MANAGEMENT OF WATERSHEDS AS A PLANNING, MONITORING AND EVALUATION ZONE UNIT FOR THE DEVELOPMENT OF THE CITY; Case Study of Karangmumus Watershed at Samarinda City, East Kalimantan Province, Indonesia

ABSTRACT

The changing land use affects the social and economic characteristics and environmental issues in a watershed. To support sub-watershed management, land use scenarios and the level of community involvement must be improved. This research is a study to analyse and evaluate the condition of the Karangmumus watershed covering 365.25 km2 which is mostly located in Samarinda City, the capital of East Kalimantan Province. Research was conducted with various sources of data analysed using descriptive quantitative methods. In assessing the condition of a watershed, it is absolutely necessary to have debit data and other data to support the analysis and evaluation. In reality, currently the quantity and quality of flow data is still far from expected. This is due to the difficulties that cause the flow data collection process can not be done in all places, but only in certain watersheds. In the watershed monitoring carried out, there are still obstacles, one of which is the continuity of observation.

Keywords : *Watersheed, development, monitoring, analyze, evaluation*

Introduction

Forests and land resources degradation processes have proven to have far-reaching impacts, covering biophysical, environmental, economic, institutional and socio-political aspects. The degradation occurs in all functions of forest areas and outside forest areas, as a result of weak forestry institutions and law enforcement in forest and land management, excessive forest exploitation, rampant forest encroachment and illegal logging, forest fires that are difficult to control, and weak public awareness and concern for the sustainability of watershed ecosystems. The watershed management is a human effort in controlling the mutual relationship between renewable natural resources in the form of forests (vegetation), soil and water with humans and all their activities with the aim of fostering sustainability of the ecosystem (environment) and increasing the benefits of natural resources for human life. [2, 3].

The amount of carrying capacity and sustainability of the productivity of natural resources of land and water is largely determined by the interaction between the way humans manage the natural resources themselves with existing biophysical environmental factors [2, 3]. The imbalance of population and needs with the carrying capacity of natural resources of vegetation, soil and water encourages the need for a watershed management which according to the American Forester Society (1994) cited by [10, 11] is defined as part of the management of natural resources, especially watersheds for the production and

protection of water resources including protection against erosion and flooding and aesthetic values associated with water.

Watershed is an ecosystem in which there is a process of interaction between biotic, non-biotic and human factors. As an ecosystem, any *input* into it, the processes that occur and take place in it can be evaluated based on the *output of* the ecosystem. Each watershed has its own characteristics that affect the process of flowing rainwater that falls in it until it comes out in the estuary and enters the sea or lake. Watershed characteristics are mainly determined by land factors (topography, geology and geomorphology) and vegetation factors as well as the use or land use that will affect river discharge and mud content [4, 7, 10].

The municipality of Samarinda about more than 820.000 inhabitants known as a capital city of East Borneo Province and became the center of government and economic activities. Total city area approximately 718 km^2, is a riverside city on the edge of Mahakam River and Karangmumus River (KMR). Conversely, humans in the watershed ecosystem is an important resource that is very influential on the development and preservation of watershed capabilities. Thus the watershed is actually also a resource unit, therefore there is a tendency to make the watershed as a unit or development area [6, 8]. In this study, we focused on the Karangmumus River, it is because the river is located along the city and the estuary is located in the center of this city

Research Methods

This research is a study of various things about watershed management with the main subject of the Karangmumus watershed in Samarinda, which is carried out using quantitative descriptive methods with combination of primary data in the form of field observations and secondary data from secondary data obtained from various source. Data-based analysis Regulation the Minister of Forestry of the Republic of Indonesia Number 61 of 2014 concerning Monitoring and Evaluation of Watershed Management [3].

Results and Discussion

Karang Mumus sub-watershed is located between 0°19'28.93"S - 0°26'54.72"S and 117°12'06.24"E - 117°15'41.27"E. Karang Mumus sub-watershed has an area of 365.27 km^2 (BWS Kalimantan III, 2017). Administratively, the Karang Mumus sub-watershed is located in Samarinda City and Kutai Kartanegara Regency. In Samarinda City, most of it is located in North Samarinda District and a small part in Sungai Pinang, Samarinda Ulu, Samarinda Ilir, Samarinda Kota and Sambutan Districts. In Kutai Kartanegara Regency, the entire area is located in Muara Badak District [6, 7]. Karang Mumus Sub Watershed has an area of 365.27 km^2 or 36,527 hectares with a circumference of 103.26 km^2. Karang Mumus Subwatershed has 20 Subwatersheds (SWS) that can be grouped into an upstream WS group (10 SWS) with a total area of 190.70 km^2 (60.31%), a middle SWS group (9 SWS) with an area of 101.96 km2 and a downstream SWS group (1 SWS) with an area of 23.56 km^2 (Figure 1). The length of the main river of Karang Mumus Sub Watershed is 37.65 km.

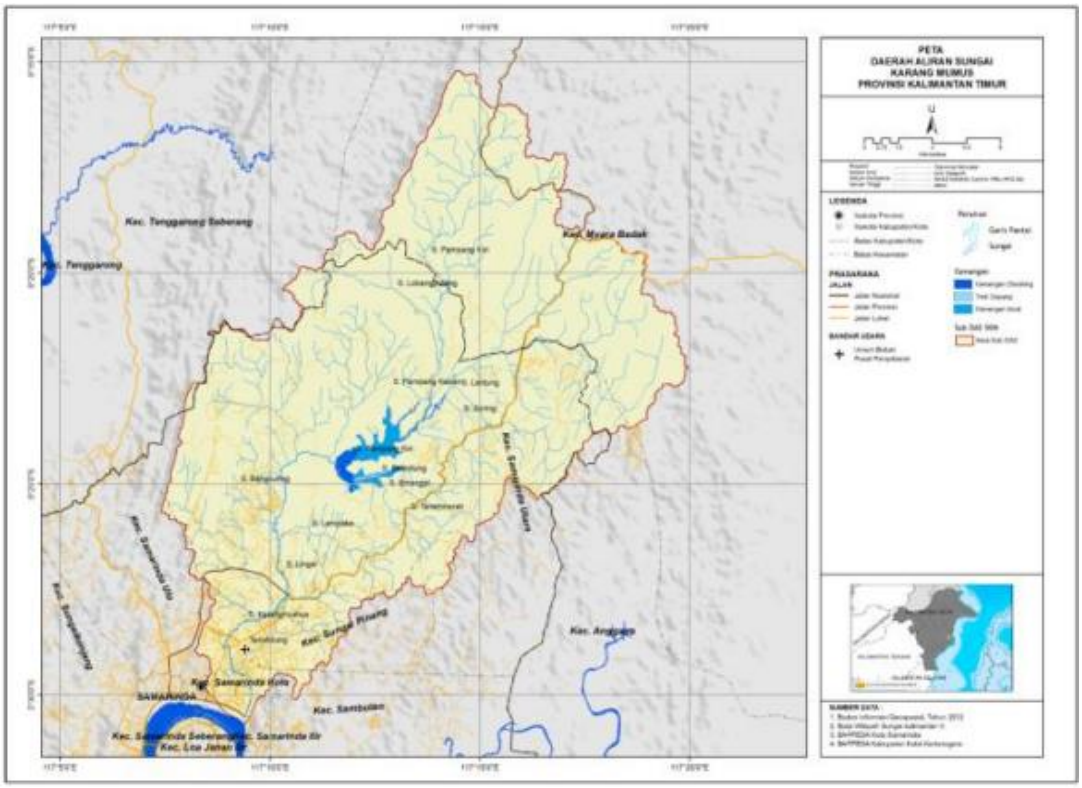

Fig 1 : Map of Karang Mumus Sub-watershed (research site map)

Common Problems of Karangmumus Sub Watershed

Watershed degradation is one of the important problems in Indonesia, indicated by deteriorating water system conditions, widespread critical land, high rates of erosion, sedimentation, large fluctuations in rainy and dry season discharge. All forms of forest management activities and various treatments carried out in and outside the forest area affects the balance of watershed management that passes through it. For this reason, all forms of treatment in a watershed area must pay attention to aspects of nature and environmental sustainability [4, 5]. Among the aspects of sustainability that are very important to maintain is the watershed water system component. The water system includes; water discharge, fluctuations and quality of its flow. For this reason, water system conditions in watershed areas periodically and continuously must always be monitored [3, 4].

According to [4, 10, 15] the management of Sub Watersheds with good and correct procedures is an effort in controlling the interrelationships between natural resources in the form of vegetation, land and water with humans and all their activities. So that the purpose of Sub Watershed management is to ensure sustainability and Ecosystem compatibility and increasing the benefits of natural resources contained in it for human life can be achieved. Among the aspects of sustainability that are very important to be maintained are hydroorological conditions, especially watershed water system components. The water system includes; water discharge, fluctuations and quality of its flow. Under normal conditions, the function of vegetation (forest) as a regulator of water management will have an impact on certain discharge conditions, erosion rates and

sedimentation. For this reason, the condition of water management in a watershed area, in this case, the Karangmumus Sub Watershed periodically and continuously must always be monitored.

This is intended as an effort to maintain the water discharge of rivers that empty into the Karangmumus river in the dry season is relatively stable. In addition, it also avoids an increase in surface water flow discharge in the rainy season which can result in a higher frequency of flooding in the Samarinda City area. Along with the development of the city, most of the upstream area of the Karangmumus watershed has experienced degradation, especially due to logging, residential needs, and changes in the function of the area. The direct impact felt is the change in water balance in the Karangmumus watershed which is manifested by the occurrence of droughts and floods that are increasingly widespread and increasingly frequent in various aspects of life[6, 7, 10, 11].

One of the problems in restoring the condition of the Karang Mumus Subwatershed is the uncontrolled growth of settlements in riparian areas. This condition is due to the weak capacity and control of the local government in the utilisation of riparian areas so that they become slums. The population in the Karang Mumus Subwatershed is more than 820.000, more than half of which are located in riparian areas and are vulnerable to flooding. The settlement pattern in the Karang Mumus Subwatershed follows the profile of the road and river, in groups and irregularly. Access roads, clean water and sanitation facilities are mostly in poor condition. Houses on the riverbank are colonnaded and overhang the water body, reducing the river's flow capacity, either by reducing the river's dimensions, silting and obstructing the flow due to piles of rubbish under the houses. This is exacerbated by the community's low awareness of waste and waste management. The longevity of the community's residence in the river basin does not encourage the growth of local wisdom to live in harmony with the river. Instead, relocation activities often become a means of profit-making through high compensation demands.

The actual watershed system is a "non-linear time variant". However, assuming the watershed as a "linear time variable" system, the conversion of rain into flow becomes simpler. With this assumption, then the input that occurs every time will result in the same flow. Thus a particular watershed has a specific response to inputs of a certain magnitude, such responses in the concept of hydrological models are known as unit hydrographs [14, 15].

In this connection, monitoring the quality of a watershed area is carried out, because through a systematic and continuous monitoring mechanism, the latest information can be obtained about the condition of the watershed area so that various policies can be taken that accompany it. This should be done, including through an assessment of the level of degradation of the downstream area of the Karang Mumus Sub Watershed (parent) with the following considerations:

1. Karang Mumus River where the river flow and catchment area are mostly in the Samarinda City area as the capital of East Kalimantan Province.
2. The strategic position of the Karang Mumus Sub Watershed, which is mostly included in the Samarinda City area, has decreased in quality, marked by concrete examples of environmental quality degradation, including being prone

to flooding in the rainy season in Samarinda City, especially around the Karang Mumus Watershed.

3. Flood and overflow events of S. Karangmumus almost always occur every rain event with a rain time of more than 3 hours.

Watershed as an Area Unit of Planning, Monitoring and Evaluation

In accordance with the mandate stated in the Outline of State Policy 1999 - 2004 which states that "Managing natural resources and maintaining its carrying capacity in order to benefit the improvement of people's welfare from generation to generation. Increase the potential of natural resources and maintain the environment by conserving, rehabilitating and saving use by applying environmentally friendly technology. Utilise natural resources for the greatest prosperity of the people by taking into account the preservation of the function and balance of the economic environment and the culture of local communities as well as spatial planning.[13, 14, 15]"

From the hydrological point of view, the watershed is a hydrological unit, while in terms of the concept of watershed is a unit of landforms, namely the association of land in the summary of a particular landscape. From the point of view of resources, watershed is a typical resource system, as well as an ecosystem that by various experts accepted as a basic unit of development planning. Indeed, watershed management efforts in Indonesia has long been implemented and has positive results as well, but because of the complex problems that involve various aspects of the watershed stability conditions are needed as a unit of development areas that require integrated management of various institutions / agencies with their respective functions and duties [13, 15].

It has been stated earlier that the watershed is an ecosystem, then any input (input) into the ecosystem can be evaluated processes that have been and are taking place by looking at the*output (output*) of the ecosystem. In the watershed ecosystem, the input component consists of rainfall while the output component consists of water discharge and sediment load at the *outlet of* the watershed concerned. The watershed which consists of vegetation, soil and water/river components in this case acts as a processor. Watershed ecosystems, especially upstream watersheds, are an important part because they have the function of protecting the entire watershed [8,9]. Therefore, upstream watershed planning is often the focus or priority given that in a watershed, upstream and downstream areas have a biogeophysical relationship through the hydrological cycle. Land use change activities and or the construction of conservation structures implemented in the upstream area can have an impact on the downstream area in the form of changes in water discharge fluctuations and sediment transport and other dissolved materials. More specifically, the relationship between*inputs* and*outputs* of the watershed can be used simply to analyse the impact of a development activity on the environment (hydrology) and also vice versa the impact of the hydrological environment on development in the area, especially its influence in downstream areas [17].

The Importance of Water Flow Data in Watersheds

The concept of watershed management actually existed since the Dutch era, especially in forest management where the division of forest areas is regulated based on watershed units. In 1973–1981 FAO and UNDP conducted trials to obtain appropriate methods for land rehabilitation and soil conservation in the upstream areas of the Solo watershed. The results of this test have been applied in the INPRES Reforestation and Greening project since 1976 in 36 (thirty-six) watersheds in Indonesia. Integrated watershed management efforts have been implemented for the Citandui watershed since 1981, this is where a cross-sectoral and cross-disciplinary approach is implemented [9, 16]

In order for the condition of a watershed to be maintained the sustainability of its resources, the planning, implementation and monitoring activities of Watershed Management must follow the principles of Hydrology, where the main input is rain and the output is discharge and sediment. For that in learning Watershed response to input in the form of rain, observation and measurement of river flow is needed. Thus analysis and evaluation of watershed conditions can be carried out. In this case, it is absolutely necessary to provide river flow data and other data to support the analysis and evaluation. In Indonesia, such flow data cannot always be expected to be available in a watershed area. From the problem of data scarcity, methods of analyzing surface water flow using other approaches were developed.

In fact, now the quantity and quality of the flow data is still far from expected. This is due to various difficulties that make the process of collecting flow data cannot be done everywhere, but only in certain watersheds. Even in the watersheds carried out monitoring, problems are still encountered, one of which is the continuity of continuous observation.

The most important obstacles in providing this flow of data are cost constraints and expert (implementer) constraints. Cost constraints are a classic problem in East Kalimantan and other regions, resulting in not all parts of the watershed having flow data. This is because the cost of making and installing river flow observation stations such as SPAS costs a lot if pursued in all parts of the watershed. Then the lack of trained personnel who can be reliable in the work of collecting and processing flow data can also be an obstacle to the availability of flow data.

CONCLUSION

Watershed ecosystems, especially upstream watersheds, are an important part because they have the function of protecting all parts of the watershed. In particular, the Karangmumus Watersheds is located in the centre of the provincial capital with high social and economic dynamics and high incidence of flooding. Therefore, upstream and downstream areas have biogeophysical linkages through the hydrological cycle. Land use change activities and / or the creation of conservation buildings carried out in the upstream area can have an impact in the downstream area in the form of changes in fluctuations in water discharge and sediment transport and other dissolved materials. More specifically, the relationship between inputs and outputs from watersheds can be used simply to analyze the impact of a development activity on the environment (hydrology) and

vice versa the impact of the hydrological environment on development in the area, especially its influence in the downstream area

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