusing on different aspects of urban development, two projects stand out due to their size and scope. First, Berlin’s Schumacher Quartier is taking a different approach with their project “Sponge City Berlin.”²⁷ Residential

24 Katalinic et. al. “Skin Cancer Screening in Germany” (2015)

25 Berlin – Green Areas- <https://oppla.eu/berlin-nbs-urban-green-connectivity-and-biodiversit>

26 Urban Development Concept Berlin 2030 https://use.metropolis.org/system/images/1935/original/BerlinStrategie_Broschuere_en.pdf

27 Sponge City Berlin- <https://www.schumacher-quartier.de/en/das-projekt/klimaangepasste-stadt#:~:text=The%20Quartier%20is%20becoming%20Berlin's,district%20without%20additional%20energy%20expenditure.>

buildings and open spaces on the grounds of the decommissioned Tegel Airport are being planned within the scope of the project. The Quartier is becoming Berlin's reference project for urban development that adapts to climate change and is sensitive to its water needs.

A “sponge city” retains rainwater within a residential estate. During hot spells the rainwater evaporates and thereby cools the residential district without additional energy expenditures. Surplus water seeps slowly into the groundwater instead of being drained off through the sewage system. Keeping rainwater in the Quartier brings several advantages:

- improving the micro-climate and enhancing quality of life
- reducing drainage costs
- supporting biodiversity through spacious and open areas that are rich in species
- protecting Berlin's stretches of waters against inputs of oxygen-depleting nutrients, since wastewater from the drainage system during heavy rains overflows less frequently and flows into natural bodies of water
- encouraging building owners to re-green courtyards of apartment blocks and planting grasses and mosses on rooftops to absorb rainwater
- establishing more ponds and wetlands across the city
- installing swales at the side of roads in place of a storm sewer system.

Another pilot project, the district of Moabit's urban development concept, called “Green Moabit,”²⁸ aims, among other things, to adapt this densely urbanized area to climate change. It proposes quantitative targets for:

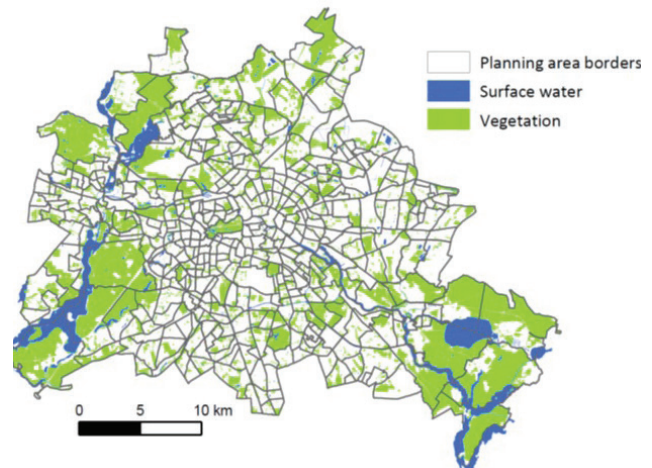
- the greening of rooftops, facades, streets, and courtyards;
- the transformation of impervious surfaces into green surfaces.

The concept also suggests subsurface solutions for rainwater harvesting.

The concept includes physical targets for the volume of humidity for evapotranspiration to be achieved in urbanized areas. These targets are based on the calcu-

lation of evaporation volumes obtained in a forest. Half of the evaporation required will be guaranteed by increasing vegetation (e.g., green roofs, walls, pocket gardens, etc.) and the other half by using stored rainwater to be evaporated on rooftops, in public paved spaces, and used for irrigating green public spaces.

Figure 6: The 447 Planning Areas of Berlin, Vegetated and Surface Water Areas



Source: Schuster et al., 2014.

2.5. WATER RESOURCE MANAGEMENT IN BERLIN

An estimated 522 million m³ of rainwater falls onto Berlin's urban area each year. There are several risks as a result. Of this volume, 321 million m³ leaks away, 142 million m³ infiltrates the surface, and just under 70 million m³ is released through the sewage system. AFOK models predict two trends that are particularly noteworthy: first, an increase in yearly precipitation of between 3 and 10 percent until 2050 and between 8 and 18 percent until 2100, especially in the winter. Second, an increase in heavy rain occurrences due to climate change of between 14 and 40 percent yearly by 2050 and between 22 and 80 percent by 2100 could be anticipated.²⁹

The combined sewer system, which discharges rainwater and wastewater into one sewer system, is a well-known concern. This system is primarily found in Berlin's inner-city for historical reasons. When heavy rain occurs, the combined sewer system becomes overloaded and discharges precipitation and untreated

²⁸ Green Moabit Project-Reiner Lemoine Institut <https://reiner-lemoine-institut.de/en/stadtteilentwicklungskonzept-stek-green-moabit/>

²⁹ Adapting to the Impacts of Climate Change in Berlin – AFOK https://www.berlin.de/sen/uvk/_assets/klimaschutz/publikationen/adapting-to_the_impacts_of_climate_change_in_berlin.pdf

sewage directly into surface waters. The Senate and Berlin Wasserbetriebe (BWB) have invested significantly in plans to enlarge the subsurface storage volume. However, since heavy rain events may become more frequent as a result of climate change, there is an obvious risk that this would reverse the improvements to the sewage system made by BWB's previous investments.

In the future, hotter summers may be coupled with prolonged dry periods. Due to a decrease in water flow via the sewage system, unpleasant odors will emerge. Additionally, it is possible that this will lower the Spree River's water levels and flow. The city's water consumption will rise as a result of current weather conditions. In order to prevent damages and lessen financial burdens, there is a clear need for adaptability in this area of action. Berlin's water supply and distribution may be made climate-proof by combining a variety of strategies. It is highly beneficial in this regard that the BWB has recently started a number of research and development programs that specifically address these upcoming difficulties.

The efforts are meant to promote decentralized rainfall infiltration, to prepare the city's surface for controlled drainage and brief floods, and to only treat the water that will inevitably stay in the traditional sewage system. The amount of free drinking water available in the public area must be quickly increased. The city's water system must be improved in terms of accessibility and visual appeal.

Berlin's Urban Development Agenda to Combat Climate Change includes the following provisions:

- Decoupling of rainwater management from centralized systems
- Flood-fit design of surfaces
- Adapting infrastructure to heavy rain events
- Adapting infrastructure to drought and heat
- (Drinking) water quality protection
- Increasing climatic effectiveness of water bodies
- Expanding the drinking fountain network
- Creating bathing facilities and swimming pools
- Promoting water-sensitive climate adaptation as a public issue
- Providing information for vulnerable urban areas

- Exploring the effects of climate change on water balance

To decrease runoff and relieve the sewer, the city's surface should be modified and more permeable to rainfall. Here, trough-trench systems and desealing are essential. To prevent vulnerable structures and infrastructure from flooding and to relieve the sewers, projected precipitation peaks need to be separately collected by defined road sections, park spaces, or city courts. The evaporation rate needs to be greatly increased at the same time.

If Berlin is transformed according to these principles, it may be more resilient to the two main consequences of climate change: greater heat waves and rainfall. The quality of life and visits to the city can be improved while the rise in the expense of public infrastructure may be moderated, if not even decreased.

2.5.1. Wastewater Treatment in Berlin

Berliner Wasserbetriebe, Berlin's integrated drinking water and sewage company, has a unique duty to promote sustainable growth as water delivery and sewage treatment in Berlin demand a significant amount of energy. Berliner Wasserbetriebe has been reducing the amount of energy needed to run its pumping stations, sewage treatment facilities, and waterworks in recent years. The internal production of power and heat is just as vital as the effective utilization of energy. The firm supports the State of Berlin's climate protection goals by continually improving its systems and processes, which helps to reduce CO₂ emissions. The company's stated goal is to build a sewage treatment facility that is energy self-sufficient through sewage sludge that produces sewage gas, 95% of which is used to generate power and heat.

A significant step toward energy self-sufficiency has already been made at the Schönerlinde wastewater treatment facility. With the addition of two micro gas turbines and three wind turbines with a combined capacity of 2 MW, up to 84% of the energy needed may be produced internally, saving up to 13,000 tonnes of CO₂ annually.³⁰

³⁰ Keeping Berlin Ahead of the Curve-Waterworld <https://www.waterworld.com/wastewater/article/16201122/keeping-berlin-ahead-of-the-curve>

3. BERLIN'S VULNERABILITY IN THE CONTEXT OF CLIMATE CHANGE

3.1. BERLIN'S PHYSICAL AND ENVIRONMENTAL VULNERABILITY

For over a decade, we have been living in an era of urban age challenged by the consequences and risks of climate change.³¹ Rapid urbanization increases our vulnerability to this phenomenon. Especially vulnerable groups such as immigrants, the elderly, women, children, and the urban poor are affected by the negative impacts of this global crisis. In this context, climate change-related risks and the costs for cities and settlements might be caused by interactions between ever-changing urban forms, exposure, and vulnerability, as indicated in the IPCC report.³² Cities account for 70% of global greenhouse gas emissions. For this reason, cities need to respond to climate change in terms of adopting both mitigation and adaptation policies.³³ In this setting, Berlin, the capital and largest city of Germany, which hosts a total of 3.7 million people, deserves special attention in both the general debate on climate change and in the context of this project.

Berlin strives to present itself as a diverse, cosmopolitan, and international city. Hosting a total of approximately 742,000 foreigners from about 170 different nations, Berlin is a city with a tolerant, multicultural populace that values diversity.³⁴ The city is

also a well-known hub for the creative and technology industries and therefore has good prospects in terms of new enterprises and jobs. Almost 180,000 small and medium-sized enterprises are based in Berlin, and the city has a higher share of companies compared to the rest of the country despite its small size.³⁵ Indeed, Berlin is a magnet for people from all over Germany and the world. Its popularity is also due to its high standard of living at a reasonable price, active local communities, and multicultural population. Furthermore, the city is known for being the greenest capital in Europe in terms of the number of green spaces. Approximately 44% of the city is covered by green areas such as forests, parks, sports grounds, and allotments. This amount is almost double the green space of New York or Paris.³⁶ Like many other big cities, up until the outbreak of the COVID-19 pandemic in 2020, Berlin profited from rapid economic growth. For years, the increase in the gross domestic product and the proportion of persons who are employed have been higher than the national average. Additionally, there was an observable positive trend in the number of jobs that required social security contributions. However, while the gross domestic product increased by 2.6% in 2019, COVID-19 caused it to decline by 3.3% in 2020. Additionally, there was a 0.4% decrease in employment when compared to the prior year. In 2019, employment grew by 2.2%. It was anticipated that the economic level of 2019 would be reached by the beginning of 2022 after a stagnant start to the year³⁷; however, due to the Russian invasion in Ukraine, the economy still could not catch up the pre-pandemic period.³⁸

31 United Nations Population Fund [UNFPA] United Nations [UN], *UNFPA state of world population 2007 Unleashing the Potential of Urban Growth*, by United Nations Population Fund [UNFPA], 1, 55, January 1, 2007, https://www.unfpa.org/sites/default/files/pub-pdf/695_filename_sowp2007_eng.pdf

32 Sonia I. Seneviratne et al., *Changes in climate extremes and their impacts on the natural physical environment*. In: *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*, ed. Matilde Rusticucci and Vladimir Semenov (Cambridge, UK and New York, NY, USA: Intergovernmental Panel on Climate Change [IPCC], Cambridge University Press, 2022), 111-113.

John Handmer et al., *Changes in impacts of climate extremes: human systems and ecosystems*. In: *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*, ed. Sebastian Vicuna and Avelino Suarez (Cambridge, UK and New York, NY, USA: Cambridge University Press, Intergovernmental Panel on Climate Change [IPCC], 2022), 234-235, 246.

Susan Cutter et al., *Managing the risks from climate extremes at the local level*. In: *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*, ed. Eduardo Calvo and Khamaldin Daud Mubtabazi (Cambridge, UK and New York, NY, USA: Cambridge University Press, Intergovernmental Panel on Climate Change [IPCC], 2022), 294.

33 Özlem Aslan, *Dirençli Toplumlardan Sorumlu İdarelere: İklim Temelli Aşırı Hava Olaylarına Hak Temelli Bir Yaklaşım*, 3-4, April 2022

34 Office for Statistics Berlin-Brandenburg and State of Berlin, "Demografische Daten zu Berlin" [Demographic data on Berlin], Berlin Partner: Business Location Center, last modified 2022, <https://www.businesslocationcenter.de/wirtschaftsstandort/berlin-im-ueberblick/demografische-daten>

35 Malte Zeeck, ed., "Find Out How to Get a Job and Work in Berlin," InterNations, <https://www.internations.org/berlin-expats/guide/work-ing-short>.

36 State of Berlin, "Wissenswertes über Berlin" [Things to know about Berlin], Berlin.de, <https://www.berlin.de/berlin-im-ueberblick/hauptstadtleben/wissenswertes/>

State of Berlin, "Berlin as an Economic Center," Berlin.de, <https://www.berlin.de/en/business-and-economy/economic-center/>.

Special Unit for Climate Protection and Energy [SR KE] Senate Department for Urban Development and the Environment, *Anpassung an die Folgen des Klimawandels in Berlin [AFOK]*, by F. Reusswig, et al., trans. Christiane Latzel, 18, July 2016, https://www.berlin.de/sen/uvk/assets/klimaschutz/publikationen/adapting_to_the_impacts_of_climate_change_in_berlin.pdf.

37 State of Berlin, "Berlin as an Economic Center-Economic Development-Why Berlin?" Berlin.de, www.berlin.de/en/business-and-economy/economic-center/5611367-4011028-economic-development.en.html

38 Reuters, "Less growth, more inflation for German economy in 2022 -Ifo", <https://www.reuters.com/markets/europe/less-growth-more-inflation-german-economy-2022-ifo-2022-06-15/>

On its official website, Berlin calls itself a “climate-friendly” city. In terms of legal and institutional policies, climate protection has become an integral part of Berlin’s government policy.³⁹ Climate adaptation has also been integrated into this plan. Berlin has already adopted specific measures that are also tracked at the local level. Especially urban spaces, infrastructure, the health sector, and urban green spaces are being transformed into spaces that are resilient to the effects of climate change. Moreover, in Berlin, emissions per person in 2014 were 4.9 tons of CO₂, which is almost half the national average of 9.6 tons of CO₂ in 2015. By the middle of the century, Berlin intends to reduce urban carbon emissions by 95%.⁴⁰ According to the OECD Germany Report published in 2021, greenhouse gas (GHG) emissions per capita generated in the majority of German states were below 10 tons of CO₂ per capita.⁴¹

The main climate challenges for Berlin are rising temperatures, severe storms, and heavy rainfall. The city has already experienced all of these events in the recent past. The consequences of climate change were evaluated firstly in 2009 and 2011. *The Urban Development Plan Climate (SteP Klima)* in 2011 was updated in 2015/2016. As mentioned above, the *Adapting to the Impacts of Climate Change in Berlin – AFOK* report (2016) draws a general picture of Berlin in terms of its physical, environmental, and economic vulnerability.⁴²

The state of Berlin has set itself the task of protecting the climate and advancing adaptation to the consequences of climate change. The *2016 Berlin Energy Turnaround Act* turned the city’s climate adaptation initiatives into a legal mandate. To this end, Berlin has set concrete goals for the year 2050. To achieve this goal, in January 2018, *Berlin Energy and Climate Programme 2030* (BEK 2030) was passed, which, as mentioned above, specifically addresses the city’s opportunities and needs. Additional sectoral projects that were predicated on the recommendations of the study “Adapting to the Impacts of Climate Change in

Berlin” were also implemented. The objective is to include climate adaptation in several fields, including water management, buildings, and urban planning, as well as human health and civil defense.⁴³

As mentioned above, according to climate change reports published by the Berlin municipality, the physical and environmental vulnerability of Berlin has four levels. These levels are temperature, precipitation, wind, and soil. The rise of temperatures has already impacted Berlin in recent years. According to local reports, the average daily maximum temperatures are predicted to rise by another 1.2°C soon and by an additional 3.2°C in the distant future. It is expected that while the summers will be warmer, autumns and winters will be more affected by the temperature rise. In addition to the high temperatures, longer dry periods are to be expected during the summer months in the future. Berlin will see an increase in average annual precipitation of between 3 to 10% in the near future and 7.5 and 18% in the distant future. It is predicted that in 2100, Berlin’s climate will be like Toulouse, which is in the south of France if the trend continues. Heavy rain will also affect the city. Now, Berlin experiences approximately 11 heavy rains annually. About 15 (in the near future) or 17 (in the distant future) occurrences will occur annually.⁴⁴ The Berlin region is likely to experience an increase in rainfall in winter and a decrease during summer.⁴⁵

The growing urban space also has a negative impact on climate change. As the number of inhabitants increases by about 40,000 people per year, largely due to the global migration movement, the city’s urban space is growing rapidly. “Urban heat islands” are one of the main consequences and challenges in all urban areas. According to the *Berliner Energie- und Klimaschutzprogramm 2030*, the temperatures in the inner-city area within the Berlin S-Bahn ring are around 5°C higher than in the large open area surrounding it.⁴⁶ Additionally, it should be kept in mind that building stocks are

39 Senate Department for the Environment, Transport and Climate Protection and Special Division for Climate Protection Brückenstrasse 6, *Climate protection in Berlin* (Berlin, Germany: Senate Department for the Environment, Transport and Climate Protection, 2018), 1, <https://www.berlin.de/sen/uvk/service/publikationen/index.php/detail/102>

40 Senate Department for the Environment, Transport and Climate Protection and Special Division for Climate Protection Brückenstrasse 6, *Climate protection*, 1

41 OECD, *Regional Outlook 2021- Country notes Germany Progress in the net zero transition*, 2, September 8, 2021, <https://www.oecd.org/regional/RO2021%20Germany.pdf>

42 Special Unit for Climate Protection and Energy [SR KE] Senate Department for Urban Development and the Environment, *Anpassung an die Folgen*, 6.

43 Senate Department for the Environment, Urban Mobility, Consumer Protection and Climate Action, “Anpassung an den Klimawandel” [Adaptation to the consequences of climate change], ed. Kai Lehmann, Berlin.de, <https://www.berlin.de/sen/uvk/klimaschutz/anpassung-an-den-klimawandel/>.

44 Special Unit for Climate Protection and Energy [SR KE], 8-9.

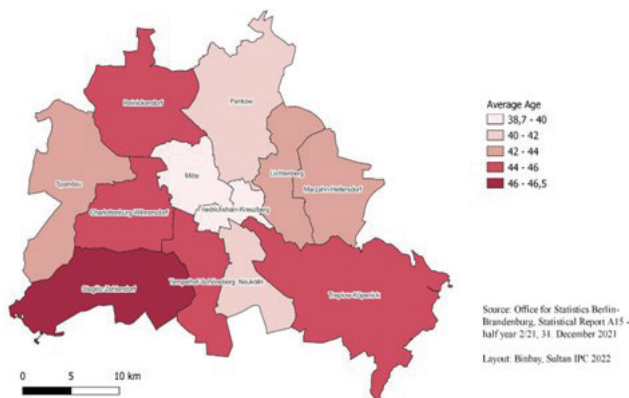
45 Ulrich Cubasch and Christopher Kadow, “Global Climate Change and Aspects of Regional Climate Change in the Berlin-Brandenburg Region,” *DIE ERDE – Journal of the Geographical Society of Berlin* 142, nos. 1-2 (January 4, 2011): 142, <https://www.die-erde.org/index.php/die-erde/article/view/40>.

46 Referat Klimaschutz und Klimaanpassung Senatsverwaltung für Umwelt, Verkehr und Klimaschutz, *BEK 2030 Berliner Energie- und Klimaschutzprogramm 2030*, by Senatsverwaltung für Umwelt, Verkehr und Klimaschutz and Referat Klimaschutz und Klimaanpassung (Berlin, Germany: Senatsverwaltung für Umwelt, Verkehr und Klimaschutz, 2019), 92.

one of the key sources of greenhouse gasses in Berlin. However, it is not easy to establish a compact city over short distances in a global city whose population is increasing each year, all while staying climate friendly. Nevertheless, urban planners have developed solutions such as retaining green spaces and implementing green roofs and facades, as well as making sealed surfaces permeable for precipitation.⁴⁷

The urban heat problem in Berlin is also directly related to vulnerable groups. According to the Berlin-Brandenburg Office of Statistics, young people tend to live in the city center in districts like Mitte or Friedrichshain-Kreuzberg, while older people live further away from it.⁴⁸ This distribution is due to several factors, like the broader range of leisure activities in the center. However, this distribution also helps to prevent the worst-case scenario for the elderly in the face of temperature rise as they live in cooler parts of the city.

Figure 7: Age distribution by district in Berlin



Berlin also faces a severe precipitation problem. With the process of urbanization, the number of impervious surfaces increases, leading to the loss of green and fallow spaces. Thereby, the retention, evaporation, and infiltration of rainwater are disrupted.⁴⁹ The excess rainwater ends up in Berlin’s mixed sewage system, through which it is discharged together with wastewater. During heavy rainfall, the capacity of the sewage system is often exceeded. As a result, the mixed water overflows into the urban surface water and thus impairs the water quality.⁵⁰

47 Special Unit for Climate Protection and Energy [SRKE] Senate Department for Urban Development and the Environment, *Anpassung an die Folgen*, 14.

48 Office for Statistics Berlin-Brandenburg and State of Berlin, “Demografische Daten,” Berlin Partner: Business Location Center.

49 “Regenwassernutzung” [Rainwater harvesting], Berliner Wasserbetriebe, <https://www.bwb.de/de/regenwassernutzung.php>.

50 BEK 2030, 94.

These trends contribute to the composition and activity of soil microorganisms impacted by rising soil temperatures, which also affects how quickly numerous material conversion and degradation processes occur in the soil. Long-term droughts can cause the soil to harden and become compacted; precipitation water primarily runs off the surface, and it cannot permeate sufficiently and thus is unavailable for plants as a result. Soil erosion can be exacerbated by heavy rain. This causes pollutants and soil material to be both flushed into surface water.⁵¹

In addition to the environmental impact of climate change, this situation also threatens the health of humankind and biodiversity. To maintain the health of its population, Berlin must, without a doubt, adapt its infrastructure to the changing environment. City dwellers are already threatened by gradual changes in weather parameters and increased weather extremes such as heat waves. The negative consequences of climate change have already hit the elderly—as aforementioned— infants, and chronically ill people. There were 1,400 additional heat-related deaths annually between 2001 and 2010.⁵² According to the Robert Koch Institute, around 490 people died in 2018 as a result of the great heat wave in Berlin.⁵³ Climate change also challenges biodiversity by altering the living conditions of plants, animals, and microorganisms. For example, due to changes in climatic conditions, climate change has induced a prolonged blossom period that causes pollinosis, i.e., pollen allergies, which are air transmissible. Approximately 700,000 people in Berlin suffer from pollinosis, which can result in chronic asthma if left untreated.⁵⁴

One of the most vulnerable groups in Berlin is immigrants. Some major urban centers where immigrants reside in Berlin are Mitte, Friedrichshain-Kreuzberg, and Neukölln. There are five planning areas (PLAs) where immigrants are highly concentrated, all with the worst environmental assessment score. Vulnerable groups are disproportionately more exposed to environmental burdens than the overall population, of which 47.2% are affected by a high or very high level of environmental burdens (EBs). In comparison,

51 BEK 2030, 94.

52 AFOK, 11-12.

53 Robert Koch-Institut, Jamela Seedat, Dr., and Francesca Smolinski, eds., “Schätzung der Zahl hitzebedingter Sterbefälle und Betrachtung der Exzess-Mortalität; Berlin und Hessen, Sommer 2018” [Estimating the number of heat-related deaths and considering excess mortality; Berlin and Hesse, summer 2018], *Epidemiologisches Bulletin*, no. 23 (June 6, 2019): 193, https://www.rki.de/DE/Content/Infekt/EpidBull/Archiv/2019/Ausgaben/23_19.pdf?__blob=publicationFile.

54 AFOK, 11-12.

59.7% of inhabitants with a migration background live in burdened PLAs. Furthermore, despite immigrants making up 28.5% of Berlin's population, they make up 36% of the residents impacted by EBs.⁵⁵

According to the BEK 2030, the municipality of Berlin determined six measures to tackle vulnerabilities in the field of buildings, urban development, and green and open spaces. Firstly, Berlin set the goal of securing climatic relief areas. Spacious open spaces with a good water supply and characterized by flat vegetation such as meadows, fields, allotment gardens, and park landscapes are sources of cold and fresh air. Due to their relief function, they must be utilized to cool inner-city areas. Secondly, the creation of new green and open spaces is planned. The third is the objective to increase the resilience of urban green spaces. This should protect urban vegetation from high summer temperatures and long dry periods in the future. Fourth, to avoid negative effects on the urban climate, decoupling measures must be taken in new construction projects that consider the areas of heat-adapted and water-sensitive cities. This applies to the preservation of fresh air aisles, facades, and roof design with materials that have a high albedo, the creation of green areas for cooling and shading, and the verification of suitable facades or roof greening. Fifth, it aims to increase the climatic qualification of city surfaces. The measures taken in this area are aimed at optimizing or adapting both open spaces and building surfaces in Berlin. Lastly, the expansion of Berlin's drinking fountain network is planned.⁵⁶

There are four additional measures for the area of Environment and Nature in the energy and climate protection program released by the Berlin municipality. First is the general consideration of the interests of preventive soil protection in spatial planning. Second is the establishment of inner-city soil monitoring areas and a digital soil point database. Third is the planning of near-natural forest conversion for the forests of Berlin. Lastly, as a prevention measure, is forest monitoring.⁵⁷

Different projects are being completed in Berlin within varied institutional settings. One of the best practice examples in the field of urban adaptation is the project "Green Moabit." This project aims to build a climate-adapted and sustainable neighborhood by focusing on

the reduction of CO₂ emissions and the more efficient use of resources in the Moabit neighborhood of Berlin. The project was initiated in 2014 and funded with EUR 230,000 from the District Office, the Department for Urban Development and the Environment, and the Department for Economics, Technology, and Research. For the first time, the potential for sustainable climate protection and adaptation to climate change was examined in an existing area of commercial and industrial character. A group of urban planners, administration, and communication experts developed a district development concept that designed eight subprojects within the scope of Green Moabit. One of its subprojects focuses on green mobility. Even though the share of motorized individual transport within the neighborhood is a low share (23%), many employees commute to Moabit by car. As an alternative, the "Green Card Moabit" project sought to provide a multifunctional mobility ticket that can be used for public transport including bicycle transport. Among other things, it was offered access to car and bike sharing systems. Other projects concern the use and/or production of energy, such as convoy (consulting) projects on energy efficiency in industry, efficient heat supply through combined heat and power, solar power plant Moabit, and saving energy through heat recovery. Some of the projects address the benefits of rainwater, like the integrative rainwater concept and cooling with rainwater. Others, like Green Card Moabit, and the creation of new green spaces through the Civic Academy (Moabit) try to improve other areas. Later, the project received funding from the largest European innovation initiative for climate-friendly technologies "Climate-KIC."⁵⁸

3.2. BERLIN'S ECONOMIC VULNERABILITY

According to the World Economic Forum's *Global Risks Report 2018*, four of the most significant global hazards are related to climate change. The report emphasizes that global infrastructure and physical assets are most at risk.⁵⁹ As one of the key economic centers of Germany, the economic risks that might emerge because of climate change for Berlin should be examined. One example of Berlin's economic vulnerability in the face of climate change is its dependency

55 Sonja Edith Hölzl et al., "Vulnerable socioeconomic groups are disproportionately exposed to multiple environmental burdens in Berlin- implications- for planning," *International Journal of Urban Sustainable Development* 13, no. 2 (April 5, 2021): 340-342, accessed July 27, 2022, <https://doi.org/10.1080/19463138.2021.1904246>.

56 BEK 2030, 92-93.

57 BEK 2030, 95.

58 BEK 2030, 12.

Berlin Referat MQ A - Integrierte Quartiersentwicklung Senatsverwaltung für Stadtentwicklung, Bauen und Wohnen, *Stadtteilentwicklungskonzept Green Moabit*, by Bezirksamt Mitte von Berlin, ed. A. Stahl, 2, September 2021, <https://www.stadtentwicklung.berlin.de/nachhaltige-erneuerung/tiergarten-nordring-heidestrasse/moabit-west-green-moabit.pdf>

59 World Economic Forum, *The Global Risks Report 2018*, by Aengus Collins and the Global Risks Report 2018 team, 3, 68, January 17, 2018, <https://www.weforum.org/reports/the-global-risks-report-2018/>.

on foreign trade. Climate change alters markets and supply chains, posing an enormous threat to Berlin's economy, which is tremendously impacted by foreign trade. In addition, climate change inevitably affects infrastructure; therefore, the city's infrastructure needs to be either adjusted to withstand this or fixed upon impact. Both options would be a burden on the economy.⁶⁰ Since the 2000s, Berlin's significance as a business location has continuously grown. Currently, the annual economic growth of Berlin is higher than the national average. The service sector (trade, business-related, and social services) has a gross value-added share of approximately 84%, surpassing both the manufacturing industry (12%) and the construction industry (4%).⁶¹ Berlin's economy, which employs over 1.3 million people, is made up of more than 170,000 businesses, the majority of which are small and medium-sized enterprises. The manufacturing and construction industries are also important.⁶² Berlin's economy is characterized by a strong business, trade, and service sector. As of 2019, these industries make up most of Berlin's firms, roughly 89%. With sales of more than EUR 185 billion in 2019, these firms made a considerable contribution to the GDP and the Berlin economy. However, Berlin's need to support ongoing economic growth is considered a limitation to reducing its energy consumption.⁶³

According to the BEK 2030, Berlin's economy could mainly suffer on three levels because of climate change. Firstly, it is noted that severe weather conditions have the potential to harm structures and equipment. Secondly, depending on the industry, various consequences for economic processes can occur. The fields of logistics, water and energy supply, and waste disposal may be especially impacted. Thirdly, extreme weather conditions could impair the health and performance of employees, particularly for those who are working outdoors.

In the BEK 2030, a measure of the vulnerability of the action area industry, trade, and finance is defined. This includes the creation of industry-specific and operational climate adaptation concepts. The increase in extreme weather changes the framework for economic activity. This applies to weather-sensitive sectors such as construction, agriculture, forestry, and water management. In addition, there are numerous occupational groups such as street cleaning staff and waste

collectors as well as post and parcel deliverers who are particularly hard hit by extreme weather conditions. Therefore, the stakeholders in Berlin's economy must be aware of the topic of climate adaptation. As part of the development of industry-specific or company climate adaptation concepts, individual vulnerabilities should be identified, and specially tailored adaptation measures should be implemented.⁶⁴

To increase energy efficiency and phase out fossil fuels from the economy, Berlin employs a combination of consulting, networking, and promotion. Berlin was the first German federal state to announce that it is phasing out coal. According to the principles of Berlin's Energy Turnaround Act, the Senate wants to end the production of energy from hard coal at the very least by 2030.⁶⁵

In 2019, close to 20% of Berlin's total emissions, about 3.6 million tons of CO₂, were discharged into the atmosphere. The contribution of the economy to CO₂ reduction is mainly made by changing energy sources and less by absolute final energy savings.⁶⁶

Along with the effects of climate change on the most vulnerable groups, extra costs may be placed on them because of adaptation plans. The Berlin municipality has made switching from fossil fuels to renewable and green energy one of its main priorities. Different policy initiatives have varying effects on ensuring that energy and resource costs are based on the "polluter pays" principle, establishing incentives/standards for investments, or encouraging climate-friendly behaviors across socioeconomic groupings. This situation means that low-income consumers will face a new burden. For instance, compared to more affluent homes, low-income households in Germany pay a significantly higher percentage of their income to heating and electricity.⁶⁷ Though it is argued that eco-friendly homes would reduce energy bills significantly, it requires significant investments to make a house eco-friendly, which most low-income households do not possess the means to make.⁶⁸ In sum, adaptation policies should

⁶⁰ Special Unit for Climate Protection and Energy [SR KE], 10.

⁶¹ BEK 2030, 96.

⁶² Special Unit for Climate Protection and Energy [SR KE], 21.

⁶³ BEK 2030, 110, 70.

⁶⁴ BEK 2030, 96.

⁶⁵ Senate Department for the Environment, Transport and Climate Protection and Special Division for Climate Protection Brückenstrasse 6, *Climate protection*, 2.

⁶⁶ BEK 2030, 47.

⁶⁷ Katja Schumacher, Dr. and Katja Hünecke, eds., "Energiewende – verursachergerecht und sozialverträglich" [The energy transition – socially just ... and the polluter pays], Oeko.de, <https://www.oeko.de/en/research-consultancy/issues/energy-and-climate-protection/the-energy-transition-socially-just-and-the-polluter-pays>.

⁶⁸ Paul Collins, "Eco-friendly houses: Characteristics, prices and examples," Climate Consulting, last modified January 31, 2022, <https://climate.selectra.com/en/advice/eco-house>.

pay regard to the inequalities in society and develop new policies in accordance with social policies.

Without a doubt, climate change affects every country, industry, and position on the planet. Even Germany, the EU member state with the largest economy, must acknowledge the financial threats posed by climate change. The legislation that protects both employees and employers should be controlled, and stakeholders such as unions should also be included. Small and medium-sized businesses should be supported since they play a huge part in Berlin's economy.⁶⁹ Climate change presents a challenge to the whole economy. Germany's economy is dependent on exports; yet, supply lines and markets around the world are impacted by climate change. Aside from business and industry, the tourism sector may also be impacted by climate change; increasing temperatures prevent tourists from staying outdoors for prolonged amounts of time, for example. Considering that a significant number of touristic activities are done outdoors, a more strategic approach to deal with the effects of climate change in the tourism sector is needed.⁷⁰

Berlin Municipality also scrutinizes the economic impact, predictions, and measures to be taken in the face of climate change. As a result of more extreme weather, the setting for economic activity has shifted. This predominantly concerns weather-dependent industries like forestry, agriculture, and water resource management. As a result, it is critical to improve citizens' awareness of climate-related topics and increase climate adaptation knowledge among Berlin's economic stakeholders. To build industry-specific or company-wide climate adaptation concepts, it is necessary to identify distinct vulnerabilities and demonstrate specifically planned adaptation techniques.⁷¹

According to the BEK 2030, Berlin set fifteen goals in the field of economy.

- 1 | **Implement criteria for climate neutrality:** With approaches like the energy-saving and climate gas-reducing requirements for the construction and renovation of public buildings, the state aims to utilize emissions reduction potentials.

69 Special Unit for Climate Protection and Energy [SR KE] Senate Department for Urban Development and the Environment, *Anpassung an die Folgen*, 21.

70 Special Unit for Climate Protection and Energy [SR KE] Senate Department for Urban Development and the Environment, *Anpassung an die Folgen*, 10, 23.

71 BEK 2030, 96.

- 2 | **Implementation of efficient street lighting technologies:** Through the procurement and operation of electrically operated, efficient lighting technology, significant savings potential and thus a considerable reduction in operating costs should be achieved. As a past example, the Senate aimed to achieve an energy saving target of 30 to 50 percent for public lighting in Berlin from 2008 to 2020. At the time the BEK 2030 was written, there were around 34,000 public lights operated with electricity and 190,000 lights operated with gas. By equipping these with energy-efficient lamps, the state aims to achieve significant energy savings.
- 3 | **Effort to limit light pollution from neon signs:** By using energy-efficient outdoor advertising and reducing light pollution, for example, through excessive advertising lighting, a significant reduction in energy and emissions can be achieved in the state of Berlin. In addition, small shops and boutiques should be made aware of the potential cost savings that result from the use of energy-efficient lamps.
- 4 | **Campaign for energy-efficient behavior in the workplace:** In the areas of lighting, use of devices with stand-by mode, and office heating, there is a potential of saving five to ten percent of energy consumption in every company, which can be achieved through appropriate information, work and awareness raising, combined with low-investment measures.
- 5 | **An industry-specific campaign with high visibility in the tourism sector is planned:** In order to ensure the visibility and perception of climate protection in public life, an awareness campaign for industries such as tourism and culture, including businesses and hotels, is planned. In addition, the relevant actors should be encouraged to initiate corresponding activities promoting energy efficiency themselves and thus act as role models for the industry.
- 6 | **Harmonization and qualification of advisory services:** This provision aims to increase accessibility to services related to energy efficiency.
- 7 | **Advisory services for small businesses and retail:** Since the majority of small businesses do not focus on the issue of energy efficiency and climate protection due to a lack of human and financial resources, targeted energy service

offerings in the areas of sensitization and mobilization, advice, cooperation and networking as well as financing should actively support them.

- 8 | **Creation, promotion, and implementation of innovative and integrated energy and climate protection concepts for existing commercial areas**
- 9 | **Initiate the construction of a zero-emissions business park as a showcase for a climate-neutral Berlin**
- 10 | **A plan for training and education for craftsmen involving energy savings renovations**
- 11 | **Establishment of a coordination office for operational climate protection:** The city should enable companies to gain uncomplicated access to know-how about the topics of energy efficiency and climate protection.
- 12 | **The continuation and expansion of the climate protection agreement:** The agreement was made between the state of Berlin and large companies such as BSR, BWB, and FU Berlin. Companies such as Vattenfall, GASAG, and Vivantes are an important element of Berlin's climate protection policy due to these companies' investments in energy efficiency, renewable energies, and climate protection, which are to be continued and expanded both in the field of energy supply and in the fields of economy, buildings and urban development, and transport.
- 13 | **Initiation of round tables on the topic of "Climate-neutral Berlin 2050.":** Here, central actors from different institutions with a common thematic connection come together and exchange information on specific projects at regular meetings.
- 14 | **Development of innovative savings contracting models for the public sector**
- 15 | **The "Berlin saves electricity" program:** In cooperation with chambers and associations, the aim is to increase electricity efficiency, especially in small industrial and commercial companies. The focus of the funding should be on the implementation of measures in cross-sectional technologies such as ventilation and cooling.⁷²

Finally, the energy problem lies at the heart of the economic impact of climate change with its various aspects related to both mitigation and adaptation. For this reason, this issue is also the target of NGOs and scholars working in the field. Moreover, living conditions and health are negatively impacted by energy poverty. Inefficient energy policies also affect low-income individuals, widespread poverty, inadequate housing, and a housing tenure system that discourages energy efficiency. While energy poverty is strongly ingrained in state policy in various European states, there are very few policies, compared to other European states, that specifically address it in Germany. Designing energy transitions and climate protection policies in a socially responsible manner is particularly difficult, but it is crucial to gaining widespread public support for the extensive changes required to meet aggressive emissions reduction targets.⁷³

The European Green Deal aims to increase collaboration between EU countries to become a carbon-neutral continent by 2050. The deal was set back due to the policies enacted by several countries to deal with the COVID-19 pandemic, though Germany suffered from fewer severe impacts than other countries. To work, the deal needs political and economic support throughout the EU, which was also set back due to the pandemic's influence on the economy and political climate. Furthermore, if the Green Deal is to be successful in Europe, it should work hand in hand with economic policies to prevent the trend toward recession. An article by *Intereconomics* defines the needed changes to achieve the Green Deal goals in an economically sustainable way. They include traditional solutions like switching to renewable energy, transforming the car-based mobility system, accelerating the energy renovation of the building stock, research, and development in digitalization for energy savings, and advanced green vocational education. Others are more unconventional; they suggest increasing the capabilities of the EU in the management of climate-related issues, constructing a European "silk road" to decrease the use of heavy vehicles like trucks to transport exports and imports, and a European planetary health policy.⁷⁴ However, this road map has to be adjusted in the face of the Ukrainian War without changing the main target: a carbon-neutral continent and cities by 2050.

73 Cludius, Johanna and et al. "Policy instruments and measures to alleviate energy poverty in Germany-learning from good practices in other European countries." Institut Working Paper 4, 6, June 2018, <https://www.oeko.de/fileadmin/oekodoc/WP-Energy-Poverty-2018.pdf>.

74 Sarah Wolf et al., "The European Green Deal – More Than Climate Neutrality," *Intereconomics: review of European economic policy*, 2021, 101-103, <https://doi.org/10.1007/s10272-021-0963-z>

3.3. BERLIN'S SOCIAL VULNERABILITY

During the G7 Leaders' Summit, Germany assumed responsibility for making the future more sustainable by further grounding gender equality. Since women are more affected by climate change than men, both (women and climate change) have begun to be addressed together. The climate crisis exacerbates existing inequalities, particularly discrimination against women and girls.

At the G7 Leaders' Summit, it was underlined that in order to build a flexible and inclusive democratic society, it is imperative to protect the rights of women and girls and to ensure gender equality. For that purpose, the leaders committed to eliminating harmful gender norms and stereotypes. The inclusion of women, girls, and LGBTIQ+ people in all policy areas is the main objective in politics, economy, education, and all other areas of society. As they work to meet the challenges of the COVID-19 pandemic, they are determined to address their gendered impact. The COVID-19 pandemic has disproportionately affected women and girls. It has been observed that inequalities have deepened with the pandemic. Although men have been affected by the pandemic at least as much as women in terms of health, women and girls have become more vulnerable than men in social and economic terms.⁷⁵

Compared to other EU member states, Germany's performance on gender equality is below average. Women do not provide adequate representation in both political and economic decision-making processes. Although laws protect women's rights in many countries, equal rights for women are still not fully possible in most societies. In Germany, this is particularly evident in the inequality of opportunity in business life and politics. However, women and men are in the same situation in terms of reaching education rights and working conditions. Though employment rates of women have increased, women are working in jobs that provide fewer working hours and low wages. A significant proportion of women face the risk of poverty after retirement. Although the problem of the gender pay gap has decreased over the years, it continues in Germany.⁷⁶

75 For further information: G7 Leaders' Communique, 28.06.2022, <https://www.g7germany.de/resource/blob/974430/2062292/9c213e6b4b36ed1bd687e82480040399/2022-07-14-leaders-communique-data.pdf?download=1>

76 European Commission, "She Figures 2021: Gender Equality in Research and Innovation-Germany" https://ec.europa.eu/info/sites/default/files/research_and_innovation/strategy_on_research_and_innovation/documents/ec_rtd_she-figures-2021-country-fiche-germany.pdf
See also: <https://eige.europa.eu/gender-equality-index/2021/country/DE>

A data study on gender pay gap will be mentioned under the "gender-based vulnerability" sub-section.

Many of these problems that exist in Germany also exist in the city of Berlin. The fact that gender equality cannot be achieved, especially in all areas of working life, is an issue that needs to be resolved for Berlin as well. However, a more important issue that needs to be developed for Germany in general and Berlin in particular is the need to increase the participation of individuals (especially women and young people) in civil society and decision-making mechanisms.

According to a study conducted in Berlin in 2010, it was seen that the educated middle class was more willing to participate in decision-making processes than the poor. Similarly, men and women over middle age were more willing to participate in the decision-making process than young people. In this respect, it is necessary to support and encourage the poor, women, and young people to take more part in decision-making mechanisms. On the other hand, there does not seem to be a problem with the representation of non-governmental organizations representing vulnerable groups in local governments. However, there are deficiencies in the direct individual representation of vulnerable groups.⁷⁷

Many projects have been implemented in Berlin to improve the physical environment for vulnerable groups. At the same time, projects were carried out to empower women and children, especially in school and education system. For example, the participation of mothers of children (especially migrants) at education age in socio-economic life is high. When looking at immigrant groups, mothers are interested in both the social and educational life of their children within the traditional family structure. Ensuring equal opportunities in education and increasing education opportunities in poor neighborhoods where immigrants live is an important development in Berlin.⁷⁸

When looking at the vulnerable groups in Berlin, immigrants, women, and children are in the most vulnerable. Therefore, any negativity experienced in Berlin directly affects these three groups the most. For example, women have been most affected by the housing crisis, especially after the COVID-19 pandemic. As mentioned above, on average, women earn less than men. Currently, the gender pay gap

77 Silver, H., Scott, A. and Kazepov, Y. (2010), "Participation in Urban Contention and Deliberation", *International Journal of Urban and Regional Research*, Vol. 34, No.3, September 2010, pp. 453-477.

78 Arzu Başaran Uysal, "Sosyal Şehir Programı ve Yerel Katılım: Berlin Örneği", *Çağdaş Yerel Yönetimler*, 25(4), 2016, pp. 27-47.

in Germany is 21%. Additionally, the rent crisis also increased psychological violence among women as many feel unsafe due to their inability to find affordable housing.⁷⁹ On the other hand, child poverty, which has also increased with the COVID-19 pandemic, has become one of the biggest problems of Berlin. The most vulnerable group experiencing child poverty in Berlin is immigrant child.⁸⁰

Although the German economy has been experiencing important developments in many areas for many years, the situation of children and youth living in poverty in the country cannot improve. According to statistics, one in five children and young people live in poverty. Of course, the effect of the pandemic in this regard is quite large. According to the report of the Bertelsmann Foundation, 2.8 million children and young people live in poverty in Germany. This number is equal to 21.3 percent of the population under the age of 18 living in Germany. In the country where child poverty is a very important problem, adequate studies have not been carried out. All these outputs expressed throughout Germany consist of data in Berlin and Bremen in particular. Especially in Berlin, the number of children growing up in families with poor financial situations is higher than in other cities.⁸¹

3.3.1. Migrant Women and Children

Approximately 12% of people living in Berlin are born outside of Germany or born of non-German parents. This makes Berlin Germany's most international city. Berlin is made up of people of different origins, religions, perspectives, and cultures. With the reunification of Germany after 1990, many social responsibility activities began to be implemented in Berlin to reduce social problems. In order to strengthen every vulnerable group excluded from socio-economic and cultural life, management paradigms have been changed, and civil society has received more support than before.⁸²

In the Neukölln region of Berlin, 20–25% of the population are immigrants. This region is one of three regions in Germany with a high immigrant density. Migrant women typically have problems adapting to the region in which they settle. Women contribute to the education of their children and have difficulties accessing medical services, especially without having a good command of the language spoken in the region. The local authorities in Berlin provide training for migrant women on topics such as day nursery, bilingual education, children's rights, preventive health, sexual development, physical development, media, nutrition, addiction prevention, and home safety. Local authorities identify local migrant mothers and recruit them to take part in the program. More than 400 migrant women have been recruited to date. This step taken toward the adaptation of migrant women to the city is very important.⁸³

Another project realized is the city tour through the eyes of refugees. The project was designed for asylum seekers living in Berlin to get to know and experience the city. The main purpose here is to offer asylum seekers the opportunity to see the city they live in through the eyes of other people and to confront their prejudices.⁸⁴

Climate change, which affects the whole world, also poses threats to Berlin, which is growing and developing day by day. Therefore, it has become essential to create a comprehensive harmonization process for Berlin. Because, as in every country and city, in Berlin, it is necessary to adapt actively and to take advantage of the opportunities that climate change will bring in order to reduce the damages caused by future climate change. It is an important question how resilient Berlin, which is a highly developed city in terms of economic, social welfare and technological advances, is against the effects of climate change. The vulnerability of the city depends on several factors. As in all other regions, there are tangible damages of climate change. These concrete destructions, which are the most important factors, have direct or indirect effects on people and especially vulnerable groups. For example, natural disasters, heat waves or adverse weather conditions affect people working outside. In addition, these

79 Ekaterina Kropacheva, Feyza Sayman, Nikita Schweizer, "Gender-Based Housing: The Berlin Housing Crisis for Women, 2021, https://www.cud.tu-berlin.de/wp-content/uploads/2021/06/6_fem_MAP_housing.pdf

80 Kropacheva, Sayman, Schweizer, 2021. See also: "OECD Interim Economic Assessment, Coronavirus: The world economy at risk", 2.03.2020, <https://www.oecd.org/berlin/publikationen/Interim-Economic-Assessment-2-March-2020.pdf>

81 Almanya'da 5 çocuktan 1'i yoksulluk içinde yaşıyor, 22.07.2020, <https://www.dw.com/tr/almanya-da-5-c3%A7ocuk-tan-1-i-yoksulluk-i%C3%A7inde-ya%C5%9F%C4%B1yor/a-54263412>

82 Khadka, S., Gender Roles And Migration: A Qualitative Field Study Of Nepalese Migrants in Berlin, Retrieved August 4, 2022, <https://vid.brage.unit.no/vid-xmlui/bitstream/handle/11250/225156/Master%20MGS%20Saban%20Khadka%20v14.pdf?sequence=1>

83 "Neighbourhood Mothers Neukölln-Stadtteilmütter Neukölln: integrating immigrant mothers via local women", 26.01.2018, https://ec.europa.eu/regional_policy/en/projects/germany/neighbourhood-mothers-neukolln-stadtteilmutter-neukolln-integrating-immigrant-mothers-via-local-women

84 Alice Dundon, "Breaking Down Barriers in Berlin: Refugees Let Visitors Explore the City Through Their Eyes", 25.05.2018, <https://theculturetrip.com/europe/germany/berlin/articles/breaking-down-barriers-in-berlin-refugees-let-visitors-explore-the-city-through-their-eyes/>

adverse weather conditions also affect young children and individuals with chronic diseases very quickly.

On the other hand, environmental and climate refugees migrating to Berlin pose some problems for the city. People who migrated from their settlements due to increasing floods and droughts prefer to live in cities such as Berlin where opportunities are diverse. However, Berlin's immigration due to climate change reveals some inadequacies in the city. In addition to the effects of climate migration due to climate change, it is seen that the market and supply are also negatively affected. This unbalanced situation in the market creates negativities in Berlin's foreign trade. On the other hand, tourists coming to Berlin, which is a touristic city, can carry diseases or be directly affected by climate change.⁸⁵

Climate change affects vulnerable groups, even in a developed city like Berlin. Refugees, especially those living in cities, are the first vulnerable group to be affected by climate change due to their low level of welfare. As mentioned above, the biggest impact of climate change is on children and women. Child poverty, which has increased after the pandemic, is both an effect and a result of the climate crisis. People who have migrated from one place to another due to adverse climatic conditions, expressed as climate migrants, are vulnerable groups living in Berlin.

Non-governmental organizations and local organizations that carry out studies and projects on the impact of climate change on vulnerable groups are not able to put forth sufficient effort. There are not many exemplary projects on this subject, but there are also practices organized for vulnerable groups to adapt to changing conditions.

3.3.2. Gender-Based Vulnerability

Following a decision by the Berlin House of Representatives in 2003, Berlin has tried to create a gender-sensitive budget that is practiced in local governments in Berlin. In the practice of gender-based budgeting, gender-disaggregated data of the personnel employed in each department are presented.⁸⁶ However, it is not

certain that these data will create an imbalance based only on gender in the coming years. Gender-based information is included in Berlin's 2016–2017 budget processes. Although Berlin has strived to strengthen gender equality through the presentation of clear data, there are concerns that a qualitatively effective analysis cannot be made. Therefore, it does not appear that Berlin has yet reached the final stage on gender equality.⁸⁷

Although they were not completely closed during the pandemic, many workplaces had to temporarily suspend their work. Every individual in the society has been negatively affected by this process, but it has been very difficult for women to harmonize their responsibilities in their home life and changing working systems. Therefore, negative effects of gender roles in society have been observed during the pandemic process. As seen in many countries after the COVID-19 pandemic, it has been revealed that women are affected more negatively economically than men in Germany. Women are more likely to be fired or quit than men. In social professions where women are employed, their salaries need to be increased and responsibilities at home need to be distributed more equitably.⁸⁸

Gender-based inequality between men and women in Berlin is mostly found in the economic field. The COVID-19 pandemic has also triggered this inequality and therefore the vulnerability of women. In order to resolve the vulnerability based on income inequality, women need to be more actively involved in managerial positions of workplaces. Also, in Berlin, women are not active enough in social professions and digital living spaces compared to men. Increasing the effectiveness of women in these areas will support the reduction of gender-based vulnerabilities.

85 Berlinbaut, "Adapting to the Impacts of Climate Change in Berlin-AFOK", file:///C:/Users/nuysal/Downloads/adapting_to_the_impacts_of_climate_change_in_berlin.pdf

See also, download of the AFOK final report at: <https://www.berlin.de/sen/uvk/>

86 Shelia Quinn, "IMF Working Paper, Europe: A Survey of Gender Budgeting Efforts", 16/155, pp. 22-25, 2016, file:///C:/Users/nuysal/Downloads/[9781475520088%20-%20IMF%20Working%20Papers]%20Volume%202016%20(2016).%20Issue%20155%20(Jul%202016).%20Europe.%20A%20Survey%20of%20Gender%20Budgeting%20Efforts.pdf

87 H. Hakan Yılmaz, İtibar Aydemir-Uslu, Mustafa Biçer, "Yerel Yönetimlerde Toplumsal Cinsiyete Duyarlı Bütçeleme: Tekirdağ Büyükşehir ve Urla Belediyesi Uygulamaları", *Manisa Celal Bayar University Journal of Social Sciences*, ISSN: 1304-4796, 2021; 19(2); pp. 15-46, <https://dergipark.org.tr/tr/download/article-file/693899>

See also: Ayşegül Yakar Önal, "Toplumsal Cinsiyete Duyarlı Bütçeleme: Türkiye'de Katılımcı Demokrasinin Güçlendirilemesi: Toplumsal Cinsiyet Eşitliğinin İzlenmesi Projesi Faz II", March 2021, <https://ceidizler.ceid.org.tr/dosya/toplumsal-cinsiyete-duyarli-butcelemedf.pdf>

88 Esin Koç, Zuhâl Yeniçeri, "COVID-19 Pandemi Sürecinin Toplumsal Cinsiyet Eşit(siz)liğine Etkileri" *Akdeniz Kadın Çalışmaları ve Toplumsal Cinsiyet Dergisi*, IV (1), pp. 80-102, 12.04.2021, <https://dergipark.org.tr/en/download/article-file/1649590>

4. CONCLUSION

This report aims to examine the relationship between climate change and vulnerable groups in Berlin. The report was prepared by a joint research team from IKV, IPC and TEPAV. The research team conducted a literature review. While this report focuses on the relationship between climate change and vulnerable groups, it also examines the legal and institutional procedures related to climate change in both Germany and Berlin. The report analyses the impact of climate change and the emerging problems of vulnerable groups in Berlin.

The global climate crisis has created an environment of insecurity, especially for vulnerable groups, in many parts of the world. Cities are one of the major causes of climate change, as urban activities are significant producers of greenhouse gas emissions. According to estimates, cities produce 70% of the global greenhouse gas emissions, with transportation and construction as two of the biggest sources. Therefore, more efforts are needed to eliminate the vulnerabilities of individuals in cities and increase their resilience. Success can only be attained through implementing a coordinated strategy and efforts at the global, regional, national, and local levels. Making cities a vital component of the solution to combating climate change is therefore essential. Urban residents can make their voices heard through local representatives and contribute to decision-making processes. In this way, they will be able to convey the problems they face to the relevant authorities and have a say in the decisions taken for the region.

Berlin Municipality has prepared a detailed climate change action plan and set several goals to this end. BEK 2030 has drawn a broad road map to address the challenges of climate change. As one of the economic hubs of Germany, Berlin's emissions per person in 2014 were 4.9 tons of CO₂, which is almost half the national average in 2015. As a "climate-friendly" city, Berlin intends to reduce urban carbon emissions by 95% compared to 1990 by 2050. The rise in temperature, increased precipitation, stronger winds, and changing soil are the main challenges in Berlin. In the meantime, urban heat islands jeopardize vulnerable groups such as the elderly, children, and refugees. Although Berlin's green spaces are more plentiful than in similar-sized cities in Europe and the United States, the temperature rise challenges the viability of these spaces. Raising citizens' awareness of climate change and developing alarm systems are critical issues for the city.

The city's economic activities are also threatened by climate change. The rise of temperatures and how it could harm economic sectors is one of the essential dimensions of this issue. There are fifteen mitigation and adaptation measures set out in the BEK 2030, from energy-savings to campaigns to raise awareness in economic sectors. These measures also depend on institutional coordination. The plan also covers the situation of outdoor labor and tourism in detail. Moreover, it sets extensive road maps that might be useful for other cities on the same scale as Berlin.

The individuals most vulnerable to climate change are refugees, women, and children living in Berlin. Refugees who fled to Berlin due to climate change-related natural disasters are still struggling. Many institutions in Berlin carry out projects that address migrants' challenges. Project contributions to this end, examples of which are included in the study, are significant. However, it is evident that they are insufficient to fully prepare Berlin's vulnerable populations for the oncoming climate crisis. Due to its high refugee population, much more advanced and extensive studies should be carried out in Germany in general and Berlin in particular. It is essential to address the concerns brought on by climate change, such as women's unemployment and child poverty and to involve disadvantaged groups in local decision-making.

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