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Water Distribution System of Petanu River Estuary for Coastal Area in Bali-Indonesia

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Abstract Quantity and quality of water is needed along with the increase of population, the increasing change of agricultural land function and tourism development in Bali. This means that the need for domestic and non-domestic water will also increase, thus research on water quality in river estuary, water resources for water and land conservation in Gianyar regency of Bali province is indispensable for sustainability of water supply in terms of water quantity and quality, river area, and water management and land allotment in accordance with existing watershed conditions in Gianyar regency of Bali province in order to reduce land conversion change (Gianyar in figures 2010-2015) and village nomography. Raw Water Distribution (SPAB) in the downstream of Petanu river with SWOT analysis beginning to be managed by indigenous society and based environment. Research method used is quantitative research. This research used primary data in the form of water quality and water quantity data in downstream of Petanu River, population in coastal area of Gianyar Regency, topography data, bathymetry in coastal area of Gianyar Regency, and environmental condition of downstream of Petanu river. The downstream water potential streaming is designed using WATERNET software which is then applied to the Raw Water Flow System in the downstream area of the Petanu river which will be managed by indigenous villagers. The results of this study resulted in water quality at the mouth of the river for odor, color, taste, temperature, turbidity, pH and detergent meet quality standards, while salinity, BOD and COD as well as total coliform does not meet the quality standard, class I. The simulation result from WATERNET shows that the discharge of the river amounted to 20 million m3/year can be utilized for industrial water (hotel) 1,636 rooms, for domestic water 98,181 inhabitant, for 2.33 ha pool water managed by indigenous villagers for the coastal society of Saba Gianyar Regency.

1. Introduction

The province of Bali has 401 rivers where 162 rivers runs into the ocean. The characteristics of existing rivers are mostly intermittent and annual rivers so that the utilization of water sources from these rivers cannot be expected throughout the year. Only less than 11% of rivers have flow rates during the dry season. According to [1] of potential rivers in Bali amounted to 66 rivers. One of them is Petanu River in Gianyar Regency.

Water is very important and very necessary for the needs of irrigation/agriculture and for the daily life of the society and can support tourism activities in Bali Province [2].

Quantity and quality of water is needed along with the increase of population, the increasing change of agricultural land function and tourism development in Bali. This means that the need for domestic

and non-domestic water will also increase, thus research on water quality in river estuary, water resources for water and land conservation in Gianyar regency of Bali province is in dispensable for sustainability of water supply in terms of water quantity and quality, river area, and water management and land allotment in accordance with existing watershed conditions in Gianyar regency of Bali province in order to reduce land conversion change [3] and village nomography. Raw Water Distribution (SPAB) in the downstream of Petanu river with SWOT analysis beginning to be managed by indigenous society and based environment.

This research produces a model of water resources management that can be applied in the Raw Water Distribution System (SPAB) that is sourced from the potential (quantity and quality) of water in downstream Petanu river area based on traditional village with environmental insight. The research method used quantitative research using primary water quality data.

There are some previous research that also study about this topic, as follows:

- The conditions established quality standard [4].
- Flood control (flood control management) is a flood control measures such as minimizing run off that occurs when it rains, restrict groundwater pumping is causing subsidence of ground water [5].
- Environmental management of the river (river environment management) is an effort to control the use of land in the area of riparian and aquatic biota in order to increase the function of water resources is maintained [6].
- Management of water infrastructure (infrastructure management) is an attempt to do in the management of irrigation facilities and infrastructure function that is maintained in accordance with the age and the intended purpose [7].
- Research and development (research and development) is to support and improve the management of water resources in a region with innovations both in the field of technology and management [8].

2. Methods

2.1. Method of data collection

Data velocity and depth of the estuary of the river water to obtain a water discharge at river estuary is obtained from measurements with current meter and morphology of river estuary is obtained from a field survey to see the profile of the mouth of the river and water quality.

Water sampling estuary held for 1 (one) year is the dry season and the rainy season in 2013/2014. This research intended to collect potential of the water at the estuary of the river in terms of water discharge (quantity of water) and some of the water quality in a body of water that will be researched in the field and in the laboratory, with a number of specific sample but has the same characteristics as body water. Samples were taken at three points, with the distance of each point of 100 m. Sampling was carried out around the point 1 at 14:50, point 2 at around 15:00, and point 3 approximatel y at 15:10.

Water sampling using a Van Dorn water sample. First water sample to be used should be clean, rinsed with distilled water first, then with the water sample to be taken. After the closing tool to open before the water sample that sunk into the water sample by means of a water depth of 1 m and a weight was dropped right on top of the device through the rope so that the lid tightly closed. Then the water is put into bottle until it is full and closed well to avoid contact with air.

Preservation of samples intended to prevent disturbances that could alter the nature of the original state of the sample. This research used a special glass bottles with different treatments depending on the parameters in the review. For testing samples of COD and BOD use glass bottles to be filled and sea led with a glass bottle cap. There should be no bubbles, if there is a bubble of water then water sampling repeated.

Water testing of the parameters of physics, chemistry and biology is done with the following steps: before entering the water samples, the mouth of the bottle first heated, then fill the sample until the bottle is full, then discarded samples 3/4, the mouth of the bottle in reheat, then closed with aluminium

foil to avoid contact with air. After sampling, the bottle is stored in a special box so that the quality of water taken unchanged from its original nature.

2.2. Time and place of research
The research location is in the River Estuary Petanu ended on the beach Saba, Gianyar Bali Province.

2.3. Technique of data analysis
The research method used is quantitative research with primary water quality data. This research produces a model of water resources management that can be applied in the Raw Water Distribution System that is sourced from the potential (quantity and quality) of water in downstream Petanu river area based on traditional village with environmental insight.

3. Results and discussion

Implementation of water quality research in terms of physics, chemistry and biology for the estuary of the river Petanu implemented downstream of the river in Banjar Saba Saba Village Blahbatuh Gianyar District. The quality of the water under study is tested by the standard water quality standard of Class I. [9] The downstream area of the Petanu river is the agricultural area (rice field) and housing. Water quality downstream of the Petanu river is based on primary data and compared with secondary tones from 2013 to 2016 for pH, Temperature, BOD, COD and DO by involving researchers with a team from the Technical Implementation Unit of the Bali Province PU Laboratory Laboratory taking a composite sample sample) is by taking samples of water from several points by using a plastic bottle sample for physics, chemistry and for microbiological parameters with sterile glass bottles at one point monitored water conditions assumed to be homogeneous, then made into one location retrieval at a depth of 30 cm from the surface of the waters to obtain a description of the actual water quality condition at the mouth of the river at the time of the study.

The total annual rainfall in Gianyar Regency in 2016 is 2 259 mm. Average monthly rainfall ranges from 11 mm to 401 mm. The highest rainfall occurred in January and the August lows. Based on the monthly average rainfall data of 200 mm monthly rainfall is an input in the analysis using Ribasim software. Water potential is obtained in the downstream of the river precisely at the mouth of the river Petanu of 11.2 million m^3 / year. (See Figure 1).
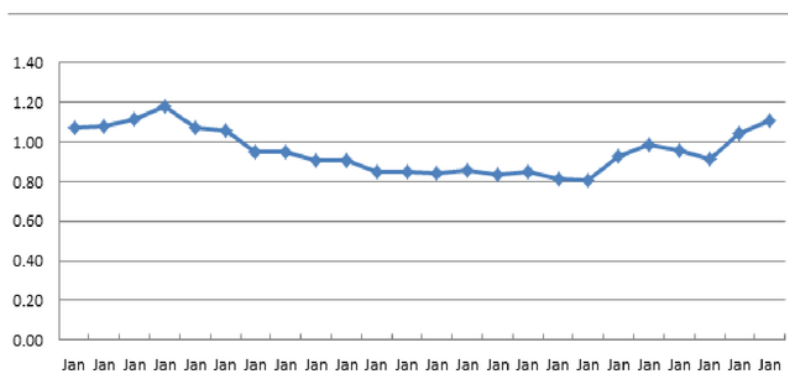

Figure 1. Annual discharge of petanu river estuary.

The measurement of water velocity (V) during the dry and rainy seasons in the Petanu River Estuary, is averaged so as to obtain the velocity of water velocity (V) in the Petanu Estuary of 0.456 m/sec. Measurement of surface water discharge at Petanu estuary was conducted in field in May 2016. Petanu

estuary located in coastal area of Saba Gianyar regency, for the implementation of debit measurements conducted at a distance of 100 m - 200 m from the edge of the beach using a tool current meter. Water debit studies at the mouth of the river are measured at low tide, during the dry season and the rainy season. The result of measurement of water debit at Petanu River estuary in dry season is 0,88 m³/s (27,372 million³/yr). Potential water at Petanu river estuary: dry season = 0.88 m³/s, rain season of 1,141 m³/s then average discharge at 1.01 m³/s. Based on [1], for Bali each person needs water 25 ltr/hr/soul (0.0003 m³/st/ soul), for 1 room the hotel needs water 200 lt/room/day (0,0023 m³/room/s), agricultural land requires irrigation water 1 ltr/sec/ha (0,00001 m³/s/ha). The mouth of the river averaged ± 6.5 m, the direction of the flow of water is not fixed, resulting in the direction of the flow of water in the mouth of the mouth of the river moves in accordance with the direction. (See Figure 2 and 3)
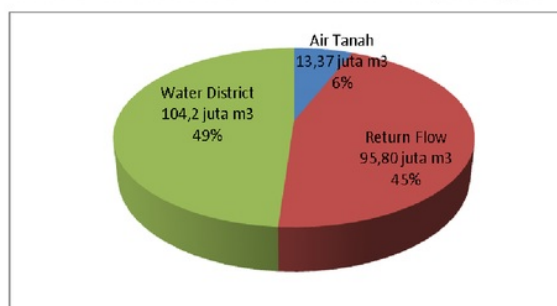
Figure 2. Water distribution of petanu river estuary.

Figure 3. The petanu river estuary.

The observation of water quality in terms of chemistry is to observe some characteristics for BOD3, and preserved by using acid (H₂SO4) for COD and ammonia, for further analysis in the laboratory. The BOD measurements in tropical waters were carried out by incubating the sample water for 3 days at a temperature of 300C as equivalent to the BOD measurements with the sample water incubation for 5 days at a temperature of 200C (Polii, 1994). Laboratory analyzes were conducted with staff and carried out at the Water Quality Laboratory of the Ministry of Public Works, Bali Province. The pH value can be determined by means of pH meters or by litmus paper test. For water research results at the Petanu River Estuary pH = 6.96 during dry season and pH = 6.34 during the rainy season.

Biological Oxygen Needs (KOB) is the amount of dissolved oxygen required by living organisms to break down or oxidize waste materials in water. If high oxygen consumption is indicated by the smaller residual dissolved oxygen, the organic pollutant content is high. The standard quality of COD grade for class I water quality based on Bali Governor Regulation Number 8 Year 2007 [1] is a maximum of 10 Mg/ltr. The content of COD in the water at the mouth of the Petanu River during the dry season of 12 still meet the quality standard, but the COD content of the rainy season in the river area of 12 mg/l. exceed quality standards due to population settlements and other activities that produce waste domestic. According to Standard Class Quality Standard I [1]. Total Coliform content is permitted at 1000 ml/100ml. For water in the downstream/ estuary of the Petanu River during the dry season of = 4600 jml/100 ml has exceeded the quality standard and during the rainy season Total coliform in the downstream/estuary of the Petanu river = 2100 ml/100 ml does not meet the quality standard. Total coliform content of downstream/estuary of Saba River during dry season = 1500 ml/100 ml, has exceeded the quality standard during the rainy season it will enter the river. Content Total coliform in the rainy season downstream of Saba River amounted to, did not meet the quality standard. Sampling of river water samples is conducted at three sites around the mouth of the river at the same distance, determining the water quality point taken to represent surface water, taken at low tide to obtain data on the influence of dominant waste load flow. Water testing carried out from surface water retrieval is tested for water quality standard with quality standard according to Governor Regulation and Ministry of Environment Regulation. Water tests of physical parameters consist of odor, taste, color, turbidity, salinity. Chemical parameters are pH, BOD, COD and Detergent. The microbiology parameter is the total coliform. Research the quality of water and water discharge at the mouth of the Petanu River. Water quality research results for the estuary of Petanu River are as follows: water quality test in terms of physical (temperature, color, turbidity and salinity) for the dry season and rainy season, the results of the research on the class water quality standard I obtained the following results: some meet the quality standards for odor, color, temperature, turbidity while those that do not meet the quality standard are salinity. Water quality test results in Muara Petanu estuary in terms of Chemical (pH, BOD, COD and detergent) during dry season and rainy season Testing Quality of Petanu River Water viewed from pH and Detergent meet quality standard while for BOD and COD not meet the standard water quality class I according [1] and [10]. Water quality test in the estuary of Petanu river in terms of Biology (total coliform) does not meet the standard quality of class I according to according [1] and [10]. The water resources management model for Petanu watershed is planned based on simulation results with RIBASIM. Water resources management according to Law Number 7 Year 2004 regarding water resources understanding is water resources. Water and water resources management. Water availability and water requirements are included in scenarios (1, 2 and 3) associated with population growth rate in Gianyar Regency BPS Bali Province in 2010 obtained by 1.8% percentage. Water Resource Management is the basic framework for planning, implementing, monitoring and evaluating water resources conservation activities, utilizing water resources and controlling damaged water. The design of the water management model downstream of the Petanu River can be well implemented, as is the goal for water and land conservation. For downstream river water management can be initiated with conservation measures in the upper watershed two segments, the middle of the Petanu Basin, two segments and downstream of the river are also two segments with environmental conservation involving the community and supervised by traditional village. The running result of the waternet program for SPAM, the management of water potential in the downstream area of the Petanu River can be streamed into the community downstream with the help of pumps. Potential water downstream of Petanu River from quality can be utilized as raw water. Development of raw water sources from downstream of the river, it is necessary to establish a criterion of raw water design especially for domestic raw water and irrigation. The implementation of SPAM development is planning, executing, managing, maintaining, rehabilitating, monitoring and/or evaluating physical (technical) and non-physical systems of drinking water supply. SPAM development providers shall be conducted by state-owned enterprises/ regional-owned enterprises, cooperatives, private business entities, and/or Water collection from their sources shall take into account the carrying capacity of water resources and shall be prohibited from causing

damage to water resources and the environment and taking into account the aspirations of local communities and biodiversity conservation in water resources. Prediction of success of drinking water supply system development can be analyzed by doing several stages, that is; (1) calculate the percentage of the number of people served by the piping system; (2) calculate the percentage of the number of systems according to the condition of the pipeline network; (3) calculate the achievement of the service until the targeted year by projecting the existed condition, as compared to the regional and national targets; factors affecting the condition of the pipeline network, (5) analyze the probability of achieving service targets by taking into account the constraints that the community groups are conducting the development of SPAM. Waternet is a Windows-based computer program that is a simulation program in the engineering of a clean water supply pipeline system, which consists of the point/node/junction pipes, pumps, valves [11]. Development of raw water sources from downstream of the river, it is necessary to establish a criterion of raw water design especially for domestic raw water and irrigation. The implementation of SPAM development is planning, executing, managing, maintaining, rehabilitating, monitoring and/or evaluating physical (technical) and non-physical systems of drinking water supply. SPAM development organizers shall be conducted by state-owned enterprises/regional-owned enterprises, cooperatives, private business entities, and/or water sources from the source must pay attention to the carrying capacity of water resources and are prohibited from causing damage to water resources and the environment and taking into account local aspirations and the preservation of biodiversity within water sources. Prediction of success of drinking water supply system development can be analyzed by doing several stages, that is; (1) calculate the percentage of the number of people served by the piping system; (2) calculate the percentage of the number of systems according to the condition of the pipeline network; (3) calculate the achievement of service up to the targeted year by projecting the existed condition, as compared to the regional and national targets; factors affecting the condition of the piping network, (5) analyze the probability of achieving service targets by taking into account the constraints that the community groups are conducting the development of SPAM. Waternet is a windows-based computer program that is a simulation program in the engineering of a clean water supply pipeline system, which consists of a point/node/junction pipe, pump, valve. Results of the analysis of water discharge in Petanu River estuary during the dry season (September 2013) amounted to 0.156 m³/second in the rainy season (January 2014) of 1,023 m³/sec. Based on the flow rate in the DAS Saba semi-monthly then simulated by software RIBASIM, the obtained water potential of 9,336,514 m³/year (9.34 millionm³/year) water potential is assumed to be used: 50% for irrigate on water, domestic water (household) 40%, for industrial water (water for the hotel) 8% and 2% fish pond water. Management of water resources in coastal areas Saba River estuary, the potential of the water can be managed with the reservoir, through the management of water quantity (water quantity management), management of water quality (water quality management), water management and flood/control of water damage (flood control management) as well as the environmental management of river estuary. The draft model of management of water resources at the mouth of the river estuary Saba can be done by observing the morphological characteristics of the watershed, the morphological characteristics of the river estuary, water potential, infrastructure and utilization of water resources of the river estuary area.

4. Conclusion

The result of the measurement of water debit at the estuary of Petanu River in dry season is 0,88 m³/s (27,372 million³/yr). The water potential downstream of the river is precisely at the Petanu estuary of 11.2 million m³/year processed and simulated with RIBASIM software to support irrigation activities by 50%, domestic water (household water needs) by 40% and tourism activities by 8% as well as fish pond water in the downstream area of 2%. Potential water downstream of Petanu river as raw water can be channeled to the community using pump from Waternet running for Water Distribution System. Water quality at monitoring stage showed BOD value at (downstream) of 2.16 mg/L while the requirement for water quality standard class 1 of 2 mg/L did not meet the quality standard. Water quality testing for COD was COD 6.4 mg/L and DO 4.83 mg/L. meet the water quality standard of class 1.

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