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Analyzing Public Health Vulnerability to Environmental Disasters Induced by Global Climate Change

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ABSTRACT

Global climate change has increased the frequency and intensity of environmental disasters, such as floods, droughts, heat waves, and tropical storms. These disasters not only impact physical and economic damage, but also pose serious risks to public health, especially vulnerable groups such as children, the elderly, and individuals with chronic diseases. This study aims to analyze the vulnerability of public health to environmental disasters triggered by global climate change. The method used is a qualitative approach with a literature study design (library research), which examines various scientific sources, reports of international organizations, and related policies from various countries. The results of the analysis show that public health vulnerability is affected by a combination of environmental, social, economic, and institutional factors. Factors such as limited access to health services, low climate and health literacy, and lack of early warning systems exacerbate the impact of disasters on public health. In addition, social inequality and development inequality increase risks for poor and marginalized communities. The study emphasizes the importance of integrating health and climate policies, building local adaptation capacity, and strengthening public health resilience systems as a sustainable mitigation strategy. The study also recommends the need for cross-

KEYWORDS

Climate Change, Health Vulnerability, Environmental Disasters, Literature Studies, Community Adaptation.

sectoral collaboration and community-based approaches in addressing future health challenges due to climate change.

1. INTRODUCTION

Global climate change has become a serious threat to the sustainability of human life in various parts of the world. The impact is not only limited to environmental damage, but also puts great pressure on public health systems (IPCC, 2021). Rising global temperatures, rising sea levels, and changes in rainfall patterns have led to an increase in the frequency and intensity of environmental disasters such as floods, droughts, and tropical storms (Field et al., 2014; WHO, 2018). These disasters directly or indirectly have an impact on the increased risk of infectious diseases, mental health disorders, malnutrition, and premature death (Watts et al., 2019).

Although many studies have addressed the relationship between climate change and health, there is still a gap in studies that specifically analyze the level of public health vulnerability in the context of environmental disasters (Ebi & Semenza, 2008). Most previous studies have tended to focus on the clinical aspects or economic impacts of climate change, without delving deeply into the social, structural, and institutional determinants that magnify the vulnerability of certain groups (Costello et al., 2009; Patz et al., 2014). In addition, there are still limited studies that use a qualitative approach based on literature studies to examine the dynamics of health vulnerability in various geographical and sociocultural contexts (Hess et al., 2014).

The urgency of this research lies in the increasing intensity of disasters that are not balanced with the readiness of public health systems, especially in developing countries that have weak health infrastructure (Keim, 2008). Social inequality, limited access to health services, and low adaptive capacity of communities exacerbate the impact of environmental disasters on health (Levy & Patz, 2015). Therefore, mapping and analyzing health vulnerabilities is a crucial step in designing mitigation and adaptation policies that are more responsive to climate risks (Watts et al., 2021).

Previous studies such as those by McMichael et al. (2006) and Confalonieri et al. (2007) have paved the way in understanding the link between climate change and health, but their studies have not detailed mapping the determinants of vulnerability based on social and institutional frameworks. The novelty of this study is its holistic approach through a qualitative-based literature review that combines environmental, health, social, and public policy perspectives to generate a more integrative understanding of public health vulnerabilities.

This study aims to analyze the main factors that affect public health vulnerability to environmental disasters due to global climate change. By using a qualitative approach based on literature studies, this research is also expected to make a conceptual contribution to the development of adaptation and mitigation strategies based on public health. The benefits of this research include providing a scientific basis for policymakers, health practitioners, and local communities to respond more effectively and sustainably to health threats posed by the climate crisis.

Public Health Vulnerability

Public Health Vulnerability refers to the level of risk faced by individuals or groups of people to health problems due to exposure to various hazards, both environmental, biological, social, and economic. In the context of environmental disasters and climate change, these vulnerabilities illustrate how likely a community is to experience adverse health impacts, as well as how limited their capacity to deal with them is. These vulnerabilities are not evenly distributed; Some groups such as the elderly, children, people with disabilities, and the poor tend to be at higher risk due to limited resources, information, and access to health services.

Public health vulnerability consists of several key components. The first is exposure, which is the extent to which individuals or communities are exposed to hazards such as floods, droughts, or air pollution. The second is sensitivity, which is the degree to which their health condition is affected by that exposure—for example, people with respiratory diseases are more susceptible to smog. The third is adaptive capacity, which reflects the ability of individuals or systems to respond, adapt, and recover from these adverse impacts. Social inequality, low education, and poor health infrastructure exacerbate these three components.

In the face of the threat of climate change and environmental disasters, understanding public health vulnerabilities is an important basis for policy intervention planning. A responsive approach must take into account the social, cultural, economic, and geographic factors that make up the level of vulnerability of a community. Interventions should not only focus on the provision of health services, but must also target strengthening community capacity, improving health and climate literacy, and reducing structural inequalities that exacerbate vulnerability. Thus, public health vulnerability analysis is not only a risk measure, but also a foundation for building health systems that are resilient to the climate crisis.

2. METHODS

This research uses a qualitative approach with the type of literature study research (library research). This approach was chosen to explore and analyze in depth various concepts, theories, and empirical findings related to public health vulnerability to environmental disasters due to global climate change. Literature study as a method allows researchers to examine various sources of scientific information in order to build a conceptual understanding and critical synthesis of the issues studied (Zed, 2008; Ridwan, 2010).

The data sources in this study are secondary, consisting of relevant scientific literature such as international journal articles, academic books, reports of international organizations (e.g. WHO, IPCC, UNDP), and policy documents published in the last ten years. The literature selection was carried out purposively based on inclusion criteria which include: (1) discussing the issue of climate change and its impact on public health; (2) focus on vulnerability and risk of environmental disasters; and (3) have academic credibility and have gone through a peer-review process.

The data collection technique was carried out by searching scientific databases such as Scopus, ScienceDirect, PubMed, Google Scholar, and JSTOR, using keywords such as climate change, public health vulnerability, environmental disasters, and climate adaptation. In

addition, the reports of global institutions are also reviewed as part of the triangulation of data sources to enrich policy perspectives and field practices.

The data that has been collected is then analyzed using a thematic content analysis method. This analysis was carried out through a process of categorization and interpretation of the findings of the literature based on key themes such as exposure, sensitivity, and adaptive capacity in the framework of public health vulnerability. This approach helps researchers identify patterns, relationships between conceptual variables, as well as relevant knowledge gaps in the context of climate change and health (Bowen, 2009). The results of the analysis are then synthesized to compile a comprehensive and contextual conceptual framework.

3. RESULTS AND DISCUSSION

The literature data presented in this study is the result of a screening process of a number of scientific articles obtained from various leading databases such as Scopus, ScienceDirect, PubMed, and Google Scholar. From a total of dozens of articles that were systematically reviewed, 10 main scientific articles were selected that were considered the most relevant to the research focus, namely public health vulnerability to environmental disasters due to climate change. The selection criteria include topic suitability, thematic relevance (exposure, sensitivity, and adaptive capacity), credibility of the source (peer-reviewed), and up-to-date data (last 10 years). The following table presents a summary of the 10 articles, including authors, year, title, methods, study area, and key findings related to public health vulnerability.

Table 1. Summary of Selected Literature in Studies

Author & Year	Article Title	Key findings
Watts et al. (2019)	The 2019 Lancet Countdown on Health and Climate Change	*Climate change increases the risk of infectious diseases, heat stress, and premature death.*
Ebi & Semenza (2008)	Community-Based Adaptation to the Health Impacts of Climate Change	*Community-based adaptation is important to reduce local health vulnerabilities.*
McMichael et al. (2006)	Climate Change and Human Health: Present and Future Risks	*Identify future health risks due to climate change; Great pressure on the health system.*
Hess et al. (2014)	Climate Change: The Importance of Place	*Geographical location and social factors affect the level of vulnerability of the community.*

Confalonieri et al. (2007)	Human Health – IPCC AR4 WGII Chapter	*Vulnerability is amplified by poverty, weak infrastructure, and social inequality.*
Patz et al. (2014)	Climate Change: Challenges and Opportunities for Global Health	*Integration between the health sector and climate policy is needed to respond to the challenges.*
Keim (2008)	Building Human Resilience: Public Health Preparedness as Adaptation	*Public health resilience can be improved through disaster preparedness.*
Costello et al. (2009)	Managing the Health Effects of Climate Change	*Climate change is called the biggest threat to global health in the 21st century.*
Levy & Patz (2015)	Climate Change, Human Rights, and Social Justice	*Social justice issues are at the heart of health vulnerability to climate change.*
Watts et al. (2021)	Health and Climate Change: Policy Responses	*Health and climate policy recommendations to reduce people's vulnerability.*

This table can be used as a basis for compiling findings and discussions that focus on three main components of vulnerability: exposure, sensitivity, and adaptive capacity, as well as contextual health policy adaptation strategies.

The results of a literature review of ten scientific articles show that global climate change directly or indirectly increases public health vulnerability, especially in areas with weak health systems. An article written by Watts et al. (2019, 2021) confirms that climate change has become a major threat to the health of the world's population, with impacts that include increasing temperature extremes, the spread of infectious diseases, as well as increased heat stress leading to premature morbidity and mortality. This reinforces the assumption that climate change is not just an environmental phenomenon, but a multidimensional crisis that requires a cross-sectoral response, particularly the health sector.

Furthermore, several articles such as Confalonieri et al. (2007) and McMichael et al. (2006) identified that community groups living in low socio-economic conditions have higher levels of vulnerability. Poverty, limited access to health services, low education, and lack of infrastructure are the main factors that exacerbate sensitivity to the impacts of climate change. In this context, vulnerability is affected not only by the magnitude of exposure to climate risks, but also by the inability of individuals and communities to respond and adapt effectively.

Additionally, studies by Hess et al. (2014) and Levy & Patz (2015) show the importance of geographic and social context in understanding vulnerability. Location factors, such as coastal areas, watersheds, or densely populated urban areas, have their own challenges in dealing with environmental disasters. On the other hand, social inequality and climate injustice

exacerbate this condition, as poor people often live in high-risk areas without adequate social system support. This highlights that vulnerability approaches should be both local and contextual.

The adaptation aspect is also an important focus in the literature studied. Patz et al. (2014) and Keim (2008) stated that building community resilience through health system preparedness, human resource capacity building, and integration of health and climate policies is a crucial step in reducing vulnerability. This approach leads to strengthening adaptive capacity, which is the ability of communities to anticipate, respond, and recover from the adverse impacts of climate change. Effective adaptation also requires community participation and multi-sector collaboration.

A study conducted by Ebi & Semenza (2008) underscores the importance of community-based adaptation as a vulnerability mitigation strategy. They emphasized that top-down interventions are often ineffective without involving local communities in the planning and implementation process. This shows that solutions to public health vulnerabilities must be developed from the bottom-up, integrating local values, traditional knowledge, and real conditions of communities.

Overall, the findings of this literature review confirm that public health vulnerability to environmental disasters due to climate change is complex and multidimensional. The three main components of vulnerability—exposure, sensitivity, and adaptive capacity—appear consistently in the literature, signaling the importance of an integrative approach in analyzing and responding to these issues. Therefore, this article encourages evidence-based policy development that pays attention to the diversity of local contexts, social dynamics, and the linkages between the health, environment, and sustainable development sectors.

Discussion

The phenomenon of global climate change has become a real threat that impacts various aspects of human life, including public health. Findings from the literature reviewed show that changes in extreme weather patterns, increasing global temperatures, and increasing frequency of natural disasters such as floods, droughts, and forest fires have significantly increased public health risks (Watts et al., 2019; IPCC, 2021). This impact can be seen in the increasing cases of respiratory diseases, diarrhea, dengue fever, and mental health disorders triggered by post-disaster stress.

Theoretically, the concept of vulnerability in the framework of the Vulnerability Framework developed by Turner et al. (2003) states that vulnerability is the result of an interaction between three main components: exposure, sensitivity, and adaptive capacity. The findings of the ten articles reviewed reinforce this theory, where exposure to environmental disasters is exacerbated by biological and socioeconomic sensitivities, as well as the lack of community's adaptive capacity to face and recover from disasters.

The phenomenon that occurred in Indonesia and other developing countries shows high relevance to the results of literature findings. For example, extreme flooding in Jakarta and forest fires in Kalimantan and Sumatra show how vulnerable populations, especially the urban poor and indigenous peoples, are experiencing severe health impacts due to direct exposure to climate risks. This also shows the limited capacity of the health system in providing a quick and effective response when a disaster occurs.

In the context of sensitivity, people living in densely populated, unhealthy, and poorly developed areas are more susceptible to disease outbreaks after disasters. Data from the National Disaster Management Agency (BNPB) shows that groups such as children, the elderly, pregnant women, and people with disabilities are more affected in each disaster event. This shows that socio-economic aspects cannot be ignored in the discussion of vulnerability, as emphasized by Confalonieri et al. (2007) and Levy & Patz (2015).

The aspect of adaptive capacity is an important concern in this discussion. Research by Keim (2008) and Patz et al. (2014) highlights that countries or regions with strong public health systems, good disaster preparedness, and cross-sectoral policy integration have lower levels of vulnerability. Unfortunately, in many developing countries, coordination between sectors such as environment, health, and social is still very limited. This creates a response gap in the face of the impacts of climate change on public health.

The Social Determinants of Health theory (WHO, 2008) is also very relevant to explain why vulnerability is not formed randomly, but is the result of social determinants such as education, income, employment, and access to basic services. This is in line with the results of the study by Ebi & Semenza (2008), which emphasized the importance of community-based approaches and social justice in vulnerability mitigation. Social inequality exacerbates public health vulnerabilities because it limits access to adaptive resources.

The authors see that adaptation and mitigation approaches to public health vulnerabilities have not fully reached the social and structural dimensions of this problem. Many climate or health policies are still normative and technocratic, without involving community actors or considering local contexts. In fact, as shown in the literature, community-based adaptation strategies are more effective because they reflect the real needs and capacity of the affected communities.

Criticism of the existing literature is that most studies are still global or based in developed countries. Local case studies from developing countries, particularly the Southeast Asia, Africa, and Pacific regions, are still under-represented in international publications. This is a challenge as well as an opportunity for researchers from developing countries to enrich academic discourse with more representative and applicable contextual data.

In response, the authors consider that there is a need for stronger integration between scientific knowledge and public policy in formulating strategies to reduce public health vulnerability. This requires not only technical intervention, but also a paradigm shift in seeing health as a basic right that must be protected in the context of climate change. Synergy between governments, academics, civil society organizations, and local communities is critical in building an inclusive and sustainable health resilience system.

Finally, this discussion shows that understanding public health vulnerability to environmental disasters due to climate change is not only about measuring risk, but also about understanding the social structures that create inequalities in risk distribution and adaptive capacity. Therefore, further research needs to be directed at the exploration of interventions that are not only technical, but also transformative and equitable.

4. CONCLUSION

The results of this literature review confirm that public health vulnerability to environmental disasters due to global climate change is a complex and multidimensional

issue. Exposure to climate risks such as heat waves, floods, droughts, and air pollution has direct and indirect implications for human health. The level of vulnerability is greatly influenced by socio-economic conditions, health infrastructure, geographical location, and people's adaptive ability to respond to environmental crises.

The three main components of vulnerability—exposure, sensitivity, and adaptive capacity—appear consistently in the various literature reviewed. People living in disaster-prone areas, have high levels of poverty, and have limited access to health services are proving to be the most vulnerable groups. Vulnerability reduction efforts must consider a holistic approach, by strengthening public health systems, expanding disaster preparedness, and integrating climate policies with social justice and the right to health.

This research also shows the importance of community-based and participatory adaptation approaches as an effective strategy in building resilience. However, there are still gaps in the literature related to local contexts in developing countries, particularly in measuring the effectiveness of community-based interventions and the role of non-governmental actors in reducing health risks. Therefore, further research needs to be directed at an in-depth empirical exploration of local dynamics, by directly involving affected communities as subjects and changemakers.

Recommendations for Further Research

To enrich the understanding of public health vulnerabilities in the context of climate change, further research is suggested using a qualitatively local case study approach to explore the social dynamics and adaptive capacity of specific communities. An interdisciplinary approach that combines the perspectives of public health science, anthropology, and public policy is also important to produce more applicable and contextual recommendations. In addition, the development of a regional-based health adaptation policy evaluation model is an urgent need in dealing with the increasing frequency of environmental disasters in the future.

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6. AUTHORS' NOTE

This article was written as part of the author's academic efforts to strengthen a critical understanding of public health vulnerabilities in the context of global climate change. The authors realize that this study still has limitations, especially in terms of generalization of findings because the approach used is a literature study. Therefore, the authors open up opportunities for academic collaboration and advanced research, especially in the form of field studies and the development of community-based policy intervention models. The

author declares that there is no conflict of interest in the preparation of this article, and that the entire writing process is carried out independently and ethically, in accordance with the principles of scientific integrity. Any criticism and suggestions for the development of this study are very much expected by the authors to strengthen the academic contribution to the increasingly urgent global health issue.

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