

Climate Change and Public Health Dynamics: A Bibliometric Study with Comprehensive Review

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Abstract

The study directs to analyze how global climate shift affects public well-being and identify research clusters, trends, and potential gaps in this multidisciplinary field. The study also investigates the worldwide distribution of research institutions and their collaborative networks in this crucial area. We have use advanced bibliometric techniques to achieve our objectives. The analysis involves numerous academic articles, including journals, authors, keyword co-occurrence, and affiliations. By mapping the intellectual composition and trends in the field, we can gain valued perceptions of the complex relationship involving environmental alteration and public well-being. Bibliometric data is used to track research themes and clusters over time, examining keyword co-occurrence and affiliations. A comprehensive dataset of 1854 research papers was acquired from January 2000 to July 2023. Geospatial analysis helps us understand the geographic distribution of research institutions. Research papers were collected on climatic variations and people's physical conditions from the Web of Science portal, the report includes a bibliometric analysis and methodology review. Our study highlights research clusters and evolving themes in climatic disturbances and public wellbeing, along with potential study gaps. Furthermore, it examines the global reach of this critical field by analyzing the geographic distribution of research institutions and their collaborative networks. This review specifies a broad view of climate difference's impact on public health. It helps identify trends and promotes interdisciplinary collaborations. Use it to shape evidence-based strategies for mitigating climate change's health effects in the 21st century.



Article History

Received: 07 November 2023

Accepted: 12 August 2024


Keywords

Bibliometric;
Climate Change;
Epidemiological survey
methods;
Machine Learning;
Modelling Approaches;
Public Health.

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Doi: <https://dx.doi.org/10.12944/CWE.19.2.6>

Introduction

Human activities, such as industry, transportation, and agriculture, emit greenhouse gases causing climate change. Severe consequences include extreme weather events, increasing sea levels, and species extinction, affecting sustainable development and well-being.^{1,2} The Intergovernmental Panel on Climate Change has spent 40 years researching the consequences of human activities on climatic disturbances. Change in climate poses danger to vulnerable populations through extreme weather, environmental changes, and shifts in human systems. This leads to increasing temperatures, sea levels, food production disruptions, and population displacement. Severe weather occurrences like famines, flooding, forest fires, hurricanes, and extreme heat waves events have severe impacts on the population's health, causing distress, heat-related disorders, and cardiovascular issues.^{3,4} Climate variations and physical well-being affect mental well-being through unsustainable activities like deforestation and reliance on fossil fuels. These lead to food and water insecurity, air pollution, and land and water contamination, exacerbating the climate crisis.⁵ We review the impacts of climatic alterations on human health, including extreme heat, floods, water scarcity, air pollution, vector-borne diseases, COVID-19 impact, and the health of displaced inhabitants. We identify gaps in knowledge and propose policy recommendations targeting vulnerable demographics.

Climate Change and Health Threats

Human activities have triggered a 1°C surge in worldwide temperatures since pre-technological and industrial revolutions, with a probable scale of 0.8°C-1.2°C.⁶ Research predicts a temperature increase of up to 1.5°C by 2052 if global warming persists, leading to extreme weather and ecological changes. Urgent action is necessary, including reducing carbon emissions, preserving natural resources, and promoting eco-friendly practices for a sustainable future.⁷ Studies support that the ramifications of climate change are vast and ominous, with the potential to wreak havoc on both human well-being along with the surrounding environment.⁸ The urgent issue of climate change demands responsible action to reduce our carbon footprint and protect our planet. Its potential implications on public health make it imperative that we find viable solutions to mitigate its impact.^{9,10,11} Extreme temperatures

and high precipitation levels increase the chances of gastric diseases and diarrheal symptoms, with poor hygiene conditions, water availability, and improper sanitation being responsible for 90% mortality, typically amongst children below the age of 5 years.¹⁰ Mauritania faces a high death rate from diarrheal diseases, with 2150 annual deaths. Climate change exacerbates these risks, particularly in the West-African Sahel area where temperatures are predicted to increase 1.5 times faster than the worldwide average. Collaborative efforts aim to mitigate the impact of communicable diseases in low and middle-income countries.

Impact of Extreme Heat

The human being's ability to regulate the internal temperature is crucial for survival in different environments. It allows us to withstand extreme temperatures and thrive in various conditions. Without this mechanism, our ability to survive and evolve would be limited.¹² High temperatures can lead to discomfort as our bodies try to regulate internal temperature. This is because we exchange heat with the air, which is harder in extreme heat. This can lead to various physical and mental responses.^{13,14,15,16,17} Researchers in environmental science have developed various methods to understand how heat impacts our health. These assessments include measuring changes in sweat composition, heartbeat rate, blood pressure, and core body temperature. The goal is to identify risks and develop strategies to prevent heat-related illness and injury.^{16,18,19}

Health Consequences of Changing Climate Waterborne

Due to various environmental issues like pollution and, promotion of vector breeding led by seasonal variations, surface and groundwater sources have been contaminated. These factors result in severe water-borne illnesses which can cause several conditions, such as gastrointestinal problems, skin infections, and respiratory diseases.^{20,21} Health systems often struggle to accurately collect and report data on waterborne infections.²² To prevent such diseases, it is crucial to guarantee and maintain the standard and quality of the water we consume.^{23,24,25} Despite significant strides in healthcare and sanitation, developed nations remain vulnerable to the threat of water-borne diseases. Gastrointestinal disorders are alone responsible

for 1.5 million fatalities annually.²⁶ Low- or Middle-Income Countries (LMIC) face numerous deaths due to diarrheal illnesses, with over 360,000 fatalities involving children under five.¹⁸ The absence of basic cleanliness and sterility standards and deteriorating infrastructure are major obstacles in the universal combat against water related diseases.²³ Water-borne infections outbursts, predominantly transferrable intestinal disorders, have been attributed to numerous pathogens,²⁷ as described in Table 1.

Foodborne

Foodborne illnesses, caused by consuming unhygienic food and water, affect a significant

number of children under five in developing regions, with climate change exacerbating the problem. Crosssector collaborations can help implement interventions at various levels for a safer and healthier future.²³ People can get ill through animals, humans, and water. Water has a significant contribution in spreading food-borne illnesses, which can be hard to distinguish from food as an exposure source, especially in communities.²³ To provide a more comprehensive understanding, Table 1 outlines the various bacteriological, pathological, and lethal drivers which are connected with food-borne and water-borne ailments in individuals.

Table 1: Direct and Indirect impacts on health due to changing climate

Direct health impacts	Indirect health effects	
	Through natural systems	Through socioeconomic systems
Respiratory diseases	Airways diseases	Food and water security
Cardiovascular diseases	Allergens	Undernutrition
Undernutrition	Foodborne disease	Occupational health
Mental illness	Vector-borne disease	Vulnerable population
Allergens	Waterborne disease	Forced displacement
Poisoning	Cardiopulmonary	Mental illness

Air Borne-Vector Borne Diseases

Vectors transmit infectious pathogens from an infected host to an uninfected one. Major vector-borne infections include Zika virus, dengue, and malaria, and are sensitive to weather and climate. The impact of climatic variation on these disorders is, however, uncertain. Nevertheless, it is crucial to understand the possible influences of switching climatic patterns on these diseases to develop applicable prevention and regulation strategies.²⁸ Risk from vector-borne illness is innately sensitive to changes in meteorological conditions and climate which has been evaluated comprehensively.^{29,30}

Mental Health

The influence of environmental variations on physical health have been well documented.^{31,32} but mental well-being is also affected.^{33,34} Current studies have revealed that a increase in average

heat and a surge in the occurrence and severity of heatwaves have been strongly connected with a heightened level of psychological distress among the general population,³⁵ self-harm,³⁶ hospital psychiatric admissions,^{37,38} and suicide.^{39,40} Heat waves exacerbate prevailing mental disorders,⁴¹ particularly in combination with high level of humidity⁴² and decrease the impact of various psychotropic medicines.⁴³ Climate change disrupts systems, affecting weather and ecosystems, with lasting impacts on societies and economies.

Methodology

To investigate the influence of climatic variation on public well-being, we conducted a comprehensive literature search using the Web of Science portal's database. The methodology commenced with identifying 860 relevant research papers that directed on the intersection of changing environment and

health. Each paper was meticulously evaluated for research quality and the applicability of its findings to ensure robustness and relevance. Subsequently, we expanded our dataset to encompass 1854 research papers, globally, published between January 2000 and July 2023, providing a broader and more detailed perspective on the subject. Bibliometric analysis was performed on this extensive dataset to identify trends and crucial contributors in the field. This analysis included methods used to determine the global extent of climatic variations and its impact on health, along with identifying major research fields, prominent institutions, and leading authors contributing to this body of research. Furthermore, a detailed review was conducted of various methodologies employed to measure the impact of climate alteration on public health, offering insights into the diverse approaches and tools used by researchers, and highlighting the strengths and limitations of various methods.

The analysis further delved into key research areas within the dataset, identifying focal points such as epidemiological studies, climate modeling, and population vulnerability assessments. We also highlighted the contributions of major institutions and prolific authors, mapping the landscape of leading entities in this research domain. The methodology section of our review concludes with proposed future research directions, emphasizing existing gaps in knowledge and suggesting areas for

further investigation. These recommendations aim to enhance understanding the link between environment modification and community health, enlightening future research agendas and policy decisions. The impact of climate variations on humans has stayed the subject of numerous review papers. One of the primary concerns is accurately estimating this impact. This paper explores different methods for measuring the change in health among vulnerable populations, facilitating the identification of both existing and novel models and tools. Through this detailed and systematic approach, our study offers a thorough overview of the influence of climatic variability on public health, supported by robust data and thorough analysis. Conclusively, the report concludes with proposed future research directions.

Bibliometric Analysis

Bibliometric analysis is a powerful tool for researchers to track research evolution and identify emerging trends. It uses mathematics, statistics, and philology for quantitative and visual analysis of literature, delivering valuable visions into the research landscape. By analyzing bibliographic data, researchers can identify important trends and patterns, helping them to stay ahead of the curve in their fields using author, co-citation, and co-word analysis for subtle evolutionary aspects. The number of publications and citations in a field is a reliable indicator of scholarly interest.

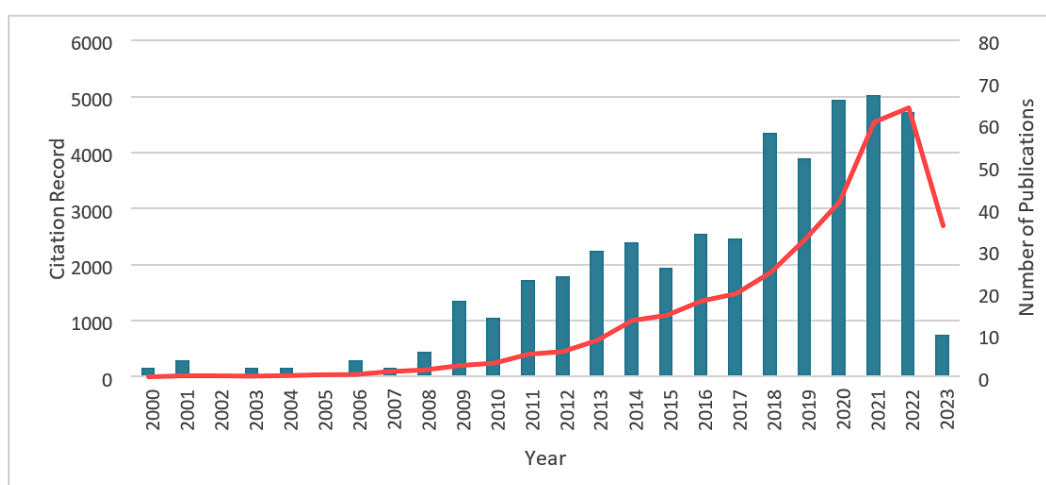


Fig. 1: Number of published documents in each year along with citation report (2000–2023)

As depicted in Figure 1, reports on the influence of climatic disturbances on public health have been progressively surging since 2009. However, after 2018, it has shown exponential growth, which is a clear indication of the growing interest of scholars in this field of study. Furthermore, Figure 1 also presents the changing trends in the number of citations in different documents on the influence of climate variability on vulnerable populations along with future dimensions from the past 2.25 decades. The most cited article is Watts's article (2015) on "Health and Climate Change: Policy Responses to Protect Public Health" which is cited 985 times with a mean citation value of 109.44 per year.⁴⁴

Based on the published documents Figure 2 gives an outline of the crucial topics in climate variation and public health research, along with their corresponding weights. Web of Science database primarily guides the research from the database. Most of the research is focused on topics such as Environment Sciences, Ecological studies, Environmental Occupational Health, and Climatology and Atmospheric Sciences. However, only a minor portion of the investigation is allocated to examining the physiological impacts of environmental disturbances on public health.

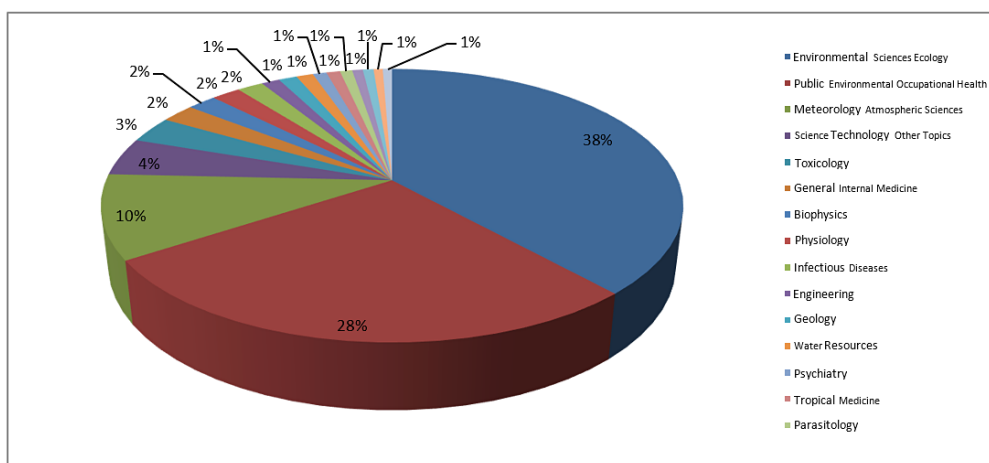


Fig. 2: Major Areas of Research Publication

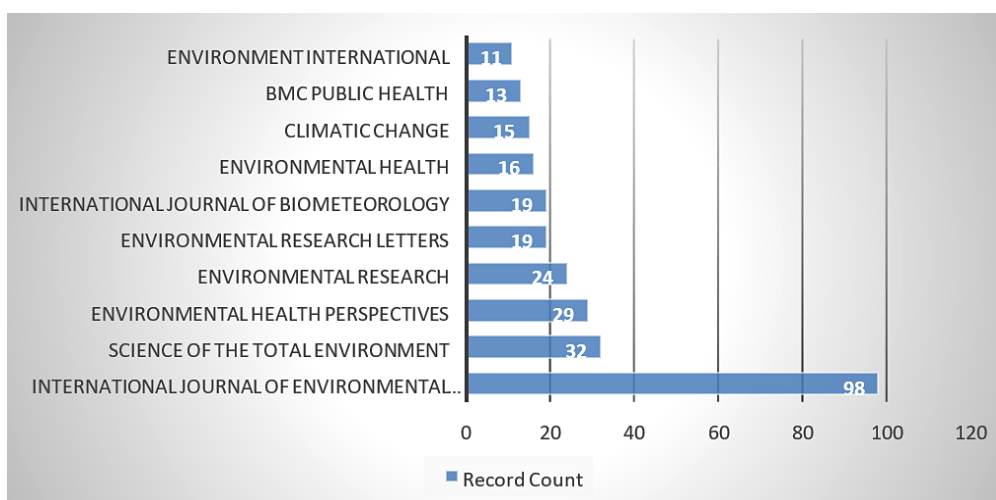


Fig. 3: Top 10 journals with the maximum published articles

Analysis of Resources/Journals

Figure 3 reveals that the "International Journal of Environmental Research and Public Health" broadcasted the most investigative articles on climatic disturbances and their impacts on public health, with 98 publications. "Science of the total environment" and "Environmental health perspectives" followed closely behind with 32 and 29 research publications respectively. These journals have also received numerous citations from other sources and appear to have formed internal cooperation networks.

Figure 4's bibliometric network reveals how citations are distributed globally. The US, China, and England have extensive networks and publications in climate variations and public well-being, providing the basis for climate resilience and societal well-being. These regions face significant climate issues due to change in climate that affect over 3.3 billion people, making research crucial for developing effective strategies.

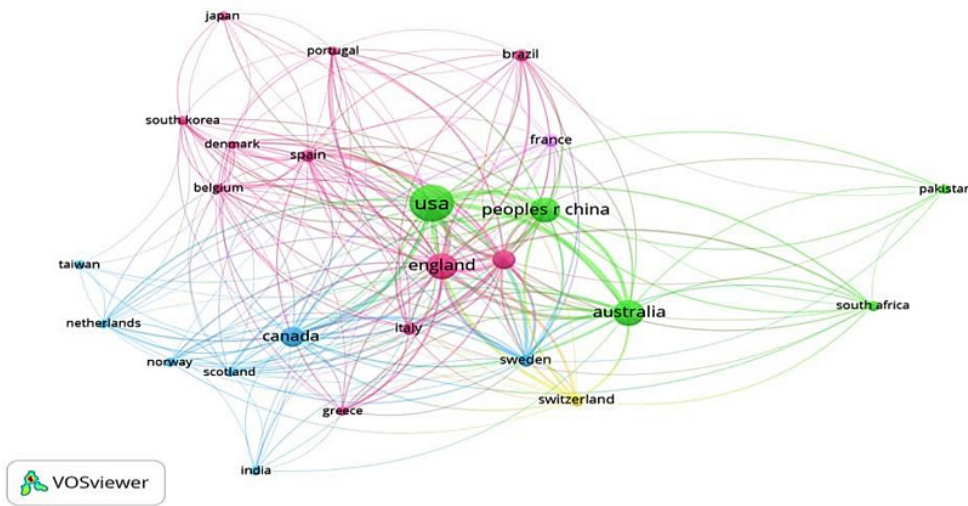


Fig. 4: Cooperation network between countries

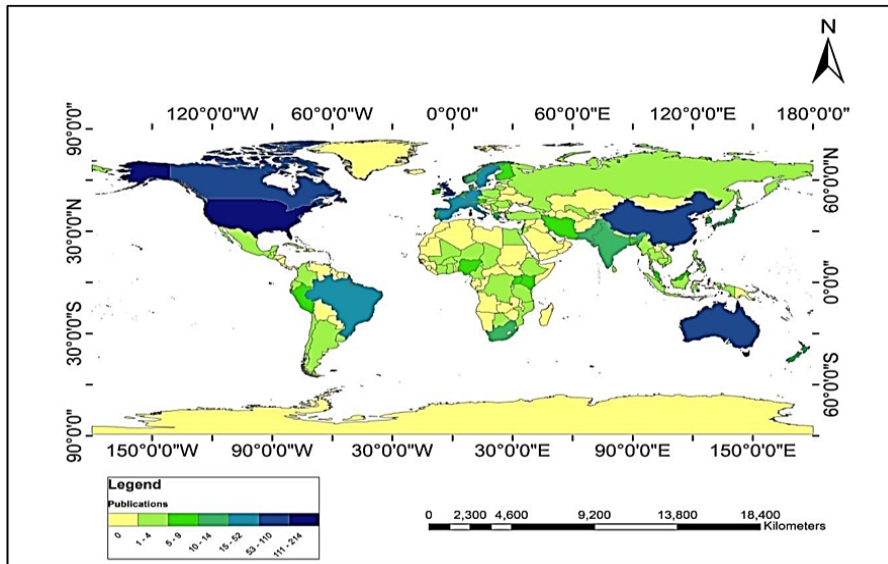


Fig. 5: Global distribution of published documents (2000-2023)

Figure 5 shows the distribution of publications on climate variability and health effects. To gather the data, a list was compiled from the Web of Science (WoS) data of the countries that researched this topic. Subsequently, an ArcGIS-powered map was created to effectively visualize the findings. The United States leads with 214 publications, followed by the United Kingdom (110) and Australia (99).

Table 2 shows the top 10 affiliations in climate variability and health, with the University of London leading with 38 publications. US and London affiliations focus on heat waves and adaptation due to the extremities of the impact in tropical/subtropical countries. New technologies such as GIS and statistical tools are used to mitigate the effects of climate change.

Table 2: Top 10 affiliations based on the number of publications in climate change and public health

Affiliation	Fields	Publications	Region/ Country
University of London	Heat Waves, Climate Change Adaptation, Aerosols & Air Pollution	38	London
Harvard University	Heat Waves, Disaster Medicine, Food Allergy, Aerosols, Science Communication, Air Pollution & Air Pollution	31	USA
London School of Hygiene Tropical Medicine	Heat Waves & Climate Change Adaptation	27	London
University of California System	Heat Waves, Climate Change Adaptation, Virus, Microbial Source Tracking, Aerosols & Air Pollution,	25	USA
Queensland University of Technology	Heat Waves, Dengue, Air Pollution, Foot-And-Mouth Disease Virus	21	Australia
World Health Organization	Heat Waves, Dengue, Air Pollution & Ptsd	21	USA
Harvard T H Chan School of Public Health	Disaster Medicine, Aerosols, Air Pollution, Heat Waves & Food Allergy	20	USA
White Rose University Consortium	Heat Waves, Climate Change Adaptation, Aerosols & Science Communication	19	London
University of Washington	Heat Waves, Dengue, Climate Change Adaptation & Air Pollution	18	USA
University of Washington Seattle	Heat Waves, Dengue, Climate Change Adaptation & Air Pollution	18	USA

Table 3 lists the top ten authors in Climate variability and resilience sciences, with the theme "The 2020 Report of the Lancet Countdown on Health and Climate Change" standing out with 739 citations. Three authors who contributed to this paper, Ebi KL, Kinney PL, and Rocklov J, are also in the top ten. The report analyzes 43 indicators across five segments, delivering perceptions into the correlation between health and climate change for improved planning and decision-making.

Figure 6's network diagram shows Climate Change keywords' co-occurrence across documents and time periods. Adaptation, Health, and Mortality form a distinct cluster used mainly after 2000, implying their significant relevance and impact on people. This analysis highlights essential criteria for understanding Climate Change's implications on human well-being.

Table 3: Top 10 authors with the highest publications and citations.

Rank	Author	Title of the Highest Cited Article	Citations of the Highest Cited Article	Total Publication of the Author
1	Ebi KL	The 2020 report of the Lancet Countdown on health and climate change: responding to converging crises ⁴⁴	739	16
2	Bi P	Infectious Diseases, Urbanization and Climate Change: Challenges in Future China ⁴⁵	45	12
3	Berrangford L	Adapting to health impacts of climate change: a study of UNFCCC Annex I parties ⁴⁶	70	11
4	Tong SL	Ambient air pollution, climate change, and population health in China ⁴⁷	512	11
5	Bell ML	A systematic review of the physical health impacts from non-occupational exposure to wildfire smoke ⁴⁸	289	9
6	Guo YM	Impact of heatwave on mortality under different heatwave definitions: A systematic review and meta-analysis ⁴⁹	236	9
7	Hess JJ	Urban Form and Extreme Heat Events: Are Sprawling Cities More Vulnerable to Climate Change Than Compact Cities? ⁵⁰	293	9
8	Kinney PL	The 2020 report of the Lancet Countdown on health and climate change: responding to converging crises ⁴⁴	739	9
9	Rocklov J	The 2020 report of the Lancet Countdown on health and climate change: responding to converging crises ⁴⁴	739	9
10	Ford JD	Adapting to health impacts of climate change: A study of UNFCCC Annex I parties ⁴⁶	70	8

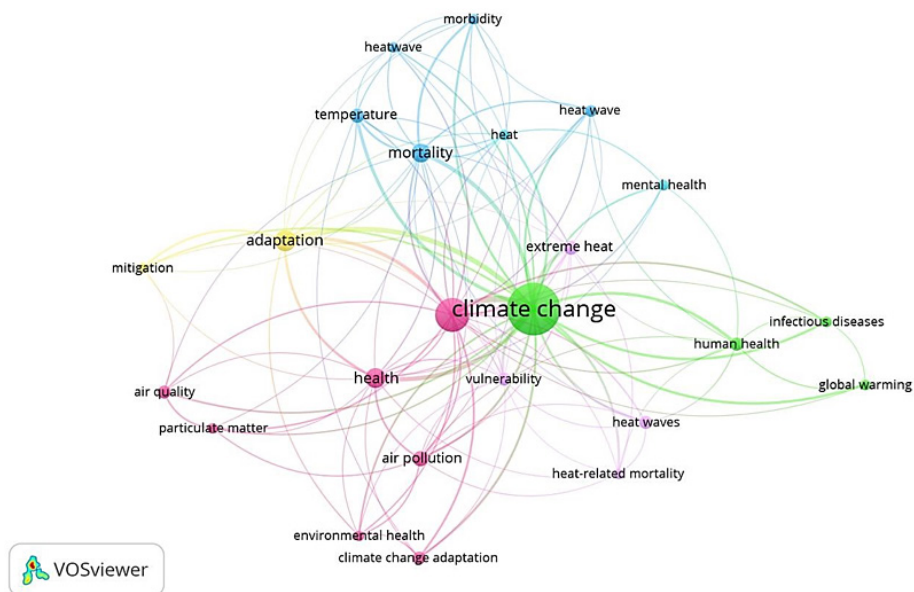


Fig. 6: Co-occurrence networks of keywords.

Technical Review and Appraisal

We will now conduct a technical review to estimate the effects of weather change on vulnerable populations, in accordance with the results of the bibliometric analysis conducted in the previous section. Building on the previous analysis, we studied research papers that assessed the link between climate variability and health, as well as the challenges faced by people due to changing climate. The review focuses on the different methodologies used and how they have evolved, from survey methodology for primary data collection to data analysis using various statistical software and models for evaluating issues on a large scale, along with providing future directions.

Survey Methodology

Surveys are a crucial research technique for collecting data from a sample through questionnaires or interviews. They play a dynamic role in understanding public perceptions and behaviors related to climate-induced health risks. The knowledge gap was addressed on child undernutrition in post-flood contexts.⁵¹ Using a two-stage survey, the study evaluated the effects of education, income, livelihoods, and caste on child stunting and wasting. The study suggests immediate nutritional responses and long-term policy strategies such as education promotion, sustainable livelihood development, and delayed motherhood. Conversely, a new method was explored to estimate the adaptive capacity of climatic variability's impact on human health.⁵² They used seven key attributes and established an adaptive capacity index based on gross revenue, income inequality, health assistance, and connectivity to information. The index proves to be an effective tool for comparing vulnerabilities among countries and aiding targeted intervention strategies. The study's approach provides actionable insights for designing effective strategies to mitigate health risks arising from climate change impacts. Additionally, health professionals recognize climate change as a significant cause of health harm and feel responsible for educating the public and policymakers.⁵³ However, time constraints hinder their efforts. Recommendations include continuing education, communication training, and guidance on creating sustainable healthcare workplaces. Furthermore, it was found by researchers that climatic variability is a significant danger to humans, with Canadians and Maltese more concerned than

Americans.⁵⁴ Vulnerable populations perceive the impact differently. Strategies to raise awareness of the effects on health are recommended. A moderate knowledge but high awareness of the healthiness and impact of climatic variability in Bangladesh was discovered.^{55,56} School-based interventions for knowledge enhancement and necessary health adaptations are recommended. Climate change leads to extreme weather events, displacement, increased healthcare expenditure, and climate-sensitive diseases.

Statistical Tools and Modeling

Five statistical methods for modeling health risks associated with exposure to multiple contaminants and their interactions were reviewed.⁵⁷ The paper emphasizes the importance of method choice aligned with study objectives and provides valuable guidance for researchers in this field. The link was explored between environment variability, tremendous weather incidents, and waterborne diseases in Vancouver. The study estimates an approximate 16% increase in illness rates due to extreme rain events by the 2080s.⁵⁸ A new technique was introduced to estimate heat exposure days that considers acclimatization and analyzes the spatiotemporal distribution of heat exposure days and their connection to heat-related mortality risk in China. The insights from these studies contribute to a more inclusive understanding of the challenges posed by changing weather, enabling targeted interventions to protect vulnerable populations.⁵⁹ Several studies have contributed valuable insights in the research of changing climate. Furthermore, valuation of the monetary value of premature mortality risk due to climate variability in the Czech Republic was done and derived a Value of Statistical Life estimate.⁶⁰ A new approach was presented to assess vulnerability to heat-related health impacts by estimating daily years of life lost social disparities (DYLLD), highlighting the influence of temperature on health inequalities⁶¹ while research on the potential health consequences of projected increases in temperature due to climate alteration was carried out by scientists in California.⁶² Finally, WHO/Europe project provided concentration-response functions between air pollutants and health outcomes, supporting the 2013 revision of air quality policies in the European Union.⁶³ The quantification of health effects from air pollution in a

changing climate was reviewed using statistical tools⁶⁴ while a practical model was developed to assess health impacts from building-related emissions on a city level.⁶⁵ The quantification of cardiovascular mortality due to the influence of temperature changes in Brazilian cities was carried out, emphasizing the need for emission reductions to mitigate related health consequences by combining experimental exposure-response functions through temperature projections from two representative concentration pathways (RCP), namely RCP8.5 and RCP4.5, and two regionalized environment model replications and simulations, the research projects potential health outcomes.⁶⁶

Excess mortality due to climate change's effects on food pattern and weight associated risk issues was modeled by researchers. Their research estimates 529,000 climate-related deaths by 2050 worldwide because of reduced global food accessibility, including fruits, vegetables, and red meat consumption.⁶⁷ A review on previous research on the global economic impacts due to change in climate was done and in turn it enhances our understanding of it which includes replication, survey methods and statistical tools.⁶⁸ Additionally, a method to map high-risk areas was proposed for heat-related health issues in urban areas⁶⁹ while conjoint choice questions were used to capture the insights of climate experts on the adaptive capability of hypothetical countries to environment variability impacts on human health.⁵² A study found that heat still has an impact on mortality in Italian cities, but adaptation measures can help prevent heat-related deaths.⁷⁰ It was discovered that a 1% increase in temperature variation could result in a 0.226% rise in deaths from cardiovascular diseases. Under alternative IPCC climate change scenarios, the mortality rate could surge by 1.2% to 4.1%. The research underlines the need for active procedures to mitigate the opposing impact of environment change on public wellbeing and economies.⁷¹

Artificial Intelligence (AI) and Machine Learning (ML) Tools

Artificial Intelligence and Machine Learning are comparatively new and emerging technologies that can be utilized for analyzing the impacts of adverse climate alterations on community health. Such investigation was carried out which explores the

multifaceted interplay between climate alteration, air pollution, and data science tools. They identified algorithms such as gradient boosting machines, random forest, and classification and regression trees (CART) as significant tools for prediction of air pollution, enabling authorities to take timely actions to minimize the impact on vulnerable populations and the environment. The study suggests that emerging technologies offer promise for mitigating the risks posed by climate-change-induced air contamination on well-being of people.⁷² Additionally, a framework was developed to categorize the effects of emerging technologies on greenhouse gas emissions. The framework identifies policy levers for responsible use and provides a valuable conceptual tool for researchers and policymakers to assess the multifaceted interactions between AI/ML and GHG emissions. The study emphasizes the requirement for research and scenario analysis to effectively use technology in the fight against climate alteration.⁷³

Alternatively, the influence of air contamination on the environment and wellbeing was reviewed by exploring AI and ML methodologies for pollution forecasting, including hybrid models, and highlight their role in early warning systems for mitigating pollution's adverse effects. The inclusion of performance evaluation metrics like R2, RMSE, MAE, and MAPE provides transparency and allows readers to gauge the effectiveness of various AI models. The study includes performance evaluation metrics for identifying the most suitable AI and ML approaches for specific pollution forecasting tasks.⁷⁴ Furthermore, the intersection between global warming, climate change, and the use of Machine Learning (ML) was explored in Climate Change Risk Assessment (CCRA). The identification of commonly used ML algorithms, such as Decision Trees, Random Forest, and Artificial Neural Networks, elucidates the prevailing approaches in this field. Notably, the recognition of ensemble or hybridized applications of these algorithms underscores the complexity of analyzing flood and landslide risk events. The study offers valuable visions for researchers, policymakers, and practitioners.⁷⁵

Conclusion

Investigators in this field have shown increasing curiosity in the prediction of severe climate events and mitigation rules related to environment change

and vulnerable populations health. A bibliometric analysis of 860 publications discovered that most articles were published in scientific journals like the *Journal of Environment, Public Health, and Climate Change*. The United States, China, and England were the top three countries for research in this area. The University of London has published the maximum number of research documents along with many citation networks in the study area. Ebi K. L., Bi P., Berrang-Ford L., and Tong S.L. have all made noteworthy contributions, according to our investigation of the publication authors, as identified in our study. Machine learning and artificial intelligence have gained noteworthy consideration in recent years, but their absence of interpretability can make it hard for decision makers to use them effectively. Decision Trees, Random Forest, and Artificial Neural Networks are the most effective models for improving risk assessment and management.

Future Research Avenues

As a recommendation, increased focus on the significance of such studies can be viewed in the following ways:

Assessment of Human Well-being and Vulnerability

Climate change affects human health. Understanding its mechanisms is crucial in identifying vulnerable populations and developing targeted interventions to mitigate risks.

Adaptation Strategies and Policy Development

Policymakers need to understand climate-related health risks to develop active adaptation strategies that protect public health. Studies on the health consequences due to climatic variability provide the essential evidence to create policies that address the root reasons of climate change and safeguard public wellbeing.

Interdisciplinary Collaboration and Global Perspective

Climate change's health impacts require interdisciplinary cooperation involving environmental scientists, healthcare professionals, policymakers, and communities.

Understanding these effects fosters international cooperation to tackle climate-induced health hazards.

Geographic Information System (GIS) and Artificial Intelligence and Machine Learning (AI-ML) systems can revolutionize risk assessment. With GIS, vast amounts of spatial data can be analyzed for extreme heat, climate variability, and disease spread. AI-ML models can then isolate features and predict future public health aspects. AI-ML models like decision trees, neural networks, and random forests can be trained by past data to forecast future aspects of public health. The concept of big data presents a promising area for researchers to delve more into the development of related models in areas such as climate prediction and exposure mapping. By integrating GIS and AI-ML techniques, we can improve risk assessment accuracy for vulnerable populations and mitigate public health issues.

Acknowledgment

The author would like to thank The Department of Environmental Science, The Maharaja Sayajirao University of Baroda for granting the Ph.D. research work.

Funding Sources

No funding was received to support the writing of this paper.

Conflict of Interest

The authors have no competing or conflicting interests.

Data Availability Statement

Data acquisition was done from the Web of Science publication database.

Ethics Statement

Ethical approval was not required for this work as no new empirical data were collected.

Authors' Contribution

Shivani Raval (Author 1) carried out the research work including data acquisition, GIS analysis, bibliometric analysis, and manuscript writing. K. Muralidharan (Author 2) supervised the research work throughout by giving valuable insights.

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