

## Adaptive Capacity of Brantas Watershed in Malang City Facing of the Climate Change Impact

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### Abstract

The impact on global warming is the occurrence of climate change that affect the condition of watershed ecosystem (DAS). This condition causes a decline in the level of community welfare and increases the level of community vulnerability. Furthermore, these ecological changes may have an effect on the adaptive capacity of community living in the watershed area. This paper raised the issue of climate change that occurred in the Brantas watershed society of Malang city. Adaptive capacity has an important role in addressing and minimizing vulnerability in an area. This study aims to analyze the level of adaptive capacity community on climate change. This type of research is classified as a quantitative descriptive where data acquisition and processing are derived from secondary data of regional device organization classified into several parameters and indicators then processed using weighted scale and displayed in spatial maps. This paper shows that the phenomenon of climate change has been significantly felt by the people living in the Brantas watershed. Nevertheless, these symptoms have not been considered a significant problem by the community. This is influenced by limited knowledge of the symptoms of climate change. Other findings show that adaptive capacity is not only determined by environmental conditions. The social structure of both patron-client and institutional relationships at the village level is very influential on the adaptive capacity of the Brantas watershed of Malang city.

**Keywords:** Adaptive capacity, Brantas watershed, Climate change, Malang city, GIS, Social structur

### INTRODUCTION

Global warming is a problem that humanity must face now and no longer a problem of the future. This incident is the long-term accumulation of atmospheric pollution caused by human activity that causes the release of greenhouse gases into the atmosphere at a very high rate which then impacts on climate change.

Climate phenomena such as floods, long droughts, strong winds have been felt increasingly occurring lately with high intensity. As a result, the impact is increasingly greater with the high level of environmental damage. [1]

Show that based on the results of the search for the International Disaster Database database, of natural disasters that enter into the global disaster category as many as 345 disasters. [2]

About 60% of these natural disasters are natural disasters due to extreme climates such as floods, droughts, forest fires, strong winds/storms, landslides, high tides and outbreaks of disease. Climate change based on

the definition of the Ministry of Environment that is changing the physical condition of the earth's atmosphere, among others, temperature and distribution of rainfall that bring widespread impact on various sectors of human life. [3]

As a result of climate change related to human life, that is, a temperature rise of up to 3° C over the last hundred years has affected the food and water ecosystem, increasing precipitation in high latitudes. Brantas watershed degradation of Malang City cause ecosystem can not optimal provide function and service which is very important for human life. These events led to decrease in the level of community welfare and increased levels of community vulnerability. Community vulnerability is a condition of society that can not adapt to ecosystem changes caused by a particular threat [4].

Brantas watershed upstream is the catchment area for rainwater toward the river that flows into Batu and Malang City with Malang district. Damage to the Brantas watershed area may result in flooding in Malang city. Brantas watershed as a catchment area becomes a source of water supply for some areas that it runs like Jombang, Mojokerto, Surabaya and Sidoarjo. Brantas watershed that runs across the administrative area of Batu, Malang and district

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(upstream) and Sidoarjo district (downstream) into a unified system that must be managed in an integrated and comprehensive from upstream to downstream. [4].

Meanwhile, if in watershed management practices and land use practices are not done in an integrated and unplanned manner, it affects the occurrence of erosion and sedimentation. The shifting of seasons in the Brantas watershed area has caused in agricultural activities by the community. [5].

Agriculture that relies on water supply from the Brantas watershed is less effective and unprofitable. Unpredictable climate Phenomenon is also one of the reasons farming is unproductive. Water production at some point has decreased and even disappeared. While the number of dangerous and vulnerable areas has increased. [5].

Likewise, landslides have increased in the past 2 years . Brantas watershed Degradation is increasingly critical to cause the watershed is not optimal to provide functions and services for the community. Upper Brantas watershed as buffer zone, water catchment area, water filter , and carbon absorb will be damaged. As a consequence Malang city will lose water supply and in rainy season will cause flood. [5].

In a matter of years, Brantas watershed area of Malang city will become critical. Sensitive community will be more vulnerable, while adaptable people will survive. Based on these conditions, there needs to be a study in looking at the extent of the adaptive capacity of the community to climate change in the Brantas watershed of Malang city. [6].

So through this study can be known the level of adaptive capacity of people in the Brantas watershed area of Malang City with the base of the village through several indicators. The final outcome of this study bring up the conclusions and recommendations of any region whichever the level of adaptive capacity is low, so that it can be an input or idea for urban area development planning that is adjacent to the watershed area (DAS). [6].

## RESEARCH METHODS

The research method used is quantitative to analyze this research, where the data obtained from the OPD or institution regional and research focus on the vulnerability of society in Brantas watershed area of Malang City which there are 4 sub-districts consisting of 11 village. Data processing from each village data is compared

with the total area of study/city scale so that the range of values between 1-5, where each determined its weight to then be displayed in spatial map. [7].

And finally it can be clearly known which areas are not vulnerable, vulnerable and highly vulnerable to physical parameters (area, historical floods and landslides, elevation, rainfall, number of health facilities (physicians), number of posyandu facilities, EWS, availability of evacuation stages, number of buildings in river border and drinking water access from the study area. [8].

## Method of collecting data

Data collection methods in this study use secondary data where data obtained from various agencies such as Barenlitbang, BPBD, DLH (environmental services), PODES, Indonesian Disaster Risk Index and several other agencies involved. The comparison data shows up to village data. The data result from OPD or institution as follows:

**Table 1.** Data Research and Processing

No	Data	Data Obtained
1	Total Doctor	Health Departement
2	Total Infrastructure	Health Departement
3	Total volunteers	BPBD
4	Total UMKM	Trading Department
5	individuals who work	Manpower Departmen
6	Total EWS	BPBD
7	Evacuation route	BPBD

**Source:** Secondary data obtained. [7],[8], [9].

Then the process of collecting primary data is done through AHP (Analytical Hierarchy Process) quisioner activities that are distributed to cadre and volunteers disaster formed by BPBD (disaster agency) Malang City scattered in each village. The goal is to obtain precise and accurate information from the required data.

The method is done by using a quisioner that contains questions related to understanding the actual condition of the actual Methods performed using the AHP quisioner.

## RESULTS AND DISCUSSION

Adaptive capacity is defined as the ability of a system, region, or community to adapt to the effects of climate change . Adaptive capacity has an important role in addressing and minimizing vulnerability in an area. In order to understand the adaptive capacity of the watershed community, it is important to clarify the definition of the concept. In this context the

intended pressure is a climate change whose symptoms can already be felt in the watershed (DAS) region. Vulnerability is the degree to which a system is vulnerable to and able to overcome the effects of climate change, including climate variability and extremes. [10].

Vulnerability is a function of character, distance and rate of climate change and open system variation, sensitivity and adaptive capacity. Vulnerability is a set of conditions and / or a result of circumstances (physical, social, economic and environmental factors) that adversely affect disaster prevention and mitigation efforts. [11].

If a hazard is a phenomenon or condition that is difficult to change then the relative vulnerability of society can be changed. Therefore, disaster risk reduction can be done by minimizing vulnerability. Vulnerability is associated with the human ability to protect the individual and the ability to cope with hazards/natural disasters without outside help. [10].

The complexity of the meaning of disaster vulnerability can then be defined and elaborated on the criteria of disaster vulnerability based on the impact characteristics generated on a particular object. Vulnerability, resilience, capacity, and responsiveness in emergency situations can be implemented at the individual, family, community and institutional levels. [12].

Some vulnerability formers include; number of persons, places where groups are in vulnerable positions and assets owned by a region. The exposure of climate change points to the presence of disasters in individuals, households, or social groups. Hence, susceptibility is often defined as a function of exposure risk or as a measure of coping ability. [13].

Thus, one measure of social susceptibility indicators departs from the understanding that social vulnerability refers to the exposure of a hazard or to the presence of stress conditions at the group or individual level due to exposure to a hazard. [14].

The level of vulnerability of the community is strongly influenced by access to natural resources and diversity of sources of income. Vulnerability may change at any time in the short or long run depending on how much the adaptation changes: the threat character, sensitivity, sensitivity, and recovery effort that results in quick results. Community resilience or also means the adaptation capacity of

communities to defend their condition from the dangers of climate change. [14].

Therefore, the development of community adaptation is a way to be done in returning resilience as a result of climate change.

Strategies to improve people's resilience to climate-induced dangers with the aim of restoring or return their original state, can be done in various ways of adaptation such as through community based adaptation approaches through networking, or with local cultural and wisdom approaches. [15].

The selection of indicators on adaptive capacity parameters is based on the availability of data that can be processed up to the village boundaries, so that the resulting analysis can show and compare the adaptive capacity conditions of each village. with an explanation of adaptive capacity in the following numbers; Health Facilities(1); Disaster Volunteers(2); Financial Services Providers(3); Posyandu Infrastructure(4); EWS(5); Evacuation Line System(6); Household Heads who work by type of employment(7). [16];[17].

The analysis in the calculation of adaptive capacity parameters of the community created in the table as follows:

**Table 2.** Adaptive Capacity of Brantas Watershed Area

No	Brantas Watershed	Sub-District	Villages	1	2	3	4	5	6	7
1	Hulu	Lowokwaru	Dinoyo	0.1540	0.0480	0.0710	0.0550	0.0740	0.0710	0.032
2			Jatimulyo	0.0260	0.0710	0.0710	0.0550	0.0740	0.0710	0.057
3			T. Wulung	0.0770	0.0710	0.0710	0.0940	0.0740	0.0710	0.051
4			Tlogomas	0.0770	0.0710	0.1070	0.0630	0.0740	0.0800	0.039
5	Tengah	Klojen	Kiduldalem	0.0770	0.0710	0.0710	0.0630	0.0740	0.0710	0.020
6			Oro Dowo	0.1790	0.0710	0.0710	0.0550	0.0740	0.0710	0.027
7			Samaan	0.1030	0.0710	0.0710	0.0710	0.0740	0.0710	0.040
8			Penanggungan	0.1030	0.0570	0.0710	0.0630	0.0740	0.0630	0.030
9	Hilir	K.Kandang	Kota Lama	0.0770	0.0710	0.0710	0.0630	0.0370	0.0710	0.138
10		Blimbing	Jodipan	0.1030	0.0620	0.0710	0.0630	0.0740	0.0710	0.078
11			Polehan	0.0260	0.0710	0.1430	0.0550	0.0740	0.0710	0.085

**Source:** Secondary data obtained [7],[8], [9].

The calculation of adaptive capacity parameters mentioned above is based on the condition of the region conducted the study compared to the total area of the region that entered into the study area. [18].

The result of weighting in secondary data analysis above then multiplied by the weight value of AHP questioner result given to cadres or disaster volunteers that have been formed by BPBD at each village on each parameter in measuring adaptive capacity. [19].

This method is one that is be a requirement in using the AHP (apple to apple) method. The result of weights that has been obtained by filling out the questionnaire sheet by the cadres and disaster response volunteers created table as follows:

**Table 3.** Adaptive Capacity Capacity of Brantas Watershed

No	Adaptive Capacity	Total	Score
1	Health Facilities	84	0.108
2	Disater Volunteers	134	0.172
3	Financial Services Providers	114	0.147
4	Posyandu Infrastrusture	100	0.129
5	EWS	53	0.068
6	Evacuation Line System	36	0.046
7	Household Heads who worl by type of employment	257	0.330
TOTAL SCORE		778	1.000

Source: Secondary data obtained [7],[8], [9].

So as a follow-up of the calculation of adaptive capacity parameters, the weight of the result of questioner assessment with AHP method (primary data gain result) is multiplied by the result of calculation of secondary data, with an explanation of adaptive capacity in the following numbers; Health Facilities(1); Disater Volunteers(2); Financial Services Providers(3); Posyandu Infrastrusture(4); EWS(5); Evacuation Line System(6); Household Heads who work by type of employment(7).

Finally, the result of weight calculation by multiplying the weight of the result of qesioner filling can be labeled as follows:

**Table 4.** Weight of adaptive capacity of each village

No	Brantas Watershed	Sub-District	Villages	1	2	3	4	5	6	7
1	Hulu	Lowokwaru	Dinoyo	0.452	0.354	0.286	0.258	0.251	0.129	0.664
2			Jatimulyo	0.216	0.708	0.286	0.258	0.251	0.129	0.664
3			T. Wulung	0.324	0.708	0.286	0.516	0.251	0.129	0.664
4			Tlogomas	0.324	0.708	0.286	0.258	0.251	0.168	0.664
5	Tengah	Klojen	Kiduldalem	0.324	0.708	0.286	0.258	0.251	0.129	0.664
6			Oro Dowo	0.432	0.708	0.286	0.258	0.251	0.129	0.664
7			Samaan	0.339	0.708	0.286	0.387	0.251	0.129	0.664
8			Penanggungan	0.339	0.354	0.286	0.258	0.251	0.084	0.664
9	Hilir	K.Kandang	Kota Lama	0.226	0.708	0.286	0.516	0.251	0.129	1.328
10		Blimbing	Jodipan	0.339	0.531	0.286	0.258	0.251	0.129	0.996
11			Polehan	0.226	0.708	0.572	0.258	0.251	0.129	0.996

Source: Secondary data obtained[7],[8], [9].

The results of the analysis obtained from all villages compared with adaptive capacity parameters, then added horizontally to get the value of each village and weighted with a value between 0-5, it will obtain weight for adaptive capacity in the table as follows:

**Table 5.** Weight of village adaptive capacity

No	Brantas Watershed	Sub-District	Villages	Weight
1	Hulu/Upstream	Lowokwaru	Dinoyo	2
2			Jatimulyo	2
3			T. Wulung	3
4			Tlogomas	3
5	Tengah/Central	Klojen	Kiduldalem	3
6			Oro Dowo	3
7			Samaan	3
8			Penanggungan	1

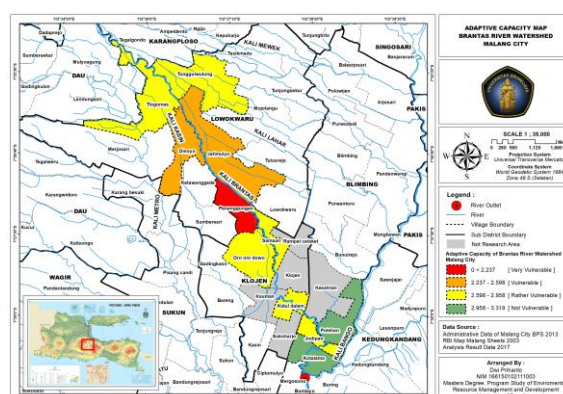
9	Hilir/Downstream	K.Kandang	Kota Lama	4
10		Blimbing	Jodipan	3
11		Polehan		4

Source: Secondary data obtained[7],[8], [9].

From the results of the adaptive capacity weighting table of the village area as a basis for the manufacture of spatial maps. [20]. Weighting values can be explained as follows:

- weight 4 : very high
- weight 3 : high
- weight 2 : medium
- weight 1 : low

After the weight value of each village is known then in overlay into the spatial map so that obtained the distribution of adaptive capacity map of Brantas watershed of Malang City as follows[20]:



**Picture 1.** Map of Adaptive Capacity of Brantas Watershed Area Malang city

## CONCLUSION

Kota Lama and Polehan are villages with adaptive capacity in low category. Kota Lama and Polehan is also a village downstream of Brantas watershed of Malang City. Elements that make adaptation capacity low include the availability of a minimal early warning system (EWS) compared with the number of residents who are on the river banks Brantas watershed, including the number of evacuation routes are very small.

The number of resilient volunteers is only 10-15 people, whereas the population is 650 households. Likewise the number of banking institutions engaged in micro business community groups vulnerable to disasters is very limited.

Methods and analysis used in this adaptive capacity study using seven criteria of research indicator, since data obtained from local or regional organizations are very limited so that it will affect the results of each study village

## **SUGGESTION**

Malang City Government must conduct structural mitigation by building retaining wall in areas prone to landslide disaster, improving sustainable drainage system; strengthening weather and climate information systems by developing weather and climate information technologies, developing an early warning system (EWS) for landslides and floods, improving the conservation of water resources by planting trees and bamboo, developing absorption wells, and making biopore holes.

While non-structural can be done by increasing the capacity of volunteer cadres and volunteers, mapping of potential areas and vulnerable to landslide hazards and floods make operational standards of disaster emergency response procedures, establishing disaster risk reduction forums for rural and urban areas, reviewing related to spatial planning Brantas watershed of Malang City based on climate and disaster.

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