Spatial Analysis of Filariasis and Malaria Determinants as Neglected Tropical Diseases in Indonesia

Wahyu Indah Dewi Aurora[1(✉)], Ima Maria[2], Erny Kusdiyah[1], Armaidi Darmawan[1], Nuriyah[2], and Deri Mulyadi[2]

[1] Center of Excellent (COE) Environmental Health Sciences and Diseases (SEHAD), Universitas of Jambi, Jambi, Indonesia
puiptsehad@unja.ac.id

[2] Faculty of Medicine and Health Sciences, Universitas of Jambi, Jambi, Indonesia

Abstract. Introduction: Neglected Tropical Diseases are found in tropical or subtropical areas. Neglected tropical diseases are infectious diseases that only affect people who have a low standard of living, are poor, do not have access to good sanitation, or who do not receive special attention such as other infectious diseases such as malaria, HIV, tuberculosis, etc. The causes of this disease vary, some are caused by bacteria, viruses, protozoa or worms. Examples of neglected tropical diseases in Indonesia are Malaria and Filariasis. The purpose of this study was to analysis spatial malaria and filariasis by region and to analyze the determinants of these diseases.

Methods: This research is a research with spatial analysis design using thematic map generated by ArcGIS 10.8 software by creating an overlay of dependent variables (Filariasis and Malaria) and independent variables. Official data is taken from the Indonesia Health Profile 2021. The graduate color map is constructed from layers of dependent variables classified into five classes using the Natural Breaks (Jenk) method. Class division for each independent variable aims to facilitate map reading, and can be used to assess program success. Graduated symbol map is built from independent variable layer with Manual method.

Results: The results of this study found that the prevalence of filariasis ranged from 0–1,055 per 1,000,000 population in 34 provinces, with an average of 75.7 per 1,000,000 population. In malaria mapping, the incidence of malaria ranges from 0.17–80.05 per 1,000 population in 34 provinces, with a mean of 0.14 per 1,000 population. The highest malaria cases were found in Papua, West Papua, and West Nusa Tenggara. Districts/cities that have implemented the Germas policy in 2021 are 232 districts/cities (45.1%).

Conclusion: From 5 determinants analyzed, the highest filariasis was found in areas with low STBM coverage, did not meet GERMAS targets, high poverty rates and did not meet adequate water coverage according to WHO standards. Population density has no effect on high disease rates, because the geographical area is still in the form of forests and fields, which has the potential to increase the development of disease vectors such as mosquitoes.

Keywords: Neglected Tropical Diseases · Filariasis · Malaria

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1 Introduction

Neglected Tropical Diseases is a disease that is commonly found in tropical and subtropical areas, where this disease spreads in population groups that tend to be marginalized such as having a low standard of living, poverty, not having access to good sanitation (1). WHO has released 21 diseases that are included in the Neglected Tropical Diseases (NTD), one of which is Filariasis and Malaria (2).

Diseases caused by parasites make a high enough contribution to the incidence of Neglected Tropical Diseases. Filariasis is also known as elephantiasis disease and Malaria is also transmitted by mosquitoes. Filariasis disease does not cause death but causes deformities and disabilities so that it has a bad impact on socio-economics (3).

WHO has determined filariasis to be a disease that must be eliminated by 2030, with an estimated 1.3 billion people worldwide who are at risk of contracting this disease spread over 83 countries of which 60% are in Southeast Asia(2). In Indonesia, the chronic incidence of filariasis continues to decline until 2021. However, there are still several provinces that become endemic filariasis(4). Several provinces in Indonesia have even been free from malaria. The Indonesian government has set a target for malaria elimination by 2030 with various programs and strategies to accelerate the reduction in the number of malaria cases (5).

The purpose of this study was to map malaria and filariasis by region and to analyze the determinants of these diseases.

2 Method

This research is a research with spatial analysis design using thematic map generated by ArcGIS 10.8 software by creating an overlay of dependent variables (Filariasis and Malaria) and independent variables. Official data is taken from the Indonesia Health Profile 2021. The graduate color map is constructed from layers of dependent variables classified into five classes using the Natural Breaks (Jenk) method. Class division for each independent variable aims to facilitate map reading, and can be used to assess program success. Graduated symbol map is built from independent variable layer with Manual method. Each independent variable is classified as follows Population density is divided into two classes by geometrical interval method.

The coverage of STBM is divided into two classes: 100% and <100%, based on the indicators of the success of the program achievement of the Regulation of the Minister of Health of the Republic of Indonesia Number 3 of 2014.(6) The implementation of GERMAS is divided into 2 classes: <35% and 35%, based on the Action Plan for Health Promotion and Community Empowerment Activities 2020–2024 (7).

The percentage of poor people is divided into 2 classes: 7% (meet the target) and >7% (does not meet the target), based on the target of the 2020–2024 National Mid-Term Development Plan.(8) Coverage of access to safe water: <74% (not meeting the target) and 74% (meeting the target), based on WHO targets.(9).

3 Result

1. **Determinant Analysis of Filariasis in Indonesia in 2021**

The results of this study found that the prevalence of filariasis ranged from 0–1,055 per 1,000,000 population in 34 provinces, with an average of 75.7 per 1,000,000 population. The highest filarial prevalence was found in Papua Province and the lowest in North Kalimantan Province. Figure 1 shows the red zone in Papua, the orange zone in West Papua, the yellow zone in East Nusa Tenggara.

Analysis of Population Density and Filariasis Cases

Based on filariasis prevalence and population density, DKI Jakarta has the highest population density and North Kalimantan has the lowest population density. Papua and West Papua, with a high prevalence of filariasis, actually have a lower population density compared to East Nusa Tenggara (yellow zone) (Fig. 2).

Community Based Total Sanitation Analysis (STBM) and Filariasis Cases

Based on filariasis prevalence and STBM coverage in each province, Papua (red zone), West Papua (orange zone), and East Nusa Tenggara (yellow zone) are areas that have low STBM coverage (Fig. 3).

Analysis of GERMAS Application and Filariasis Cases

Based on the prevalence of filariasis and the implementation of GERMAS in each province, Papua, West Papua and East Nusa Tenggara did not meet the target of GERMAS implementation. However, there are also areas that do not meet the target of GERMAS

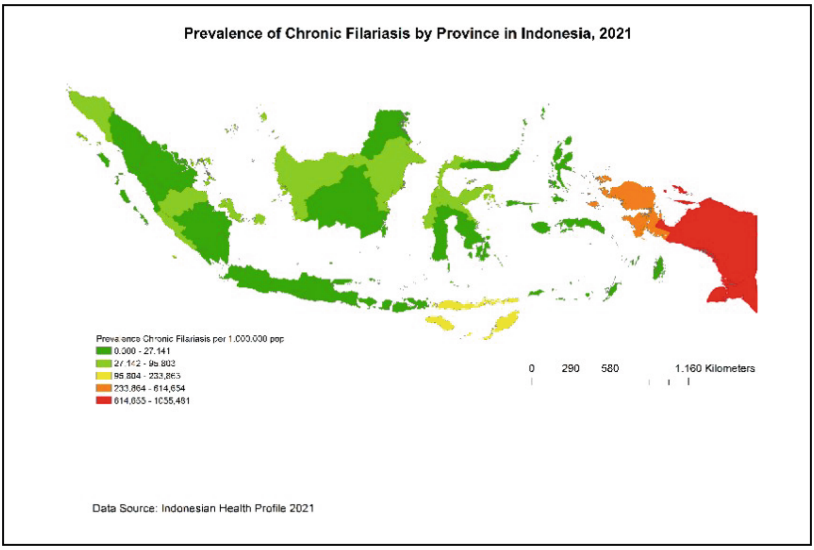

Fig. 1. Chronic Filariasis Prevalence in Indonesia, 2021

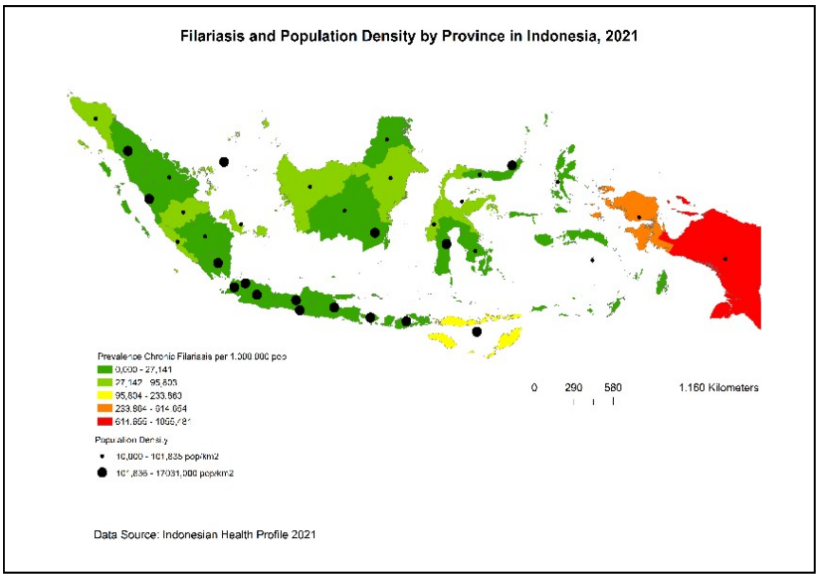

Fig. 2. Filarial Prevalence and Population Density in Indonesia, 2021

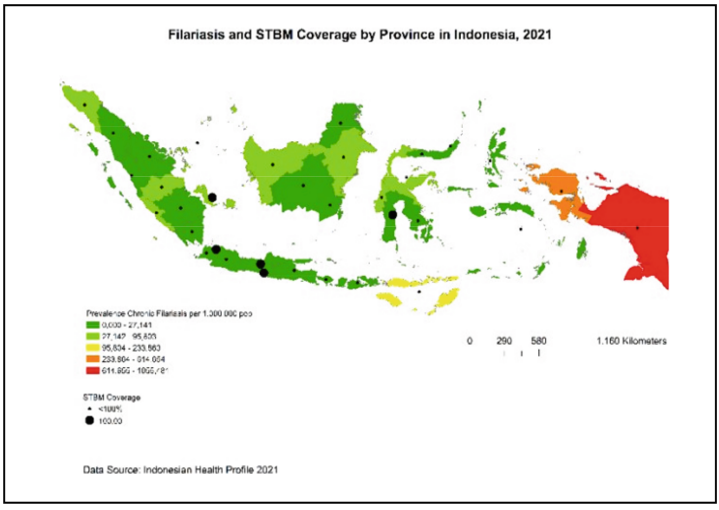

Fig. 3. Filariasis Prevalence and STBM Coverage in Indonesia, 2021

implementation with the lowest filariasis prevalence zoning, such as North Sumatra, West Sumatra, South Sumatra, South Sulawesi, North Sulawesi, and Maluku (Fig. 4).

Analysis of Poverty Levels and Filariasis Cases

Based on filariasis prevalence and poverty rate, Papua, West Papua, and East Nusa Tenggara are provinces with high poverty rates. However, there are still provinces with

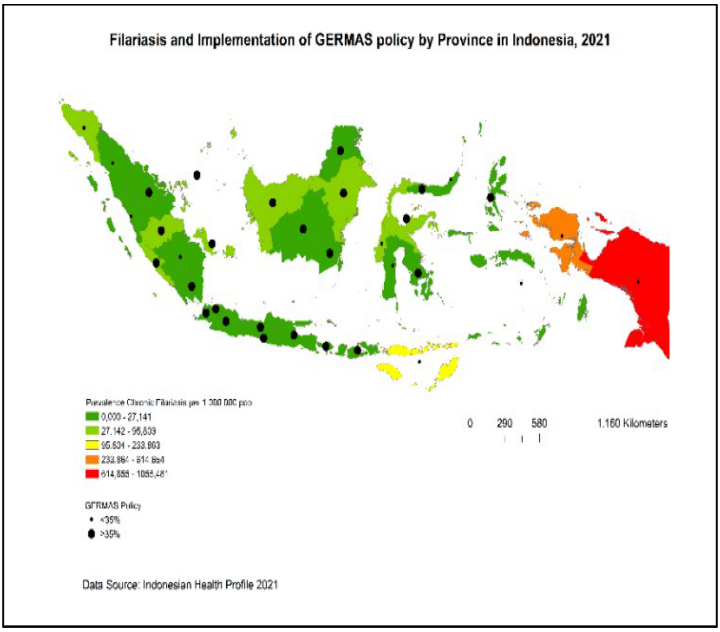

Fig. 4. Filariation Prevalence and Application of GERMAS in Indonesia, 2021

the lowest filariasis prevalence category that have a high poverty rate, such as North Sumatra, South Sumatra, Lampung, West Java, D.I. Yogyakarta, Central Java, East Java, West Nusa Tenggara, North Sulawesi, Gorontalo, South Sulawesi, Southeast Sulawesi and Maluku (Fig. 5).

Analysis of Adequate Water Coverage and Filariasis Cases

Based on filariasis prevalence and adequate water coverage, only Papua does not have access to proper water according to WHO indicators (Fig. 6).

Determinant Analysis of Malaria in Indonesia 2021

In malaria mapping, the incidence of malaria ranges from 0.17–80.05 per 1,000 population in 34 provinces, with a mean of 0.14 per 1,000 population. The highest malaria cases were found in Papua, West Papua, and West Nusa Tenggara. Figure 7 shows the red zone in Papua, the orange zone in West Papua, the yellow zone in East Nusa Tenggara.

Analysis of Population Density and Malaria Cases

Based on the incidence of malaria and population density, Papua and West Papua, with high malaria incidence, actually have a lower population density than East Nusa Tenggara (yellow zone) (Fig. 8).

Community Based Total Sanitation Analysis and Malaria Cases

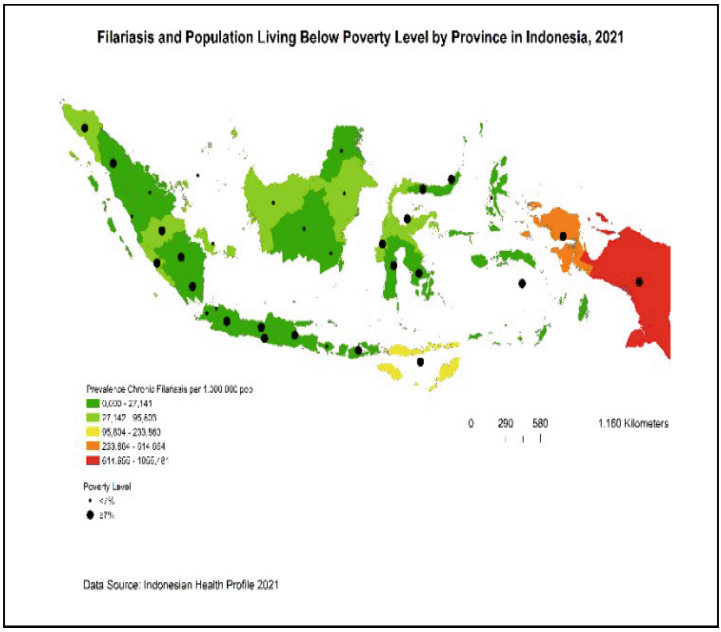

Fig. 5. Filariasis Prevalence and Poverty Rate in Indonesia, 2021

Based on malaria incidence and STBM coverage in each province, Papua (red zone), West Papua (orange zone), and East Nusa Tenggara (yellow zone) are areas that have low STBM coverage (Fig. 9).

Analysis of the Application of Germas and Malaria Cases

Based on the incidence of malaria and the implementation of GERMAS in each province, Papua, West Papua, and East Nusa Tenggara did not succeed in meeting the target of implementing GERMAS. However, there are also areas that do not meet the target of GERMAS implementation with the lowest filariasis prevalence zoning, such as Aceh, North Sumatra, West Sumatra, South Sumatra, West Sulawesi, South Sulawesi (Fig. 10).

Analysis of Poverty Levels and Malaria Cases

Based on malaria incidence and poverty rate, Papua, West Papua and East Nusa Tenggara are provinces with high poverty rates (Fig. 11).

Analysis of Adequate Water Coverage and Malaria Cases

Based on the incidence of malaria and adequate water coverage, only Papua does not have access to proper water according to WHO indicators (Fig. 12).

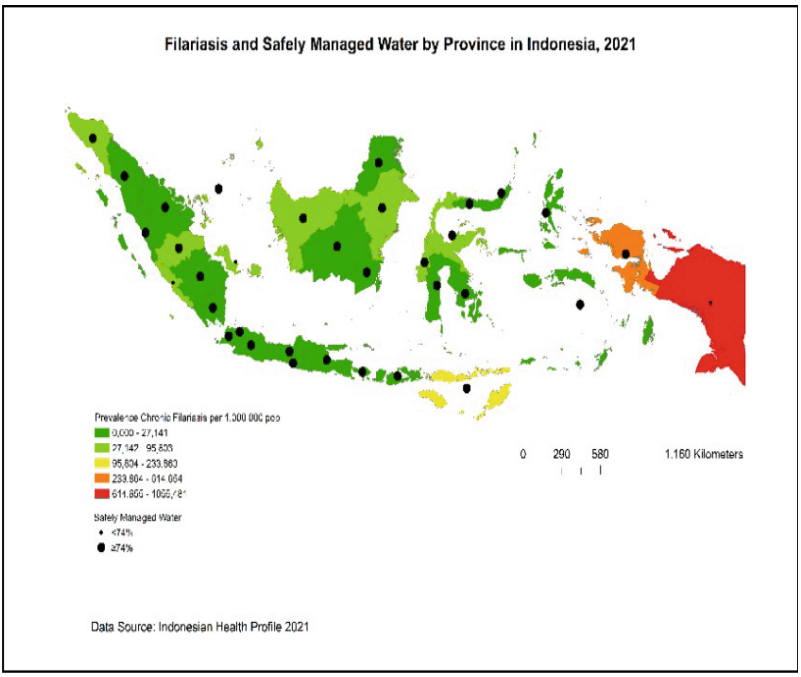

Fig. 6. Filariasis Prevalence and Access to Safe Water in Indonesia, 2021

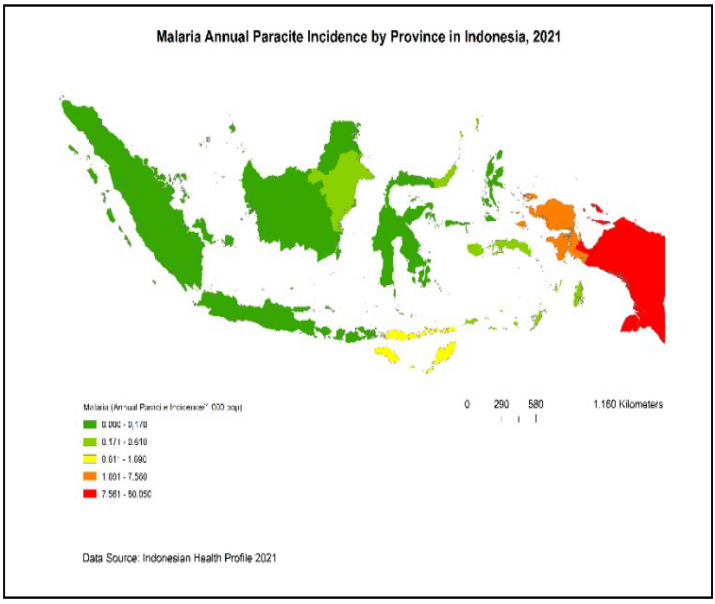

Fig. 7. Malaria Incident in Indonesia, 2021

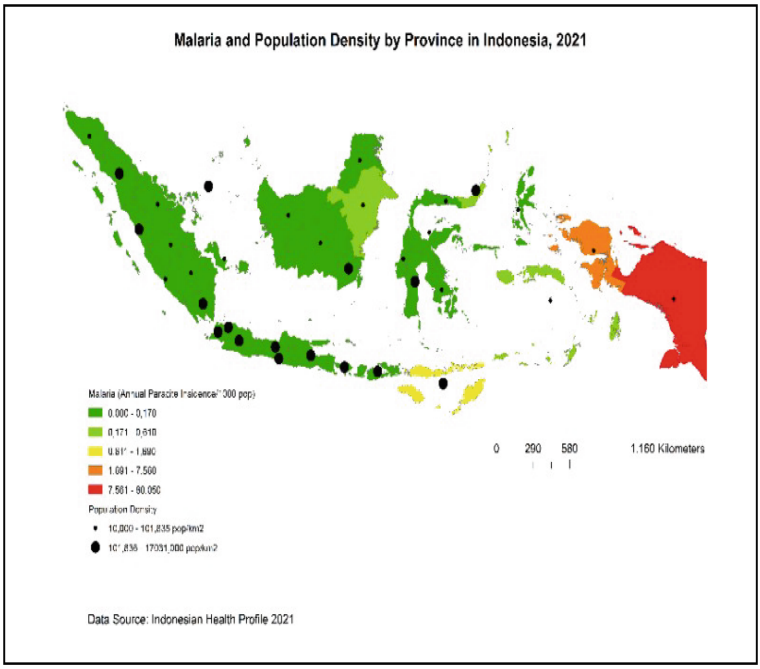

Fig. 8. Malaria Incidence and Population Density in Indonesia, 2021

4 Discussion

Neglected tropical diseases are longstanding diseases that burden and affect more than 11 billion people worldwide, mainly in tropical and subtropical climates and in neglected populations [9]. Transmission of this infectious disease can be caused by viruses, bacteria, worms and parasites. Two examples of NTDs caused by parasites are filariasis and malaria.

Filariasis is a tropical disease caused by a parasitic infection that can cause permanent disability for the sufferer. This disease is transmitted by various types of mosquitoes that live in tropical and subtropical lands. Parasites that enter the lymph cause swelling of the legs or genitals, causing permanent disability [3].

In addition to filariasis, malaria is also caused by a parasite, namely Plasmodium, where this parasite will enter the bloodstream and infect the red blood cells of the sufferer. Certain types of malaria can cause complications that are quite severe and can even cause death [5]. From the map that has been produced, in Indonesia, almost most of the provinces in Indonesia are in the green zone. Some areas that were formerly endemic for filariasis and malaria, have now decreased and some have even managed to reduce to 0 cases. But there are still some areas that are still endemic, namely in eastern Indonesia such as Papua, West Papua and East Nusa Tenggara [4].

The Indonesian government has made several programs to control and eliminate Filariasis and Malaria. Provision of Mass Prevention Drugs is considered quite effective in reducing cases of Malaria and Filariasis in several areas [10]. In 2021, there are four

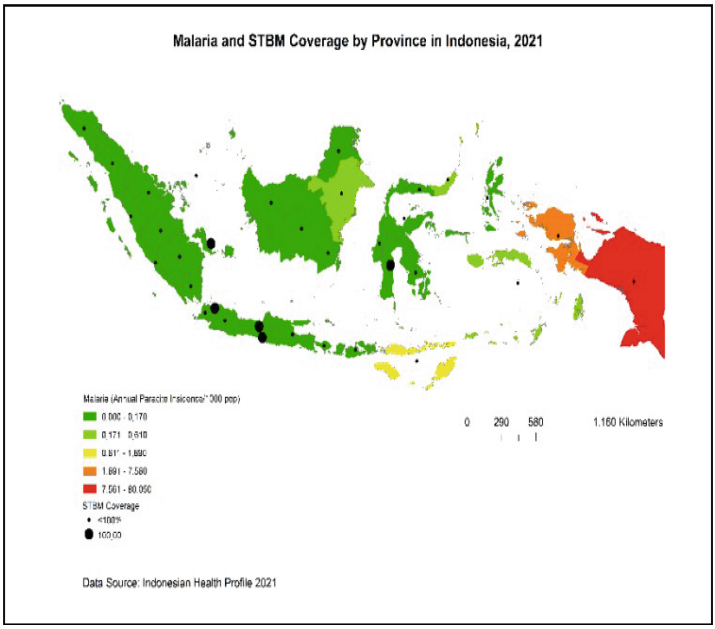

Fig. 9. Malaria Incidence and STBM Coverage in Indonesia, 2021

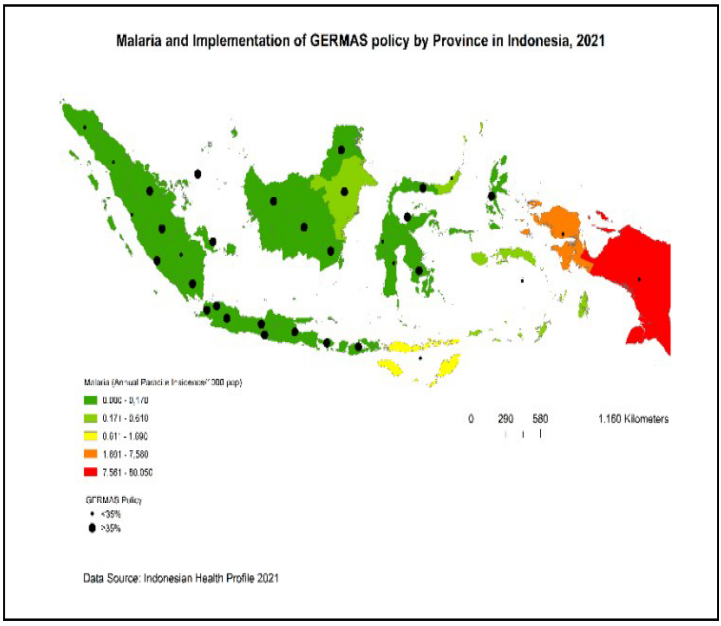

Fig. 10. Malaria Incident and Implementation of GERMAS in Indonesia, 2021

Fig. 11. Malaria Incidence and Poverty Rate in Indonesia, 2021

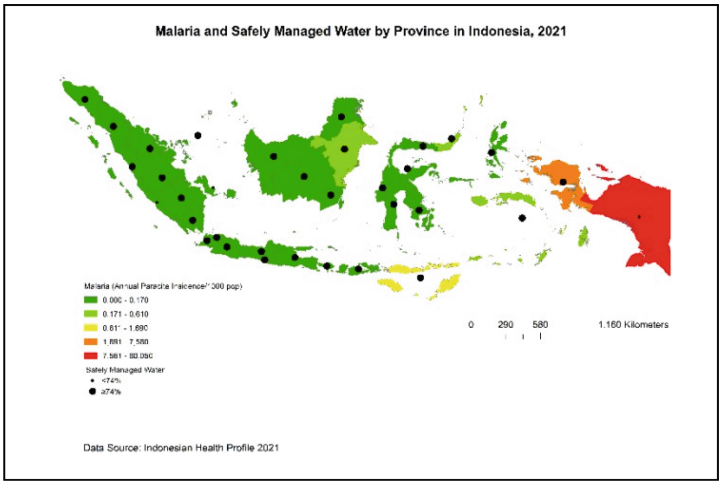

Fig. 12. Malaria Incident and Access to Safe Water in Indonesia, 2021

provinces that are designated as malaria-free areas, namely DKI Jakarta, Bali, East Java, and Banten. In addition, there are three provinces where all regencies/cities have not had malaria elimination status, namely Maluku, West Papua, and Papua. However, there are several districts in the three provinces that have low endemic status. With an effective intervention, this status can be improved to be free of malaria. Malaria elimination can

be pursued by increasing the percentage of confirmation of blood availability and the percentage of standard treatment. In the picture above, it can be seen that in 2021 as many as 67.5% of districts/cities in Indonesia or as many as 347 districts/cities have malaria-free status. The number of districts/cities with malaria-free status in 2021 is higher than in 2020 which was 318 districts/cities [4, 11].

In Indonesia, in 2021 there will be 9,354 chronic cases of filariasis spread across 34 provinces. This figure seems to have decreased from the previous year's data because several cases of death were reported and there was a change in diagnosis after data validation/confirmation of chronic clinical cases reported the previous year. Provinces with the highest cases are in eastern Indonesia, namely Papua with 3,629 cases, East Nusa Tenggara with 1,307 cases, and West Papua with 620 cases. Provinces with <5 cases of filariasis, namely Gorontalo, Bali, DI Yogyakarta, and North Kalimantan [4].

In addition to mass drug administration, there are various risk factors that also influence the development of Malaria and Filariasis. The determinants are population density, Community-Based Total Sanitation Coverage, Germas Implementation, Poverty Rate and adequate clean water coverage [5]. Implementation of Community-Based Total Sanitation is a program from the Government of Indonesia with the aim of improving public health behavior by referring to 5 pillars, namely the behavior of stopping open defecation, washing hands with soap, managing drinking water and household food, managing household waste and managing liquid waste. Household [12]. The implementation of community-based total sanitation can effectively increase the number of prevention of morbidity and mortality due to a disease [13].

The implementation of the Healthy Living Community Movement (Germas) program has been launched by the Government of Indonesia since 2017. The main activities carried out in this movement are increasing physical activity, increasing clean and healthy living behavior, providing healthy food and accelerating nutrition improvement, increasing prevention and early detection. Disease, improving environmental quality and increasing education on healthy living [14].

Districts/cities that have implemented the Germas policy in 2021 are 232 districts/cities (45.1%). There are 4 (four) provinces that achieve 100% of the Regency/City implementing the Germas Policy, namely North Maluku, West Nusa Tenggara, DI Yogyakarta and Bengkulu. Provinces with a low percentage of districts/cities implementing the Germas Policy are West Papua (7.7%), East Nusa Tenggara and Maluku (9.1%) while Aceh (13.0%). There is 1 province that has not implemented the Germas Policy, namely Papua [4].

The poverty rate can be measured using the level of income, level of expenditure, as well as a combination of both. Indonesia is one of the countries that measure poverty data using the level of expenditure per capita with the concept of the ability to meet basic needs (basic needs approach). Measuring the poverty rate using the expenditure poverty line method, both the non-food poverty line and the food poverty line. The poverty line shows the minimum amount of rupiah needed to meet the minimum basic needs for food which is equivalent to 2100 kilocalories per capita per day and basic non-food needs.

The number of poor people in September 2021 was 26.50 million people, decreased by 1.04 million people against March 2021 and decreased by 1.05 million people in September 2020. The percentage of poor people in September 2021 was 9.71 percent,

decreased by 0.43 percent points against March 2021 and decreased by 0.48 percentage points against September 2020. The percentage of the urban poor in March 2021 was 7.89 percent, down to 7.60 percent in September 2021. While the percentage of the rural poor in March 2021 was 13.10 percent, down to 12.53 percent in September 2021 [4].

Provinces with the highest percentage of households with access to safe drinking water are DKI Jakarta (99.86%), Bali (97.56%), and DI Yogyakarta (95.69%). Meanwhile, the provinces with the lowest percentage were Papua (64.92%), Bengkulu (67.39%), and the Bangka Belitung Islands (73.40%). The percentage of families with access to proper sanitation facilities (healthy latrines) in Indonesia in 2021 is 86.1%. Provinces with the highest percentage of families with access to proper sanitation facilities (healthy latrines) are DI Yogyakarta (100%), South Sulawesi (99.4%), and Central Java (96.1%). Provinces with the lowest percentages are Banten (3.7%), Papua (56.5%), and West Papua (69.9%).

Of the three regions, namely the Provinces of Papua, West Papua and East Nusa Tenggara, which are the 3 regions with the highest rates of Filariasis and Malaria, have not reached the coverage of Community-Based Total Sanitation in accordance with the target, have not implemented Germas, poverty rates are still high and clean water coverage and poor access to sanitation. The gap in facilities and infrastructure, health facilities, human resources can also be a factor in the delay in Eastern Indonesia to be able to eradicate these two diseases.

Population density does not affect the development of malaria and filariasis, which means that environmental influences and disease-causing agents are still high in Eastern Indonesia. Of course, improving environmental health will also have an impact on reducing cases of environmental-based diseases [15].

5 Conclusion

The highest ilariasis and malaria is in Papua, West Papua and East Nusa Tenggara. Of the 5 determinants analyzed, the highest filariasis was found in areas with low STBM coverage, did not meet GERMAS targets, high poverty rates and did not meet adequate water coverage according to WHO standards. Population density has no effect on high disease rates, because the geographical area is still in the form of forests and fields, which has the potential to increase the development of disease vectors such as mosquitoes.

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