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Economic Valuation on Water Management in Urban Area

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Abstract: ***Densely populated areas need special attention in water management considering the rate of land conversion the years. Economic valuation can help the city government in providing solutions to minimize land conversion to maintain the sustainability of water supply or future drought threats. Urban water management is needed to regulate the sustainability of water supply. The lack of water catchment areas in urban areas is a threat to the control of water supply. Applications of infiltration wells, retention basin (embung), and greening are alternatives for urban water supply control. This study uses benefit-cost analysis to measure and assess costs and benefits of making alternatives given from the economic side. The results of this study are Net B/C, NPV, IRR, and PBP are feasible on economic analysis.***

Keywords: Economic Valuation, Water Management, Benefit-Cost

1. Introduction

The rapid growth of urban forces forced the change of land use of an area. Changes in land use will cause changes in rainfall runoff in the area. Rainfall runoff increases with increasing waterproof coating. The phenomenon of increased water runoff effect on flood disaster or inundation in the area if not handled adequate mitigation. Development of densely populated areas, especially in urban areas, should have disaster mitigation planning in the form of adequate drainage system development and good urban governance.

Waterproof coatings in urban areas also have an impact on the sustainability of underground water reserves. In addition to puddles or flooding problems faced is the sustainability of water supply in order to avoid drought. Densely populated areas such as urban areas have high levels of water demand, therefore sustainability of water supply is a very important part of concern for the government. Optimum utilization and control in rainwater runoff is an effort that can be done in maintaining water supply.

Urban water management is constrained on the extent of the waterproof layer, so rainwater can not get into the soil. The cause of the problem is the amount of land that is converted to a building and not a good hydrologic cycle. This paper offers the use and control of rainwater to be a solution of urban water problems. Water catchment areas are needed for urban drainage and water management systems. The water catchment area is the area of water entry from the soil surface into the saturated zone of ground water flowing into the lower area (Saraswati, 2011). Water catchment areas utilize and control rainwater used through absorption wells, retention basins (embungs) and afforestation as support.

Densely populated areas need special attention in water management considering the rate of land conversion over the years. Economic valuation can help the city government in providing solutions to minimize land conversion to maintain the sustainability of water supply or future drought threats.

2. Literature Review

1. Land Conversion

Kustiawan (1997) argues that the conversion or conversion of land in general concerns the transformation in the allocation of land resources from one use to another. According to the market economy law, land conversion takes place from activity with a lower land rent to higher land rents activities. Land rent can be interpreted as the net profit value of land use activity union land area and In terms of water resources management, the pressures generated by land use change in urban areas generally result in an increase in runoff volume and a decrease in water absorption rate. This condition can further lead to inequality of water distribution between the dry season and the rainy season. The facts show that in the last few years there has been a phenomenon of drought during the dry season while in the rainy season the floods still occur [Suripin, 2004].

The demand for land for development is so strong, while the land is not increased or limited. So far, agricultural land has a low value of land compared to other land use (non-agricultural), consequently agricultural land will continue to experience land conversion to non-agricultural. Whereas agricultural land (rice field) in addition to having economic value as a buffer for food needs, also ecological functions such as regulating water, carbon sequestration in the air and so forth (Hariyanto, 2010).

2. Infiltration Wells

The absorption well is a hole created to absorb rainwater into the soil and / or layers of water-carrying rocks. (Kep.Men.L.H No.12 Year 2009). Sunjoto (1989) argues that the effort to build a rainwater absorption well is a water conservation technique which is essentially human effort in maintaining, improving and developing water use in accordance with its allocation and can be achieved by enlarging groundwater storage, minimizing the dimension of drainage network, maintaining elevation groundwater level, preventing sea water intrusion for coastal areas and minimizing groundwater contamination levels. The infiltration well is an artificial catchment system that can accommodate rainwater, either from the ground surface or from rain water channeled through the roof of the building. Physically these wells can be well-shaped, ponds with recharge, porous ducts, ducts and the like.

3. Retention Basin (Embung)

Water management then uses retention basin (embung). Embung is a water conservation building in the form of a pool to accommodate rainwater and running water and other water sources to support agriculture, plantation and animal husbandry especially during the dry season. Embung is a deep depth in a hilly area. Water embungs come from rainwater runoff that falls in the catchment area. Embung is a water storage building built in a depressed area, usually outside the river.

The purpose of making the embung is:

a. Provide water for irrigation crops in the dry season
b. Increasing land productivity, planting period and farmer income in rainfed land
c. Enabling farmer labor in the dry season, thus reducing urbanization from village to city
d. Prevents / reduces water floods in the rainy season and reduces flood risk.

4. Greening

Water management in urban areas and environmental arrangement through afforestation. The greening movement serves to overcome the decline of environmental quality such as water scarcity. Greening the city is expected by planting trees that can absorb water and lead. Greening is one of the important activities that must be implemented conceptually in handling environmental crises. In spatial contexts, reforestation is urgently needed especially for developing cities and experiencing spatial function for built-up areas (Kelvin, 2008). Surakarta city is one of the cities in Indonesia are incentive to do greening movements. Rapid population growth has resulted in rapid and uncontrollable population densification and settlements (Sihono, 2003). The reforestation is carried out as one of the efforts to save the environment due to the rapid increase of population in this city. Reforestation activities were conducted evenly to the level of kelurahan (Samsudi, 2010).

5. Economic Valuation

Economic valuation is one of the efforts used to provide quantitative value to goods and services produced by natural resources and environment both on market value (Market Value) and non market value (Non Market Value). According to Hufscmidt in Djijono (2000) in general the method of assessing the economic benefits (environmental costs) of a natural resource and the environment can basically be divided into two major groups, based on a market-oriented approach and survey-oriented approach.

3. Methodology

This is the application of the cost benefit method to uncover the formation of the value of the development of absorption wells, ponds, and afforestation in urban water management. This research uses descriptive and quantitative research methods.

We use the cost-benefit method to analyze the implementation of absorption well development, retention basin (embung), and afforestation. In the economic valuation we calculate how the costs of absorbing wells, embung and afforestation are incurred and give value to each of the benefits.

Cost-Benefit Analysis Methods used includes:

a. Net Present Value (NPV)

NPV is the net benefit that has been discounted using the Social Opportunity Cost of Capital (SOCC) as the discount factor.

$$NPV = \sum_{i=1}^{n} NB_i (1+i)^{-n}$$

Or

$$NPV = \sum_{i=1}^{n} \frac{NB_i}{(1+i)^n}$$

Or

$$NPV = \sum_{i=1}^{n} \overline{B_i} - \overline{C_i} = \sum_{i=1}^{n} N\overline{B_i}$$

Where:
NB = Net benefit = Benefit - Cost
C = Investment cost + Operating costs
= Benefit that has been discounted= Cost that has been discounted
i = Discount Factor
n = year (time)
Criteria:
NPV> 0 (zero) → business / project is feasible
NPV <0 (zero) → business / project is not feasible
NPV = 0 (zero) →business / project in a state where the BEP TR = TC
in the form of present value.

To calculate the required data on the estimated NPV of investment costs, operating costs, and maintenance as well as the estimated benefits of the planned project.

b. Internal Rate of Return (IRR)

IRR is a discount rate that results in NPV = 0 (zero).

If IRR> SOCC so the project is feasible
IRR = SOCC means the project on BEP
IRR <SOCC said that the project is not feasible.

To determine the value of IRR should be calculated first NPV1 and NPV2 by trial and error. If discount factor of $NPV_1$is positive so the second must be greater than SOCC, and otherwise.

From these experiment, explain the IRR value is between positive NPV and negative NPV, so there is the NPV = 0.

$$IRR = i_1 + \frac{NPV_1}{(NPV_1 - NPV_2)}(i_2 - i_1)$$

where: i_1 = discount rate that produces NPV1

i_2 = discount rate that produces NPV2

c. Net Benefit Cost Ratio (Net B/C)

Net B / C is the ratio between the discounted net benefit is positive (+) with a net negative benefits, which has been discounted.

$$NetB/C = \frac{\sum_{i=1}^{n} N\overline{B_i}(+)}{\sum_{i=1}^{n} N\overline{B_i}(-)}$$

If: Net B / C> 1 (one) means the project (business) feasible

Net B / C <1 (one) means the project is not feasible
Net B / C = 1 (one) means cash inflows = cash out flows(BEP) or TR = TC

d. Pay Back Period (PBP)

PBP is a specific period of time indicating the occurrence of flows (cash in flows) are cumulatively equal to the amount of investment in the form of present value. PBP is used to determine how long the project can recover the investment.

$$PBP = T_{p-1} + \frac{\sum_{i=1}^{n} \overline{I_i} - \sum_{i=1}^{n} \overline{B_{icp-1}}}{\overline{B_p}}$$

Where:
PBP = Pay Back Period
Tp-1 = The year before PBP
Ii = investment amount has been discounted
Bicp-1 = Number of benefits that have been discounted before PBP
Bp = Number of benefit to the PBP

4. Empirical Results

The discussion in this paper covers the calculation of the investment costs that must be incurred with benefits to be received over five years. The result of this research is to give economic value from the development of absorbing well, embung, and afforestation. Economic valuation aims to measure and assess the environmental impact that will occur in the economic form to develop appropriate management.

The process of determining the economic value of the environment is an important thing done as a consideration in allocating natural resources and determining government policies to be taken. Economic assessments are useful for illustrating the interrelationships between economies and the environment, which are necessary for proper management of natural resources. The relationship illustrates the advantages or disadvantages associated with various choices of policies and programs of natural resources management, as well as beneficial in creating justice in the distribution of the benefits of natural resources.

The absence of a local regulation requiring every Building Permit (IMB) applicant to create a recharge well resulted in easy land conversion. The pace of land conversion has increased, which has been transformed into infrastructure, buildings, and shelter, so water absorption areas are also reduced. Reclamation wells are expected to be a solution to the water crisis problem that will be faced due to the threat of land conversion.

Economic valuation using the value of money will be able to indicate the value of indication of acceptance and loss of benefits or welfare due to environmental damage (Tampubolon, 2008). The valuations to be calculated in this paper are as follows:

Table 1: Valuation of Water Management

Water Management	BENEFIT	COST	B/C	NPV (12%)	NPV (15%)	BCR	IRR	PBP
Infiltration Wells	7,605,000	8,000,000	1.93	112,478.00	-83,274.50	-1.351	13.56	Year 4
Retention Basin	5,077,176,000	4,475,550,000	6.03	219,237,313.50	-131,901,787.30	-1.662	13.56	Year 5
Greening	420,000,000	438,000,000	2.10	15,274,500.00	-3,079,000.00	-4.961	13.56	Year 5

1. Net Benefit Cost Ratio (Net B/C)

In the calculation of net benefit-cost ratio is each component of benefits and costs become present value. We can find Net Benefit Cost Ratio (Net B/C) from divide NPV1 (discount factor 12%) with NPV2 (discount factor 15%)

a. Infiltration Wells: The result of Net Benefit Cost Ratio (Net B/C) is 1.93, so Net B/C more than 1, so that explainwater management using infiltration wells is feasible.
b. Retention Basin (Embung) : The result of Net Benefit Cost Ratio (Net B/C) is 6.03, so Net B/C more than 1, so that explainwater management using retention basin is feasible
c. Greening: The result of Net Benefit Cost Ratio (Net B/C) is 2.10, so Net B/C more than 1, so that explainwater management using greening is feasible.

2. Net Present Value (NPV)

a. Infiltration Wells: The result value of NPV showing that NPV > 1, so this indicated water management using infiltration wells is feasible.
b. Retention Basin : The result value of NPV showing that NPV > 1, so this indicated water management using infiltration wells is feasible
c. Greening : The result value of NPV showing that NPV > 1, so this indicated water management using greening is feasible

3. Internal Rate of Return (IRR)

a. Infiltration Wells, Retention Basin and Greening : This analysis uses discount factor level 12% and 15%, so we can see the result of IRR = 13.56 explained IRR is bigger than social discount rate (12%). water management using infiltration wells, retention basin, and greening is feasible

4. Pay Back Period (PBP)

a. Infiltration wells : Base on the analysis, the calculation of NPV reduction sequentially indicates that PBP was paid during the period of 4 years, it means that water management using infiltration wells is feasible
b. Retention basin : Base on the analysis, the calculation of NPV reduction sequentially indicates that PBP was paid during the period of 5 years, it means that water management using retention basin is feasible
c. Greening: Base on the analysis, the calculation of NPV reduction sequentially indicates that PBP was paid during the period of 5 years; it means that greening is feasible.

5. Conclusion

1. The results of the analysis of the Net Benefit Cost Ratio (Net B/C) indicate that the Net B/C more than 1 for infiltration wells, retention basin, and greening, so water management using the three construction is feasible
2. The results of the analysis of the Net Present Value (NPV) indicate that
   a. Infiltration wells = 112,478
   b. Retention basin = 219,237,313.50 million
   c. Greening = 15,274,500 million

It shows NPV> 1, so the Water Management using infiltration wells, retention basin, and greening is feasible.

3. The results of the analysis of the Internal Rate of Return (IRR) indicate that the IRR = 13.56explained IRR is bigger than sosial discount rate (12%), so Water Management using infiltration wells, retention basin, and greening is feasible.
4. The results of the analysis of the Pay Back Period (PBP) indicate that the PBP was paid during the period of 4 years for infiltration wells, 5 years for retention basin, and greening, it means Water Management using three alternatives is feasible.

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by Evi Gravitiani

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Table 1: Valuation of Water Management

Water Management	BENEFIT	COST	B/C	NPV (12%)	NPV (15%)	BCR	IRR	PBP
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c. Greening : The result value of NPV showing that NPV > 1, so this indicated water management using greening is feasible

3. Internal Rate of Return (IRR)

a. Infiltration Wells, Retention Basin and Greening : This analysis uses discount factor level 12% and 15%, so we can see the result of IRR = 13.56 explained IRR is bigger than social discount rate (12%). water management using infiltration wells, retention basin, and greening is feasible

4. Pay Back Period (PBP)

a. Infiltration wells : Base on the analysis, the calculation of NPV reduction sequentially indicates that PBP was paid during the period of 4 years, it means that water management using infiltration wells is feasible
b. Retention basin : Base on the analysis, the calculation of NPV reduction sequentially indicates that PBP was paid during the period of 5 years, it means that water management using retention basin is feasible
c. Greening: Base on the analysis, the calculation of NPV reduction sequentially indicates that PBP was paid during the period of 5 years; it means that greening is feasible.

5. Conclusion

1. The results of the analysis of the Net Benefit Cost Ratio (Net B/C) indicate that the Net B/C more than 1 for infiltration wells, retention basin, and greening, so water management using the three construction is feasible
2. The results of the analysis of the Net Present Value (NPV) indicate that
   a. Infiltration wells = 112,478
   b. Retention basin = 219,237,313.50 million
   c. Greening = 15,274,500 million

It shows NPV> 1, so the Water Management using infiltration wells, retention basin, and greening is feasible.

3. The results of the analysis of the Internal Rate of Return (IRR) indicate that the IRR = 13.56explained IRR is bigger than sosial discount rate (12%), so Water Management using infiltration wells, retention basin, and greening is feasible.
4. The results of the analysis of the Pay Back Period (PBP) indicate that the PBP was paid during the period of 4 years for infiltration wells, 5 years for retention basin, and greening, it means Water Management using three alternatives is feasible.

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