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Foundation:

Environmental Grace & Problems in Brantas River Watershed and Its Coastal Area

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Abstract: Brantas River originates from Community Forrest Park, Arjuno Mountain and flows until Eastern Java sea for 320 km, The inhabitants in the watershed are more than 45% of the population in East Java. Brantas River is a source of people's lives in East Java and also Bali. An important contribution is in particular, to supply of electricity with installed capacity of 239MW to hydroelectric power stations that generates annual production of 1 billion kW-hours supported by 14 dams. Brantas river also serves; as flood control equivalent to 60,000 hectares (ha) in major rivers, irrigation source for agricultural area of 340,000 ha (83,000 ha directly from the main river), plays a role in the provision of raw water for the people for 240 million m^3 per year and 135 million m^3 for industrial and provide open water for fisheries around 15,000ha. The extensive Brantas watershed (1,118,559 ha) is classified into upper zone (238,148 ha with 3 sub-watersheds), the middle zone (606 290 ha with 4 sub-watersheds), and a lower zone 344 121 ha with 3 sub-watersheds). Brantas River is inter-administrative body river that flows through 14 districts, viz Malang, Blitar, Tulungagung, Trenggalek, Kediri, Pasuruan, Sidoarjo, Mojokerto, Jombang, Nganjuk, Gresik, Madison, Pasuruan, and Ponorogo, and 4 cities viz Malang, Mojokerto, Kediri, and Surabaya. Populations, industrial activities, residential area, commercial and social activities in the watershed are rapidly being increased. This situation has led to increase in demand for water availability year by year. A water demand calculation by BBWS Brantas has indicated required amount of water 4,963,813, 5,528,316 and 5,853,317 million m^3/year in 2005, 2020, and 2030, respectively. The demand is not only quantities, but also the needs are recognized for conservation of water quality and watershed level environmental rehabilitation to mitigate threats of available amount of water too. The situation is further exacerbated by global climate change. The degradation of Brantas watersheds and river does not only occurr by the effect of the bio-physical and chemical environmental processes, but it is also significantly affected by regional socio-economic development. Under these circumstances, the government of the Republic of Indonesia has designated Brantas river basin as a critical watershed and highest priority for restoration since 2008. Brantas River flowing into the east coast of Surabaya is causing coastal and marine environmental degradation. According to several studies about the impacts, actual information is still lacking, particularly that for sustainability of marine and coastal life. It is indicated that costal area management is also necessary to enter in to the integrated watershed planning. The importance of conservation and rehabilitation of Brantas river watershed is rapidly gaining significance. Hence, a comprehensive research, technical and social engineering capacity development is needed, which is also including the environmental education for the future Brantas watershed inhabitants. Simultaneously, an increase in public awareness for the grace of the watershed should be improved. Various agencies have been ever committed to act quickly and precisely, and the integrated institution is also already associated among various stake holders.

Keywords: *Ecosystem biology, Integrated coastal and watershed management, Multilayer individualism, Open collaboration, Public participatory approach*

1. Introduction

Indonesian Law No. 7/2004 Article 1 defines what is meant by Watershed in an area of land which is a unit of ecosystem in the river and its tributaries which serves to accomodate, store and drain water from rainfall to the lake or the ocean naturally, which is the separation boundary on land topography and sea boundary until the drainage area that is affected by land activities (Bambang Priyono 2012). Watershed is different from river basin (Mohammad Bisri 2009), the river has a sense of one of the sources of water that is above the ground surface of water bodies that have components in the region. Understanding other states, places and drainage networks from spring until their estuary with restriction on either side by a line of river border. Brantas watershed is geographically located between longitude 111°35'58"– 112°56'03" East longitude and South latitude 7°15'03"– 8°15'07". Judging from the physical topographic boundary of Brantas basin in the north it is bounded by limestone mountains Kendeng, in the east by clusters of Mount Bromo and Mount Semeru, the south is limited by the cluster of Limestone Mountains and west bounded by Mount

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Wilis. In the middle of the watershed are several mountains that are still active, Mounts: Arjuno, Welirang, Anjasmara, Butak, Kawi, and Indemnity. Many mountains that are still active indicates that the Brantas River Basin is a region with fertile alluvial soil derived from volcanic rock that is very good for farming (BPDAS Brantas 2011a). Brantas watershed's fame can be traced to various historical sites, kingdoms and towns in East Java that puts the Brantas River as the primary means of supporting the activities and social life at the time (Suparto 2012).

Given its vital role in society, problems occurring lately in Brantas River Basin Province of East Java and the various environments in the watershed demand that the government and the public participate actively in mitigating the damages for sustainable and progressive utilization.

2. Brantas watershed characteristics

2.1. Bio-physics

Brantas River begins in the village of Batu Brantas with its source at the foot of Mount Anjasmoro and Arjuno, State Forestry. The river flows along the 320km passing through the area of Malang, Blitar, Tulungagung, Kediri, Nganjuk, Jombang, Mojokerto and end in Sidoarjo and Surabaya. An area of 1,118,559 ha of Brantas watershed is divided into Upper Brantas watershed (upper zone) area of 238,148 hectares (ha), Watershed Brantas Middle (middle zone) 606,290 ha and Brantas watershed downstream (lower zone) 344,121 ha. Shape (morphology) DAS (watershed) approach round. Slope gradient and slope topography is dominated by the class I (0-8%) with flat topography covering 762,472.12 ha or 64.15%. Shaped dendritic drainage pattern of smooth and medium. Flux density (Drainage Density) between 0.21km/km^2 - 0.46km/km^2. Based on Lynsley (1949 in Sriyana 2011), if the density of ≤ 0.62 km/km^2 drainage basin will experience flooding and if ≥ 3.10 km/km^2 DAS will often experience drought. The results of the analysis of BPDAS Brantas 2010, drainage density: Upper Brantas by 0.46 km/km^2, at 0:33 km/km^2 middle and lower reach of 0.32 km/km^2.

2.2. Hydrology

The rainfall monthly average over the last 10 years ranging from 26-329mm, with comparison in dry and wet months of 0.01 to 1.00. According to Schmidt-Ferguson method, climate type is majorly type D, and then types C, E while the types A and B constitute only a small part. Based on the type of climate from Schmidt-Ferguson method, most DAS area Brantas has type D and C where the wet months and dry months are 6 months 3-4 months respectively. As for the rest types A, B and E with a wet month ranged from 4-10 months dry month range 1-6 months. The average rainfall per year is 1.060 mm/yr 3.043 mm. Greatest streamflow for rivers Ngrowo was 1771 m^3, while the smallest in the River streamflow Lahor was 0.43 m^3. The discharge of Brantas River captured at Perning Station, the maximum and minimum discharge were 486 m^3 and 112 m^3 with an average of 254 m^3. Discharge in the upstream (Station Gondang) maximum 1.582 m^3.

2.3. Erosion and sedimentation

Erosion class in the Brantas watershed is the largest class II (15-60 tons/ha/year) of 11.93%, followed by class II (60-180 tons/ha/year) of 7.06%, grade IV (180-480 tons/ha/year) of 5.21%, and class V (>480 tons/ha/year) of 2.20%. The Brantas watershed sedimentation occurs by an average of 0.439 mm/year.

2.4. Geology and Soil Types

Based on the study of Streening Brantas Watershed (BPDAS Brantas 1988), Brantas watershed geology shape is composed of four (4) major geological formations, the Marine and alluvial deposits, volcanic rocks, marine sedimentary and pyroclastic rocks and sedimentary limestone. Of the three largest formations forming geomorphology is the largest cluster of volcanic formations Selas 591,911.52 ha (49.80%), both formations Alluvial area of 530,672.91 ha (44.65%) and the formation of clusters of lime / karstic area of 65,974.57 (5. 55%). The extent of cluster formation types indicates the role of the volcanic mountains in the middle and the surrounding set up a formation in the Brantas river basin geomorphology and soil fertility indicated in the Brantas watershed. While cluster Alluvial river indicate the important role in the formation of soils in the watershed. Soil type also has fertile soil properties and is suitable for farming because it contains minerals that come along the river before it is deposited. Many volcanoes in the Brantas watershed have formed Alluvial soil, a fertile soil because it comes from volcanic rock. While the topography and high rainfall in some places will be a threat to the fertility of this land.

The depth of the soil in the Brantas basin mostly > 90 cm (deep) with an area of 893,666.19 ha (75.19%). Soil depth < 30 cm (very shallow) and depth between 30 - 60cm (shallow) indicates the critical area of 140,257.44 ha (11.80%). The remaining soil depth 60-90 cm (medium) with an area of 154,635.37 ha (13:01). Good soil depth indicated that Brantas watershed is an area that is very conducive to farming activities and enable the growth of a variety of plant roots well.

3. Problems in the Brantas watershed

3.1. Bio-Physical Problems

3.1.1. Bio-physical Brantas Watershed

Brantas watershed's biophysical problems in this paper were obtained from Bogor Agricultural Institute and Brantas Watershed Management in 2010 (BPDAS Brantas 2010). They are as follows:

In general, Brantas watershed had problems due to the decreased function of protection and production of land resources and water resources due to poor management of carrying capacity of the land capability, and land suitability. Based on the government law No. 41 of 1999, forest area in the watershed must be at least 30%, and then the Brantas Watershed should develop the forest area up to 27.128ha (2.28%).

Land cover of upstream of Brantas watershed has not been suitable with the expectations. The function of the protected area must gradually protect the area underneath. The abolishment of middle watershed land cover is

inadequate, while in the downstream watershed land cover is very inadequate. Some protected areas including the Bromo Tengger Semeru National Park should be rehabilitated and reforested.

Critical land occurred in the upstream of Brantas watershed mainly caused by land erosion due to the easily erodability of the soils. The results of the calculation in 2011 show the average amount of erosion in the Brantas watershed is about 1944/ton/ha/year (above the tolerance threshold). Erosion Index (EI) of Brantas watershed is 4 (bad) with a large area at high danger level of erosion and very heavy at about 33.1%. Erosion hazard rate spread most widely in the upper and middle, mostly occurred in forest areas with slope class >40% of the thickness of the land <90 cm, and in the cultivation of the grade slopes >25%. Average for each watershed sediment ranged from 0.6 to 4.9 mm / year with the highest value in the center of the watershed. The conditions of the land cover in some areas of Brantas watershed stimulate the high rate of *run-off*, implying the low water infiltration into the land, and reduced water yield. Erosion and sedimentation in the Brantas watershed has disrupted the functions of building water / reservoir. Simultaneously, it will affect to the reservoir function and shorten its existence (life time).

The water in the Brantas watershed is used for various needs such as: for irrigation, urban households (domestic and municipal), industrial, power generation and fisheries. The results of the analysis of the Brantas Watershed Center for the year 2010 shows the changing needs of water occurs exponentially. If the present needs of water is still around 5-6 billion m^3, it can be estimated that in 2030 it will increase up to 7.38 billion m^3. Presumably in 2091 the number will exceed the needs of its surface water potential that is about 11,883 million m^3. The calculation has included reduction in water demand for irrigation, rising domestic needs, industry and others.

Human resources are still becoming a problem in the Brantas watershed conservation. Knowledge and awareness is still low (including legal consciousness) resulting in various forms of violation and destruction of the land. Some effort is being put in place to build awareness and empowerment, including legislative and regulatory instruments of socialization by government.

3.1.2. Bio-physical-chemical Brantas River Water

The Bio-physical problems affecting the Brantas watershed are that of quality. Some of the critical issues faced in the management of the Brantas River (Widyo Parwanto 2009) are: 1) the fluctuation of the high river water between rainy and dry seasons. 2) The high sedimentation which is resulting in buildup of sediment in the reservoir and the high cost for dredging, 3) domestic solid waste dumped into rivers and collects in the reservoir resulting in a reduction in capacity of reservoir patch, 4) pollution by chemicals from agricultural lands upstream and middle resulted in a seasonal algae boom. Bacterial contamination caused by elision waste of livestock and possibility done by human population. In the Brantas watershed downstream, besides pollution by domestic waste, it is also done by the factories. Cases of mass mortality of fish in the Brantas River in Surabaya caused by the high of Biological Oxygen Demand (BOD) due to discarding of waste by the sugar mills.

3.1.3. Problems in Coastal Areas

The coastal area is a transition zone between land and sea, ecosystems are affected by various conditions change on land and sea. Coastal areas included in the Brantas mangrove ecosystem are that spread in the Surabaya city and Sidoarjo. This ecosystem has been degraded by land conversion for housing and urban infrastructure and pollution by industrial waste. Rivers and coastal pollution causes fluctuations of aquaculture production with very high effects, causing most of the farms to be abandoned.

Management of watershed and coastal region is still self run. This problem occurs because the ecosystem within the remit of stakeholders and different policies. Besides, studies on the importance of integration between regional watershed planning with coastal and marine areas is not supported by the results of the study.

3.2. Socio-Economic Issues

3.2.1. Socio-Economic Issues

Issues associated with over population are the cause of many problems in the Brantas watershed; land degradation, deforestation, land grabbing, illegal logging, landslides, erosion, flooding and drought. In urban areas, the economic pressures have been so pressing on the environment and affect the health of the watershed. Limited education, knowledge and skills also seem to be a factor, showing the low quality of human resources to be able to maintain and even improve watershed conditions. The observation results of the Bogor Agricultural Institute together with Brantas Watershed Management (BPDAS Brantas 2012.b) indicate that human resources capacity is the main cause of many problems in the Brantas watershed.

3.2.2. Addressing Educational Problems as a Key for Long-Term Management of Watershed Conservation

It was agreed by all education experts that the preparation and management of the human future must be done through education. Environmental protection activity is an activity that aims at sustainability. Based on these considerations, educational activities become a very vital role in the water and watershed management.

Until now, planning and watershed management still relies on physical activities and social short-term. This is due to the recommendations given by the experts that the technical recommendations based on the results of field studies in accordance with the frame work thinking that they have. This condition is exacerbated by the absence of the educators who are directly involved in the planning environment, including watershed. This situation is caused by the paradigm of thinking that these are not the domain of educators but the technicians in charge of the realm of direct in technical things to do in the short term. This Paradigm is often reinforced by policy makers in the field of education or appraisers who assess the progress of educators in the field of environmental conservation planning is supporting activities

that are not important or even negligible. This condition causes the alienated educators (marginalized or excluded) from the discourses that it is contextually needed to raise the soul, thoughts and behavior of students in the present and the future.

Negative impact of these conditions is shown by the researchers of Brantas Watershed Management of Bogor Agricultural Institute together with Brantas watershed management (BP DAS Brantas 2011) which reported that the biggest problem facing the Brantas watershed management today is mainly the human resource capacity. Their research findings shows: people or groups of people who have the knowledge, values and attitude towards the environment will do well in responding towards environmental conservation, and linearly related to the welfare that they feel. Instead, people or society without knowledge and awareness will be a cause of damage having no responsibility for the future of life. This bad behavior is not only harming the environment, but also related with low levels of social welfare.

3.2.3. Education in Watershed Management in Indonesia

Integrated watershed management is regulated by the Indonesian Government Regulation No. 37 of 2012. Government regulation is one that is higher than the regulations at the ministerial level that is considered less effective. Education in integrated watershed management has a very important role as mentioned in Part Two; Article 61, 62 and 63. Education in watershed management works to empower people with the aim to increase the capacity, capability, and the role of public concern in the watershed. Mandate of community empowerment in minimal government regulation is done through: education, training, counseling, mentoring, giving loan or capital assistance, socialization and dissemination and or the provision of facilities and infrastructure.

Social management domain in watershed management is often a big problem since the results cannot be seen on a short term so it is often considered a problem for decision-makers to provide appropriate financial support. Observers of watershed still have to work hard to find a way out to make sure and guarantee that education can give a significant contribution in the management processes even further thinking and preparing for the future.

4. Conclusions

Based on the explanation and research findings about Brantas watershed, it can be concluded that:

1. Brantas watershed has a very vital and strategic role in all aspects of development activities, especially in East Java. The existence of the Brantas River is a blessing that must be conserved for the next generations.
2. Watershed as a whole ecosystem has relevance between one ecosystem components with other components of the ecosystem. Ecosystem problems in the region are also interlinked with other.
3. Problems in the Brantas watershed are very complex both in bio-physical and social problems. The results of the analysis to the problems shows that human resources factor becomes the main cause for the emergence of a variety of other problems in the Brantas watershed issues, both bio-physical and social problems.
4. As stated in latest government regulations regarding watershed management, educational activities play an important role in determining the success of the Brantas watershed management. However, educational activities must be designed in such a way that can give confidence to the public and stakeholders that education is able to participate in watershed management and give a new expectation for watershed sustainable development.

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