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The Socioeconomic Impacts of Heatwave and its Alternatives for Pakistan

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Introduction

Heatwaves are among the most dangerous natural hazards but they are rarely discussed.[1] One of the major causes of extreme heatwave event is climate change. In the pre-industrial era, there was less technology and but due to the increased anthropocentric inputs, climate crisis has erupted more than ever. Post-industrial revolution, anthropogenic activities can be considered as a major cause for climate change.[2] In 2012, the Intergovernmental Panel on Climate Change (IPCC) issued a prediction regarding the increasing frequency and intensity of heatwaves over most land areas in the twenty-first century. The IPCC defines a heatwave as a period of exceptionally hot weather, typically characterised by temperatures exceeding a relative threshold, lasting from two days to several months. According to the World Meteorological Organization (WMO), a heatwave is identified as a period in which the daily maximum temperature surpasses the maximum normal temperature by 9 degrees Fahrenheit (5 degrees Celsius) for more than five consecutive days.[3]

Heatwave has severely impacted the social and economic sectors, globally.[4] In 2022 the countries that faced severe and frequent heatwaves and are considered as the hotspots are California, India, United States, Japan, United Kingdom, China and Pakistan.[5] Argentina was one of the most affected countries in the South American region that faced the record-breaking heatwave in the mid of January 2022, with temperatures reaching as high as 44 °C (111 °F).[6] Pakistan, located in South Asia, experiences a hot and dry climate for most of the year, with heatwaves being a common occurrence, particularly during the summer months. The earliest recorded heatwave in Pakistan dates back to 1965 when temperatures reached 51°C in Jacobabad, Sindh. Since then, Pakistan has experienced several heatwave events that have caused significant damage to the economy and resulted in the loss of countless lives.

According to the Pakistan Meteorological Department, there have been several deadly heatwaves in Pakistan in the recent years. The worst heatwave on record occurred in June 2015, which claimed the lives of more than 2000 people and caused widespread power outages, leading to civil unrest.[7] In May 2018, temperatures in the city of Nawabshah reached 50.2°C (122.4°F), which was the highest temperature ever recorded in Pakistan for the month of May.[8] The heatwave also affected other parts of the country, including Punjab and Balochistan, where several people lost their lives due to heatstroke. In June 2019, the city of Sukkur, located in the Sindh province of Pakistan, experienced a severe heatwave that lasted for several days, with temperatures reaching up to 50°C. The heatwave resulted in the deaths of at least 64 people, while several others were hospitalized due to heatstroke.[9] Since 1901 this March 2022 heatwave was found as the hottest in Pakistan.[10] Jacobabad and Sibi in Pakistan both hit 47 °C (117 °F), while Nawabshah reported a high rise of 49.5 °C (121.1 °F).[11]

Causes of Heatwaves

Although a plethora of studies have mentioned climate change as the major cause of heatwaves but some studies highlight other causes as well due to which heatwaves are intensifying and becoming more dangerous for the livelihoods and economies. Some of them are discussed below:

High Pressure System

Heatwaves may also be caused by a high-pressure system that remains stagnant (due to the

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presence of a persistent high-pressure system or a blocking pattern in the atmosphere) over a region for an extended period. When this occurs, the sinking and compression of air lead to an increase in temperature, intensifying the already-hot conditions. Such extended high-pressure conditions can also cause a reduction in cloud formation, leading to a lack of shading and further intensifying the heat.[12]

Urbanization

Heatwaves can be affected not only by weather patterns but also by urbanization. Urban areas have the tendency to hold and trap more heat due to the presence of solid concrete that absorbs and retains heat from the sun's rays. Additionally, urban areas tend to be more densely populated, which can lead to increased heat generation from human activities such as transportation and construction. This can cause what is known as the "urban heat island effect" where urban areas have higher temperatures than surrounding rural areas. During heatwaves, this effect can further increase temperatures in urban areas, worsening the impact of the heatwave on local populations.[13]

Land Use Changes

Forests play a critical role in regulating temperature and humidity in the atmosphere through processes such as evapotranspiration and shading. Deforestation can disrupt these processes, resulting in increased temperatures and reduced moisture levels in the surrounding area.[14]

Anthropogenic Activities

Human activities such as the combustion of fossil fuels, industrial procedures, and transportation result in the release of substantial quantities of greenhouse gases, which encompass carbon dioxide, methane, and nitrous oxide. These gases possess the ability to trap heat in the atmosphere, consequently leading to global warming and an increased likelihood of heatwaves. One prominent source of greenhouse gas emissions is the combustion of fossil fuels for energy generation. The burning of coal, oil, and natural gas releases significant quantities of carbon dioxide into the atmosphere, thereby making a noteworthy contribution to the escalation of global temperatures. Furthermore, industrial procedures such as cement production and chemical manufacturing also give rise to substantial emissions of carbon dioxide and other greenhouse gases.

Urban Heat Island

The emission of greenhouse gases from transportation is a notable factor in contributing to climate change. The combustion of gasoline and diesel fuels in vehicles releases substantial quantities of carbon dioxide into the atmosphere. The rise in the number of vehicles, especially in urban regions, has resulted in deteriorating air quality and elevated temperatures, exacerbating the effects of heatwaves.[15]

Natural Climate Variability

Natural climate variability, such as El Niño and La Niña events, can play a significant role in the occurrence of heatwaves. These events are a natural part of the climate cycle and occur in the Pacific Ocean, characterized by changes in sea surface temperatures and atmospheric circulation patterns. During El Niño events, warmer than usual sea surface temperatures occur in the central and eastern Pacific, leading to changes in atmospheric circulation patterns. This can result in changes in precipitation patterns and droughts in some regions, while other regions may experience higher temperatures than normal. The occurrence of heatwaves in affected areas can be exacerbated during such events.

It is important to note that natural climate variability alone cannot fully explain the recent trends of increasing heatwaves around the world, as human activities such as greenhouse gas emissions are primarily driving these trends.[16]

Impacts of Heatwaves

Previous studies has discussed about various socioeconomic impacts of heatwaves affecting the community. [17] [18] Some of them are directly affecting the health and others may affect the agriculture, infrastructure and economy of the country in any way. Some of the major impacts are given below:

Heatwaves can have significant social impacts, with vulnerable populations often bearing the brunt of these effects. Human's body in normal

condition cool itself by sweating. But during heatstroke when the humidity is high, sweat cannot evaporate as quickly as in normal condition, leading to severe heat related illness and mortality. The heat related illness may include dehydration, heat exhaustion and heat stroke.

Heatwaves can have wide-ranging economic impacts, with vulnerable populations often bearing the brunt of these effects. For instance, low-income households might not have access to air conditioning or other cooling systems, which makes it challenging for them to continue working and supporting their families during periods of intense heat. This can result in lost wages and increased financial strain. Businesses may additionally suffer during heatwaves due to lower production and higher employee absenteeism rates. In rare instances, during lengthy periods of excessive heat, businesses that strongly rely on outside operations, such as agriculture or construction, may endure significant disruptions or even entire shutdowns. Overall, heatwaves can have a large negative economic impact in terms of both short-term expenses and long-term consequences (Changes in weather patterns).[19]

Heatwaves can have devastating effects on agriculture, impacting crop growth and productivity in numerous ways.[20] High temperatures and drought conditions can cause soil moisture depletion, leading to reduced yields and crop failures. These effects can be particularly devastating for small-scale farmers and rural communities that rely on agriculture for their livelihoods. The resulting food shortages can contribute to increased food insecurity and malnutrition, particularly among vulnerable populations.

Wildfires are also a major threat for animals and humans during heatstroke conditions. Recently, in Australia and regions of Pakistan like swat, buner and dir. The wildfire impacted the living of the community over there.

Heatwaves can place significant strain on critical infrastructure systems, particularly those related to energy and water.[21] Infrastructure has been destroyed recently due to high floods and GLOF caused by a heatwave that damaged bridges, houses and power plants. Additionally, the increased demand for water during heatwaves can strain water supplies, leading to reduced availability and even water rationing in some areas. These impacts can have cascading effects on other sectors, such as agriculture or manufacturing, that rely on water to operate. Infrastructure systems may also be more vulnerable to damage or malfunction during extreme heat events, increasing the risk of disruptions and downtime. As such, preparing infrastructure for the impacts of heatwaves is critical to ensuring that essential services remain available and that the public is protected from the potentially severe consequences of infrastructure failure.

Conclusion

Heatwaves are a growing concern in Pakistan due to rising temperatures and changing weather patterns, leading to severe health impacts, economic losses, and social disruptions. The incidence of heat-related illnesses, particularly among vulnerable populations, has increased significantly. Heatwaves in Pakistan have severely impacted the vulnerable populations, including the elderly, pregnant women, and outdoor workers. Recent heatwaves have seen temperatures as high as 49°C (120°F), leading to dehydration, heat exhaustion, and heatstroke, which can result in hospitalization and death. Also heatwave can affect crops growth, its yield and productivity which directly affecting Pakistan's agriculture economy. The lack of access to safe drinking water may cause serious diseases that can be fatal as well.[22] To address these issues, effective heatwave management strategies are necessary, including the development of early warning systems, cooling centers and shelters, public awareness campaigns, and improved urban planning and design. Additionally, promoting alternative energy sources like solar and wind power can reduce Pakistan's reliance on fossil fuels, mitigating the impacts of heatwaves on the environment. It's crucial to recognize the interrelationship of climate change, energy, and health and adopt a holistic approach that prioritizes sustainable and equitable development. By investing in clean energy, improving public health systems, and promoting community resilience, Pakistan can reduce the negative impacts of

heatwaves and create a more sustainable future for its citizens..

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