VILLAGE VULNERABILITY AND CLIMATE RISK INDEX

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1 INTRODUCTION

Global warming due to an increase in the concentration of greenhouse gasses in the earth's atmosphere has caused a great impact on the global climate system. Extreme climate events are on the rise and their intensity has also tended to increase, and the resulting economic impact and damage gas tended to increase (IPCC, 2014). Without efforts to increase the resilience of development system to climate change, the impacts of climate change will undermine the sustainability of development.

Village resilience to the impacts of climate change is determined by the vulnerability of villages. A very vulnerable village would have a low resilience level. When highly vulnerable villages are exposed to climate change, the resulting impacts will be greater than villages that are not vulnerable. Thus, efforts to mitigate the impacts of climate change involve reducing the vulnerability of the village. The level of village vulnerability will be determined by the environmental, social and economic conditions.

2 DEFINITION OF VUNERABILITY AND CLIMATE RISK INDEX

Referring to the explanation above, **vulnerability index** can be defined as a measure that describes the "*degree or vulnerability to be subject to or inability of a system in facing the adverse impacts of climate change, including climate variations and extreme climates*". A village with a high level of vulnerability will have a low capacity to face the impacts of climate change. In other words, it's resilience is low.

Village vulnerability index can be composed based on three factors that determine vulnerability, i.e., exposure, sensitivity, and adaptive capacity of a village. *Exposure* indicates the degree, duration and or possibility of a system to get in contact with a shock or a disruption (Adger 2006; Kasperson *et al.* 2005). *Sensitivity* is the internal condition of a system that indicates the degree of its vulnerability to disruption, which is strongly determined by the conditions of humans and their environment, such as population density, economic structure, ecosystem structure and function, and others. *Adaptive capacity* shows the system's capacity to adapt with climate change (including climate variability and climate extremes) and anticipate hazard potentials, manage impacts or overcome impacts (IPCC 2007).

Village climate risk index illustrates the vulnerability and the possibility (magnitude of threat) of a village to be exposed to climate change. A village that has high climate risk is one that has high vulnerability and possibility or high climate threat level (extreme climate events). [sic] So villages with an increasing potential for exposure (magnitude of threat) to extreme climate events due to climate change in the future will have an increasing village climate risk level notwithstanding its vulnerability remaining constant. Similarly, if the possibility for extreme climate events does not change in the future, but the vulnerability increases, the village's climate risk will also increase in the future.

Efforts to avert or reduce the possibility of climate change include reducing greenhouse gas emissions, also known as mitigation, while reducing vulnerability is known as adaptation. Adaptation efforts include improving environmental, social and economic conditions that will impact greatly the system's vulnerability. In general terms, the relationship between vulnerability, climate change and climate risk can be seen in Figure 2-1.

Figure 2-1 Relationship between vulnerability (exposure, sensitivity and adaptive capacity), climate change, risk and adaptation efforts (modified from IPCC, 2014)

2.1 VULNERABILITY INDEX INDICATORS

Indicators that can be used to describe the vulnerability, sensitivity, and adaptive capacity of a village include village biophysical, and socio-economic data. Such data is development activity data that is usually collected by relevant agencies, such as the Central Statistics Agency (BPS), Regional Apparatus Working Units (SKPD) and other institutions. It is imperative to have the knowledge and understanding about how these 'data' relate to factors that determine vulnerability. Data that can directly or indirectly describe the degree or vulnerability or inability of a system in facing certain stresses (in this case climate change) can be called vulnerability indicators.

Vulnerability indicators include number of Households (HH) that live and number of buildings along riverbanks. Such data can be used as a vulnerability indicator for the exposure factor. Relatively speaking, a village with a very high percentage of households and buildings close to riverbanks will have a higher chance for the households and buildings to be exposed or subject to the hazard of flooding or landslides. Thus, the higher the percentage of housing/buildings along the riverbanks, the higher the exposure level of the village to climate variability and climate change.

Data on main source of household livelihood in the village can be used as a vulnerability indicator for the sensitivity factor. Villages with populations relying mainly on agriculture as the main source of livelihood are considered to have higher sensitivity. This is because agricultural activity is relatively sensitive to climate conditions. The presence of climate anomalies will strongly determine the community's income level, as regions where the main livelihood is agriculture will be more sensitive to climate change compared to regions where the main livelihood is not from agricultural activity.

Data on village education facilities or the education level of its community can be used as a vulnerability indicator for the adaptive capacity factor. The higher the percentage of educated population, the better the relative ability to respond to change or stress.

The number and quality of indicator data used will strongly determine how a village's vulnerability condition can be described. The limited number of indicators and data inaccuracies will determine the outcomes of vulnerability analysis in describing the actual condition. Thus, determining key indicators and developing a monitoring system and good data management is very important, as well as checking the data quality produced by the data source agencies.

Data searches at provincial and district level revealed that the data types available at the two administrative levels are not the same. At the district level, there are several types of data can be used to represent the exposure factor, sensitivity or adaptive capacity that are not available at the provincial level. The general types of village potential data or other types of data that relate to the three determinant factors for vulnerability can be seen in Appendix 1.

The analysis of village vulnerability at the provincial level uses indicators that are slightly different that those at the district level. For all villages in the province there are only four types of data that represent the adaptive capacity, and eight types of data for sensitivity and exposure. Meanwhile, there can be more types of data available at the district level with better information detail. For example, in Manggarai District, there are seven types of indicator data for adaptive capacity, and eight types of data for exposure and sensitivity with a better data detail. A case in point is data regarding lighting facility for the vulnerability level regarding adaptive capacity. At the provincial level, the types of data available for all villages are only data regarding the number of households that have and do not have electricity facility. At the district level, the information is more detailed, not only whether or not there is electricity facility, but also information regarding the type of electric facility, namely PLN (State-owned Electric Utility Company), non-PLN (e.g. electric generators) and non-electricity (oil lamp, etc). The data used as village vulnerability indicators at the provincial analysis unit and three selected districts for SPARC activity in this study can be seen in Table 2-1.

Table 2-1 Indicators that are used to describe the exposure, sensitivity factor (ES) and adaptive capacity (AC) for provincial-level and district-level analysis for Manggarai, Sabu Raijua and East Sumba

Indicator	**Province NTT**	**District**		
		Manggarai	**Sabu Raijua**	**Sumba Timur**
Adaptive capacity indicator	Indicator Symbol			
Education Facilities	KA_1	KA_1	KA_1	KA_1
Health Facilities and Personnel	KA_2	KA_2	KA_2	KA_2
Number of HH based on Lighting Source			KA_3	KA_3
Electric Facility	KA_3	KA_3		
Number of HH based on Fuel Source		KA_4		
Number of Families Based on Toilet Criteria		KA_5	KA_4	
Regional Original Revenue			KA_6	KA_4
Road Infrastructure	KA_4	KA_6	KA_5	KA_6
Farmer Groups		KA_7		KA_5
Indicator of exposure and sensitivity	Indicator Symbol			
HH living on riverbanks	KS_1			
Buildings along riverbanks	KS_2			
Population density	KS_3	KS_1	KS_1	KS_1
Number of families by type of house			KS_2	
Paddies	KS_4	KS_2	KS_3	KS_2
Farmland	KS_5	KS_3	KS_4	KS_3
Main source of livelihood	KS_6			
Village locations			KS_5	KS_4
Village slope		KS_4	KS_6	KS_5
Coastal village presence			KS_7	KS_6
Dependency rate		KS_5	KS_8	KS_7
Poor populatoin ratio		KS_6	KS_{11}	KS_8
Waste disposal place		KS_7		
Nummber of HH by source of waterx	KS_7	KS_8	KS_9	KS_9
Nuber of farming families	KS_8		KS_{10}	

2.2 METHOD TO DETERMINE VULNERABILITY LEVEL

Village vulnerability level is determined using the Adaptive Capacity Index (IKA) as well as Exposure and Sesitivity Index (IKS) based on a quadrant system as shown in Figure 2-2. The IKA and IKS values are calculated based on indicator data selected according to Table 1-1. The IKA and IKS calculation follows a formula developed by Boer et.al (2013):

$$IKA_i = \sum_{j=1}^{n} w_j * I_{Aij}$$

and

$$IKS_i = \sum_{j=1}^{n} w_j * I_{Bij}$$

Where *i and j* represent the *i-th* village/*kelurahan*, and *j*-th indicator, and w_j is the weight for every *adaptive capacity (A) or j-th exposure/sensitivity (B)* indicator. The weight value at the provincial level is determined based on expert assessment, while at the district level with stakeholder involvement. The weight value is strongly determined by the knowledge of experts or relevant stakeholders regarding the understanding about closeness or strength of relations between indicators to explain the exposure, sensitivity, and adaptive capacity factors. Besides these, there is also a quantitative approach, such as the use of a ranking system, *Analytical Hierarchy Process* (AHP), and other techniques.

Based on calculations of IKA and IKS values, the village vulnerability category in the province shall be determined based on the village position in the quadrant as shown in Figure 2-2. The categorization of village vulnerability level in the province uses five categories. Based on Figure 2-2, a village is categorized as having very high vulnerability (very vulnerable) if it is located in Quadrant 5. A very vulnerable village will have a low IKA and high IKS. A village would be categorized as having very low vulnerability (very invulnerable) if it is located in Quadrant 1. Invulnerabe villages have high IKA and low IKS.

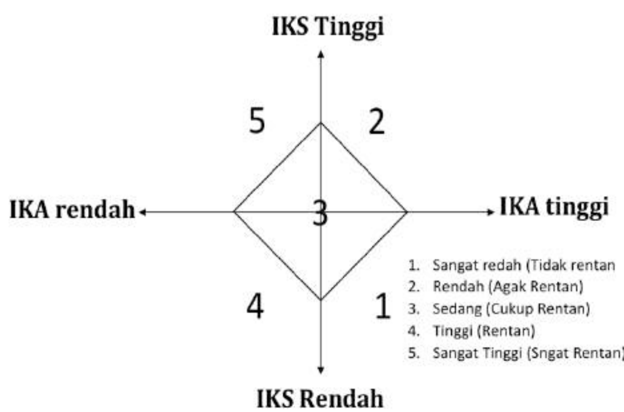


Figure 2-2 Relative position of village vulnerability level based on a quadrant system at the provincial level

Furthermore, a spiderweb diagram can be made in order to learn which indicator strongly contributes to the village vulnerability level. An ideal village condition is one where all determinant indicators for adaptive capacity are as high as possible, whereas the indicators of exposure and sensitivity determinants are as low as possible. Such a condition can be created through various adaptation programs. Based on that, Figure 2-3 shows that the vulnerability of Village A is lower than Village B. However, although Village A has lower vulnerability level, indicators that illustrate IKS, namely KS1 and KS5, are higher than Village B whose vulnerability is higher. This means that the adaptation efforts would still be needed in the village that is not vulnerable, depending on whether or not the indicator determining the vulnerability is generally below the average village condition. However, it needs to be noted that vulnerability analysis results is just one of the considerations, as indicators are constrained by the lack of data. Thus, more knowledge is needed to determine the actions in addition to vulnerability analysis results.

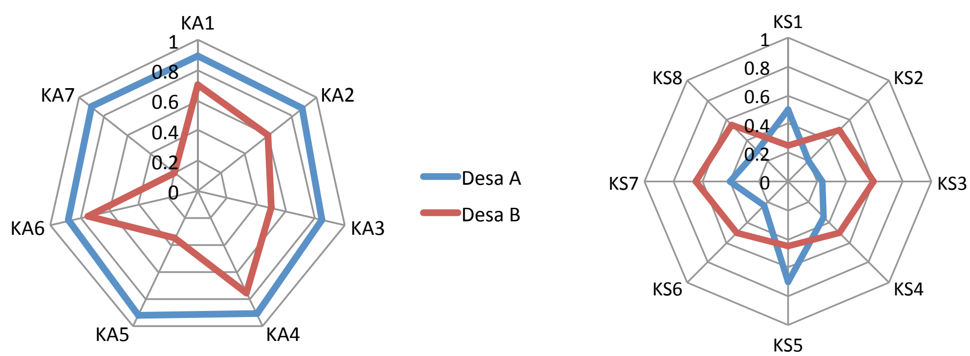


Figure 2-3 Spiderweb diagram showing indicator relative conditions

Categorization of village vulnerability based on IKS and IKA values at the district level shall be made more detailed by using six categories as shown in Figure 2-4. In this approach, the low vulnerability level would be divided into two categories, i.e., moderately low and low, and high vulnerability levels would be divided into two categories, i.e., moderately high and high, and the middle category would be eliminated. The middle vulnerability level category can be kept if needed, but there would be seven vulnerability level categories (Figure 2-4).

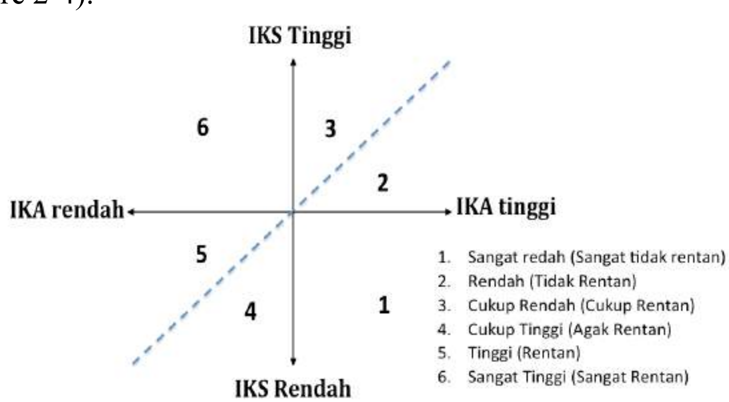


Figure 2-4 Determining the village vulnerability level based on a quadrant system at the district level (six categories)

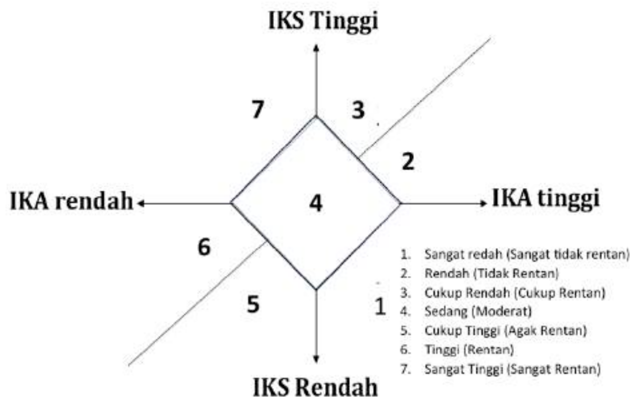


Figure 2-5 Determining village vulnerability level based on a quadrant system at the district level (seven categories). Note: Regional borders for medium vulnerability category (4) can also be made as a circle, not a rectangle

Formula for calculating IKS and IKA value based on vulnerability indicator data presented in Table 2-1 can be seen in Attachment 2.

2.3 METHOD TO DETERMINE CLIMATE RISK LEVEL

Village climate risk level is determined based on the possibility for extreme climate (threat) to occur and the village vulnerability level using risk matrix. A village with very high vulnerability level and high possibility to be exposed to climate threat will have a very high climate risk. A statistical approach is used to determine the change to climate risk level in the future relative to the current risk level. An analysis is performed to determine the possibility for extreme climate event that is projected to cause a negative impact. To this end, extreme climate analysis is done referencing the daily maximum precipitation 10% percentile (dry) and 90% percentile (wet) based on precipitation data of 1981-2010 period. A large change of future climate threat is established based on the change to the recurrence period of the precipitation event based on projected rain data. In this analysis, three threat level categories are made, i.e., ‘increasing’, ‘steady’ and ‘decreasing’ (Table 202). A threat level is said to ‘increase’, if the 10-yearly daily precipitation event recurring period in the future increases to 6 years or less than 6 years. A threat level is said to be ‘steady’ if the 10-yearly maximum daily precipitation event in the future has a trange of change between 6 to 14 years. Whereas a threat level is said to be ‘decreasing’, if the 10-yearly daily precipitation event recurring period in the future falls to 14 years or more.

Table 2-2 Categorization of possiblity value at the threat level of future condition

No	Threat Category	Recurring period of 10-yearly rainfall in the future
1	Increasing	≤ 6 Years
2	Steady	6 – 14 Years
3	Decreasing	≥ 14 Years

Table 2-3 Provincial-level village climate risk matrix

Kerentanan \ Periode Ulang		3 Naik	2 Tetap	1 Turun
5	Sangat Rentan	SNT	T	ST
4	Rentan	T	ST	S
3	Cukup Tinggi	ST	S	RS
2	Agak Rentan	S	RS	R
1	Tidak Rentan	RS	R	SR

SR: Sangat Rendah
R: Rendah
RS: Rendah-Sedang
S: Sedang
ST: Sedang-Tinggi
T: Tinggi
SNT: Sangat Tinggi

Table 2-4 District-level village climate risk matrix

Kerentanan \ Periode Ulang		3 Naik	2 Tetap	1 Turun
6	Sangat Tinggi	SNT	T	ST
5	Tinggi	T	ST	S
4	Cukup Tinggi	ST	S	RS
3	Cukup Rendah	S	RS	R
2	Rendah	RS	R	SR
1	Sangat Rendah	R	SR	SR

SR: Sangat Rendah
R: Rendah
RS: Rendah-Sedang
S: Sedang
ST: Sedang-Tinggi
T: Tinggi
SNT: Sangat Tinggi

Using the risk matrix, the future climate risk level can be established. In this analysis, the village vulnerability levels at the provincial-level analysis unit are divided into five categories (five quadrants), while the district-level analysis unit has six categories (six quadrants). Thereby, the resultant village climate risk matrix for province and district is as presented in Table 2-3 and 2-4.

The approach used in the above analysis does not follow a direct correlation between extreme climate events and disaster events. The analysis only uses the assumption that the 10-yearly recurring extreme climate event has the potential to cause disaster. This is done due to lack of data series on climate disaster events available for the study area. If such data series is available, the analysis method used can be changed, for example, by employing the 'threshold analysis' approach and 'logistical regression' approach.

2.4 VULNERABILITY AND VILLAGE CLIMATE RISK LEVEL, PROVINCIAL SCALE

Analysis for 2005 and 2011 shows that in general villages di NTT Province fall under the 'rather vulnerable' and 'quite vulnerable' categories (Figure 2-5). Rather vulnerable villages have a high IKS and high IKA, while quite vulnerable villages have medium IKS and IKA category. In the two-year periods, the number of villages with rather vulnerable and quite vulnerable categories saw an increase, from 2158 villages (79%) to 2436 villages (82%). However, villages under the ‘very vulnerable’ category, i.e., villages with low IKA and and high IKS, have slightly decreased from 434 villages (16%) in 2005 to 341 villages (12%) in 2011.

Generally, the vulnerability levels in 2005 compared to 2011 have declined (Figure 2-5 and 2-6). This indicates that the socio-economic conditions of most villages in NTT Province have improved. The change in the vulnerability level was quite pronounced in Manggarai District.

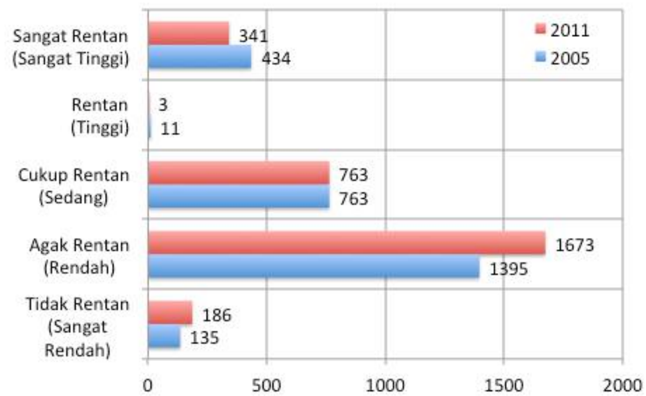


Figure 2-6 Number of villages in NTT province by vulnerability level in 2005 and 2011

In 2005, most of the villages in this district were under the ‘very vulnerable’ category, but in 2011 it has improved to become rather and quite vulnerable. The trend is also similar for villages in West Sumba District and Kupang District, South Central Timor (TTS) District and North Central Timor (TTU) District. However, the opposite is true for some of the villages in Ngada, Ende, Sikka, East Flores, Lembata Districts and Kupang City, where the vulnerability level slightly rose, from rather vulnerable to quite vulnerable and very vulnerable (Figure 2-6).

Furthermore, indicators that contributed to provincial-scale village vulnerability can be seen in the spiderweb diagram in Table 2-5. Indicators that greatly contributed to village vulnerability for every vulnerability level category are quite varied. Generally, villages that fall under the very high vulnerability category have indicator conditions that are far below the province average condition. However, villages that fall under the very low vulnerability catergory still have indicators that are not good, namely, indicators that pertain to health and education facilities and high population density.

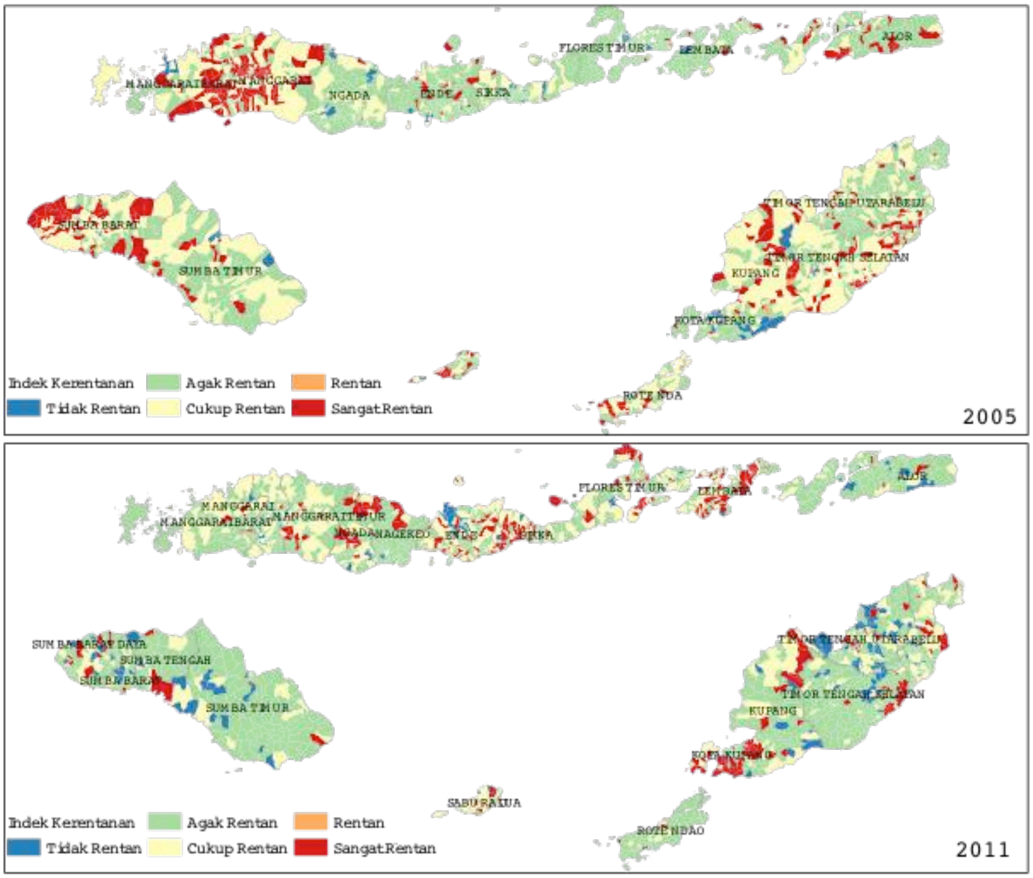
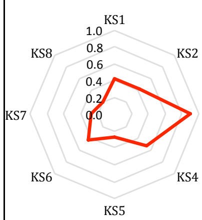
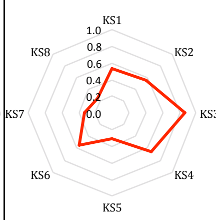
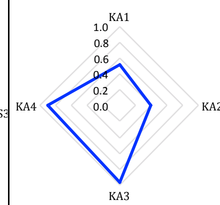
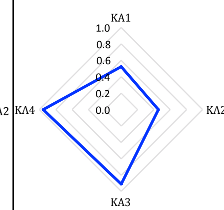
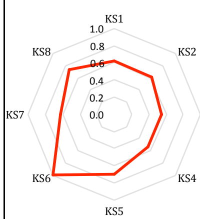
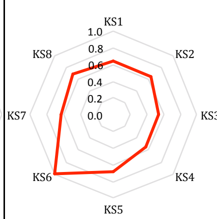
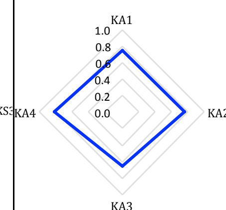
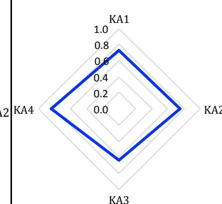
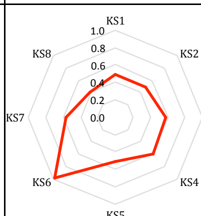
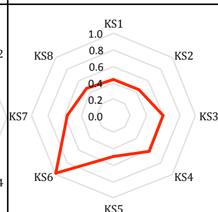
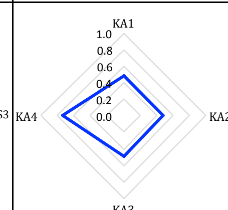
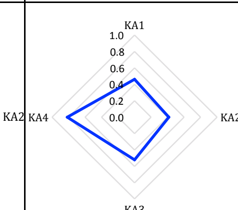
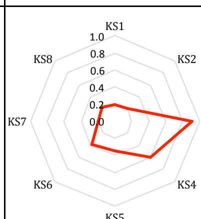
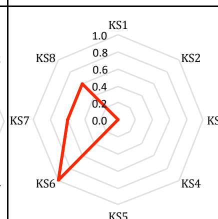
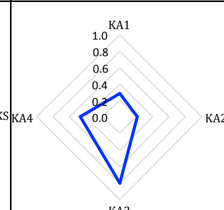
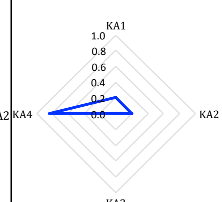
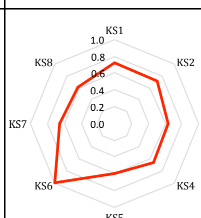
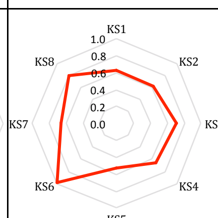
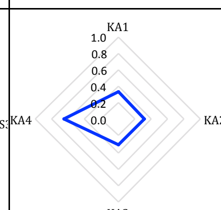
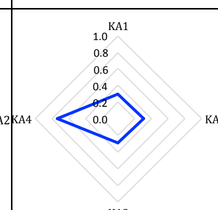


Figure 2-7 Village vulnerability in NTT province in 2005 and 2011

If changes to village village vulnerability level in every district are analyzed in greater detail based on provincial indicators (see Table 2-1), many villages in East Sumba District will experience an increased vulnerability level to become very high. While in other districts, the village vulnerability has generally seen a decrease. Maps showing village vulnerability levels in all districts can be seen in the book '**Peta Kerentanan and Risiko Iklim Villages Provinsi NTT**'.

Categorization of province-scale village climate risk level is established using the risk matrix as shown in Table 2-3, while village climate risk analysis at the district level uses the risk matrix in Table 2-4.

Table 2-5 Condition of village vulnerability indicators by vulnerability level category

Vulnerability Category	IKS		IKA		Remarks
	2005	2011	2005	2011	
Very Low					High population density and low quality of education and health facilities
Low					Livelihood still largely depends on agricultural sector that is sensitive to climate variability and relatively many HH's still do not have electricity
Medium					Livelihood still largely depends on agricultural sector that is sensitive to climate variability, lahan pertanian yang masih dominan. Additionally, a few HH have electricity, minimal education and health facilities
High					High population density, livelihood still relying on agricultural sector. Additionally, very few HH have electiricty, low levels of health and education facilities
Sangat Tinggi					Livelihood still largely depends on agriculture, many HH and buildings along riverbanks, relatively high population density. Additinally, very few households have electricity, low health and education facility

Remark: Indicator values normalized with village area, such as populasi density, fraction of paddy area, fraction of farmlands that have no value for administratively split villages where the village area is unkown.

For 2011 vulnerability, villages that have been administratively split fall under high vulnerability, so theyhave no indicator value.

The types of climate risk that prevails in NTT Province include flooding, landslides, droughts, and high winds. Tempeature rise is expected to increase the intensity and frequency of drought events. Temperature rise will increase the rate of evaporation from the ground and pants that can hasten the decline in groundwater availability. The threat of sea level rise combined with an increased wind intensity will increase coastal erosion and coastal flooding. The threat level for the four disaster types, i.e., flooding, droughts, winds and landslides in NTT Province has been analyzed by the National Disaster Mitigation Agency (BNPB) alonf with the the Meteorology, Climatology and Geophysics Agency (BMKG). The threat possibilities are divided into three categories, i.e., low, medium, and high (Figure 2-7).

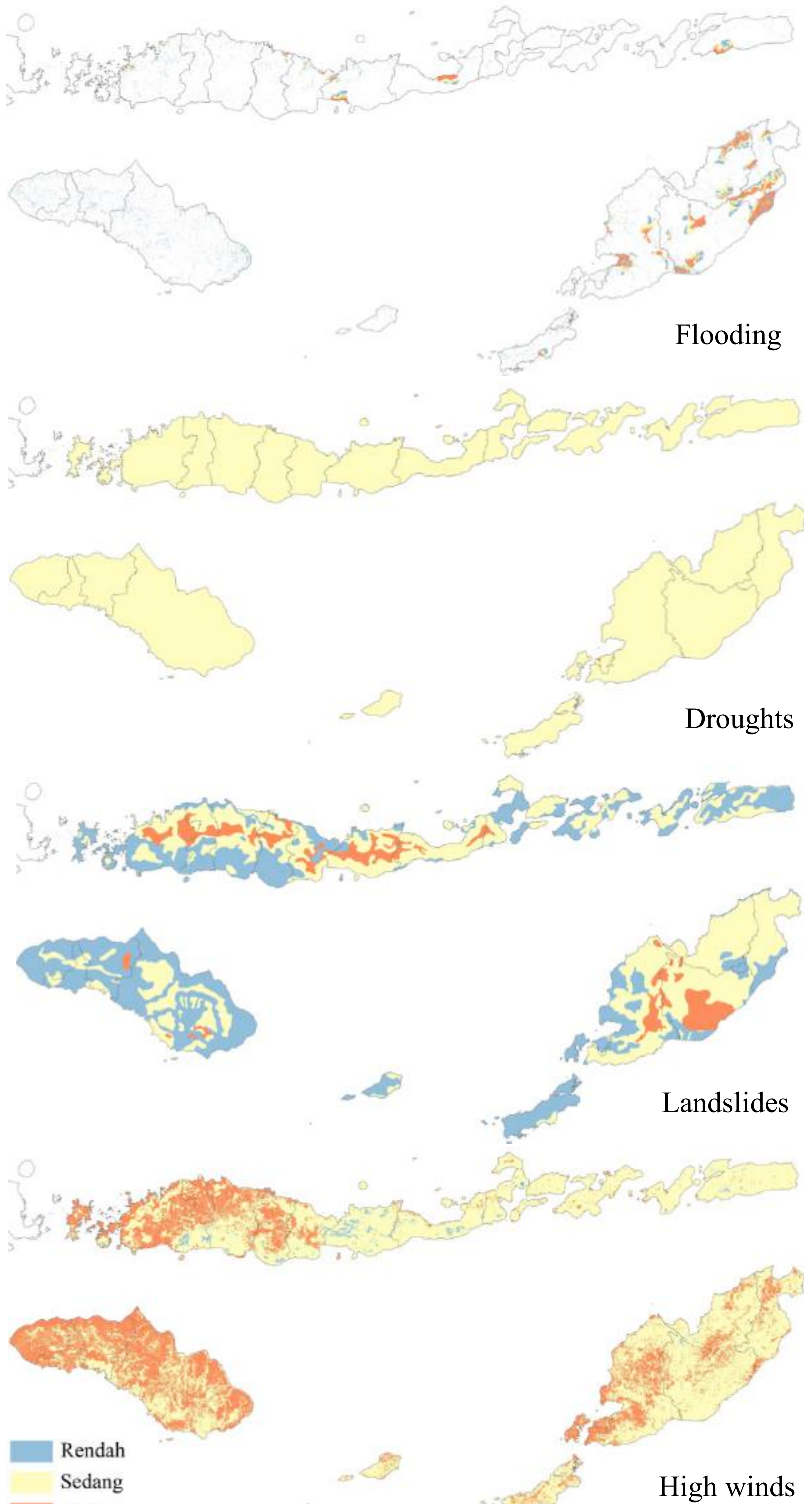


Figure 2-8 Risk level of climate disasters, flooding, droughts, landslides and high winds (analyzed based on data from BNPB and BMKG)

Analysis shows that around 8% of villages in NTT Province are currently estimated to have a high to very high flooding risk, around 12% for drought risk, 11% for high winds risk and 9% for landslide risk. High and very high flooding risk is generally found in villages in West Manggarai, Manggarai, West Sumba, and TTS Districts (Figure 2-8). Landslide, drought, and high winds risks also remain relatively high in villages in those districts.

Climate change in NTT Province is projected to increase the frequency of high and low extreme rainfall based on RCP4.5 scenario (Faqih, 2014). In most regions, the intensity of wet extreme rain will increase in the future. This condition will lead to an increased flooding risk in most of villages in NTT Province (Figure 2-10). At present, there are still villages in NTT that have a very low and low risk level. However, in the future, the risk level will increase to become low-to-medium to medium. In terms of drought risk, villages that previously had low-medium risk will become low to very low in the future. However, some villages will see an increased drought risk level. Presently, a very high drought risk level category does not exist. However in the future, it is projected that there will be villages with very high drought risk. The distribution of villages by present and future drought and flooding risk level is presented in Figure 2-11 and Figure 2-12. The drought and flooding risk distribution map by village in every district can be seen in the book **'Peta Kerentanan and Risiko Illim Villages Provinsi NTT**.

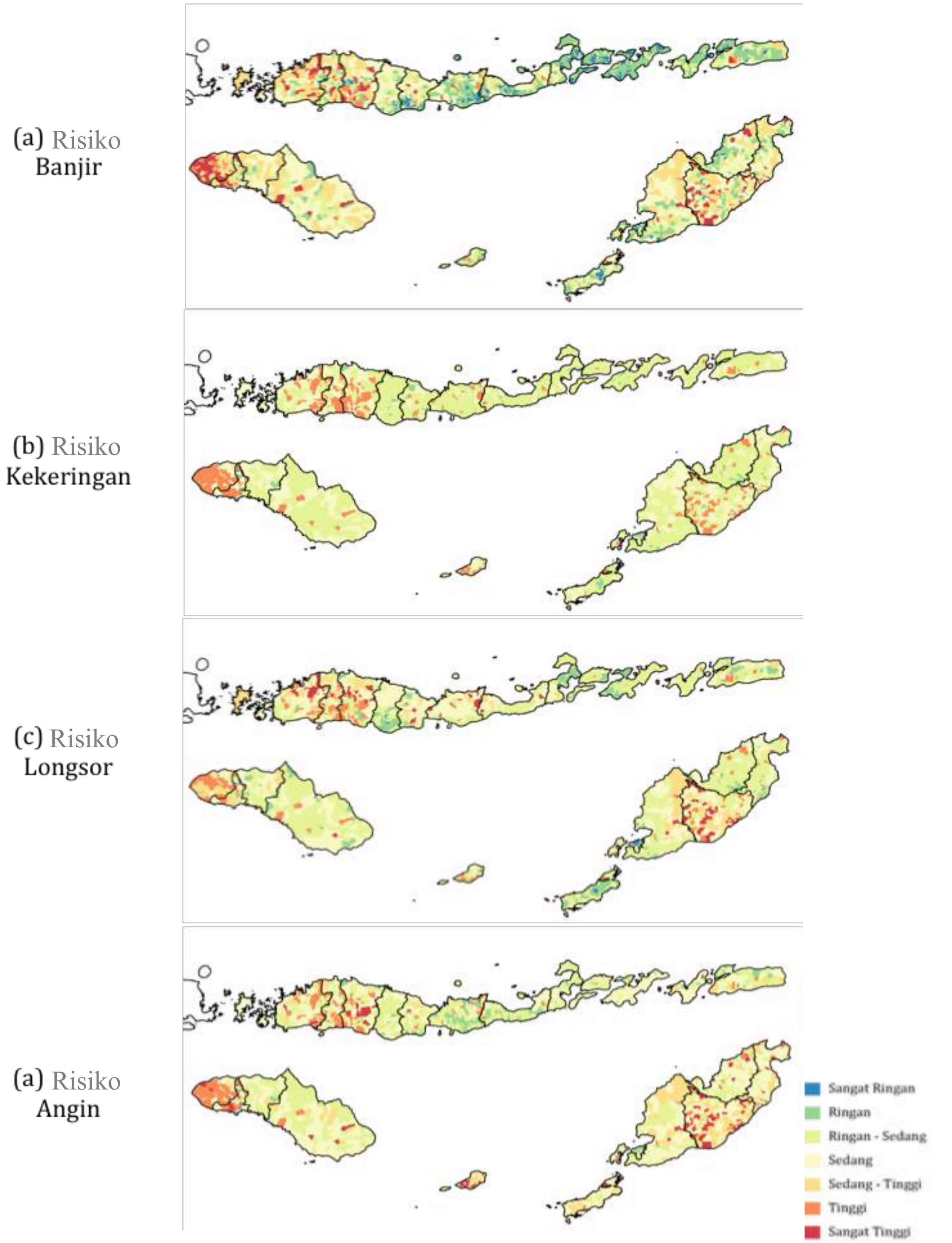


Figure 2-9 Present climate risk in NTT Province

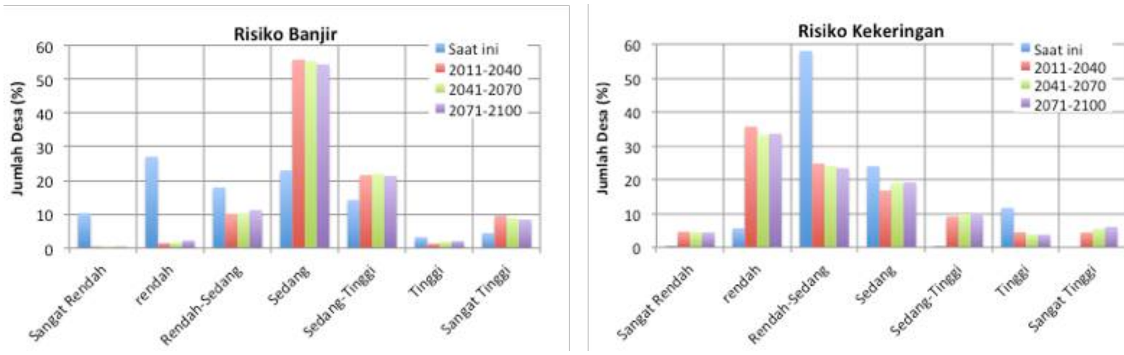


Figure 2-10 Percentage of villages in NTT Province by flooding and drought risk level at present and future conditions for scenario RCP4.5

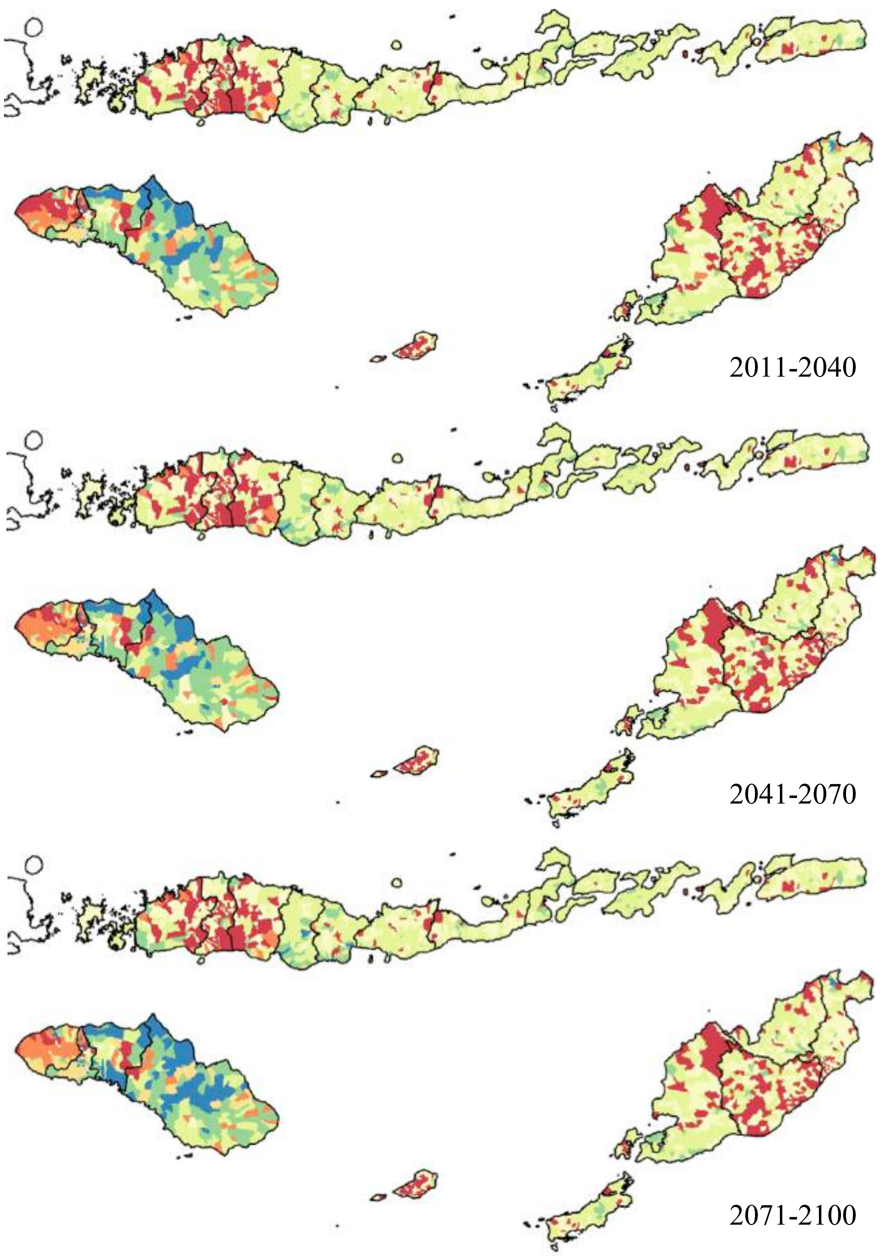


Figure 2-11 Wet extreme climate risk level in the future in NTT Province

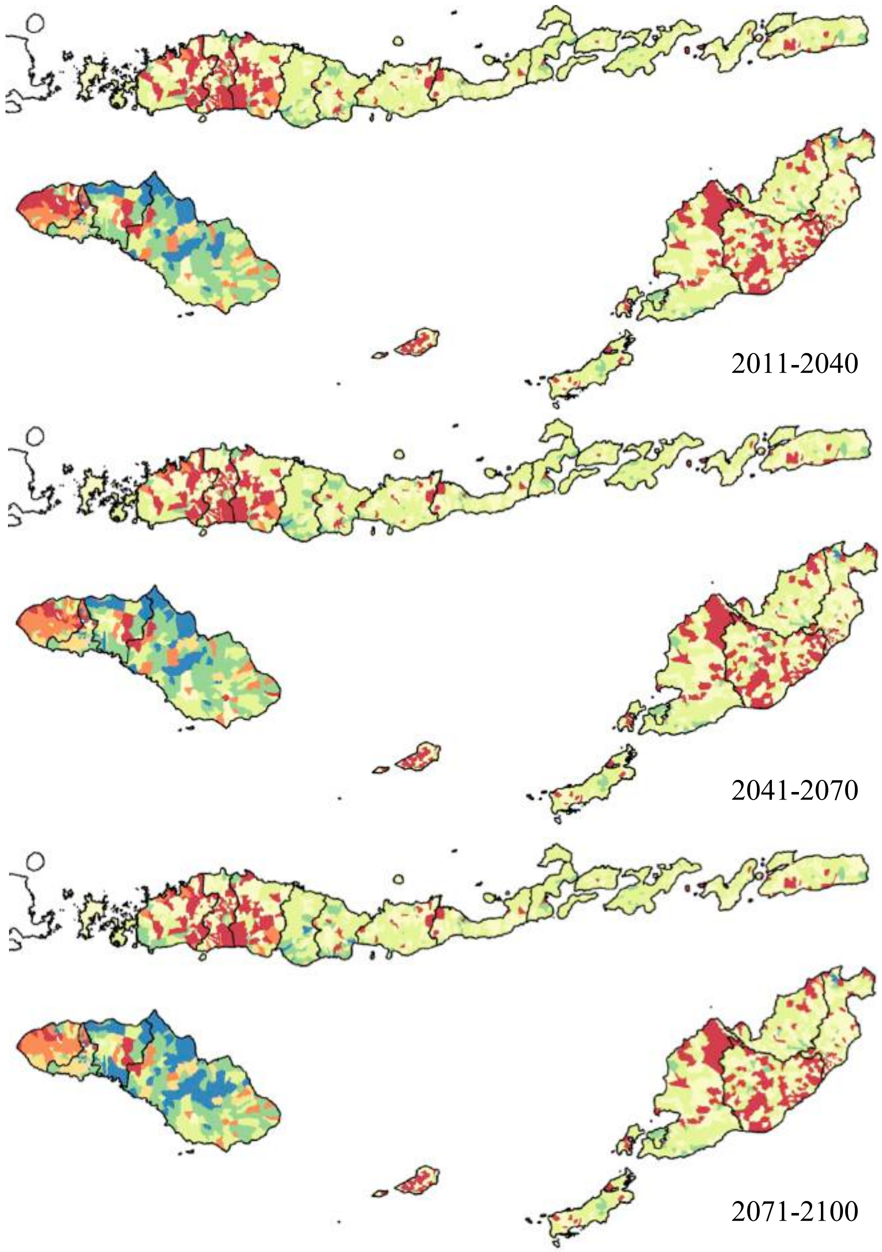


Figure 2-12 Dry extreme climate risk level in the future in NTT Province

The vulnerability and climate risk analysis as specified above uses the provincial scale village data indicator, meaning that the comparison of vulnerability level and climate risk conditions between villages can be one for all regions in the province because the indicators used for all villages are the same. This way, the result of this analysis can be used by the NTT Provincial Government to compare conditions between villages in the region. If the analysis level is reduced only for villages in certain districts, the vulnerability indicators can be added according to data availability as shown by Table 2-1. In this regard, comparing vulnerability level and climate risk conditions between villages can only be done for that particular district only. Result of vulnerability and climate risk analysis for three districts, i.e., Manggarai, Sabu Raijua and East Sumba, using indicators that are spesifik for the district is explained in the following sub-chapter.

2.5 VILLAGE VULNERABILITY AND CLIMATE RISK, DISTRICT SCALE

2.5.1 Manggarai District

Climate risk analysis for present condition for Manggarai District [shows] that there are villages that have high to very high level climate risk, including flooding risk in 39 villages (27%), drought in 58 villages (39%), landslides in 50 villages (34%) and high winds 56 villages (38%). However, there are are also villages that have low to very low climate risk level. High climate risk level was found in villages located in the central and southern parts of Manggarai District (Figure 2-13). In the future (2011-2040), climate change is projected to increase climate risk level of villages di Manggarai District. Villages with very high flooding risk level increase in numbers by 28% and for drought will reach nearly 40% (Figure 2-14).

2.5.2 East Sumba District

In East Sumba District, from 100 villages, the number of villages with high to very high risk to flooding disaster is currently around 22 villages, drought around 15 villages, landslides 13 village and high winds 18 villages. While the number of villages that have low to very low risk to flooding, drought, landslide and high winds disaster is still more, respectively 36, 51, 47 and 42 villages. In the future (2011-2040) it is estimated that the number of villages with high to very high climate risk for both flooding as well as drought will slightly decrease compared to the present condition. The distribution of villages by climate risk level, presently and in the future, as well as the percentage change of villages by climate risk level is presented in Figure 2-16, 2-17 and 2-18.

2.5.3 Sabu Raijua District

In Sabu Raijua District, currently out of 102 villages, no village is found to have high to very high risk for flooding, while for drought 26% and for landslides and high winds respectively 18% and 32%. In the future (2011-2040), the flooding risk level will tend to decrease, while on the other hand drought risk is projected to increase. The distribution of villages by climate risk level, presently and in the future, as well as the percentage change of villages by climate risk level is presented in Figure 2-19, 2-20 and 2-21.

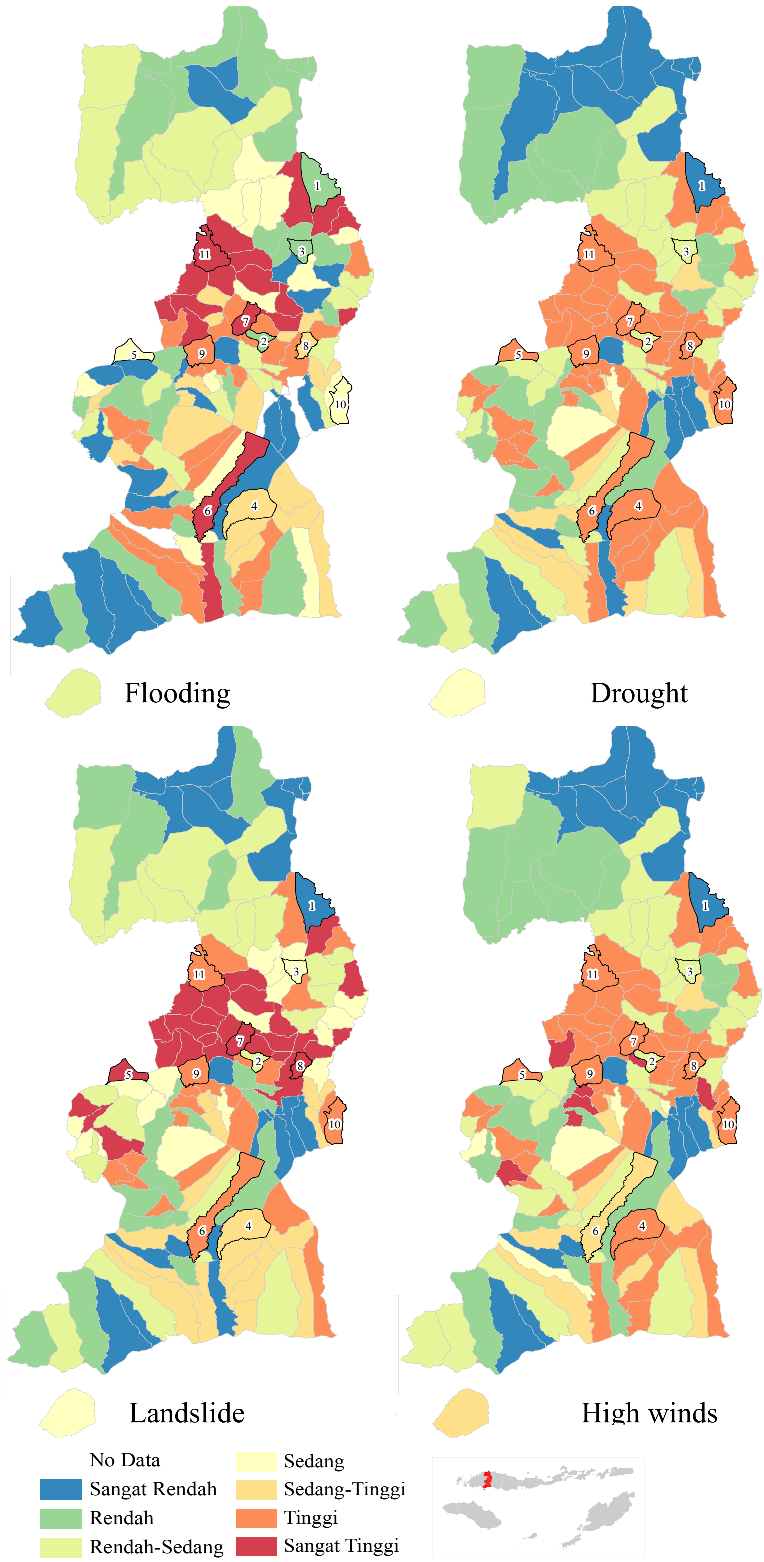


Figure 2-13 2013 climate risk in Manggarai District

Figure 2-14 Flooding risk (above) and drought risk (below) in the future in Manggarai District with scenario RCP4.5

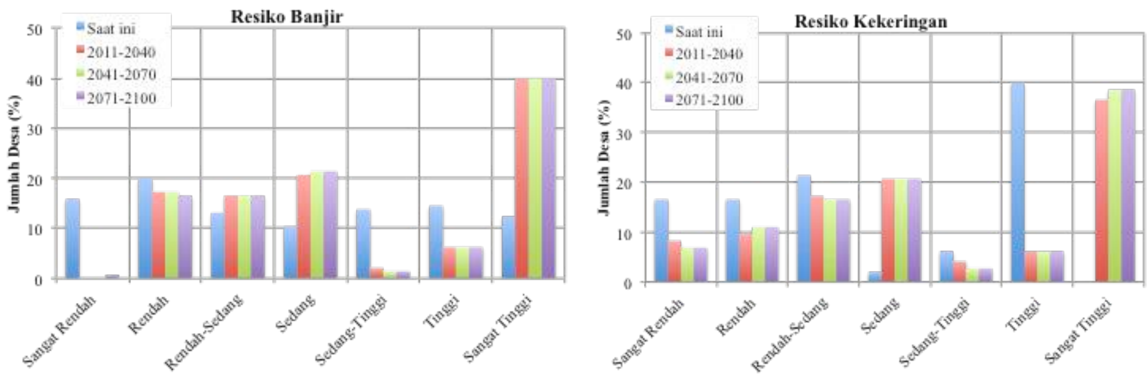


Figure 2-15 Percentage of villages in Manggarai District based on flooding and drought risk level at present and future conditions with scenario RCP4.5

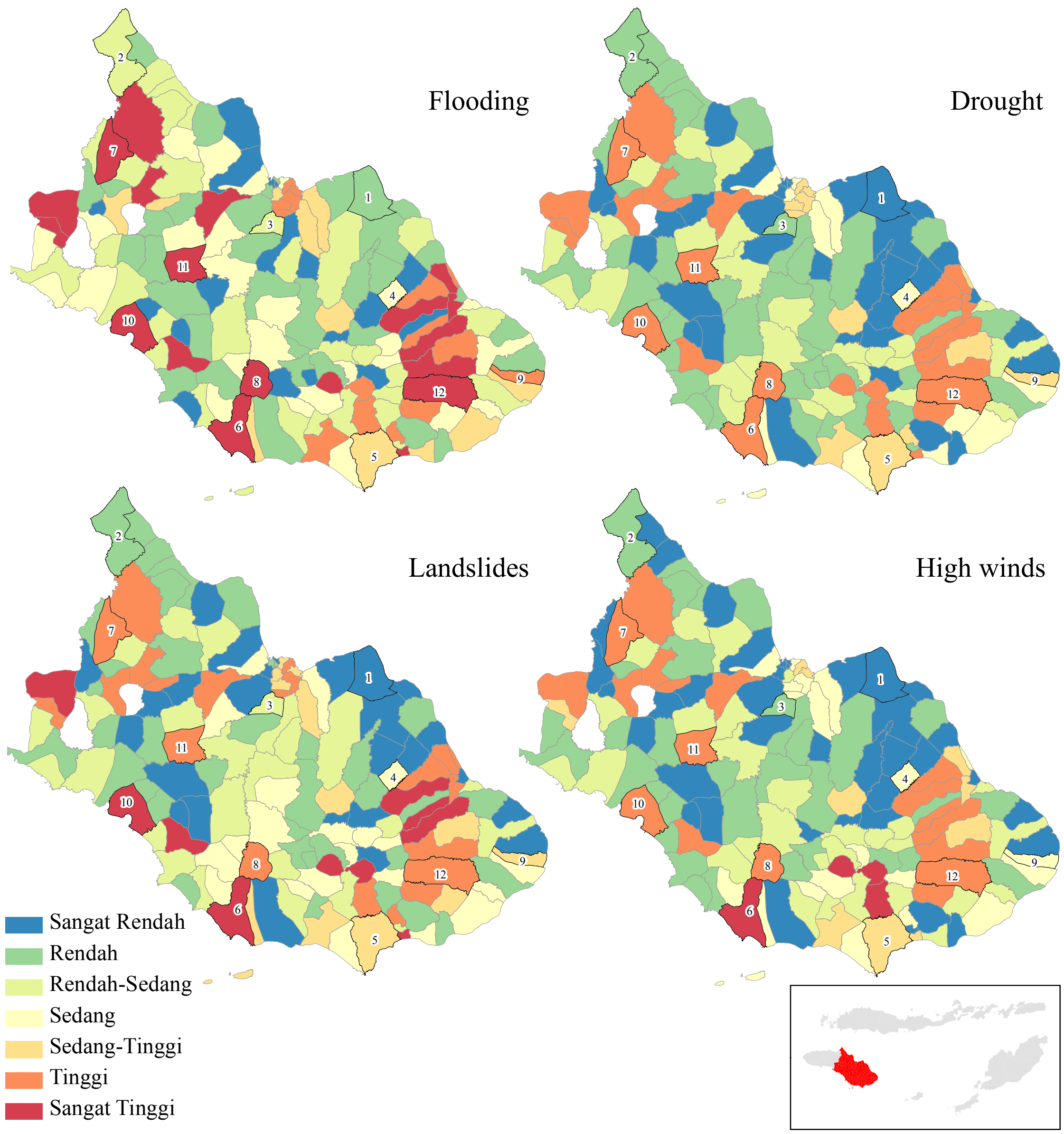


Figure 2-16 Climate risk 2013 in East Sumba District

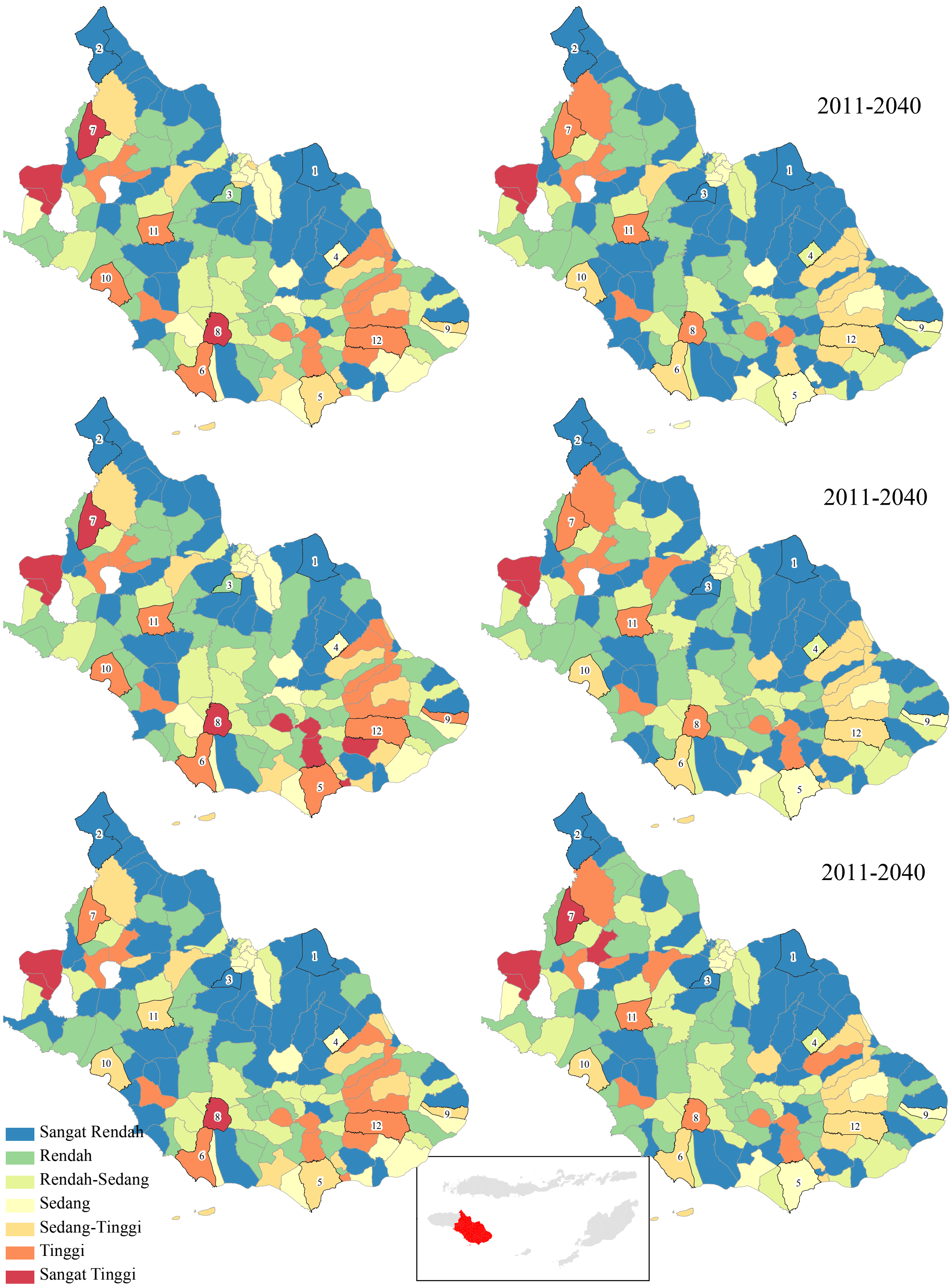


Figure 2-17 Flooding risk (above) and drought risk (below) in the future in District Sumba Timur with scenario RCP4.5

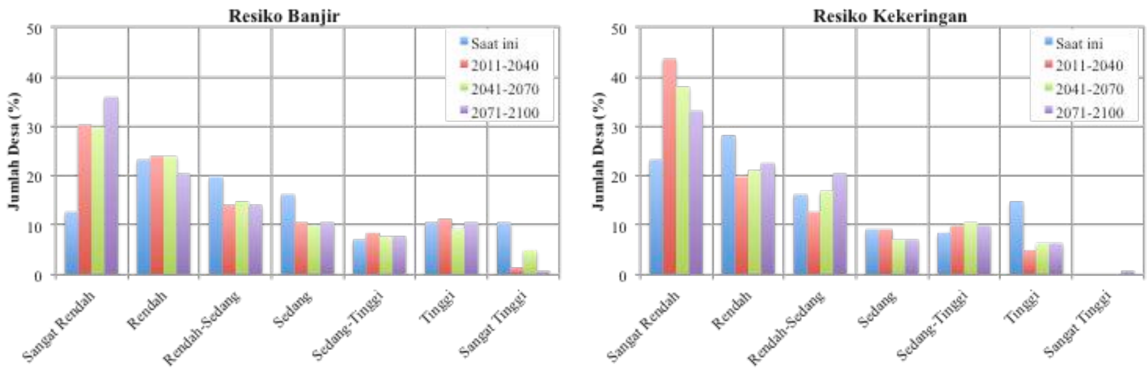


Figure 2-18 Percentage of villages in East Sumba District based on flooding and drought risk level at present and future conditions with scenario RCP4.5

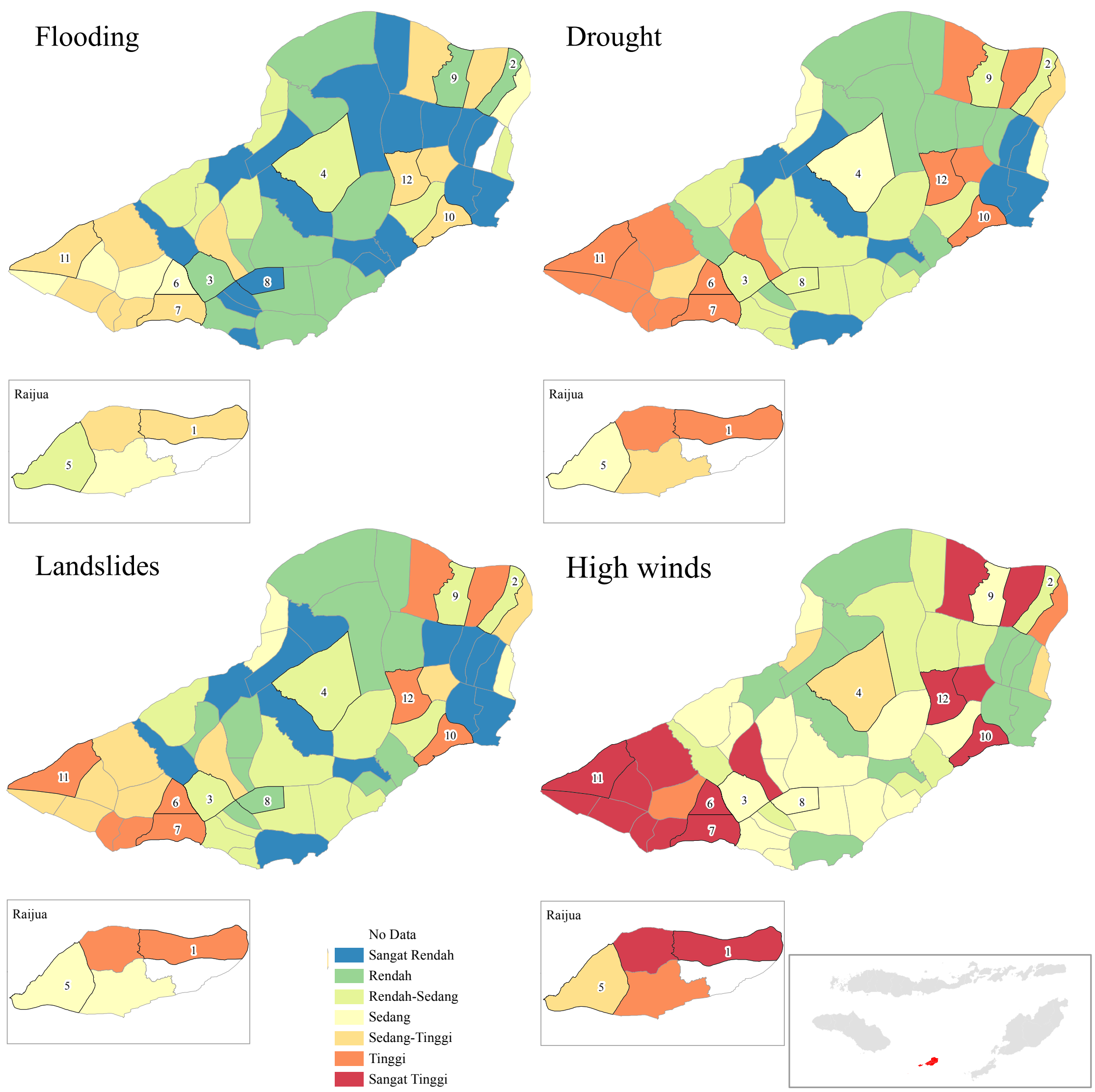


Figure 2-19 2013 Climate risk in Sabu Raijua District

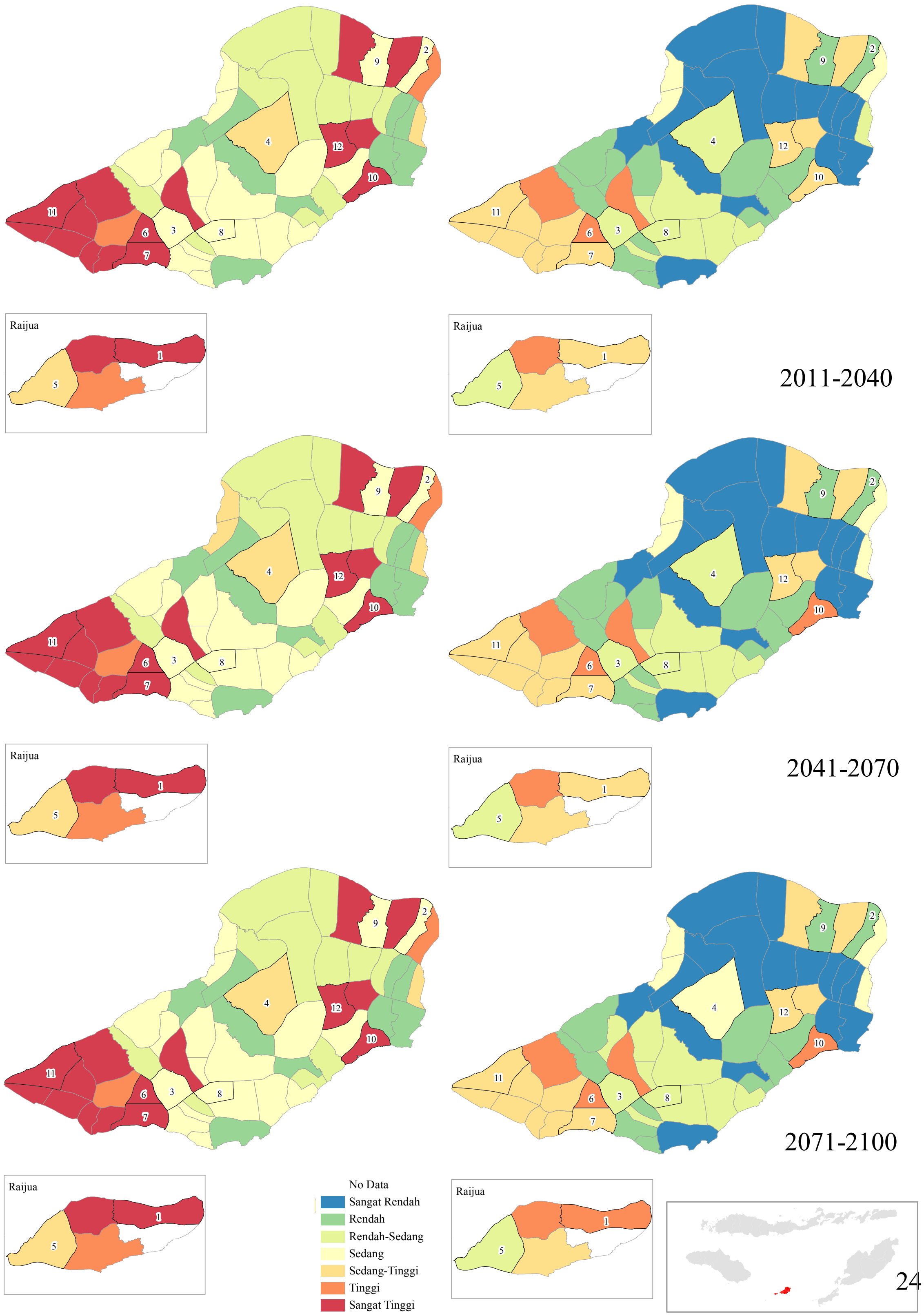


Figure 2-20 Flooding risk (left) and drought risk (right) in the future in Sabu Raijua District with scenario RCP4.5

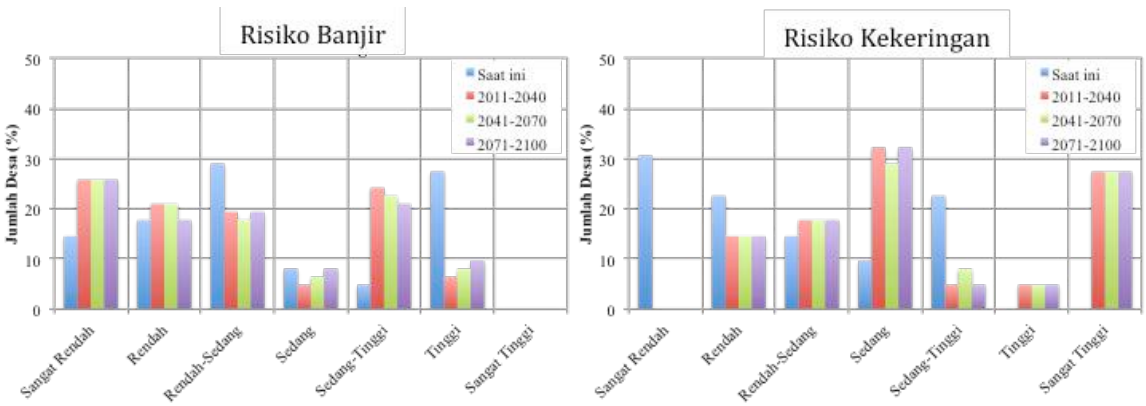


Figure 2-21 Percentage of villages in Sabu Raijua District based on flooding and drought risk levels at present and future conditions with scenario RCP4.5

3 CONCLUSION

Village vulnerability level in NTT Province between 2005 and 2011 generally saw a decline. However, if the village vulnerability level is not improved, the village climate risk level village will tend to increase in the future. Adaptation efforts or programs need to be done as early as possible and prioritized in villages with medium to very high climate risks. Programs or actions to be taken shall be aimed at improving the indicators that have large contribution to vulnerability level, including those that pertain to education, health, and information facilities and infrastructure, as well as development of alternative sources of livelihood. Results of vulnerability and climate risk study is important to serve as reference for preparing an adaptivedevelopment plan in NTT, especially in determining the location and climate change adaptation priorities.

BIBLIOGRAPHY

Adger, W.N. 2006. Vulnerability Global Environmental Change, Vol.16, no.3, pp. 268-281.

Boer, R, A, Rakhman, J, Pulhin.2013. *Vulnerability And Climate Risk Assessment Of Villages At The Citarum River Basin.* CCROM-SEAP, Bogor Agricultural University. AECOM. Asian Development Bank (ADB). Agency for Envionmental Management of West Java Province.Ministry of Environment, Republic of Indonesia.

IPCC, 2007.*Climate change 2007: Impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Parry, M.L., O.F. Canziani, J.P. Palutikof, P.J. van der Linden, and C.E. Hanson (eds.)].*Cambridge University Press, Cambridge, UK, pp. 992.

IPCC, 2014: Summary for policymakers. In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1-32.

Kasperson, J., R. Kasperson, B.L. Turner, W. Hsieh and A. Schiller. 2005. Vulnerability to Global Environmental Change , in J. Kasperson and R. Kasperson, eds, The Social Contours of Risk. Volume II: Risk Analysis, Corporations & the Globalization of Risk, London: Earthscan, pp. 245–285

Faqih, A. 2014.Keragaman and Climate change di Nusa Tenggara Timur: Analysis Condition Iklim Historis and Proyeksi Climate change di Manggarai District, Sabu Raijua and Sumba Timur. Kementrian Lingkungan Hidup and Kehutanan, Republik Indonesia.

Appendix 1 Village potential data pertaining to exposure, sensitivity and adaptive capacity factors

Factor	Indicator	Description
Exposure	Village Geographic Location	Describes the relative position of the village in regard to how easy it can be exposed to climate variability and climate change (coastal, valley, highland villages, etc). Villages located near the coastline have high exposure to coastal tides, villages on mountain slopes to the landslides hazard, villages in valleys to flooding hazard, etc
	Riverbank Households Riverbank Buildings	Describes the number of households and residential buildings near riverbanks. Relatively speaking, places with high percentage of households and buildings close to riverbanks, the possibility of the households and buildings being exposed or subject to the hazards of flooding and landslides in that place will be high. The higher the percentage of housing/buildings on the riverbank, the higher the exposure level of the area to climate variability and climate change.
	Paddies Agricultural lands	Describes the fraction of land cover in an area with high sensitivity to climate variability and climate change. The agricultural sector is a sector that has high sensitivity to climate variability and climate change, so that areas with relatively vast agricultural lands will be more easily exposed to climate variability and climate change with a higher impact.
	Population Density	Describes the average level of land use by person. Places with high population and small area will have a high population density. Places with high population density, when exposed to disaster, the possibility that the people will be subject to disaster will be higher compared to places with low population density, so it is said that areas with high population density have high exposure level.
Sensitivity	Dependence ratio	Describes the population number that is has high dependence (children and elderly) compared to those who do not (adults between 16-64). Villages with high dependency ratio will have a higher sensitivity compared to villages that have low dependency ratio.
	Main Source of Livelihood	Describes the sensitivity level of livelihood source of a family to climate conditions. Regions where the main source of livelihood is agriculture are relatively more sensitive to climate conditions. Oresence of climate anomalies will strongly determine the source of livelihood so that regions where most of the livelihood is from agriculture will be more sensitive compared to regions whose source of livelihood is not from agriculture.

	Main drinking/cooking water source	Describes the how easily people in a region can access drinking water source. Having a drinking water supply system that can reliably supply water throughout the year, the sensitivity of the region to climate shocks or anomalies in terms of drinking water provision will become low. For example, families whose drinking water source is from the Regional Drinking Water Utility (PDAM) are relatively less sensitive to climate shocks compared to families with drinking water source from wells or rivers as water supply from these sources fluctuate with seasonal conditions. Thus, regions whose drinking water is partly supplied by PDAM would have a lower sensitivity compared to regions that get their water from wells or rivers.
	Agricultural Households	Describes the number of families who are very dependent on the agricultural sector. The agricultural sector is relatively sensitive to climate change, so the more families in a region depend only on agriculture for their livelihood, the internal conditions of the region would be relatively more sensitive to climate change.
	Slum Households	Describes the number of households living in slums. Relatively speaking, villages that have a high percentage of households living in slums have higher sensitivity to stimuli/stress.
	Percentage of irrigated paddies	Describes the how easily paddies can be subject to impacts of climate change. Villages where most paddies are not irrigated will be relatively more sensitive to climate variability and climate change.
	Forest cover/ open green spaces	Describes the fraction of regions that are still forested or are green. Villages where most of the land is not forested would have a higher sensitivity to climate change.
Adaptive Capacity	Income per capita HH with savings	Describes the average income of the population or a community's financial conditions. Villages with an average income per capita or a percentage of population with higher savings would relatively have a higher adaptive capacity.
	Credit facilities Cooperative facilities	Describes how easily people can access source of funds and life needs. The number of such facilities describes the condition of institutions in this village. The more villages having this capacity, they relatively have better adaptive capacity.
	HH electricity/ Number of HH with electric lighting Main source of fuel	Describes the level of wealth of a family. Families with higher income level would have a higher adaptive capacity as well.
	Education facilities	Describes the education level of the community in the village. A community with high levels of education will have a higher capacity in addressing or facing the climate risk

Health Facilities	Describes the condition of village health facilities that strongly influence access of the community to health facilities. The better and more health facilities, the community's health condition would be relatively better, which means the ability to face changes or stress will be better. In addition to that, recovery from health problems due to disasters will also be quicker.
Road Infrastructure	Describes the condition of transportation system. The better the road facility and infrastructure, the community's economic activities will proceed more fluently and may impact on village economic improvements. In addition, the people will more easily overcome the situation during disasters, such as evacuations, aid distribution, etc. The better the road infrastructure, the better the adaptive capacity.
Agricultural Facility Kiosks	Describes the ease of access of communities in meeting the need for agricultural facilities. The more kiosks in a village, the people would relatively act quicker and easier for them to get agricultural inputs as well as conduct recovery efforts for their agricultural business in the event of a disaster.
Migrant Workers	Describes the number of the population who are migrant workers. Generally, migrant workers provide a lot of contributions to village income, so that villages that have a high number of migrant workers will netd to have a higher average family income. The higher the average community income, the higher their ability to do adaptive afforts in the face of stresses or changes that occur.
Market Facilities	Describes the easiness with which communities can access to meet their life needs and village economic conditions. Villages that have market facilities will relatively habe better economic activity and easier access to get goods for their llife needs, so that the adaptive capacity is better.
Toilet Facilities	Describes a community's socio-economic cnoditions. Village where most of the households have their own toilets will have a relatively beter adaptive capacity due to the economic condition and environmental awareness of the people that are generally good.
Availability of Field Campaigners/ Guides/ Facilitators	Describes the availability of field facilitators who play an important role to support the people in their economic activities and address problems. Villages that have a large number of guides/facilitators will have a better adaptive capacity.

Remarks: Indicators that are used can be added according to the availability of data and how close such an indicator explains the exposure, sensitivity and adaptive capacity level. Some additional indicators that can explain exposure include, for instance, the fraction of residential areas and farmlands that are located within a 1 km radius from the coastline, the sensitivity level such as the rate of garbage production and the ability to process it (the higher the ratio the more sensitive the region to flooding disaster), adaptive capacity, such as agricultural facilities kiosk (easy of access of communities to meet their agricultural facilities needs, the people can get their agricultural inputs relatively faster and easier, as well as to conduct recovery efforts for their agricultural business in the event of a disaster). Data regarding the institutional capacity used by BNPB is highly relevant to be included into the capacity indicators for climate change adaptation.

Appendix 2 Calculating the Exposure and Sensitivity Index (IKS) and Adaptive Capacity Index (IKA)

Method for Calculating the Village Vulnerability Indicator Value at Provincial Scale (Boer et.al, 2013)

Data source used to calculate village vulnerability level at the provincial scale is the Village Potential (Podes) data of 2011 produced by BPS.

Referring to the indicator data presented in Table 2-1, four were used to describes the adaptive capacity factor for all villages in NTT Province.

The first indicator (KA_1) was education facilities. The value is calculated as a ratio between the numbers of education facilities (SD, SMP, SMU and Universities) with the population size. Villages with high risk have a high school capacity that indicates that the education service for the community in that village is already good. It is assumed that the better the education service, the better the community's education, which means the higher their adaptive capacity. The education service indicator value (I_{KA1i}) is calculated with the following formula:

$$I_{KA1i} = 1/P_i * (0.07*TK_i + 013*SD_i) + 1/P_{ij}*(0.20*SMP+0.27*SMU_j)+1/P_{ik}*(0.33*U_k)$$

where P_i, P_{ij} and P_{ik} are population from the *i*-th village, *j*-th suib-district from the *i*-th village, and *k*-th district from the *i*-th village. The value that accompanies the number of school is the weight value. The highest weight is assigned to the highest education level (university) for its contribution to determine the highest adaptive capacity. In the above formula, the population value used as the denominator for secondary and high school education services is the population of the sub-district where the village is located, while for universities the population of the district where the village is located. This is done with the assumption that the secondary and high school education services in a village can be enjoyed by other villages in the same sub-district, and university services in a village is intended to serve the population in other villages in the district.

The second indicator (KA_2), health facilities, describes public access to health facilities. It is assumed that the better the health facility of a village, the better the adaptive capacity of the community in that village, because health level determines one's ability to work. Data used to calculate the indicator value is the data of the number of Polyclinics (PL), Integrated Services Posts (Posyandu: PS), Community Health Centers (Puskesmas: PK), Midwife Clinics (B) and Doctor Clinics (D). The formula for calculating the health indicator (I_{KA2i}) is:

$$I_{KA2i} = \frac{1}{P_i}\{0,3 \times (PLi) + 0,2 \times (PSi) + 0,2 \times (PKi) + 0,1 \times (Bi) + 0,2 \times (Di)\}$$

where P_i is the population of the *i*-th village. The value associated with the types of health services is the weight. The highest weight is given to polyclinics as theya re seen to be the most accessible health service facility.

The third indicator (KA_3) is the ratio of the number of families using electricity facilities both from PLN as well as non-PLN. This indicator is used to describe the prosperity level of a villge household. The indicator value (I_{KA3i}) is calculated using the following formula

$$I_{KA3i} = \frac{KK\ Listrik_i}{KK\ Total_i}$$, where *i* represents data from the *i*-th village.

where KK $Listrik_i$ and KK $Total_i$ is the number of families that have electricity facilities and the the total HH number in the *i*-th village.

I_{KA1} I_{KA2} and I_{KA3} have a very small value and high variability if there is a very large population difference between villages. Thus, this indicator value is divided into five classes using a quartile system (Q1, Q2 and Q3) as shown by Table L-1. All indicator values under class 1 will have a score of 0.2, under class 2 will have a score of 0.4 and so on. The Q1, Q2 and Q3 value shall be calculated using data from all village in NTT Province.

Table L- 1 Determining classes using quartile system

Class	Quartile System (Q)	Score
1	I_{KA}< Q1	0.2
2	Q1 <I_{KA}<(Q1+Q2)/2	0.4
3	(Q1+Q2)/2<I_{KA}<(Q2+Q3)/2	0.6
4	(Q2+Q3)/2<I_{KA}<Q3	0.8
5	I_{KA}>Q3	1

The fourth indicator (KA_4) is road access that describes the condition of supporting facilities for community economic activity and how easily the community can mobilize in the event of a disaster. Villages with good road infrastructure have relatively better economic activity or can access other economic ctivity centers. The score for this indicator is determined by the type of roads as shown by Table L-2.

Table L- 2 Score given for road infrastructure indicator

No	Type of Road Surface	Score
1	Others	0.25
2	Hardened Road	0.50
3	Concrete	0.75
4	Asphalt	1.00

Based on the value of the four indicators above and IKA value is established based on the following formula:

$$IKA_i = \sum_{j=1}^{n} w_j * I_{Aij}$$

where i and j represents the i-th village for A vulnerability indicator, and w_j is the weight for every indicator of the j-th adaptive capacity. The determination of the weight is subjective, depending upon the understanding and knowledge about the indicator's contribution amount in determining the adaptive capacity.

There are 8 main indicators for IKS (KS_1, .., KS_8) that represent theexposure and sensitivity level as shown in Table 2-1.

The first indicator (KS_1), i.e. number of households (HH) living along riverbanks. The value of the indicator (I_{KS1}) is calculated as a ratio of the number of HH living along the riverbanks with the total number of HH, as follows:

$$I_{KS1i} = \frac{KK\ bantaran\ sungai_i}{KK\ Total_i},$$

Whe i represents the data of the i-th village/urban ward. The value of this indicator will then be converted to become a score by using the quartile system as shown in Tabel L-1. This indicator can show the exposure level of villages. Villages where the majority of the households live along the riverbanks have a greater chance to be exposed to disasters, particularly flooding, and the danger of landslides. Thus, villages with a high score will have a high exposure level compared to other villages with a low I_{KS1} score.

The KS_2 indicator is the number of buildings located along riverbanks. This indicator shows the level of exposure. The value of this indicator is calculated with the following formula:

$$I_{KS2i} = \frac{Bangunan\ bantaran\ sungai_i}{KK\ Total_i},$$

where i represents the data of i-th village/urban ward.

The third indicator (KS_3) is population density. This indicator shows the level of exposure. Villages with high population density have a highest level of exposure to disasters. The value of the population density indicator is calculated using the following formula:

$$I_{KS3i} = \frac{Jumlah\ penduduk\ _i}{Luas\ area_i},$$

where i representes the data the i-th village/urban ward. The value of this indicator is then converted into a score using a quartile system as shown in Table L-1.

The fourth (KS_4) and fifth (KS_5) indicator is the fraction of the area of paddies and farmlands in a village. This data is used to show the level of exposure, because rice and agricultural plans are very prone to the impacts of climate disasters. Villages where most of the land is rice paddies and farmland have a high likelihood to be exposed to climate disasters compared to villages that have less farmland. The formula to calculate this indicator is as follows:

$$I_{KS4i} = \frac{Luas\ lahan\ sawah_i}{Luas\ area_i}\ , \text{ and } \qquad I_{KS5i} = \frac{Luas\ lahan\ pertanian_i}{Luas\ area_i}\ ,$$

where *i* represents the data of the *i*-th village/urban ward. The value of this indicator is also converted into a score using the quartile system as shown in Table L-1.

The sixth indicator (KS_6) is the community's main livelihood. Villages having the main source of livelihood that are highly influenced by climate conditions are considered to have a high sensitivity to climate variability and chang. In this analysis, villages/urban wards with the main source of livelihood from agriculture will have a high score, as shown in Table L-3.

Table L- 3 Indicator value by type of main community source of livelihood

No	Main source of livelihood	Score (indicator value)
1	Agriculture	1.00
2	Mining and Processing Industry	0.75
3	Trade, transportation and household business	0.50
4	Services	0.25

The seventh indicator (KS_7) is the most dominant drinking and cooking water source in a village. This indicator describes the level of sensitivity of a village. Villages with water sources not affected by seasonal changes will have a lower sensitivity. Villages with Water Utility (PDAM) as the main source of drinking water are relatively less sensitive than villages with the dominant source of water outside of PDAM. The values of village indicator by the main drinking water source is shown in Table L-4.

Table L-4 Indicator value by dominant type of community drinking water source in every urban ward

No	Main drinking water source	Score (indicator value)
1	PDAM	0.25
2	Electric/hand pump, Well, Spring	0.50
3	River/lake	0.75
4	Rainwater and other	1.00

The eighth indicator (KS_8) is the number of farming HH in a village. This value is normalized by dividing it with the total nu,ber of HH per village as follows:

$$I_{KS8i} = \frac{KK\ pra\ sejahtera_i}{KK\ Total_i}\ ,$$

where *i* represents data of *i*-th village/urban ward. This indicator represents the sensitivity level. Villages with a high percentage of the population whose life depend only on agriculture, the internal conditions of this region will relatively be more sensitive to climate change. This indicator value is converted into a score with the quartile system as shown in Table L-1.

Based on all indicators above, the IKS values is determined as follows:

$$IKS_i = \sum_{j=1}^{n} w_j * I_{Bij}$$

where i and j represents every i-th village/urban ward *and* the j-th exposure/sensitivity indicator (B) and w_j is the weight for every j-th vulnerability/sensitivity indicator.

Method for Calculating the Value of District-Scale Village Vulnerability Indicator

The indicator to represent exposure, sensitivity and adaptive capacity of a village at the district scale is slightly different than that used at the provincial level (See Table 2-1). Based on consideration of characteristics and availability of data at the district level, some indicators that are used at the provincial scale are slightly different than those at the district scale. As an example, the indicator for electricity facility at the provincial scale only provides information about the number of households having electricity facility and those that do not, while at the district scale, a more detailed information, such as the number of households by the type of electricity source. In addition to that, some districts added new indicators. The similarity to calculate the indicator value from a different type of data for the three districts are elaborated as follows:

Indicators that Represent Adaptive Capacity

Number of HH based on Source of Fuel. This data is used to represent adaptive capacity of a village as it can describe family prosperity. A family with cooking fuel source that uses gas from a city pipe is assumed to have a higher level of prosperity compared to families that uses firewood or charcoal as fuel. Families with higher prosperity level have a relatively better daptive capacity. Village score by types of fuel is presented in Table L-5.

Number of HH by Type of Lighting. This data is also used to represent the level of family prosperity in villages/urban wards. Available data in the form of household number by type of lighting includes PLN electricity, non-PLN electricity and non-electricity (e.g.: kerosene lamp). The score for this indicator is calculated with the following formula:

$$I_{KAi} = \frac{KK\ ListrikPLN_i + KK\ ListriknonPLN_i}{KK\ Total_i},$$

where i represents the data of i-th the village/urban ward.

Table L- 5 Village scoring by type of fuel source

No	Criteria by type of fuel source	Score (indicator value)
1	City Gas	1.00
2	LPG	0.80
3	Kerosene	0.60

4	Firewood	0.40
5	Others (coal, charcoal, etc)	0.20

Regional Original Revenue. This data describes the capacity of village institutions to solve development issues. Villages that have high Regional Original Revenue (PAD) will have more resources to resolve problems faced compared to villages with low PAD. Based on this data, the village score by PAD is calculated with the following equation:

$$I_{KAi} = \frac{PAD_i}{Jumlah\ penduduk_i},$$

where *i* represents the data of the *i*-th villages/urban ward

Farmer Groups. This data provides the information on the number of farmer groups in the main sector in the region (agriculture). This information describes the condition of farmer institutions in the village. Villages that have many and strong farmer groups have a relatively better adaptive capacity. The presence of farmer groups can accelerate and make effective the implementation of a program or dissemination of information as well as technology. The score for this indicator is calculated using the following formula:

$$I_{KAi} = \frac{Kelompok\ Tani_i}{Jumlah\ RT\ pertanian_i},$$

where *i* represents data of the *i*-th villages/urban ward

The Number of Families based on Toilet Criteria. Data on the number of families based on toilet criteria (own-SD; public-UM; shared-BR; and others-LN) is used to describe the level of prosperity or level of living and knowledge about sanitation and cleanliness. Villages/urban wards where most of the families already have their own toilet describes a relatively more prosperous level of living.

$$I_{KAi} = \frac{1}{KK_i}\{0.4 \times (SDi) + 0.3 \times (UMi) + 0.2 \times (BRi) + 0.1 \times (LNi)\}$$

where *i* represents tha data of *i*-th village/urban ward, and the multiplier number of HH by type of toilet is the weight value. HH with own toilet have a greater weight compared to HH using shared or public toilet.

Indicators that Represents the Level of Exposure and Sensitivity

Villages Location/Position. This data shows the village topographic condition used to describe the village exposure level to disaster potentials due to climate. It is assumed that villages located on plains have a greater exposure compared to those on slopes, in valleys, and peaks (Table L-6).

Table L- 6 Scoring system for village locations

No	Village locations	Score (indicator value)
1	Slope	1.00
2	Peak	0.75
3	Valley	0.50
4	Plain	0.25

The use of score values in Table L-6 can change and can be arranged by taking into consideration the type of disaster and the easiness with which the village can be exposed to climate disasters according to the village's geographic position. Examples can be seen in Table L-7.

Table L- 7 Village score by location on land other than coasts and vulnerability to climate disaster

Type of Disaster	Disaster weight	Peaks	Valley	Plains	Slopes
Drought	0.35	4	0	1	3
Flooding	0.35	0	4	2	0
Winds	0.15	4	1	1	2
Landslides	0.15	2	2	0	4
Risk level	$\Sigma □_i □□_i$	2.3	1.85	1.2	1.95
Score		0.32	0.25	0.16	0.27

Remarks: 0 to 4 shows the vulnerability to disaster (n). A score of 4 shows the highest vulnerability to disaster (i) while 1 is the lowest, and 0 means no possibility for disaster.

Villages Slope. The informasi on the slope of a village as one of the indicators can describe the exposure condition of a region, where regions with high slope will have a higher possibility for disasters, especially landslides. The scores for village slopes can be seen in Table L-8.

Table L- 8 Scoring for village slopes

No	Village slope	Score (indicator value)
1	Gentle (<15^{o})	0.25
2	Medium (15^{o}-25^{o})	0.50
3	Steep (>25^{o})	1.00

Presence of Coastal Villages. NTT has a lot of coasts, and the presence of coastal villages is one of the indicators that can describe the exposure level of the region to coastal flooding and sea-level rise. Villages under the coastal village category will have a score of 1, while non-coastal villages will have a score of 0.

Indicators of village location, slope and presence of coastal villages may be combined into one indicator. The land slope indicator can be used to demonstrate the location/position of the village. For slope data, if the village slope is gentle, then the village location/position can be categorized as a plain village. If it is dominated by medium and steep slopes, it would be under the category of slope village. For presence of coastal village, an additional type of village can be added, namely, coastal village. [sic] If this approach is used, the village score by location that considers its vulnerability to climate disaster is shown in Table L-9.

Table L- 9 Village score by topography and vulnerability to climate disaster

Type of disaster	Weight (w_i)	Peak	Valley	Plains	Slope	Coastal
Drought	0.30	4	0	1	3	2
Flooding	0.30	0	4	2	0	3
Winds	0.15	4	1	1	2	3
Landslides	0.15	2	2	0	4	0
Coastal fooding/ Sea-level rise	0.10	0	0	0	0	4
Risk level	Σ□$_i$□□$_i$	2.1	1.65	1.05	1.8	2.35
Score		0.23	0.18	0.12	0.20	0.26

Remarks: Value of 0 until 4 shows the vulnerability to disaster (□□. Value of 4 shows the highest vulnerability to disaster (i) while value of 1 the lowest and 0 has no possibility for disaster threat.

Level of Dependency. The level of dependency is the comparison between the child and elderly population with respect to the productive-age population. This indicator can represent the sensitivity level. Villages with high level of dependency will have a high sensitivity to disasters. The following equation is used to obtain the level of dependency:

$$I_{KS5} = \frac{Jumlah\ penduduk\ usia<15_i + Penduduk\ usia>64_i}{jumlah\ penduduk\ usia\ 15-64_i}$$

Number of families by type of house. This data describes the sensitivity level of assets to disaster. Villages that have a lot of non-permanent houses will have a higher sensitivity commapred to villages that have permanent houses. The form of data available includes families by type of house-Jr (permanent-PR; semipermanent-SP; and emergency-DR). The equation used to calculate the score for this indicator is:

$$I_{KSi} = \frac{1}{KK_i}\{0{,}25 \times (PRi) + 0{,}35 \times (SPi) + 0{,}4 \times (DRi)\}$$

where *i* represents data for the *i*-th village, KK_i represents the number of HH's in the *i*-th village/urban ward. The number that follows the type of houses shows the weight. Houses with higher sensitivity level have the highest weight.

Number of farming families. Data on the number of farming families can describe the sensitivity of a village to climate disasters. A village with a high number of farming families will have a higher sensitivity to climate change as the productivity of the agricultural sector is highly influenced by climate conditions. The formula used to calculate the score for this indicator is as follows:

$$I_{KSi} = \frac{Keluarga\ pertanian_i}{Keluarga\ Total_i} ,$$

where *i* represents data of the *i*-th village.

Waste disposal. This data shows the waste management system of a village used to describe the village sensitivity. A village with waste management that is not good will have a relatively higher sensitivity compared to vilages with a relatively better waste management system. Villages with bad waste management will have a bad environmental condition, because garbage that is not managed can pollute the environment and clog drainage and rivers, reducing the capacity of the channels to excess water. In such a condition, a village will become more sensitive to flooding events, as slight changes in rainfall may already cause flooding. Based on this condition, the score for this indicator is presented in Table L-10.

Table L- 10 Scoring system for place of waste disposal

No	Waste disposal place criteria	Score (indicator value)
1	Waste bin, the transported	0.20
2	In a hole/ burned	0.40
3	River/ irrigation channels	0.60
4	Drainage (ditches)	0.80
5	Others	1.00

All indicator values calculated using the above formula can be grouped using the quartile system as presented in Table L-1. **However, the Q1, Q2 and Q3 values are calculated only using the data of all villages in each district, not data of all villages at NTT Province**. This is done in order that the comparison of vulnerability level between villages in one district refers only to villages within that district. The formula to calculate IKS and IKA is the same as the one at the provincial level, however the weight used is adapted to follow the different indicators used and is expected to have a large effect on the vulnerability. The weigth value for each indicator is presented in L-11.

Table L- 11 Weight value for indicators for Provincial and District level analysis

Indicator	NTT Province	District Manggarai	District Sabu Raijua	District East Sumba
Adaptive capacity indicator	Indicator Symbol			
Education facilities	KA_1=0.25	KA_1=0.25	KA_1=0.25	KA_1=0.25
Health facilities and personnel	KA_2=0.30	KA_2=0.15	KA_2=0.20	KA_2=0.15
Number of HH by lighting source			KA_3=0.1	KA_3=0.05
Electricity facility	KA_3=0.25	KA_3=0.15		
Number of HH by fuel source		KA_4=0.10		
Number of families by toilet criteria		KA_5=0.05	KA_4=0.15	
Regional Original Revenue			KA_6=0.20	KA_4=0.20
Road infrastructure	KA_4=0.20	KA_6=0.20	KA_5=0.10	KA_6=0.20
Farmer groups		KA_7=0.10		KA_5=0.15
Indicator of exposure and sensitivity	Indicator Symbol			
Number of HH living along riverside	KS_1=0.05			
Number of buildings along riverside	KS_2=0.05			
Population density	KS_3=0.10	KS_1=0.16	KS_1=0.10	KS_1=0.12
Number of families by type of house			KS_2=0.06	
Paddies	KS_4=0.05	KS_2=0.12	KS_3=0.06	KS_5=0.08
Farmland	KS_5=0.10	KS_3=0.04	KS_4=0.04	KS_6=0.04
Main source of livelihood	KS_6=0.25			
Village location			KS_5=0.06	KS_2=0.06
Village slope		KS_4=0.08	KS_6=0.04	KS_3=0.06
Presence of coastal villages			KS_7=0.04	KS_4=0.04
Dependency rate		KS_5=0.12	KS_8=0.18	KS_7=0.15
Poor population ratio	KS_7=0.20	KS_6=0.24	KS_{11}=0.21	KS_8=0.24
Waste disposal		KS_7=0.09		
Number of HH by type of water source	KS_8=0.20	KS_8=0.15	KS_9=0.12	KS_9=0.21
Number of farming families			KS_{10}=0.09	