Risk Assesment Study of Water Availability Related to Impact of Climate Change (Case Study: Tanjung Api-api Port Area, Banyuasin Valley)

Yunan Hamdani[1], Dwi Setyawan[2], Budhi Setiawan[3], and Azhar. K. Affandi[4]

Abstract— Climate change as impact of global warming could exacerbate the decline in environmental quality as a result of drought risk, water reduced availability and flooding. There are five approaches in Climate Change Impact, Adaptation and Vulnerability assessment, where the risk assesment is the one of approach to be applied in mainstreaming adaptation option into policy-making globally.

South Sumatra is very vulnerable due to its lowland areas that it may threat coastal, water, agriculture, and health sector.

The study concluded the oceanographic scientific basis of sea level rise to around 13.5 ± 6.15 cm in 2030[14]. The low vulnerability have an index of vulnerability by 0.18 and the moderate vulnerability by 0.52. The percentage of low risk was 80.15% and 18.32% moderate risk and high risk of 1.53% at projection condition in 2030 with retaining green open area of 30% of the area Banyuasin Valley area.

Keywords— Climate change, Lowland, Risk Assesment.

I. Introduction

SOUTH Sumatra Province is an area particularly vulnerable to Climate Change to Sea-level rise, Extreme waves, ocean currents, rising temperature, Increased frequency of extreme events such as Elnino and La nina, Changes in rainfall. Precipitation, sea level rise and extreme waves cause Flood, inundation, Erosion and deposition, Salt water intrusion,Its impact on water resources, Agriculture and Forestry, health and Infrastructure [15]

Sea Level Rise is likely to cause saltwater intrusion into surface waters and coastal aquifers, advance of saltwater into estuaries and coastal river systems, more extensive coastal inundation, higher levels of sea flooding, increases in the landward reach of sea waves and storm surges and new or accelerated coastal erosion. These consequences are expected to be overwhelmingly negative and particularly serious in deltas and small islands. Climate change and climate variability is also expected to impact agriculture, largely through a decline in soil and water quality.

Climate change is defined as long process and contain high complexity that very unpredictable, although using strictly mitigation. From [6], climate change is forecasted to bring gradual changes in weather patterns, and changes in the variability of extreme events to broad geographic regions. Climate change may increase the risk of structural damage to buildings, especially damage resulting from strong wind, flood associated with more intense tropical cyclone and storms.

The IPCC has outlined representative examples of projected infrastructure impacts of extreme climate phenomena [10]. Identifying the impact of climate change on infrastructure as distinct from other influences on our need to maintain, repair, and replace infrastructure, benefits from explicit attention to a conceptual model for impact assessment.

As a awareness to climate change, Bappenas (Republic of Indonesia) with GIZ (*Deutsche Gesellschaft fuer Internationale Zusammenarbeit*) have doing vulnerability assessment in macro level (national). This assessment developed to meso level (regional) by [17] in South Sumatera Province.

In the district`of Banyuasin, at this time the program has been planned deep sea port development in the Tanjung Api-api [2]. Supporting region District Tanjung Api-api covers most of the areas Banyuasin District II, District Tanjung Lago, and Muara Telang District. The area is bordered by the supporters of protected forest and river water telang Banyuasin to the north and west, Telang River to the east, and Canal Sebalik (PU) in the south. Overall the area is about 12,282 hectares. The development of Tanjung Api-api International seaport are also prone to the impact of flood and sea level rise.

Risk assesment approach has been well developed within the disaster communities and has been increasingly adopted within the Climate Change comunities. Risk Assesment Framework, based on [22], can be schematized as R=HxV. Under this approach, hazards is the natural events that may affect different places singly or in combination which can be though as the manifestation of the agent that produces the loss. This paper derived Hazards from the climate change parameters such as change of Precipitation (P), Sea Level Rise

Yunan Hamdani, Doctoral Candidate of Environmental Program, Sriwijaya University, Jln. Padang Selasa no. 524 Palembang-30139, e-mail: yunanhamdani@ymail.com

Dwi Setyawan, Doctoral of Environmental Program,Sriwijaya University, Jln. Padang Selasa no. 524 Palembang-30139, e-mail: dwiunsri@yohoo.co.id

Budhi Setiawan, Doctoral of Environmental Program,Sriwijaya University, Jln. Padang Selasa no. 524 Palembang-30139, e-mail: budhisetiawan@gmail.com

Azhar. K. Affandi, Doctoral of Environmental Program,Sriwijaya University, Jln. Padang Selasa no. 524 Palembang-30139, e-mail: azhar_affandi@yahoo.com.

(SLR), and extreme events (EE). For flood hazards assesment the parameters P, SLR, and EE are converted into flood hazards maps. Vulnerability refers to the potential for casualty, destruction, damage, disruption or other form of loss in a particular element. Therefore, under this framework, hazards assesment caused by climate change is firstly done, then it will be continued with vulnerability assesment. After that risk assesment is conducted.

II. MATERIAL AND METHOD

The research was conducted from April 2011 to June 2012, take a sample of raw water at five locations and laboratory test to know turbidity,salinity and conductivity of raw water, distributing questioner to find out data condition of people at Banyusin Valley. As many as 253 respondents were randomly selected from comunity of 3 village i.e Tanjung Lago, Muara Telang and Banyuasin II. Direct observation was also done to find out data for tidal measurement for hazard by sea level rise.

Flood hazards model is using administrative map of Banyuasin Valley, Digital Elevation Model (DEM), rainfall data, and land use map. Hazards in this study is a result of the components of the hazard scenarios from the sea. The rise in sea level made up the highest seawater tidal components (HHWL) and the average tide (MHWL), high sea waves, the projected sea level rise due to climate change (SRES A1B), La-Nina phenomenon, as well as threats storm waves from the South China Sea.Vulnerability in the study was obtained from the preparation of component parameters / indicators of vulnerability consisting of housing conditions, number of occupants, water consumption, and income per month which will be overlays with land use maps at the sites. Following the definition of Risk (R) as function of Hazard (H) and Vulnerability (V) or R = f(H,V), risk is produced by overlay hazards and vulnerability maps using GIS method.

III. RESULT AND DISCUSSION

A. Hazard Assesment of Climate Change

The components of coastal flooding hazards caused by the combination of sea level rise, storm surges, and La-Nina phenomenon at maximum tide. The study concluded the oceanographic scientific basis of sea level rise to around 13.5 ± 6.15 cm in 2030 relative to current conditions (greenhouse gas emission scenarios are moderate - SRESa1b). Sea level rise is complete sea level variability, both of which occur periodically every day once the tide (with riding around 3.3 m) and that occur incidental result of the increase in La-Nina phenomenon (the influence of the Pacific Ocean) which can lead to an increase at 15 cm to sea level under normal conditions may occur once in 1-3 years. In the future La-Nina phenomenon predicted the long and often occur that can result in increasingly high waves. The storm surge of the South China Sea with a height of about 20 cm can occur 3 times a year. [17] From the measurement results obtained in the calculation of the location of high tide water level maximum (HHWL) 190 cm and the mean high water tide - average (MHWL) is 140 cm.

Based of the results of scientific studies and oceanographic measurements on the tides hazard scenarios formulated by the hazard element that can be seen in Table I.

TABLE I.
ELEMENT OF HAZARD AT RESEARCH LOCATION

Element of Hazard	Hazard code	SRES A1B Projection 2010 (cm)	2030 (cm)
Tide (MHWL)	1a	140	140
Tide (HHWL)	1b	190	190
Maximum Wave	2a	31.1	31.1
Significant Wave	2b	38.4	38.4
Sea Level Rise	3	0	13.5 + 6.1
La Nina	4	15	15
Surges	5	20	20
Flooding	6	100	100

TABLE II
SCENARIO OF HAZARD

Scenario	**Cummulative**	SRES A1B PROJECTION 2010 (cm)	2030 (cm)
1a (Existing)	1a + 2a + 3	171.1	184.6
1b (Extreme)	1b + 2b +3	228.4	241.9
2a (Extreme + La-Nina)	1b + 2b + 4 + 3	243.4	256.9
2b (Extreme + Surge)	1b + 2b + 5 + 3	248.4	261.9
3 (Extreme + La-Nina + Surge)	1b + 2b + 4 + 5 + 3	263.4	276.9
4 (Extreme + La-Nina + Flood)	1b + 2b + 4 + 6 + 3	343.4	356.9

Calculation of hazard assessment done by following a script that has been compiled as table II. for baseline conditions (in 2010) and the condition of projection (in 2030). Further elevation of sea level is the 0 m mean sea level so in this study the map inundation scenarios simulated using DEM with inundation at an elevation of 0 m above sea level at the height of immersion scenarios 1a 171.1 cm for 2010 and scenario inundation at an elevation of 0 m above sea level with altitude 356.9 cm for projection condition at 2030.

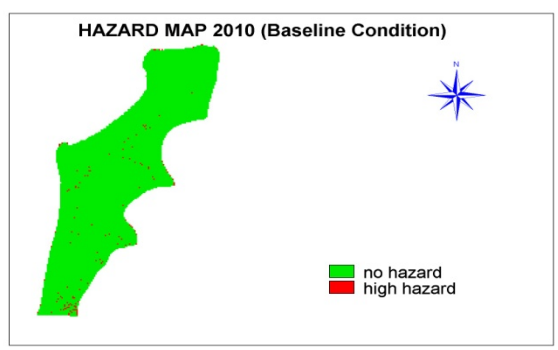

Fig. 1 Hazard Map for scenario 1a at 2010 (Baseline)

Based on calculations it is known that in scenario 1a Hazard of sea level rise in 2010 at the height of tide (baseline condition). As for the flooded area is 1.06% or 130.19 ha area and the area that is not inundated (no hazard) of 98.94% or 12,151.81 hectares. In scenario 1b to scenario 3 using tidal height in 2010 and 2030, the area of the danger posed by rising sea level is 566.20 ha (4.61%) and the area that is not inundated (no hazard) is 11715.80 ha (95.39%), while in scenario 4 using tidal height in 2030 (projection condition) the area of danger from sea level rise is equal to 1845.98 ha (15.03%) and the area that is not flooded 10436.02 ha (84.97%) of the total area Banyuasin Valley region.

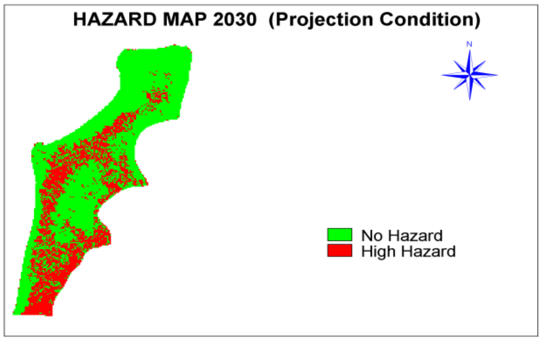

Fig. 2 Hazard Map for scenario 4 at 2030 (Projection)

Projection hazard (hazard) is more focused on the rise of sea level (sea level rise), which has been projected in accordance with the Global Circulation Model [9]. The projection used to use IPCC SRES (Special Report on Emission Scenarios) A1B. Based on projection, in the period of 2020 – 2030 the risk of extreme precipitation more than 100 mm/year [15]. Visually can not see a significant difference between the scenario projection hazard of climate change, this is due to changes in sea level (sea level rise) that occurred 0.6 - 0.8 cm / year [14]

B. Vulnerability Assesment

The vulnerability assessment at Banyuasin Valley, the vulnerability is determined by the index of vulnerability resulting from the parameters / indicators that are owned by the elements - elements that have the potential risk to the impacts of climate change. In this study, the type of vulnerability focused on the conditions and circumstances that existed throughout the Tanjung lago village to Sungsang village. Parameter / vulnerability indicators used in the assessment of vulnerability is the condition of the home, number of occupants, water consumption, and a monthly income of existing residents and the region will be in overlay to land use at the sites. The index of vulnerability is classified into three classes, namely low vulnerability, moderate vulnerability and high vulnerability.

The vulnerability results from MapCalculation total and Slicing using ILWIS GIS applications. Based on the results of the calculations using ILWIS GIS applications that generate vulnerability maps in total with the level of vulnerability information. On the vulnerability map it is known that at the sites did not reach a high level of vulnerability. The low vulnerability have an index of vulnerability by 0.18 and the moderate vulnerability by 0.52.

C. Risk Assesment

The level of risk is classified into three classes, namely low risk,moderate risk, and high risk. The level of risk resulting from the overlay level hazard and vulnerability levels in 2 dimensional table.

Based on the study of climate change hazard assessment, the risk assessment has a scenario are:

1. The risk of tidal flooding and maximum altitude in 2010
2. The risk of floods and sea level rise by 2030, with maximum precipitation and tidal height - average.
3. The risk of floods and sea level rise by 2030, with max precipitation and tidal height average and retaining green open area of 30% of the area Banyuasin Valley area[23].

From the analysis scenario 1 of the risk using ILWIS GIS applications is known that there are houses that have a high level of risk, moderate risk level 7 houses, and 124 schools with low levels of risk and the rest are not at risk . The percentage is 94.66% lower risk and moderate risk of 5.34%. From the analysis of the risk scenario 2 it is known that the risk level in residential buildings, there are 3 homes that have a high level of risk, the risk level was 59, and 69 homes with a low risk level. The percentage of low risk was 52.67% and 45.04% moderate risk and high risk of 2.29%. An increase in the percentage of 39.7% for moderate risk from 2010 to 2030 and the percentage decrease of 41.99% for low-risk homes. Subsequently tried 3rd scenario for 2030 by maintaining open green area by 30% as a watershed, and with the help of a dynamic program to determine the amount of flooding that occurred as well in overlapping stacking with total vulnerability to obtain the results of the risk analysis to note that the level of risk in buildings home there are 2 houses that have a high level of risk, 24 homes were moderate risk, and 105 homes with a low risk level. The percentage of low risk was 80.15% and 18.32% moderate risk and high risk of 1.53%.

TABLE III
RECAPITULATION OF RISK ANALYSIS RESULT

Level of Risk	in 2010 Scenario 1	in 2030 Scenario 2	in 2030 Scenario 3
Low Risk	94,66 %	52,67 %	80,15 %
Moderate Risk	5,34 %	45, 04 %	18,32 %
High Risk	0 %	2,29 %	1,53 %

From the summary above shows that by maintaining green open space in accordance with the law No. 32 on the Strategic Environmental Assessment (KLHS) can reduce the risk in 2030 to the Hazards of climate change.

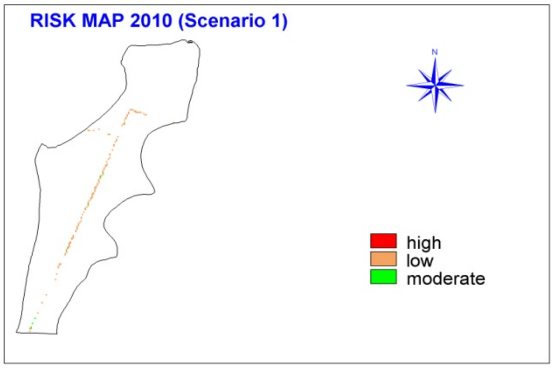

Fig. 3 Risk Map scenario 1 at 2010 (Baseline)

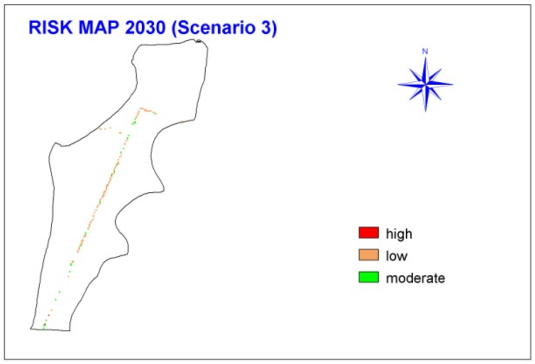

Fig. 4 Risk Map scenario 3 at 2030 (Projection)

IV. CONCLUSION AND REMARK

From the preliminary test result of water quality at research study the location is still possible to take raw water for clean water at Canal Sebalik and must be kept from impact of climate change. From preliminary study at Banyuasin Valley, hazard and vulnerability at baseline condition is still in safe condition and and the need to restructure the space for future development to keep from impact of climate change. In projection condition with scenario 3 by maintaining green open space area 30 % can reduce the risk in 2030 to the hazards of climate change.

Risk assessment approach provides framework for science based adaptation planning as well as integrating those chosen adaptation programs into the planning process at all level of government from national to local level. The risk assessment approach has been applied so far in preparing Indonesia Climate Change Sectoral Roadmap (ICCSR) in 2009. Therefore, it is arguably that the exploration of risk assessment for climate change adaptation in Indonesia has been successful. The strength of the approach includes primary on a systematic step by step process. However, it has also requires good historical data of climate and social economics aspects which are unfortunately not easily available in Indonesia. Application of risk assessment in the South Sumatra Province was able to delineate the flood risk maps. Based on the risk maps then adaptation option was identified. The next step which needs to be taken but not included in this paper is to prioritize adaptation actions.

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