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Design of Contribution Model in the Upstream and Downstream of Watershed Management Based on Economy

[1]Baria Satyagraha, [2]M. Bisri, and [2]Lily Montarcih Limantara

[1]Doctoral Program on Department of Water Resources, Faculty of Engineering, University of Brawijaya, Malang, East Java of Indonesia
[2]Department of Water Resources, Faculty of Engineering, University of Brawijaya, Malang, East Java of Indonesia

ABSTRACT

Up to now, in reality, expenditure concept of watershed management by paying the environmental service is still low, if it is compared with the cost demand for preventing the faster environmental degradation. The role sharing between upstream and downstream of watershed has not been well built. If the downstream one obtains some benefit, how many times of it has to be return to environment? However, if the upstream one carries out well regional management, what will be it obtained?; or on the contrary, if the upstream one causes flood in downstream who has to mutual the damage? The any questions have not been well answered. This study intends to obtain the answer of any questions as above by suggesting the balanced role sharing model so the sustainability of water resources can be well maintained. The methodology consists of experimental method by simulation. The experiment which will be implemented is by building the component condition of watershed. However, because it involves the wide region and long period, the experiment is indirectly carried out by simulation. Result is hoped to be able to give some indicators that the watershed component which determines water value is land use change and the policy of decision maker in watershed, but the most important to determine water availability contribution is land use..
KEYWORDS: watershed management, contribution, upstream downstream

INTRODUCTION

Watershed management needs very long time and continuously as well as very high in cost. If it is only depended on the allocation of development fund of Regional or National Spending-Income Budget (APBD/ APBN), the water resources management can only be carried out partially and in limited period. The limited budget of watershed management is as the dominant factor on making effort to emphasize the degradation rate in watershed region. Therefore, it is needed the other alternative of water resources management funding. One of them is by giving the price for the user of environmental service. The user involving of environmental service or water user in the downstream of a watershed like irrigation area, household, regional company of drinking water (PDAM), and hydro electrical power (PLTA) in preparing the activity funding of watershed conservation is as the forward step in making effort of watershed management. The effort of price giving is known as Payment Environmental Service [1][2][3][4].

Up to now, the expenditure of environmental service has not shown the suitable result in making effort to maintain environmental quality degradation [1]. It is related with who else has the responsibility to pay the environmental service – the water user in the downstream or waste contributor in downstream or who? .During this time, the relation between upstream and downstream frequently causes the conflict by the ending of ignoring on watershed condition. Downstream area which during the time accepts the benefit of more water availibility, now it also gets the flood disaster because the damage of land use in upstream area. However, in upstream area which during the time maintains the land use being well remained, does not accept the benefit, so there are many efforts to be carried out for maintaining life sustainability. It is started from selling the agricultural area to non-farmer for becoming into residence or by cutting tree to get wood for himself as energy source as well as the material of household equipment. This condition is continuously from year to year, so if the relation between upstream and downstream is not repaired, the watershed condition will be damaged. By the higher population growth, the upstream area where is as water catchment, begins to be cropped with concrete crop into building which has a of water impenetrable. This condition causes the damage on hydrological function of water catchment that changes the water balance [5], flood in rainy season and drought in dry season. To get water is as the right of everybody in the world, so the activity that makes difficult for everybody to get water consciously as well as unconsciously is as the collision of human right. However, the higher demand of area in marketing mechanism is as the highest factor in getting economical profit. Therefore, the released from right of hydrological function is forgetter for getting the periodic economical profit [6][7].

***Corresponding Author:** Baria Satyagraha, Doctoral Program on Deaprtment of Water Resources, Faculty of Engineering, University of Brawijaya, Malang, East Java of Indonesia. Email: bsgarema@yahoo.com; mohammadbisri@ub.ac.id

This study will be conducted in Tuntang Watershed and intends to identify the economical component due to the specification of selected watershed; to analyse the setting component watershed to water availability contribution; to build Role Sharing Model of watershed management based on economy; and to carry out the simulation by modelling to some alternatives of policy.

MATERIALS AND METHODS

Tuntang watershed is located in Centre Java Province, spreading out from Rawa Pening to east northern through the areas of Kedungjati, Gubug, Dempet, Guntur, Bonang, and estuaries in Java Sea. The area number of Tuntang watershed is 796 km^2, included the catchment area in the upstream of Wara Pening with area number of 282 km^2. Tuntang watershed in southern is restircted by the mountainous of Merbabu, Telomoyo, and Ungaran; in eastern by Grobogan Regency and Telawa District (Demak Regency); and in western by Semarang Regency. Administratively, Tuntang watershed includes Semarang Regency, Salatiga City, Grobogan Regency, and Demak Regency [8][9][10] .Map of location is as in Figure 1 below.

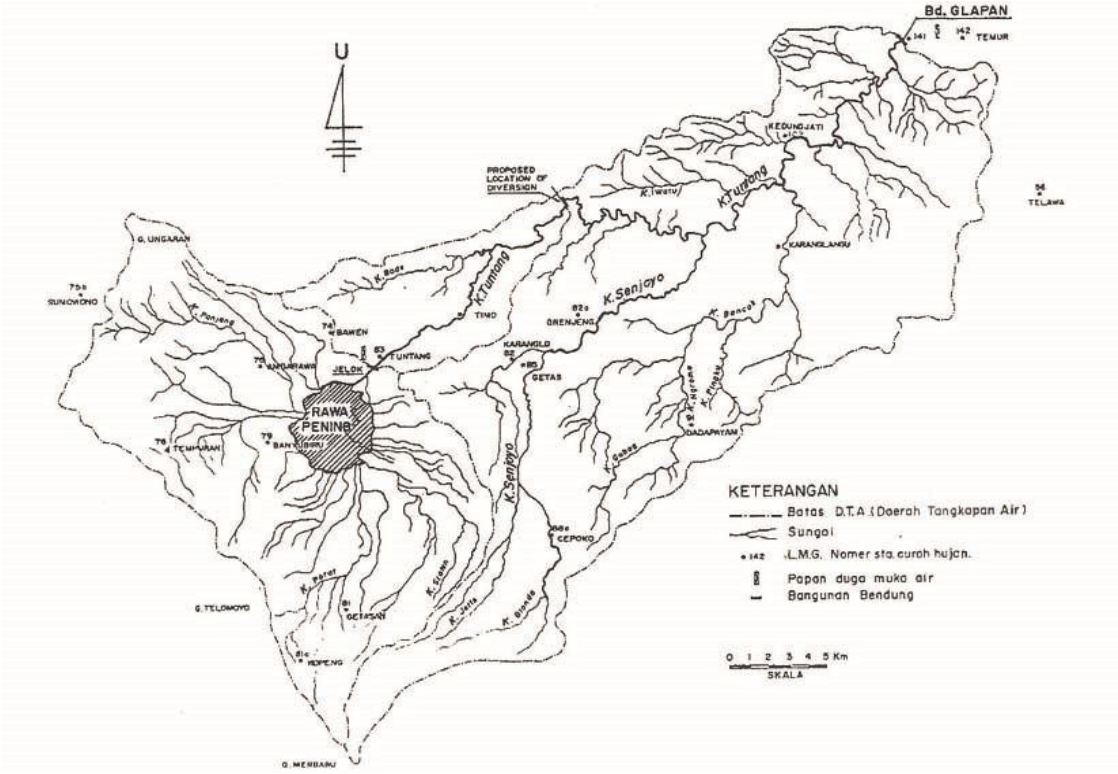

Figure 1 Tuntang Watershed

This research uses experimental method by simulation. Experiment that will be used is by building the component condition if water catchment. However, because it involves the wide area and log period, experiment is indirectly carried out by simulation. To be able to carry out the simulation of a system area, there is needed a model that can present the system condition. However, for obtaining the representative model of watershed system condition, it can be carried out by evaluating and studying the work performance data of watershed. Purnomo [11] suggested the steps in building a model such as to identify the issue, aim, and limitation of model. Identification of issue intends to know where the modelling was really needed to be carried out. The issue had to be clearly presented with the neutral sentence without prejudices that were not followed by field prove. The next step was to determine the aim of modelling. The aim had to be explicitly and specifically presented for making ease in modelling. After the issue and aim were determined then it can be determined the model limitation such as what was enter or not to the model. The clearness of components was as the attention in study.

Water Balance

Quantitative estimation of hydrological cycles can be expressed based on the principal of mass conservation which is known as water balance equation. This equation illustrates that in a hydrological system (watershed, reservoir, lake, surface run-off) can be evaluated on water inflow and outflow from the system in a

period. Water balance can be expressed for short or long period interval for a watershed or water body like reservoir or lake. Generally, water balance equation can be presented as follow [12][13]:

$$P + Q_i + G_i - E - T - Q_0 + G_0 - \Delta S = 0 \qquad \text{.....(1)}$$

Note:

P	=	precipitation
Q_i, Q_0	=	inflow and outflow
G_i, G_0	=	inflow and outflow of groundwater
E	=	evaporation
T	=	evapotranspiration
ΔS	=	storage volume change.

Hydrological cycles and economy

To maintain the sustainability of water resources, the policy of water resources development has to be comprehensively carried out. For helping the decision maker in water resources development, Ward [14][15] suggested to use Cost Benefit Analysis (CBA) as the basic of policy determining. In warershed scale, the usage of this method is constrainted in benefit determining and cost allocation which are suitable with the produced benefit. In order to be ale to use the method accurately, Ward suggested the Hydroeconomic Model as an effort to give the illustration of policy impact. Figure 2 presented the development of water resources, institutional and economical aspects in watershed scale that was presented by Ward [14][16].

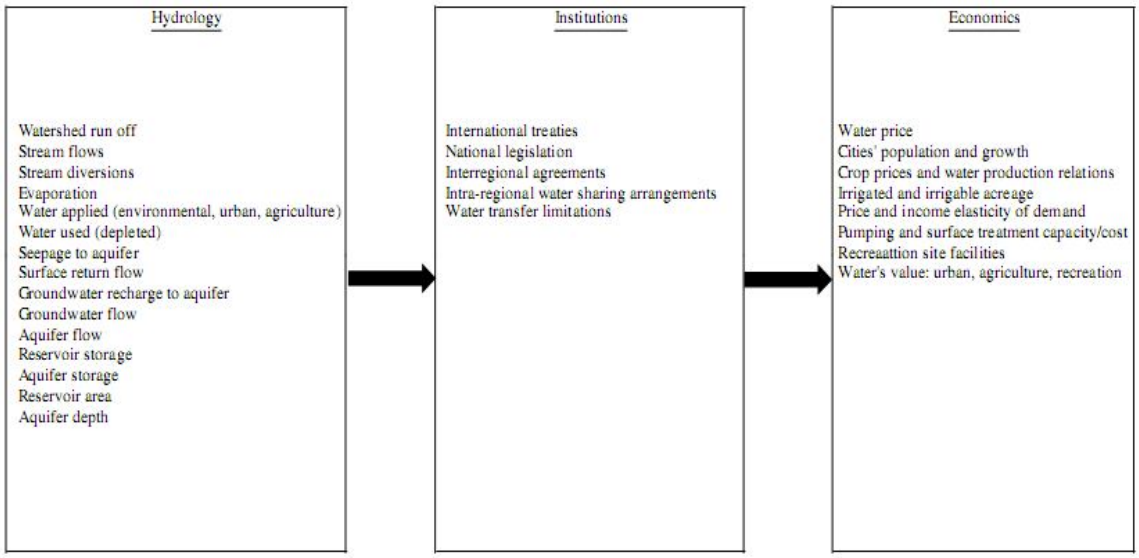

Figure 2 Comprehensive Structure of Hydroeconomic Model [14]

RESULTS AND DISCUSSION

System Analysis of Tuntang Watershed

Tuntang Watershed is estuaried in Rawa Pening which get the water from 9 affluents that enter to Rawa Pening from mountain foot of Merbabu and Telomoyo. The nine affluents consist of S. Blobok, S. Aglik (S. Rengas), S. Bejalen (S.Panjang), S. Torong, S.Galeh, S. Muncul (S. Parat), S. Kedung Ringis, S. Legi, S. Sraten.

From Rawa Pening, water flows to east-northern and part of water is taken for hydroelectrical power (PLTA) in Jelok and Timo. From intake of Jelok-Timo PLTA, water flows to downstream with the affluents such as River Senjoyo and River Bancak to downstream into Kedung Jati area. In this area, there is seen the land use change which has great potency of area erosion that causes sedimentation in River Tuntang. From Kedung Jati, the water flows to downstream until Glapan Weir. From Glapan Weir, water turns to west-northern through Semarang Purwodadi Road in Gubug area. From Gubung, Tuntang River continuously flows to west-northern to be passed with the roadway of Semarang-Kudus such as Buyaran Area (Demak Regency). Before Glapan Weir, there are two rivers such as Senjoyo River and Bancak River. Flowing system of Tuntang Watershed is presented as in Figure 3.

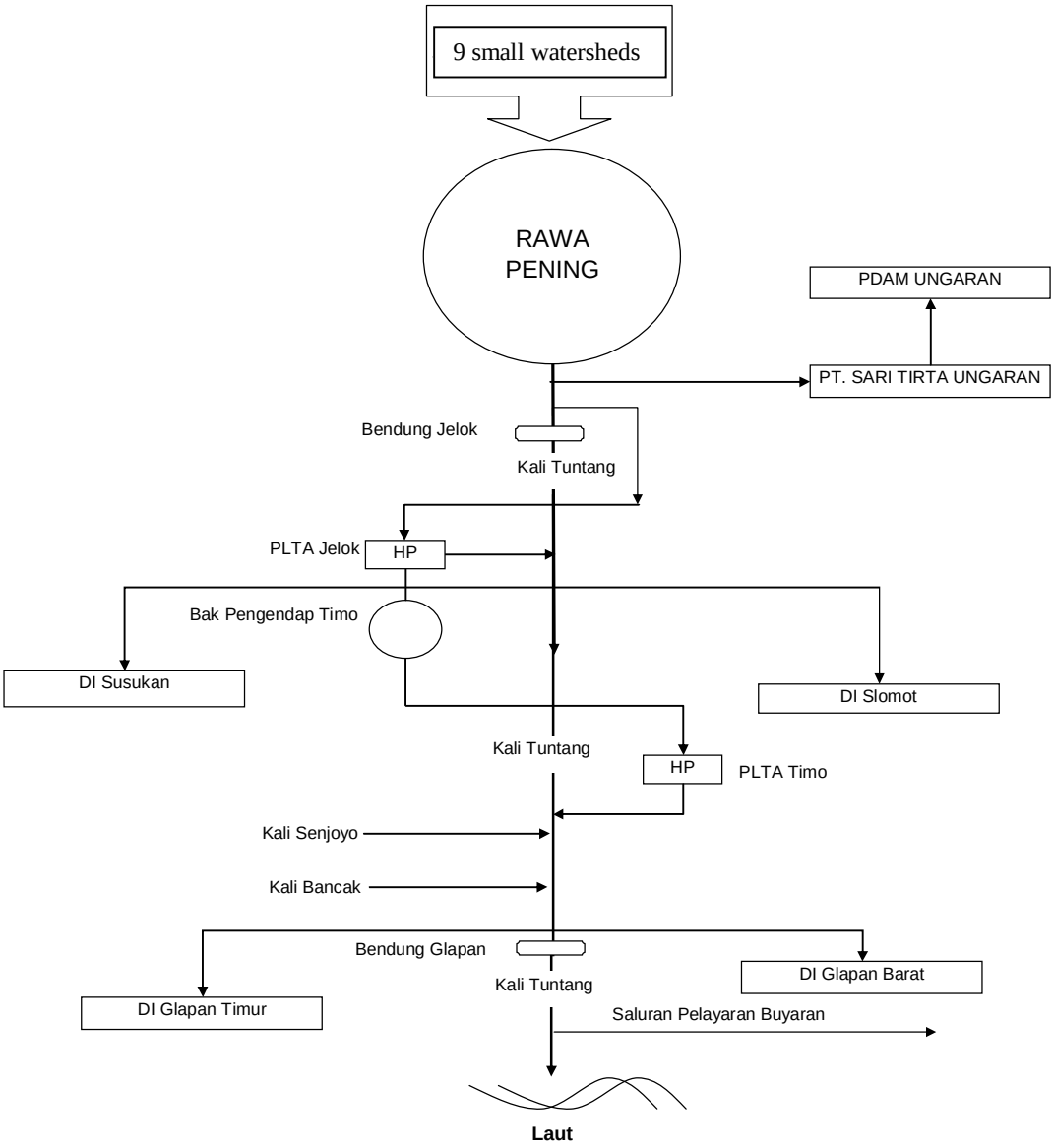

Figure 3 System of Tuntang Watershed

Identification issue, aim, and limitation [17]

Environmental degradation from time to time is more and more anxious especially watershed, number of watersheds are more and more critical from year to year, although there are some efforts to manage but the critical velocity is faster than the recovery velocity of watershed condition. Watershed management needs long period as well as more cost continuously by the limitation of National and Regional Spending-Income Budget (APBD/ APBN) and the cost demand fro carrying out the management becomes to be pursued. For stimulating the whole sides to be functioned in the funding of watershed management from upstream to downstream, there is needed the same opinion and function in the watershed management, Therefore, this study suggests the model research of role sharing between upstream and downstream in watershed management. This model intends to formulate each function in the form of economical value, who is acting that influences the watershed condition and it can be calculated the impact of economical value positively as well as negatively.

The components that are entered into model are the whole components in hydrological cyclus which can be quantitative calculated into economical value negatively (to damage as flood and drought) as well as positively (profitable as water availibility).

Conceptualization of Model

In making effort to maintain the sustainability of a watershed, there is needed clear expenditure by the whole interest decision maker in the watershed. There is founded 6 basic components on the system analysis result of Tuntang watershed in role sharing of watershed management as presented in Figure 4 below.

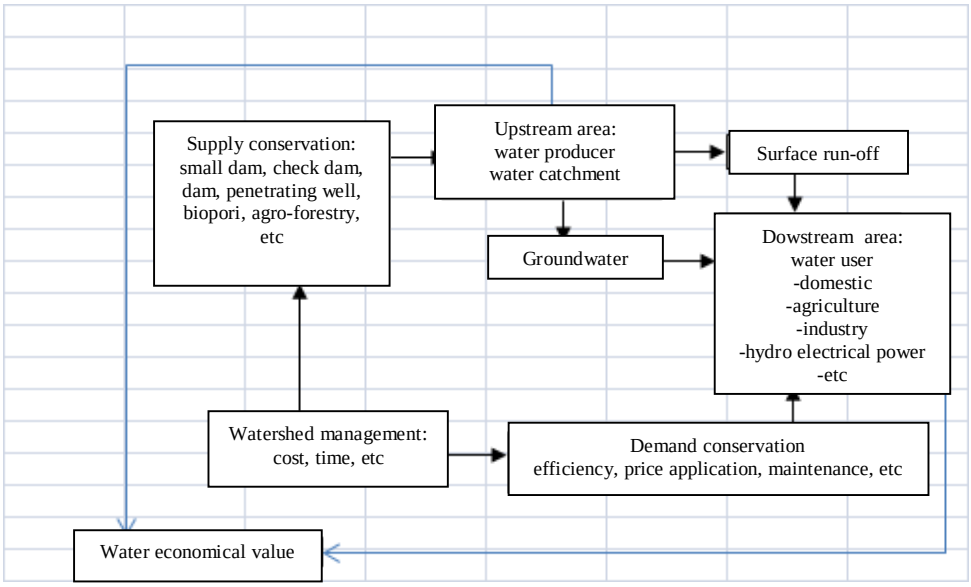

Figure 4 Conceptualization of Model

Specification of Model

Based on the conceptual of model, there are 5 sub-models in Role Sharing Model of watershed management based on economy such as sub-models of water producer, water user, watershed management, demand conservation, supply conservation, and model of economical value.

1. Sub-model of water producer:
   Sub-model water producer is located in upstream of a watershed or is known as water catchment. To carry out the evaluation and system cyclus, there are analyzed by the model of USLE and Mock [18]
2. Sub-model of water user:
   Most of water users are in the downstream. Population growth causes the stress to water availibility. In this sub-model, there will be evaluated the growth of water need demand by using economical growth approach.
3. Sub-model of watershed management:
   Watershed management is foccussed to maintain water availibility or monthly discharge distribution everagedly. Thus, suggested aspect is conservation one. Selection of activity will determine management cost demand by the main approach of conservation. The whole alternative forms of conservation activities will be implemented in the form of economical value so to obtain the optimal result there will be carried out the optimization.
4. Sub-model of supply conservation:
   According to supply side, watershed management intends to carry out water resources conservation, availibility change from year to year, and the implication to water availibility. This sub-model will carry out the analysis to the condition as above.
5. Sub-model of demand conservation:
   If the supply conservation side is impossible, it meant that discharge increasing with conservation has been impossible, so conservation of supply side has to be applied lile price application, saving, improvement of distribution, etc. This sub-model will handle the process.
6. Sub-model of water economical value:
   This sub model will analyze quantitative economical value of water [19][20]because the change on sub-model of producer (water catchment) [21] or sub-model of user (downstream area/ water user) [22], the water value can be positive (benefitable) or negative (unbenefitable).

Evaluation of Model

Evaluation of model will be carried out by using direct observation data of Jelok and Glapan Weir discharge data, some observed data of hydro power electrical production, the intensity of irrigation cropping, and the price of fresh water. After there is obtained dependable model, it has to be carried out the evaluation to some changes of waterhed condition system and it is known as sensitivity of model.

CONCLUSION

Based on the analysis as above, it is concluded as follow:

1. Components of watershed that determines water value are land use change and the policy of interest decision maker in the watershed
2. Component of watershed that is the most important to determine water availibility contribution is land use.
3. Role Sharing Model of watershed management based on economy consists of 6 sub-models such as sub-models of water producer, water user, water management, supply conservation, demand conservation, and quantitative water value.
4. Simulation of model can be usd to determine the protion of expenditure for each alternative of amnagement.

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