

Assesment Environmental Sustainability at Upper Watershed Area Based on Bioindicators Knowledge Using The Rapid Appraisal of River Conservation Status (RapRiCons) for Sutable River Conservation

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Article Info

Article history:

Received Jul 12th, 2017

Revised Aug 20th, 2017

Accepted Oct 26th, 2017

Keyword:

Environmental
Sustainability
RapRiCons
upper watershed
conservation
Bioindicator

ABSTRACT

River conservation activity is an activity that must be performed continuously and takes a long period in socio-ecological-economy and politics area. This conservation activity will run well if supported by community's awareness of this conservation activity. Unfortunately, not every element of society consciously takes part in river conservation activity. Main issue in this research is the presence of people knowledge about bioindicator increase can be used as consciousness leverage in doing river conservation. River conservation that has been recorded by people can be evaluated by developing five dimensions' measurement which is ecological dimension, economical dimension, technological dimension, socio-cultural dimension, and ethical dimension that summarized in evaluation tool called The Rapid appraisal of River Conservation Status (RapRiCons) which is an evaluation tool for environment sustainability. This tool is a modification from RAPFISH. This research used quantitative approach with descriptive analytic method. The results and conclusions from this research show that environment sustainability that revealed in five measurement, all shows that good scores and shows enough environment sustainability status. The result from this research can be used as reference about strength and weakness on each measurable dimension as bioindicator based river conservation evaluation that performed independently by community.

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1. INTRODUCTION

As a part of watershed, river is a source of water that can be used by human in fulfilling their daily life. Naturally, a river can be having a quality degradation if the river is being polluted by human activity [1,2], without having dilution in water bodies, or having incomparable water volume with contaminant. Almost every human activity on watershed area affects the river water quality. The people cannot be separated from natural environment, and the world can't be seen as collection of separated objects, but as a phenomenon network that basically interconnected and interdependent. The understanding community behavior with every knowledge it has become very important in building the consciousness about environment preservation and river conservation. People's apathy in river damages shows low participation on their environment sustainability. Yet on the other hand, public participation is a very good social capital for environmental conservation from low level participation to high level of participation [3] especially on water resources [4]. Communities can produce ideas, initiative and

innovation in environmental conservation efforts. Community participation based on existing knowledge of bioindicators in the community can be used as a trigger of river conservation. Bioindicator knowledge-based participatory approach in IWRM (Integrated Water Resources Management) is a matter that needs to be applied to all countries.

RapRiCons (The Rappid Appraisal of River Conservation Status) is a method to determine the status of environmental sustainability that were made based on the modification of RAPFISH (The Rapid Appraisal of Fisheries Status) which has been developed by Pitcher 1999 [5,6,7,8,9,10]. This method was developed by using the five environmental dimensions (ecological dimension, the socio-cultural dimension, the economic dimension, the dimension of technology, ethical dimension) that were used to assess the sustainability of the environment in a comprehensive manner.

RapRiCons ecological dimension is used to determine both whether or not the quality of the existing environment in the upstream watershed with ecological processes in it which plays an important role in the maintenance of ecosystem quality in the study area. Studies on the Interactions species can be increased appreciation of the importance individual function in environment. Ecological dimension is translated into nine attributes, which contains people's knowledge on bioindicator on Riparian vegetation bioindicators, macroinvertebrates bioindicator, and Odonata bioindicator. The socio-cultural dimension is a manifestation of how the existing social systems that exist in the upstream watershed area whether or not to support the socio-cultural dimension in the long-term sustainability of the river. The extent of public responsibility, and community involvement Reflects the level of public awareness of the nature [11]. Human activities on the high insistence of the Environment on the spatial and temporal scale, will have an impact on biodiversity [12]. The socio-cultural dimension was translated into operational attributes that can describe the state of River conservation and water sources in the upstream area analyzed in terms of the socio-cultural dimension. The growing human intervention in form of urbanisation and deforestation has equally contributed more to the disappearing forest [13]. The technological dimensions on RapRiCons sustainability analysis is a reflection of the degree of utilization of natural resources by using existing technology. The good use of technology will be needed to better understand and manage the impacts of local decisions on natural resources consumption in the long term [14]. Technological dimension in the sustainability analysis is translated into six attributes that operationally can describe the use of technology. Economic dimension is a reflection if the the existence of a conservation gain economically results in the sustainable and long term. The economic value obtained in two forms, namely tangible and intangible. Both of these values are closely intertwined with other aspects of sustainability goals. Understanding these dimensions translated into eight attributes that operationally can describe the overall sustainability of economic dimension in upstream watershed conservation. Ethical dimensions was functioned to understand people's behavior towards nature, and the relationship between community members who in turn will affect relational relationship with nature including traditional beliefs that developed in the community. Ethics emphasize on how people should behave towards nature in harmony with their daily lifes.

2. RESEARCH METHOD

This study took location at Batu district area, East Java, Indonesia. Selection of study sites in the Brantas River upstream watershed in Batu district, on the ground that Batu district has the highest number of springs and watershed areas that undergo quite large changes in land use and there has been a decline in the number of springs significantly [15]. The study approach used in this study is the quantitative approach, with descriptive analysis methods [16]. The study population in this study is people choosen from the three Villages from two districts out of the three districts in Batu district as areas that have the highest springs that can represent Brantas upstream watershed part (Forest area, agricultural area, and urban area).

The method used is Multi-Dimensional Scaling (MDS) approach [7, 8, 9 10], which was developed based on the Ecology dimension with bioindicator knowledge, Socio-cultural, Economic, Technology and Ethics is used to assess the sustainability of Community Participation Model In Upstream Watershed Conservation as a bioindicator Based Sustainable River Management Plan. The Attributes determination in each dimension is done through a

literature review [17, 18, 19, 20, 21, 22, 23, 24, 25, 8, 9, 26] interview sources, and field observations. Each attribute scoring in the dimension of ecological, economic, socio-cultural, ethical, and technology was done based on field observations and expert opinion (scientific judgment) in accordance with the stipulation of a predetermined number. In the study, the range of scores ranged from 1-3, which is interpreted from bad to good or vice versa based on the attributes that have been set.

Parameters contained in the five (5) measurable dimensions describe the environmental dimension of each aspect in the form of the ranking scores. Ordination of dimensions and measurable attributes processed using multi-dimensional scaling (MDS), followed by the process of scaling and rotation. Every attribute leverage that was obtained can be calculated by the Stepwise Analysis procedure. Ordination is done by Benchmark that is pegged at a fixed point which will simulate worst and best assessment. On the other hand, the stakes will also maintain normalcy second ordination axis of the first axis. Significant differences are indicated by counting the Monte Carlo Simulation of error associated with the initial assessment [9].

Ecological dimensions describe the environmental situation in which society exists, the condition of the habitat for plants and animals, vegetation diversity and Odonata, the impact of environmental stress as a result of human activities in the area [19, 20, 21, 22, 24, 25, 27, 29].

Socio-cultural dimension is developed based on the regulations in force (Law, Government Regulation, Regulation, local laws), local knowledge developed in the community, community involvement in environmental management that supports sustainable conservation, the influence of public education on regulatory compliance applicable, a growing culture in society that lead to environmental management, the existence of NGOs which can encourage activity on environment preservation, environmental knowledge that has been developed in the community, the conflicts that occur in the community related to the environment [8, 9, 17, 26].

The development of the technology dimension RapRiCons was based on the use of technology in the delivery of programs that were developed to the community, handling the pollution and efforts to rehabilitate, efforts to prevent environmental damage [9, 24, 27].

Economic dimensions Development was based on the principles of utilization that refers to the economic value to the area of vegetation, river and water sources and, the diversity of work that can be used as an alternative income for the community, subsidies that lead to the development of community self-reliance, and the magnitude of the poverty index [10,17, 18].

Ethical dimension was developed based on public attitudes towards environmentally damaging action, society emotional and physical intimacy to rivers and water sources, community togetherness in awareness of environmental management, maintenance of a harmonious relationship between society and the government, the development of active public participation in environmental stewardship [17, 26, 30, 31, 33, 34]. Incorporate the results of the scoring process was analyzed by MDS program to determine the environmental conservation sustainability index. Sustainability index scale lies between 0 - 100. With MDS method, can be described with a sustainability point of visualization between the horizontal and vertical axis to the extreme "bad" was given a score of 0% and the extreme point of "good" was given a score value of 100%.

Table 1 Category Status Upstream Watershed Conservation Sustainability (RAPRiCons)

Index Score	Category
0,00 - 25,00	Bad (unsustainable)
25,01 – 50,00	Low (less sustainable)
50,01 – 75,00	Fair (sustainable enough)
75,01- 100,00	Good (highly sustainable)

3. RESULTS AND DISCUSSION

1. Description of Study Area

The study was conducted on people who live in the Brantas upstream watershed area, which is geographically located between 7044' - 8026' N and 122 017' - 122 057' E [36]. with elevation of 690-1200 m above sea level. In the most upstream part of the Brantas River watershed there are several springs which is the beginning of the Brantas River.

Brantas River watershed is the largest river basin in East Java province, a river that is very strategic for the life of the surrounding community. The length of the Brantas River ± 320 km with an area of 12,000 km² and includes a spacious 26.5% of East Java Province has the potential water resource ± 12 billion m³ were used as raw water by the community in many ways such as the power source of electric power generation, irrigation, water companies, industry, tourism, and others. Brantas wide watershed area as in Figure 1 below.

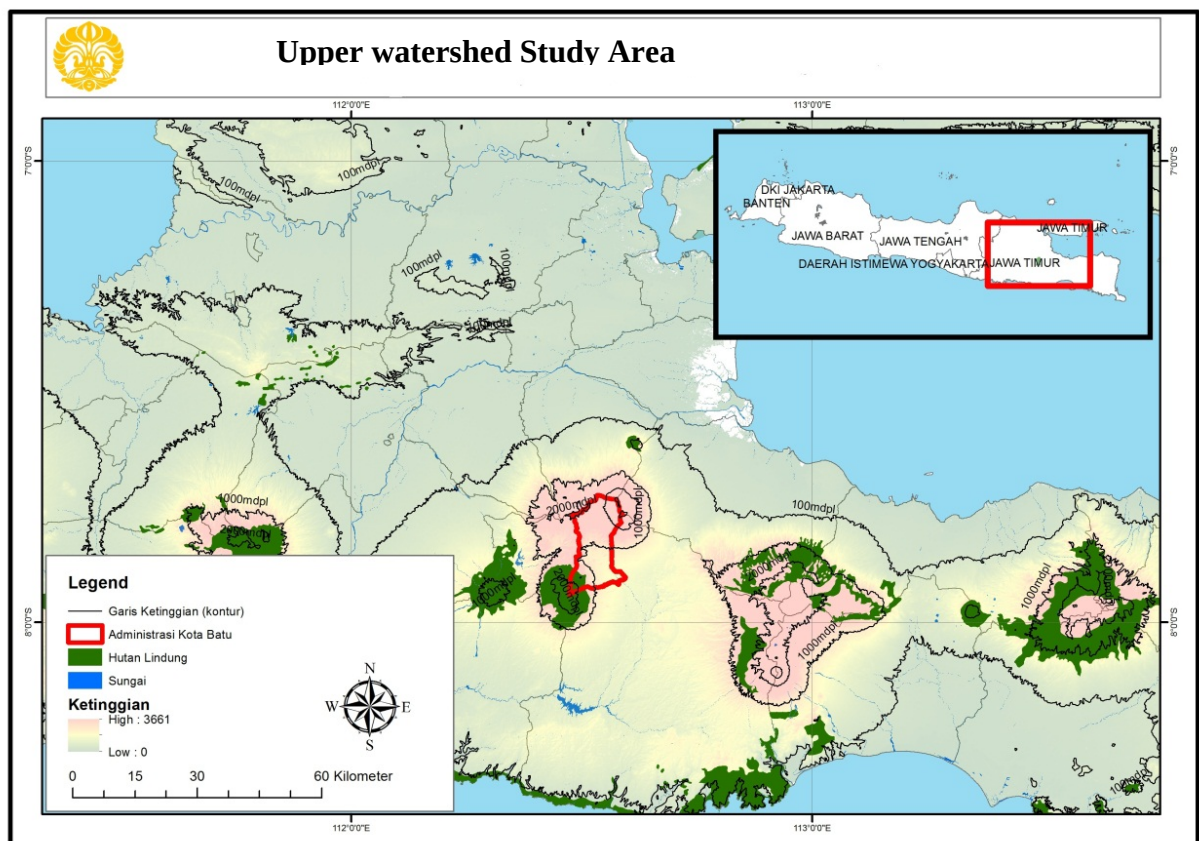


Figure 1 Upper watershed Brantas study area

Brantas river watershed covers a wide area in East Java Province, running through 9 regencies and 6 Cities which includes Batu City, Malang City, Malang Regency, Blitar Regency, Blitar City, Trenggalek Regency, Kediri Regency, Kediri City, Nganjuk Regency, Ponorogo Regency, Mojokerto Regency, Mojokerto City, Sidoarjo Regency, and Surabaya City. Based on the flow of river water, the Brantas River watershed is the estuary of several sub-watershed, among others, is a sub-watershed Brangkal, sub-watershed Konto, sub-watershed Upstream Brantas, sub-watershed Central Brantas, Panggul watershed, Penguluran watershed, Lorog watershed, sub-watershed Ngrowo Ngasinan, sub-watershed Wadas, sub-watershed Marmoyo, sub-watershed downstream Brantas, and sub-watershed Lekso [36]. Upstream Brantas river watershed consists of sub-watershed upstream Brantas (182 km²), Amprong (348 km²), Bango (262 km²), Metro (309 km²), Lahor (188 km²) and Lesti (608 km²).

Upstream Brantas River watershed that is located in Batu City, occupies 16.7% of the total 1897 km² area of the Upstream Brantas river watershed with most water sources in this watershed area [35].

The overall level of social and economic life in Batu a weighted average of the growth rate of each sector of the economy. In 2013, the economy in Batu show higher growth process than before. GDP Batu is represented by the total value of production of goods and services produced in Batu within one year. All sectors of economic activity contribute to economic growth posisif to GDP in 2013. In addition to the main livelihood of the people in the study area is agriculture, trade is an important sector in supporting the economy of Batu. Economic growth in the trade sector reached 8.04 in 2011 [35], especially in the tourism sector that can implies in multiple sector and connections [38], hotels, restaurants and trade. Batu City local government efforts in attracting investors in various sectors, local, regional, national and global were successful enough to increase the revenues in taxes, levies and Tourism sector. Batu city as a one of ecological destination tourism in East Java Region, is the place where a visitor or a tourist stops either for a night or for a period of time, or the terminal point of a tourist's holiday, whether they are travelling for nature's tourism.

Ecological conditions of the study area divided Three area: firstly is Sumberbrantas village which is a village located in the upper most part of the Brantas River watershed, has a dense forest with high species diversity. Vegetation coverage in the study area is still well within the range of 60% to 95%. Existing forests can generally be divided into a protected forest (Perhutani in Mount Kawi-Panderman and Tahura Suryo in mountain Anjasmoro-Arjuna), forest conservation, and forest production plants managed by Perum Perhutani. Secondly is Pandanrejo village, an area with a large population in agricultural activities. Most agricultural activities in this area are the flowers and vegetables. The vegetation in this area is generally in the form of forests, shrubs or bamboo that dominates by 60%. Thirdly is Torongrejo village, ecological circumstances as the last area of research has vegetation cover on land by 80%. Community income derived from agricultural products, particularly onions and vegetables.

2. Sustainability Analysis on River Conservation using RapRiCons

Analysis results compilation from each dimension (Ecological Dimension with bioindicator knowledge, Socio-cultural dimension, economic dimension, Technology dimension, and Ethics dimension) which was developed to measure environmental sustainability Model of Community Participation On Upper Watershed Conservation Based on bioindicator For Sustainable River Management Program in the RapriCons multidimensional analysis as in Table 2.

Tabel 2. MDS Result, Monte Carlo and River conservation sustainability statistical analysis

Dimension	Sustainability Index		Difference	Statistics		Iteration
	M	Monte		Str	R ²	
	DS	Carlo		ess		
Multidimension	59,98	59,77	0,22	0,20	0,89	3
Ecological Dimension	60,97	61,04	0,07	0,19	0,93	2
Socio-Cultural Dimension	68,06	69,34	0,38	0,19	0,93	2
Economics Dimension	54,17	54,12	0,05	0,21	0,91	3
Technology Dimension	57,07	57,50	0,43	0,22	0,90	3
Ethics Dimension	56,25	56,13	0,12	0,21	0,91	3

To uncover analysis results ordination stability, Monte Carlo analysis was done in regression modelling [38], to look at the level of disturbance (perturbation) against the ordinated value with 25 iterations. Monte Carlo analysis

on the use of RapRiCons is a simulation method to evaluate the impact of random errors in calculated dimensions at 95% confidence interval. It is known that cross section uncertainty is one of the main parameters to affect the uncertainty of the criticality [39].

By looking at the results of Monte Carlo analysis can be seen the extent to which of the analysis is done reliably. The results of the Monte Carlo calculation of the five dimensions showed a small difference value (0.07% - 0.43%) between the calculation with RapRiCons and Monte Carlo analysis. This situation shows that the results of the analysis performed on the ordination of five-dimensional measurement is stable enough.

Figure 2 below described results of analysis ordination and Kite diagram of bioindicators knowledge-based upstream watershed environmental sustainability. The result shows that Sustainable river management effort refers to socio-cultural dimension which is the dimension with the highest analytical results and is followed by the ecological dimension, the dimension of technology, ethical dimension, and economic dimensions by the value respectively 68.06; 60.97; 57.07; 56.25. Socio-cultural can provide unique and important contributions to society's understanding of the relationships between humans and nature and to improving conservation practice and outcomes [40]. This means that on the basis of the existing criteria, sustainable river management efforts by increasing public knowledge of bio-indicators that exist in their environment, have an index value of 50.0. Based on the criteria set out in Table 2 it can be seen that the environment has sufficient status (sustainable enough). This is consistent with field conditions that are ecologically socio-cultural life of the community and the surrounding abiotic environment as a harmonious interrelation and can not be separated from one another. Coping complex socio-cultural systems in the service of a sustainable, convivial human society, is itself a complex activity [41]. Socio-cultural making specific interaction and continuity between the measured dimensions, so that the obligations and responsibilities of the community does not stop on the relationship between the members of society, but also by taking into account the ecological conditions that exist around the community. Activation on river conservation can be raised by increasing public interest in living organisms to their environment [15]. Acquisition value in each dimension of analysis ordination and kite diagram is shown in Figure 2.

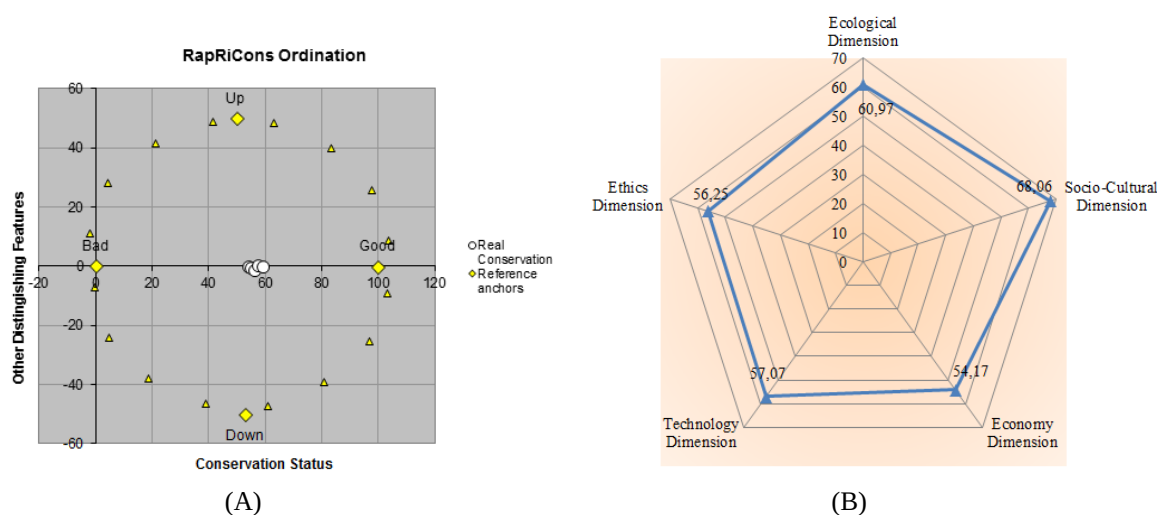


Figure 2. Results of analysis ordination (A) and Kite diagram (B) upstream watershed environmental sustainability as a knowledge-based bio-indicators of Sustainable river Management

The high value of the socio-cultural dimension (68.06) is the embodiment of social justice, human dignity and improvement of the quality of human life. The emergence of local wisdom in the community, showing the development of culture in the local area. Custom made hereditary in the area of research in the form of *bersih desa*

is an environmental wisdom of local communities in the maintenance of environmental damage in his village. This activity is carried out by cleaning the water source, and the flow of the water in their village. the situation in the research area is reinforced by Negi opinion [43] sustainable natural resource management is driven by the beliefs and behaviors of human communities, and local cultures.

Ecological sustainability with the value (60.97) reflects the ecological conservation in the area of research with all the wealth inside. The success of this ecological dimension is not the only material success, but also on the ecological quality of community life assurance, socio-cultural, and economic in a balanced and proportionate way. Because there is essentially a manifestation of harmonization of environmental conditions is a reciprocal relationship between humans and the natural environment and of the natural environment by human beings who live in the area [43].

The use of technology with the value (57.07) in environmental management is not used as a resource drain, but rather used as a safety (Safeguarding) on the use of renewable natural resources and suppress unrenewable exploitation of natural resources to ensure the availability of natural resources for generations to come. Post year-2015 Development targets are addressed to the achievement of sustainable development objectives that depends on Management of Natural Resources, innovation and technological progress [44]. Technology can also be used as a guarantor of public welfare in a sustainable manner and not only to pursue the fulfillment of the economy in one generation.

Ethical dimension (56.25) develop relational relationship between humans and nature in addition to the relationship between man and man. The ethical position underpinning conservations is an important concern for conservation biologists when setting priorities for interventions [45]. Ethics associated with depictions of moral and behavioral requirements, which indicates that there is a way that is acceptable and unacceptable to the community based on the philosophical principles [46]. Keywords that require deeper manifestation to perpetuate a relationship that has been built is the responsibility of man. This responsibility is a human obligation to protecting the environment and human beings in sustainability. Responsibility can also be interpreted as a form of human prudence in the use and management of existing resources in the fulfillment of his intent for the current generation and maintenance for the benefit of future generations.

Sustainability of the economic dimension with the value (54.17) requires several considerations associated with the use of renewable resource and non-renewable resources to maintain the quality of the environment. There is a lack of understanding between the communities in the research concerning the method and philosophy in the economic dimension of the environment has an important role in environmental sustainability. Lack of understanding of economic dimension can also be an obstacle to conservation. The use of renewable resources using the principles of which correspond to the carrying capacity of the environment and attention to ecosystem resilience. The economic dimension is obtained in two forms, namely tangible and intangible. Both of these values are closely intertwined with other aspects of sustainability goals.

CONCLUSION

People's understanding of the condition of the environment, especially the knowledge of bioindicators are close to people's daily life can affect a variety of public awareness of environmental conditions that exist around them. Understanding of this bioindicator become a river conservation activities trigger by the community independently. This conservation activities carried out jointly as a form of public awareness of the environment in the watershed area upstream from the bottom up.

Community activities in the river conservation efforts can be measured by looking at RapRiCons five dimensions that can describe the activities carried out by the community as a whole and comprehensive. Dimensions that were developed, revealed wisdom of local communities and the public understanding of the bio-

indicators in the environment of their lives. Conservation activities undertaken consciously and independently can be used on river conservation activities in a sustainable manner.

ACKNOWLEDGMENTS

The author would like to thank the beneficial help and support for the completion of this paper from The Directorate General of Higher Education (DIKTI) Republic of Indonesia, University of Muhammadiyah Malang, and University of Indonesia.

CONFLICT OF INTEREST

This research is free from any conflicts of interest.

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