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Vol. 01, No. 3, August 2024, 8-16
e-ISSN: **3047-8839**

The Effect of Climate Change on the Spread of Communicable Diseases in Urban Environments

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Article Information
Received: August 28, 2024
Revised: September 05, 2024
Online: September 12, 2024

Keywords
Climate Change, Spread of Communicable Diseases, Dengue Fever

ABSTRACT

Climate change is one of the biggest global challenges of the 21st century with far-reaching impacts on various sectors, including public health. This research aims to study how climate change affects the spread of infectious diseases in urban environments, with an emphasis on environmental and behavioural factors that influence the spread of disease. The quantitative method used in this study is descriptive-analytic design. Descriptive research is used to describe the phenomenon of the spread of infectious diseases in urban environments associated with climate change components such as air temperature, rainfall, and humidity. Over five years, the incidence rate of dengue fever in West Sumatra has fluctuated and continued to increase. As shown, the rainfall pattern is changing and increasing. The picture shows a trend of increasing rainfall along with an increase in the number of dengue cases. However, there is a time difference, or time lag, between the increase in cases. Every region should have an early warning system for extraordinary dengue events. As climatic factors change, environmental improvements are also needed along with changes in other factors such as behaviour and health services.

Keywords:*Climate Change, Spread of Communicable Diseases, Dengue Fever*

INTRODUCTION

Climate change is one of the biggest global challenges of the 21st century, impacting a wide range of sectors, including public health. Here are some aspects that show the impact of climate change on public health: Extreme Weather: Climate change causes extreme weather such as storms, droughts and floods, which can increase the risk of disease and injury (I Gusti Bagus Widyantara, 2016; Putri Abdillah et al., 2024). Ecosystem Damage: Loss of biodiversity can affect the food chain, leading to nutritional deficiencies and increased risk of disease (Anugrah, 2020; Razi, 2024). Water Quality: Climate change can affect water quality, which can lead to the spread of diseases such as diarrhea and other water-related illnesses (KDP Division Promotion, 2023).

http://doi.org/10.69855/mgj.v1i3.61
https://gpijournal.com/index.php/miracle
PUBLISHED BY : GPress Indonesia

Rising global temperatures, changing rainfall patterns, and higher frequency of natural disasters have affected ecosystems and increased the risk of spreading infectious diseases, especially in urban areas. Cities are often centers of disease spread due to high population density, intensive mobility, and rapid environmental changes (Adlakha & Sallis, 2020; Tarmizi, 2023).

In urban environments, conditions such as increased air temperature, changes in rainfall patterns, and flooding events often create habitats that favor the spread of disease vectors such as mosquitoes and rodents (Irma et al., 2023). Here are some reasons why these conditions impact the spread of disease vectors: 1. Increased Air Temperature: Mosquitoes: Flies and mosquitoes, such as Aedes aegypti, which are vectors of diseases such as dengue fever and Zika, can breed faster in higher temperature conditions. Warmer temperatures speed up their life cycle, so they can spread faster. 2. Changes in Rainfall Patterns: Flooding and Waterlogging: Changes in rainfall patterns can cause floods and puddles. These floods and puddles can provide breeding grounds for mosquitoes and rats. For example, the Aedes aegypti mosquito often breeds in watery places, such as rain puddles or unmaintained water reservoirs. 3. Flood Events: Infrastructure Damage: Flooding can damage city infrastructure, including sewage systems and waterways. This damage can increase the likelihood of standing water and breeding grounds for disease vectors. 4. Population Density and Mobility: Spread of Vectors: In dense urban environments, population density and intensive mobility can accelerate the spread of disease vectors. People who move more have a higher likelihood of exposure to and transmission of disease (Ghiffari, 2020).

For example, vector-borne diseases such as dengue fever, malaria and leptospirosis are increasingly common in urban areas due to increased temperatures and stagnant water that serve as breeding grounds for these vectors. Climate change also affects water and air quality, which indirectly worsens public health and increases vulnerability to infectious diseases. Thus, urban environmental conditions affected by climate change can increase the risk of disease spread through vectors such as mosquitoes and rodents. Effective vector control efforts, such as changing the physical and social environment, are essential to reduce the risk of spreading these diseases (Ismanto, 2006).

In addition, rapid urbanization without careful planning often leads to environmental degradation, such as reduced green space and poor sanitation. This contributes to an increased risk of spreading infectious diseases. Increased temperature and humidity, which are impacts of climate change, also create more favorable conditions for the development of pathogenic microorganisms that cause respiratory and gastrointestinal infectious diseases.

The challenge of mitigating health risks due to the spread of infectious diseases in Indonesia, especially in urban areas, remains significant. Climate change has worsened the public health situation by increasing the incidence of infectious diseases such as dengue hemorrhagic fever (DHF) and leptospirosis. Here are some key points that explain the relationship between climate change and the spread of infectious diseases in urban environments:

a. Climate Change and Disease Spread: Increased Temperature and Humidity: Climate change increases temperature and humidity, which accelerates the life cycle of disease vectors such as mosquitoes. The Aedes aegypti mosquito, a vector of dengue, can breed faster in warm and humid conditions (Sholeha, 2024).

b. Changes in Rainfall Patterns: Flooding and Waterlogging: Changes in rainfall patterns can lead to flooding and standing water, which become breeding grounds for mosquitoes and rats. This increases the risk of spreading diseases such as dengue and leptospirosis (Rahmadiyanti, 2024).

c. Population Density and Mobility: Spread of Disease: In dense urban environments, population density and intensive mobility accelerate the spread of disease. People who move more have a higher likelihood of being exposed to and transmitting diseases (Ari, 2024)

d. Lack of Health Facilities: Disease Management: Environmentally degraded cities often face the problem of lack of adequate health facilities. This can worsen the situation of disease spread and make disease management more difficult.

e. Required Solutions: Awareness Raising and Preparedness: Increased awareness in the community and preparedness in the medical field are needed to deal with the impact of climate change on the spread of diseases. In-depth research on the relationship between climate change and the spread of infectious diseases is essential to design more effective interventions.

f. Technology Innovation and Green Economy: Renewable Energy Technology Development: Technological innovations such as renewable energy and the development of better batteries can help address the challenges of supply instability and improve environmental conditions, thereby reducing the risk of disease spread (Sharif, 2023).

This research aims to study how climate change affects the spread of infectious diseases in urban environments, with an emphasis on environmental and behavioral factors that influence disease spread. The results are expected to assist in making health policies more adaptive to climate change and support the development of more targeted mitigation strategies to deal with disease threats.

Thus, in-depth research on the relationship between climate change and the spread of infectious diseases in urban environments is essential to design more effective interventions to mitigate its effects. This includes raising public awareness, improving medical preparedness, and implementing technological innovations and green economy to reduce the risk of disease spread.

METHODS

The quantitative method used in this study is descriptive-analytic design. Descriptive research was used to describe the phenomenon of the spread of infectious diseases in urban environments associated with climate change components such as air temperature, rainfall, and humidity. Meanwhile, analysis was conducted to identify the relationship between climate change and infectious disease incidence.

The study was conducted in several major cities in Indonesia that are highly urbanized and vulnerable to the impacts of climate change, such as Jakarta, Surabaya, and Bandung. The study

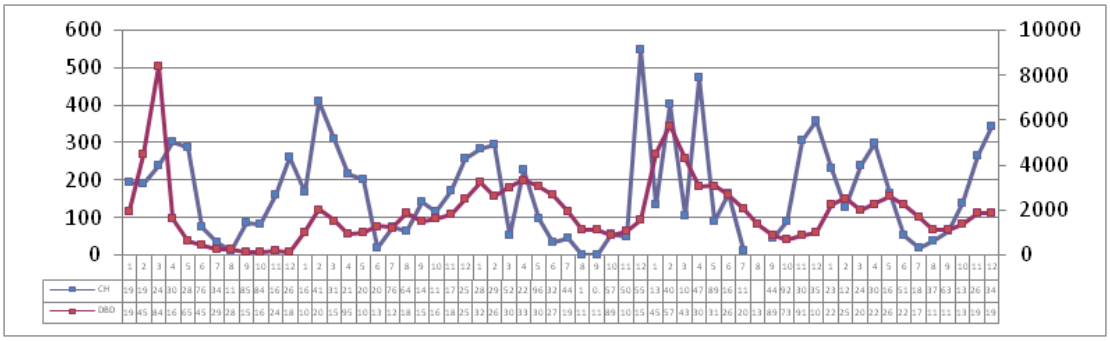
was conducted over six months to gather information on infectious disease trends and climate change.

This study involved residents of major cities in Indonesia affected by infectious diseases such as dengue fever. The stratified random sampling method was used to collect the sample. This method draws samples based on the incidence rate of infectious diseases in some urban areas affected by climate change. In addition, samples were drawn from public health data from health centers or hospitals in urban areas. To ensure the validity of the results, a minimum of 300 cases will be sampled. The parameters of air temperature, rainfall and humidity are used to measure the independent variables of climate change in this study. However, cases of infectious diseases, such as dengue hemorrhagic fever (DHF), are the dependent variable. Data on climate change was collected through daily weather monitoring from an official source (BMKG), data on infectious disease incidence from health reports available at puskesmas or hospitals, and questionnaires were used to find out more about the community on what they know and do about the risk of spreading infectious diseases amid climate change. Data analysis consisted of descriptive analysis that shows how climate change affects the spread of infectious diseases in urban areas, individual correlation analysis that evaluates the relationship between climate change and infectious disease cases, and regression analysis that determines how much influence climate change has on the spread of infectious diseases in urban areas. Multiple linear regression with a significance p of 0.05 was used.

RESULTS

In West Sumatra, climate change data, including rainfall, was collected for five years (2019 - 2023). This data was then computerized to illustrate rainfall patterns and dengue fever cases. Over five years, the incidence rate of dengue fever in West Sumatra has fluctuated and continued to increase. As shown, the rainfall pattern changes and continues to increase.

The picture shows a trend of increasing rainfall along with an increase in the number of dengue cases. However, there is a time difference, or *time lag*, between the increase in cases. To determine how much influence rainfall has on the number of dengue fever cases, a linear logistic regression analysis was used. The annual equation is shown in table 1, which shows that rainfall has a considerable influence on the number of dengue infectious disease cases in 2019 and 2020.



Patterns of Rainfall Change and Dengue Fever Incidence in West Sumatra 2019 - 2023

Table 1. Influence of Rainfall on the Incidence of Dengue Fever Infectious Diseases in 2019 - 2022

Year	β0	β3	r2
2019	1459	0,8	0,21
2020	536,9	0,8	0,34
2021	-487	-0,3	0,67
2022	1200	0,04	0,30

DISCUSSION

The occurrence of a disease according to the epidemiologic triangle theory is as a result of the interaction between the host, the disease agent, and the environment. This theory explains that disease occurs when there is interaction between these three main factors, namely (epidemiolog.id, 2023):

1. Host: This factor includes individuals or living things that are susceptible to disease. Factors that affect the host, such as age, gender, nutritional status, and behavior, can increase the risk of disease occurrence.
2. Disease Agents: This factor includes all living and non-living elements that can cause disease. Examples of disease agents are viruses, bacteria, fungi, and other microorganisms.
3. Environment: This factor includes everything that surrounds and conditions outside a human or animal that can cause or allow disease transmission. Examples of environment are population density, geographical conditions, climate, and social factors.

Thus, the epidemiological triangle theory explains that disease occurs due to the interaction between a susceptible host, an existing disease agent, and an environment that allows disease transmission.

However, Henrik L. Blum may have a broader perspective on disease that considers elements such as environment, behavior, healthcare, and heredity. However, in general, the main concept in epidemiology is still the epidemiological triangle theory, which explains the interaction between host, agent, and environment as the main factors that cause disease.

Weather and climate do influence the pathogenesis of many vector-borne diseases, including mosquitoes. Climate change can increase the potential for increased incidence of mosquito-borne diseases in several ways (Pittara, 2022):

1. Increase Vector Population:

Changes in temperature and humidity can increase mosquito populations. For example, the Aedes aegypti mosquito, a vector of dengue hemorrhagic fever (DHF), can breed faster in warm and humid conditions.

2. Extend Vector Lifespan:

Climate change can also extend the lifespan of mosquitoes. For example, the Culex tritaeniorhynchus mosquito, a vector of the inflammatory brain disease Japanese Encephalitis, can live longer in warmer and more humid conditions.

3. Expanding the Spread of Vectors:

Climate change can expand the habitat of mosquitoes, resulting in the spread of disease. For example, floods and stagnant water caused by changes in rainfall patterns can provide breeding grounds for mosquitoes, such as the Culex mosquito that transmits Japanese Encephalitis.

4. Increase Vector Activity:

Climate change can also increase mosquito activity. For example, Culex mosquitoes being more active at night may increase the risk of transmitting diseases such as Japanese Encephalitis.

5. Mosquito-borne Diseases (Dwinanda, 2023)

Malaria is transmitted by Anopheles mosquitoes. Climate change can increase the population and activity of Anopheles mosquitoes, increasing the risk of malaria transmission.

DHF is transmitted by the Aedes aegypti mosquito. Changes in temperature and humidity can increase the population and activity of Aedes aegypti mosquitoes, thus increasing the risk of dengue transmission.

Filariasis is transmitted by the Mansonia mosquito. Climate change can increase the population and activity of Mansonia mosquitoes, thus increasing the risk of filariasis transmission.

Japanese Encephalitis is transmitted by the Culex tritaeniorhynchus mosquito. Changes in temperature and humidity can increase the population and activity of Culex tritaeniorhynchus mosquitoes, thus increasing the risk of Japanese Encephalitis transmission.

Thus, climate change has a significant impact on the spread of mosquito-borne infectious diseases. Vector control efforts, such as the use of insecticides, biological interventions, and environmental interventions, are essential to reduce the risk of transmission of these diseases (ARIF, 2022).

The increased incidence of dengue fever can be caused by several factors associated with the spread of the disease through mosquito vectors. Here are some key points that explain how rainfall, stagnant water, and other environmental factors affect the spread of dengue (Sholeha, 2024):

1. Stagnant Water and Mosquito Breeding Sites:

Heavy rainfall can cause stagnant water, which is a convenientbreeding ground for the Aedes aegypti mosquito, a vector of dengue hemorrhagic fever (DHF).

2. Environmental Factors and Breeding Habitat:

Mosquito breeding sites are strongly influenced by altitude, slope, and land use. These factors can influence the presence and activity of mosquitoes in an area.

3. Weather Elements and Mosquito Metabolism:

Weather elements such as rainfall and relatively long exposure affect mosquito metabolism, growth, development, and population. Warm and humid weather can accelerate the life cycle of mosquitoes and increase their activity.

4. Increased Number of Vectors:

The increasing number of mosquito vectors as intermediaries for disease spread is one of the main causes of the increasingincidence of dengue fever. Aedes aegypti mosquitoes can breed faster in warm and humid conditions, thus expanding the range of dengue transmission.

Thus, the increased spread of dengue may be caused by a combination of environmental factors, weather, and the presence of more mosquito vectors. Vector control efforts such as clearing standing water, using mosquito repellents, and raising public awareness about the importance of avoiding mosquito bites are essential to reduce the risk of dengue spread (UPT Kemenkes, 2024).

Studies on climate change and the spread of dengue virus found that average temperature and rainfall have a significant impact on the number of dengue fever cases. Previous studies have shown that rainfall is one of the main factors indicating the spread of dengue fever. The results of this study support this finding. Because high rainfall will increase relative humidity, so the lifespan of adult mosquitoes is extended. High rainfall can also increase larval habitats and populations, creating new habitats for adult mosquitoes. Compared to nearby provinces in Sumatra, West Sumatra has a higher incidence of dengue fever and rainfall. The research showed that some data was incomplete for use in the analysis.

CONCLUSIONS

According to the results of the study, it can be concluded that the increase in the number of dengue fever cases is influenced by climate change, particularly changes in rainfall. To prevent this dengue disease caused by climate change, various efforts are needed, including mitigation, which means reducing the causes and effects of disease, and adaptation, which means reducing health risks. Every region should have an early warning system for dengue extraordinary events. As climate factors change, environmental improvements are also needed along with changes in other factors such as behavior and health services.

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