International Journal of Environmental Monitoring and Analysis
2017; 5(2): 48-55
http://www.sciencepublishinggroup.com/j/ijema
doi: 10.11648/j.ijema.20170502.15
ISSN: 2328-7659 (Print); ISSN: 2328-7667 (Online)

Analysis Strategy and Climate Change Adaptation and Disaster Risk Reduction

Adriani Bandjar[1, *], Rafael Marthinus Osok[2], I Wayan Sutapa[1]

[1]Chemistry Department, Mathematic and Natural Science Faculty, Pattimura University, Ambon, Indonesia
[2]Agriculture Faculty, Pattimura University, Ambon, Indonesia

Email address:
adrianibandjar@fmipa.unpatti.ac.id (A. Bandjar)
[*]Corresponding author

To cite this article:
Adriani Bandjar, Rafael Marthinus Osok, I Wayan Sutapa. Analysis Strategy and Climate Change Adaptation and Disaster Risk Reduction. *International Journal of Environmental Monitoring and Analysis.* Vol. 5, No. 2, 2017, pp. 48-55. doi: 10.11648/j.ijema.20170502.15

Received: October 24, 2016; **Accepted**: March 15, 2017; **Published**: March 28, 2017

Abstract: Strategies and Climate Change Adaptation and Disaster Risk Reduction in Central Maluku of district Haruku Island-Indonesia have been conducted. This study was conducted consisting of a profile districts obtained Haruku island, the determination of V and C, as well as the picture of extreme rainfall. Based on the analysis of the obtained results as follows: In administrative districts of Haruku Island that consists of 11 villages were entirely concentrated on the island of Haruku. Haruku is part of the Maluku Islands is included in the category of patterns of local rainfall for the period of summer rains that took place as parts of Indonesia on generally experiencing drought. The rainy season occurs from May to August, the extreme rainfall occurred in 1989 and 2013 as many as four times. Based on calculations there is a village is in quadrant 5, three villages wards are in quadrant 2, three villages / wards are in quadrant 1, and four villages are in quadrant 3.

Keywords: Analysis, Disaster Risk Reduction, Haruku Island, Rainfall, Maluku

1. Introduction

Sea level was rised due to melting glaciers and polar ice caps and thermal expansion will contribute to the increase in floods and landslides. Increased intensity of tropical cyclones observed in recent decades can increase the surface temperature of the sea water. Influenced by hydrological cycle, global warming is expected to change the range of the climate, the average shift in regional climate, resulting a shift in climate zones, and causing frequency and higher amplitude than the weather [1, 2, 7, 11, 18]. Climate variability and changes that occur with the backdrop of rising global population and the globalization of economic processes can be expected to trigger increased competition over resources and new vulnerabilities. The phenomenon arises due to climate change caused by global warming. Caused by increased risk of the climate, many countries, particularly the least developed and developing countries may find difficult to achieve the Millennium Development Goals related to poverty, hunger, and human health [3, 6].

Indonesia is a country prone to natural disasters such as floods, droughts, hurricanes, landslides, volcanic eruptions, and forest fires. Indonesia is more frequent and severe climate-related hazards experienced in recent years. Floods and storms accounted for 70% of total disaster and the remaining 30% of the total donated by the catastrophic droughts, landslides, forest fires, heat waves, storms, floods and others. In the period 2003-2005, in Indonesia there are about 1,429 catastrophic events. Approximately 53.3 per cent are hydro-meteorological disasters [3, 7, 19].

The rising of sea levels pose a further risk of around 24 small islands Indonesia already submerged. This vast archipelago are particularly vulnerable to sea level rise of more than 13,000 islands, a coastline of over 80,000 Km, and the majority of the population live in coastal areas where most of the economic activities of the people took place. Currently, approximately 42 million people in Indonesia living in areas less than 10 meters above mean sea level [4]. Most of the households living in the coastal areas have revenues between US $ 2 and US $ 1 per day is included in the poverty line, too many Indonesian people live in poverty and remain highly vulnerable to the impacts of climate change. The high population density in Indonesia will further improve sensitivity to climate hazards [5, 6, 11].

Maluku province is an area consisting of islands large and small scattered at a considerable distance from each other. Maluku is geographic most of its area is sea and only 10% of it is land (islands numbering about 1700 islands). There are three islands covering an area large enough island of Buru, Ceram and Ambon Island. Under these conditions, the climate change which resulted in an increase in sea level, high winds, extreme rainfall, extreme ocean waves and extreme temperatures, will bring enormous impact local communities in the islands in the region. Sub district Haruku Island as part of the islands in the Maluku islands is one of the very large potential for affected as the implications of climate change caused by geographical conditions of the region. Sub district Haruku Island is the area that will be seriously affected by climate change. Almost every year and some areas along river and coastal areas in the district has been affected by stagnant and aberration due to increased sea level rise [7, 8, 9, 10].

Under these conditions through this research will be obtained: Risk Mapping and implementation of Climate Change Adaptation and Disaster Risk Reduction to Resilience in the district Haruku Island.

2. Research Method

Research methodology in this study consisted of the analysis of biophysical, social analysis, further mapping and search-regulatory policies regarding adaptation to climate change that already exist. The steps of this research can be described as follows:

2.1. Stage Data Collection

Primary data was collected through observation, surveys, in-depth interviews and discussions with relevant parties such as, Public Health Service, The Disaster Mitigation Agency Central Maluku and The Disaster Mitigation Agency Maluku. Secondary Data institutional form of data, policies, maps and other information needed is collected from various related agencies.

2.2. Data Processing

Data have been obtained both primary data and secondary data further processed using statistics (simple) to get an overview of data biophysics, while spatial data is processed to get an idea of the spatial (mapping) of the study area spatial conditions, to get an idea of the spatial (mapping) the condition of the study area.

2.3. Analysis

Conduct research relevant are vulnerability (V) in profile of climate change, the study of the capacity of community and government policies central and local involved in adaptation to climate change. The qualitative analysis carried out by three steps is: 1. Mechanical depth interviews with communities in the study area through FGD (Focus Group Discussion), 2. Search informants (snowball) in accordance with the topic and adequacy of information to be obtained, 3. Triangulation Data (crosscheck data).

2.4. Develop a Synthesis of the Results of the Analysis.

Compiling the synthesis of the results of the analysis carried out by sharpening through an indication of the strengthening of community resilience in the face of climate change, and provides identification or sharpening of the areas that require further treatment.

3. Results and Discussion

3.1. Administration Areas

In administrative districts overall Haruku Island sub district consists of 11 villages which is entirely concentrated on the island of Haruku. In The district Haruku Island Pelauw village that has the greatest area and Wassu village has the smallest area [12, 13].

3.2. Climate and Extreme Weather Events

Indonesia generally has three rainfall patterns; there are the pattern of the monsoon rains, equatorial rain patterns, and local rainfall patterns. Territory monsoon rain patterns have a clear distinction between the period of the rainy season and dry season period, with the type of rain have one peak of the rainy season. In this pattern, the rainy season occurs in December, January, and February. While the dry season occurs in June, July, and August [11, 15].

Table 1. *Areas name and an area [14].*

Areas Name	Area (Km^2)
Haruku	13.00
Oma	10.00
Wassu	7.00
Aboru	17.00
Hulaliu	12.00
Kariu	8.00
Pelauw	35.00
Kailolo	13.00
Kabauw	12.00
Rohomoni	15.00
Sameth	8.00

While the equatorial rain pattern area has two peak rainfalls which usually occurs around March and October. While local rainfall pattern region has a peak of the rainy season but it is the antithesis of the type of the monsoon rains. The Haruku island is part of the Maluku Islands are included in the category of local rainfall patterns due to ongoing rain season periods when parts of Indonesia in general experienced a dry season. The rainy season occurs in May through August. Intensity of rainfall in Ambon greatly influenced by regional factors such as Low Pressure, Tropical Storm, and global factors such as the influence of El Nino and La Nina.

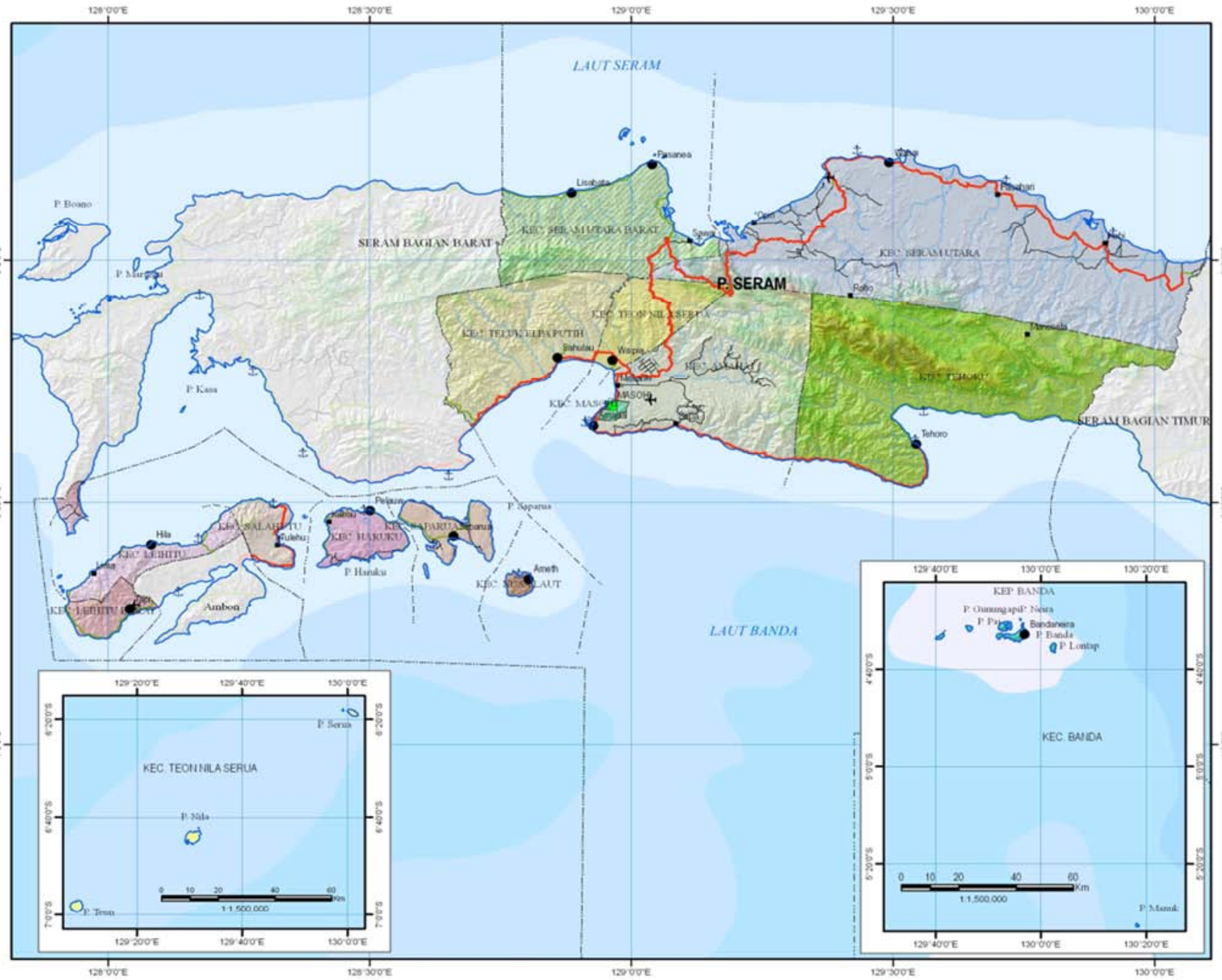


Figure 1. Map of the District administration Haruku Island.

From Figure 2, it can be seen that the extreme rainfall occurred in 1989 and 2013 as many as four times. At the extreme weather conditions, the frequency of extreme precipitation shows an increasing trend. This shows the tendency that is large enough for the occurrence of extreme rainfall in the coming year.

3.3. Exposure and Adaptive Capacity

To determine the capacity and vulnerability index, we use survey data directly Data urban / rural from the Central Bureau of Statistics, while for some biophysical data acquired from related sectors or generated based on satellite interpretation with GIS techniques. All data was given measured according to their relative importance in determining vulnerability (V) and capacity to adapt (C).

To determine the relative position of the village in terms of vulnerability and adaptation capacity used the capacity (CI) and the exposure index (VI). Capacity Index (CI) was designed using five main indicators (A1-A5). Each indicator is given a score. Scoring is based A1 indicator percentage of households in the village that use electricity. This indicator is the level of welfare of the village / villages concerned. A2 indicator is educations that can show the community capacity in the village in dealing with risk. The higher of the education will have the better in their capacity to manage risks. This indicator consists of five sub-indicators: the number of kindergarten, elementary, junior high school existing village level district level, and at the University of the District Level. Scoring of IA2 in each village is calculated using the following formula [16, 17, 20, 21]:

$$IA2i = 1 / Pi * (* Ni + 0{:}07\ 0{:}13\ 0{:}20 * * Ei + Ji) + 1 / Pij * (0{:}27 * SJ) + 1 / Pik * (0.33 * Uk)$$

While Pi, PIJ, and Pik row is the population of the village-i, Sub-j of village-k and k Sub-district / village-i. Because the value of scores of this indicator is very small, all values are normalized with the highest scores to obtain a score of indicator values range from 0 to 1. Indicators A3 are the main source of income in rural communities / villages. Therefore, the main income source village community / village strongly influenced by climate variability that has a capacity lower scores. In this case, for example, district / village where the main source of income of the agricultural community, scoring value is 0.25.

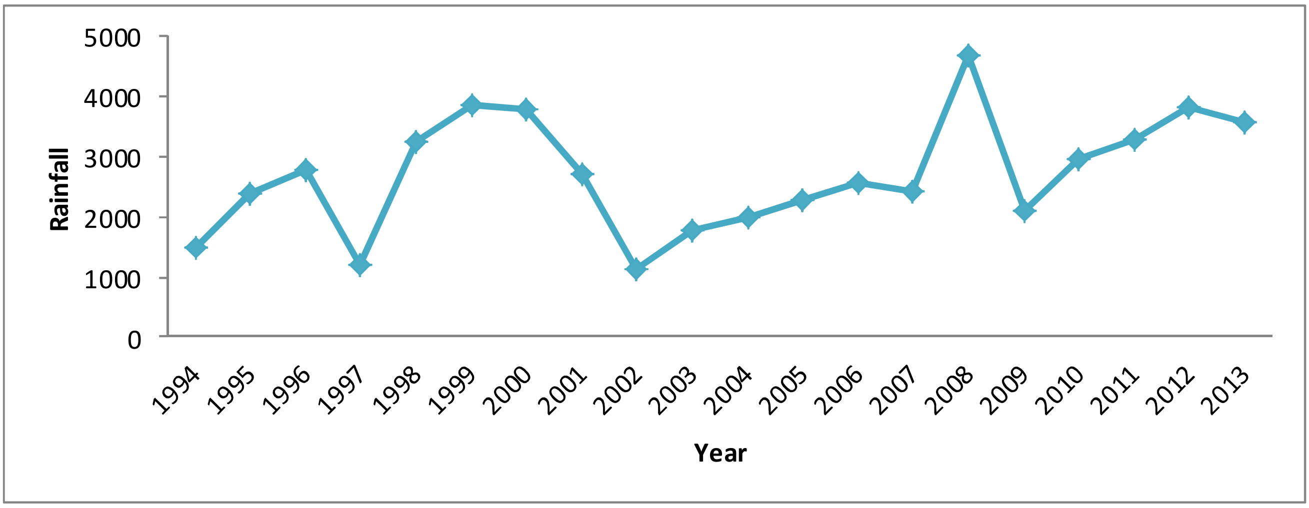


Figure 2. *Graph of rainfall and the surrounding islands Haruku.*

A4 Indicator: health facilities are public access to health facilities. The better of the health facilities in the village will have the higher capacity. This indicator is divided into five sub-indicators: number Polyclinic (Pl), one-stop centers (Posyandu, Ps), Community Health Center (Public Health Center, Pk), (Community Health Sub-center Pu), Midwife Clinic (B) and Clinic (D). All the values of sub-indicators are normalized by the size of the population according village. A score of IA4 in each village is calculated using the following formula:

$$IA4i = 1 / Pi * (0.3 * 0.2 * Pli + Psi + 0.2 * (PkI + PuI) + Bi + 0.1 * 0.2 * In)$$

Because the value of scores of these indicators is very small, all values divided by the highest score to get the values of the indicator scores ranging from 0 to 1. Indicator A5 is the road infrastructure. For this data we define Village / villages where roads are predominantly made of asphalt will have a value of 1, while for those who are non-asphalt will have a value of 0. The formula for calculating the IC is as follows:

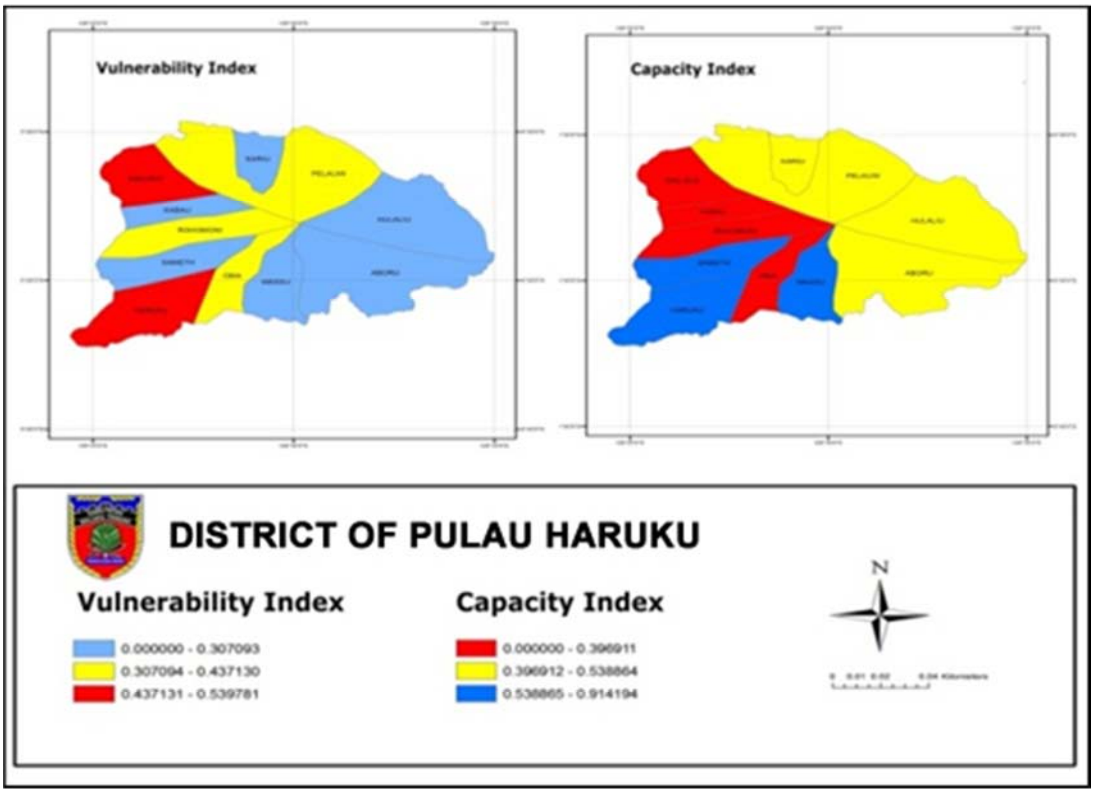
$$\text{ICi} = \sum_{i=1}^{n} w_{ij} * I_{Aij}$$

Where -i is the subscript represents the village / rural-i and wj is the weight of the indicator value Aj village-i. Selection of the weight values are subjective, based on the understanding and knowledge of experts on the relative importance of the indicators in determining the level of capacity [16, 17, 20, 21].

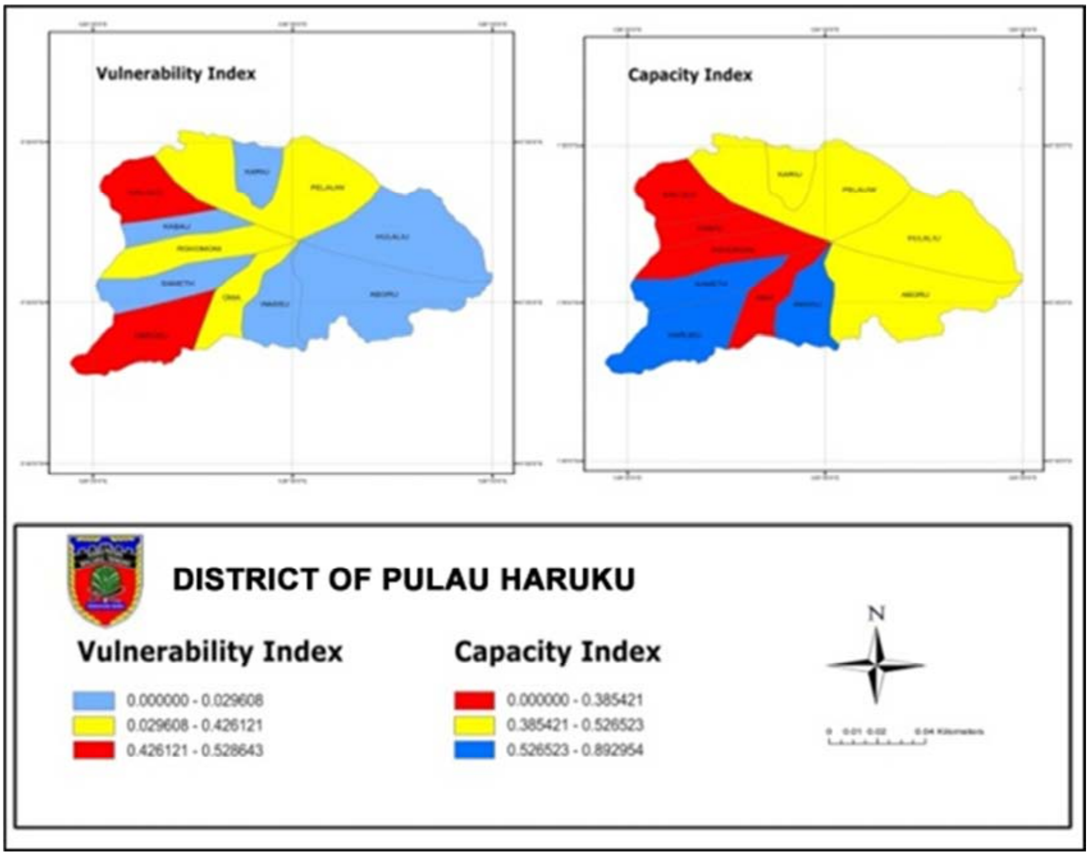
Similar to Capacity Index (IC), an index of vulnerability was also developed using the same approach. There are ten main indicators (B1,..., B10) for floods and (B1,..., B8) to landslides B1 indicator is the percentage of households in the village on the banks of the river when in flood analysis and the percentage of households in the village on the slopes to landslides. The value of this indicator will be very small, which is the indicator value ranges from 0 to 1, all values in this indicator are divided by the maximum value (highest score). B2 indicator is the number of buildings located on the banks of the river for flood analysis and is the number of buildings located on the slopes to landslides. All the values of these indicators are normalized to the maximum number of buildings located on the banks of the river to flood and the maximum number of buildings located on the slopes of the mountain.

B3 is an indicator of production capacity in the Drinking Water Company supplies water to the village. Villages in which most people get drinking water from the State Water Company will be less susceptible to the effects of drought as the taps are usually still able to supply drinking water regardless of the season (dry or wet). This indicator values are normalized to the number of inhabitants of the village accordingly. Because the value of scores of these indicators is very small, all values are normalized again to the maximum value (highest score) to get the value of the indicator scores ranging from 0 to 1.

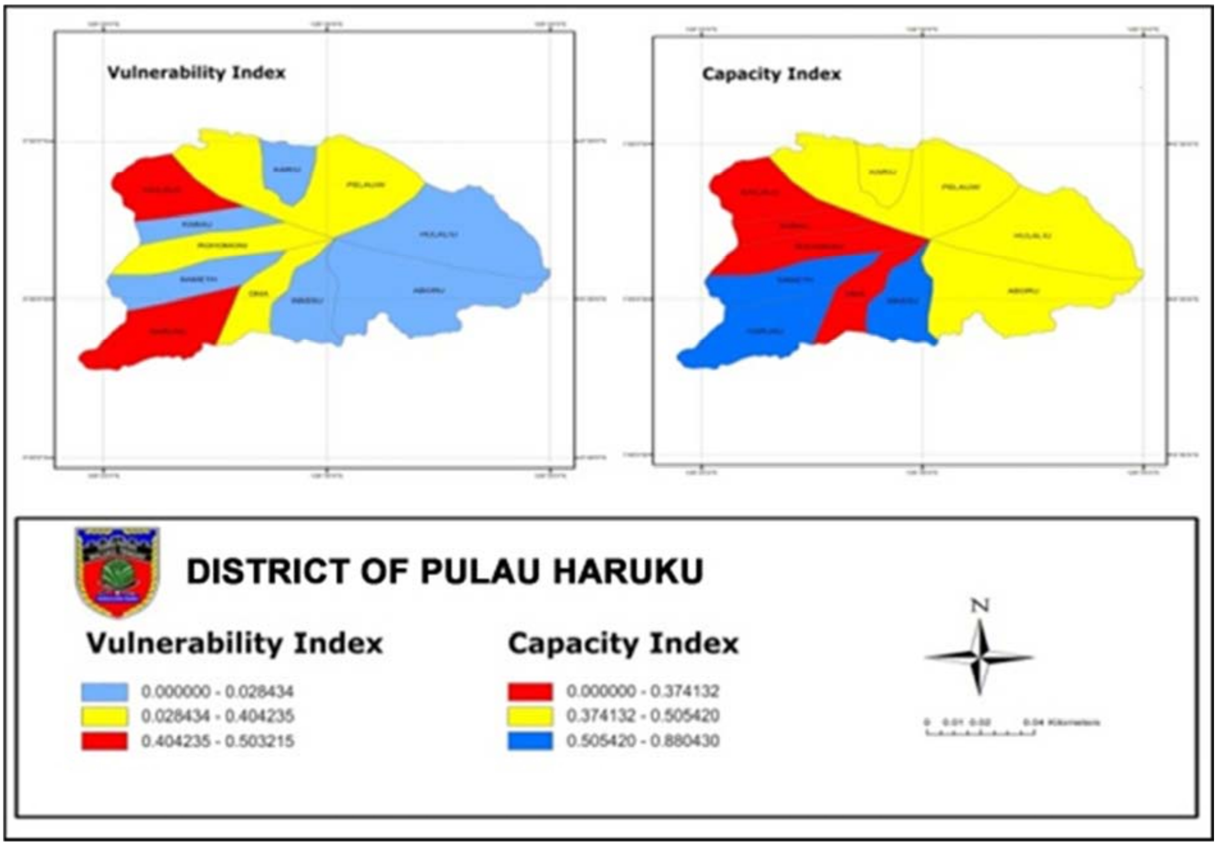
One value of this indicator score will be reduced to normal values. Indicator B4 is the higher population density population density higher degree of exposure of the population to disasters. This puts the level of vulnerability of the village to village. To get the value of the indicator ranges from 0 to 1, all values in this indicator is divided by the maximum value. B5 indicator is the number of poor households. The value of this indicator is normalized by the number of village residents. B6 indicator is the number of children in the village.


Vulnerability Index
Capacity Index
DISTRICT OF PULAU HARUKU
Vulnerability Index
0.000000 - 0.307093
0.307094 - 0.437130
0.437131 - 0.539781
Capacity Index
0.000000 - 0.396911
0.396912 - 0.538864
0.538865 - 0.914194
N

(a)


Vulnerability Index
Capacity Index
DISTRICT OF PULAU HARUKU
Vulnerability Index
0.000000 - 0.029608
0.029608 - 0.426121
0.426121 - 0.528643
Capacity Index
0.000000 - 0.385421
0.385421 - 0.526523
0.526523 - 0.892954
N

(b)



(c)

Figure 3. *Vulnerability and capacity index of the village Baseline (a), 2034 (b) and 2083 (C) districts Haruku Island for flood disaster.*

B7 indicator is the number of elderly in the urban/rural. Urban/rural which have more number of elderly who are more susceptible than the village which has a fewer number of elderly. B8 indicator is the percentage of households in the village on the beach. The value of this indicator will be very small, which is the indicator value ranges from 0 to 1, all values in this indicator is divided by the maximum value (highest score). B9 indicator is the number of buildings located on the beach. All the values of these indicators are normalized to the maximum number of buildings located on the waterfront. B10 showed plantations or fractions of land closure. The fraction determined by dividing the area of plantation estates with a total area. The formula for calculating the VI is:

$$\text{VIi} = \sum_{i=1}^{n} w_{ij} * I_{Bij}$$

The subscript i is the weight value of village i and wj for Bj Sub-indicators i. Selection weights are subjective, based on the understanding and knowledge of experts on the relative importance of the indicators in determining the level of capacity [16, 17, 20, 21]. Based on calculation of formula above then it was applied on Haruku Island, we can get value of vulnerability and capacity index for every village showed on Figure 3.

3.4. Village Classification Based on Vulnerability and Capacity

To classify the village is based on vulnerability and capacity levels, all grades VI and CI at all villages minus 0.5. Values VI and CI ranged from 0 to 1, by reducing the value of the index by 0.5, VI and CI will range from -0.5 to +0.5. The relative position of the village according to VI and CI are determined based on their position in the five quadrants as shown in Figure 4. Urban/rural located in quadrant 5 will have a high VI and low CI, while the village is located in quadrant 1 will have a low VI and high CI.

According to the system of classification, if the village is located in quadrant 5 exposed to certain dangers, the impact is more severe than the village which is located in quadrant 1. Based on calculations there is a village is in quadrant 5, three villages are in quadrant 2, three villages are in quadrant 1, and four villages are in quadrant 3.

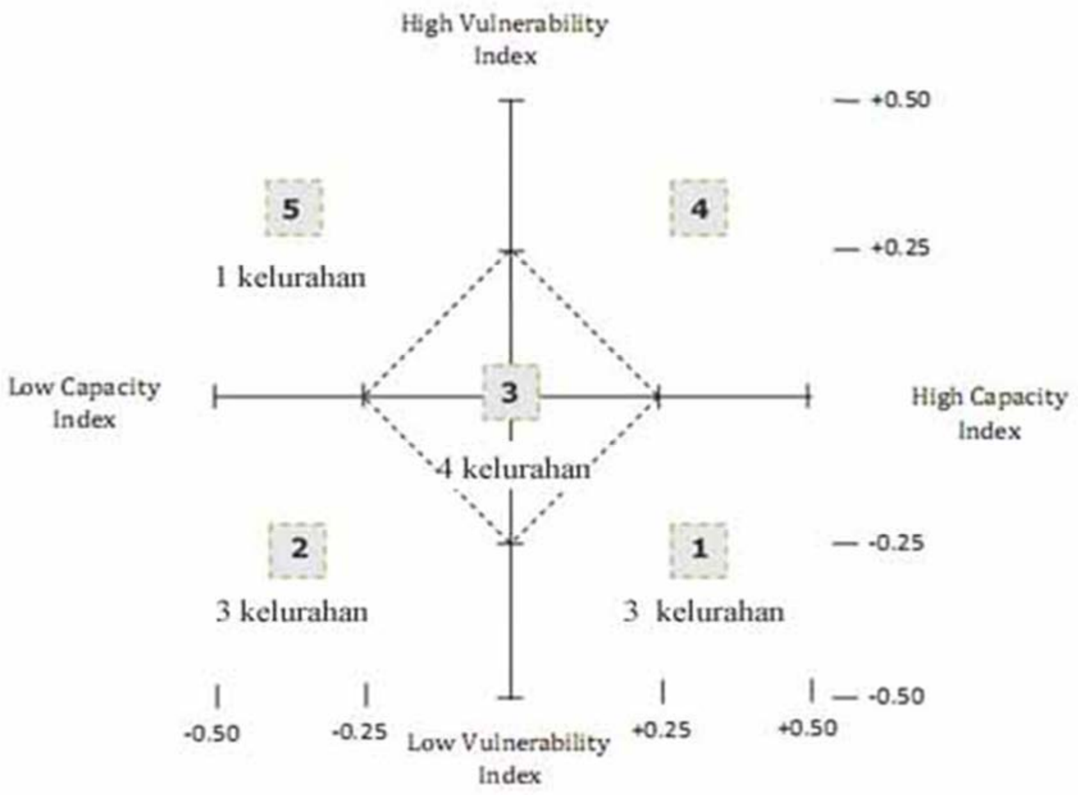


Figure 4. *Splitting villages based on vulnerability and capacity indices.*

To assess changes in V and C in the future, we only consider a change of population density (based on government projections), non-green open areas, and education (based on spatial planning) because other data are not available. Based on the distribution V and C then it appear there is a change vulnerabilities and decrease the capacity of each village. This condition shows the necessary efforts to increase the capacity of the community so that people are better able to adapt.

4. Conclusion

Based on the research that has been done, it has obtained the results as while following:

a) Haruku which is part of the Maluku Islands are included in the category of local rainfall patterns due to ongoing rain season periods when parts of Indonesia in general experienced a dry season. The rainy season occurs from May to August, the extreme rainfall occurred in 1989 and 2013 as many as four times.
b) Based on calculations there is a village is in quadrant 5, three villages are in quadrant 2, three villages are in quadrant 1, and four villages are in quadrant 3.
c) The above analysis shows that changes in the socio-economic and biophysical will change the capacity of the village.

Acknowledgements

Authors are thankful to Ministry of Higher Education Indonesia for providing financial support by Grand "*Hibah Unggulan Perguruan Tinggi*" on year 2016.

References

[1] Folland, CK, Parker, DE, Colman, A & Washington, R. 1999. Large scale modes of ocean surface temperature since the late nineteenth century, in A Navarra (ed.), *Beyond El Nino: Decadal and Interdecadal Climate Variability*, Springer-Verlag, Berlin, pp. 73- 102.

[2] Mantua, N. J., S. R. Hare, Y. Zhang, J. M. Wallace, and R. C. Francis. 1997. A pacific interdecadal climate oscillation with impacts on salmon production. *Bull. Amer. Meteor. Soc.*, 78, 1069-1079.

[3] Boer, R & Faqih, A. 2004. Global climate forcing factors and rainfall variability in West Java: case study in Bandung district, *Indonesian Journal of Agricultural Meteorology*, vol. 18, no. 2, pp. 1-12.

[4] Hendon, HH. 2003. Indonesian rainfall variability: Impacts of ENSO and local sea water interaction, *Journal of Climate*, vol. 16, no. 11, pp. 1775-90, doi: 10.1175/1520-0442(2003)016(1775:IRVIOE)2.0.CO;2.

[5] Chang, CP, Wang, Z, Ju, JH & Li, T. 2004. On the relationship between western maritime continent monsoon rainfall and ENSO during northern winter, *Journal of Climate,* 17**,** 665-672.

[6] IPCC. 2007. Climate Change 2007: The physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press: Cambridge, United Kingdom and New York, NY, USA.

[7] Kirono, DGC, Tapper, NJ & McBride, JL. 1999. Documenting Indonesian rainfall in the 1997/1998 El Nino event, *Physical Geography*, vol. 20, no. 5, pp. 42235.

[8] Haylock, M & McBride, J. 2001. Spatial coherence and predictability of Indonesian wet season rainfall, *Journal of Climate*, vol. 14, no. 18, pp. 3882-7, doi: 10.1175/1520-0442(2001)014<3882:SCAPOI>2.0.CO;2.

[9] Mitchell, TD Jones, PD. 2005. An improved method of constructing a database of monthly climate observations and associated high-resolution grids, *International Journal of Climatology*, vol. 25, no. 6, pp. 693-712.

[10] Anonym, 2012. Ambon City Disaster Report. The Disaster Mitigation Agency – Ambon.

[11] Faqih, A. 2004. Correlation Analysis of Citarum Dams Inflows with Global Sea Surface Temperatures in Dry Season, *Indonesian Journal of Agricultural Meteorology*, vol. 18, no. 1, pp. 1-13.

[12] Anonim. 2016. Mollucas in Figures 2015: The Mollucas Central Bureau of Statistics.

[13] Anonim. 2015. The Central Mollucas in Figures 2015: The Mollucas Central Bureau of Statistics-Central Mollucas.

[14] Anonim. 2016. District Haruku Island in Figure 2015: The Mollucas Central Bureau of Statistics-Central Mollucas.

[15] Anonim. 2016. Rainfall Daily report Ambon in 2012: The Mollucas Meteorology Climatology and Geophysics Council.

[16] Borst D, Jung D, Murshed SM, Werner U. 2006. Development of a methodology to assess man-made risks in Germany. Nat. Hazards Earth Syst. Sci, 6: 779802.

[17] Taylor, John. 2009. Community Based Vulnerability Assessment: Semarang and Bandar Lampung, Indonesia. ACCRN, Mercy Corps. Jakarta, Indonesia.

[18] Saji, NH, Goswami, BN, Vinayachandran, PN & Yamagata, T. 1999. A dipolemode in the tropical Indian Ocean, *Nature*, vol. 401, pp. 360-3.

[19] Ministry of Environment Republic of Indonesia, 2007, Climate Variability and, Climate Changes, and Their Implication. Jakarta.

[20] Mitchell, TD & Jones, PD. 2005. An improved method of constructing a database of monthly climate observations and associated high-resolution grids, *International Journal of Climatology*, vol. 25, no. 6, pp. 693-712.

[21] Strahler, A. N. 1986. Physical Geography. John Wiley & Sons, New York.