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Impact of Climate Change and Human Health on Lucknow

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A B S T R A C T

This study investigates the multifaceted impact of climate change on human health in Lucknow, a prominent city in North India. Climate change, characterized by global warming and shifting weather patterns, poses a significant threat to the well-being of the city's residents. The research explores the various dimensions of this impact, focusing on both direct and indirect consequences on public health.

Examining temperature variations, extreme weather events, and changing disease patterns, the study establishes a comprehensive understanding of how climate change influences health outcomes in Lucknow. Rising temperatures, altered precipitation patterns, and increased frequency of heatwaves contribute to heat-related illnesses, vector-borne diseases, and respiratory issues among the population.

The research identifies vulnerable groups, such as the elderly, children, and individuals with pre-existing health conditions, who are disproportionately affected by climate-induced health risks. Additionally, it analyzes the role of transportation planning factors in exacerbating or mitigating the impact of climate change on public health in Lucknow.

The findings underscore the need for adaptive strategies and public health interventions to address the emerging challenges. Furthermore, the study emphasizes the importance of community awareness and government initiatives in building resilience and promoting sustainable practices to mitigate the health risks associated with climate change.

In conclusion, this research provides valuable insights into the intricate relationship between climate change and human health in Lucknow. It calls for urgent action to implement adaptive measures and public health policies that safeguard the well-being of the city's residents in the face of ongoing climate challenges.

Keywords: Climate Change, Human Health, Local Impacts, Climate Patterns, Adaptation Strategies, Environmental Health, Ground water

INTRODUCTION

Clean air is really important for people to stay healthy. But because of too much and poorly planned development, the air, water, and soil are getting really dirty. This makes it hard to fix the balance of nature in the area. The problems like losing plants and a drop in the environmental health index (which looks at air quality, forests, water quality, and climate change) happen because of this unplanned development, a lot of people, and the strain on the existing infrastructure.

Climate change is an urgent global concern with far-reaching consequences, and its impact on human health is a growing area of research. Lucknow, like many other urban centers, faces unique challenges stemming from shifts in climate patterns. Rising temperatures, changes in precipitation, and increased frequency of extreme weather events contribute to a complex web of environmental factors that directly affect public health.

One of the primary concerns in Lucknow is the deteriorating air quality, largely attributed to anthropogenic activities such as vehicular emissions, industrial sources, and power plants. Poor air quality can lead to respiratory issues, cardiovascular problems, and other health complications. Additionally, the city's vulnerability to extreme weather events, such as heatwaves and floods, further amplifies health risks.

This study aims to systematically analyze the nexus between climate change and human health in Lucknow. By examining the specific health challenges faced by the local population, the research seeks to provide a nuanced understanding of the intersections between climate change impacts and public health vulnerabilities. The insights gained from this study can inform targeted strategies and policies to enhance health resilience, mitigate risks, and foster sustainable development in the face of a changing climate.

Climate change stands out as one of the most pressing concerns of our time. The rapid global development, particularly in rapidly urbanizing and industrializing nations like India, has intensified the environmental challenges. Unfortunately, India's recent emphasis on development has often overlooked its impact on the climate, especially in densely populated urban areas.

A report from the Ministry of Earth Sciences (MoES), Government of India, titled "Assessment of Climate Change over the Indian Region," reveals that India's average temperature has increased by approximately 0.7°C from 1901 to 2018. This rise, attributed to greenhouse gas-induced warming, underscores the urgent need for environmental consideration. Projections suggest that India's temperature could surge by around 4.4°C by the end of the century, a significant departure from global climate standards.

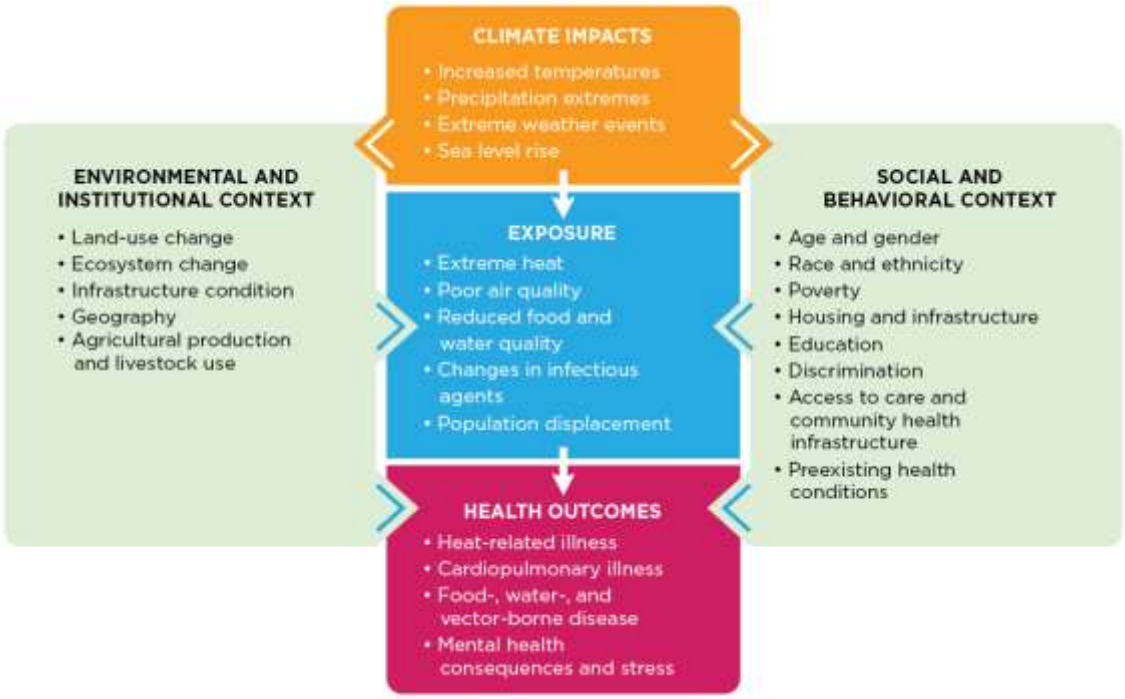


Figure 1-Climate Change and Health Pathway

Source:https://www.epa.gov/climate-indicators/understanding-connections-between-climate-change-and-human-health

This study delves into the perceptions of residents in the state of Uttar Pradesh, India, regarding their local weather and climate change impact. It explores citizens' understanding of their environment, the importance they attribute to environmental laws, and their awareness of activities affecting the environment. Similar investigations worldwide have consistently highlighted the widespread impact of climate change, even at the micro-level.

The global trend of unsustainable practices, marked by resource overexploitation and unchecked urbanization, is exacerbating climate issues. Political will, often geared towards economic growth at the expense of sustainability, has perpetuated this problem. The race for global leadership has led nations to prioritize industrialization, often at the cost of natural resources and ecosystems.

The early recognition of these unsustainable practices in the 1960s prompted global leaders to unite in the 1970s and formulate strategies. The Brundtland Report marked a pivotal moment in our history, fostering a growing awareness of both environmental and developmental concepts. However, even after thirty-four years, conflicts persist between development and the environment. Resolving these tensions requires a profound understanding of sustainability, acknowledging the importance of preserving resources for future generations rather than exploiting them for immediate gains.

The challenge posed by the Brundtland Commission in 1987 was groundbreaking, introducing the novel concept of sustainable development. This included considerations of equity and justice within and between generations, a shared vision for long-term human life on Earth, innovative governance instruments, and a call for collective action and leadership. Despite these principles, contemporary circumstances still present challenges, with a concerning lack of recognition for the extent of environmental damage and its future consequences.

Present-day economists often overlook environmental concerns when formulating economic plans, equating monetary growth with development. This perspective neglects the natural capital invested in infrastructure and development achievements. The consequence is a potential future where generations must contend with depleted resources due to our present-day disregard for environmental sustainability.

While scientific warnings about global warming existed for decades, it only gained public attention in 1988, the hottest year since the mid-nineteenth century. Dr. James Hansen's testimony before the U.S. Congress highlighted the detected greenhouse effect and its immediate impact on climate change.

The Ministry of Environment, Forest and Climate Change in India oversees international climate change negotiations, recognizing the critical importance of addressing environmental issues on a global scale.

Lucknow, the capital of Uttar Pradesh in North India, experiences a distinct continental climate due to its landlocked location. The city witnesses four seasons, including a winter extending from December to February, followed by a summer season until mid-June, monsoons in September, and a transitional period in October and November. The extreme temperatures, reaching as high as 46 degrees Celsius in summer and dropping to 3 degrees in winter, directly impact various aspects, including flora, fauna, health, and water resources. The state of Uttar Pradesh exhibits significant spatial and temporal temperature variability, emphasizing the need for comprehensive climate considerations.

Table 1: Temperature variability

Season	Statistics	Maximum Temperature (°C)	Minimum (°C)
Annual	Average	**31.4**	**18.4**
	Range - (OC)	**26.7-32.6**	**14.9 -19**
	Trend	-0.11	0.57
Winter (JF)	Average	23.5	8.9
	Range -Average (OC)	23.9-29.5	6.3-9.9
	Trend	-0.91	0.98
Pre Monsoon (MAM)	Average	36.1	20.2
	Range - Average (OC)	30-38.1	15.8-21.2
	Trend	0	0.56
Monsoon (JJAS)	Average	34.2	25.2
	Range -Average (OC)	30.2-35.8	21.4-26
	Trend	0.31	0.23
Post Monsoon (OND)	Average	28.3	13.7
	Range - Average (OC)	18.7-25.9	10.9-15.1
	Trend	-0.23	0.77

Source: IMD Gridded temperature data (1969-2005)

As the impact of climate change persists, gaining insight into how individuals perceive and experience local weather alterations becomes crucial. Personal experiences play a significant role in shaping preferences and behaviors related to mitigation and adaptation strategies. Local weather conditions serve as readily available information, and when aggregated over time, allow people to observe and understand long-term climate trends. This, in turn, influences their perspectives on global warming.

However, it's important to consider motivated reasoning—a cognitive bias where individuals tend to interpret information in a way that aligns with their preexisting beliefs. This bias may introduce limitations to the accuracy of people's perceptions regarding weather changes in a specific region.

1.1 STUDY AREA

This study focuses on the city of Lucknow, located in the northern Indian state of Uttar Pradesh, as its primary research area. Lucknow experiences extreme weather conditions, characterized by harsh winters and scorching summers, along with transitional seasons. Over the past two decades, extensive developmental projects in the city have significantly influenced its climate and weather patterns. Notably, there has been a noticeable shift in temperatures in the last decade, resulting in adverse effects on the residents, including uncomfortable weather changes and an increase in seasonal diseases.

The selection of Lucknow as the study area is based on its diverse range of seasons and the substantial variations in climate throughout the year. The sample population for this research is drawn from various parts of the city, strategically chosen to represent all geographical corners.

1.2 HYPOTHESIS

The escalating impact of climate change in Lucknow, marked by variations in temperature and weather patterns, is closely associated with detrimental effects on human health. Our hypothesis suggests that the increasing temperatures and evolving climatic conditions are linked to a heightened occurrence of health issues, including respiratory ailments, cardiovascular diseases, and the proliferation of diseases transmitted by vectors. This situation poses a significant threat to the overall health of Lucknow's residents. Moreover, we expect that certain vulnerable demographics, such as the elderly and individuals with pre-existing health conditions, will bear a disproportionate burden of these climate-related health risks in the city.

2. DATA

2.1 Air Quality

The air quality of lucknow getting worse day by day and health of people also getting effected due to air in their surrounding.

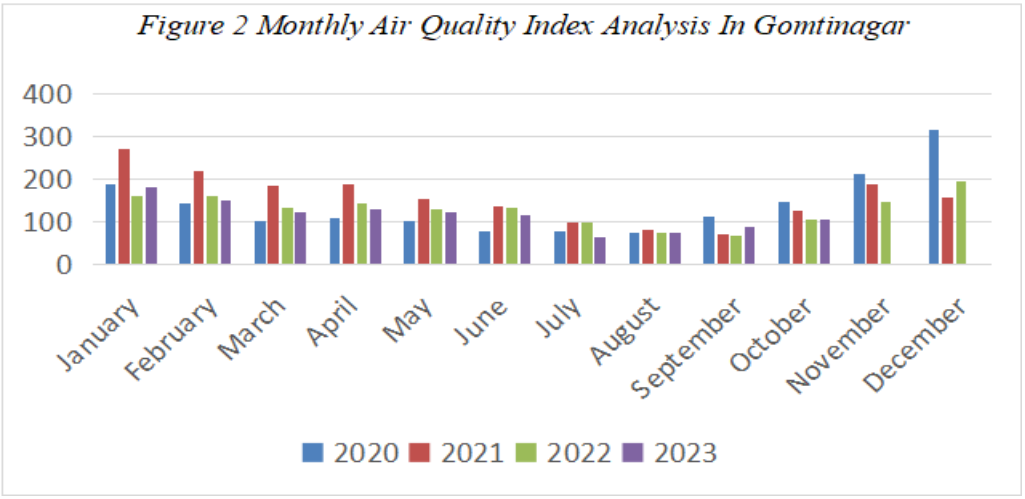
2.1.1 Sources of Air Pollution

The air The transport, domestic and industrial sectors are the major contributors to the rise in the ambient air pollution levels. All the values of PM10 is the increasing number of vehicles in the city.

- Last 4 years AQI analysis indicates poor air quality in pre & post Monsoon period.
- This poor air quality may be due to the burning of crackers & bio-mass materials during winter.
- Vehicular emission and day by increasing private vehicles on road.
- Rapid urbanization on the expenditure of greenery.

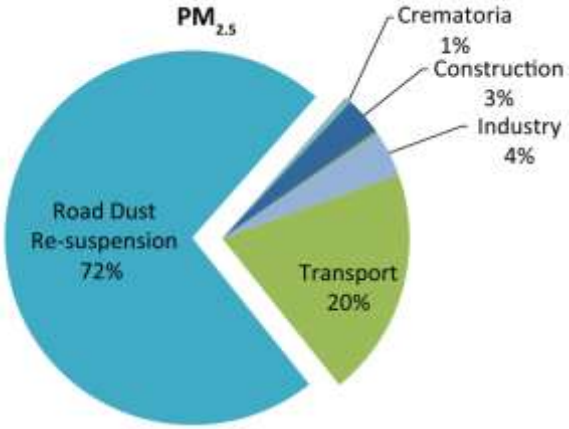
Source- UPPCB

Figure 2 Monthly Air Quality Index Analysis In Gomtinagar



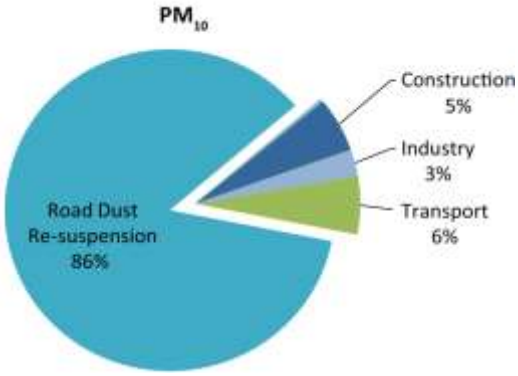
2.1.2 Overall Emissions From All The Sectors In Lucknow City

Figure 2.1 Percentage contribution of PM2.5 emissions in Lucknow city (2022)



Source- UPPCB

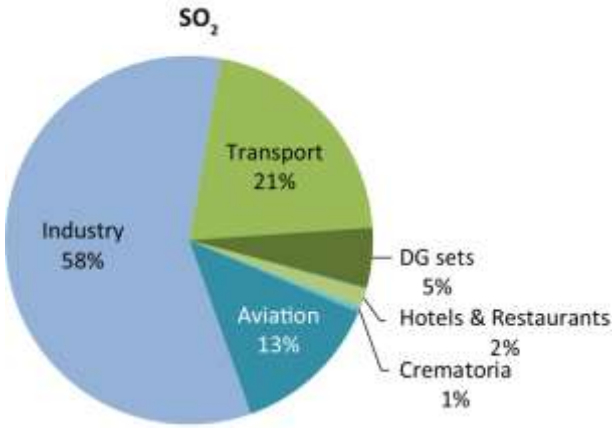
Figure 2.2 Percentage contribution of PM10 emissions in Lucknow city (2022)



Source- UPPCB

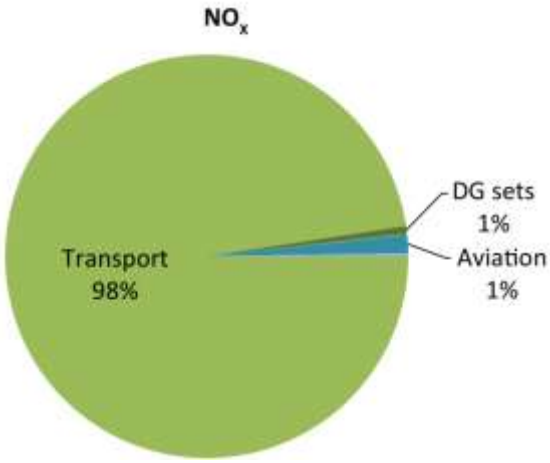
In Lucknow city, around 49.7 and 14.2 kt/year of PM10 and PM2.5 is released in the year 2019. Share of emissions from different sectors shows that major source of particulate pollution is from the road dust re-suspension which emits about 86% of the total PM10, and 72% of the total PM2.5.

Figure 2.3 : Percentage contribution of SO2 emissions in Lucknow city (2022)



Source- UPPCB

Figure 2.4 Percentage contribution of NOx emissions in Lucknow city (2022)



Source- UPPCB

However, Transport sector is the major emitter of gaseous pollutants and emit about 98% of the total NOX, 98% of the total CO and 99% of the total NMVOC.

Industries emits about 58% of the total SO2 , transport shares about 21% of the total SO2 and diesel generators emits about 5% of the total SO2 .

2.2 Underground Water Source

Survey by state groundwater department, pre and post-monsoon in 2012, 2013 and 2014 paints a bleak picture for Lucknow which has water table going down by 80cm to 1 m every year.

In Lucknow city, river Gomti has been the main source for drinking water, but now 70% of municipal water supplies are dependent on ground water, making it a predominant source for city's water supplies.

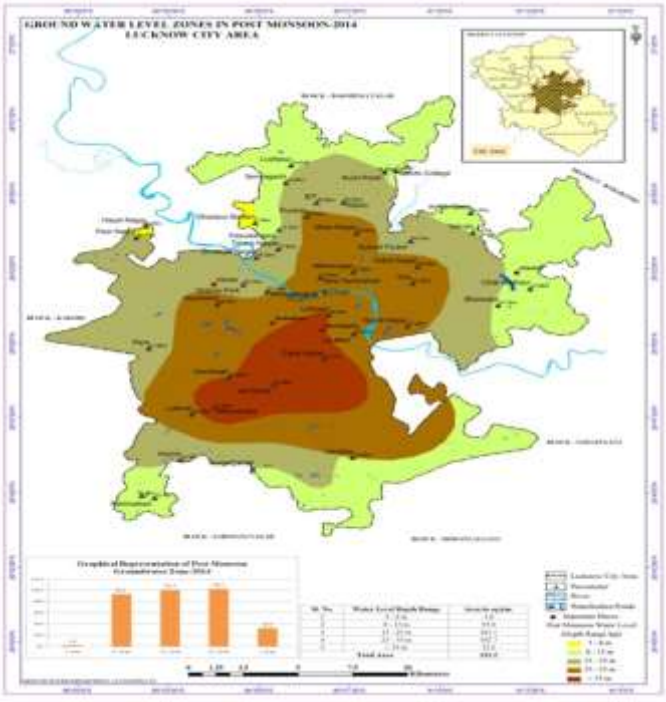


Figure 3: Ground water level in Lucknow (2014)

Source- ground water department uttar pradesh

a. Lucknow leads in overexploitation of groundwater in Uttar Pradesh with an average of 3.5 million litres of groundwater extracted per one square km which is alarming. to put it rather mildly

b. Lucknow's groundwater exploitation is 17 times more than the rate of recharge: TERI

c. Over 72 per cent of households in Uttar Pradesh's capital use groundwater. By 2031, the groundwater table in the city is expected to decline. Union Minister Prakash Javadekar has stressed on rooftop rainwater harvesting and dual piping system to save water for domestic use.

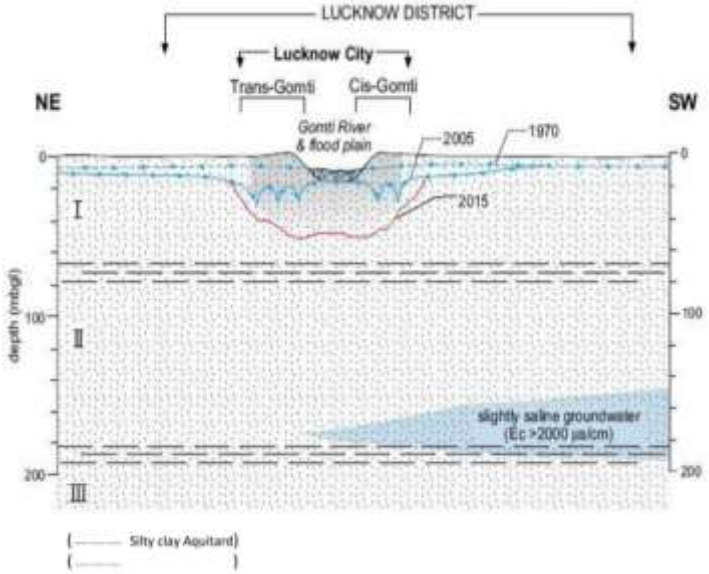
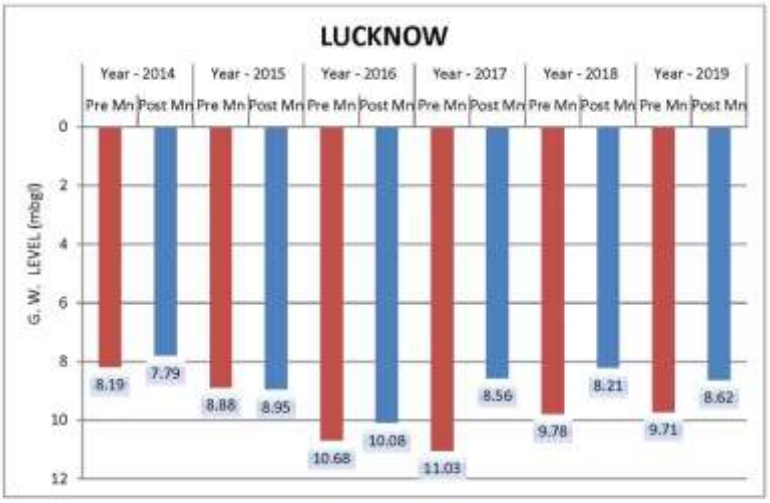


Figure 3.1Hydrological cross-section of Lucknow district

Source- Ground Water Department, Uttar Pradesh Lucknow

The cross section shows of Lucknow City clearly shows that since 1970 how ground water has depleted. The graph shows a "Trough" like situation that has developed in the Lucknow city as depicted by ground water level of 2015.

Figure 3.2 Average Ground water level in Lucknow (2014-2019) (in mbgl)



DISTRICT	Year - 2014		Year - 2015		Year - 2016		Year - 2017		Year - 2018		Year - 2019	
	Pre Mn	Post Mn	Pre Mn	Post Mn	Pre Mn	Post Mn	Pre Mn	Post Mn	Pre Mn	Post Mn	Pre Mn	Post Mn
LUCKNOW	8.19	7.79	8.88	8.95	10.68	10.08	11.03	8.56	9.78	8.21	9.71	8.62

Source- Ground Water Deparment Uttar Pradesh

2.2.1 Impact

a) The impact of above probable extraction of high magnitude is clearly visible on fast declining groundwater levels, which have been heavily depleted all across the Lucknow city and are continuously going down beyond the unsustainable depths.

b) Tube well yields have reduced significantly. Data shows that in Municipal tube well yields have reduced from 1500 LPM in 1970's to 600-800 LPM currently. This is direct manifestation of depleting aquifers & water level lowering.

c) The declining ground water levels have changed the condition of Gomti River from effluent (gaining flow from natural ground water discharge) to influent (losing flow to ground water infiltration).

d) Depression/Hydrogeological Trough has developed within the ground water regime of the city due to extensive ground water withdrawals and subsequent lowering of water levels. (This is supported by the fact that in the peripheral region, water level decline is relatively low to moderate).

3. ANALYSIS

3.1 Air Quality

Alambagh, Amausi and Chowk reported the highest SO2 and NO2 concentrations as vehicular movements and various commercial activities dominantly prevailed near the sites of these sampling locations.

The overall trend analysis results revealed that air pollution levels decreased in Lucknow city in comparison to 2022. This may be attributed to intermittent and scattered rainfall during the survey in many parts of the city.

Tree cover- There are many species of trees found in the city especially Sheesham, Dhak , Mahua, Babul ,Neem, Peepal, Ashok, Mango and Gular trees etc.

HAL – Maulishri, Sheesham, and other native plants etc.

Road Medians – Plumeria regia (Kanakchampa), kaner etc.

India was the seventh most-affected by the devastating impact of climate change globally in 2019 according to the Global Climate Risk Index 2021. The report by Germanwatch, a Bonn-based environmental organization stated that India was preceded by Mozambique, Zimbabwe, Bahamas, Japan, Malawi and Afghanistan in the list of countries which were most affected by the impacts of extreme weather events in 2019. Between 2000 and 2019, over 475,000 people lost their lives as a direct result of more than 11,000 extreme weather events globally and losses amounted to around US $2.56 trillion (in purchasing power parities). The report was released just ahead of the Global Adaptation Summit hosted by Netherlands wherein UN secretary general Antonio Guterres is likely to call upon developed countries and donor agencies to increase funding to adaptation measures of developing countries.

The 10 most affected countries in 2019

RANKING 2019 (2018)	COUNTRY	CRI SCORE	FATALITIES	FATALITIES PER 100,000 INHABITANTS	ABSOLUTE LOSSES (IN MILLION US$ PPP)	LOSSES PER UNIT GDP IN %	HUMAN DEVELOPMENT INDEX 2020 RANKING
1 (54)	MOZAMBIQUE	2.67	700	2.25	2.25	12.16	181
2 (132)	ZIMBABWE	6.17	347	2.33	2.33	4.26	150
3 (135)	THE BAHAMAS	6.5	56	14.7	14.7	31.59	58
4 (1)	JAPAN	14.5	290	0.23	0.23	0.53	19
5 (83)	MALAWI	15.17	95	0.47	0.47	2.22	174
6 (24)	ISLAMIC REPUBLIC OF AFGHANISTAN	16	191	0.51	0.51	0.67	169
7 (5)	INDIA	16.67	2267	0.17	0.17	0.72	131
8 (133)	SOUTH SUDAN	17.33	185	1.38	1.38	0.74	185
9 (27)	NIGER	18.17	117	0.5	0.5	0.74	189
10 (59)	BOLIVIA	19.67	33	0.29	0.29	0.76	107

Table 2: The 10 most affected countries as per Global Climate Risk Index, 2019

Source: Global Climate Risk Index report by Germanwatch

The Global Climate Risk Index (CRI) assesses the quantifiable impacts of extreme weather events, considering both fatalities and economic losses. Notably, it does not account for gradual phenomena like rising sea levels, glacier melting, ocean warming, and acidification. The index relies on data from Munich Re NatCatSERVICE, incorporating the most recent data available for 2019 and the period from 2000 to 2019.

Six out of the ten countries most affected between 2000 and 2019 fall within the low to lower-middle income category. The report emphasizes that climate impacts disproportionately affect individuals in developing countries, posing threats to lives and livelihoods. It underscores the inadequacy of international climate financing, noting that in 2018, a total of US $78.9 billion was provided and mobilized. However, the goal established in 2009 to mobilize US $100 billion annually from 2020 onward, as an agreement by developed countries to support developing nations in financing both mitigation and adaptation efforts, remains unmet.

While industrialized nations have, to some extent, successfully decoupled Sulfur dioxide emissions from economic growth through advanced technologies and a better understanding of consequences, the same cannot be said for Carbon dioxide emissions. Per capita CO2 emissions in these countries remain largely unchanged, closely tied to their economic development levels and overall standard of living.

It is evident that as long as the global economy relies on carbon-based sources like coal, oil, and natural gas for energy, overall growth cannot be significantly delinked from net CO2 emissions. Halting climate change requires substantial reductions in emission rates, but real-world complexities make this a challenging task.

The strong dependency on fossil fuels for energy and industrial development is intricately linked to the economic growth and lifestyles of many countries. Every individual contributes to a carbon footprint, and lifestyle choices significantly impact its size. Notably, a cheeseburger alone adds about 3 kg of Carbon dioxide to the environment, emphasizing that lifestyle decisions affect global carbon footprints.

The prosperity of a country correlates with its economic growth and fossil fuel consumption, leading to higher greenhouse gas emissions. Industrialized nations owe their current prosperity to years of historical emissions, which continue to contribute to the atmosphere. In contrast, developing countries are in the early stages of industrialization, resulting in lower per capita emissions compared to developed nations.

4. HEALTH ACTION PLAN

4.1 Air Pollution Related Diseases:

Air pollution can have significant adverse effects on human health, contributing to various diseases and conditions. The impact of air pollution on health depends on the type and concentration of pollutants, as well as individual susceptibility. Here are some common air pollution-related diseases: Respiratory Diseases:Asthma,Chronic Obstructive Pulmonary Disease (COPD).

In uttar pradesh, the National Clean Air Programme (NCAP) was initiated in 2019 to combat air pollution in 132 non-attainment (NA) cities, including 16 in the state. Non-attainment cities did not meet the national ambient air quality standards for 2011-15 under the National Air Quality Monitoring Program. The current annual safe limits for PM2.5 and PM10 are 40 micrograms per cubic meter (ug/m3) and 60 ug/m3, respectively. The NCAP aims to reduce key air pollutants, PM10 and PM2.5, by 20-30% by 2024, using pollution levels from 2017 as the baseline.

According to the NCAP Tracker analysis, Varanasi, although remaining one of the most polluted cities, has witnessed the highest reduction in air pollution among non-attainment cities. Annual PM2.5 levels decreased by 52%, from 91 ug/m3 in 2019 to 44 ug/m3 in 2021, while PM10 levels reduced by 54%, from 202 ug/m3 in 2019 to 93 ug/m3 last year. Ghaziabad, consistently having annual PM2.5 levels above 100, consistently ranked as one of the most-polluted cities, except in 2020 when Lucknow took the top spot.

4.2 Extreme Heat :

Urban areas often become hotspots of heat impact due to altered land use, reduced land cover, reduced natural shade, and use of built material that trap heat during day and night time. The urban heat island effect poses a greater threat to a larger swath of the population by impeding night natural cooling leading to continuous heat stress compared to that in rural areas. As such health-centric multisectoral coordinated adaptation and mitigation efforts at the city level are a necessity and an opportunity not only for reducing heat impact but also for reduction of greenhouse gas emissions.

4.2.1 Extreme Heat Related Diseases:

Exposure to extreme heat can result in a range of heat-related illnesses (HRIs), spanning from mild conditions like prickly heat to severe manifestations such as heatstroke, which can be fatal. Additionally, extreme heat increases the risk of cardiovascular, respiratory, renal issues, and overall mortality. It also contributes to higher ambulance calls and hospital admissions. The ongoing trend of anthropogenic climate change is anticipated to escalate the frequency and intensity of heatwaves across India.

As per the National Heat-Related Illness Surveillance, the years from 2015 to 2018 saw an upward trajectory in reported HRI cases. In 2019, Uttar Pradesh recorded 244 cases of HRIs, resulting in 2 deaths. In 2020, there were 3 reported cases of HRI. As of June 2022, the total count of suspected heatstroke

cases stands at 454. The Heatwave Vulnerability Index, a composite measure incorporating demographic, socio-economic, population health, and land cover indicators, classifies districts based on their vulnerability, ranging from very high to very low vulnerability.

4.2.2 City-Specific Heat-Health Action Plans should include:

i.Early warning system and inter-agency emergency response plan:

a. Analysis of historic city-level all-cause mortality with observed temperatures to establish

health impact-based warning and response trigger (IMD, SDMA)

b. Daily dissemination of forecast and observed temperature during summer to public and

government agencies (IMD)

c. Identification of roles and responsibilities of coordinating agencies with activity matrix and action checklists

ii.Public awareness- Communicating risk to vulnerable population groups

iii.Capacity building of medical professionals- On identification, management, and reporting of HRI cases and deaths

iv.Promoting short and long-term adaptation and mitigation measures-Access to potable water, shaded area, cooling spaces & Plantation, cool-roof

5. CONCLUSIONS

In conclusion, the impact of climate change on human health in Lucknow is a pressing concern, evident through various interconnected factors. The rise in temperatures, characteristic of a changing climate, poses a significant risk to the population, leading to an increased prevalence of heat-related illnesses. These range from mild discomfort to severe conditions like heatstroke, impacting overall public health. The city grapples with air pollution issues, contributing to respiratory problems among the residents. High levels of particulate matter and other pollutants are linked to various respiratory conditions, posing a significant threat to public health. Climate change influences the prevalence and distribution of vectors, leading to an elevated risk of vector-borne diseases. Lucknow faces challenges in controlling diseases such as dengue, malaria, and others, as vectors adapt to changing climatic conditions. The impact of climate change on health necessitates a robust public health infrastructure to manage the increased burden of diseases. Strain on healthcare facilities, particularly during extreme weather events or disease outbreaks, poses challenges to effective healthcare delivery. The findings underscore the importance of implementing adaptation and mitigation strategies. These may include heat action plans, improved air quality management, vector control measures, and enhancing the resilience of healthcare systems to cope with climate-related health challenges. Policymakers need to prioritize sustainable development initiatives that address both climate change and public health. This includes promoting green practices, reducing reliance on fossil fuels, and implementing policies that enhance overall environmental quality and resilience.

In summary, the impact of climate change on human health in Lucknow is multifaceted and requires a comprehensive and collaborative approach. By prioritizing the health and well-being of its residents, implementing sustainable practices, and fostering community resilience, Lucknow can navigate the challenges posed by climate change and build a healthier and more sustainable future.

References

Burns, T. R., & Witoszek, N. (2012). Brundtland report revisited: Toward a new humanist agenda. Journal of Human Ecology, 39(2), 155-170

National Action Plan on Heat-Related Illnesses (https://bit.ly/NAPHRI)

Climate of Lucknow report 2012-13, Indian Meteorological Department, Ministry of Earth Sciences, Government of India

Government of India (2020) ANNUAL REPORT 2020-21 Ministry of Environment, Forest and Climate Change, New Delhi.

http://www.uppcb.com/

https://cpcb.nic.in/air-pollution/