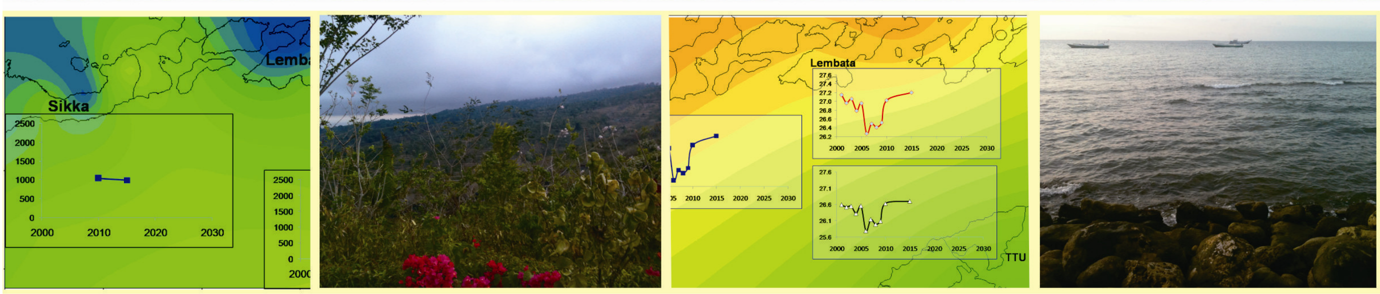
BOOK 1

CLIMATE CHANGE IMPACT IN SIKKA, LEMBATA, AND TIMOR TENGAH UTARA



Participatory Research on Climate Vulnerability

Australian AID
BNPB
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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 until now, the study that incorporated the integration between climate models and scenarios with adaptive capacity scenario as well as climate vulnerability isstill rare. This has caused a lot of uncertainties in developing adaptations that are suitable in particular regions. Hence, a study that integrated both the climate model and the adaptive capacity scenario needs 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 relied on agriculture 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 one of three books that present the reports from the study of "Participatory Research on Climate Vulnerability in NTT". The first book (this book) covers the current issue of climate model (the mean rainfall, mean temperature, and sea level rise) and its projection. The second book presents the current issues of socio-economic condition and adaptive capacities as well as its projections. The third book integrates the issues of climate models, adaptive capacities and recommendation of adaptation options in dealing with the climate vulnerability.

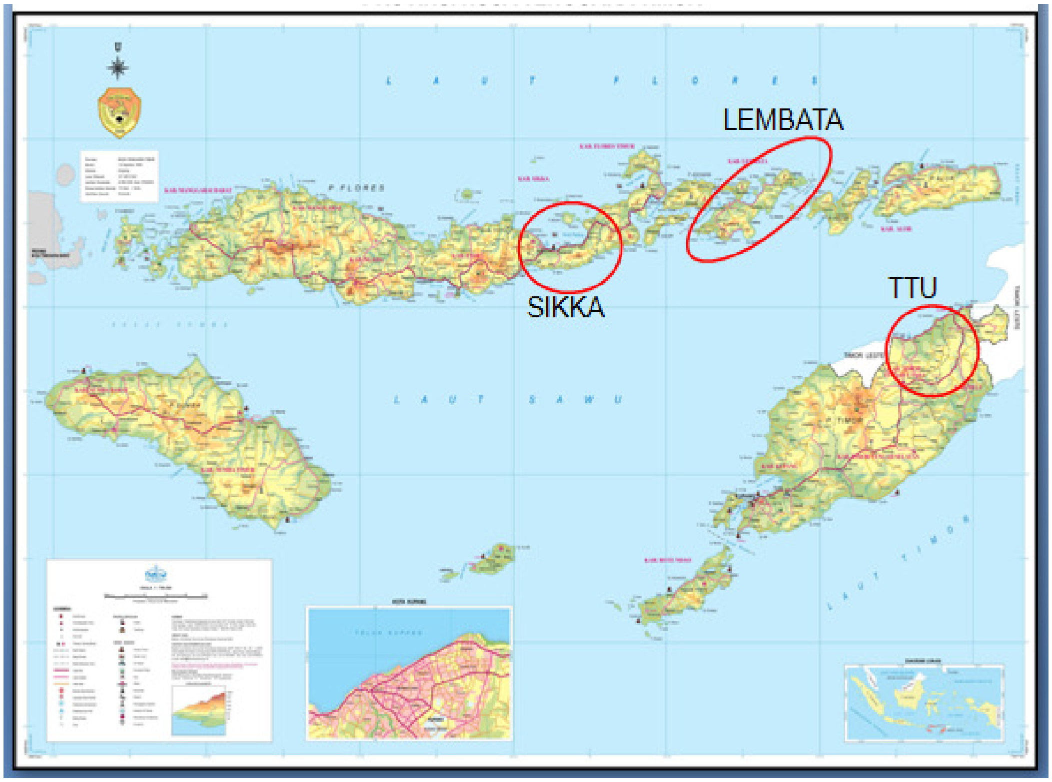

Figure 1. The NTT Province and location of case study areas

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 also the effectiveness rate of the adaptation options. The research used the Climate Smart Disaster Risk Management approach that Plan was currently implementing across a number of countries, which is funded by the 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, the local Government, and members of the community that would be affected, including women and children.

The objective of this book is to provide the results from analysis of the climate model. This book will discuss research results on projection of climate, projection of sea level rises, climate hazards in Sikka, Lembata, and Timor Tengah Utara (TTU). This book will also show the types of climate hazard that have the potential to occur in the 3 district areas.

1.3 Analytical Framework

In the analytical process, the general research framework was presented as follows (See Figure 2). First, the climate model was analyzed (this book) in detail using the consideration of mean rainfall, mean temperature and sea level rise. The adaptive capacity was 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. 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.

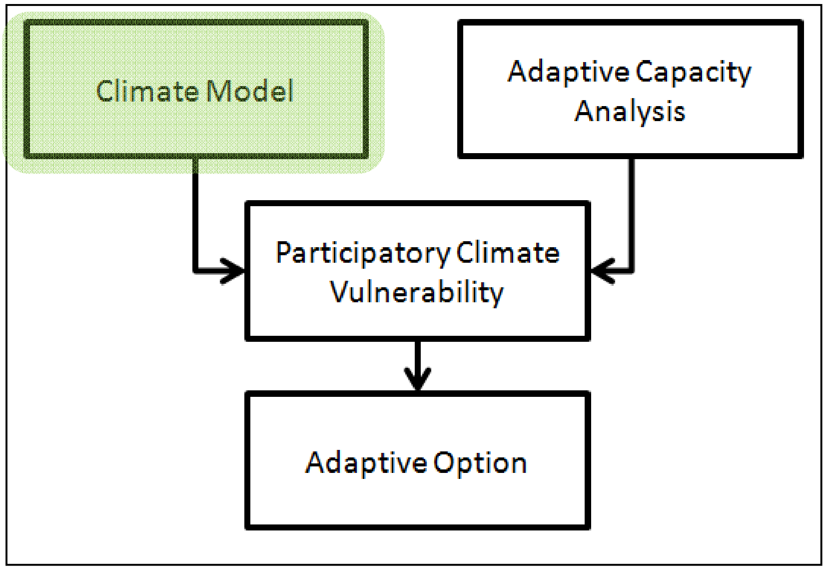

Figure 2. General Research Framework

To build projection maps, both primary and secondary data will be classified based on their variability in size and time-frame. The variable data includerainfall data, temperatures, sea level rise data, hydrological data, prosperity level data, and population data.

All data are parameters to be projected in the future using a climate model: projections made for the year 2010, 2015, 2020, 2025, and 2030. It is the same approach with the one adopted in the past by ITB while assessing climate change vulnerability in Jakarta will also be adopted, with few improvements this time in terms of its methodology. The previous vulnerability assessments done by ITB used the framework of the United Nations' Inter-governmental Panel on Climate Change (IPCC) to make climate projections: as a result, climate projections for the future had a low resolution and were not accurate enough to describe climate conditions at the local level. To make projections, the proposed research in NTT would use the new climate model combining two methods, i.e. Fast Fourier Transform and Least Square non-Linear to assess future climate conditions which are not linear, such as rainfalls and temperatures. The new method would enable more accurate projections at the local level. The results of the projections would be converted into spatial maps on a temporal scale.

To meet the needs of the climate and other projections, the research had built the Fast Fourier Transform and Least Square non Linear model for seasonal and climate changes. This method was used to divide time series data into several sub-data based on characteristic of its periodicity. This sub-data was modeled using Least Square non Linear to find the accurate curve to figure data spreading in periodic time. Both methods were the most accurate methods to model climate data due to most of it being long time series and never linear. The output of this climate projection was processed to become spatial maps, namely season and climate with high resolutions.

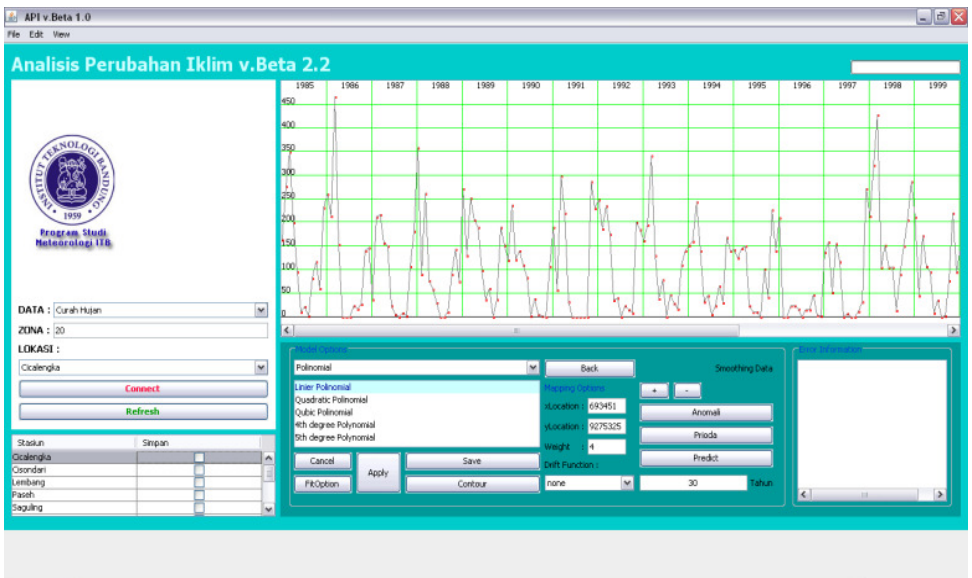

Figure 3. Software of climate model using *Fast Fourier Transform* and *Least Square Non-Linear* Methods developed by ITB (Susandi et al., 2008)

Figure 3 shows the interface of climate model developed by ITB used to build projection of climate parameters and, if possible, used to build projection of social parameters needed to analyze adaptive capacity in the 3 studied subdistricts.

The modeling process was conducted through a climatology analysis as a means to determine the characteristics of the weather and climate in a specific location. From this characteristic, the weather in the future can be predicted. To obtain the desired model and prediction, there are 4 steps that will be processed, which are Initial Model Analysis, Periodic Anomaly Analysis Behavior, Analysis Model Anomaly, and Build Data Contour. The four are conducted sequentially, because the output result from one phase acts as input for the next step.

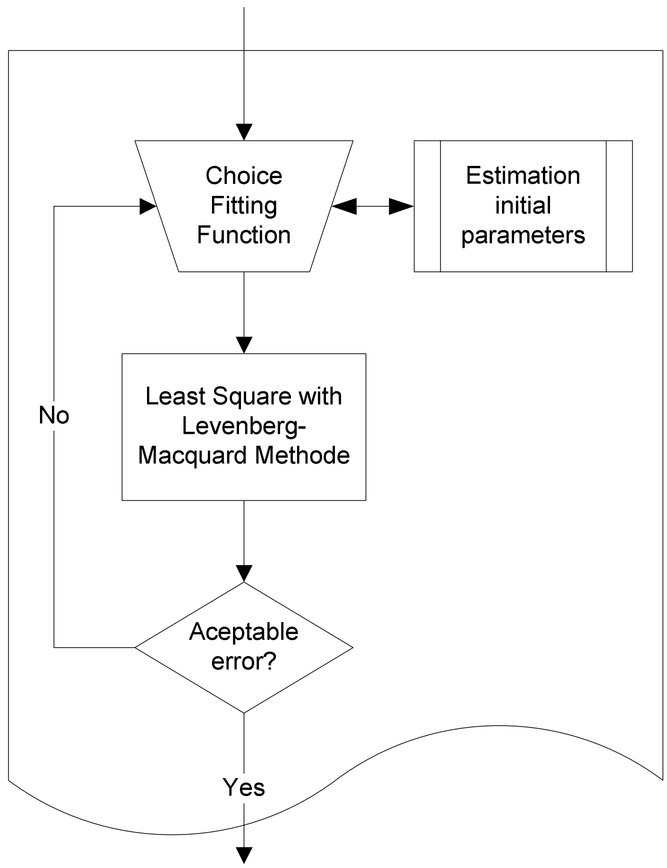

Figure 4. Work flow in climate model analysis

The first step was direct model analysis. Its target was model searching for early stable and stationary where this model expressed a pure pattern of weather data without trouble and noise in the data. Precipitation Data for one location was analyzed with Least Square to produce a curve corresponding fitting. Function that was used by the curve fitting was taken away from the inveterate equation used in modeling. Algorithm that was used in the Least Square method was the Levenberg-Maquardt algorithm, which is an algorithm standard for the Least Square non-linear solution. Figure 4 shows the work flow for this step.

The Second Step was a periodic characteristic analysis data of climate anomaly and weather. Its target was to obtain repetitive time information representing its pattern of weather anomaly. This Step was conducted under theassumption that the pattern of weather anomaly had character that changed periodically. Anomaly Data was the deviation of weather data to a weather model that was considered as pure pattern for the area being evaluated. The initial weather model intended was the early model that was produced in the initial step. The Anomaly Data expressed noise weather data that happened under local geographical factor consequences, or external factors like the El-Niño and La-Niña storms, and other factors. To obtain the value of anomaly data frequency, the method used was the discrete Fast Fourier Transform method. This Method altered data of time domain precipitation (time series) to become frequency data or precipitation period. The output at phase was the dominant frequency precipitation data that identified whether a pattern of weather anomaly would return repetitive.

The third step was analysis of anomaly model. This step targeted to refine the model that was produced in the first step. The procedures were similar to the first step, except if the early parameters that was used is taken away from dominant frequencies from the second step result. With this correction, the expected model could already reflect changes in weather patterns that were non-stationary.

The Fourth step was mapping of precipitation distribution contour for a region with the Universal Kriging method. The Universal Method was used because it gave flexibility in determining function drift in form of order n polynomial. This drift functioned to handle distribution of precipitation data that were non-stationary.

All steps above are shown in the Figure 5 below.

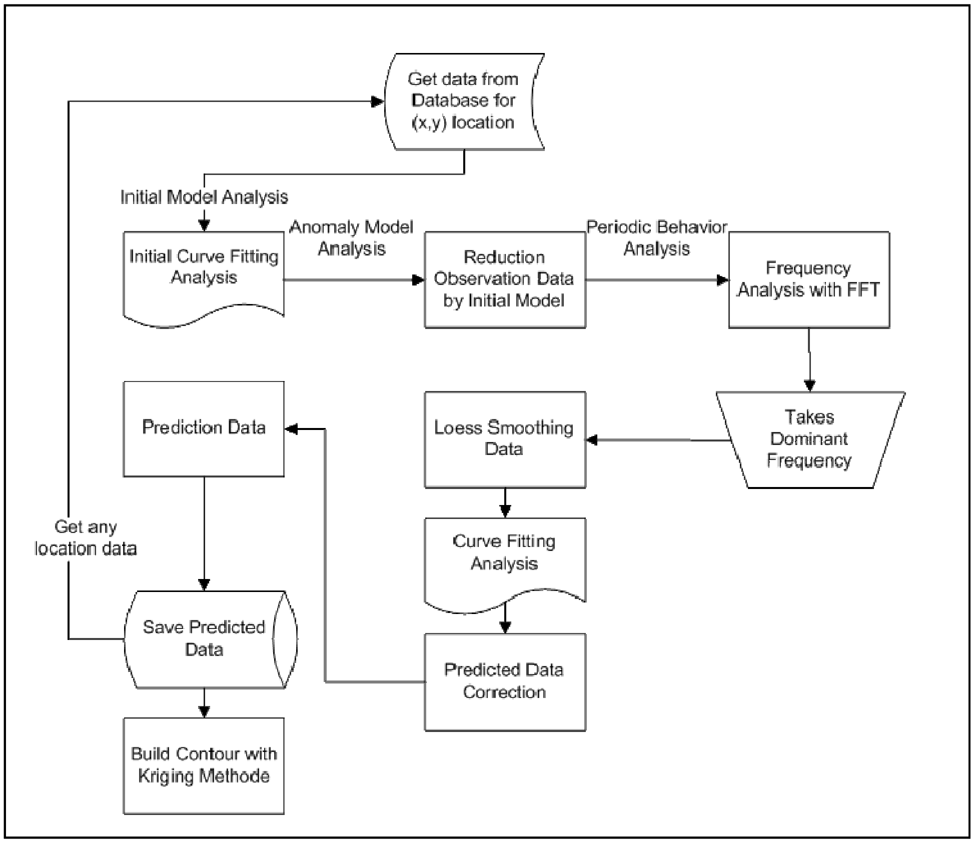

Figure 5. Plan of research work flow

II Mean Rainfall in Lembata, Sikka, and Timor Tengah Utara (TTU)

The Nusa Tenggara Timur Province, which has a tropical climate, possesses two seasons, the dry season, and the rainy season, generally changing every six months. Its geographical location is closer to Australia than the Asian continent, resulting in the territory of Nusa Tenggara Timur having low rainfall. This is due to the global circulation being very influential in this region. At the time, the sun's position was in the Southern Hemisphere, and a cloud of water vapor had been falling in the Western Indonesian region, so there wasn't much water vapor to get to the South-Eastern region of Indonesia. On the contrary, if the position of the sun is in the Northern hemisphere, there would be no cloud of water vapor, because the cloud would come from the air mass formed in the mainland continent of Australia.

In the Province of East Nusa Tenggara, there are two seasons, the dry and rainy season. During the month of December to March (a 4 month period), rainfall is usually high, whereas in April-November rainfall is very rare. During the past 10 years, it was noted that the Lembata District had the lowest rainfall compared to the other two study areas in East Nusa Tenggara. During the wet months, the Lembata District had a highest rainfall of 192 mm / month. The Lembata District had only four wet months during the year 2001-2010. While the dry season generally occurs annually for 6 months of the year.

In contrast to Lembata, the TTU District is a region that has a rainfall intensity that is quite high with the number of wet months as much as 6 months in a year. December is the peak month of rainfall occurring in the TTU with a high intensity of up to 400 mm / month. While August had been the peak month of drought in the TTU region, with a rainfall intensity of only 3 mm / month. In each month of August for the last 10 years, the TTU district had no rain at all, leading to dryness of the soil and cracks in the land. So starting in November onwards, the potential dangers of landslides and floods increased annually in TTU. This is a bad risk, especially in the agricultural sector in the region.

Table 1. Mean rainfall (mm/month) during the years 2001-2010 in the three study areas (Lembata, Sikka, and TTU) at NTT

District	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
LEMBATA	178	192	167	56	8	6	3	1	0	14	86	153
SIKKA	216	245	198	108	46	14	13	9	18	52	118	237
TTU	293	375	308	177	68	40	8	3	11	64	184	400

For the Sikka District, rainfall is likely to be similar with the rainfall conditions of Lembata. There, it is mostly dry, where no or very little rain occur during these months. Peak occurrence of drought for the last 10 years in Sikka had occurred in the month of August. As for the other months of drought which generally started in the month of May to October. After that, rain would occur in Sikka with a moderate intensity. The Sikka District is classified as mostly a dry area, so it is very difficult to adjust to, and develop the agricultural sector. Unless there are variations in the development of crops that are suitable to the area of Sikka.

Figure 6 below is a graph showing the difference in intensity of the mean rainfall that occurred during the last 10 years in the three areas into the study area in Nusa Tenggara Timur Province, namely the Lembata, Sikka, and Timor Tengah Utara (TTU). From the third graph, it showed that the three regions generally only had 4-5 wet months of rain. From the intensity of rainfall that occurred, it was seen that Lembata had the least rainfall compared to other regions. While TTU area was an area that had the highest rainfall intensity, reaching 400 mm / month generally occuring in December.

If the mean for the three districts in Nusa Tenggara Timur was calculated and rounded up for the last 10 years, the third area would have the driest climate. Except for the Timor Tengah Utara region that has a high rainfall intensity even in the dry season, the intensity of rain is also very low in general.

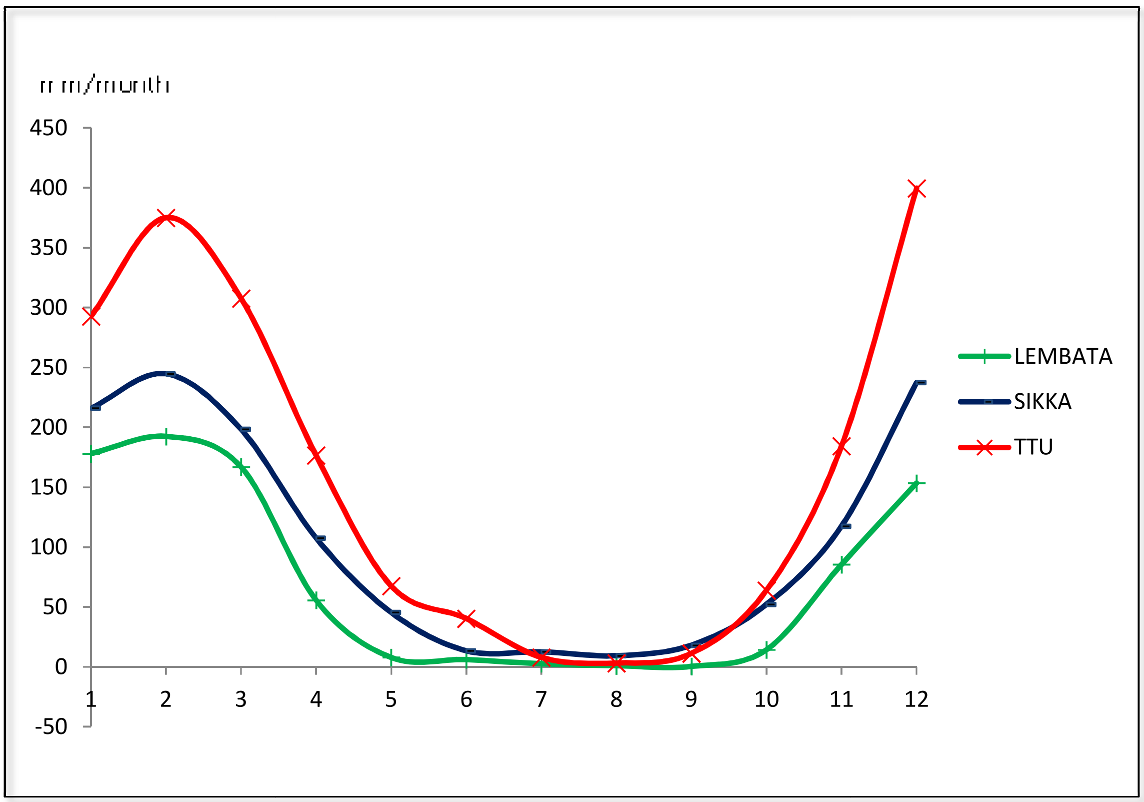

Figure 6. Comparison of the mean rainfall during the last 10 years for three district areas in Nusa Tenggara Timur

These three areas tend to have more dry months than wet months. A record of mean of a combined 5-6 months concluded that it did not, or had very little rain. But at the start of the rainy season, the TTU had a very high rainfall up to 1400 mm / month in several of the months. Rainfall conditions that occurred in the TTU was quite scarce because of the dry season, very little rain happened, but during the rainy season, the high rate of rainfall led to potential for flooding or mudslides in areas prone to them.

From the graph shown in Figure 6 above indicated that the third region experienced a peak in rainfall during December. While the next two months, ie January and February, rainfall still occurred, but the intensity of rain was not as high as it was in December. Therefore, the need to watch out for rain that occurred in December, especially in the Timor Tengah Utara District, had a higher fluctuation than the two other districts.

III Spatial Maps of Mean Rainfall in Nusa Tenggara Timur Province

In this section the condition of rainfall seen visually by using a spatial map of the mean rainfall during the last 10 years (2001 to 2010) in the territory of East Nusa Tenggara will be discussed upon. The Spatial map was constructed using kriging interpolation method with the input rainfall from 20 stations distributed in the three study areas (Sikka, Lembata, and TTU), with specifications as much as 5 station observations of rainfall in the region Lembata, 8 station observations of rainfall in the region Sikka, and 9 rainfall observation stations in the Timor Tengah Utara District.

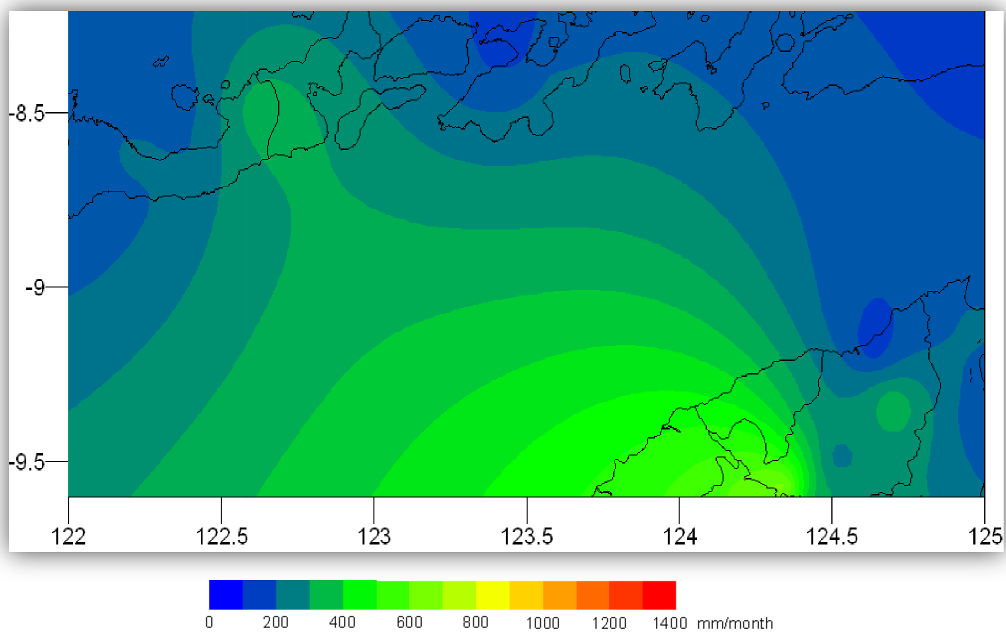

Figure 7. Mean rainfall in Januari for NTT Province during 2001-2010

In January, mean rainfall was highest in Nusa Tenggara Timur Province in the Southeast, especially in Timor Tengah Utara. While the region is part of Lembata, rainfall during this month had a lower intensity than most other regions in East Nusa Tenggara. Figure 7 above shows the distribution of the mean rainfall in January in the past 10 years in the territory of East Nusa Tenggara. It can be seen that the Southeastern part of Nusa Tenggara Timur had a high rainfall intensity, which reached 450 mm / month.

Figure 8 below shows the intensity of rainfall on mean in February during 2001 to 2010 in the territory of East Nusa Tenggara. On this period, NTT-East section retained the intensity of rainfall that was higher than most other regions. In TTU's own territory, the intensity of rainfall reached 800 mm / month. In the same month, the rainfall in Lembata had a fairly low intensity, reaching only 200 mm / month.

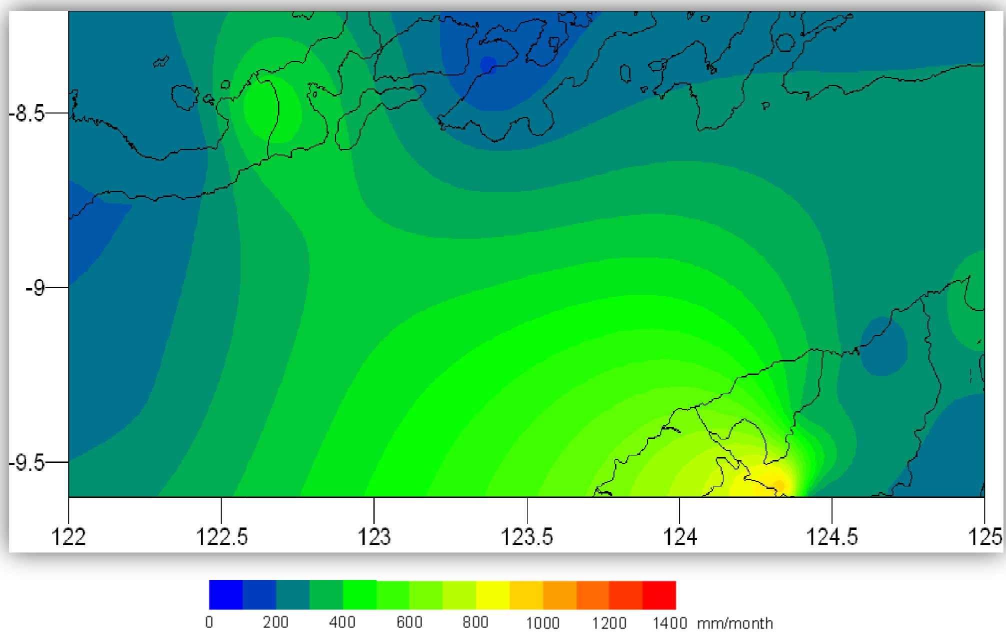

Figure 8. Mean rainfall in Februari for NTT Province during 2001-2010

Condition of the mean rainfall in March in West Timor is shown in Figure 9 below, where the TTU is a region with the highest rainfall intensity, which reached 700 mm / month. Sikka District also had a rate of rainfall that had a high enough intensity to reach 400 mm / month. While the Lembata District rate of rainfall had a low intensity, only reaching 150 mm / month.

In March, mean rainfall in the Lembata District reached 167 mm / month. With a rainfall intensity of this magnitude, then this month is the month for theLembata District to be at their most wet. However, if all the water is used for agriculture, there would still not be enough water to plant the crops, especially rice. But there are some other plants that could still survive in deep water that can be pursued with rainfall intensity of this magnitude.

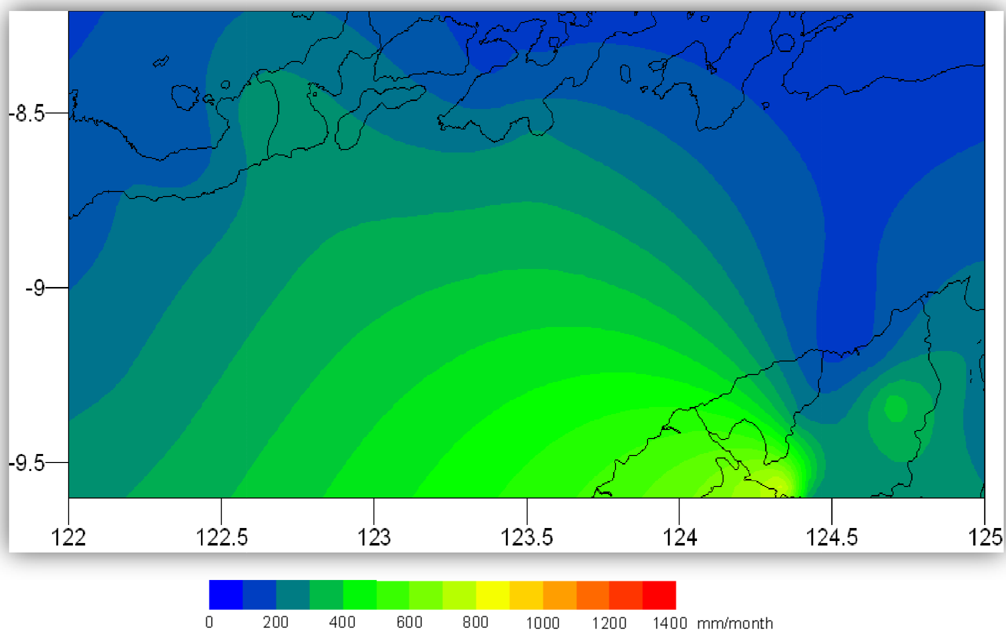

Figure 9. Mean rainfall in March for NTT Province during 2001-2010

Figure 10 below shows the distribution of the mean rainfall in April during the years 2001 through 2010. In this month, Lembata District had an intensity of 56 mm rainfall / month. The intensity of this magnitude is low, which means the month of April is part of dry season in the Lembata District. In Sikka District, the intensity of rainfall reached 108 mm / month, including the dry months. While in the TTU District, rainfall conditions are still quite large to be used for plant utilization.

Of the three areas, the rainfall rate for this month is low, especially in the north of Nusa Tenggara Timur Province. Rainfall in southeastern NTT was still quite large because of the influence of global circulation long ago, where a cloud of water vapored from the ocean and drove the islands that is now Indonesia south, and created islands that now form the islands of Java, Bali, Lombok, and southeast part of Nusa Tenggara Timur.

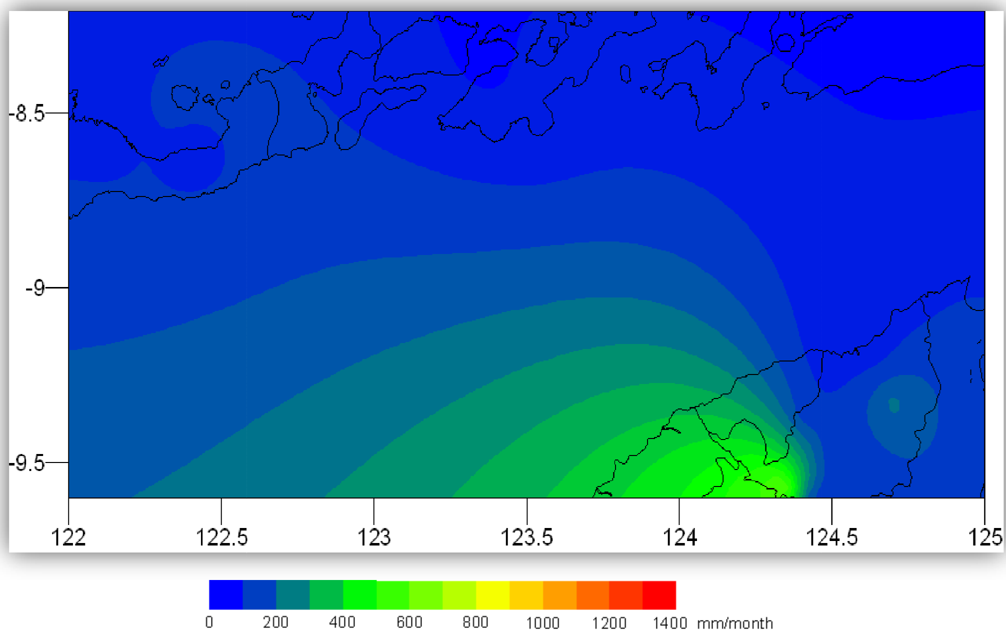

Figure 10. Mean rainfall in April for NTT Province during 2001-2010

Distribution of rainfall in the month of May in Nusa Tenggara Timur Province is shown in Figure 11 below. It is seen in the figure that the rainfall in NTT had begun to decline, especially in the northern region. Lembata District remained an area of NTT, which had the lowest rainfall. In this month, the Lembata District reached 8 mm of rainfall / month. This marked that the area had very little, or no rain at all during the period. Drought occurred in this month in nearly all of Lembata District.

Next to Sikka and TTU, rain conditions were also quite low, reaching only 46 to 68 mm / month. If the mean was calculated, daily rainfall would only reach 2 mm / day. That translated to almost no rain on this month in both Sikka and TTU. By looking at the condition of this month compared with the previous month, then it was concluded that this month was considered part of the dry season in all regions of East Nusa Tenggara, including Lembata, Sikka, and Timor Tengah Utara.

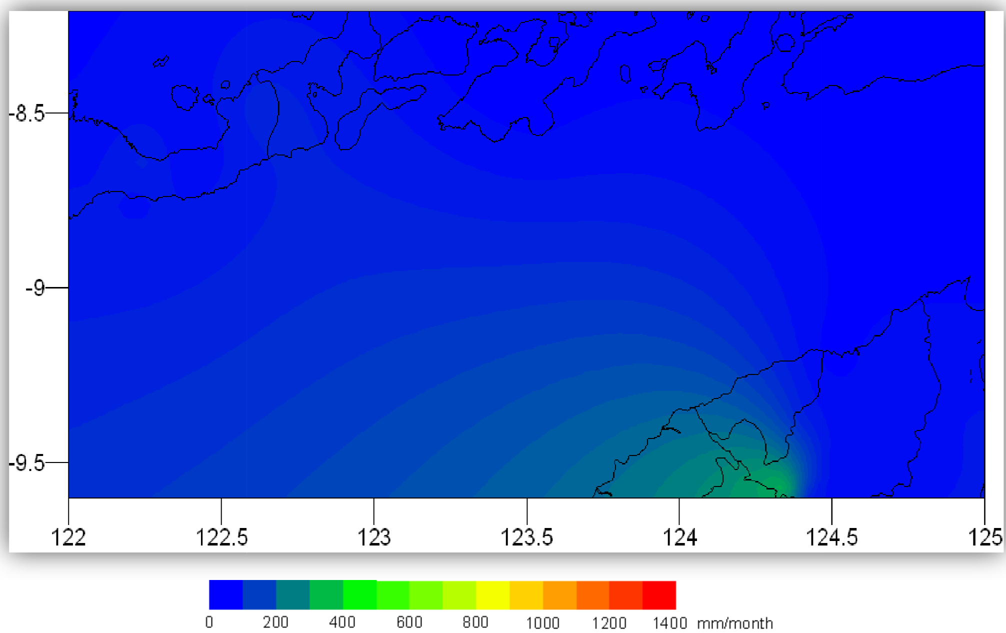

Figure 11. Mean rainfall in May for NTT Province during 2001-2010

Figure 12 below shows the distribution of rainfall in the Nusa Tenggara Timur Province in June during 2001 through 2010. It can be seen that the whole territory of NTT was dry, and had almost no rain. The TTU District usually had a high rate of rain, except for this month. The rain that occurred was only 40 mm / month. If the mean was calculated daily, then this month would only reach 1 mm / day. Therefore, the intensity value of this magnitude concluded that it barely rained in TTU.

Distribution of rainfall in Nusa Tenggara Timur Province in July is shown in Figure 8. In that month, the entire NTT Province did not rain. Therefore, July is deemed as part of the dry season, which included the peak month of August. During the past 10 years, drought in West Timor had always occured every July and August. Therefore, a strategy needs to be implemented in anticipation in the prior months to cope with the drought problems. All in all, drought generally occured in July, August and September, as shown in Figure 13, 14, and 15.

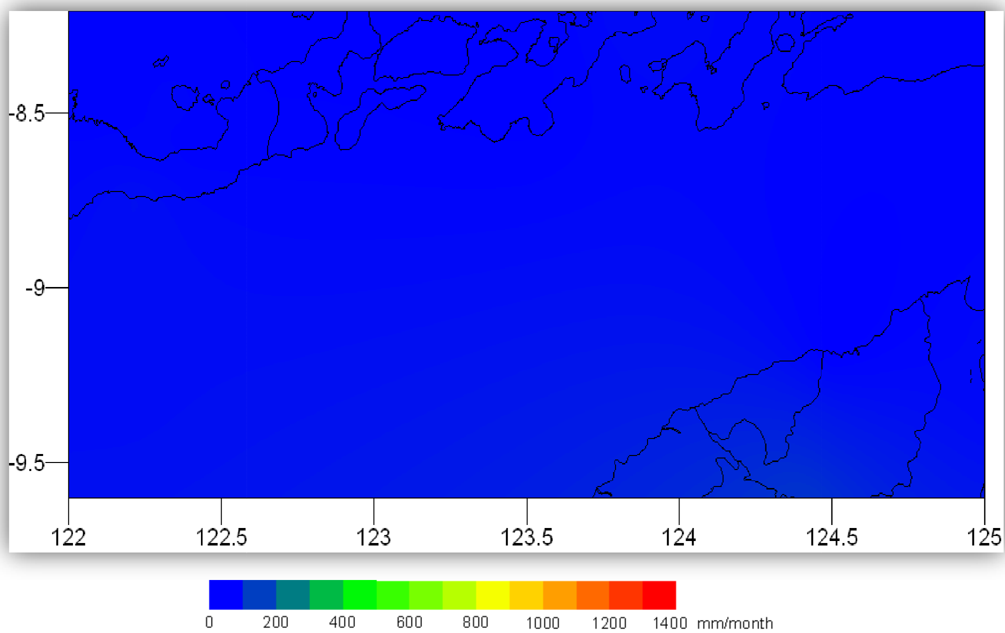

Figure 12. Mean rainfall in June for NTT Province during 2001-2010

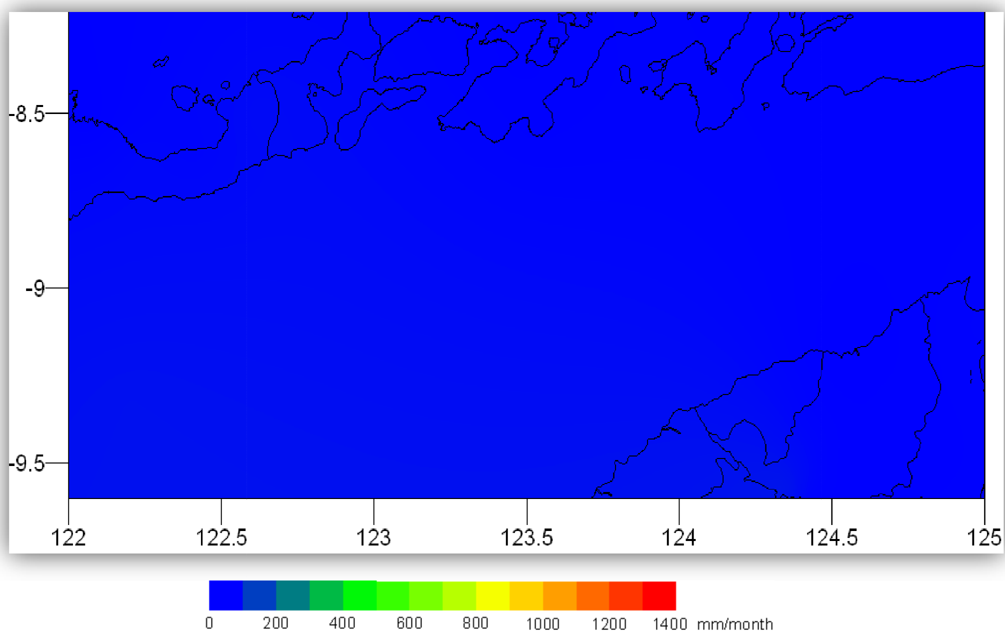

Figure 13. Mean rainfall in July for NTT Province during 2001-2010

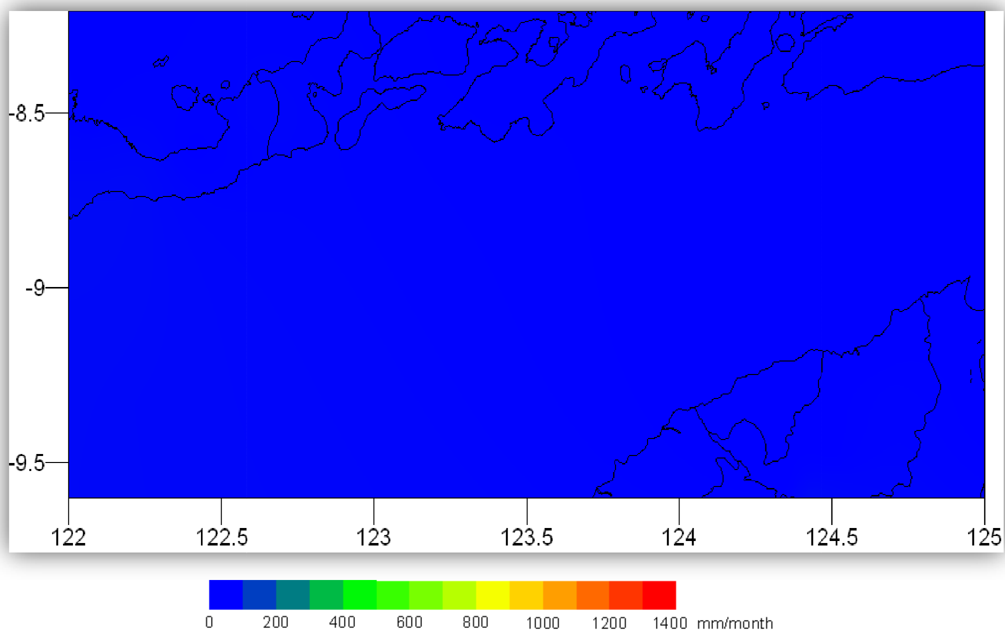

Figure 14. Mean rainfall in August for NTT Province during 2001-2010

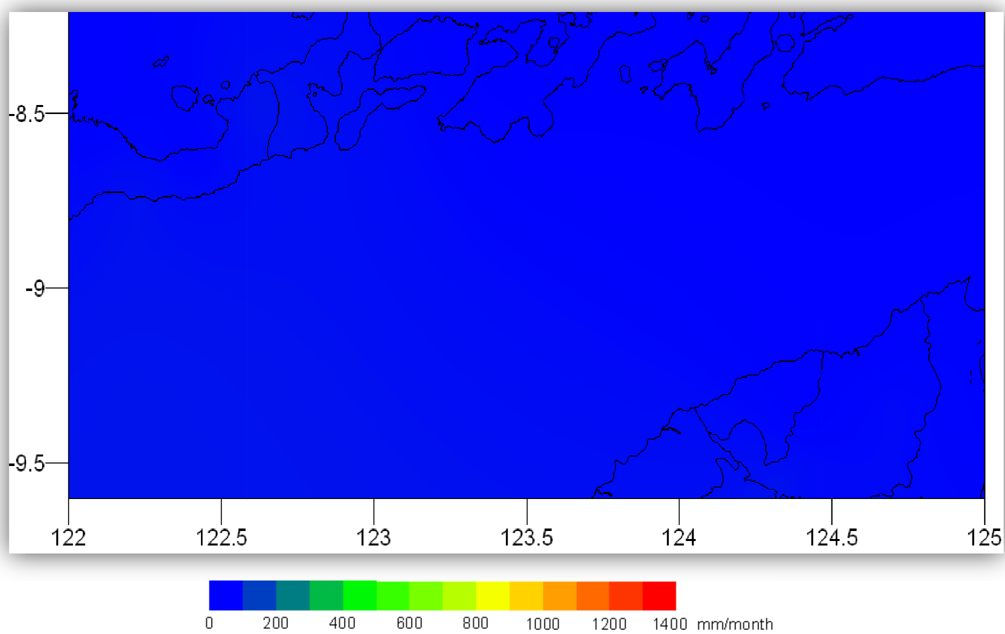

Figure 15. Mean rainfall in September for NTT Province during 2001-2010

Figure 16 shows the distribution of the mean rainfall in West Timor in October during the years 2001 to 2010. The rainy season starts again this month, beginning with the rain that occured in Timor Tengah Utara (TTU). In this month, TTU experienced rain with a rainfall intensity of 64 mm / month. Despite this month still being part of the dry season, just a few moments pior to the upcoming rainy season.

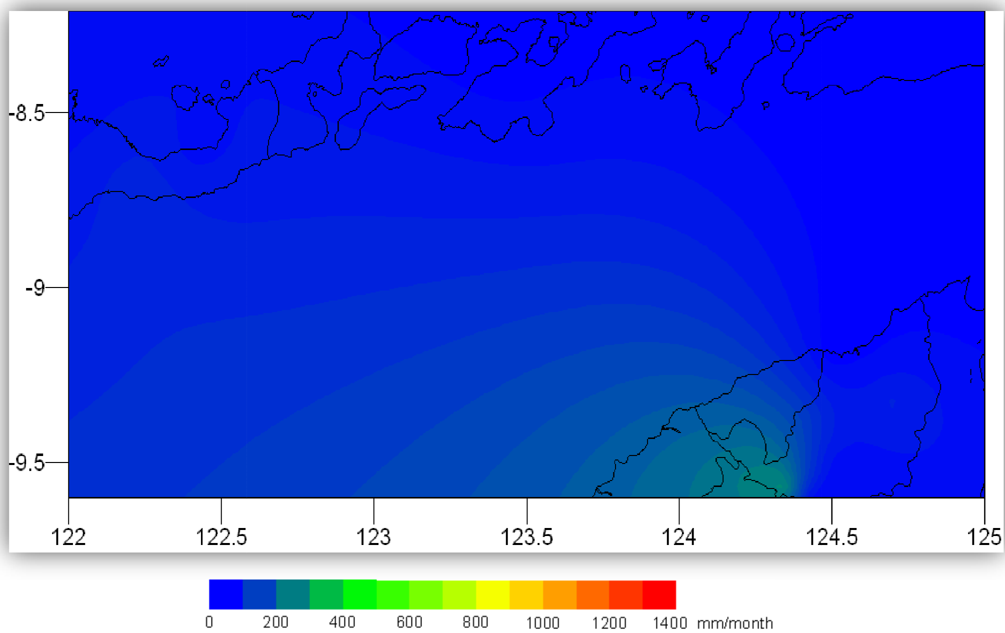

Figure 16. Mean rainfall in October for NTT Province during 2001-2010

The rainy season that had a high enough intensity actually started in November, as shown in Figure 17. In this month, the TTU area had started to rain with the intensity of rainfall mean reaching 184 mm / month. Lembata District had also begun to rain but with a low rate of rainfall intensity. The intensity of rainfall in the region of Lembata only reached 86 mm / month. This condition is shown in Figure 17 below. For the Sikka District, the intensity of rainfall reached 118 mm / month. With this intensity, it was possible for farmers to begin planting.

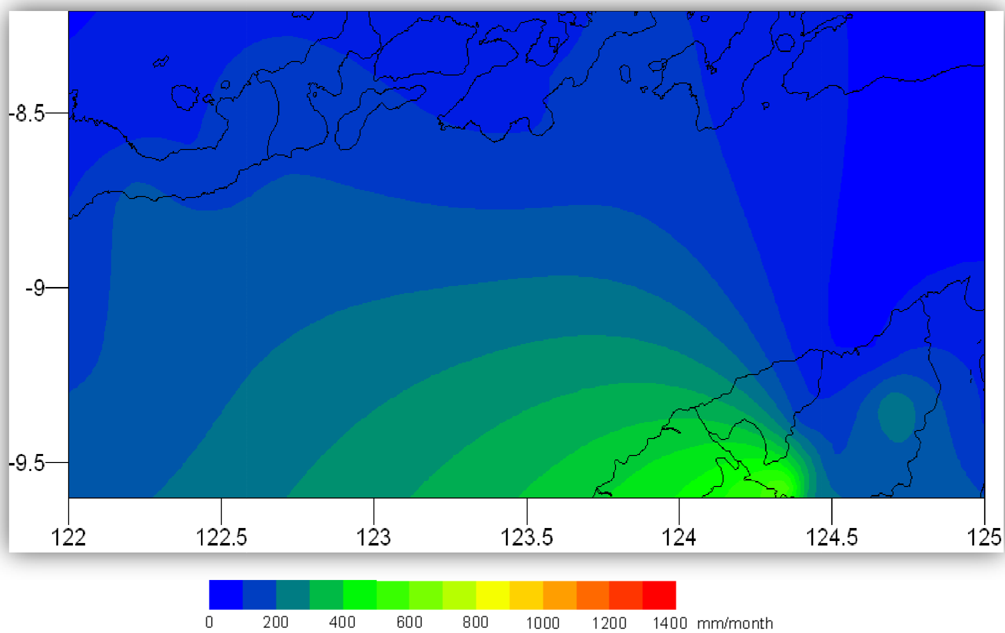

Figure 17. Mean rainfall in November for NTT Province during 2001-2010

Likewise, the condition of rainfall in December, led to NTT and TTU experiencing the rainy season with high intensity of rain. This December, including the peak wet season, the intensity of rainfall reached 400 mm / month. The recorded rainfall from the observation data, informed that in TTU, the intensity of rainfall amounted to 1000 mm / month. Therefore, the period of December needs to be monitored, as, from time to time meteorological disasters such as floods and landslides might occur with high intensity

For the Lembata and Sikka District, the intensity of rainfall in December was also quite high. The intensity of rainfall in the Lembata region reached 153 mm / month, whereas in the Sikka District it reached 237 mm / month.

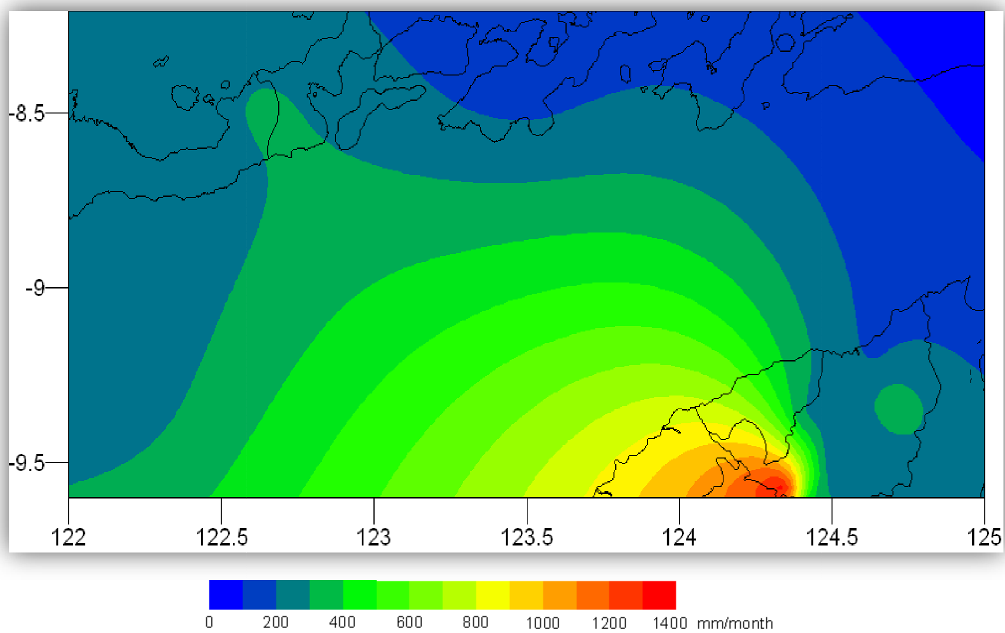

Figure 18. Mean rainfall in December for NTT Province during 2001-2010

IV Climate Change Modeling Procedure to Build Projection of Climate in Lembata, Sikka, and Timor Tengah Utara (TTU)

The modeling process is conducted with climatology analysis as a means to determine the characteristics of weather and climate in a specific location. From this characteristic then the weather in the future can be predicted. To obtain the desired model and prediction, there are 4 steps that will be processed, the Initial Model Analysis, Periodic Anomaly Analysis Behavior, Analysis Model Anomaly, and Build Data Contour. The four are conducted sequentially because output results from one phase acts as input for the next step.

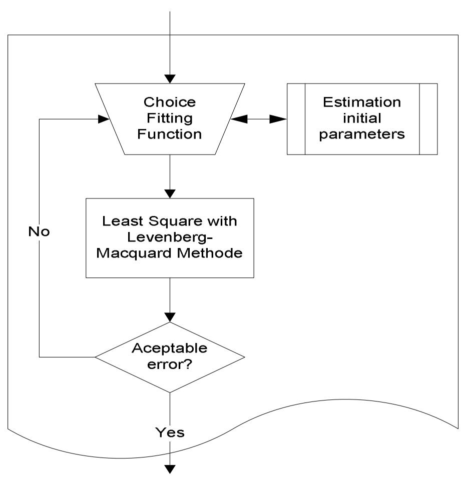

Figure 19. Work flow in model analysis, the process is conducted in a repetitive manner until an acceptable error is found, and the value of early parameter

estimation can be taken away from the dominant frequency that is produced by the second step output.

The first step is direct model analysis. Its target is model searching early stable and stationary where this model expresses a pure pattern of weather data without trouble and noise at data. Precipitation Data for one location is analyzed with Least Square to produce curve corresponding fitting. Function that's used by the curve fitting is taken away from inveterate equation used in modeling. Algorithm used in the Least Square method is the algorithm Levenberg-Maquardt, which is an algorithm standard for the Least Square non-linear solution. Figure 19 shows the work flow for this step.

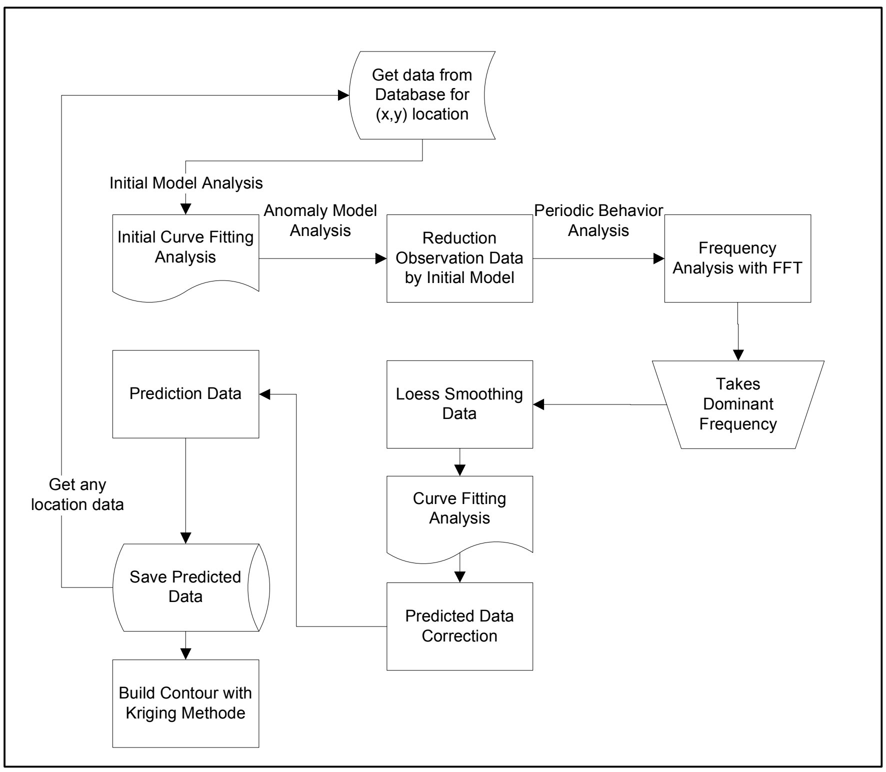

Figure 20. Plan of research work flow

Second step is periodic characteristic analysis data of climate anomaly and weather. Its target is to get repetitive time information its pattern of weather anomaly. This Step is conducted under the assumption that the pattern of weather anomaly have a periodic character. Anomaly Data is a deviation of weather data to a weather model that's considered as pure pattern for the area being evaluated. Initial weather model that's intended is an early model that was produced in the first step. Anomaly Data expresses noise weather data that happened under local geographical factor consequences, or external factors like the El-Niño, and La-Niña storms, and others. To obtain values of anomaly data frequency, the method that's used is discrete Fast Fourier Transform. This Method alters data of time domain precipitation (time series) to become frequency data or precipitation period. The output at this phase is the dominant frequency precipitation data that identifies when a pattern of weather anomaly will occur again.

Third step is the analysis of anomaly model. This targets to refine the model that was produced in the first step. The procedures are similar to the first step unless early parameters that were used are taken away from dominant frequencies from the second step result. By this correction, the expected model can already reflect changes of weather patterns that are non-stationary.

Fourth step is mapping of precipitation distribution contour for a region with the Universal Kriging method. The Universal Method is used because it gives flexibility in determining the function drift that forms theorder and polynomial. The function of this drift is for handling distribution of precipitation data that are non-stationary.

All steps above are shown in the Figure 20 above.

V Mean Temperature in Lembata, Sikka, and Timor Tengah Utara (TTU)

Temperature in the Nusa Tenggara Timur (NTT) Province is generally high in almost all locations. Included among them are the three study areas in NTT, namely Lembata, Sikka, and Timor Tengah Utara. Based on data obtained from observation stations, there are differences in temperature in the spatial scale of three districts in NTT. The figure below shows the temperature difference of 3 regions are shown in graphic form, representing the mean calculation of monthly temperature in the past 10 years, ie from 2001 until 2010.

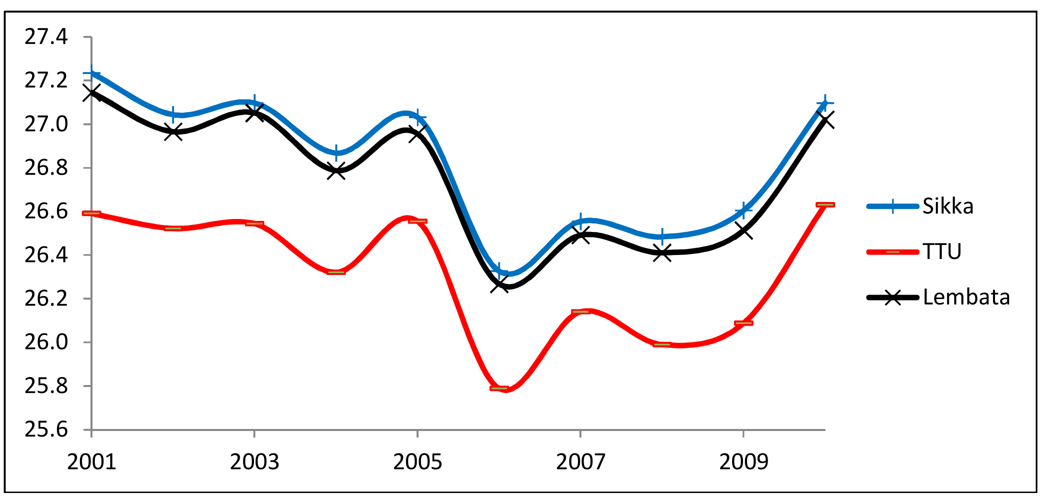

Figure 21. Mean temperatures in the three study areas in NTT during the years 2001-2010

Based on temperature data shown in Figure 21 above, the three areas in NTT experienced high temperature fluctuations in the time range of 2005 to 2007. Fluctuations that occured were a decrease in temperature that was quite significant and is equal to 0.8 °C in 2005 to the year 2006. Furthermore, an increase in temperature from 2006 to 2007 amounted to 0.6 °C.

The graph in the Figure above can also be seen in the numbers shown on the table below. It's evident that the overall temperature of the TTU District was lower than the two other districts. For 10 years, the mean temperature in TTU was 26.5 °C. There was an occurrence of relatively high temperature in this region, in 2001 and 2010 where the monthly mean temperature reached 26.6 °C.

Table 2. Data on mean monthly temperature in 3 districts of East Nusa Tenggara

Station	Lon	Lat	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Lembata	123.4	-8.4	27.5	27.3	27.4	27.1	27.3	26.6	26.8	26.8	26.9	27.3
Sikka	122.4	-8.5	27.5	27.3	27.4	27.1	27.3	26.6	26.8	26.8	26.9	27.3
TTU	124.5	-9.5	26.6	26.5	26.5	26.3	26.6	25.8	26.1	26.0	26.1	26.6

Timor Tengah Utara (TTU) is an area that had the lowest temperature compared to two other areas in the province. But this region had a higher rainfall compared to the second region. This was probably caused by the global circulation that brought more moisture to the TTU area than other areas.

Mean temperature that was highest in the region of TTU occurred in 2001 and 2010 with the temperature reaching 26.6°C. While the mean temperature was highest in the region of Lembata back in 2001. The temperature value for the year reached 27.5°C. Temperature value was 2.5°C higher than the normal air circulating in other parts of Indonesia. This condition resulted in extreme weather conditions in West Timor, where the rainfall was rare, but during the rainy season, water from the rainfall runoff led to possibility of landslides and floods.

VI Spatial Maps of Mean Temperature in Nusa Tenggara Timur Region

Here is shown the condition of the mean annual temperature ranging from 2001 to 2010. In spatial scale, the mean annual temperature in the region of NTT tend to be higher than in the northern regions. This is probably caused by the northern region being close to the equator, so it's exposed to more solar radiation than the southern region and eastern NTT. To the north, especially the Bara Sea region, the highest temperature occured in December, January, and February.

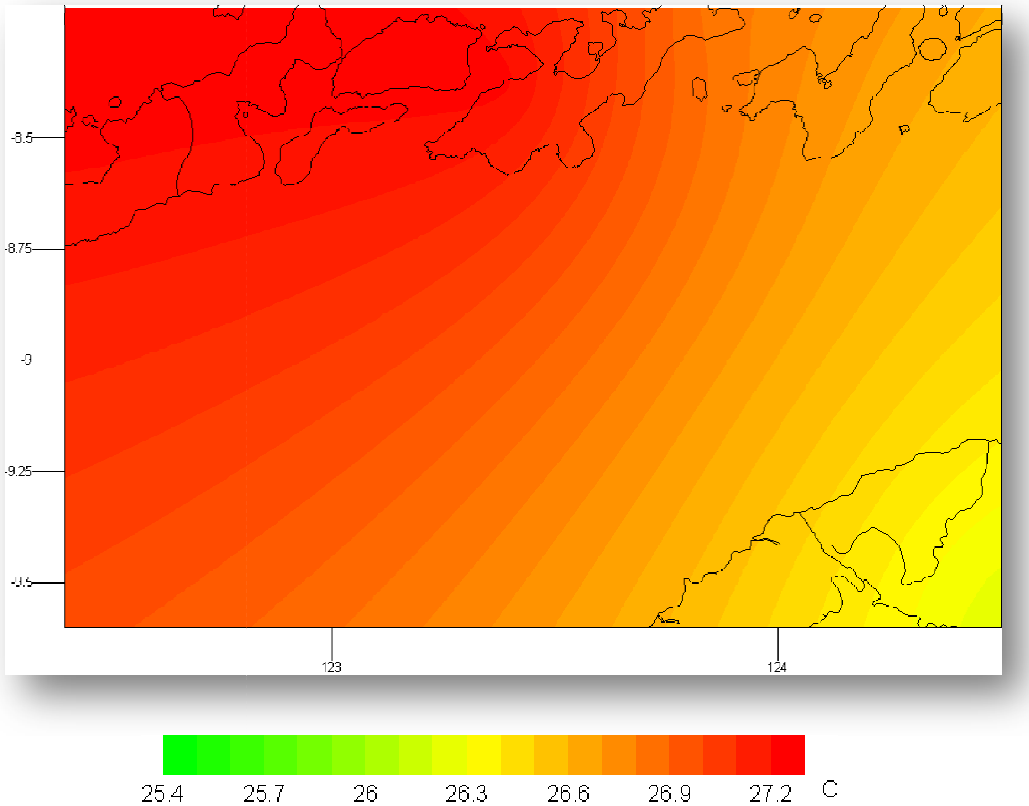

Figure 22. Mean Temperature in NTT Province during 2001

The Figure 22 above shows the spatial map of the mean annual temperature in 2001 in West Timor. It can be seen that in 2001, the highest mean temperatures occured in the northern part of NTT.

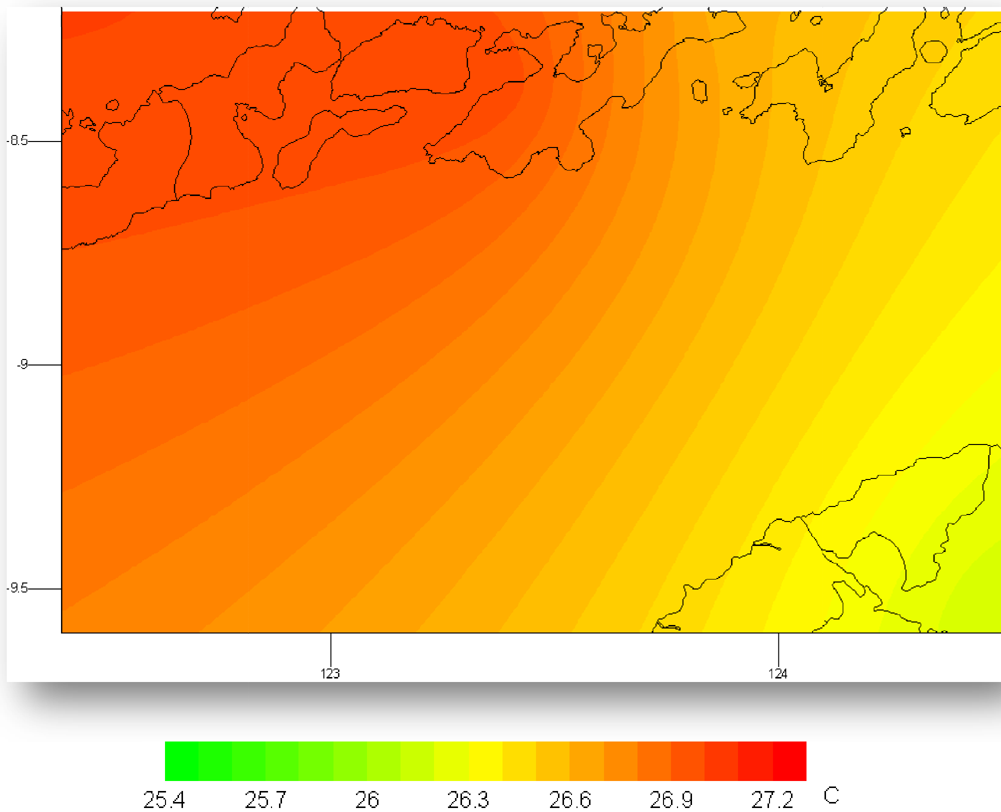

Figure 23. Mean Temperature in NTT Province during 2002

In West Timor in the south, the mean temperature of 26.5°C occurred. The NTT study area to the south of this region is TTU. The TTU District includes areas with a temperature value that is not too high when compared with the northern part of West Timor, but has a higher rainfall than other areas of NTT.

Comparison of the mean annual temperature between Sikka and Lembata District is not as drastic in margin as the comparison between Sikka and TTU. Mean temperatures in the region tend to be higher than Sikka Lembata District with a temperature difference of up to 0.6 ^{o}C.

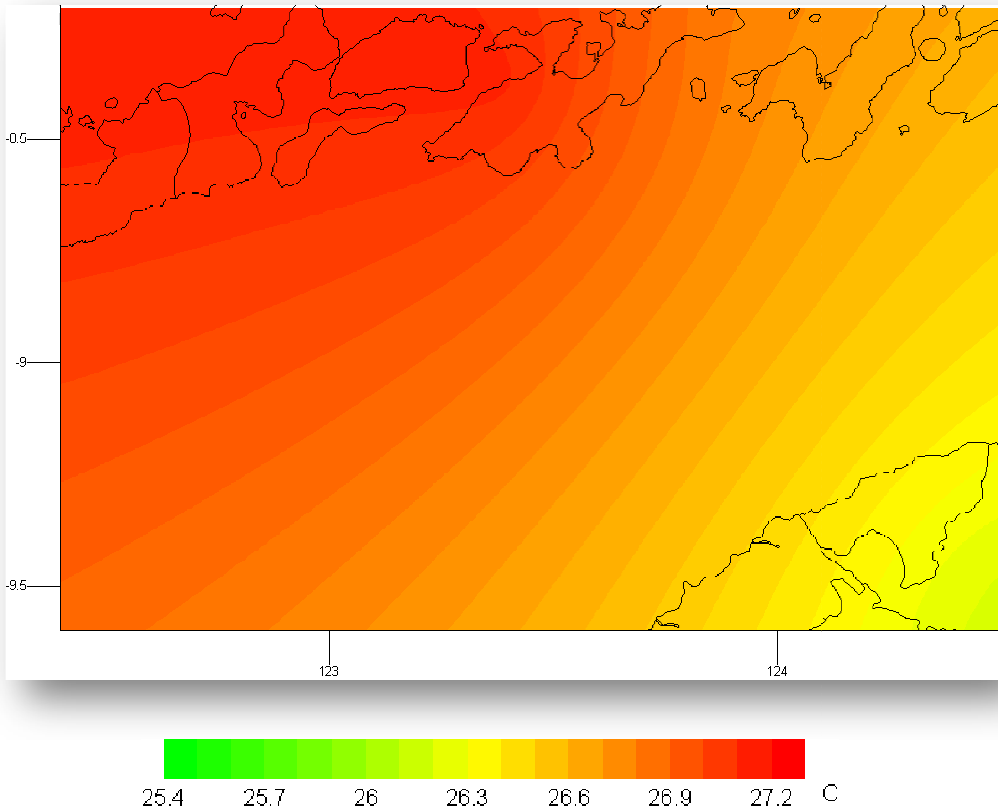

Figure 24. Mean Temperature in NTT Province during 2003

The Figure 24 above shows the mean temperature in 2003 at NTT with the temperature difference still being significant as is the case in previous years.

In West Timor in the south, mean temperatures have gone up to 26.3°C. NTT study area to the south of this region is TTU. The TTU District includes areas with a temperature value that is not too high when compared with the northern part of West Timor, but has a higher rainfall than other areas of NTT.

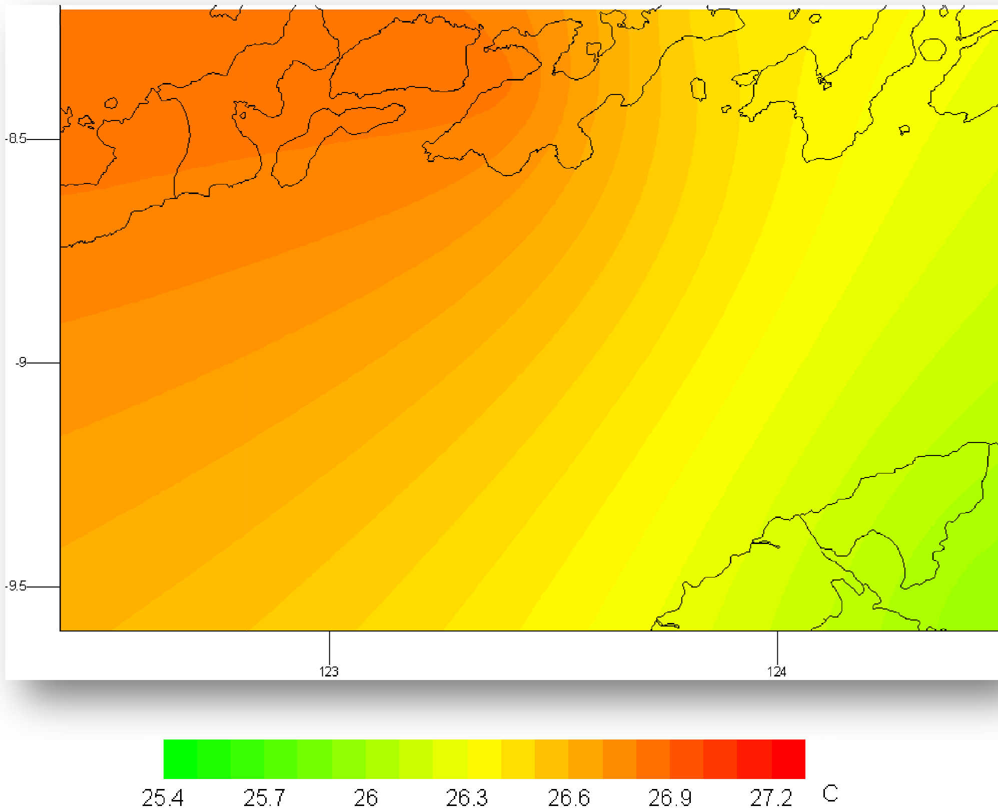

Figure 25. Mean Temperature in NTT Province during 2004

The Figure 25 above shows the condition of the mean annual temperature starting in 2004. In spatial scale, the mean annual temperature in the NTT Province tends to be higher compared to the northern area. This is probably caused by the northern region being closer to the equator, so it receives more solar radiation than the southern region and eastern part of NTT. To the north, especially the Bara Sea region, the highest temperature was achieved in December, January, and February this year.

In West Timor in the south, mean temperatures reached 26 ^{o}C. The NTT study area to the south of this region is TTU. The TTU District includes areas with a temperature value that is not too high when compared with the northern part of West Timor, but has a higher rainfall than other areas of NTT.