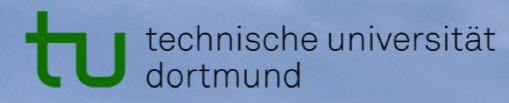




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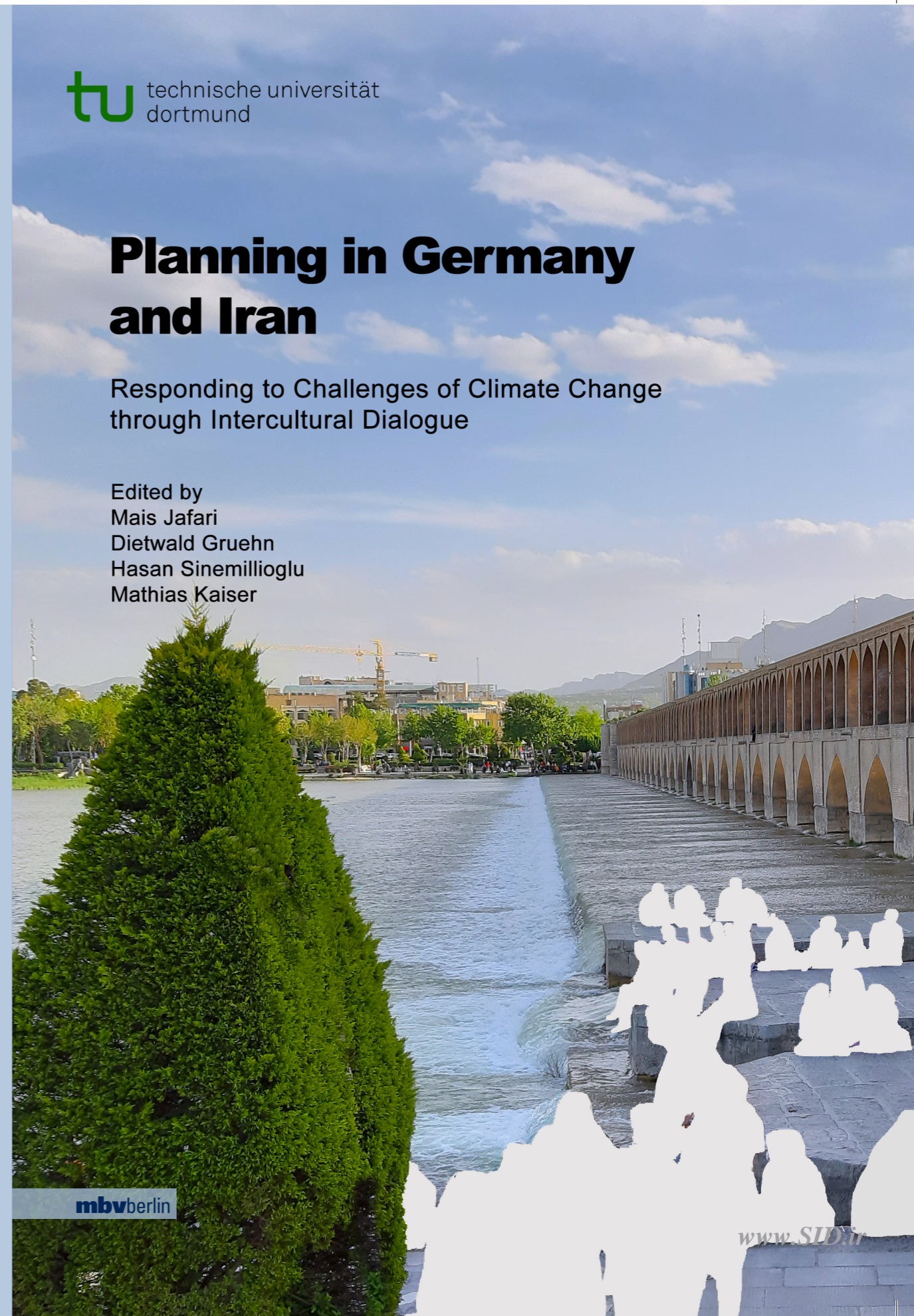
Mais Jafari - Dietwald Gruehn
Hasan Sinemillioglu - Mathias Kaiser (Hrsg.)



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عنوان :

آلودگی هوا و سلامت عمومی، تلاشی برای افزایش تاب آوری اجتماعی در برابر اثرات تغییرات آب و هوایی

Air Pollution & Public Health Efforts to increase social resilience to the effects of climate change

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Editors

Mais Jafari, Dietwald Gruehn, Hasan Sinemillioglu, Mathias Kaiser

Faculty of Spatial Planning, Chair of Landscape Ecology and Landscape Planning
TU Dortmund University

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Schriftleitung

Mais Jafari¹, Maryam Taefnia², Ghazal Farjami², Mohammad Bashirizadeh¹

¹ TU Dortmund University

² Daneshpajohan Pishro Higher Education Institute (DHEI), Esfahan, Iran

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15.**Air Pollution & Public Health: Efforts to increase social resilience to the effects of climate change**

Mahdi Suleimany, Safoura Mokhtarzadeh, Maryam Taefnia, Ghazal Farjami

Abstract

The growth of cities, the industrialization and the overuse of fossil fuels in the last two centuries, has been costly for man. One of the undesirable effects of these was the intensification of climate change and the other was air pollution. The effects and consequences of climate change and air pollution not only affect the individuals' physical and mental health, but also by threatening the health of people as social capitals of a society and diminishing social health it is causing severe damage to the socio-economic structure of that society. Therefore, this study, in order to enhance public health, increasing social resilience, and preserving social capital, first through a descriptive-analytical method has been studied the impact of climate change on physical and mental health and then analyzed the relationship between social resilience and social health to reduce the adverse effects of climate change, especially air pollution. The results show that if individuals and society are not resistant to these threats from climate change, especially air pollution, so they are unable to mitigate and control the negative consequences thereof. They, in addition to their physical and mental health problems, will face complex social and economic problems in the future. On the other hand, the relationship between social health and social resilience is a two-way relationship, so in the event of the loss of social health and reduced social resilience, society also will not be able to cope with other (natural and human) crises.

Keywords: Climate change, Air pollution, Public health, Social resilience

1. Introduction

It becomes a long time that nations have embroiled with the impacts and consequences of phenomena, which were appeared as the result of industrialization and fossil fuel overuse. One of these phenomena is climate change and the other is air pollution that has considerable direct and indirect impacts on citizens' physical and mental health. The 2015 Global Burden of Disease survey estimated that just one aspect of air pollution, fine particulate matter, is largely responsible for 7.6% of all deaths worldwide (Cohen et al. 2017). It is obvious the pace of climate change will slow down as the emission of greenhouse gasses reduce and spread of air pollution decrease. But the fact is even this trend slows down or stops right now, nations and people will be prone to changes and affection of phenomena that have been caused by emitting greenhouse gasses and air pollution in recent decades (WHO 2018).

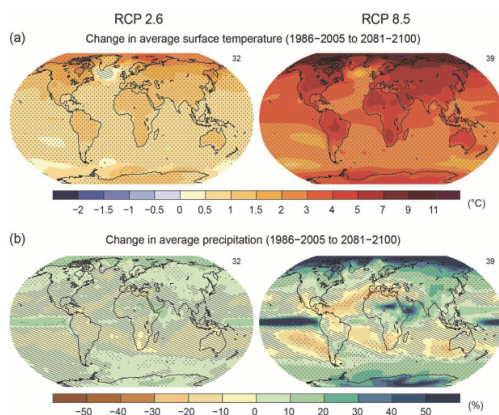


Figure 15-1 Projected changes in average temperature and precipitation by the end of the current century, under the lower (RCP 2.6) and higher (RCP 8.5) of the range of four scenarios of greenhouse gas emissions assessed by the Intergovernmental Panel on Climate Change (IPCC, 2013)

Based on figure 15-1, which predicts climate change caused by emissions and greenhouse gases by the end of the century; Pollutants released into the air over the past few decades will cause global warming and severe rainfall in many cities and populated areas (IPCC 2013). Due to the fact that global warming and climate change are almost inevitable and the consumption of fossil fuels and the volume of pollutants released does not seem to decrease significantly; Maintaining people's physical and mental health in the face of climate change and air pollution and also increasing social resilience is essential to reduce their negative impacts on public health (Suleimani et al. 2019).

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Social resilience, as the capacity of a social system to facilitate social trends, reduce vulnerability, and increase adaptability, helps individuals, groups, and organizations to sustain their existence (with maintaining relative stability) in the face of multiple types of shocks and changes, including climate change and air pollution (Berman et al. 2003). This capital that has recently been noticed by various groups of researchers, particularly in the field of ecology, urban and social studies, has significant effects on public health, especially on the mental well-being of citizens. Also, the conclusion of few pieces of research in this field shows that a well-being society is more resilient to the environmental hazards, among climate change and air pollution (WHO 2014).

Despite numerous studies in the relationship between air pollution and public health, researches on the relationship between public health and resilience, especially social resilience, have been less done. However, the effects of air pollutants on mental health conditions have been less-well studied and mostly confined to epidemiological studies, which can demonstrate an association but cannot show causation. Observational evidence has revealed small-to-moderate sized associations between increasing levels of several components of air pollution and a range of mental health outcomes (King 2018). The beginning of these studies date back to the 1970s and 1980s, and by the formation of the sustainable development's concept and its placement at the top of development plans and goals in many cities around the world, the necessity of such studies has increased. Today, the most formal type of these researches is at the request of the World Health Organization and under the auspices of the United Nations, which is reviewed and published annually at conferences on health and climate or health and air pollution.

As one of the metropolitan cities of Iran with a population of over 2 million people, Esfahan is one of the most polluted cities in Iran and even in Asia. Surrounding by heavy and polluting industries such as steel and petrochemical factories, as well as the traffic of freight and diesel vehicles from the western axis of the city, is the main reason for the city's air pollution. Also, Esfahan is among of top 50 cities in the world in terms of air pollution index and its air quality has estimated unhealthy for sensitive groups on most days of the year (Air Quality Monitoring Organization of Iran 2019).

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Table 15-1 The quality of Esfahan city’s air in AZAR 1398 (22th November - 21st December 2019) (<http://www.esf-payesh.com/>)

Friday	Tuesday	Wednesday	Thursday	Monday	Sunday	Saturday	Guide
2	1						Good
9	8	7	6	5	4	3	Moderate
16	15	14	13	12	11	10	Unhealthy for Sensitive Groups
23	22	21	20	19	18	17	Unhealthy
30	29	28	27	26	25	24	

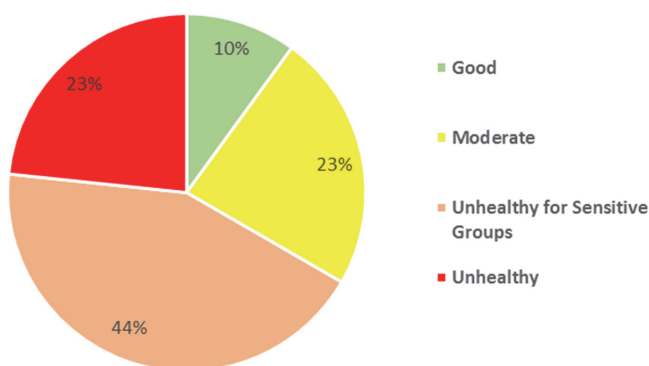


Figure 15-2 The quality of Esfahan city’s air in Azar 1398 (22th November - 21st December 2019) (Authors)

The main purpose of this research is to investigate the role public health in the social resilience and the impacts of climate change and air pollution on the citizens, as the most important social capital, through a descriptive-analytical method by reviewing the literature on air pollution, climate change and resilience.

2. Previous Literature

As mentioned in the introduction, despite numerous studies in the field of the relationship between air pollution and public health, researches on the relationship between community health and urban resilience, especially social resilience, have received less attention. Most studies in this field investigate the impact of these two phenomena (climate change and air pollution) on human health, especially physical health. Reviewing these studies will help to improve the conceptual framework of the research. The summary of the most creditable research in this field is presented in table 15-2.

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Table 15-2 Summary of the related researches in the field of air pollution, health, and social resilience (Authors)

Title	Authors	Year	Objectives	Method	Indicators	Results
Air pollution in European countries and life expectancy	Kolasa-Więcek & Suszanowicz	2019	Investigating and modeling the relation between air pollution and life expectancy	Neural network	<ul style="list-style-type: none"> -The volume of pollutants in European countries -The life expectancy rate in European countries 	Pollutants such as particulate matter (PM ₁₀ and PM _{2.5}), nitrate (NO _x), and sulfate (SO _x) pollutants, as well as carbon monoxide (CO), have the most detrimental long-term effect on public health and citizens' life expectancy among pollutants.
A spatial epidemiology case study of mentally unhealthy days (MUDs): air pollution, community resilience, and sunlight perspectives	Shao & Ha	2019	Investigating the effect of air pollution and sunlight perspectives on mental health and community resilience	Spatial multi-variable Regression	<ul style="list-style-type: none"> -The number of mentally unhealthy days (MUDs) in the US -The number of days with polluted air in the US. -Type and volume of pollutants in the US. 	People's mental health is affected by a variety of factors, including the environmental conditions in where they live. The results of this study show that in states where air pollution is less, community resilience is higher, and the number of mentally unhealthy days is lower.
Conference on Health and Climate	World Health Organization (WHO)	2018	Discussion about the importance of climate change and its impacts on citizens' health based on their age and gender	Descriptive-analytical	<ul style="list-style-type: none"> -Impacts and Consequence of climate change -The prevalence of chronic diseases 	The report cites the rise of chronic diseases, congenital diseases, waterborne or foodborne illnesses, parasitic and microbial diseases, and the decline in human efficiency as a result of climate change. It also argues that facing the effects of climate change and the phenomena that result from it is inevitable, so people, and especially the vulnerable groups, children and the elderly, must be made resilient to these changes.
Air pollution, mental health, and implications for urban design	King	2018	Investigating the impacts of air pollution on citizens' mental health in urban environments	Descriptive-analytical	<ul style="list-style-type: none"> -Type of pollutants - The impact of each pollutant on mental health 	This study shows an obvious and rational link between air pollution and depression, anxiety and distress, mental illness, neurological disorders in children, and the elderly, as well as suicide attempts.
Estimates and 25-year trends of the global burden of disease attributable	Cohen et al.	2017	Investigating and analyzing the Global Burden of Diseases Study	Descriptive-analytical	<ul style="list-style-type: none"> -Changes in the volume of pollutants from 1990 to 2015 	Exposure to air pollution, especially particulate matter and chemical compounds caused by the combination of pollutants with ozone, increases the

Title	Authors	Year	Objectives	Method	Indicators	Results
to ambient air pollution: an analysis of data from the Global Burden of Diseases Study					-Changes in the deaths attributable to air pollution from 1990 to 2015	incidence of chronic diseases and death, and is one of the most common global burdens of diseases.
Air pollution and cardiovascular disease	Franklin, Brook, Arden, & Pope	2015	Investigating the relation between air pollution and cardiovascular diseases	Descriptive-analytical	-The index of air pollution -The rate of cardiovascular diseases	Exposure to air pollution Aggravates the growth of cardiovascular disease as well as the spread of acute heart attacks.
Some resilient aspects of urban areas to air pollution and climate change, case study: Tehran, Iran (Persian)	Sharipour, Bidokhti, & Sehat	2014	Investigating the effect of climatic and meteorological factors on urban resilience in a case study of Tehran	Descriptive-analytical	-The volume of air pollutants -The climate change factors -The rate of chronic diseases	The thermal islands and the heat generated by them is increasing. Rising the emission of greenhouse gasses has increased the temperature of Tehran's air. The aggravation of this trend in the recent decade has increased the consistency of ozone near the Earth's surface, which increases the risk of developing chronic diseases, cardiovascular disease, and respiratory diseases.
Short-term effects of air pollution on health	Katsouvanni, Grvparis, & Samoli	2013	Investigating and comparing the short-term effects of airborne particles and pollutants on people's health	Comparative comparison, Correlation test and Regression	-The volume of air pollutants -The number of Death attributable to air pollution	If the consistency of particulate matter, especially PM ₁₀ , is reduced by up to 20 micrograms per square meter each day in Europe, then it will lead to a reduction in the mortality rate of 15 people per 100,000 inhabitants per year. They argue that nitrogen dioxide (NO ₂), carbon monoxide (CO), and the combination of the two gases with ozone is the most dangerous pollutants for human health.
The effect of air pollution on pregnancy result (Persian)	Delpishe, Dirkvand, & Dirkvand	2012	Investigating the effect of pollutants on fetal health during pregnancy	Systematic review	-Synoptic weather patterns -The rate of fetal diseases	Air pollution causes babies to be born with respiratory problems or babies' death. The relation between low birth weight, neonatal and intrauterine growth retardation, and air pollution have been confirmed.
The relation between air pollution and death in	Gholizade & Farajzade	2007	Investigating the effect of pollution on the death of people living	Comparative comparison, Correlation test and Regression	-The volume of air pollutants in Tehran	There is a link between air pollution and deaths from cardiovascular disease, respiratory disease, and stroke. The severity of this

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Title	Authors	Year	Objectives	Method	Indicators	Results
Tehran (Persian)			in Tehran over a period of 2000 to 2005.		-The number of Death attributable to air pollution in Tehran	relationship increases in the last months of autumn and the first winter (November to January) and the highest correlation is in the last days of autumn each year.
The estimate of respiratory death attributable to air pollution in Tehran (Persian)	Joneydi Jafari, Zohour, Rezaei, Malekafzali	2007	Assessing and estimating the number of deaths from heart and respiratory diseases due to air pollution in Tehran	Sensitivity test	-The volume of air pollutants in Tehran -The number of Death attributable to air pollution in Tehran	Weak but significant correlations are observed between the consistency of suspended particulate matter (PM ₁₀ and PM _{2.5}) and the total number of cardiac and respiratory deaths, so that 17.11% of the total natural (or accidental) mortality and 39.9% of the total deaths is from heart and respiratory diseases in people over the age of 30 can be attributed to long-term exposure to air pollution.
The relation between air pollution and heart-attack syndrome (Persian)	Ghorbani et al.	2005	Investigating the relationship between air pollution and acute heart syndrome	Descriptive-analytical	-The rate of acute heart syndrome -The air quality index	There is a direct and significant relationship between acute cardiac syndrome and an average of CO
Synoptic weather patterns and modification of the association between air pollution and human mortality	Daniel, Rainham, Karen, Smoyer, & Burnett	2005	Investigating the synoptic weather patterns and establish a link between air pollution and human death.	Descriptive-analytical	-Synoptic weather patterns - The volume of air pollutants -The number of Death attributable to air pollution	Throughout the year, and especially in the summer, there is a direct link between the weather's synoptic patterns, air pollution, and mortality rates.
Review of air pollution and health impacts in Malaysia	Rafia, Mohd, & Akmalbarhima	2001	Investigating the air pollution and its effect on health in Malaysia	Descriptive-analytical	-Air quality index -The rate of chronic diseases	They concluded that air pollution in Malaysia was based on reports of air surveillance in several major cities. They identified the city's air pollutants as carbon monoxide (CO), sulfur dioxide (SO ₂), nitrogen dioxide (NO ₂), ozone, and particulate matter, the main source of which is fossils fuel consumption in industry and transportation.

3. Climate Change and Air Pollution

The growth of cities, industrialization, and the excessive use of fossil fuels in the last two centuries have had various consequences for mankind. One of the adverse impacts of these developments is the intensification of climate change, and the other is the formation of a phenomenon called air pollution. Climate change in the meaning of mutation in the overall climate and weather pattern of a place, exists from the beginning in the environmental trends and its adverse effects were offset by the environment itself, but over the last two centuries, human activities have intensified this trend; In a way, the ability to recover and eliminate the negative effects caused by it have taken from nature and also new definitions have presented for this phenomenon. Paragraph 1 of article 1 of the United Nation Framework Convention on Climate Change (UNFCCC) states: climate change is a wide mutation in climate and weather patterns directly or indirectly caused by human activities and these changes are in addition to natural changes of climate and weather patterns that occur in different periods. These changes are reflected in an increase in average air temperature, changes in sea and ocean water temperatures and melting ice mountains, as well as changes in precipitation patterns and increased periods of drought (UNFCCC 1992)

Air pollution, which is caused by the emission of pollutants into the Earth's atmosphere, is another phenomenon created by the developments of the last two centuries in the world and has affected human life in different aspects. There are also several definitions in this regard, but the first comprehensive definition adopted by many countries was the one introduced by the Economic Community (EEC) in September 1967. In this definition, air pollution is the presence of foreign substances (pollutants) or changes in the constituent elements of the atmosphere in a way that has a detrimental effect on the environment or causes discomfort and diseases to people (Escourrou 1991).

Determining the boundary between climate change and air pollution is not as easy as writing it down, in fact, climate change and air pollution are two sides of the same coin. However, in some studies, climate change has been introduced as a result of air pollution (Schaub & Paoletti 2007). But the impact of these two phenomena on each other is so great that one cannot be considered another factor. Besides, climate change existed before the emergence of a phenomenon called air pollution in the natural context. Climate change is due to several natural and human factors, although the contribution of human factors to the intensification of these changes is very significant and widespread. Natural factors affecting climate change are divided into two categories: terrestrial and extra-terrestrial factors; Terrestrial factors are

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natural events on the earth's surface, such as changes in the trends in the atmosphere, changes in the salt level of ocean water, relocation of continents, etc. Extra-terrestrial factors are galactic trends that affect the Earth's atmosphere and climate. These factors are caused by solar processes, the impact of planets on each other, and the oscillations of the earth's orbit, and the processes that take place in the motion and rotation of the earth (Scherhag 1936). Obviously, these factors affect the Earth's climate for a very long time, although, as noted, most of these effects are neutralized or compensated for by the natural environment.

By upsetting the balance of natural reactions, trends, and mechanisms, human activities have direct and indirect effects on the earth's climate (Escourrou 1991). According to the European Climate Change Programme (ECCP), induced human activities on climate change include greenhouse gases, particulate matter and aerosol emissions, changes in land reflection and heat pollution, and also thermal islands (EU 2000). And based on reports from the Intergovernmental Panel on Climate Change (IPCC), the production and distribution of greenhouse gases by vehicles and industries has the greatest role in intensifying and accelerating the process of climate change (IPCC, 1988). Air pollution as one of the factors affecting climate change is at different levels and from different pollutants. Sources of air pollution production and emissions can be classified into three levels; The sources of pollution generated and emitted on the surface of the earth by vehicles, on the roof surface that comes out of the chimneys of houses and factories, and in connection with precipitation and weather currents that lead to the formation of the phenomena like acid rain. Carbon oxides (CO_x), Sulfur oxides (SO_x), Nitrogen oxides (NO_x), ozone compounds, suspended particles and, dust are the major air pollutants, and among them, Carbon dioxide (CO₂) has the most adverse effect on climate change (Escourrou 1991).

Climate change and air pollution are so intertwined; Some pollutants, such as carbon dioxide (CO₂) and ozone compounds, increase the surface temperature by trapping heat on the earth's surface, and others, such as Sulfur oxides (SO_x), by changing the pattern and intensity of light reflection cause altering in the process of evaporation and precipitation (EU 2010). Of course, the bilateral nature of this relationship and the impact of climate change on air pollution, despite its low affection, are undeniable. This impact occurs in two ways: by provoking chemical reactions, such as the formation of photo-oxide fog or by some peak of pollution. It can be said that the phenomenon of air inversion that occurs on cold days is the most obvious example of the dialectic relationship between climate change and air pollution (Escourrou 1991). Climate change, air pollution, and the effects of their interactions have a profound effect on the

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earth and its inhabitants. These impacts, most of which are undesirable, affect different social, economic, and environmental aspects of human life. These effects are defined in paragraph 2 of article 1 of the United Nation Framework Convention on Climate Change (UNFCCC) as unfavourable changes in the environment or habitat of plants and animals due to climate change and pollution. It has detrimental effects on the productivity of natural ecosystems or economic and social systems in mankind's life and also human health or welfare (UNFCCC 1992).

4. Climate Change, Air Pollution, and Public Health

Greenhouse gases are growing day by day, and climate change grows much quicker than expected and its effects are evident worldwide. The average global temperature for 2018 is approximately 1 °C above the baseline level before the industrial period and the last four years have been recorded in recent years. From this, climate change is the issue of determining our time and the biggest challenge for sustainable development (Ghasemi et al. 2019).

On the other hand, human health has been important for centuries since the creation of mankind. Health is a multidimensional concept that, in addition to the lack of disease and disability, includes a sense of happiness and well-being (Ryff & Singer 1996). In the category conducted by the World Health Organization, people's health is examined in three classes: physical, mental, and social health. Physical and mental health affect each other and its results appear in a concept called social health. Climate change and air pollution are directly and indirectly impact people's health, and by creating and spreading chronic, infectious, parasitic, and even genetic diseases, increasing mortality and reducing physical and mental productivity affects citizens' life (WHO 2018). In addition to climate change and air pollution leading to many diseases indirectly in the long run, the effects of these two phenomena are directly and in the form of respiratory, cardiovascular, and chronic pulmonary diseases, reduce people's health and threaten them (Chappelka & Pan 2007).

According to the category provided by the Intergovernmental Panel on Climate Change (IPCC) and the World Health Organization, climate change affects people's health in three ways; I- Direct impact on people's health; Such as diseases and casualties caused by unfavorable weather conditions, II- Indirect effects through natural systems; Such as intensifying air pollution and increasing infectious diseases, and III- Indirect impact through social systems; This form includes malnutrition, anxiety caused by heatstroke, and mental illness which have wide effects on citizens' health and may lead to reduced productivity (WHO 2018).

Table 15-3 Summary of the main expected health impacts of climate variability and climate change globally by the middle of the current century (Authors)

Effect	Exposures effected by climate change	Health risks	Health impacts	Confidence rating
Direct effects	Increased numbers of warm days and nights; increase in frequency and intensity of heat waves; increased fire risk in low rainfall conditions	Excess heat-related mortality; increased incidence of heat exhaustion and heat stroke, particularly for outdoor labourers, athletes, elderly; exacerbated circulatory, cardiovascular, respiratory, and kidney diseases; increased premature mortality related to ozone, and air pollution produced by fires, particularly during heat waves	Greater risk of injury, disease, and death due to more intense heat waves and fires	Very high
	Decreased numbers of cold days and nights	Lower cold-related mortality, reduced cardiovascular, and respiratory disease, particularly for the elderly in cold and temperate climates	Modest improvements in cold-related mortality and morbidity	Low
Effects mediated through natural systems	Higher temperatures and humidity, changing and increasingly variable precipitation, higher sea surface and freshwater temperatures	Accelerated microbial growth, survival, persistence, transmission, virulence of pathogens; shifting geographic and seasonal distributions of e.g. cholera, schistosomiasis, and harmful algal blooms; lack of water for hygiene; flood damage to water and sanitation infrastructure, and contamination of water sources through overflow	Increased risks of food- and water-borne diseases	Very high
	Higher temperatures and humidity, changing and increasingly variable precipitation	Accelerated parasite replication and increased biting rates; prolonged transmission seasons; re-emergence of formerly prevalent diseases; changing distribution and abundance of disease vectors; reduced effectiveness of vector control interventions	Increased risks of vectorborne diseases	Medium
Effects heavily mediated by social systems	Higher temperatures and changes in precipitation	Lower food production in tropics; lower access to food due to reduced supply and higher prices; combined effects of undernutrition and infectious diseases; chronic effects of stunting and wasting in children	Increased risk of undernutrition resulting from diminished food production in poor regions	High
	Higher temperatures and humidity	Outdoor and unprotected workers obliged to work in physiologically unsafe conditions, or to lose income or livelihood opportunities	Consequences for health of lost work capacity and reduced labour productivity in vulnerable populations	High

The final column refers to the level of confidence in the evidence for expected health impacts, as assessed in the 5th Assessment report of the IPCC. Other health impacts are possible but were not assigned an evidence grading by the IPCC (WHO 2018).

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In examining the relationship between air pollution and health, the destructive effects of pollutants on people's physical and mental health cannot be ignored. The impact is so severe that air pollution and its aftermaths in 2012 have directly responsible for more than 6 million people deaths worldwide. Estimates show that this number will increase to 8 million inhabitants in a year, by the end of 2020, which approximately 4.3 million of those are due to household pollutants and 3.7 million are due to industrial pollutants. Among the pollutants, particulate matter (especially PM_{2.5}), which is produced and emitted by vehicles from the burning of fossil and diesel fuels, is the main cause of many dangerous diseases which consequent on air pollution (WHO 2014). Based on the Global Burden of Disease particulate matter was a major reason for near 4 million mortalities worldwide (Cohen et al. 2017).

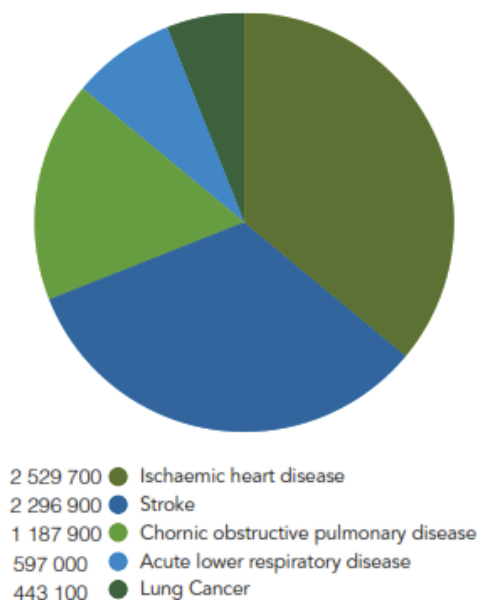


Figure 15-3 Deaths attributable to the joint effects of household air pollution and ambient air pollution by disease, 2012 (WHO, 2014)

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After particulate matter, ozone and the phenomena that result from its combination with other pollutants are considered the most dangerous pollutants. This pollutant is one of the main reasons for lung and respiratory diseases, which cause by lowering Ozone (O₃) gas as the result of global warming and its combination with pollutants such as nitrogen oxides (NO_x).

Table 15-4 The impact of various pollutants on citizens health (Authors)

The type of pollutant	Health impacts
Carbon monoxide (CO)	Combination with hemoglobin in the blood and reduced lung capacity, nerve stimulation, neurological disorders, headaches, and dehydration. Excessive exposure to this gas can lead to severe respiratory disorders and death (Heinsohn, 1999).
Sulfur dioxide (SO ₂)	Disrupting DNA and causing genetic diseases, reducing the body's resistance to infectious illnesses (Heinsohn, 1999).
Nitrogen dioxide (NO ₂)	Stimulation of the lungs and respiratory tract, irritation of the throat and eyes, fatigue, and decreased lung capacity (Heinsohn, 1999).
Ozone	Severe fatigue, severe decrease in capacity and inflammation of the lungs, asthma, and cancer (Heinsohn, 1999).
Particulate matter	Poisoning, cancer, pneumonia, and severe respiratory and cardiovascular diseases (Heinsohn, 1999).

The impact and consequences of climate change and air pollution not only affect people's physical and mental health; Rather, by threatening the health of individuals as the major social capital and human capacity of a society and reducing social health, it causes severe damage to the social and economic structure of the nations (WHO 2014). If individuals and societies do not resist these threats and are unable to reduce and control the negative consequences, they will undoubtedly face complex social and economic problems and difficulties in the future.

5. Public health and Social Resilience

Resilience literally means 'The power or ability to return to the original form' is originally from the Latin word 'Resilio' with the meaning of 'Return to the past' from the 17th century (Klein et al. 2003). But by the conventional meaning, was used by Holling in 1973 in the

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definition of 'A measure of the system's ability to absorb changes, while still having previous resistance' (Holling 1973). Nowadays, resilience is an accepted term in various fields. And different ranges, levels, and categories have been proposed for it. Some studies examine resilience at the individual, societal, or national levels, and some refer to the two levels of society and the country as social resilience (Kimhi 2016). In some researches, the resilience is defined by the spectrum of equilibrate, transformative and adaptive action (Aditya et al. 2010). For the first time in a study entitled 'A place-based model for understanding community resilience to natural disasters' Cutter et al. considered 6 forms of ecological, social, economic, institutional (organizational), individual (psychological) and physical (basic) for resilience, and mentioned that resilience involves a continuous process of change and modification (Cutter et al. 2008).

One of the most important forms of resilience is social resilience which was defined by Timmerman as a 'Reflection of society's ability to cope with probable disasters in the future' (Timmerman 1981). As it mentioned before, making resilient communities is one of the most fundamental action for achieving sustainability; Because resilience in confronting disasters is more than being prepared to cope with, and it affects and depends on different dimensions of a society like social capitals, available resources, etc. (Institute of British Columbia 2012).

Table 15-5 Common definitions of social resilience (Authors)

Timmerman 1981	The reflection of the community's ability to deal with accidents in the future.
Paton & Johnston, 2001	Ability to retreat and use economic and physical resources effectively to help recover from an accident
Bruneau et al. 2003	The ability of social units to reduce risk, including the effects of accidents and disasters. And social activities in a way that minimizes social unrest and reduces the effects of future accidents.
Goldshak 2003	A stable network of physical systems and human societies capable of managing severe events
Berman et al. 2003	Capacity of a social system to facilitate human efforts to track change trends, reduce vulnerability and facilitate adaptation
Perrings 2006	Ability to adapt existing resources and skills to communities in new functional conditions

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Colburn related the social resilience to the changeable part of social groups like adaptability and variability and divided the definition of social resilience into two parts of social capital and adaption capacity (Colburn & Seara 2011). Social capital is about the people who make up society and the quality of their communications. The benefits of social capital appear when facing natural disasters, war, and other crises. In other words, social capital is related to the contribution that trusts, norms, and social groups can have in solving problems and coping with difficulties in a society (Debertin et al. 2013). Social capital falls into three categories: commitment, solidarity, and communication (Bernier & Meinzen 2014). And the adaption capacity is about the ability of institutions and social groups to learn and experience, their flexibility in decision-making and problem-solving (Colburn & Seara 2011). Davis mentioned three characters for resilient societies. A resilient society, I- Has the ability to withstand shocks and reducing potential hazards and damages, II- Has the ability to return to equilibrium and reconstruct damages, III- Has the ability to adapt with changes and transforming to development (Davis & Izadkhah 2006).

In all definitions for social resilience and the indicators presented for it, people are emphasized as the most important part of social capital (Colburn & Seara 2011). Having a healthy, educated, young, high-spirited population is essential to increasing resilience in society. Mental Health Foundation mentioned people as the most important part of societies and declared that public health, awareness, strong communication, and access to resources are the four factors that can make a community more socially resilient (Mental Health Foundation 2013).



Figure 15-4 The main components of social resilience from the perspective of the Mental Health Foundation (MHF, 2013)

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In examining the relationship between health and social resilience, some researchers such as Cutter and Norris and organizations such as the World Health Organization, the Mental Health Foundation, and the Heinz Research Center consider health and healthcare service coverage as the main indicators of social resilience (Cutter et al. 2010), while in other studies, health is defined as a part of individual or psychological resilience that, because it affects citizens and individual's productivity as part of social capital, will also be associated with social resilience. However, the health of individuals in a society, both physically and mentally, and in the form of social relationships that are manifested in the form of social health, if it is not the most important factor for developing and increasing resilience in a society, obviously it is one of the most important and necessary factors for creating and increasing resilience in a society and achieving sustainable development.

As a result of one of its annual reports, the World Health Organization has argued a direct and strong link between the level of health of individuals in a society and social resilience in that society (WHO 2014). Of course, the dialectic relationship between health and resilience is undeniable. Although resilience is the result of improving the health of individuals in a society; but it has been a factor that in the next step affects health, especially mental and social health, and strengthens it (Sippel et al. 2015).

6. Conclusion and Results

Studies show that in the current century, increasing industrial activity, increasing the use of fossil fuels and dependence on personal transportation have played an important role in climate change and air pollution as two interconnected phenomena. One of the most important impacts of these phenomena is the endangerment of the physical and mental health of the inhabitants, especially the urban communities. Therefore, the issue of climate change and community health has become one of the important concerns of researchers in various fields of environmental, medical, psychological, social, as well as urban planning and design.

These studies have a long history in environmental and physical and mental health sciences, and the results of many of these show a decline in health due to increased pollution in recent decades. Meanwhile, despite multiple studies of the impact of different types of pollutants on people's health, especially their physical health in different samples, mental health has been less considered; Recent studies in this field show that the citizens' mental health is also strongly affected by climate change and air pollution, especially in sensitive groups of society, including

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children, the elderly and pregnant women. These results led social groups as well as urban planners to research the consequences of these phenomena (climate change and air pollution) that, given the novelty of this issue, their number is very limited.

The impact and consequences of climate change and air pollution not only affect people's physical and mental health; Rather, by threatening the health of individuals as the major social capital and human capacity of a society and reducing social health, it causes severe damage to the social and economic structure of the nations (WHO, 2014). If individuals and societies do not resist these threats and are unable to reduce and control the negative consequences, they will undoubtedly face complex social and economic problems and difficulties in the future.

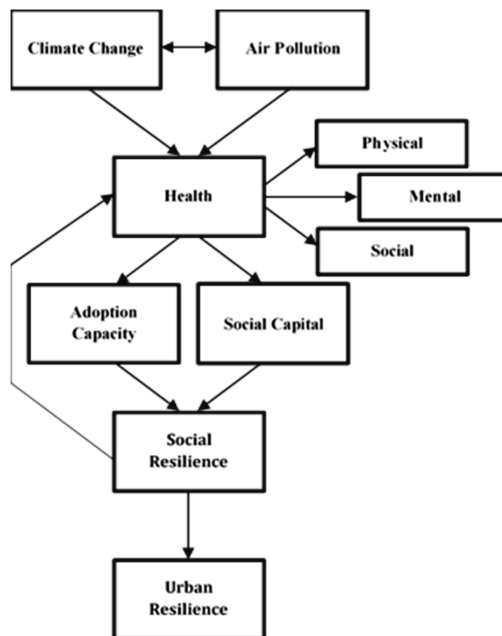


Figure 15-5 The conceptual model of the process of the impact of climate change and air pollution on social resilience (Authors)

Recent researches in the field of social and urban planning concerning climate change and the study of its impacts, introduce new approaches such as increasing the resilience of society and the city, which believes that it can play an important role in facing and reducing the negative effects of these changes. The results of these studies also show that a healthy society has more social capital and this society has a greater capacity to adapt to climate change and individual health, especially mental health in a more resilient society that has a higher level of solidarity, participation, and awareness, is less at risk for climate change. Therefore, the relationship between social health and social resilience is dialectic, so if the health of society is lost and

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social resilience is reduced, society will not be able to deal with other crises (natural and human).

Table 15-6 The most important results obtained from the study (Authors)

Research orientation	Relationship between health, especially physical health and air pollution (mental health studies are fewer)
The most important reasons for the increase of pollution	Climate change and pollution from fossil fuels and transportation
Major pollutants	Particulate matter (PM ₁₀ and PM _{2.5}), Nitrate (NO _x), and Sulfate (SO _x) pollutants, Carbon monoxide (CO)
The most important disorders in physical health	Cardiovascular disease, Parasitic and Microbial, Stroke and Respiratory diseases
The most important disorders in mental health	Depression, Anxiety, Alzheimer and Neurological Disorders, and Suicide attempts
Sensitive groups	Elderly and Children, Pregnant women

The preceding table and diagram are based on the analysis of previous studies that show how climate change and air pollution can threaten the physical and mental health of a society's inhabitants and how health reduction can affect social and urban resilience. This framework can be an important step in future studies in domestic samples, especially in the city of Esfahan, by showing the relationships between climate change, community health, and social resilience, as well as identifying influential dimensions and components.

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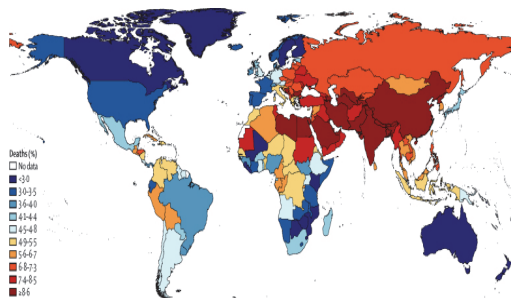
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7. Appendixes

Appendix 1:

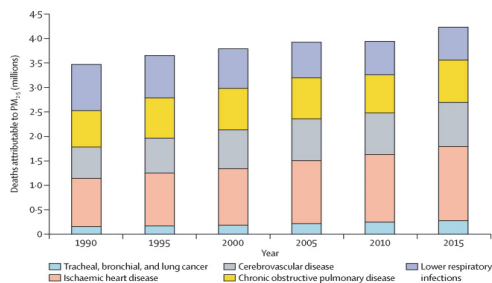
Deaths attributable to ambient particulate matter (PM2.5 and PM10) pollution in 2015



Percentage of death attributable to particulate matters from total death by each country; Cohen et al. 2017

Appendix 4:

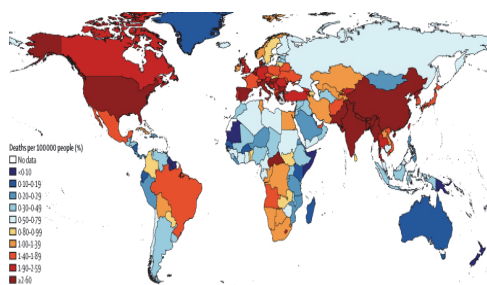
Death attributable to Ozone



Deaths attributable to ambient particulate matter pollution by year and cause; Cohen et al. 2017

Appendix 2:

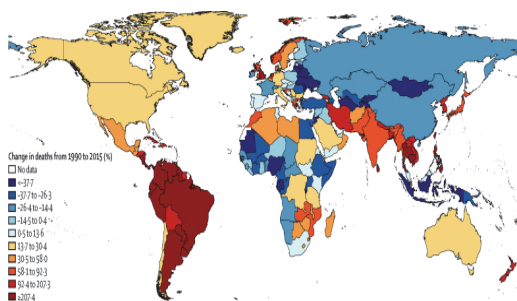
Death attributable to Ozone



Proportion of deaths attributable to ozone; Cohen et al. 2017

Appendix 3:

Percentage change in Proportion of deaths attributable to air pollution



Percentage change in Proportion of deaths attributable to air pollution from 1990; Cohen et al. 2017