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CONTENT

VULNERABILITY OF SMALL ISLANDS TO CLIMATE CHANGE IN INDONESIA: A case study of Lombok Island, Province of Nusa Tenggara Barat

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Due to its geographical and socio-economic circumtance, the majority of regions in Indonesia are considered to be vulnerable to potential impact of climate change. Therefore, the option for adaptation measure at national and regional levels are rapidly emerging as central issues to debate arround policy responses to climate change. In order to prioritize, design and implement intervention to adapt to climate change, it is essential to adopt a coherent set of approach, framework and method for examining vulnerability and adaptive capacity.

Many vulnerability studies while effective in making awareness to the possible effect of climate change, have limited effectiveness in providing local scale guidance on adaptation. Methods and tools for supporting the process of building adaptive capacity at the provincial/local level are different from the one used for assessing impacts, vulnerability and adaptation on national and global scales.

To effectively formulate adaptation strategy at the province level, it is proposed to apply "meso level-multi sectoral approach" which means assessing vulnerability at the meso-level but considering the multi sectoral impacts of climate change i.e. water and ocean sectoral. The regional approach in climate vulnerability studies is a useful approach because many practical adaptation strategies will be applied at a regional rather than sectoral scale and climate change impacts vary from region to region (DEH Australia, 2005) X

The Lombok Island was selected as a case study area because it represents small islands which could experience harmfull impact from climate change. Lombok Island is part of Nusa Tenggara Barat Province which has already prepared Provincial Action Plan for Mitigation and Adaptation to Climate Change. It shows serious commitment of its provincial government in preparing its society to face impact of climate change.

Key Words : *climate change, vulnerability, adaptation, small island.*

1. INTRODUCTION

Adaptation is a crucial part of a response to the impacts of climate change. Adaptation is essential to decreasing the current and unavoidable impacts from climate change. The net benefits of adaptation will be experienced earlier than those of mitigations as they are immediate (Berkhout, et. all., 2005). Since mitigation cannot reduce the immediate impacts of climate change, adaptation is an essential and urgent policy response. However, adaptation can not replace mitigation on political agendas; it is a must that both adaptation and mitigation operate together within the context of sutainable development. Therefore adaptation, together with mitigation, is an important response strategy. Without strong commitment of mitigation, the costs of adaptation will rise, and countries' and individual' capacity to adapt will be reduced.

Some adaptation will occur spontaneously, as individuals respond themselves to changes in the physical, market or other conditions. Adaptation aspects will also include measures which requires better planning, e.g. major infrastructure decisions. Basically, there were two kinds of adaptation: autonomous adaptation and policy-driven adaptation.

Facilitating adaptation includes providing information, making available financial and other resources and building adaptive capacity. Implementing adaptation include delivering required actions, and applying new technologies. Klein (2004) underlines that "when going from the national to the local level, the reponsibility of relevant actors shift from facilitating to implementing adaptation". Therefore, there are two broad level in delivering adaptation: strengthening adaptive capacity and implementing adaptation actions.

Unless adaptation planning decisions are well informed by an improved understanding of current vulnerabilities and the magnitude and timing of future change, the potential exists for insufficient action or for maladaptation (actions that inadvertently increase vulnerability to climate change).

Developing countries in tropical and sub-tropical regions are anticipated to experience adverse impacts from climate change. Their exposure to climate change is high especially due to their economic and social capacity. The role of government in reducing this vulnerability is through implementation of good development practice. The government responses on climate change will be focused on three aspects: making available high quality information; integrating climate change into land-use planning policy; and taking into account climate change into major infrastructure planning.

Due to its geographical and socio-economics circumtances, the majority of regions in Indonesia are considered to be vulnerable potential impacts of climate change. Therefore, the options for adaptation measures at national adn regional level are rapidly emerging as central issues in the debate around policy responses to climate change. In order to prioritize, design and implement intervention to adapt to climate change, it is essential to adopt a coherent set of approach, framework and method for examining vulnerabiltiy and adaptive capacity.

The Lombok Island was selected as a case study area because it represents small island which could experience harmful impacts from climate change. Lombok Island is part of Nusa Tenggara Barat Province which has already prepared Provincial Action Plan for Mitigation and Adaptation to Climate Change. It shows serious commitment of its provincial government in preparing its society to face impact of climate change.

2. LITERATURE REVIEW

Five approaches to Climate Change Impact, Adaptation and Vulnerability (CCIAV) assessment have so far been clasified. The Four are classified as conventional research approaches: impact assessment, adaptation assessment, vulnerability assessment and integrated assessment . The fifth approach is adopting risk assessment framework which can be considered as an emerging approach of CCIAV studies. The fifth approach has started to be applied in mainstreaming adaptation option into policy-making (IPCC, 2007). There has been another important trend that is the shift from research-driven approaches to assessments integrated toward policy-making, where decision-makers and stakeholder either participate in or drive the assessment (UNDP, 2005).

Many vulnerabilities studies while effective in making awarenes to the possible effect of climate change, have limited effectiveness in providing local scale guidance in adaptation. Method and tools for supporting the process of building adaptive capacity at the local level are different from the ones used for assessing impacts, vulnerability and adaptation on national and global scales (see Table 1).

Table 1. Different Level of Vulnerability Studies

Scale level	Data needs/analysis	Size of study region	Planning level	Accuracy	Expenditure per area
Macro	Qualitative	National	Adaptation policy	Low	Low
Meso	Combination of qualitative and quantitative	Regional	Adaptation strategies	Middle	Middle
Micro	Quantitative	Local	Adaptation measures	High	High

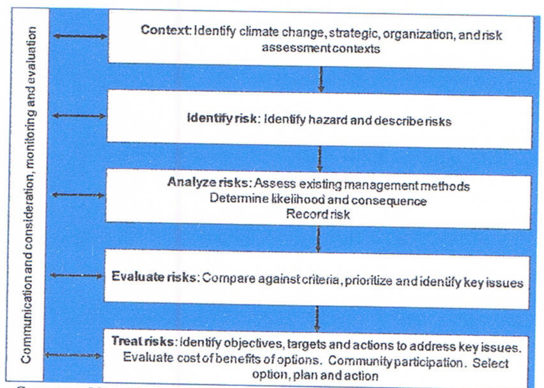
Source: modified from Messner, 2005.

To effectively formulate adaptation strategy at the Province level, it is proposed to apply "meso level-multi sectoral approach" which means assessing vulnerability at the meso-level but considering the multi sectoral impacts of climate change. The regional approach in climate vulnerability studies is a useful approach because many practical adaptation strategies will be applied at a regional rather than sectoral scale and climate change impacts vary from region to region (DE and H Australia, 2005).

The risk assessment framework has been well developed within the Natural Disaster Communities and has been increasingly adopted for vulnerability assessment to climate change (Klein, 2004). Since the Third Assessment Report, definition of vulnerability based on IPCC has been confronted, both to account for social vulnerability (O'Brien et al., 2004) and to reconcile with risk assessment (Downing and Patwardhan, 2005). The methods and framework for vulnerability assessment must also address the determinants of adaptive capacity (Turner et al. 2003, Schroter 2005, O'brien and Vogel 2006)

The risk assessment offers a framework for policy measures that focus on social aspects, including poverty alleviation reduction, diversification of food, protection of infrastructures and building of collective action (Patwardhan, 2006)

The Government of New Zealand, as an attempt to build adaptive capacity at Local Government Level, provides A Guidance Manual for Assessing Climate Change Impacts. The procedures used are Risk Assessment Framework (see Figure 1).



Source : New Zealand Climate Change Office, 2004

Figure 1 Model for Risk Assessment Process

Affeltranger, et al. (2006) presents Risk Notation (see Figure 2). He defines Risk as an overlay between Hazards and Vulnerability. Vulnerability is defined by IPCC as "a function of character, magnitude and rate of Climate Change and the variation to which a system is exposed, its sensitivity and its adaptive capacity ". In the context of climate risk assessment, based on the Risk Notation by Affeltranger, et al. and definition of Vulnerability by IPCC above, it can be defined that

"Climate Hazards is a function of character, magnitude and rate of Climate Change and climate variation"

"Vulnerability of a system is function of exposure, sensitivity and adaptive capacity"

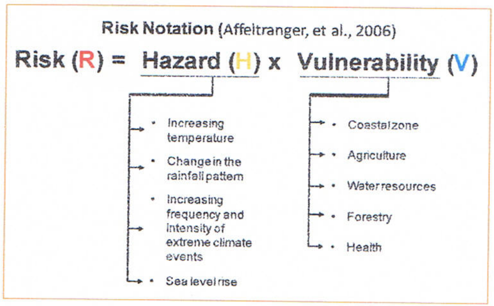


Figure 2 Risk Notation

3. METHODOLOGY

Following the above definition, a Climate Risk Assessment Framework is proposed and presented in Figure 3. The number of impacted sectors may be more than the one outlined in Figure 3. In reality, the impacted sectors will vary among provinces depending upon the actual conditions within each region.

Step 1: Define the problem and establish the context
This is a fundamental stage in the climate risk assessment process. Typical techniques that can be applied at this stage include brainstorming; public consultation; and focus group discussion. This step involves defining key sectors which are vulnerable to climate change as well as potentially affected infrastructures that are essential to a community's functioning (e.g., schools, ports, tourism facilities).

Step 2: Identify Climate Hazards
As described in Figure 4, it is defined that Climate Hazards is a function of character, magnitude and rate of Climate Change and climate variation. Therefore, Step 2 will consist of several activities as follows:

- Projections of Future Climate Change at a province level,
- Observation on Current Climate Variability and Change
  These natural variations will continue to impact Indonesia's climate through this century, and will be superimposed on the human-induced long-term climate change trend. This combination of underlying mean climate (with appropriate global warming adjustments) plus natural variations will give us the extremes which future Indonesia society will have to adapt to.
- Identification of character, magnitude and rate of hazards based on current and historical information, and projections of future climate change. For an example, in the context of sea level rise, it is expected that there will be at lea st three scenarios of projections i.e. Low, Current Trend and High.

Step 3: Identify Vulnerabilities of Key Impacted Sectors
As Vulnerability (V) is a function of Exposure (E), Sensitivity (S) and Adaptive Capacity (AC), the first phase will be to identify main indicators of E, S and AC. The next phase will be data collection based on the identified indicators. The further phase will be vulnerability analysis using i.e. GIS Tool, Statistical Approach etc. For an example, in the context of coastal zone, one of the Exposures might be elevation and location of major infrastructures such as port or tourism facilities. The sensitivity might be the rate of coastal erosion, and the adaptive capacity is perhaps the existing seawall.

Step 4: Analyse and Evaluate the risks
As defined by Affeltranger, et al. (2006), **Risk is composed of Hazards x Vulnerabilities**. Therefore, in analyzing climate risk, character, magnitude and rate of climate hazards resulted from Step 2 are overlaid with vulnerable sectors based on Step 3. For an example, if it is projected that there are three scenarios of sea level rise. Then, based on Step 3, a Map of elevation and location of coastal infrastructures is produced. By overlaying those two maps, it will be determined whether several key infrastructures would be inundated or not. If as a result of an overlay, by 2050 a tourism site would be flooded, it can be categorized as high risk.

Step 5 : Assess appropriate adaptation strategy based on the risk
Steps 1-4 should result in a good understanding of the implications and risk of climate change impact. The next step is to assess how these risks should be responded to, and treat the risk.

Step 6: Mainstreaming into Development Policies
Climate risk assessment and policy making does not occur in a vacuum, particularly within the provincial government context. Climate change is only another factor to consider among the range of aspects that provincial government already takes into account in all its policy-making. Climate change considerations may modify policies through the application of risk management processes in prioritizing possible responses to effects.

The emphasis here is on understanding the scope and variation of climate change, and applying risk assessment as a method to determine adaptation responses based on the risks. 'Best' knowledge of climate change, together with use of risk assessment procedures, can help local government prepare to help the community adapt to known climate change.

Risk management is well fitted into plan making and review processes at the stages where issues are being identified and a range of possible response options evaluated. The iterative process of plan administration, monitoring and review allows for modification of plans over time to take account of improved understanding of risks and effects associated with climate change. In considering climate change issues, the period over which the decision will have effect is of fundamental importance. Generally, whenever a decision is likely to have effects that will last 30 years or more, the implications of climate change should be taken into account.

4. RESULT AND DISCUSSION

4.1 Climate Change Projection

Complete understanding of climate change requires thorough studies of current, past (paleo), and possible future climate. A review on existing studies revealed that there are very few scientific papers on current climate change in Indonesia. The most representative study is probably by Manton et al. (2001) on "Trends in Extreme Daily Rainfall in Southeast Asia and The South Pacific : 1961-1998". The results, however, show that there were no significant trend for daily rainfall changes in Indonesia and conclusion on temperature changes was difficult to draw because of lack of consistent data. Another attempt by Aldrian (2006), on the other hand, focused on the change in annual rainfall and it was found that during 1968 through 1996 rainfall was decreasing in most of the Indonesian region. It was reported that the Island of Kalimantan was the most and Sulawesi is the least affected by the decreasing trend.

Even if the trend detected by Aldrian (2006) was true, information on the annual rainfall trend may not be very useful for application in, for example, agricultural sector because planting period, especially of food plants, is determined on seasonal basis. Analysis of seasonal rainfall trend was conducted in an investigation conducted in 2006 at the Research and Development Center of The Meteorological and Geophyiscal Agency (now BMKG) based on gridded rainfall data from Dr. Mike Hulme of Climate Research Unit (CRU). The results show a seasonal dependent of the trend but, considering the coarseness of the grid, usefulness for sectoral adaptation planning is also questionable.

The model is tried to investigate the current trend of climate change based on available data from Global Historical Climate Network (GHCN) and ASEAN Compendium of Climate Statistic Project. These data set should theoretically cover all of Indonesian region with a time span of 100 years (from 1901 to 1999) or more, but actually only few stations have good record. Manton et al. (2001) also had difficulties with data availability and only used data from five stations across Indonesia for their studies. Nevertheless, we found that monthly rainfall record of Jakarta is available for almost 100-year period. Using this particular data as an example, we analyzed the current climate change detected over Jakarta in monthly basis. It is found that large changes in monthly rainfall over Jakarta have occurred mainly during the rainy season of December-January-February (DJF). It is quite striking that the 30-year mean January rainfall over Jakarta had increased from about 300 mm to 400 mm during the 1896 to 1999 period, with the peak around 1976. On the other hand, the rainfall of February was found to have decreased from about 330 mm to 250 mm during the 1896 to 1948 period but increased again to about 300 mm in more recent period of 1948 through 1999.

Analyses of current changes in rainfall over Lombok indicate that climate sensitivity is not only seasonal, but also monthly dependent (Figure 4 and 5). These results imply that identification of current climate change in Indonesia must be made on monthly basis in order to be optimally applicable for sectoral planning. In this context, the 50-year monthly rainfall trend analysis produced (Sutamto, 2009) is probably the best product that we can use for sectoral planning. However, the method and data used in that work must be first clarified and verified.

Beside analyses of current climate change, the climate projection up to the year of 2100 is also crucial for long term development planning. Currently, a well validated climate projection model for Indonesia is not yet available. Ideally, it need both global and regional model for impact assessments. Outputs of the *Intergovernmental Panel on Climate Change* (IPCC) models are the main source of information on global climate projection. From several studies, it is pointed out that only few IPCC models have good consistency with observed monsoon variability (e.g., Annamalai et al., 2006).

Based on bottom-up analysis (or historical data), it could be conclude that the hazard potential is low due to increasing of regional temperature, that is no potential hazard due to change of annual rainfall and there is high potential hazard into agriculture sector due to shift of rainfall pattern. Therefore, based on top-down analysis (modeling output), in 2030 is not yet show impact of annual rainfall to the potential hazard, but must continue to pay attention to variability of rainfall pattern; and the impact of increasing temperature is low to moderate hazard. In 2080, it show that potential hazard due to change of rainfall pattern and temperature such as floods, droughts and landslides (water sector).

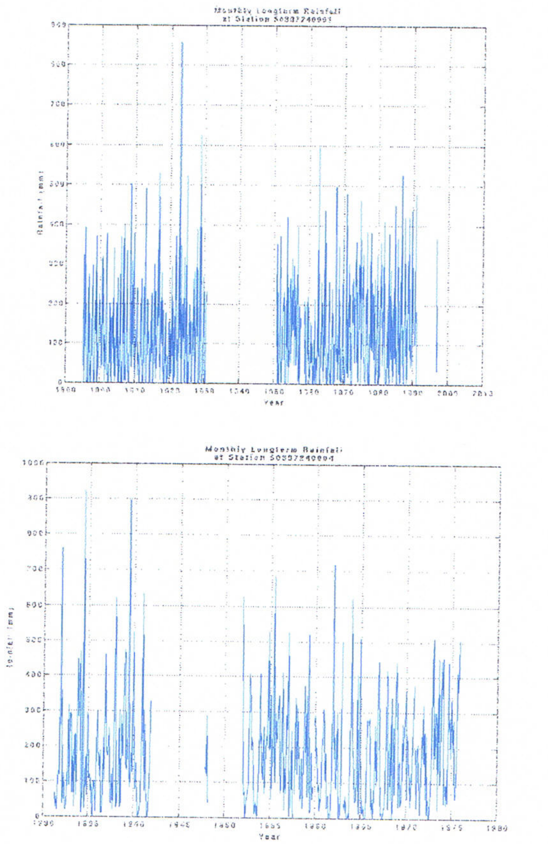


Figure 4. Monthly rainfall data at Ampenan and Babandem Station

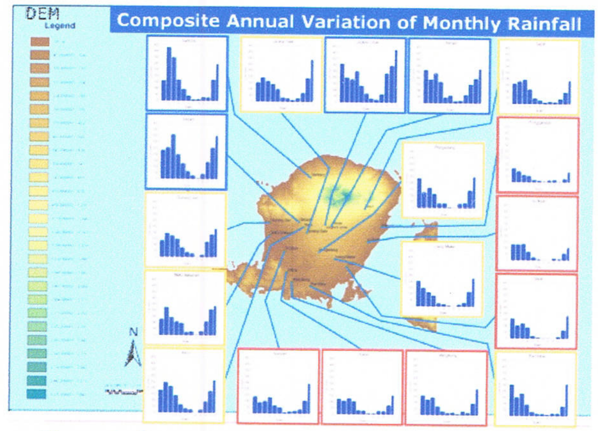


Figure 5. Composite annual variation of monthly rainfall

4.2 Sea Level Rise Projection

Based on a model using scenario from Intergovernmental Panel on Climate Change (IPCC) Special Report on Emission Scenario (SRES), the rate of sea level rise is projected to be 4 mm/year to 8 mm/year in 2100 (Figure 6 and 7). Besides having an impact on the Sea Level Rise, the experts estimated that global warming through the increase in the temperature of sea level in the tropical area will raise the frequency of the occurrence of the extreme event that result in increasingly high the frequency of the occurrence storm surges. This was seen from results of the analysis towards the potential for the El Nino occurrence and La Nina was based on results of the IPCC model.

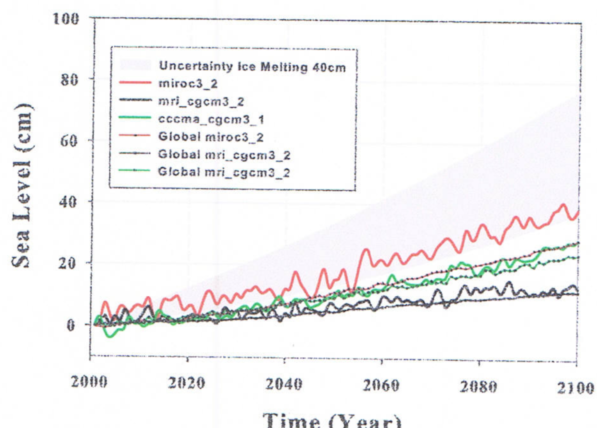


Figure 6 Estimation of mean sea level at northern Lombok Island based on IPCC SRESa1b scenarios.

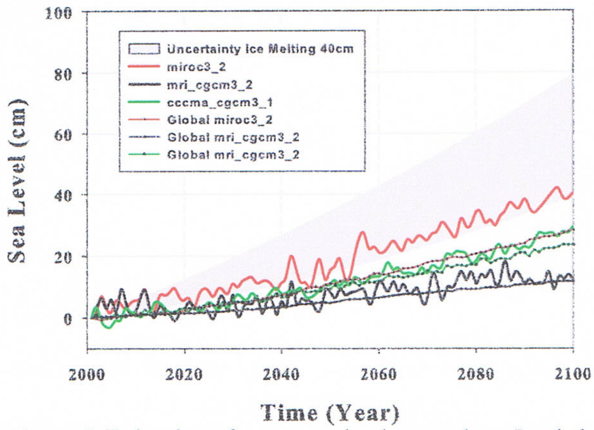


Figure 7 Estimation of mean sea level at southern Lombok Island based on IPCC SRESa1b scenarios

Table 2 is showed the summary of sea level rise rate at Nothern Lombok that is projected to be varied between 40 to 80cm until 2100. This results based on calculation using data of sea model from IPCC which the uncertainty of ice melting is 40cm. The sea level rise using tide data is the results of estimation the sea level rise at Benoa, Darwin, Sadakan and Surabaya Station with Benoa as reference.

Table 2 Sea Level Rise Projection

Period	Sea Level Rise Projection since 2000 (Northern coast of the Lombok Island)			Level of confident
	Tide Gauge	Altimeter ADT	Model	
2020	10 cm	7 cm – 8 cm	5.1 cm – 12.9 cm	Moderate to high
			3.4 cm – 9.4 cm	
			6.7 cm – 15.5 cm	
2050	25 cm	17.5 cm – 20 cm	13.6 cm – 33.4 cm	Moderate to high
			11.2 cm – 20 cm	
			16.2 cm – 35 cm	
2080	40 cm	28 cm – 32 cm	27.1 cm – 59 cm	high
			24.1 cm – 55 cm	
			24.2 cm – 56 cm	
2100	50 cm	35 cm – 40 cm	37.8 cm – 78 cm	high
			36 cm – 74 cm	
			33 cm – 73 cm	

Based on temperature of sea water and extreme event (ENSO) analysis until 2100, the result showed increasing of ENSO frequency from 3 to 7 year become 2 years. At El Nino event, sea level projected to be depreciate 20cm under normal, therefore, at La Nina event, projected to be increase to 10 – 20 cm. This condition would be impact to risk of erotion, abration and denudation especially at La Nina event with highly rainfall intensity.

4.3 Vulnerability in Water Sector

Hazards Analysis

Four parameters of climate change i.e. temperature increase, precipitation change, extreme events, and sea level rise will have impacts on water resources. Therefore, future projection of those parameters is essential for hazards analysis on water sector.

Vulnerability Analysis

The main indicator for assessing vulnerability of Water resource sector is *water balance* which consists of supply (surface water, ground water) and demand (irrigation, domestic and industry). The supporting indicators for Exposure include ratio between catchments area and total area of a province, and existing land use as indicatives of water storage capacity. The sensitivity includes degradation of catchments area, Quality of irrigation network, over pumped of groundwater, Lake Condition and water pollution. The Adaptive capacity includes Dam Condition, efficiency on water use, water treatment facilities. The vulnerability framework and map of vulnerability of water sector is shown in Table 3 and Figure 8, respectively.

Based on the map of vulnerability water sector could be identified several cities/the regency that really was susceptible to the decrease in the availability of water, that is the Mataram City and few territories in Kabupaten Lombok Tengah, Lombok Timur, and Lombok Barat. The level of vulnerability is accordance with the level of the hazard.

The vulnerability level in the Martaram City included 80% area of the territory is high due to the population density factor (in general > 32 people/km) and the number of settlement regions, the requirement for the inhabitants's water (domestic), the industry and others; and the infrastructure of the irrigation/water supplies like embung and the spring that really not all available.

Tabel 3. Vulnerabilty Framework of Water Sector

H pot	HAZARDS (H)	VULNERABILITY OF WATER SECTOR (V)		
		Comp	Type	Code
Change in precipitation pattern, increasing temperature, increasing intensity and frequency of extrem climate event, SLR, sea water soaking	Decreasing in WATER AVAILABILITY	E	Density of population (spatial), landuse (spatial)	d, tgl
		S	Water demand, soil/rock type, distribution of precipitation (spatial)	ka, gl, ch
		AC	Prosperity of population (spasial), infrastructure of irrigation	ks, inf
	FLOOD	E	Density of population (spatial), landuse (spatial)	d, tgl
		S	Degree of land degradation of cacthment area, degree of land degradation of protected forest, distribuiton of precipitation (spatial)	kr_ssws, kr_hl, ch
		AC	Prosperity of population (spasial), infrastructure of irrigation	ks, inf
	DROUGHT	E	Density of population (spatial), landuse (spatial)	d, tgl
		S	Water demand, distribution of pricipitation (spasial), degree of protected forest, slope (spasial)	ka, ch, kr_hl, kl
		AC	Prosperity of population (spasial), infrastructure of irrigation	ks, inf

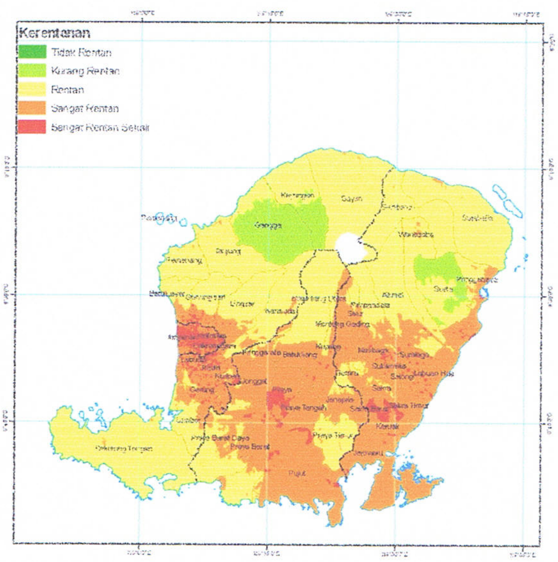


Figure 8 The map of vulnerability of water sector is shown in

4.4 Vulnerability in Coastal Sector

Hazards Analysis

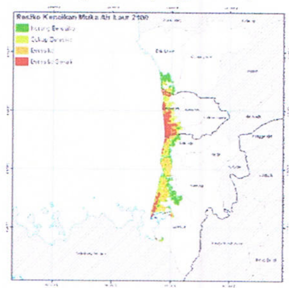
The first step is to project future sea level rise by using current trend and climate modeling. This step includes collecting historical data of tidal elevation. Then, it is analyzed using statistical approach. So that the trend of sea level rise could be determined. The projection of future sea level rise resulted from regression analysis would consist of three scenarios i.e. minimum, mean and maximum. This is just an alternative method. Other possible methods may include climate modeling.

Vulnerability Analysis

The initial stage of this step is to develop digital elevation model (DEM) for determining inundated areas. DEM is developed from a contour map. Then, a map of existing land uses which consists of coastal infrastructures, mangroves, settlement, fishponds, and coral reefs is produced from remote sensing images. Both maps are overlaid, so vulnerable coastal areas are shown.

Risk Analysis

The three scenarios of projection of sea level rise then are overlaid with vulnerable maps. The key infrastructures or ecosystems which are projected to be inundated would be rated as experiencing high risk impacts (Figure 9).



No	Level of Risk	Area (Ha)
1	Low Risk	1422.20
2	Moderate Risk	933.17
3	High Risk	958.88
4	Extreme Risk	813.44

Figure 9 Risk Impacts of Sea Level Rise

5. CONCLUSIONS

The Lombok Island will experience severe coastal hazards trigerred by climate change, especially coastal zone around the Mataram City which is rated as an extreme risk. It is recommended to conduct risk assessment at micro level to formulate adaptation actions. In terms of the water sector impacts from climate change, the sub river basin of Dodokan will experience high risk in terms of its water avaibility. The range of adaptation options includes construction of dam and "embung".

ACKNOWLEDGMENT:

This paper is drawn from the vulnerability study in the Lombok Island initiated by Partnerships of the Ministry of Environment, the Province Government of Nusa Tenggara Barat, GTZ Germany and WWF Indonesia.

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TENTATIVE SCHEDULE THE 2ND INTERNATIONAL WORKSHOP ON WATER SUPPLY MANAGEMENT SYSTEM AND SOCIAL CAPITAL

Program (Presentation 15 minutes, discussion 5 minutes)

15th March 2010

Time	Presentation
08:00 – 08:30	Registration
08:30 – 08:45	Opening Speech from Prof. Joni Hermana
08:45 – 09:00	Opening Speech from Prof. Kiyoshi Kobayashi
09:00 – 10:00	Keynote Speech from Prof. Hans Westlund
10:00 – 10:15	Coffee Break
Time	Presentation
Session 1	Wahyono Hadi
10:15 – 10:35	Entrepreneur Approach to Urban Policies and Regional Learning Kiyoshi KOBAYASHI, Hayeong JEONG
10:35 – 10:55	Optimization Of Ngobaran Water Supply System Management Rachmad Jayadi
10:55 – 11:15	Tri Hita Karana as the basic philosophy of Balinese Political Ecology: a case study of traditional Balinese agricultural organization Subak I Gede Herry Purnama
11:15 – 11:35	The Household Responses on Water Supply and Irrigation System Improvement in a Rural Community of Blora Regency, Central Java, Indonesia Ibnu Syabri, Hastu Prabatmodjo
11:35 – 11:55	Investigating on Community Based Water Management: Club Goods and Community Network Ismu Rini Dwi Ari
11:55 – 12:15	Community Based Water Supply Management Plan for Rural Area (Case Study: Borobudur Village) Mochamad Arief Budihardjo, Sri Hapsari Budisulistiorini
12:15 – 13:15	Lunch
Session 2	Ibnu Syabri
13:15 – 13:35	Vulnerability and Water Supply: Reassess Right based Approach to Water Supply in the Coastal Community Teti Argo
13:35 – 13:55	Government-society relationship in Community Based Water Supply Using Human Right Based Approach (Case Study : RW 12, Penjaringan District North Jakarta) Bintan Sholihat
13:55 – 14:15	Review of the Water Supply Project in Muntigunung, Karangasem, Bali Ni Made Utami Dwipayanti, Made Ayu Hitapretiwi, Sang Gede Purnama
14:15 – 14:35	Participatory Approach to Community Based Water Supply System Kenshiro OGI
14:35 – 14:55	An Alternative Multiple Factor Analysis to evaluate the Drainage Systems (Case Study in Sub-watershed Acay, Abepura District) Lieza Corsita, Haryo Tomo

14:55 – 15:15	Community Norm Formation By Linking Two Games Kakuya MASTUSHIMA
15:15 – 15:30	Coffee Break
Session 3	Rachmad Jayadi
15:30 – 15:50	Provision of Water Supply within the Experimentation of More Decentralized Local Institution in Indonesia Surjono, Aris Subagyo
15:50 – 16:10	Private Sector Involvement on Increasing Access Water Supply for Improving Family Health & Hygiene, in Banyuurip Village, Ujungpangkah, Gresik, East Java Angela Ika Yane Mariendrasari
16:10 – 16:30	Water Rights and Participatory Approach Hayeong JEONG
16:30 – 16:50	Clean Water Supply Concept at Downtown Area Ratih Wahyu Dyah, Fadly Usman, Septiana Hariyani, Eddi Basuki Kurniawan
Closing	

16th March 2010

Time	Presentation
Session 1	Surjono
09:00 – 09:20	Compartment and Leadership for Club Goods Provision Mamoru YOSHIDA
09:20 – 09:50	The Concept Of Deep Ground Water Management For Water Supply at Galis Dajah Village, Konang, Bangkalan-Madura Zainus Salimin, Gunandjar
09:50 – 10:10	Comparation Ozone Residual Concentration in Conventional Ozonization and Advanced Oxidation Process (Ozone and Ultraviolet) at Groundwater and Springwater M. Rangga Sururi, Kancitra Pharmawati, Sofi Widayani
10:10 – 10:25	Coffee Break
Session 2	Kakuya MATSUSHIMA
10:25 – 10:45	Impacts of Climate Change on the Sustainability of Water Supply in Indonesia Djoko S.A. Suroso, Oman Abdurahman and Budhi Setiawan
10:45 – 11:05	The Utilization Of Aerob Bacteria For Supplying Process Of Raw Water For Water Drinking Gunandjar, Zainus Salimin
11:05 – 11:25	Roughing And Slow-Sand Filters As An Alternative For Treating Polluted Wahyono Hadi
11:25 – 11:45	Social Capital- Participation in relation With Community Development for Management Waste-Water System (A Study Case Community Waste-Water Managed System From Mojokerto) Dimas Hastama Nugraha
11:45 – 12:05	Relationship between Open Green Space and Groundwater Quality in the Surabaya Nur Indradewi Oktavitri
12:05 – 12:15	Closing
Lunch	

Accepted

International Seminar on

Climate Change Impacts on Water Resources and Coastal Management in Developing Countries

Manado, Indonesia, 4 - 6 May 2009

Organized by :

Indonesian Association of Hydraulic Engineers

Directorate General of Water Resources
Ministry of Public Works
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Government of Manado City

Certificate

This is to certify that

Budhi Setiawan

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Presenter

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