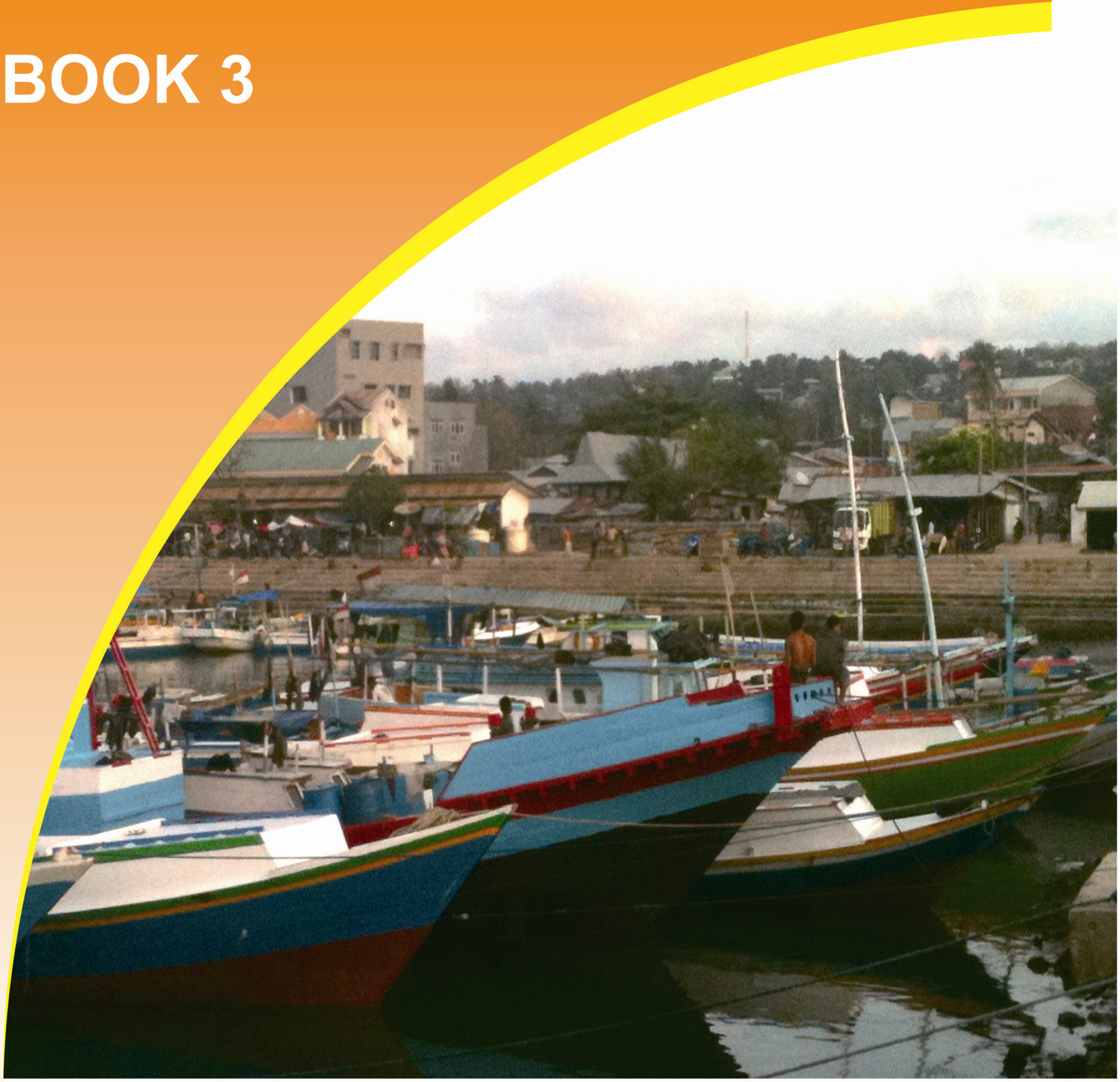
BOOK 3



CLIMATE VULNERABILITY AND ADAPTATION OPTION IN LEMBATA, SIKKA, AND TIMOR TENGAH UTARA (TTU)

Participatory Research on Climate Vulnerability

Australian AID
BNPB
AUSTRALIA-INDONESIA FACILITY FOR DISASTER REDUCTION

INSTITUT TEKNOLOGI BANDUNG 1920

Plan

AUTHORS

Report on Participatory Research on Climate Vulnerability

ITB Team

Dr. Armi Susandi, MT
Dr. Saut Sagala
Mamad Tamamadin, S.Si.
Hadian Idhar, ST.

PLAN Indonesia

Vanda Lengkong
Amin Magatani
Yohanes B. Joman
Berliana Paulina Dana Dasa
Abidin, S.H

Local Partner

Manu Drestha
Yohannes Brino Tolok
Krisantus Tri Pambudi Raharjo

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I Introduction

1.1 Background

Indonesia faces many challenges to meet the Millennium Development Goals (MDG) targets, especially with rapidly degrading ecosystems, climate change and increasing vulnerability to disasters. In order to develop appropriate adaptation actions, Indonesia needs to develop scenarios and understanding of what the climate future will hold. Up to the present, the study that incorporates the integration between climate model and scenarios with adaptive capacity scenario as well as climate vulnerability is still rare. This has caused a lot of uncertainties in developing adaptations that are suitable in particular regions. Hence, a study that integrates both climate model and adaptive capacity scenario is really needed to be conducted at the national, provincial and district level.

Indonesia's Climate change vulnerability is augmented by its extensive coastlines and the fact that 44% of the population is agriculturally reliant for their livelihoods. East Nusa Tenggara (NTT) is selected as the study area for this research due to its condition as one of Indonesia's most disaster-prone areas. The location of this research is in Lembata, Sikka and Timor Tengah Utara Districts (Figure 1).

This book is part three of three books that present the reports from the study of "Participatory Research on Climate Vulnerability in NTT". The first book covers the current issue of climate model (the mean rainfall, mean temperature, and sea level rise) and it's projection. The second book presents the current issues of socio-economic condition and adaptive capacities as well as its projection. The third book (this book) integrates the issues of climate models, adaptive capacities and recommendation of adaptation options in dealing with the climate vulnerability.

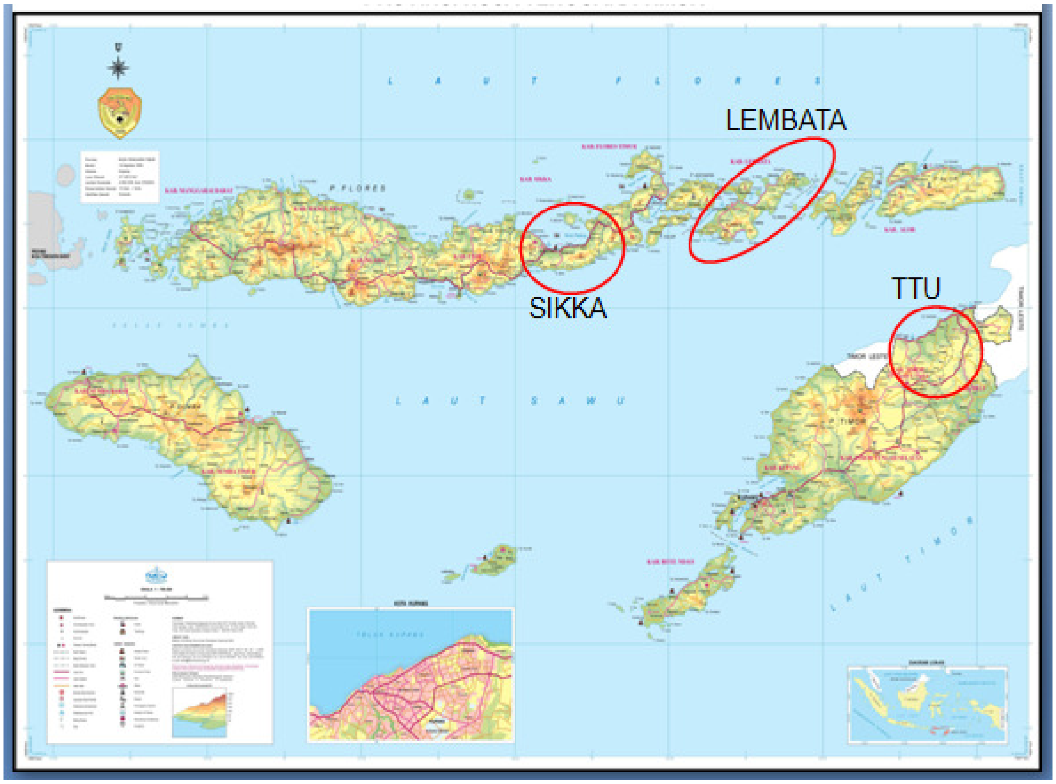


Figure 1. NTT Province and location of case study areas

1.2 Objective

The objective of the study in general was to develop participatory climate vulnerability of three districts in NTT (Sikka, Lembata and TTU). To achieve this objective, the proposed research used an innovative science-based approach to study the implications of climate change, therefore increasing the accuracy in assessing climate change vulnerability and the effectiveness rate of the adaptation options. The research used the Climate Smart Disaster Risk Management approach Plan was currently implementing across a number of countries and funded by DFID. The method and tools used through this research project aimed to build capacities in the three districts for adaptation to climate change, using a methodology that combined both science based and participatory approaches.

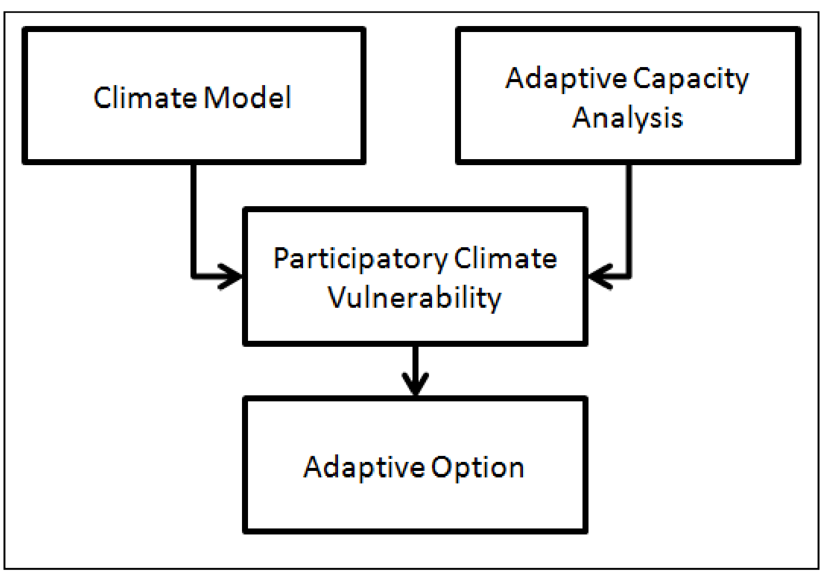
To ensure the participatory process, the research was conducted through partnership between Plan International, the Bandung Institute of Technology (ITB), University of

Timor, local academics and research institutions, DRR practitioners and managers, local Governments, and vulnerable members of the community, including women and children.

The objective of this book is to provide the results from analysis of vulnerability as combined with climate models and adaptive capacity level. This book also identified some adaptation options that are perhaps proper to be implemented in each study areas of Sikka, Lembata, and also Timor tengah Utara (TTU).

1.3 Analytical Framework

In the analytical process, the general research framework is presented as follows. First, climate model was analyzed in detail using the consideration of mean rainfall, mean temperature and sea level rise. The adaptive capacity was then analyzed using several indicators related to socio-economic and infrastructure matters of the districts. The results of the two analyses were integrated into a participatory climate vulnerability analysis showing the results of scenario of the climate as well as the adaptive capacity level (this book). Subsequently, the adaptation options were developed based on the scenarios in the participatory climate vulnerability. In each step, focus group discussions were carried with local policy and decision makers and local communities.



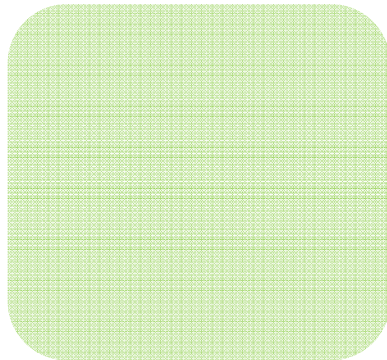


Figure 2. General Research Framework

II Concept of Climate Vulnerability

Climate change adaptation is a technical term that refers to adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. Adaptation refers to changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change (See Figure 3).

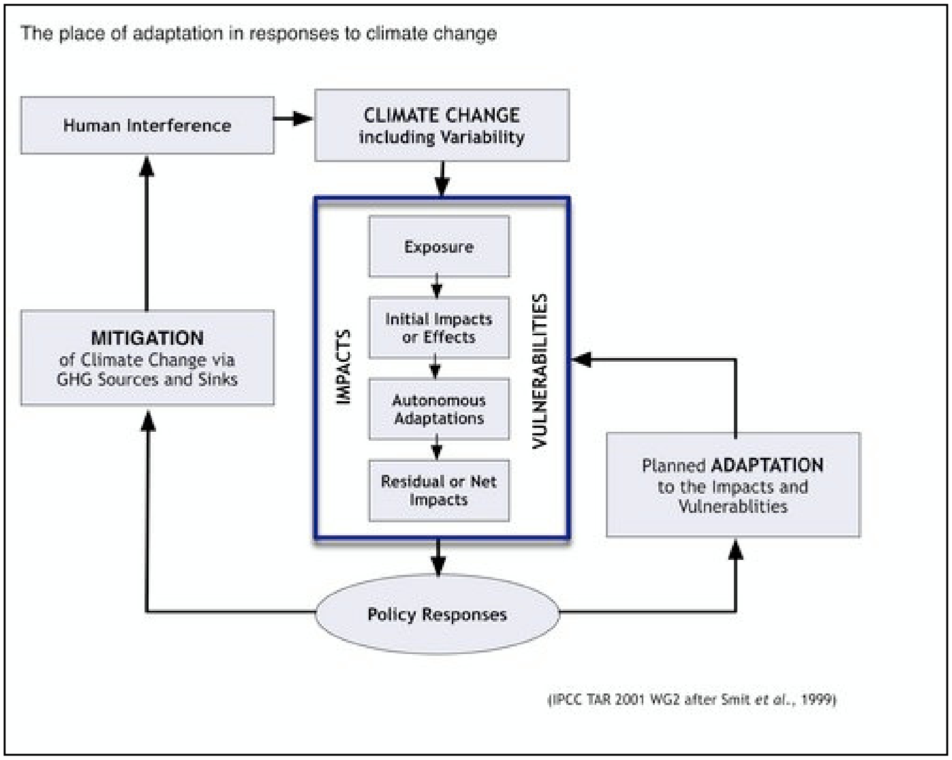


Figure 3. Concept of climate vulnerability

The vulnerability of a system to effects of climate disruption (as seen in Figure 1) depends on the sensitivity of that system to changes, its capacity to adapt to changes, and the severity of its exposure to changes. Climate scientists define vulnerability as the extent to which a natural or social system is susceptible to sustaining damage from climate change. Vulnerability is a function of the (1) sensitivity of a system to changes in climate (the degree to which a system will respond to a given change in climate, including beneficial and harmful effects), (2) adaptive capacity (the degree to which adjustments in practices, processes, or structures can moderate or offset the potential for damage or take advantage of opportunities created by a given change in climate), and (3) the degree of exposure of the system to climatic hazards. Resilience is a counter-weight to vulnerability–a resilient system or population may experience the disturbances caused by climate variability and change, but has the capacity to adapt.

Adaptation planning requires an understanding of the three major contributors to the vulnerability to climate disruptions: sensitivity, exposure, and adaptive capacity.

Researchers at the IPCC as well as the Pew Climate Center found that examining the first two factors means studying what types of climate changes and impacts we can, and which systems would be exposed, as well as whether the impacts were irreversible (such as death, species extinction or ecosystem loss).

With these adaptive capacity questions in mind, The Pew Center on Global Climate Change summarized the key factors for strengthening adaptive capacity by including broad sectors within society from economic resources to technology, education, infrastructure and institutional support. (See Table 1)

Table 1. Key Factors for Adaptive Capacity

Factors	Examples
Economic resources	Wealth of individuals and localities.
Technology	Localized climate and impact modeling to predict climate change and variability; efficient irrigation systems to reduce water demand.
Information/awareness	Species, sector, and geographic-based climate research; population education and awareness programs.
Skills/human resources	Training and skill development in sectors and populations; knowledge-sharing tools and support.
Natural resources	Abundant levels of varied and resilient natural resources that can recover from climate change impacts; healthy and inter-connected ecosystems that support migration patterns, species development and sustainability.
Infrastructure	Systems that provide sufficient protection and enable efficient response (e.g., wireless communication, health systems, air-conditioned shelter).
Institutional support/governance	Governmental and non-governmental policies and resources to support climate change adaptation measures locally and nationally.

Source: Klein (2007) IPCC as used in Pew Center (2009) Climate Change 101.

III Analysis of Climate Impact

3.1 Review of Climate Model Results

This section discusses the validity of the model results when compared with observational data that has been done in previous times. The results of the model are combination of different climate models that combine to form projections of climate parameters, such as rainfall and temperature. Furthermore, these two climate parameters are used as input to build a map projection of climate vulnerability in the three study areas, namely Sikka, Lembata, and TTU.

3.2 Validation of Climate Impact Model

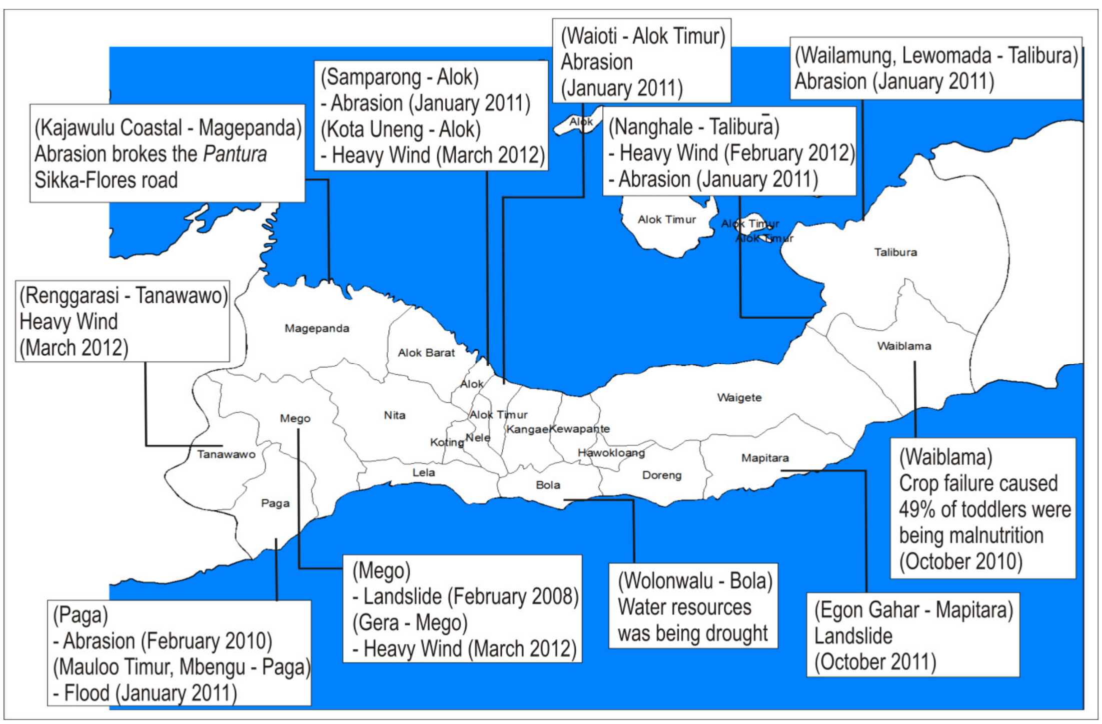


Figure 4. Climate change impact in Sikka District

Based on various sources, it was identified that abrasion was the most frequent disaster that occured in Sikka District. As shown at Figure 5(1), besides abrasion, there was also other type of disasters as well, such as heavy wind, flood, and drought. Drought disasters in the study area are usually shown as secondary disasters, such as plant failures and even food security problems. Some of the areas had even suffered from more than 1 type of disasters. Nanghale village for example, had had both types of abrasion (Figure 5(1)) and also heavy wind (Figure 5(3)). In abrasion cases of Paga village (Figure 5(4)), some local people said that the 2011 abrasion events had caused higher flood than recent years (Pos Kupang). Different to the Magepanda abrasion, which the sea intrusion caused damages in the *Pantura* main road as the Sikka-Flores region connector (Figure 5(2)).

(1) Abrasion in Nanghale

(2) Abrasion in Magepanda brokes Pantura Road

(3) Heavy wind impact in Nanghale

(4) Abrasion in Paga

Figure 5. Study cases of climate change impact in Sikka District

Various sources indicated that in Lembata District, the most frequent of disasters were landslides, drought came second as the second most frequent disaster, followed by abrasion, and heavy wind (Figure 6). Despite of that, drought still became the type of disaster which had most influence in the people of Lembata. Mostly, food security and clean water problems were the drought's secondary impact which usually occured there. Extreme dry seasons often caused many trees to die(Figure 7(1)). Besides that, the most influential impact is when the people there found it so difficult to obtain clean water(Figure 7(2)).

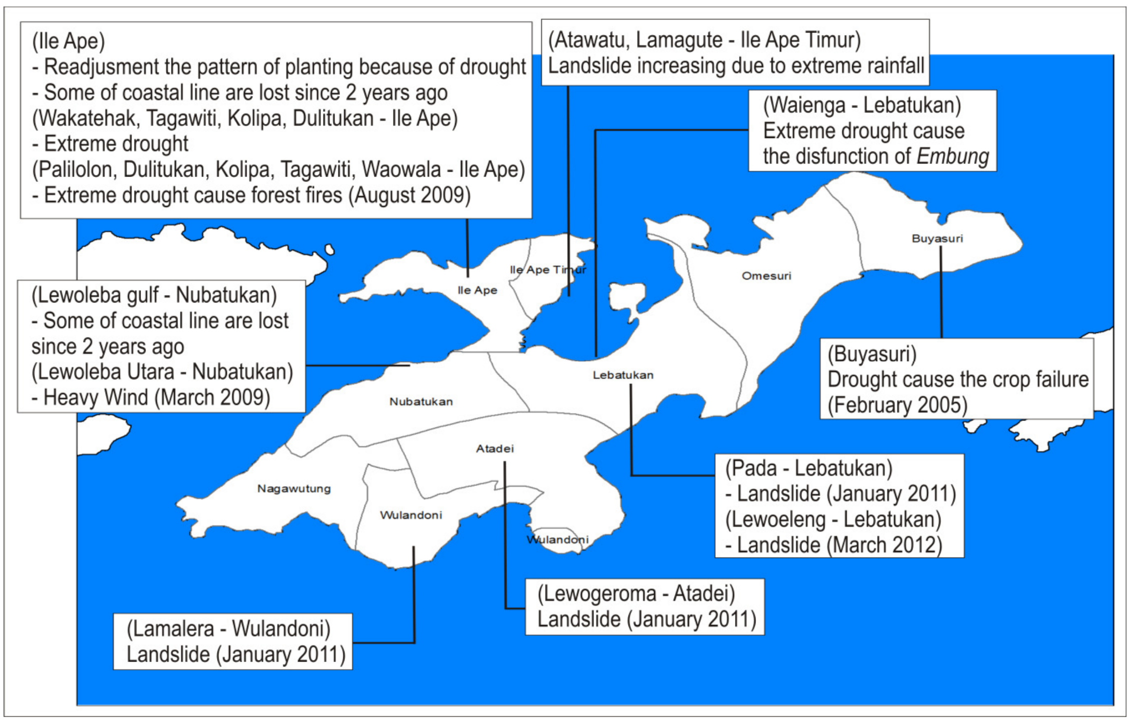


Figure 6. Climate change impact in Lembata District

(1) Drought in Ile Ape caused many trees become dry

(2) People in Ile Ape had a hard access to get clean water

Figure 7. Study cases of climate change impact in Lembata District

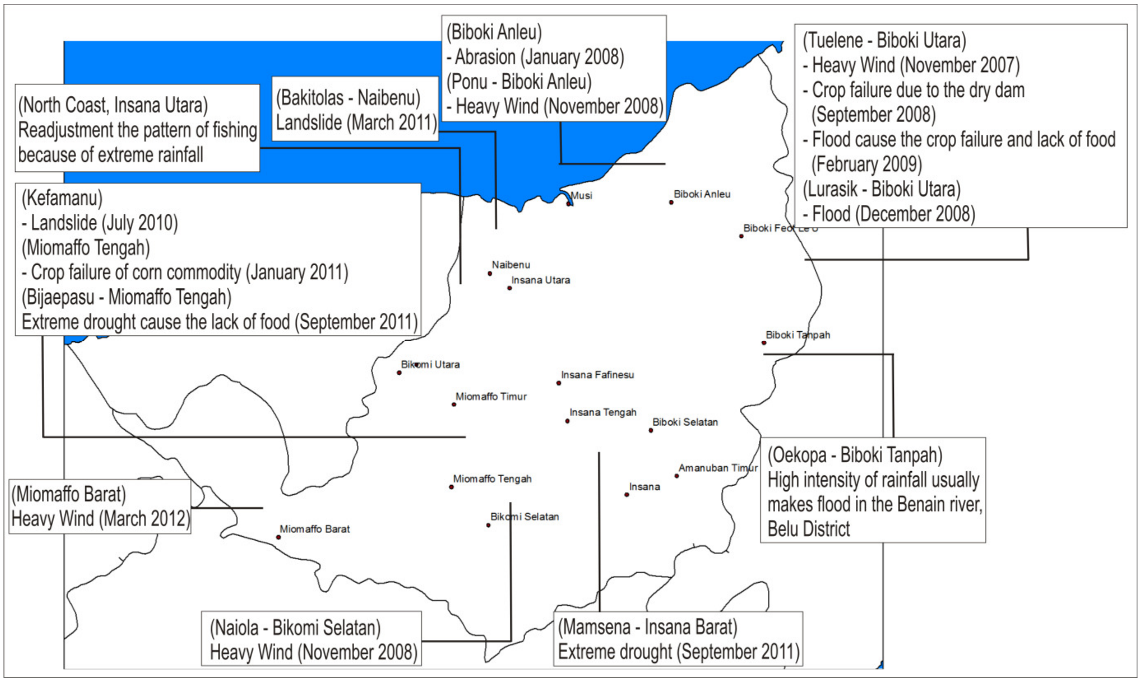


Figure 8. Climate change impact in TTU District

Figure 9. Study cases of climate change impact in TTU District

Study cases in the TTU District, showed that the most frequent of disasters were heavy wind. Some sub districts such Biboki Utara, Miomaffo Tengah, and Biboki Anleu had even had more than 1 type of disaster (Figure 8). Drought in the Bijipaesu village, Miomaffo Tengah, forced some people there to consume ‘biji asam’ in dealing with food security problems because there was a shortage in other types of food (Figure 9(1)). In other areas, high intensity of rainfall in the Oekopa village, and Biboki Tanpah, often caused the Benain River to overflow, which could lead to flooding in the Belu District (Figure 9(2)).

IV Analysis of Climate Vulnerability in Timor Tengah Utara (TTU)

The vulnerability of climate change impacts in each region varied, depending on the climate variability that occurred in the area and the community's ability to adapt to climate variability that had occurred. To properly view the many different regions that are vulnerable to climate change impacts, distribution points were often used, and then the entire value was created in a spatial map data and was differentiated following the administrative map of an area with a certain scale (City, District, or others).

On a map produced through this vulnerability process, it will then be described on differences in vulnerability to scale sub districts (*Kecamatan)*. A vulnerability map was obtained from the overlay parameter adaptive capacity, climate parameters, and potential impacts of climate change. The parameters are obtained from the adaptive capacity of key interviews and FGD activities that provided information about the adaptive capacity of society at the TTU District. The projection of the potential impact of climate disasters and climate variability was derived from climate model where the results were presented in the previous section.

Two of these parameters (adaptive capacity and potential impact) are conflicting. If a region has high levels of adaptive capacity compared with the potential impact, then the level of vulnerability would be lower. However, if the potential impact hits a location with lower adaptive capacity, the level of vulnerability will be high. The vulnerability impacts of climate change obtained in this section include vulnerability for TTU District in 2012 as the base year, then 2015, 2020, 2025, and 2030. Climate impact, adaptive capacity, and vulnerability index are scaled in the range of 0 to 1. The higher the index, it represents the increasing levels of the three phenomenons in a region that are susceptible to climate change impacts.

4.1 Projection of Climate Change Impact

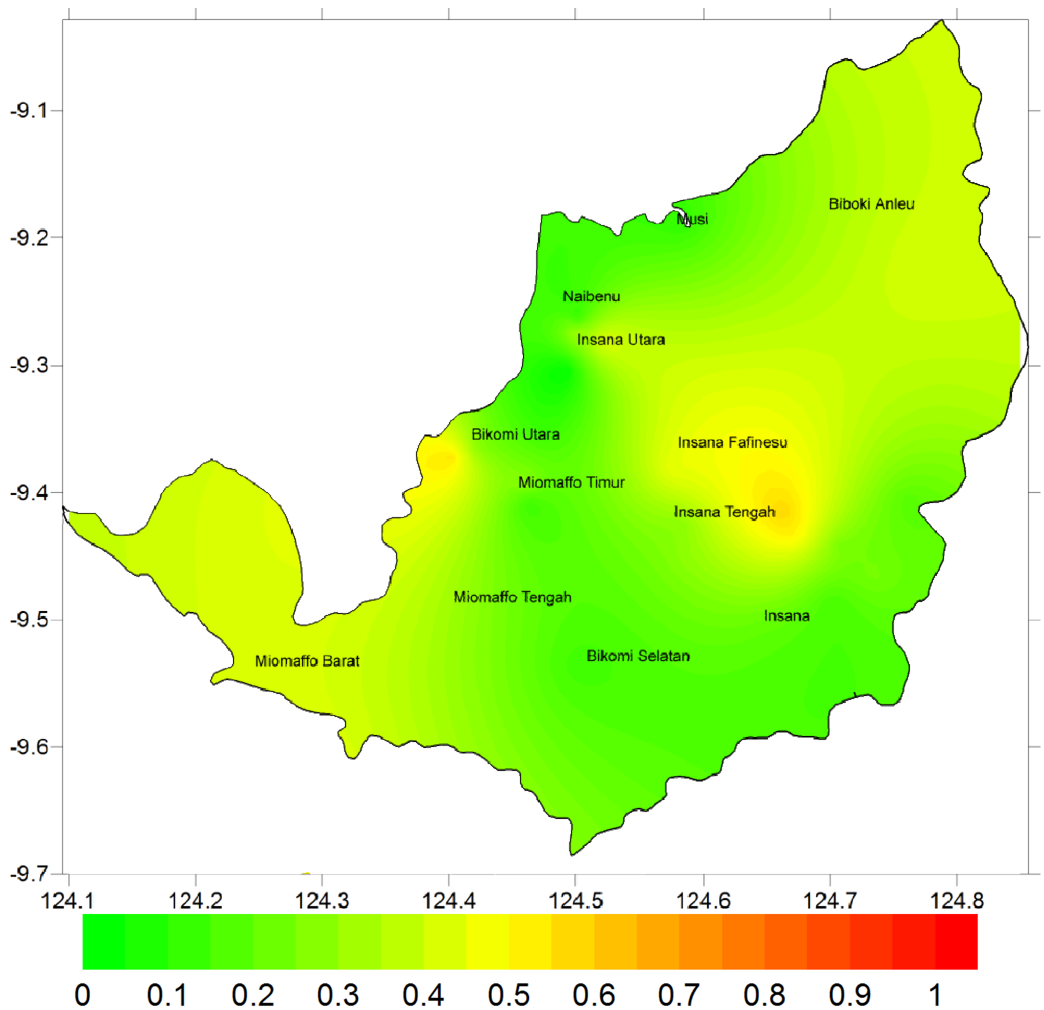


Figure 10. Map of climate change impact on TTU in 2012

In Figure 10, it shows the climate impact in 2012 that the lowest level of climate impact is in Musi area. In this region, the climate impact such as extreme rainfall and sea level rise did not significantly lead to flooding that caused damages to public facilities and infrastructure. While Insana Tengah and Bikomi Utara are regarded as areas with a high level of sensitivity to climate change. Because this region is adjacent to the coast, it will always be facing the dangers of potential tidal flooding. The following figures show potential climate change impact in spatial scales from the base year of 2012, plus projections for the upcoming years of 2015, 2020, 2025, and 2030 in TTU District.

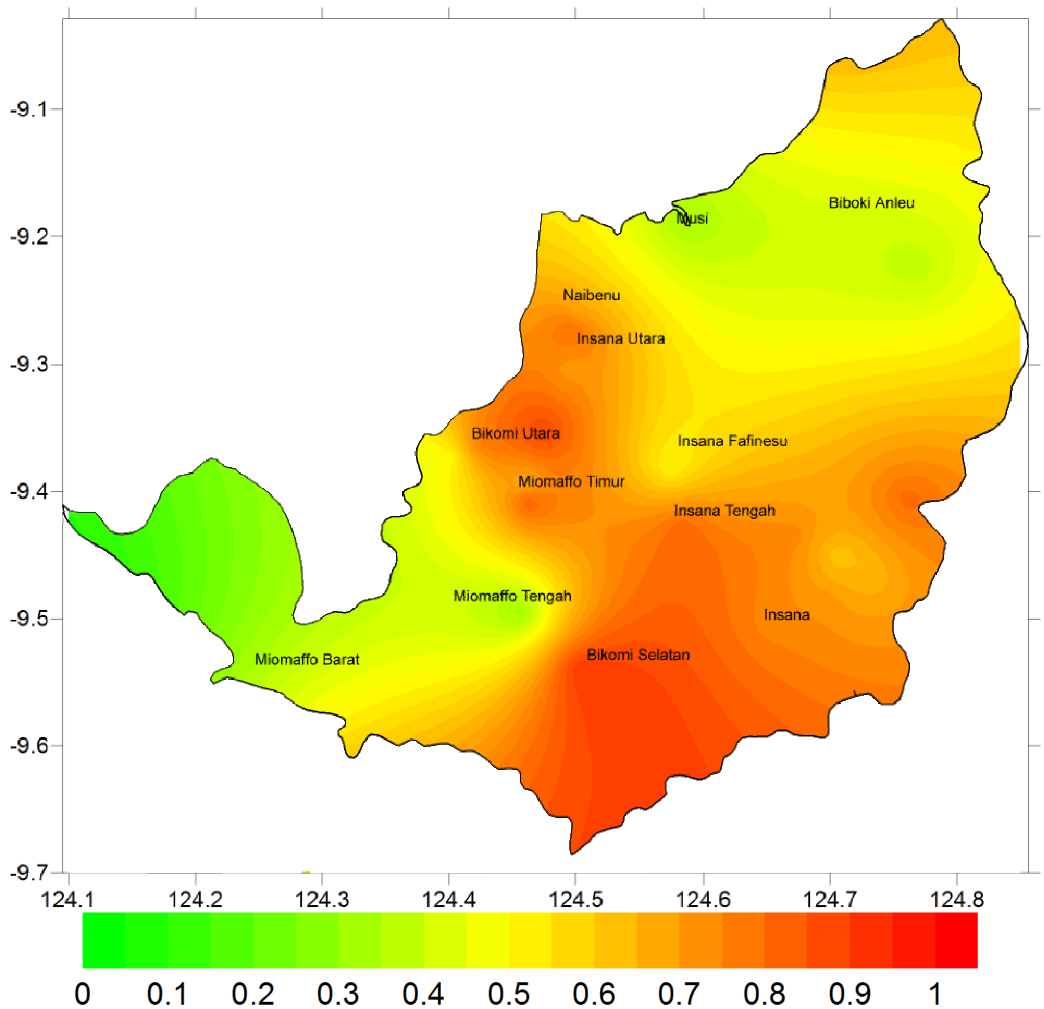


Figure 11. Map of climate change impact on TTU in 2015

In Figure 11, it shows that the level of climate change impact in 2015 will have increased from the year 2012, particularly in Bikomi Selatan and Bikomi Utara area, with average index of 0.5 compared with the average index of 0.36 in 2012. In the TTU District, increase of the climate change impact level will occur in Bikomi Selatan, Bikomi Utara, and Insana Tengah.

In 2020, the level of climate change impact will increase in the TTU District. In this District, the increase in climate change will occur in Miomaffo Timur, Insana Utara and Bikomi Selatan with a large increase in the average index of 0.6. The highest climate change impact will occur in Miomaffo Timur and Bikomi Selatan with the index reaching 0.85. The climate change impact in this year, 2020, is mapped as seen in Figure 12.

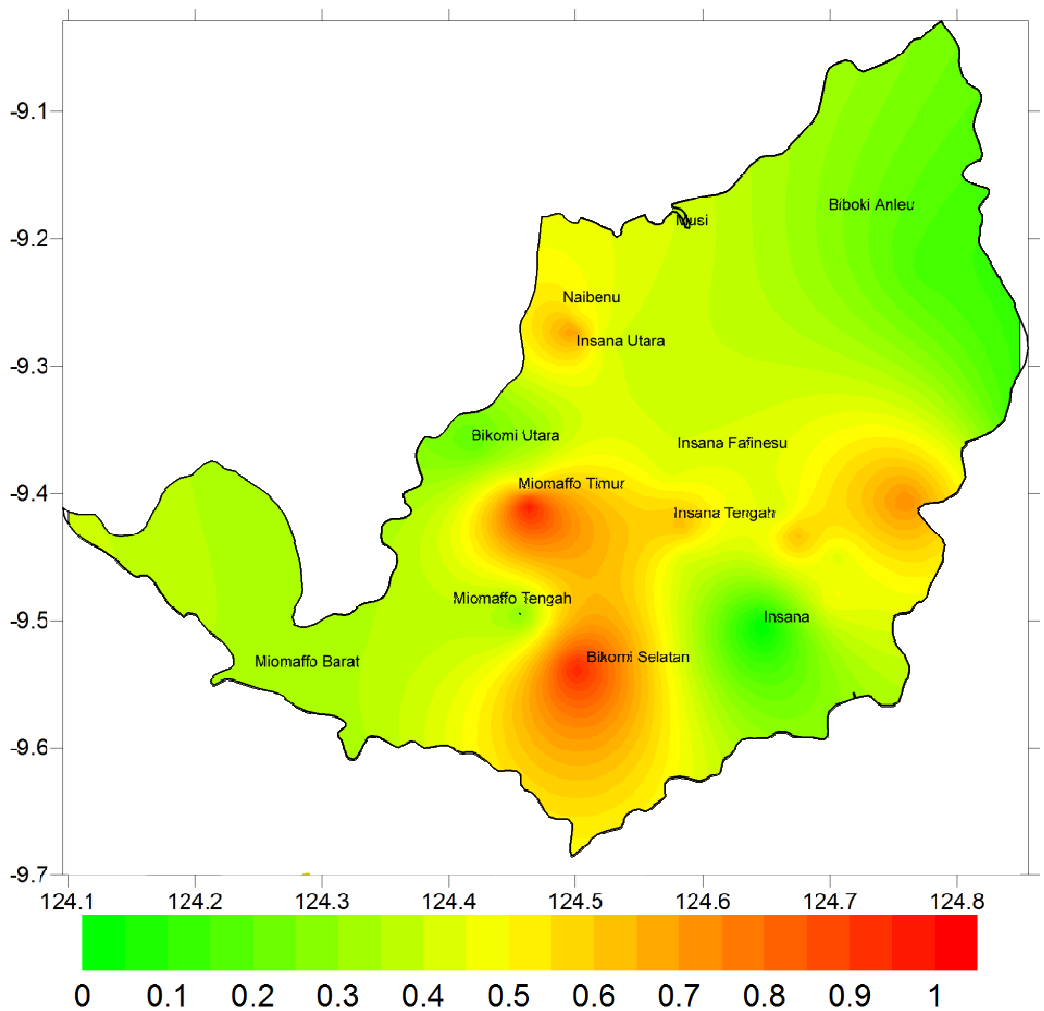


Figure 12. Map of climate change impact on TTU in 2020

In Figure 13, it shows that the level of climate change impact in 2025 will have increased from the year 2020, and is almost distributed in all area of TTU District, with the average index of 0.85 compared with the average index of 0.36 in 2012. In the TTU District, increase of the climate change impact level will occur in Miomaffo Timur and Bikomi Selatan.

In 2030, the level of climate change impact will increase in the TTU District. In this District, the increase in climate change will occur in Miomaffo Timur, Insana Utara and Bikomi Selatan with a large increase in the average index of 0.9. The highest climate change impact will occur in Miomaffo Timur and Bikomi Selatan with the index reaching 1. The climate change impact in this year 2030 is mapped as seen in Figure 14.

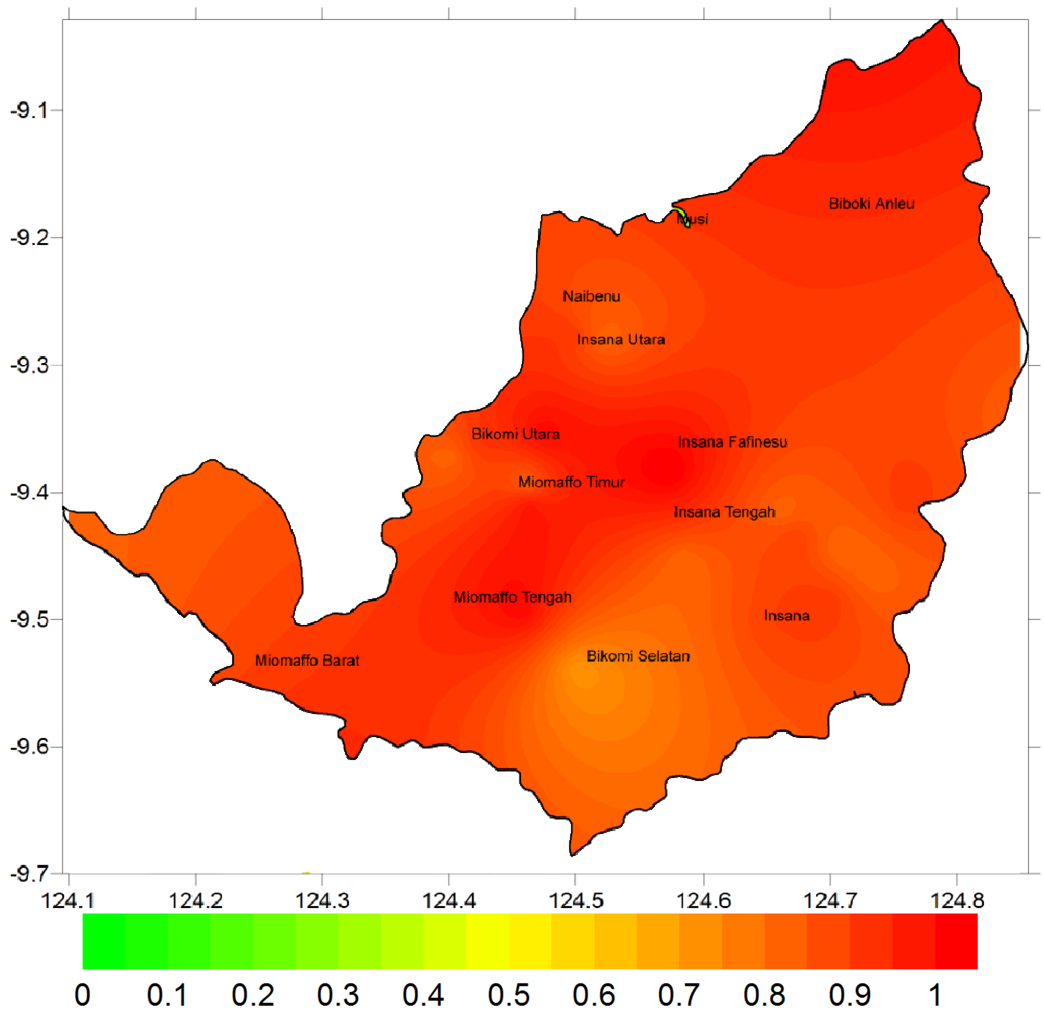


Figure 13. Map of climate change impact on TTU in 2025

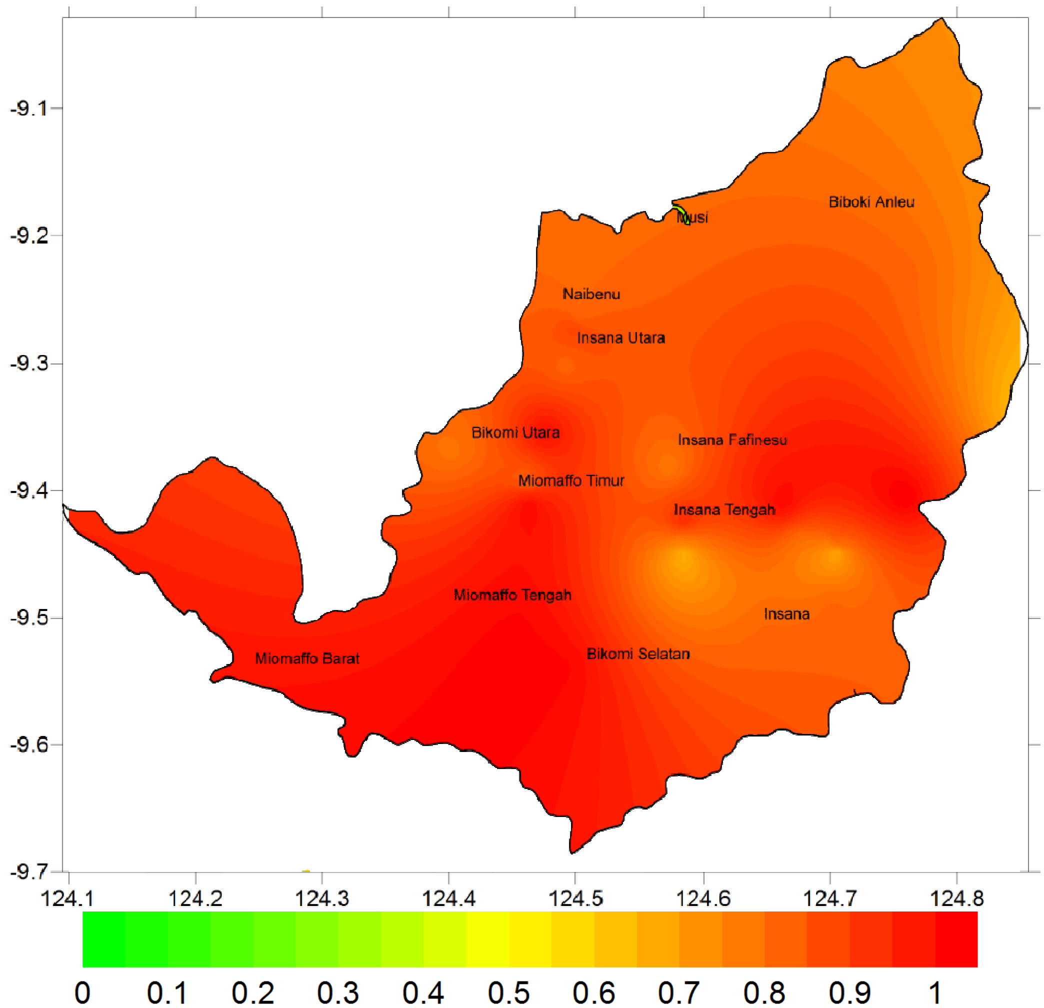


Figure 14. Map of climate change impact on TTU in 2030

4.2 Projection of Climate Vulnerability

In Figure 15 below, it shows the climate vulnerability in 2012 in TTU District area. In this region, the climate vulnerability is still low, proven by the index of climate vulnerability only reaching 0.1. Extreme rainfall and sea level rise will not significantly affect public facilities and infrastructure, as the adaptive capacity level this year will still be able to cope with climate change impact. However in this year, Insana Tengah is included in areas with extremely low adaptive capacity but with high climate change impact, so this region has vulnerability in higher value compared with other areas in TTU District. While the region is far to the coast, it will not always have suffer from the potential of tidal flooding. The following figures show climate vulnerability in spatial scale from the base year of 2012 till projection for 2015, 2020, 2025, and 2030 in TTU District.

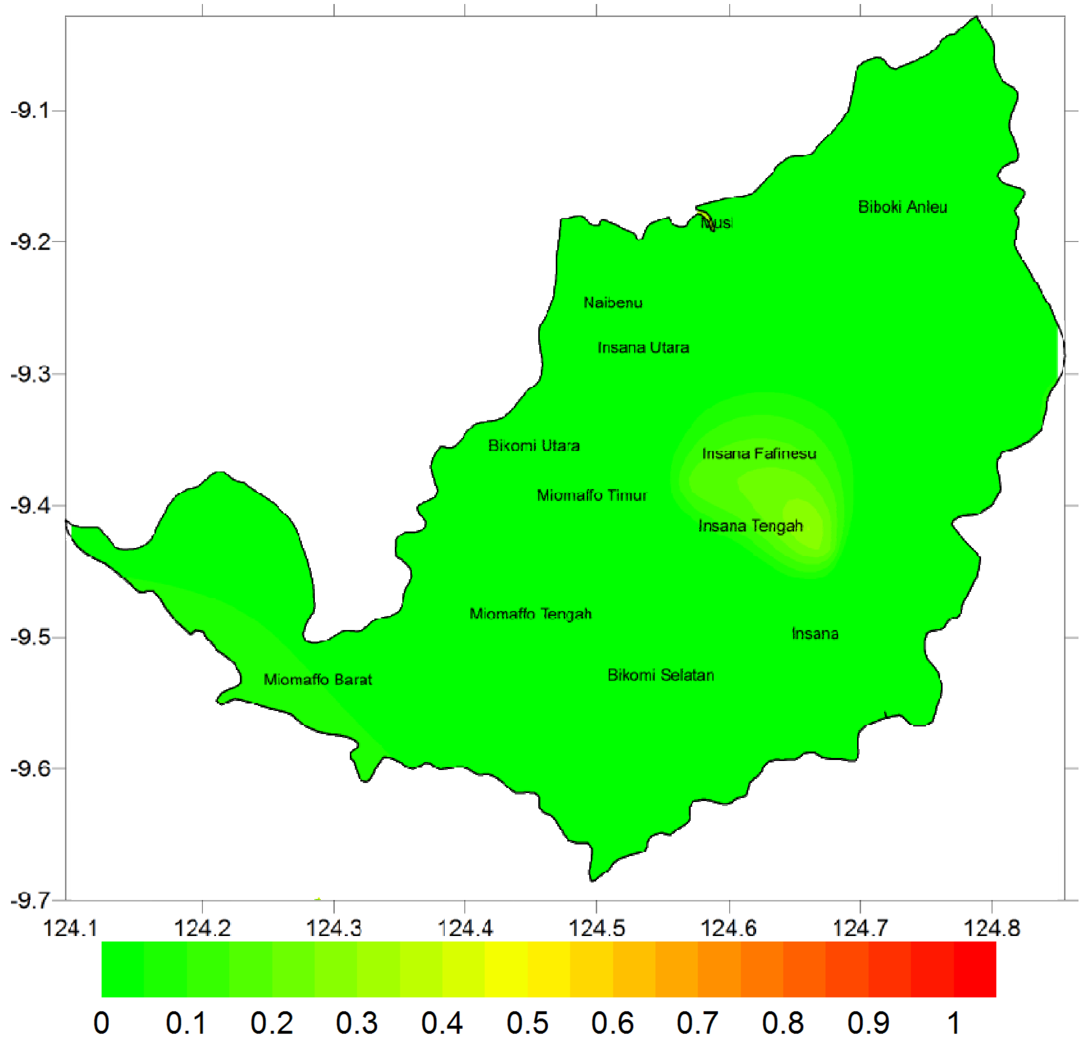


Figure 15. Map of climate vulnerability on TTU in 2012

In Figure 16 below, it shows that the level of climate vulnerability in 2015 will have increased from the year 2012, particularly in Bikomi Selatan and Bikomi Utara area, with an average index of 0.3 compared with the average index of 0.1 in 2012. In the TTU District, increase of climate vulnerability level will occur in Bikomi Selatan, Bikomi Utara, and Insana Tengah.

In 2020, the level of climate vulnerability will increase in the TTU District. In this District, the increase in climate change will occur in Miomaffo Timur, Insana Utara and Bikomi Selatan with a large increase in the average index of 0.4. The highest climate vulnerability will occur in Miomaffo Timur and Bikomi Selatan with the index reaching 0.4. The climate change impact in this year 2020 is mapped as seen in Figure 17.

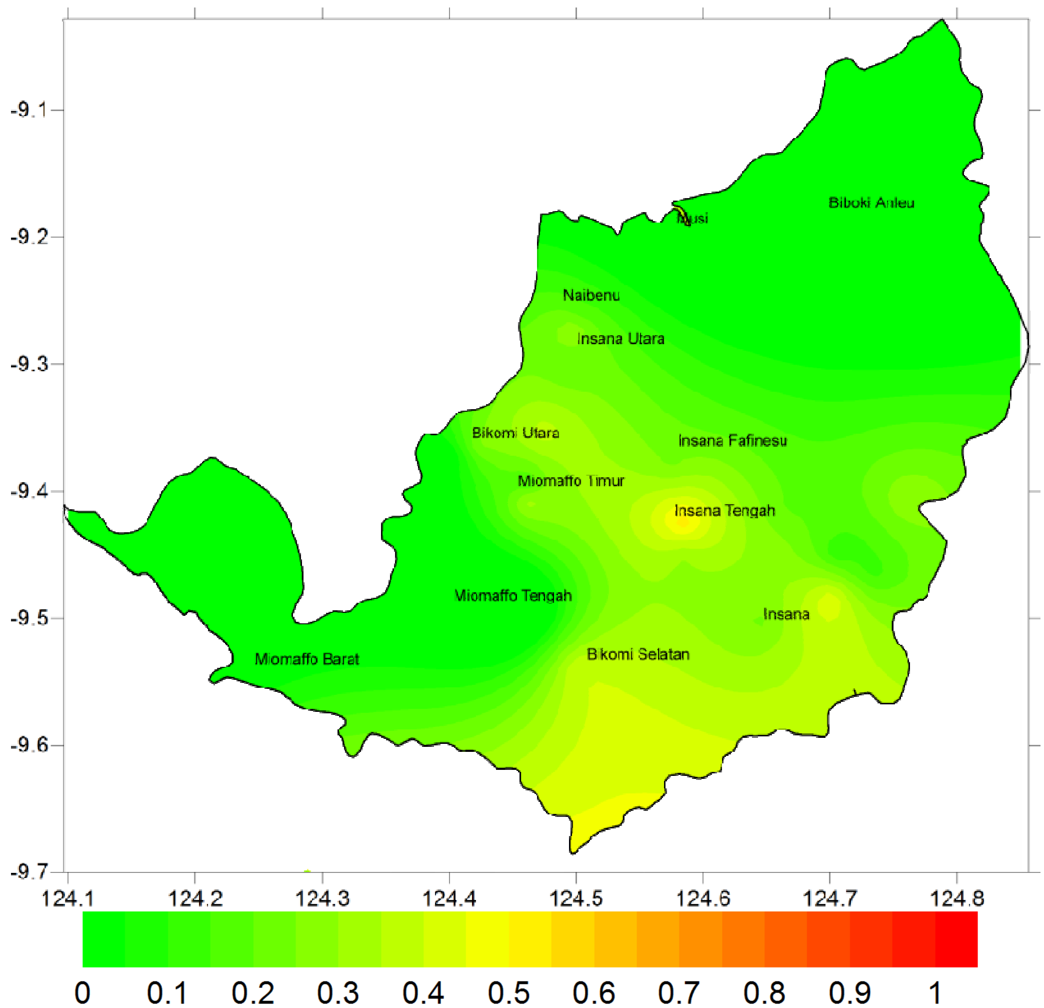


Figure 16. Map of climate vulnerability on TTU in 2015

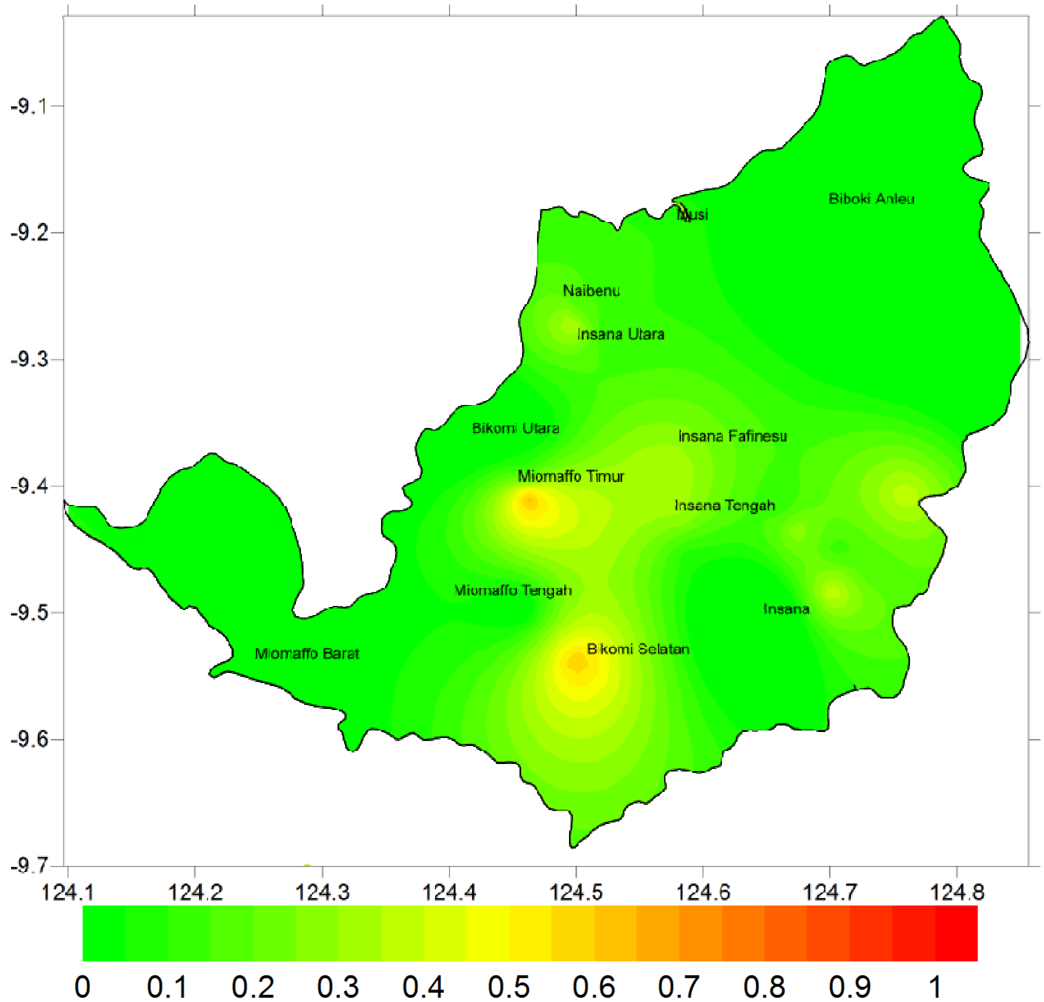


Figure 17. Map of climate vulnerability on TTU in 2020

In 2025, the level of climate vulnerability will increase in TTU District. In this District, the increase in climate change will occur in Miomaffo Tengah, Miomaffo Barat and Insana Fafinesu with a large increase in the average index of 0.8. The highest climate vulnerability will occur in Miomaffo Tengah with the index reaching 0.85. The climate change impact in this year 2025 is mapped as seen in Figure 18.

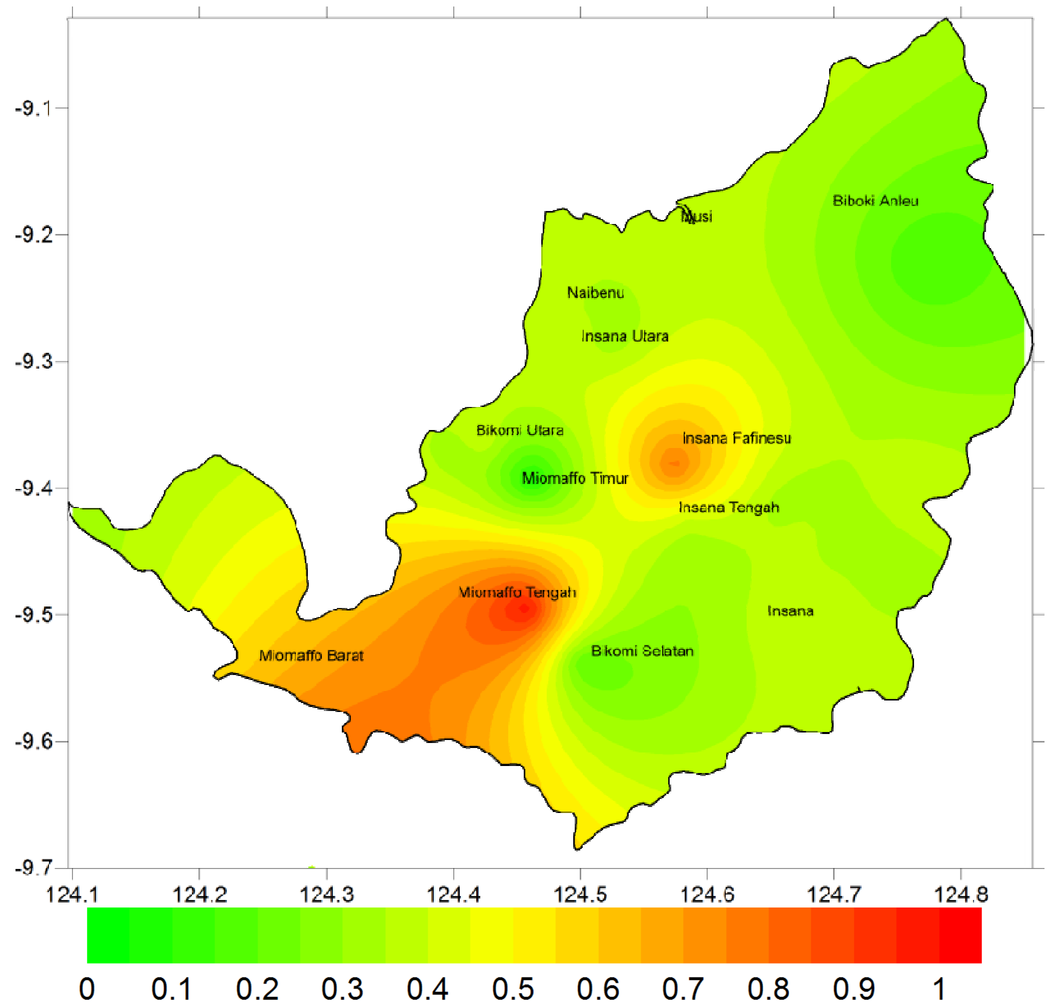


Figure 18. Map of climate vulnerability on TTU in 2025

In 2030, the level of climate vulnerability will increase in the TTU District. In this District, the increase in climate change will occur in Bikomi Selatan, Miomaffo Timur and Insana Tengah with a large increase in the average index of 0.8. The highest climate vulnerability will occur in Bikomi Selatan with the index reaching 0.85. The climate change impact in this year 2030 is mapped as seen in Figure 19.

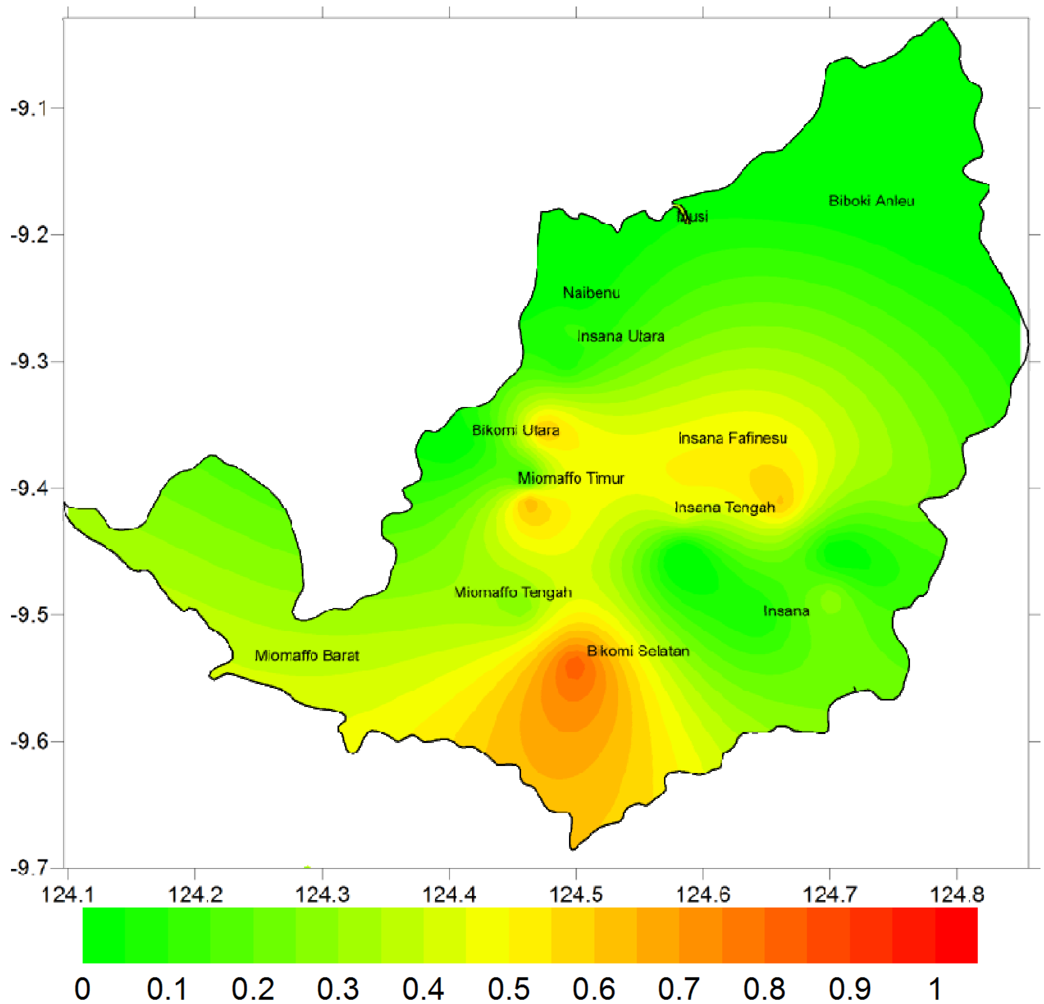


Figure 19. Map of climate vulnerability on TTU in 2030

V Analysis of Climate Vulnerability in Sikka

5.1 Projection of Climate Change Impact

Figure 20 below shows the climate impact in 2012, expressing the lowest level of climate impact. which is in the Magepanda area. In this region, the climate impact such as extreme rainfall and sea level rise has not significantly led to floods that damaged public facilities and infrastructures. While Talibura and Waiblama are considered areas that are impacted by extreme climate. While this region is adjacent to the coast, it will always have the potential to suffer from drought. The following figures show potential climate change impact in spatial scale from the base year of 2012 and projections for 2015, 2020, 2025, and 2030 in Sikka District.

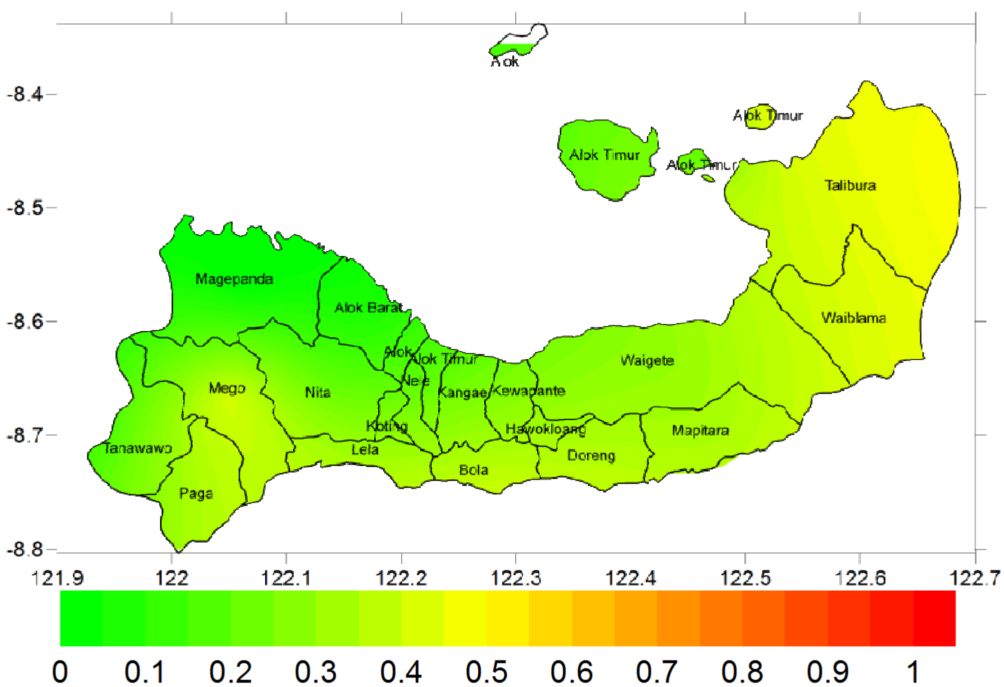


Figure 20. Map of climate change impact on Sikka in 2012

In Figure 21, it shows the level of climate change impact in 2015, which has increased from the year 2012, particularly in Waiblama and Alok Barat area, with average index of 0.5 compared with the average index of 0.3 in 2012. In the Sikka District, increase of the climate change impact level will occur in Alok Barat, Talibura, Waiblama, Alok Timur, Mapitara, Tanawawo and Insana Tengah. This region is extremely sensitive to high climate impact, particularly the ones caused by the low level of rain in these areas.

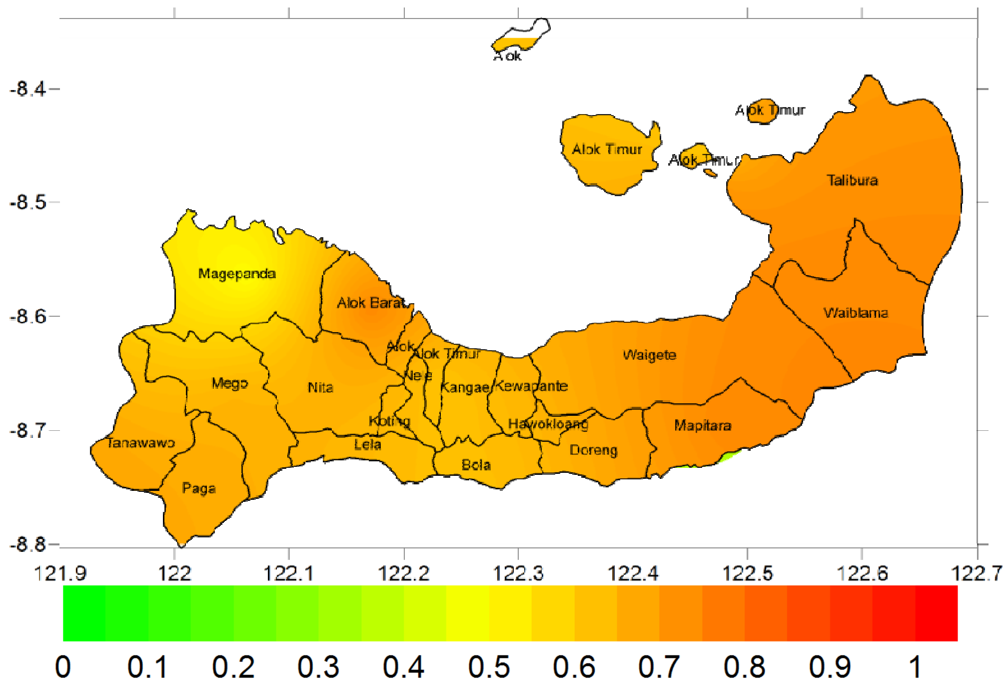


Figure 21. Map of climate change impact on Sikka in 2015

In 2020, the level of climate change impact will increase in Sikka District. In this District, the increase in climate change will occur in Alok Barat, Talibura, Waiblama, Alok Timur, Mapitara, Tanawawo and Insana Tengah with a large increase in the average index of 0.7. The highest climate change impact will occur in Alok Timur and Tanawawo with the index reaching 0.85. The projected climate change impact in the year 2020 is mapped as seen in Figure 22.

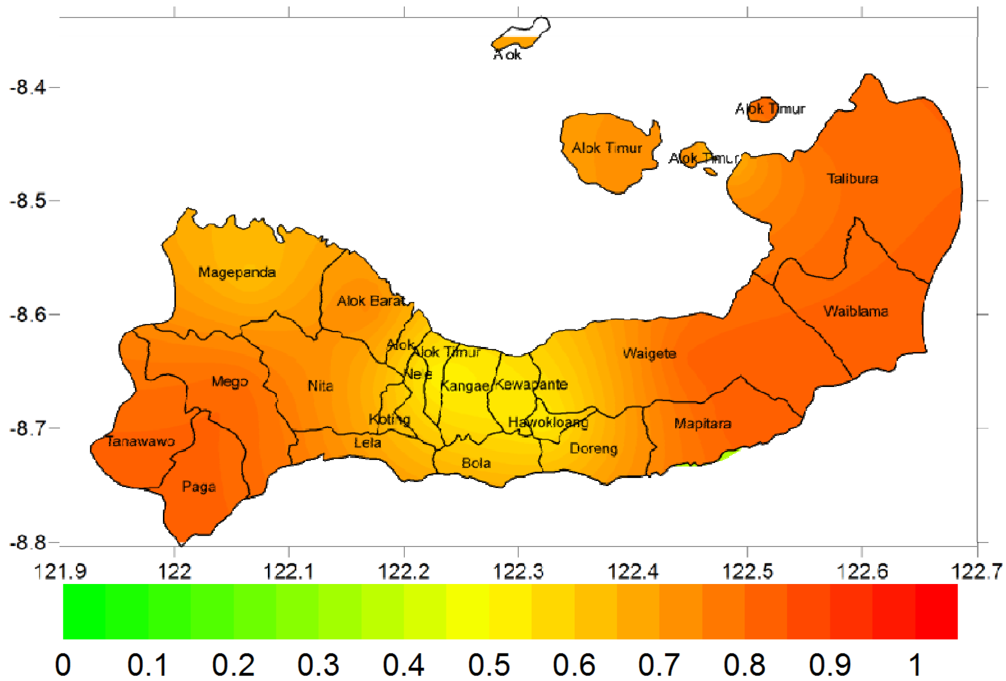


Figure 22. Map of climate change impact on Sikka in 2020

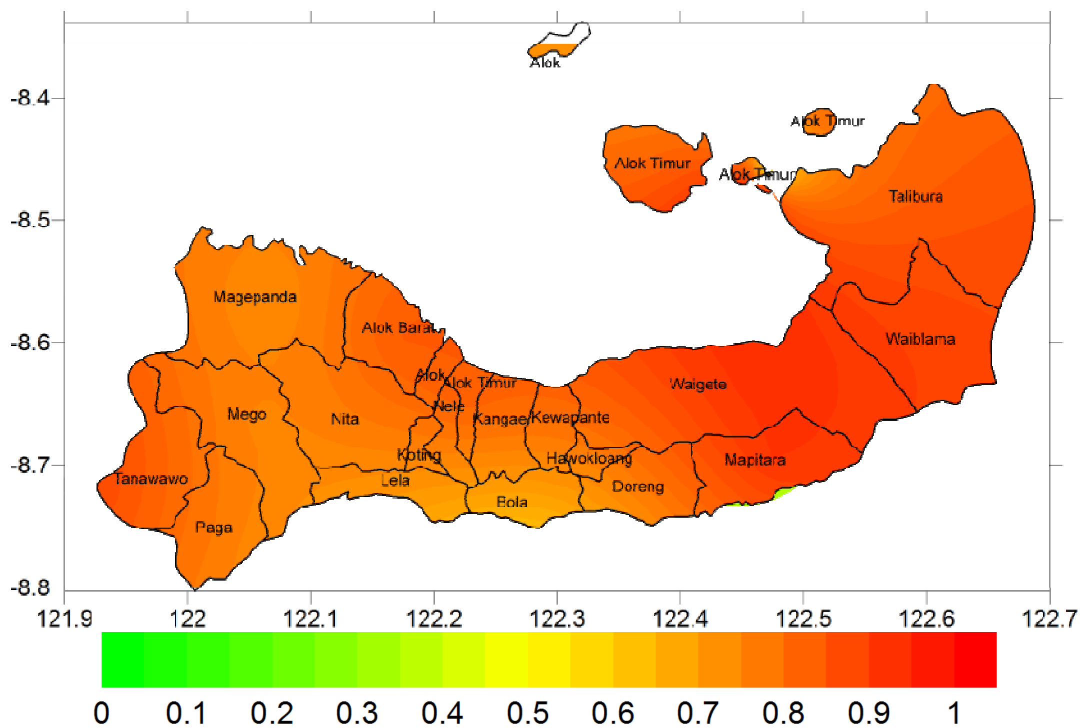


Figure 23. Map of climate change impact on Sikka in 2025

Figure 23 shows the level of climate change impact in 2025, which has increased from the year 2020, and is distributed in all areas of Sikka District, with average index of 0.9, compared with the average index of 0.36 in 2012. In the Sikka District, increase of the climate change impact level will occur in Alok Barat, Talibura, Waiblama, Alok Timur, Mapitara, Tanawawo and Insana Tengah.

In 2030, the level of climate change impact will increase in Sikka District. In this District, the increase in climate change will occur in Alok Barat, Talibura, Waiblama, Alok Timur, Mapitara, Tanawawo and Insana Tengah with a large increase in the average index of 0.9. The highest climate change impact will occur in Alok Barat, Talibura, Waiblama, Alok Timur, Mapitara, Tanawawo and Insana Tengah with the index reaching 1. The climate change impact in 2020 is mapped as seen in Figure 24.

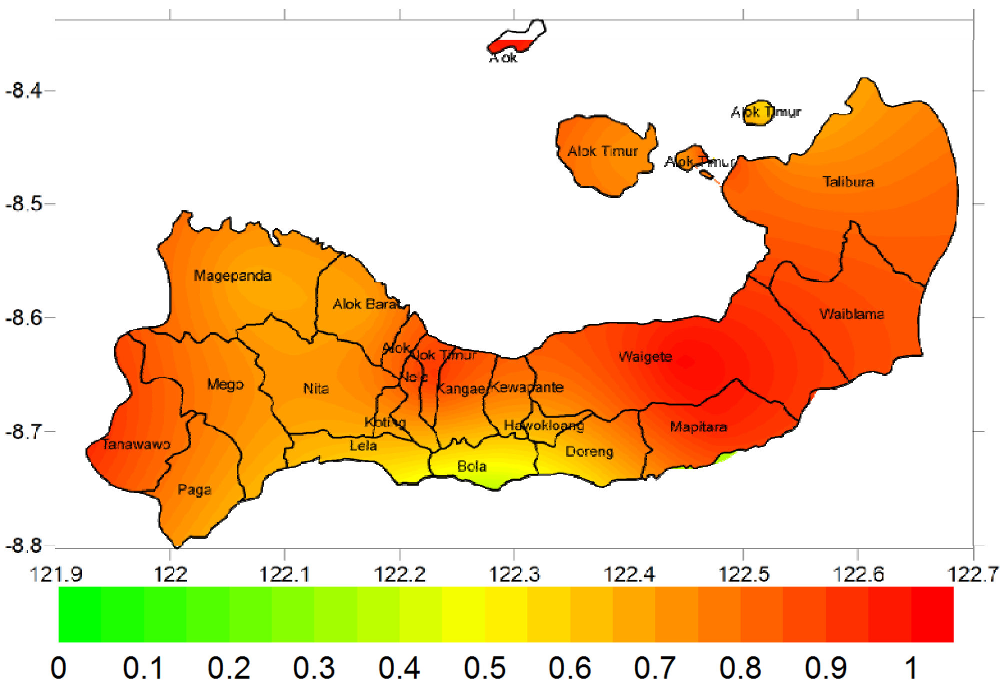


Figure 24. Map of climate change impact on Sikka in 2030

5.2 Projection of Climate Vulnerability

Figure 25 below shows the 2012 climate vulnerability rate in Sikka District area. In this region, the climate vulnerability is high, proven by the index of climate vulnerability only reaching 041. Extreme rainfall and sea level rise will not significantly affect public facilities and infrastructure caused by adaptive capacity. Overall, the location this year will still be able to cope with climate change impact. However, in this year, Talibura is included in areas with extremely low adaptive capacity but with high climate change impact, so this region has vulnerability in higher value compared with other areas in Sikka District. While the region is close to the coast, it will not always have a high rate of rainfall. The following figures show climate vulnerability in spatial scale from the base year of 2012 till projections for 2015, 2020, 2025, and 2030 in Sikka District.

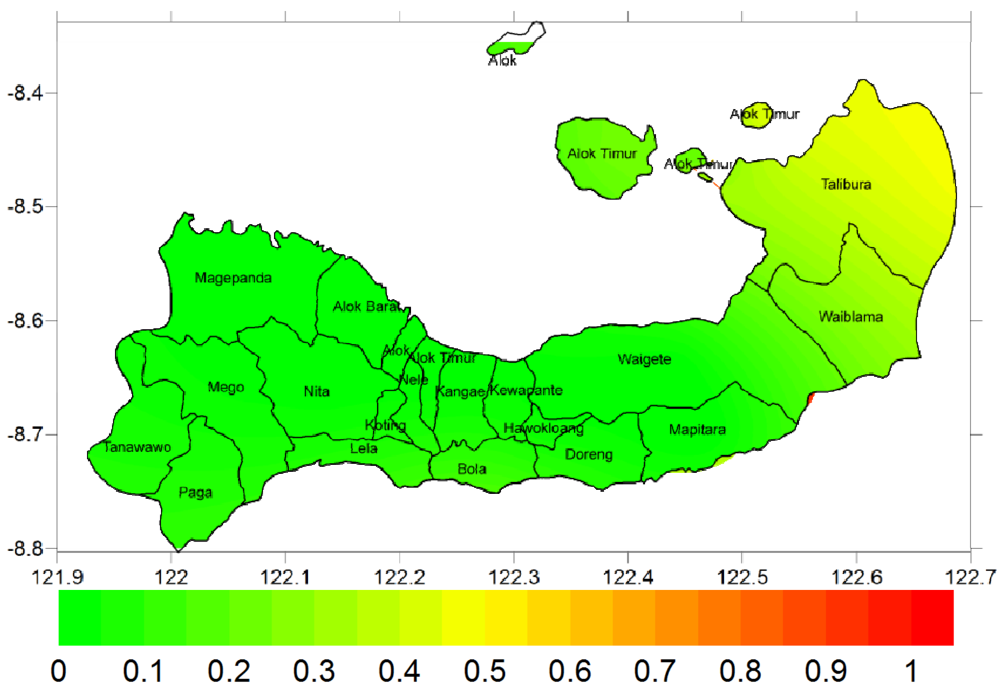


Figure 25. Map of climate vulnerability on Sikka in 2012

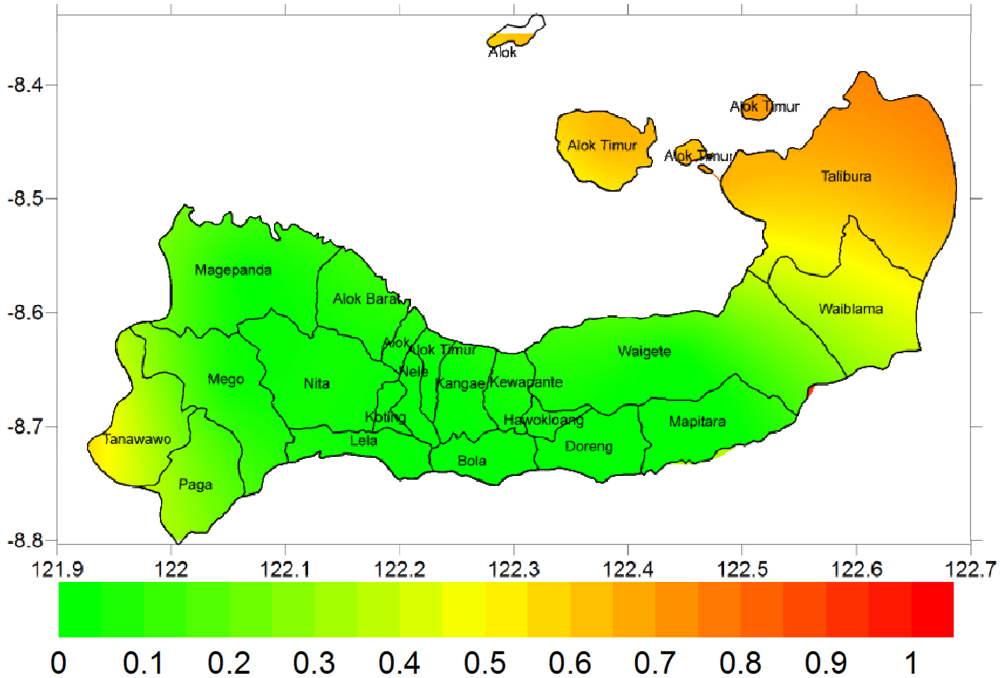


Figure 26. Map of climate vulnerability on Sikka in 2015

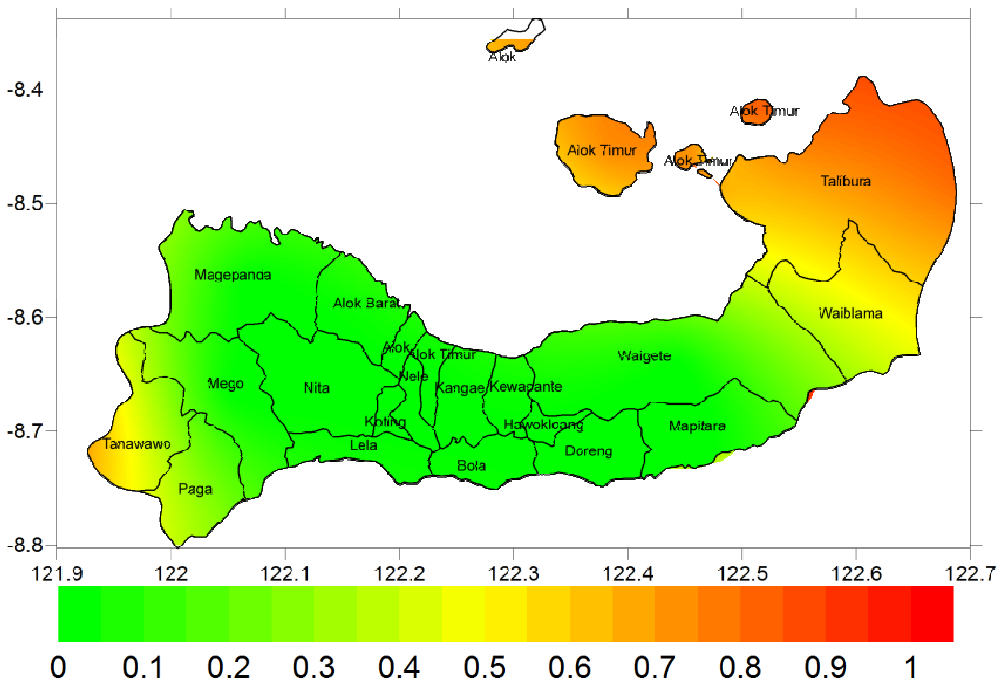


Figure 27. Map of climate vulnerability on Sikka in 2020

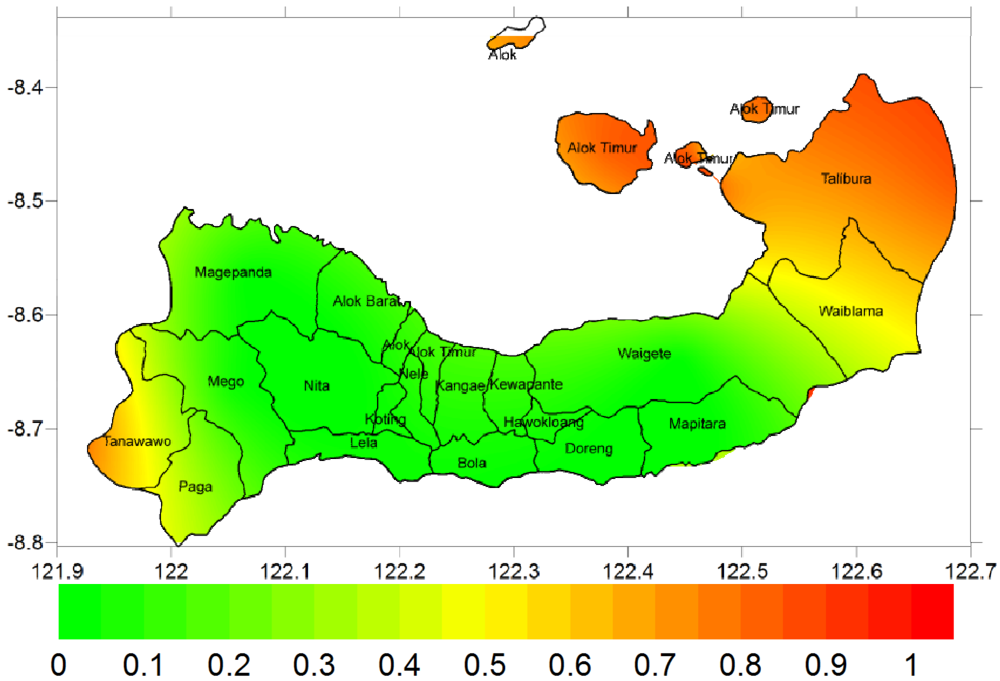


Figure 28. Map of climate vulnerability on Sikka in 2025

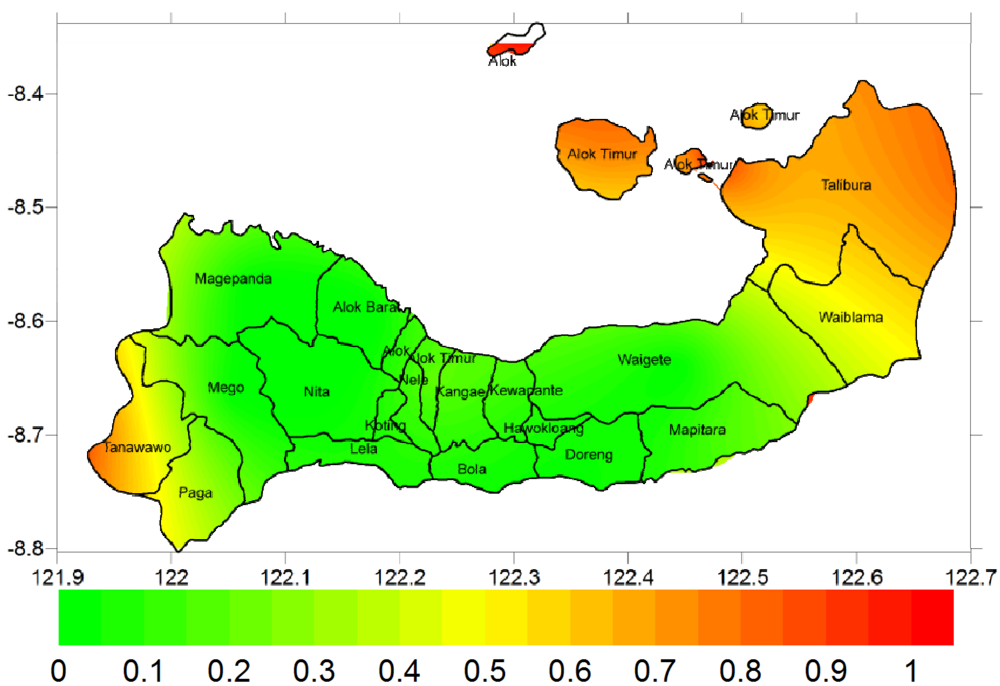


Figure 29. Map of climate vulnerability on Sikka in 2030

Figure 26 above shows the level of climate vulnerability in 2015, which will have increased from the year 2012, particularly in Talibura, Alok Timur and Tanawawo area, with average index of 0.3 compared with the average index of 0.1 in 2012. In the Sikka District, increase of the climate vulnerability level will occur in Talibura, Alok Timur and Tanawawo area.

In 2020, the level of climate vulnerability will increase in Sikka District. In this District, the increase in climate change will occur in Talibura, Alok Timur and Tanawawo with a large increase in the average index of 0.6. The highest climate vulnerability will occur in Talibura, Alok Timur and Tanawawo with the index reaching 0.6. The climate change impact in this 2020 year is mapped as seen in Figure 27.

In 2025, the level of climate vulnerability will increase in Sikka District. In this District, the increase in climate change will occur in Talibura, Alok Timur and Tanawawo with a large increase in the average index of 0.7. The highest climate vulnerability will occur in Talibura, Alok Timur and Tanawawo with the index reaching 0.6. The climate change impact in 2025 is mapped as seen in Figure 3.26.

In 2030, the level of climate vulnerability will increase in Sikka District. In this District, the increase in climate change will occur in Alok Timur and Tanawawo with a large increase in the average index of 0.9. The highest climate vulnerability will occur in Alok Timur and Tanawawo with the index reaching 0.9. The climate change impact in 2030 is mapped as seen in Figure 29.

VI Analysis of Climate Vulnerability in Lembata

6.1 Projection of Climate Change Impact

In Figure 30 below, it shows the climate impact in 2012, and proves that the lowest level of climate impact is in Wulandoni area. In this region,climate impacts such as drought, significantly affect the condition of agriculture in the area. While Wulandoni and Buyasuri are considered areas with extremely high climate impact. While this region is adjacent to the coast, it will always have the potential to suffer from drought. The following figures show potential climate change impact in spatial scale from the base year of 2012, and projections for 2015, 2020, 2025, and 2030 in Lembata District.

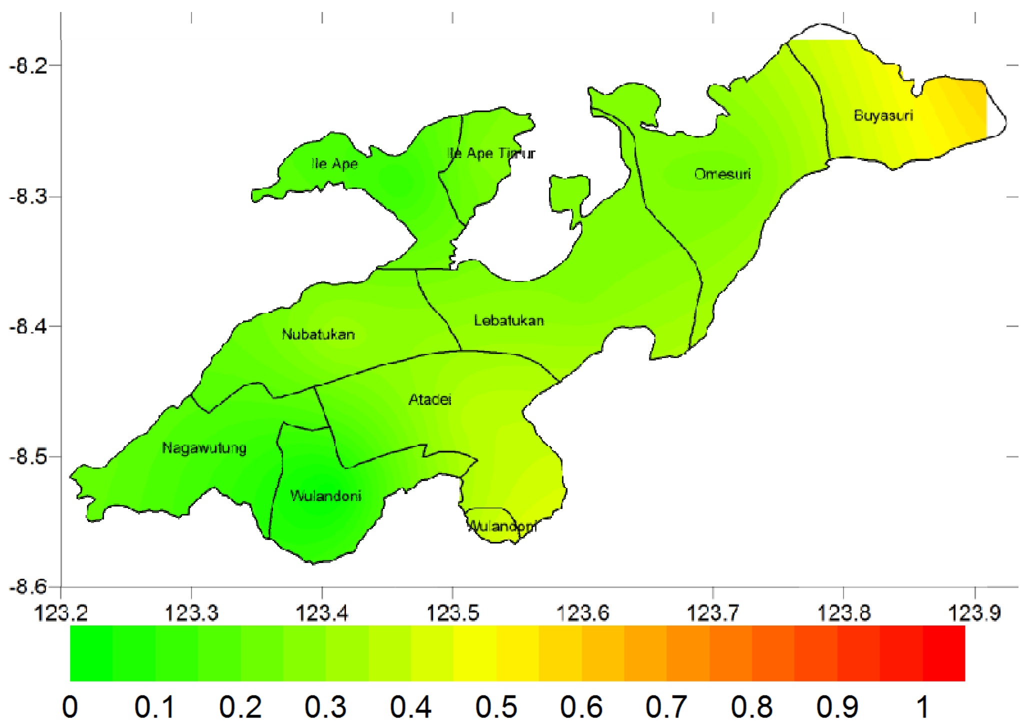


Figure 30. Map of climate change impact on Lembata in 2012

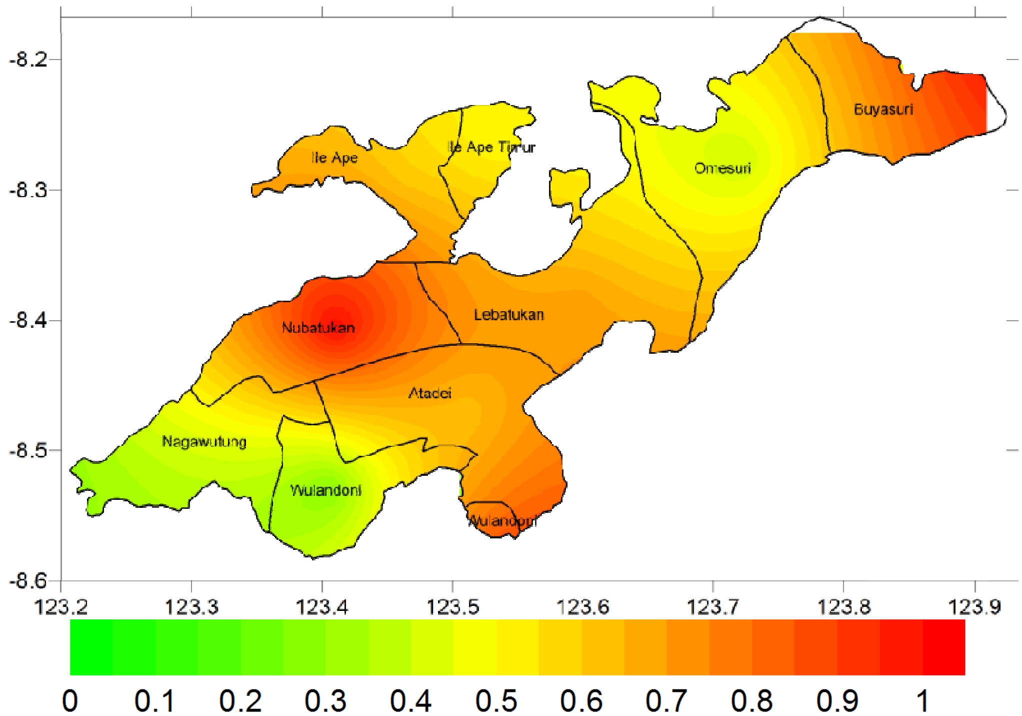


Figure 31. Map of climate change impact on Lembata in 2015

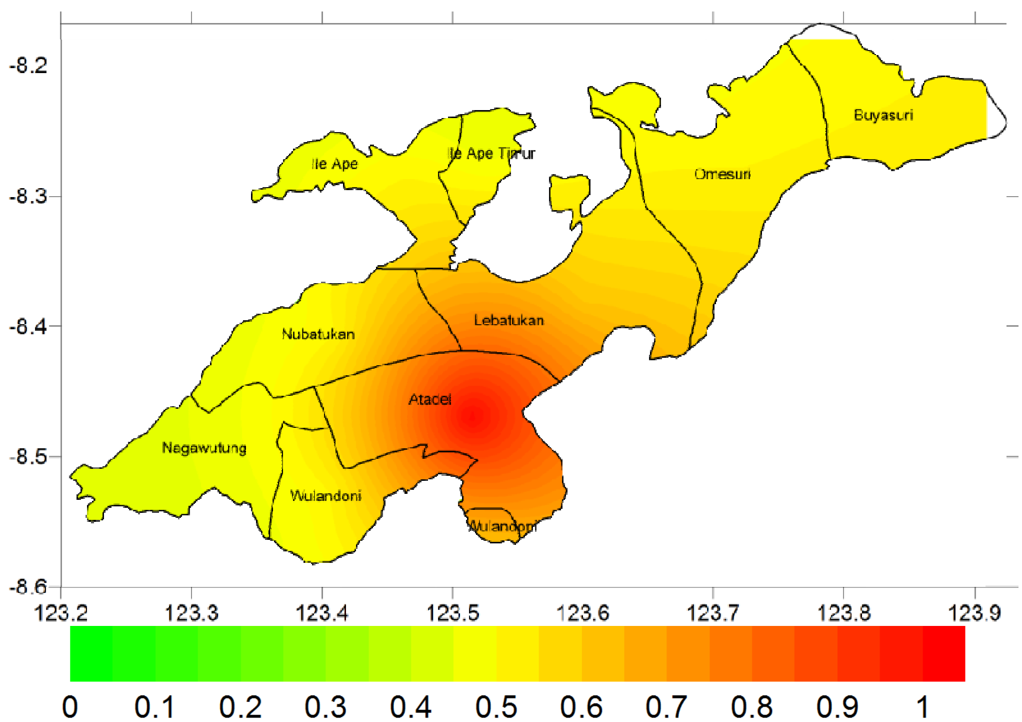


Figure 32. Map of climate change impact on Lembata in 2020

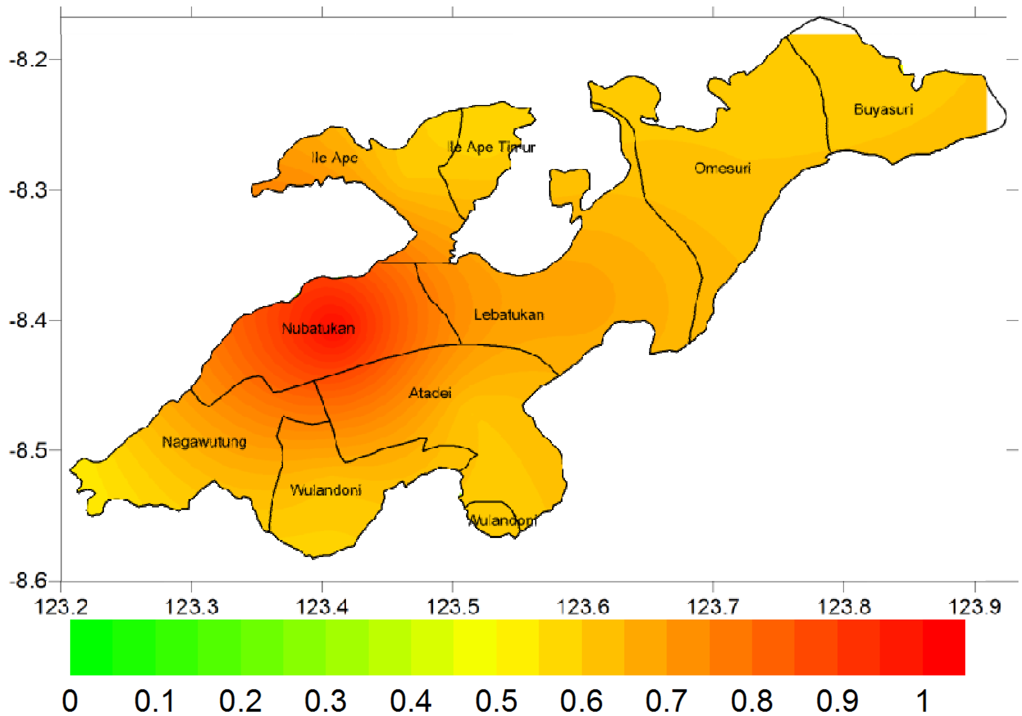


Figure 33. Map of climate change impact on Lembata in 2025

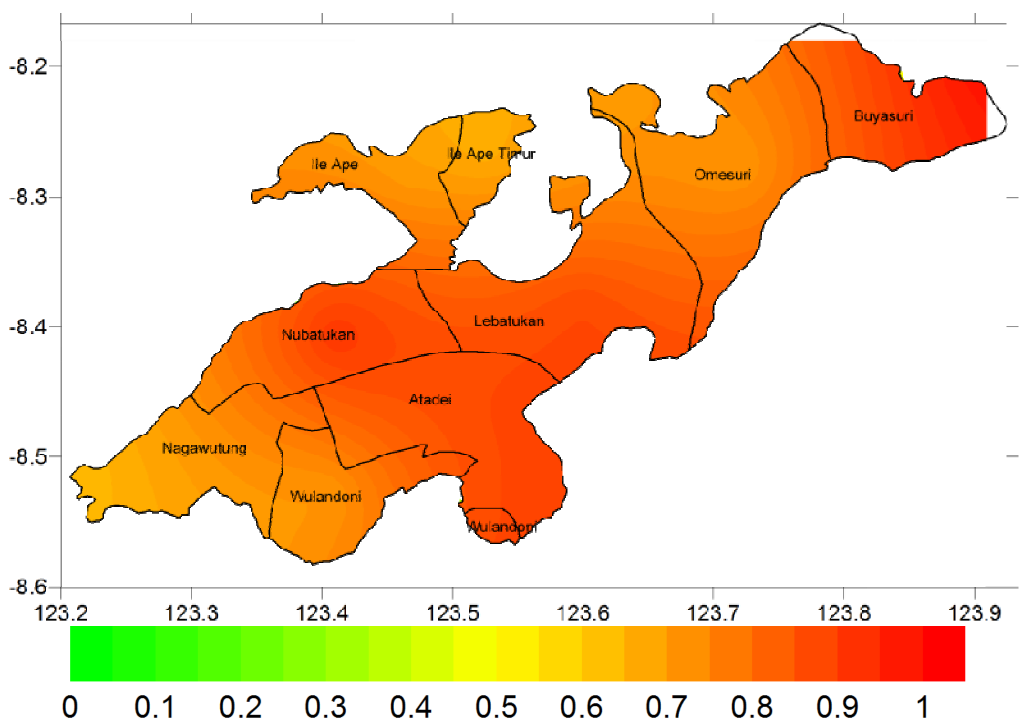


Figure 34. Map of climate change impact on Lembata in 2030

In 2020, the level of climate change impact will increase in Lembata District. In this District, the increase in climate change will occur in Nubatukan, Atadei, and Wulandoni with a large increase in the average index of 0.4. The highest climate change impact will occur in Nubatukan and Atadei with the index reaching 0.85. The climate change impact in this 2020 year is mapped as seen in Figure 32.

Figure 33 shows the level of climate change impact in 2025, which will have increased from the year 2020, and will be distributed in almost all areas of the Lembata District, with average index of 0.9 compared with the average index of 0.36 in 2012. In the Lembata District, increase of the climate change impact level will occur in Nubatukan and Atadei.

In 2030, the level of climate change impact will increase in Lembata District. In this District, the increase in climate change will occur in Nubatukan, Wulandoni, Buyasuri, and Atadei with a large increase in the average index of 0.9. The highest climate change impact will occur in Nubatukan, Wulandoni, Buyasuri, and Atadei with the index reaching 1. The climate change impact in this 2030 year is mapped as seen in Figure 34.

6.2 Projection of Climate Vulnerability

Figure 35 below shows the climate vulnerability in 2012 in the Lembata District area. In this district, the climate vulnerability is high, proven by the index of climate vulnerability only reaching 0.41. Extreme rainfall and sea level rise will not significantly affect public facilities and infrastructure, as adaptive capacity of the people in this year will still be able to cope with climate change impact. However, in this year, Wulandoni and Nagawutung are included as areas with extremely low adaptive capacity but with high climate change impact, so this region has vulnerability that's higher higher value compared with other areas in Lembata District. While the region is close to the coast, it will not always be experiencing rain. The following figures show climate vulnerability in spatial scale from the base year of 2012 and projections for 2015, 2020, 2025, and 2030 in Lembata District.

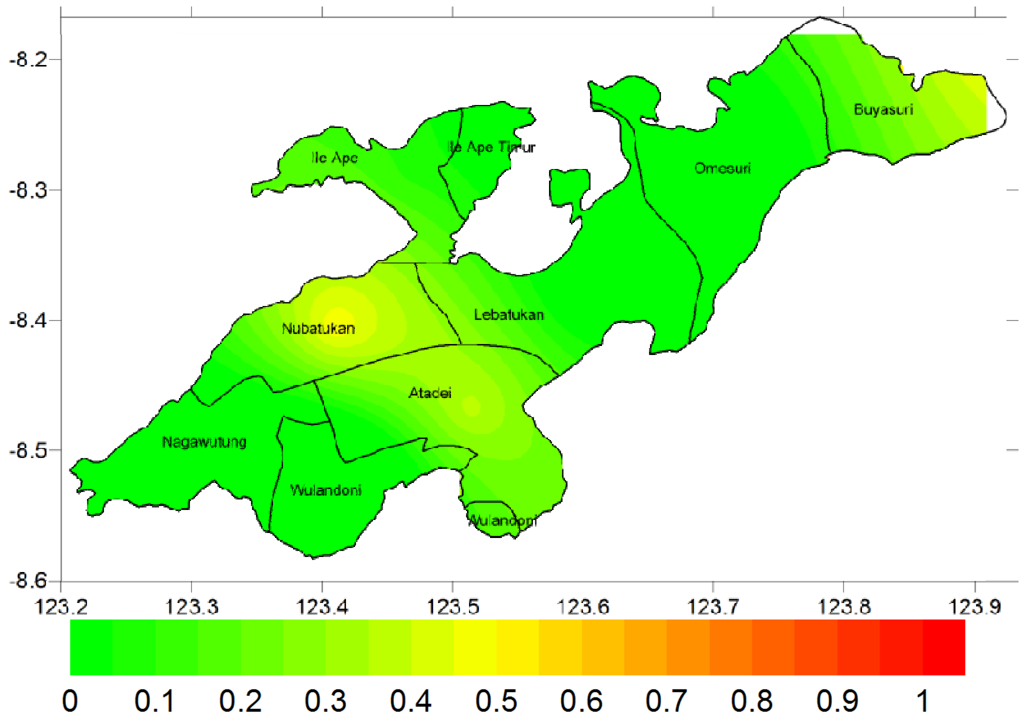


Figure 35. Map of climate vulnerability on Lembata in 2012

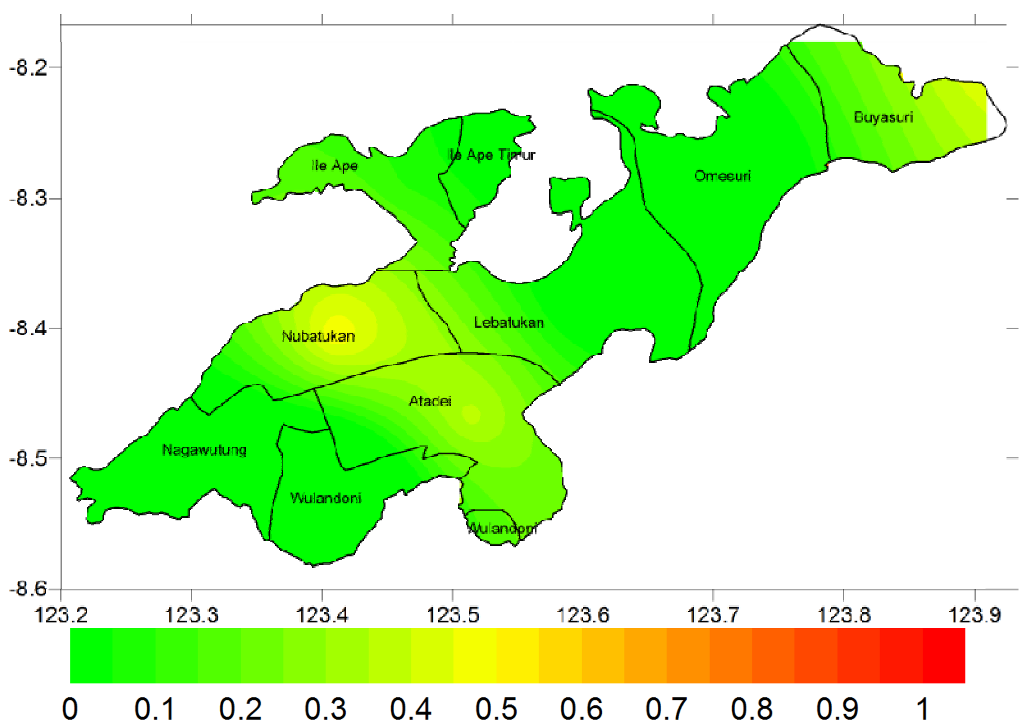


Figure 36. Map of climate vulnerability on Lembata in 2015

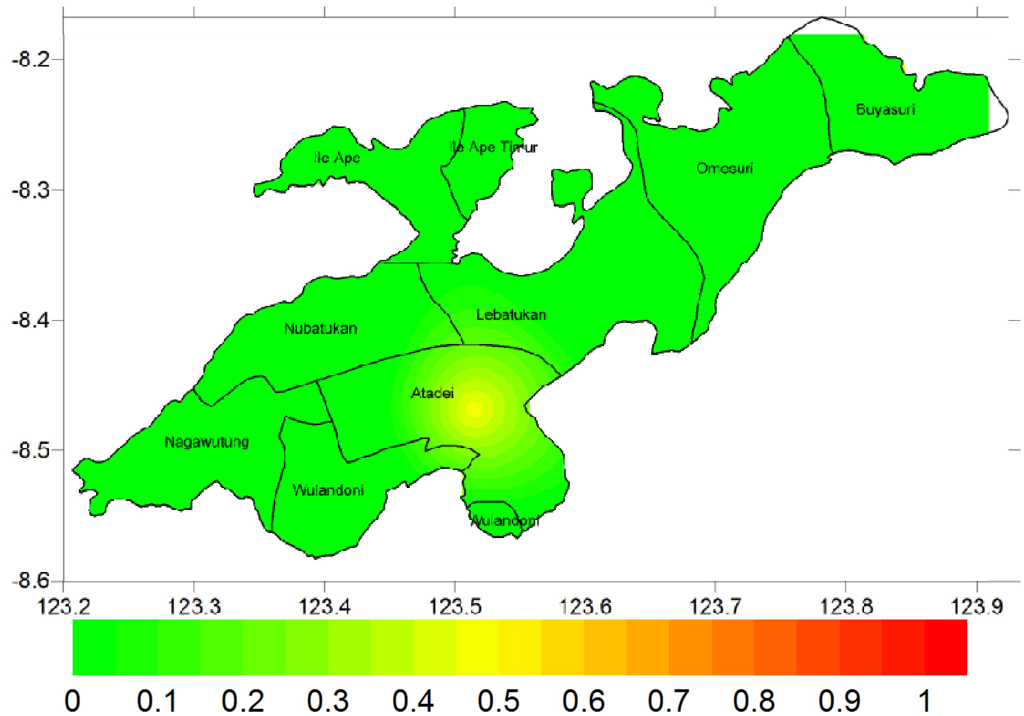


Figure 37. Map of climate vulnerability on Lembata in 2020

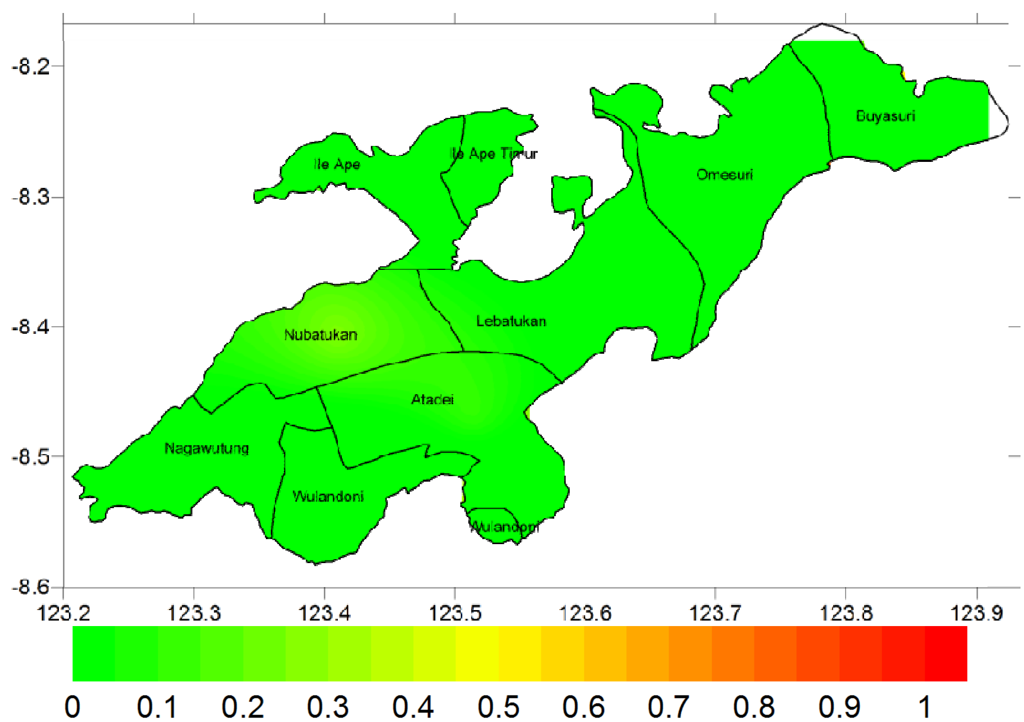


Figure 38. Map of climate vulnerability on Lembata in 2025

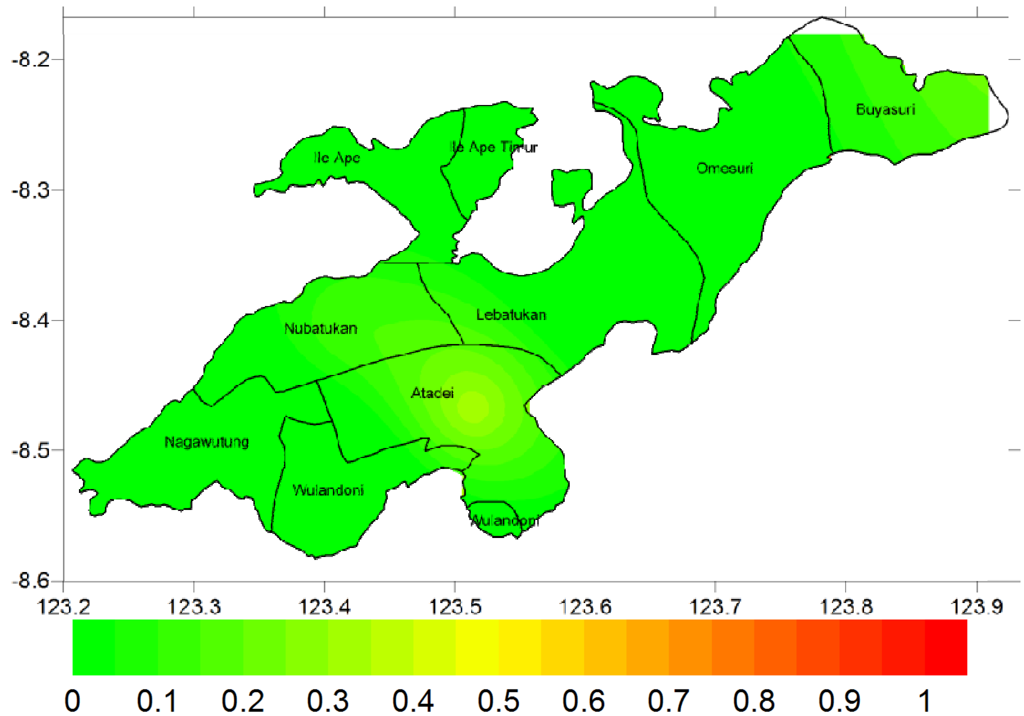


Figure 39. Map of climate vulnerability on Lembata in 2030

Figure 36 above shows the level of climate vulnerability in 2015, which will have increased from the year 2012, particularly in Nubatukan and Atadei, with average index of 0.3 compared with the average index of 0.1 in 2012. In the Lembata District, increase of the climate vulnerability level will occur in Nubatukan and Atadei area.

In 2020, the level of climate vulnerability will increase in Lembata District. In this District, the increase in climate change will occur in Nubatukan and Atadei with a large increase in the average index of 0.4. The highest climate vulnerability will occur in Nubatukan and Atadei with the index reaching 0.5. The climate change impact in the year 2020 is mapped as seen in Figure 37.

In 2025, the level of climate vulnerability will increase in Lembata District. In this District, the increase in climate change will occur in Nubatukan and Atadei with a large increase in the average index of 0.5. The highest climate vulnerability will occur in Nubatukan and Atadei with the index reaching 0.6. The climate change impact in this year is mapped as seen in Figure 38.

In 2030, the level of climate vulnerability will increase in Lembata District. In this District, the increase in climate change will occur in Nubatukan and Atadei with a large increase in the average index of 0.6. The highest climate vulnerability will occur in Nubatukan and Atadei with the index reaching 0.6. The climate change impact in the year 2030 is mapped as seen in Figure 39.

VII Adaptation Option Assessment

7.1 Workshop Activities

In the context of the current climate change phenomenon, society is not only seen as an object, but also as a subject. It is seen as an object because society is an entity of vulnerabilility, having to face the potential exposure from the risk of climate change. While as a subject, the society itself could also be the one who creates the efforts necessary to decrease the risk of a disaster, because on the other hand, the risk of climate change is a phenomenon that's almost inevitable.

The workshop was done at Kupang on 12 March 2012. It was attended by approximately 60 participants which were society members of the study area (Sikka, Lembata, TTU), non-govermental organizations (NGO), governments of the district level to the provincial level of NTT, and disaster experts, especially in the context of climate disasters, and are affliated with ITB (Bandung Institute of Technology), DNPI (National Council of Climate Change), and BNPB (National Agency of Disaster Adaptation). The activities consisted of two main parts, which are research outcome presentation and focus group discussion in each study area (Sikka, Lembata, and TTU). Some documentation of these activities is shown in Figure 40 below.

Sistematically, the workshop's purpose was to accommodate these goals:

1. Explanation of the final review in the context of climate projection in Sikka, Lembata, and TTU; temperature increment, rainfall increment, and sea level rise. Through this workshop, the participants from each study area were expected to provide validation and additional information about the impact of climate change in their area.

2. Explanation of the final review about the adaptive capacity and its projections in Sikka, Lembata, dan TTU. With this explanation, the society from each study area could get a big description on their adaptability.
3. Explanation of the final review about the level of vulnerability and its projection in Sikka, Lembata, dan TTU. The knowledge about level of vulnerability would be used as the main reference in choosing various possibilities from the adaptation options that could be implemented.
4. Formulation of adaptation options in each study area: Sikka, Lembata, dan TTU. The formulation involved society from each study area and relevant district-level and provincial-level governments. The main focus of this activity was to create a synergy effort between society and government to decrease the climate change impact in the study area.

Workshop activities held in Kupang, NTT

Workshop participants from many stakeholders

FGD Workshop with the local people

Result of research presented by ITB team

Figure 40. Workshop Activities

7.2 Adaptation Option in Sikka

Historical data from figure 41 shows that abrasion was the most type of disaster that frequently threatened Sikka, followed by heavy wind. It means that In the future, those kinds of disaster will then probably occur in the same area. Moreover, some areas such as Talibura, Alok, Mego, and Paga are areas with more than one types of hazard potency.

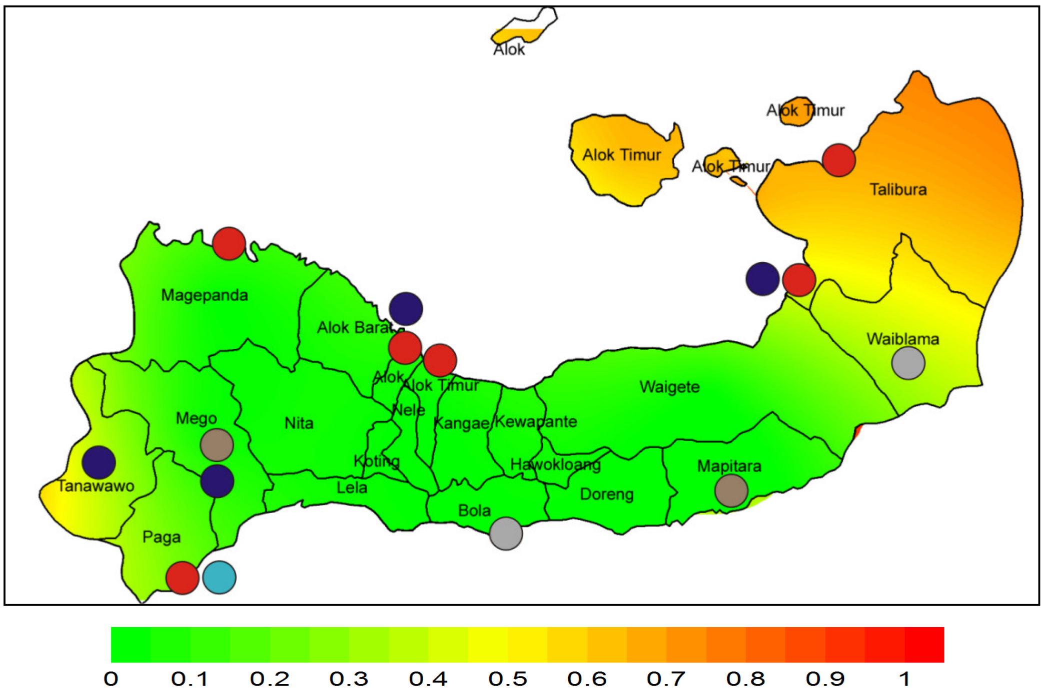


Figure 41. Potential of Disaster Events & Climate Vunerability of Sikka in 2015

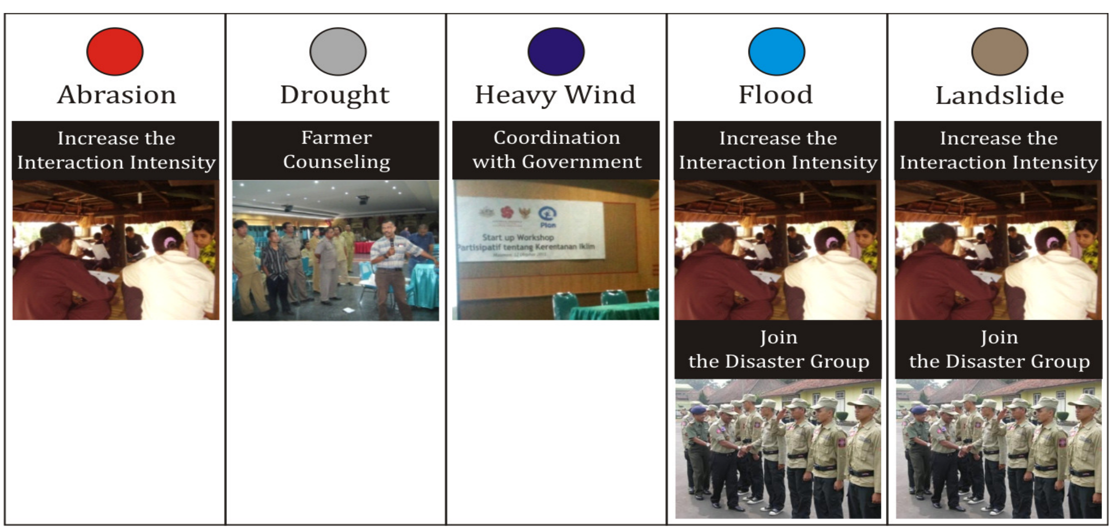


Figure 42. Adaptation Option of Sikka in 2015

There are several attempts in the formation of adaptation options, one of which is through a form of intervention. The level of vulnerability is expected to be a 'low vulnerability' when the actions of intervention was done. The intervention could be initiated by the government or the local society. After the intervention with its impacts to the level of vulnerability was done, the next process was to identify several adaptation options which could be done.

Based on the workshop with the society of Sikka, a fact was obtained that several intervention was done in that area, as shown in Figure 42. For example in the agriculture sector, interventions were done by intensification, such as technology improvements, selection of seeds, and knowledge improvements for the farmer from a socialization activity; also from the structural side such as construction of the irrigation lines. Moreover, several efforts such as relocation of agricultural area had been implemented. As for the sector of fisheries and marine, several intervention efforts such as counseling with the fisherman, improving of fishing technology, planting of mangrove were conducted. For fisheries and marine sector, some interventions had been done such as supervision to fishermen, including constructing dike *(talud)* at the coast. Some efforts such as elevation of the houses, cleaning of the drains, creation of disaster relief organizations, and coordination with local governments had also been conducted to decrease the overall level of vulnerability in residential areas.

As was explained before, the workshop had a main goal which was to identify several adaptation options that could deal with the impact of climate change in the study area. After the indentifying process, the adaptation options would be categorized into an implementation timeline. This process had to be done because every adaptation options had its own feasibility which was different from one to another, in terms of the cost, activity scale, or the synchronization with each local government policy. In this timeline, the option with the highest feasibility would be prioritized to be implemented.

The result showed that in 2015, the daily and small-scale activities will be able to be performed as adaptation options. To prevent abrasion, flood, and landslide, the first effort that can be done is to increase the interaction between society members and to encourage them to join disaster relief organizations that can increase their cautiousness. While to prevent the impact of heavy wind, coordination with the government can be done as an option, because characteristics of heavy wind can be predicted from a scientific approach. On the other hand, drought can be prevented through counseling with the farmers because this type of disaster has the strongest impact on the agricultural sector.

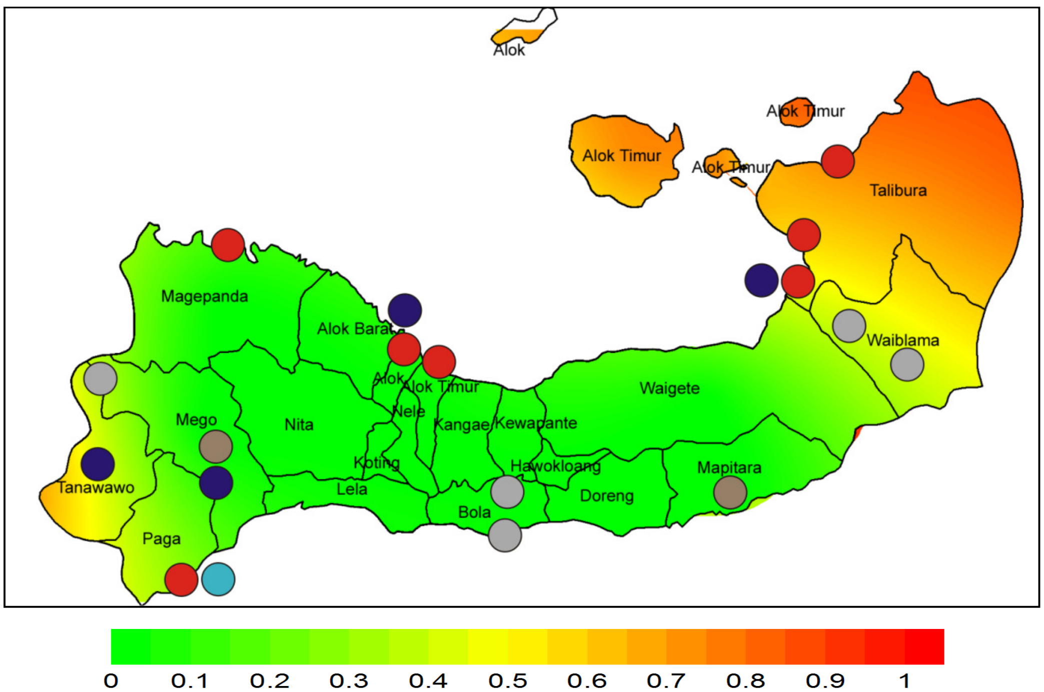


Figure 43. Potential of Disaster Events & Climate Vunerability of Sikka in 2020

In 2020, Sikka society's vulnerability to climate change disaster tends to increase particularly around Tanawawo, Talibura, dan Waiblama (Figure 43). Based on the collected data, these three areas will have experienced several times of abrasion and heavy wind. Potential disaster events also tend to increase widely, which Talibura will be facing more of, because it possesses more abrasion potency than Waiblama, Bola, and Tanawawo, which are all more prone to drought. This prediction was developed as an analyisis result from both the climate change future impact index and the historical disaster events index. In the first part, we can make predictions on the index of future climate change impact in study areas in the year 2015, 2020, 2025 and 2030. This index prediction is then matched with historical disaster events there, so we can have descriptions on the kind of disaster potentials in each of the study areas. In this case, we can only predict the main and direct climate change impact such as drought and abrasion, which can potentially lead to landslides and floods.

Therefore in the year 2020, the planting of mangrove trees will be added to the adaptation option in anticipating for abrasion. The adaptation option in Sikka in 2020 is shown in Figure 44. On the other hand to respond to the increment of potential heavy wind, local society members should increase the intensity to coordinate with their local government to increase access to information. To anticipate for the increasing trend of potential hazards, in 2020 the society expects to have a disaster-vulnerability map in Sikka.

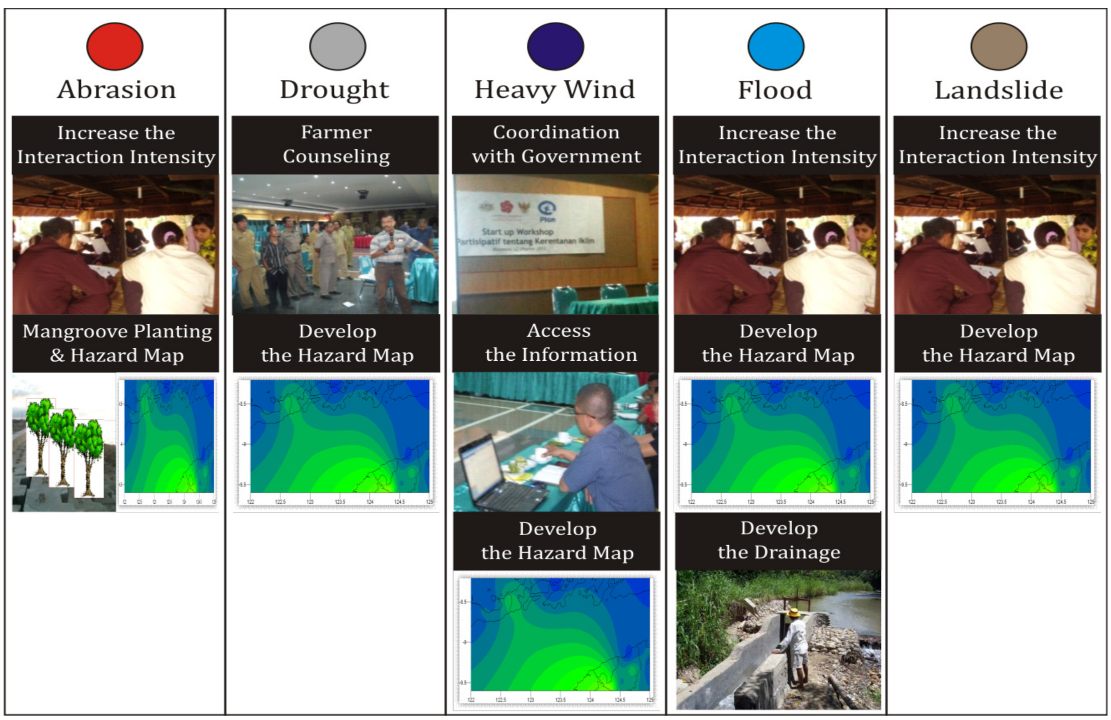


Figure 44. Adaptation Option of Sikka in 2020

In 2025, a significant increment of the vulnerability level will still occur in the same area with the previous increment. Alok Timur and Talibura are the two areas that have the highest level of vulnerability (Figure 45). That means in the year 2025 these two areas with their adaptive capacity and potential hazard, will have the highest potency of losses compared to the other areas.

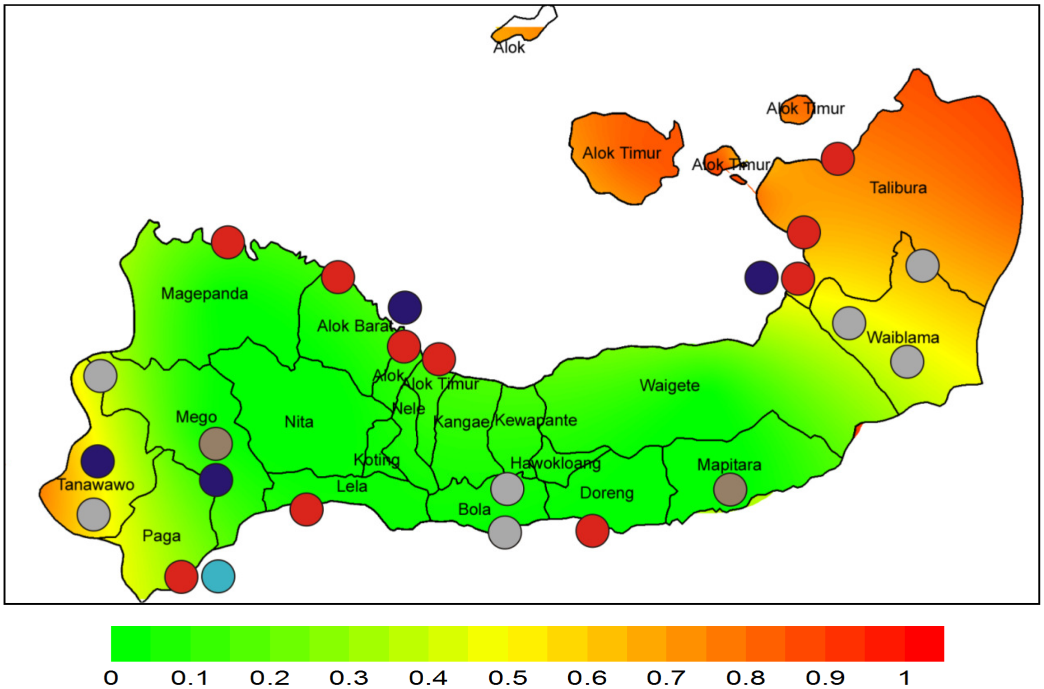


Figure 45. Potential of Disaster Events & Climate Vunerability of Sikka in 2025

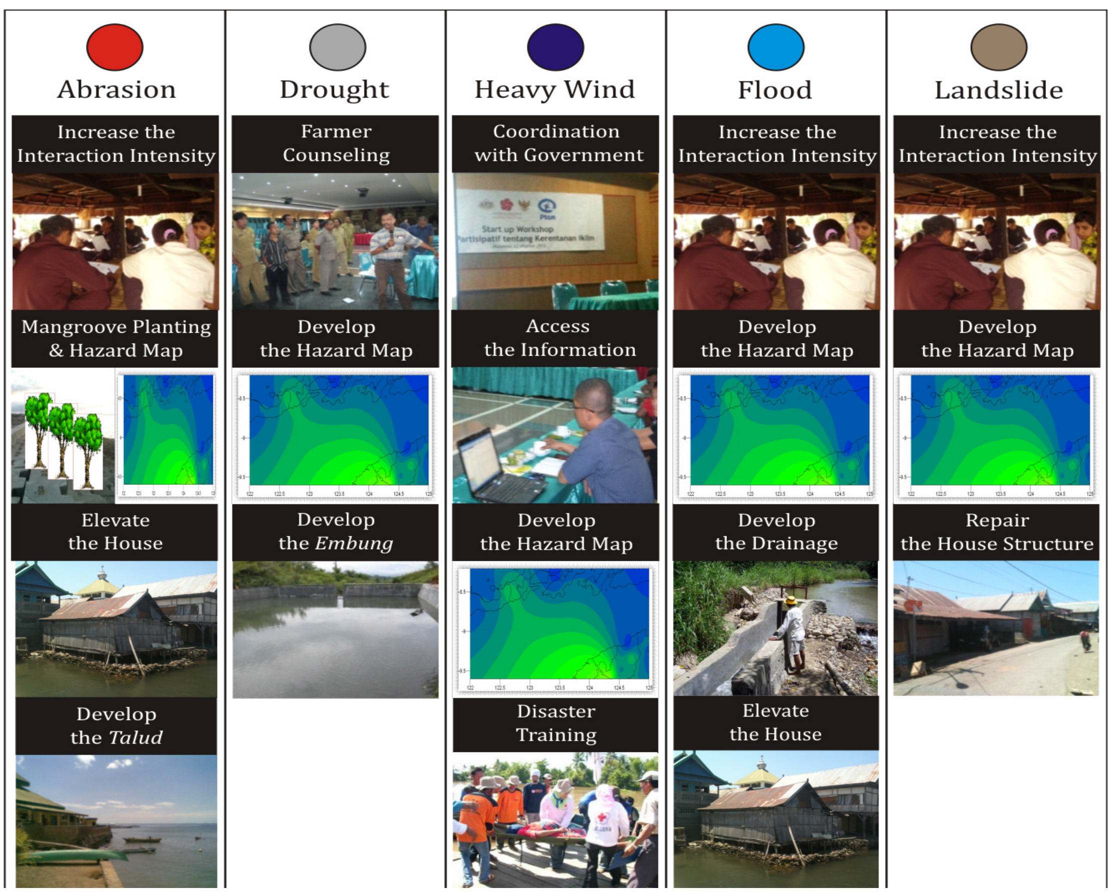


Figure 46. Adaptation Option of Sikka in 2025

In 2025, most of the additional adaptation options will be classified as structural options, which are shown in figure 46. These options need high costs and sometimes are classified as a long-term project for the government. Thus, the implementation will only be possible to begin in 2025. For abrasion, elevating the houses to prevent overflowing from the sea and construction of a tidal controller to resist the sea-water can be done as a structural prevention option. As for the drought structural adaptation option, it is to develop an 'embung' field. Through 'embung', rainwater will be accommodated for and channelled to the fields in the dry season. The potency of heavy winds will be anticipated for by the structural quality increment of the houses and disaster training. While in anticipating for floods and landslides, the additional options that can be done are to fix the residential housing structure and to conduct training on anticipating for disasters.

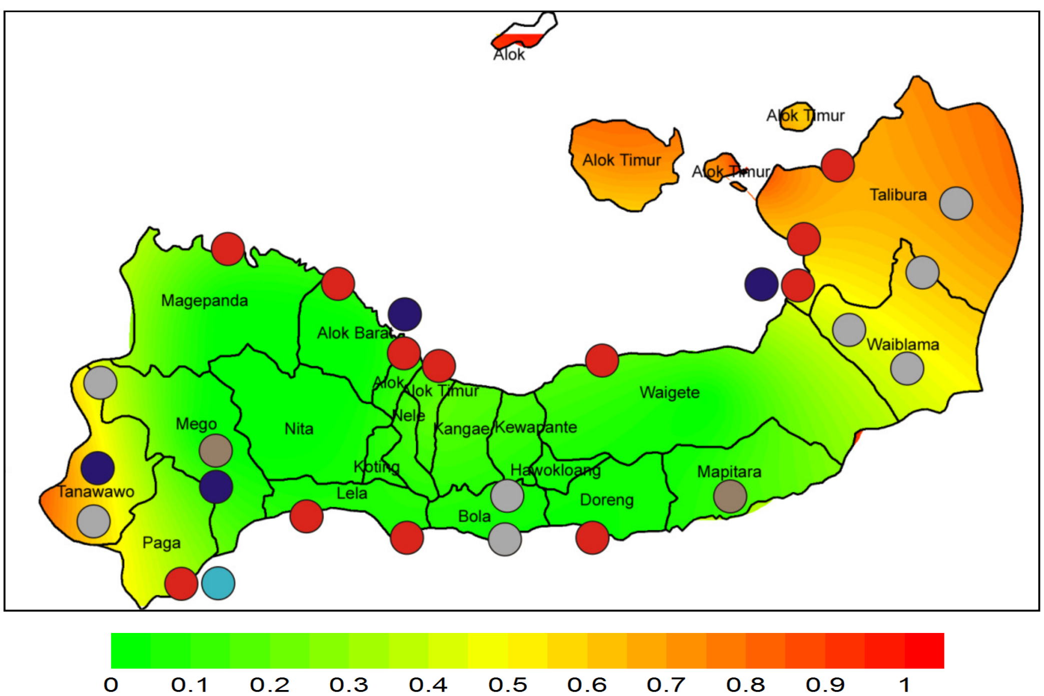


Figure 47. Potential of Disaster Events & Climate Vunerability of Sikka in 2030

As shown from Figure 47, the increasing level of vulnerability in the year 2030 will occur in Waiblama and Paga, while Talibura dan Tanawawo will still have a high level of vulnerability in Sikka. Potency of abrasion will occur widely in some north and south coastal areas in Sikka when drought disasters will be more threatening in the west (Tanawawo and Paga) and east (Waiblama and Talibura) areas.

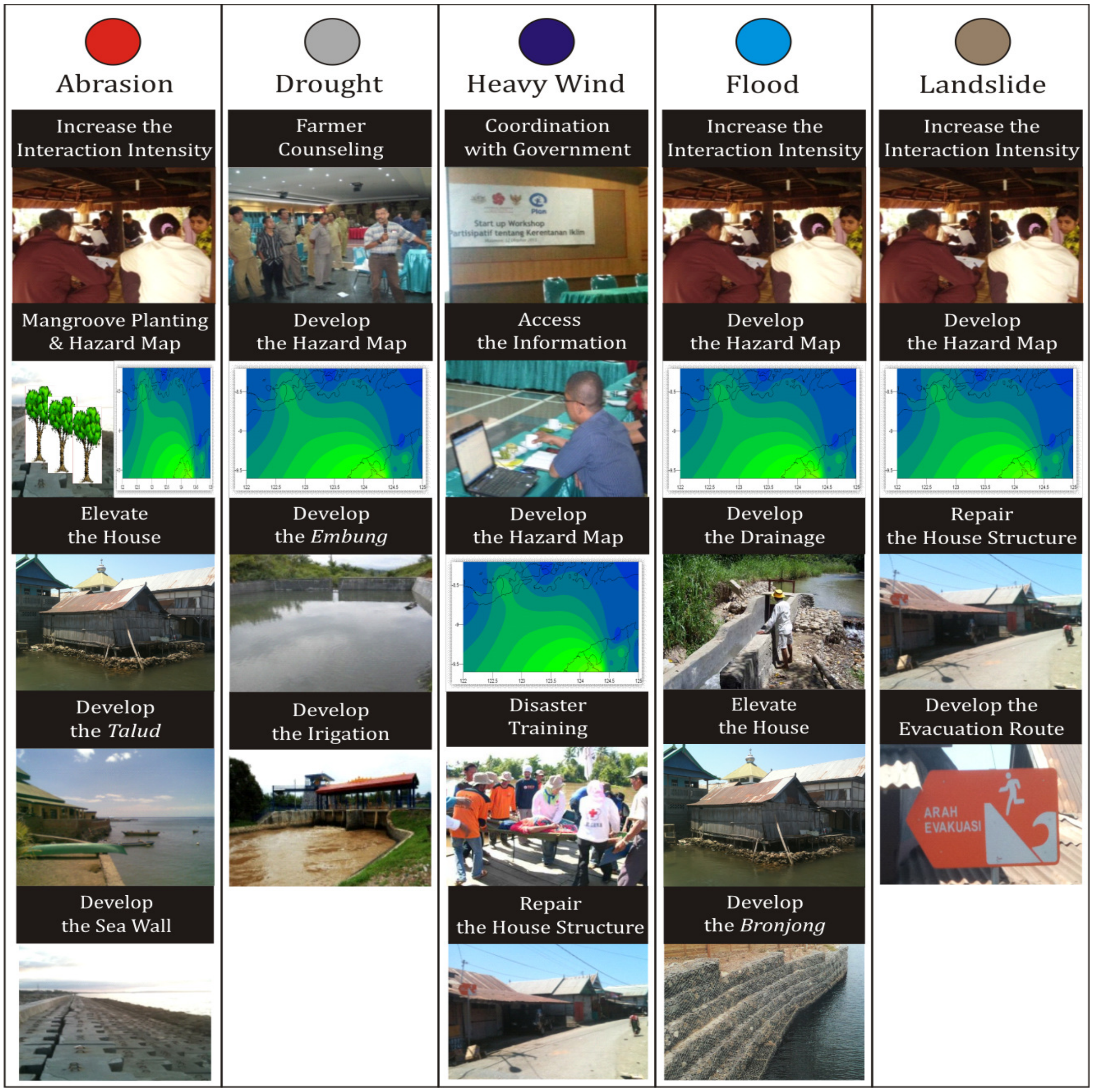


Figure 48. Adaptation Option of Sikka in 2030

To anticipate the increasing level of vulnerability, several additional options which are usually classified as a mega-project can be done, such as construction of a 'sea wall' to prevent abrasion, development of irrigation lines to prevent drought of agricultural area, construction of 'bronjong' to resist flooding, and development of evacuation tracks to decrease the losses from landslide (Figure 48).

Adaptation efforts which are already done or will be done until the year of 2030 must be supported by the government as the decision makers. Therefore, the workshop attempts to explore the role of government through its programs in its effort to support implementation of adaptation options. In Sikka, there are several current government programs that are integrated with the effort of adapting to climate change impacts, such as the climate excursion program by BMKG and formulation of Regional Action Plans for food and nutrition (RADPG) which have the concept of climate change adaptation by the Agricultural Agency. For the future, the people hope The Marine and Fisheries Agency can provide them the boat mooring and socialization on the potential spreading of fishes. Furthermore, they also hope the BPBD (Disaster Adaptation Local Agency) will draw up a climate change vulnerability map.

7.3 Adaptation Option in Lembata

Historical data shown in Figure 49 shows that landslide was the most threatening disaster in Lembata, followed by drought which often leads to food insecurity and abrasion. It means that, those kinds of hazards have the potential to occur again in the same area in the future. Some areas such as Ile Ape and Nubatukan even have more than one potential hazard in the future.

So far, several interventions in the agricultural sector that had been done to decrease the level of vulnerability in Lembata were agricultural intensification (the use of organic fertilizers, re-adjustment of the cropping pattern, technological obsolescence, seed selection, and exsistence optimization of the barns), local plants development, and construction of irrigation lines. In the fisheries and marine sector, the adjustment of local fishing patterns and development of fishing technology had been carried out by the local fisherman. As to decrease the level of vulnerability in the society residential in general, several efforts can be done such as elevating the housing structure, cleaning of drainages, increasing the coordination between the stakeholders, joining disaster organizations, and implementing the mechanism of sanction and punishments against forest burning.

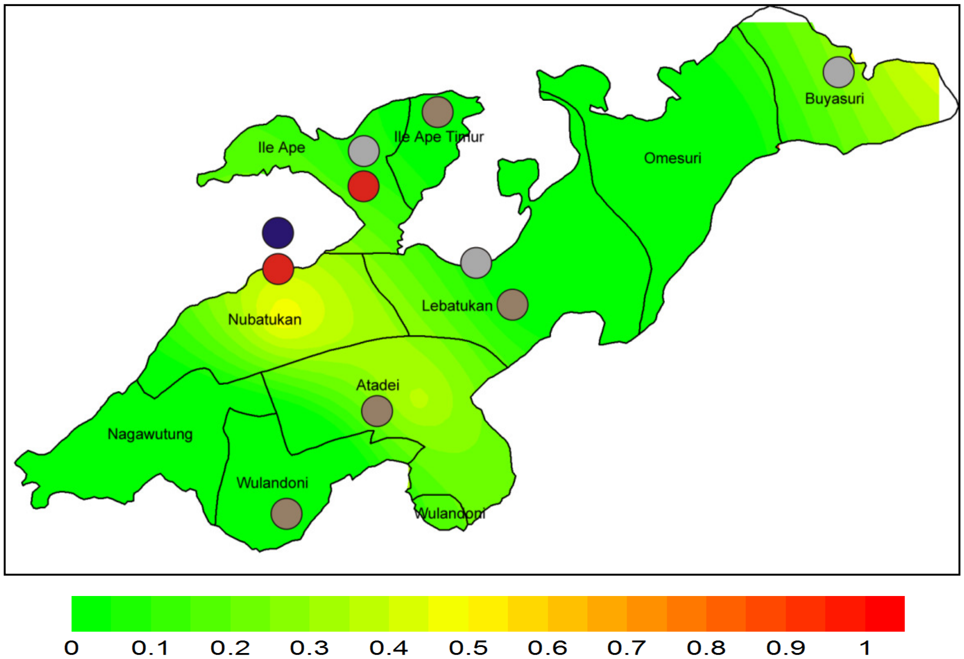


Figure 49. Potential of Disaster Events & Climate Vunerability of Lembata in 2015

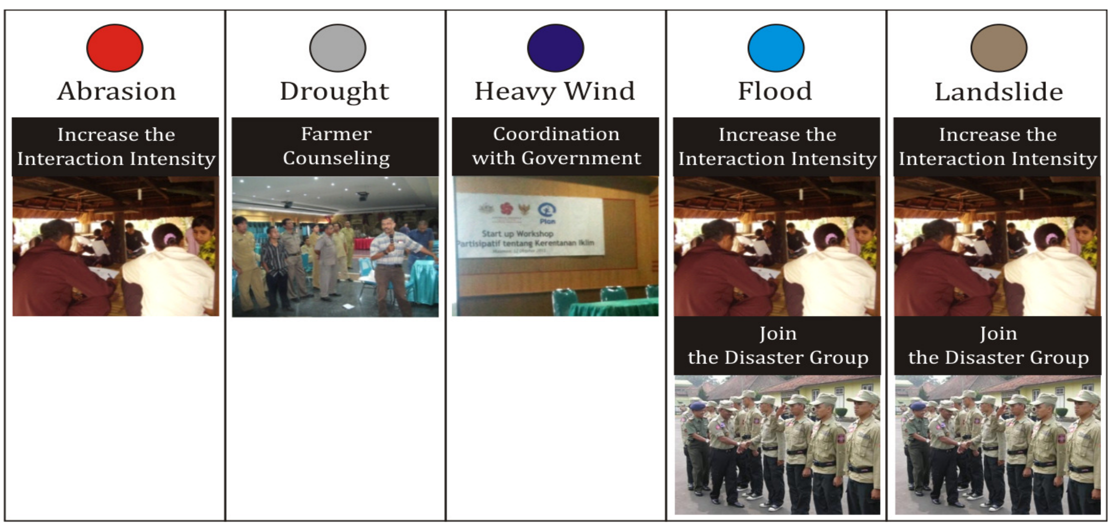


Figure 50. Adaptation Option of Lembata in 2015

There are several adaptation options which are indicated to be carried out in 2015 as shown in figure 50, such as increasing interaction to decrease vulnerability to abrasion and landslide, farmer counseling, and coordinating with the government in anticipating for drought and heavy wind. In Lembata, flooding had never been explicitely identified in the historical data used, but most of them were actually the indirect cause of landslides. Therefore, various efforts to address flooding issue should be done, such as increasing interaction and joining disaster relief organizations.

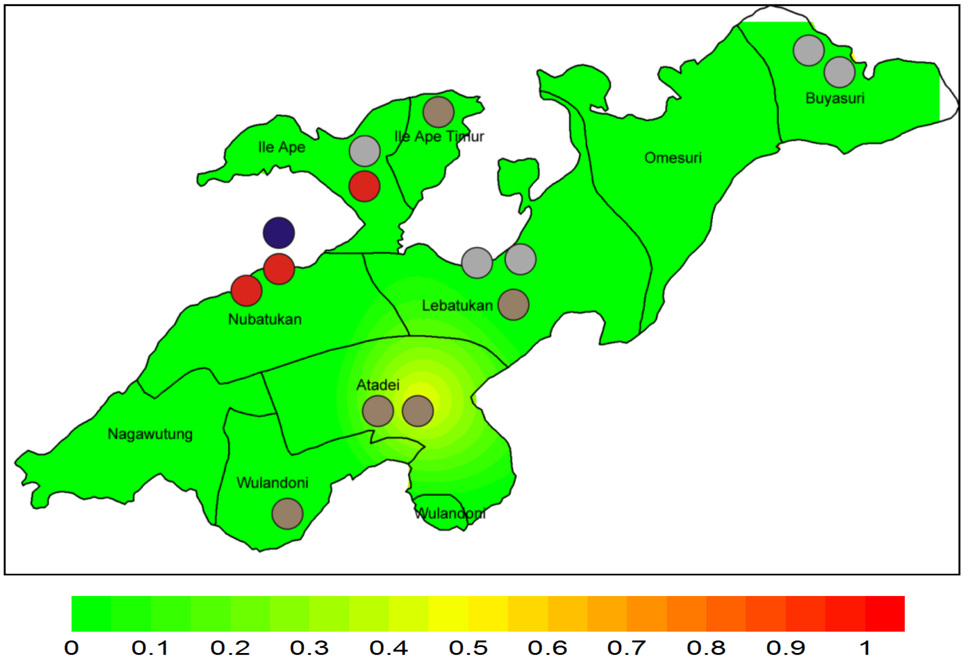


Figure 51. Potential of Disaster Events & Climate Vunerability of Lembata in 2020

Figure 51 shows that in 2020 there will be an increasing level of vulnerability to climate change in some areas in Lembata, such as Nubatukan, Atadei and Buyasuri. Therefore, the increase of disaster intensities such as abrasion and drought has great potential to occur in these areas in 2020. Nubatukan will have an increase in intensity of abrasion when Lebatukan and Buyasuri suffer from drought. To respond to that condition, several efforts to implement the adaptation option must be increased. Based on the workshop result shown in Figure 52, several additional adaptation options which can be done in 2020 are identified, such as planting mangrove (for abrasion adaptation), land optimalization and use of organic ingredients to fix the land structure (for drought adaptation), and increase quality and quantity of drainage (for flood adaptation), and increase access to information and joining disaster organizations (all are for adapting and anticipating for heavy wind and landslide)

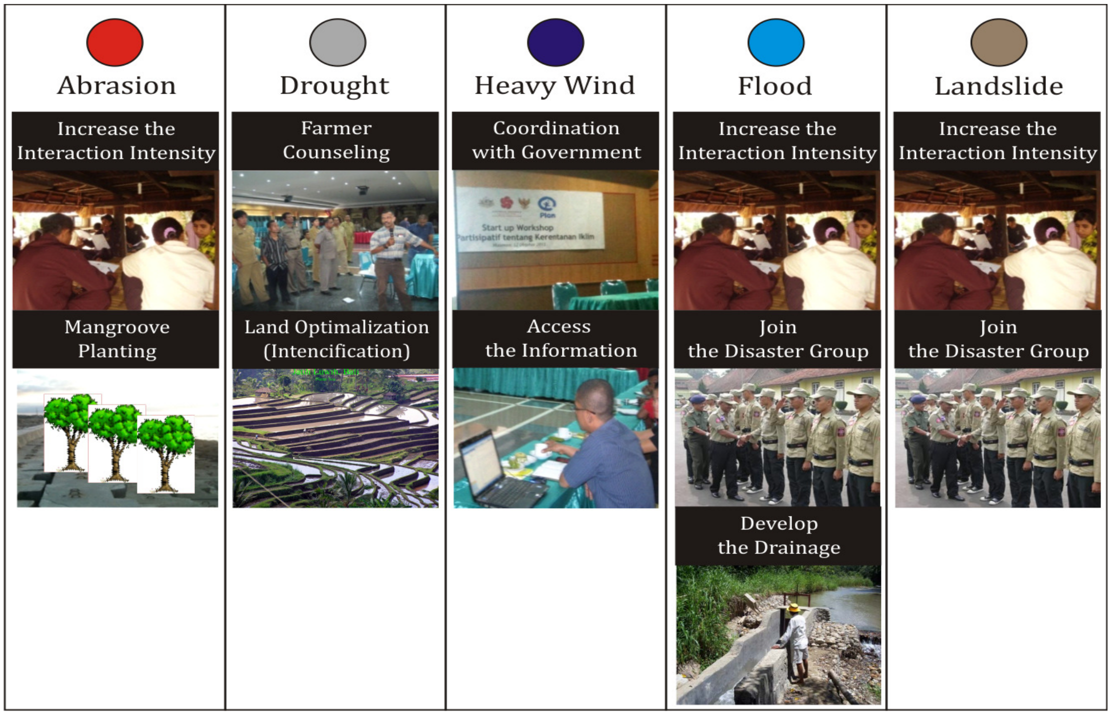


Figure 52. Adaptation Option of Lembata in 2020

In 2025, the increasing level of vulnerability would not significantly occur as shown in Figure 53. In this year Nubatukan is the only area that will show an increasing level of vulnerability, as for other areas such as Atadei, it will only experience an increase of level of vulnerability of 0.1. In this year, areas such as Nubatukan, Lebatukan, Buyasuri, and Atadei will be facing more disaster events than the last 5 years. Significant increases of abrasion, drought, and landslide will occur.

Figure 54 shows various additional options which could be done in 2025 in Lembata, such as elevating the foundation of houses andconstruction of dike *(talud)* (for abrasion adaptation), development of 'embung' or water-catchment wells (for drought adaptation), increase of housing structure quality, and adding intensity of training or drilling (for heavy wind adaptation). Each are for flood and landslide adaptation.

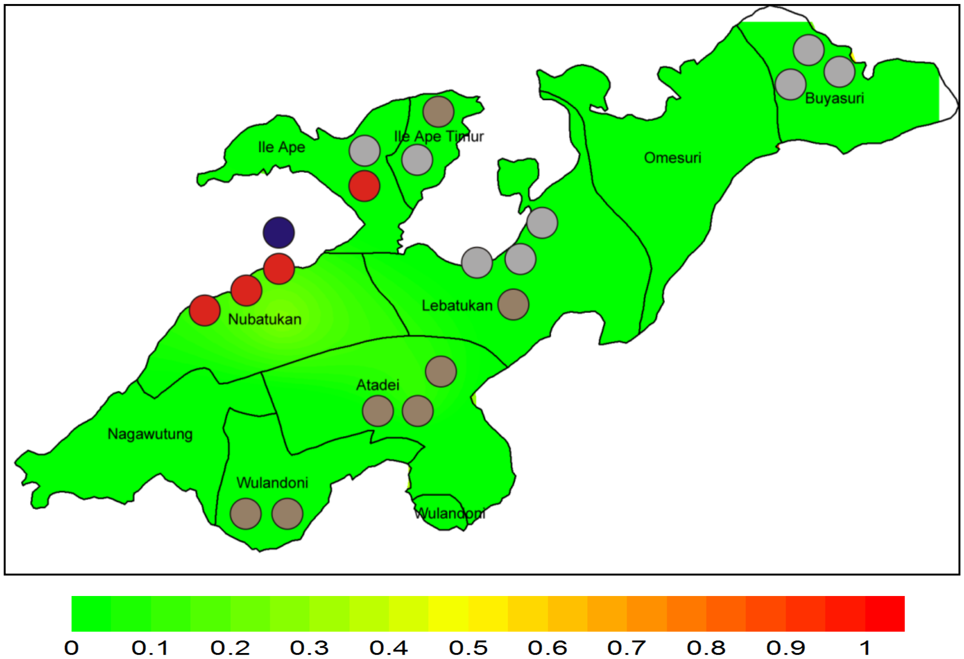


Figure 53. Potential of Disaster Events & Climate Vunerability of Lembata in 2025

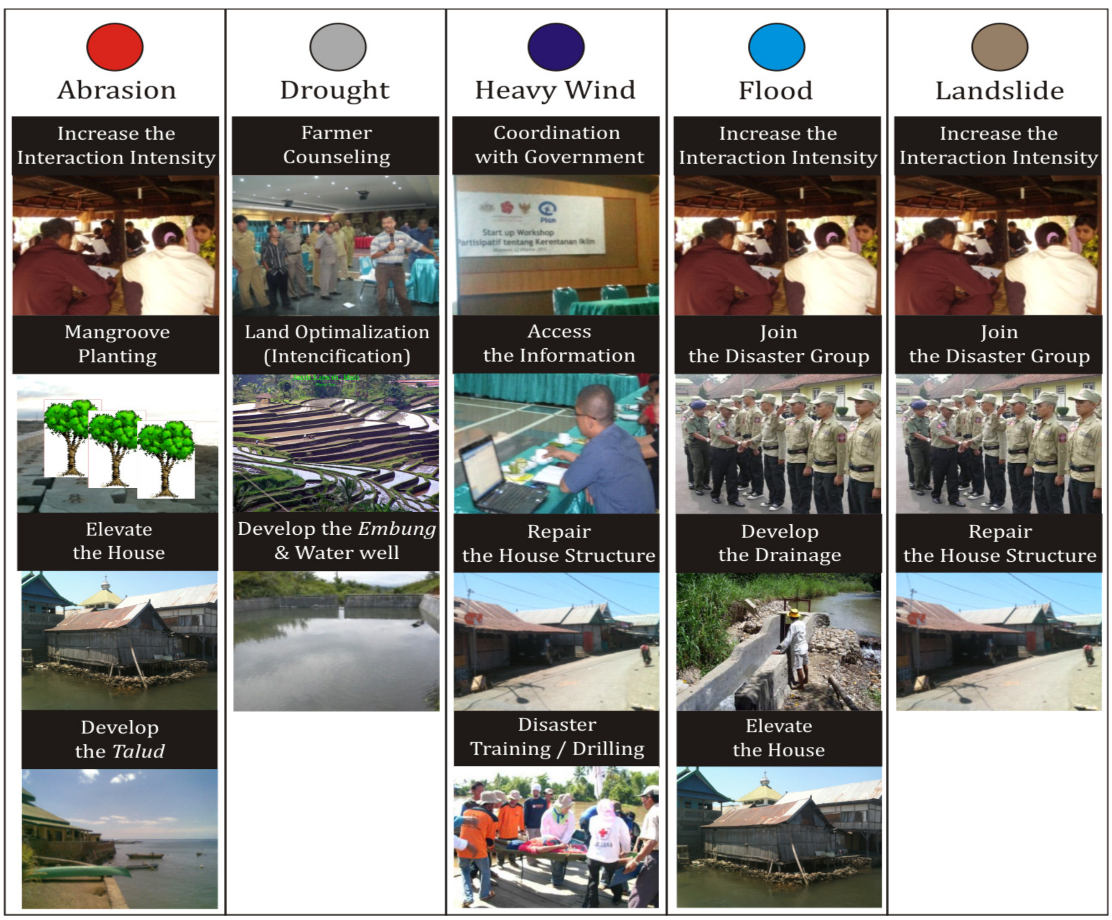


Figure 54. Adaptation Option of Lembata in 2025

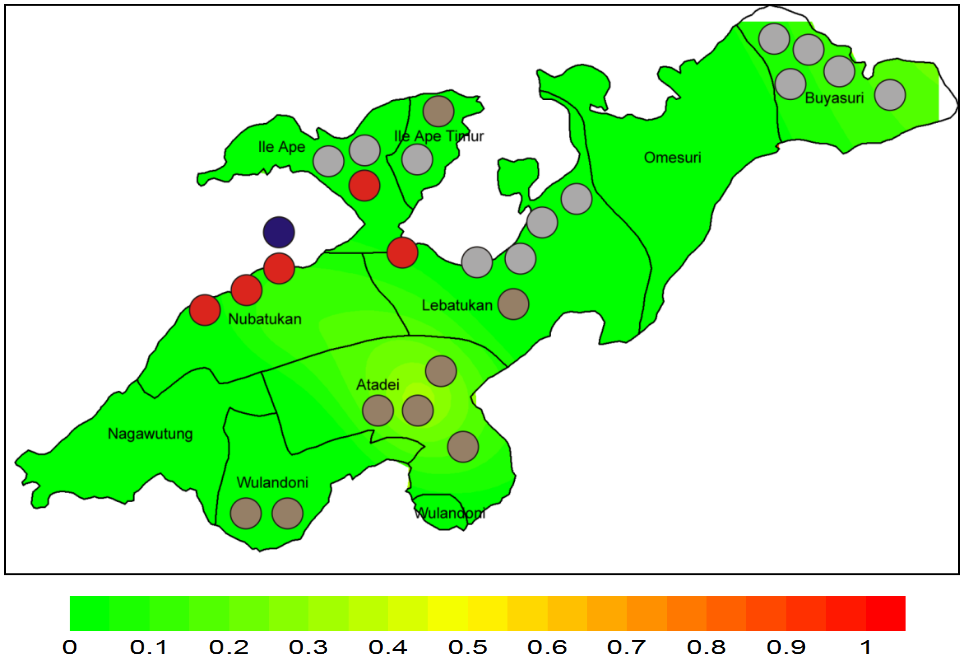


Figure 55. Potential of Disaster Events & Climate Vunerability of Lembata in 2030

In the year 2030, the increasing level of vulnerability in Lembata will not be too significant (Figure 55). Atadei is the only area which can reach the level of vulnerability of 0.4. While the other areas will only experience an increase reaching 0.1 as its level of vulnerability. In this year, abrasion events will occur often in the Lebatukan Sub District, while some areas will have a significant increase of disastrous events.

Several additional options which can be carried out in 2030 in Lembata will be similar with the options in the other areas. It has been explained before that the options in 2030 are usually classified as a big-scale and long-term options. Therefore, the implementation was usual to be implemented in many areas. To anticipate the increasing potency of abrasion, a construction of sea wall will be carried out. As for drought and flood, the option for anticipating for each disaster is to develop an irrigation line which is more integrated and to construct a 'bronjong'. As for reducing the potential losses due to landslide, in 2030, will be developed an evacuation system which consists of construction of evacuation routes and development of the implementation scheme. Overall the adaptation option in Lembata in 2030 is shown in Figure 56.

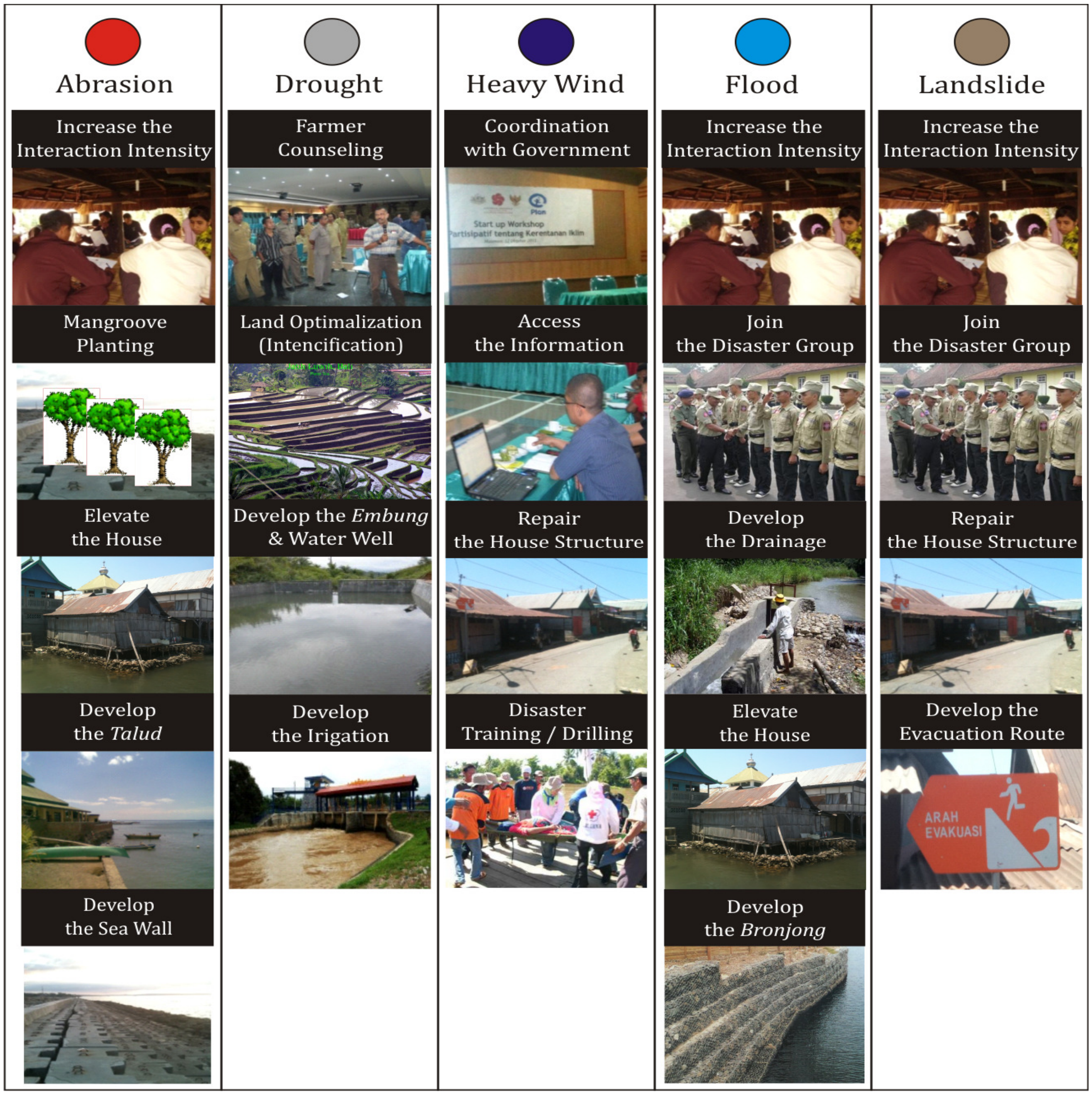


Figure 56. Adaptation Option of Lembata in 2030

To support the implementation, the government's current programs are integrated with the adaptation efforts to climate change in Lembata, such as direction of diversification and revitalisation of the agricultural sector by the Agricultural Agency and several directives related to technologies and adjustment process by Marine and Fisheries Agency. The local government has begun with the construction of water-catchment wells in some areas in Lembata and have tried to engage the climate change issue to every one of its development programs.

7.4 Adaptation Option in TTU

Historical data as shown in Figure 57, shows that heavy wind is the most frequent disaster occuring in TTU, followed by drought, landslide, and flood. It means that, in the future, the same TTU area will probably be hit by those kinds of disasters again. Even some areas such as Biboki Utara have three potential hazards, followed by Biboki Anleu and Miomaffo Tengah, which have two potential hazards.

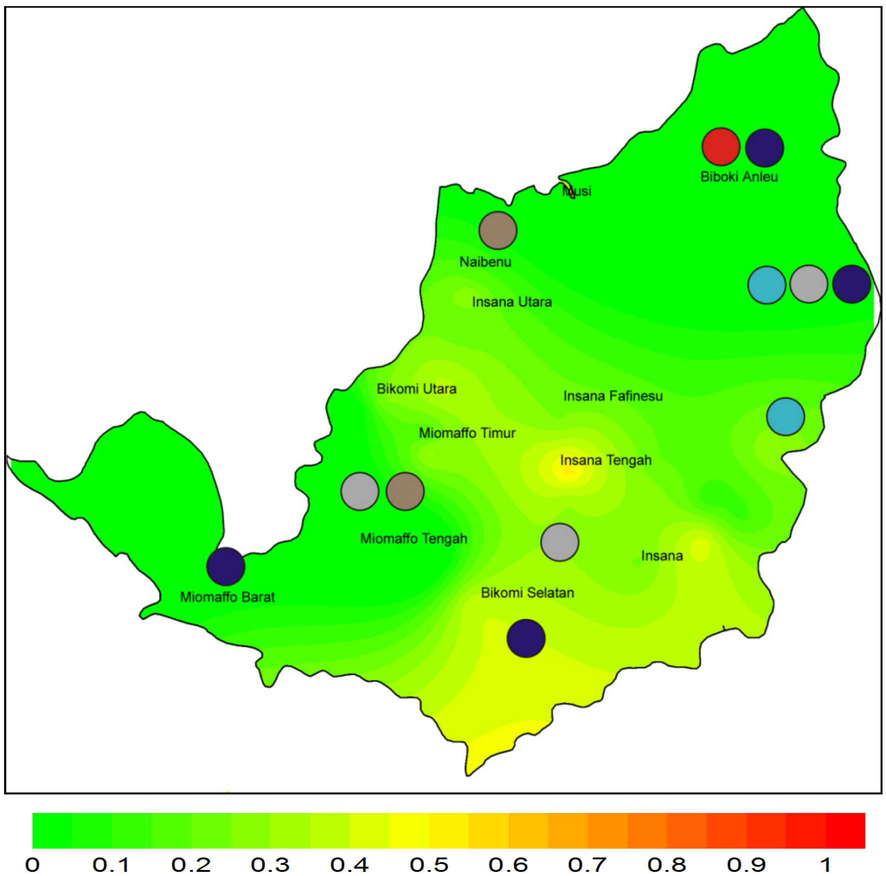


Figure 57. Potential Disaster Events & Climate Vunerability of TTU in 2015

In efforts to reduce disaster vulnerability to climate change in TTU, the government and local society have done several interventions. For the agricultural sector, they already started the construction of irrigation lines, counseling, intencification, and incorporate the elements of local wisdom into the management of agriculture. On the fisheries and marine sector, intervention had been done through re-adjustment of the fishing pattern and technology, the selection of certain types of fishes, as well as the initiation of mangrove planting at the coast. As to reduce the level of vulnerability in general in residential areas, the interventions that had been done by the people are joining disaster organizations, routine cleaning of drainage through the 'Friday Clean' program, implementing traditional ceremonies as one form of the local wisdom, development of 'bronjong', implementing reforestation, and conducting socialization, simulation, and disaster training.

Figure 58 show various adaptation options that can be done in TTU in the year 2015. Nearly identical with the two previous areas, adaptation options that can be done are in the individual,or, local scale. It is because that vulnerability reduction efforts basically have to begin with the smallest scale, which starts with the individual being vulnerable entities to the disasters. The efforts are to increase interaction with the environment (for abrasion, flood, and landslide adaptation), counsel the farmers (for drought adaptation), coordinating with the government (for heavy wind adaptation), and joining disaster organizations (for flood and landslide adaptation).

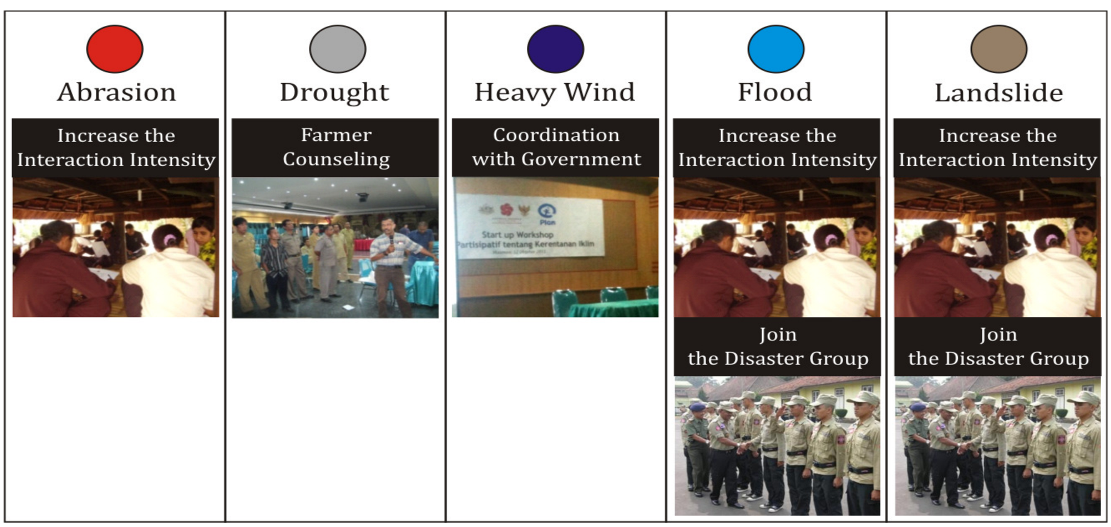


Figure 58. Adaptation Option of TTU in 2015

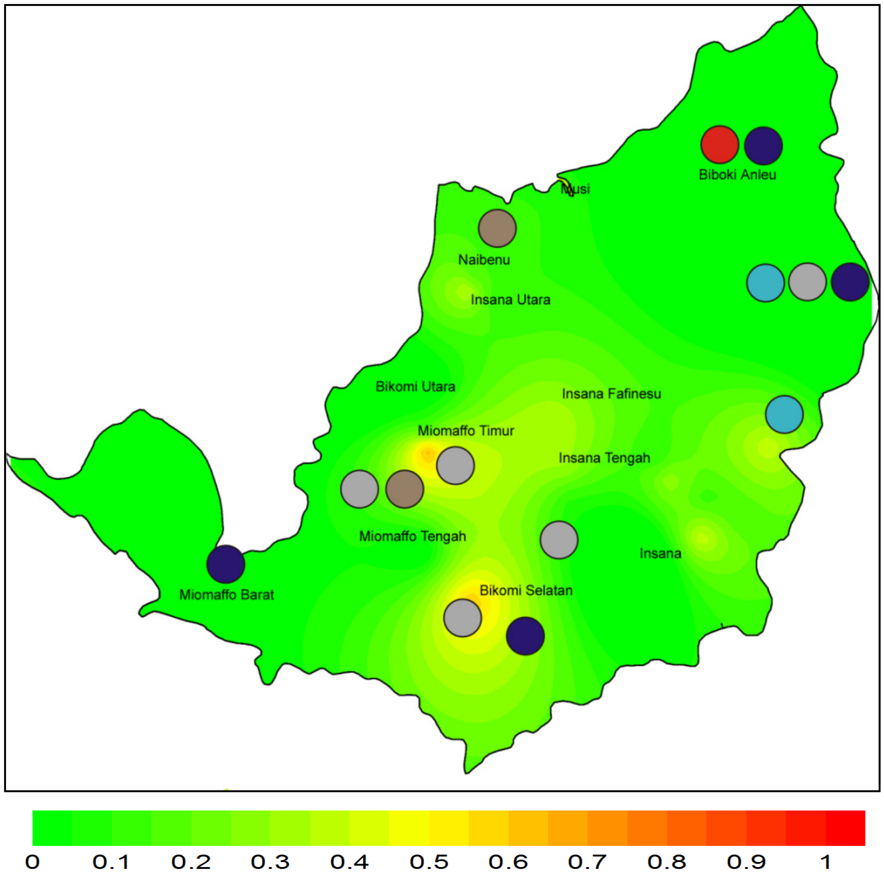


Figure 59. Potential Disaster Events & Climate Vunerability of TTU in 2020

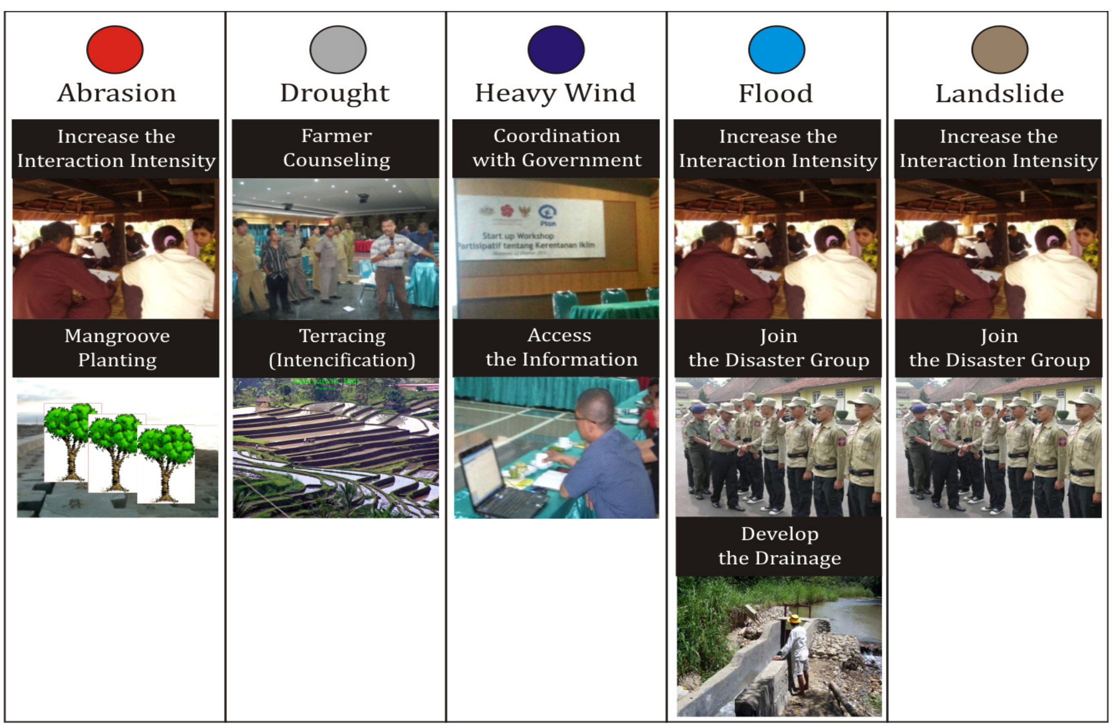


Figure 60. Adaptation Option of TTU in 2020

In the year 2020, Figure 59 shows that a significant increase will occur in Insana Utara, Miomaffo Timur and Bikomi Selatan with an index of vulnerability reaching 0.4. In lane with the increase of climate change impact index in some areas, potency of drought also will occur more than before.

Responding to the increasing level of vulnerability, several additional adaptation options that can be done in TTU in the year of 2020 are identified in the workshop (figure 3.58). The additional options are to plant mangrove for vulnerability reduction to abrasion, conducting agricultural intensification (for drought adaptation), increasing the access to information (for heavy wind adaptation), and maintaining the drainage and adding the quantity (for flood adaptation).

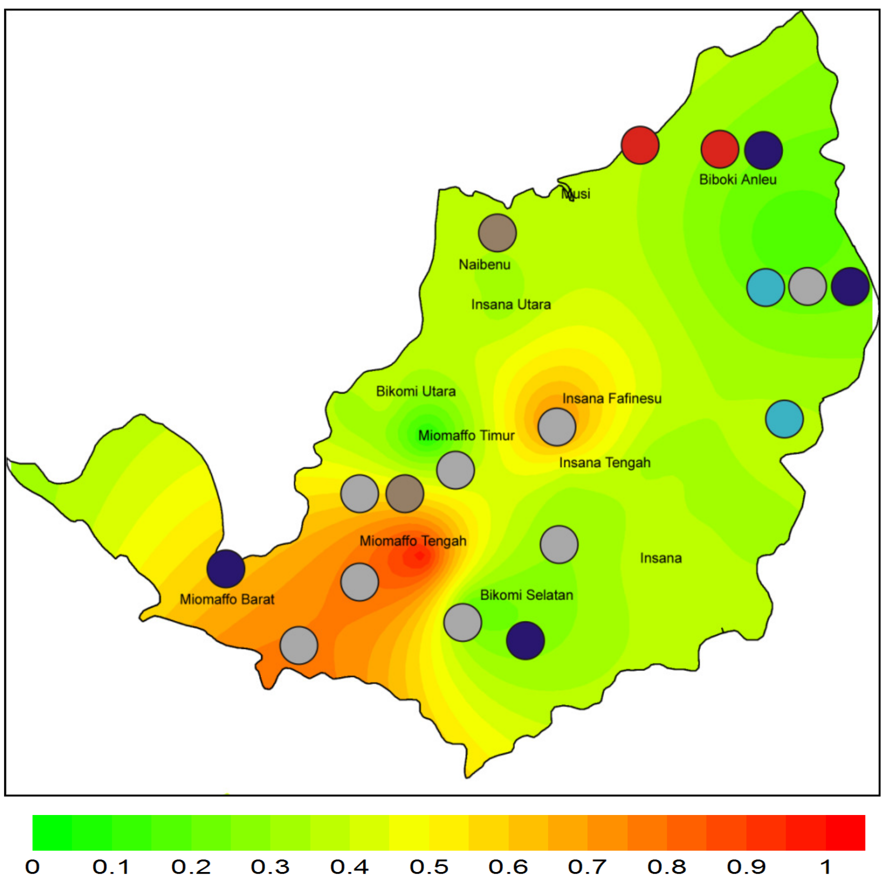


Figure 61. Potential Disaster Events & Climate Vunerability of TTU in 2025

In the year 2025, as shown in the Figure 61, a significant increase in the level of vulnerability to climate change will occur in TTU. Miomaffo Tengah, Insana Fafinesu, and Miomaffo Barat are the areas with the highest increase, followed by Insana and Naibenu. In this year, besides the increased potential for droughts, there is also an increasing potential for abrasion, which will occur in Musi and Biboki Anleu. Based on the potential level of vulberability increment, the adaptation options that had been planned, are large-scale options. Various additional options shown in figure 3.60 are house elevation and dike construction *(talud)* to anticipate for abrasion, development of 'embung' field to counter drought, improvement of housing structure and socialization, simulation, and disaster training to counter against hurricanes, and reforestation and improvement of housing structure are all targeted to anticipate for the potential of flood and landslide.

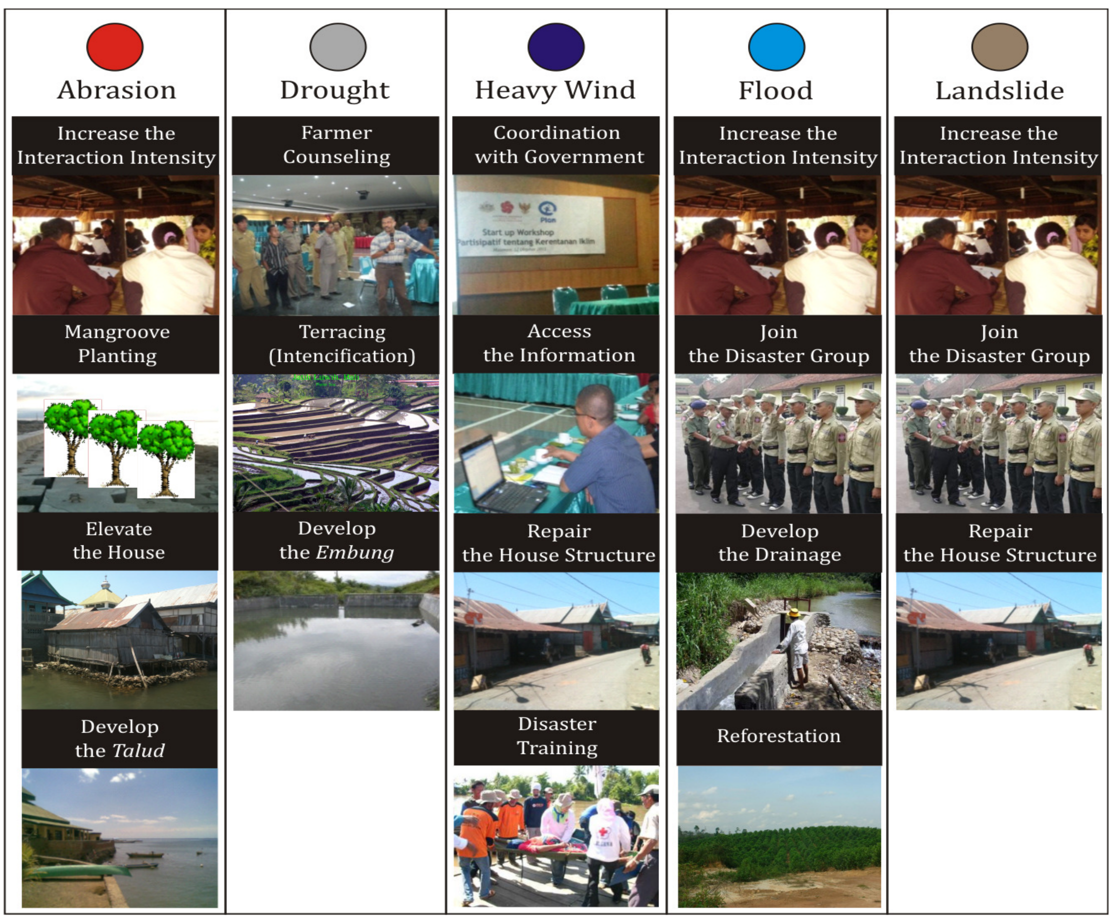


Figure 62. Adaptation Option of TTU in 2025

In the year 2030 (Figure 63), a significant increase of climate change vulnerability index is expected to occur in Bikomi Selatan which will almost reach 0.85, Miomaffo Timur with the range of 0.6, and Bikomi Utara with an index of 0.5. The other areas such Insana Tengah and Insana Fafinesu also show a high level of vulnerability index compared to the other areas in TTU. Related to the index increase of climate change impact, a significant increase of disaster events such as drought will also occur in some areas in TTU.

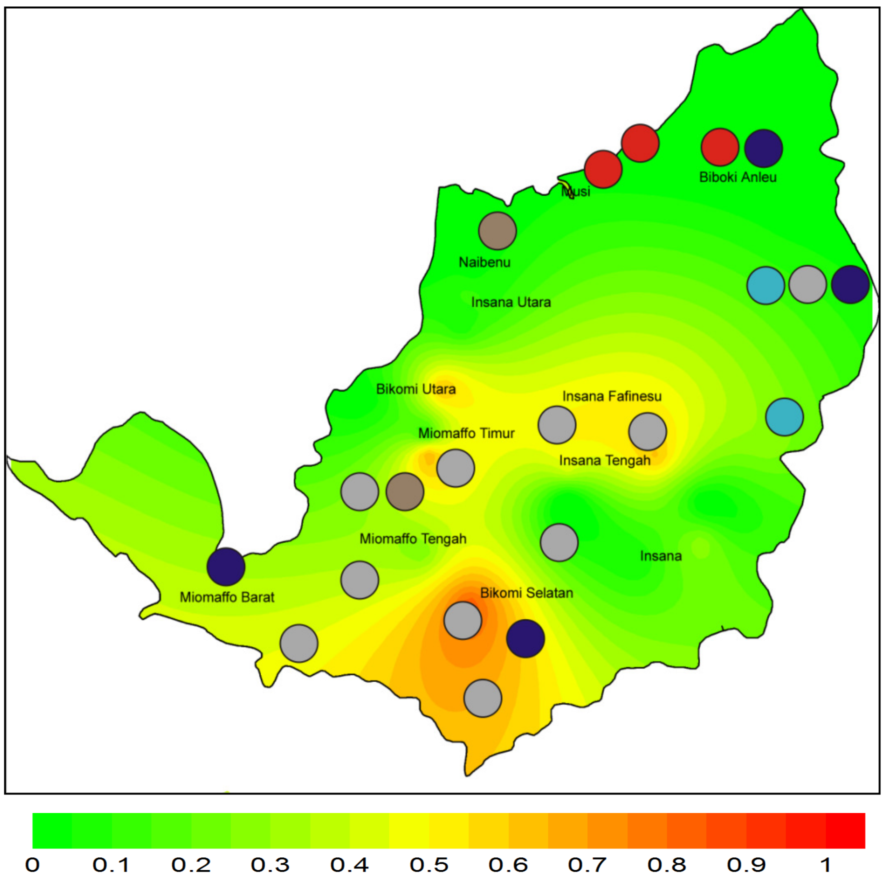


Figure 63. Potential of Disaster Events & Climate Vunerability of TTU in 2030

Overall, the options that can be done to anticipate for the level of vulnerability to climate change in TTU in the year of 2030 are shown in Figure 64. The construction of a mega-structure of sea wall is still considered the best option to anticipate for potential abrasion in TTU. Whereas the irrigation network development, 'bronjong' construction, and implementation of evacuation system are still the right choice to tackle the increasing trend of vulnerability related to drought, flood, and landslide in the study areas.

Moreover, there are several government programs that have been able to integrate the adaptation efforts to climate change in TTU, such as ‘embung’ routine maintenance, provision of barns for the purpose of marketing and food reserves, and implementation of the ‘Desa Sari Tani’ program by the Agriculture Agency. In addition, coordination and guidance for cultivating several types of fishes such as the ‘bandeng’ fish and ‘mas’ fish (‘karper’ fish) had been done by the Marine and Fisheries Agency. Furthermore, some local-based programs had been implemented, such as ‘Desa Siaga’ by the Health Agency as well as ‘Desa Tangguh’ by the BPBD (Local Disaster Adaptation Agency).

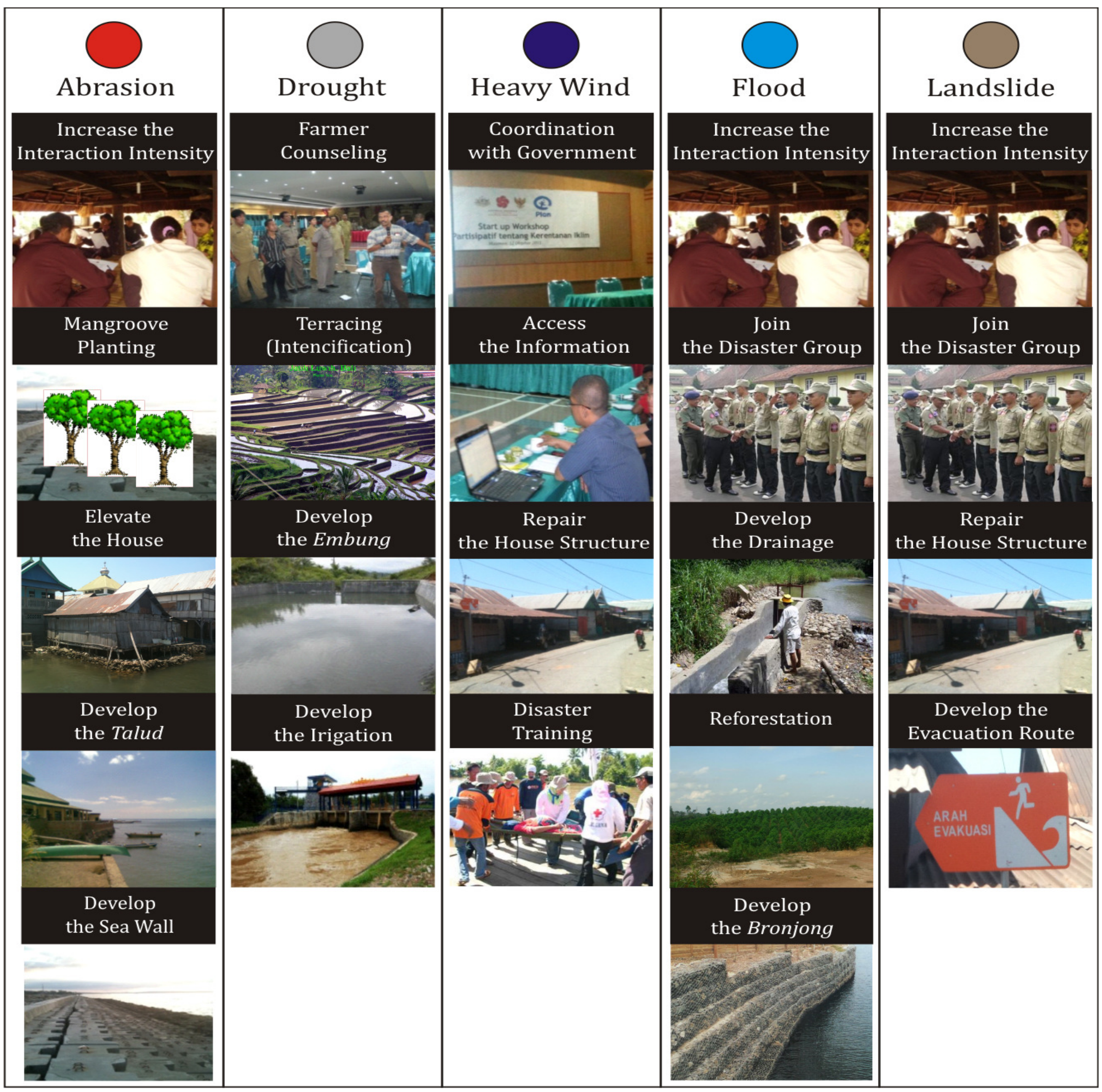


Figure 64. Adaptation Option of TTU in 2030

VIII RECOMMENDATION

Overall, based on the analyses carried out in this research and inputs during the socialization, this study recommends further actions that need to be done, which areas follows:

- **More detailed unit of analysis (scale)**. Conceptually, this research has a unit of analysis scale at the district level (Sikka, Lembata, and TTU District). In the implementation, the research team have tried to increase the detail of the research to the sub district level, though sometimes it finds difficulties in terms of gathering information resources because the initial framework detail remained for long periods at the district level. More detailed information will bring more accuracy and help with designing better suggestions for the affected communities and local governments. The team writer realized that there were 2 main goals in having the research scale to be more detailed. First, essentially the research with participatory method needs to be at a more detailed level than the others. Moreover this research implementation was done at workshop activities in the district level as hopefully the information cycle was better when conducted 1 level below in the sub district level. The first process involved processing resources availability, differentwith the second one which has more to do with sustainable implementation reasoning. Therefore, hopefully the implementations of the following participatory researches will be more detailed in the future.
- **Further focus of research aspects**. This research basically focuses to review the climate change disasters in general (participatory model developing), not in certain sectors impacted by the disasters, such as health sectors, agriculture, the economy, etc. This research implementation involves all of the relevant stakeholders, local people with different jobs and also the government from various agency backgrounds. Workshop activity becomes a direct event of exchanges between information and ideas conducted by various stakeholders. This diversity itself will

ultimately bring stakeholders to the pragmatic mindset in order to maximize the research results.

- **Go beyond administrative boundary limits**. Several types of climate change impacts such as extreme rainfall, might occur and affect other districts. This includes the examples in TTU District (as one of the study case area), which oddly, was impacted less than the Belu District (a non studied case area). To avoid the lack of information or even limitation, in the future the administrative boundaries must not always be used as a rigid guidance. This suggestion is certainly in line with the disaster management field, which conceptually, must have all of its implantation phases in acomprehensive / holistic manner.