*J. Basic. Appl. Sci. Res.*, **1(4)294-298, 2011**



ISSN 2090-424X
Journal of Basic and Applied
Scientific Research
*www.textroad.com*

# Study of Water Value at Sengguruh Dam, East Java, Indonesia

Suwanto Marsudi

Department of Water Resources, Faculty of Engineering, Brawijaya University, Malang 65145, Indonesia

***Received*** **10 March, 2011**
***Accepted*** **16 March, 2011.**

## ABSTRACT

This paper studied the water value at Sengguruh Dam due to reservoir usage age. Sengguruh dam was located at Malang Regency, East Java-Indonesia and it was used to generate hydro electrical power. The methodology consisted of analysis inflow sedimentation rate for evaluating reservoir usage age, calculation benefit of hydro electrical power and then evaluation of economical water value. Economical evaluation based on benefit-cost ratio (B/C ratio) and Internal Rate Return (IRR). Result was used as a consideration of economical evaluation for determining water value of hydro electrical power.

**Key Words:** water value, B/C ratio, IRR, hydro electrical power.

## INTRODUCTION

System view thinking and holistic urban water cycle concepts are increasingly called upon for integrated analysis of urban water systems to mitigate water stress in large urban agglomerations [1]. However, integrated analysis is frequently not applied due to the inherent complexity, limitations in data availability and especially the lack of guidelines and suitable software tools. A range of urban water scenarios, including different supply strategies and the effect of externalities such as demand change, were simulated and compared to a calibrated baseline scenario.

Fresh water availability and demand are unevenly distributed both temporally and geographically. Furthermore, the availability of fresh water has remained more or less constant, while the demand for clean water is steadily increasing [2]. With demand surpassing supply, an integrated water resource management approach is required to ensure even distribution of potable water to all levels of society while protecting the environment. In some areas of the world, especially regions with high population density and intense economic activity, the demand for fresh water has overtaken the supply. An integrated water resource management approach is required to balance environmental, social and economic issues, rather than the conventional technique of “hydraulic mission.

Water catchments worldwide are experiencing increasing pressure on the quantity and quality of ground and surface water resources [3]. Water managers are increasingly consulting community and stakeholder groups to ensure their decisions reflect the values and preferences of water users. Growing tensions between different water users require the use of techniques that can enable stakeholders to learn about each others; positions and deliberate about the costs and benefit of alternative water allocation scenarios.

Various management approaches have been used to deal with the distribution of water availability over time. One of the possibilities, particularly suitable in poor regions of developing countries, is to use small reservoirs. Some of the excess water from the wet season can be stored and then be used to grow crops and

***Corresponding Author:** Dr. Suwanto Marsudi, Department of Water Resources, Faculty of Engineering, Brawijaya University, Malang 65145, Indonesia. Email: suwantomarsudi@yahoo.co.id

support livestock during the dry season. Sedimentation has been identified as a serious problem of many water storages in both less developed countries and developed countries. It is estimated that, on average, around 5% to 1 % of global water storage capacity is lost annually as a result of sedimentation [4].

## MATERIALS AND METHODS

This study was carried out at Sengguruh dam. The dam was located at Malang regency, East Java Province, Indonesia. Sengguruh dam had effective capacity of 2.5 x $10^6$ $m^3$ and intended to generate hydro electrical power with installed capacity of 2 x 14.5 MW and would produce electrical energy of 91 million kWh.. Map of location was as Figure 1.

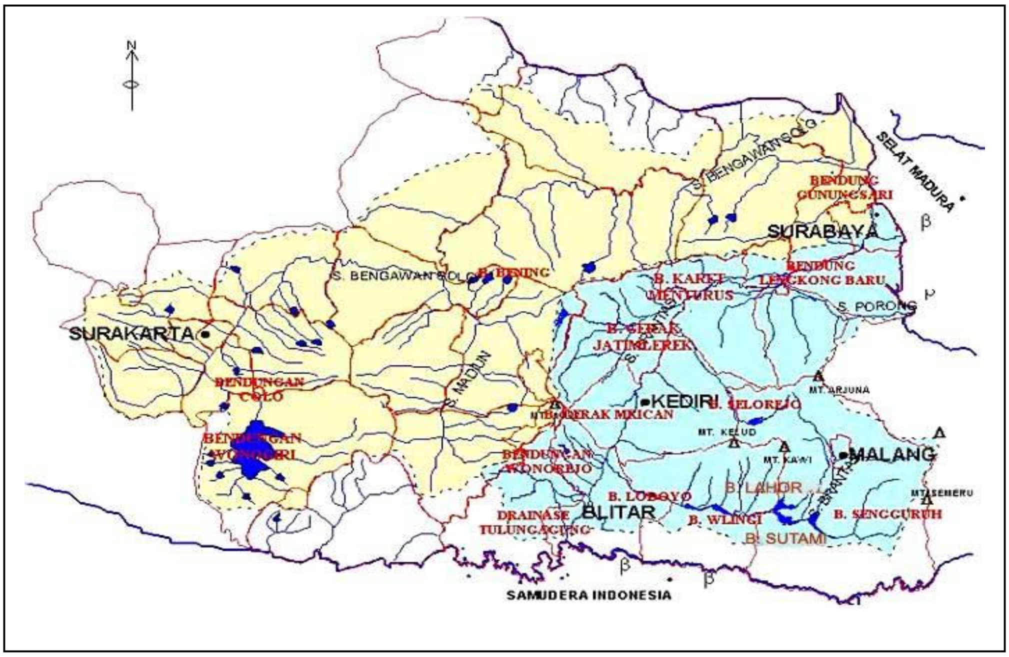


Figure 1. Location of Sengguruh Dam

Nowadays water supply at reservoir was very little mainly at dry season, it would not be enough. Sedimentation caused the change at reservoir capacity of Sengguruh dam, which influenced the economical reservoir usage age. This condition was describes as Table 1.

Table 1 Reservoir Capacity of Sengguruh Dam

| Year | Total reservoir capacity | | Effective reservoir capacity | | Dead storage | |
|---|---|---|---|---|---|---|
| | Volume | Percentage | Volume | Percentage | Volume | Percentage |
| | million $m^3$ | (%) | million $m^3$ | (%) | million $m^3$ | (%) |
| **1988** | 21.5 | 100.00 | 2.5 | 100 | 19 | 100.00 |
| **1993** | 5.36 | 24.93 | 1.21 | 48.4 | 4.15 | 21.84 |
| **1996** | 2.16 | 10.05 | 1.24 | 49.6 | 2.16 | 11.37 |
| **1997** | 5.35 | 24.88 | 1.2 | 48 | 4.16 | 21.89 |
| **2001** | 3.52 | 16.37 | 1.09 | 43.6 | 2.42 | 12.74 |
| **2002** | 3.2 | 14.88 | 1.13 | 45.2 | 2.07 | 10.89 |
| **2003** | 2.32 | 10.79 | 1.04 | 41.6 | 1.28 | 6.74 |
| **2009** | 1.03 | 4.80 | 0.62 | 24.91 | 0.41 | 2.16 |

**Analysis of reservoir usage age**

Reservoir capacity was reduced by sedimentation and it was due to [5]: 1) inflow of total sediment; 2) percentage of deposit sediment; and 3) type weight of sediment. The formulation of reservoir usage age was as follow [5]:

$$T = \frac{V}{Lj} \qquad \text{.....(1)}$$

With
T = reservoir usage age (year)
V = reservoir capacity ($m^3$)
Lj = sediment rate ($m^3$/year)

**Hydro electrical power**

Hydro electrical power was built by using turbine and generator. Power of hydro electrical power was formulated as follow [5]:

$$P = 9{,}81 \times Q \times H_{eff} \times Eff \qquad \text{.....(2)}$$

With
P = power (kW)
$H_{eff}$ = effective head (m)
Q = generated flow discharge ($m^3$/s)
$E_{eff}$ = efficiency of turbine and generator

**Future value factor**

$$F = P_o (1+ i)^{n} \qquad \text{.....(3)}$$

Note: $(1+ i)^{n}$ = compounding factor (F/P), so the formula was written as:
F = Po (F/P, i%, n)

**Benefit Cost Ratio (BCR)**

$$BCR = \frac{\text{PV benefit}}{\text{PV cos}} \qquad \text{.....(4)}$$

With
PV : present value
BCR : benefit cost ratio

**Internal Rate of Return**

$$IRR = I' + \frac{NPV}{NPV' - NPV''} \qquad \text{.....(5)}$$

With :
I’ : interest with NPV > 0
I”: interest with NPV < 0
NPV : benefit minus present value and cost minus present value
NPV’ : NPV >0
NPV” : NPV <0

## RESULTS AND DISCUSSION

Reservoir usage age of Sengguruh dam was assumed to be restricted by total sediment which was full entered at dead storage. Dead storage capacity of Sengguruh Dam was 19 million $m^3$. Before dredging, the dead storage was filled by volume of 18,589.930 $m^3$, so the reduced reservoir usage age was 0.4 year. After dredging, sediment in dead syorage was 18,589.930 $m^3$, so the reduced reservoir usage age was 1 year. Hydro electrical power at Sengguruh dam produced 74,903.259 kWh of energy.
Minimum water value if B/C = 1 was described as Table 2. Relation of benefit cost ratio was as Figure 2.

Table 2 Minimum water value if B/C = 1

| Rate (%) | P/A | Water value for hydro electrical power (Rp/kWh) |
|---|---|---|
| 6 | 15.762 | 133.132 |
| 7 | 13.801 | 152.827 |
| 8 | 12.233 | 173.391 |
| 9 | 10.962 | 194.659 |
| 10 | 9.915 | 216.559 |
| 11 | 9.042 | 239.004 |
| 12 | 8.304 | 261.989 |
| 13 | 7.675 | 285.386 |
| 14 | 7.133 | 309.228 |
| 15 | 6.661 | 333.460 |

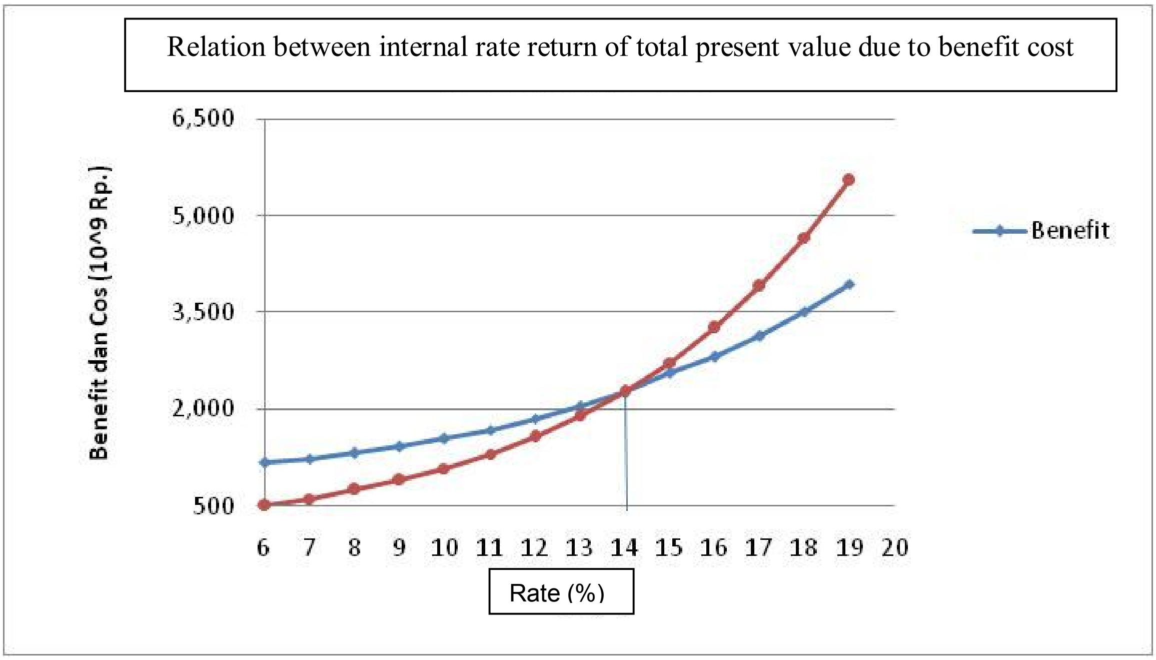


Figure 2 Relation of benefit cost ratio

Internal rate of return was analysis by trial and error of 2 or more value rate and then to analyze straight line interpolation between the rate. IRR of the project was 13.96 %.

## Conclusion

Inflow sedimentation to reservoir was 929.497 m3/year and effective reservoir capacity was reduced 1,877,248 m3. Dredging was carried out as 225,000 m3 and reservoir usage age was increasing 6 months. Energy of hydro electrical power at Sengguruh dam was 74,903,250 kWh in the year of 2009. IRR was 13.96 %.

## REFERENCES


1. Martinez, Sandra Eddo; Escolero, Oscar; and Wolf, Leif. 2011. Total Urban Water Cycle Models in Semiarid Environments-Quantitative Scenario Analysis at the Area of San Luis Potosi, Mexico. *Journal of Water Resource Manage*, 25: 239-263
2. Gupta, N; Pilesjo, P; and Maathuis, D. Use of Geoinformatics for Inter-Basin Water Transfer Assessment, *Journal of Water Resources: Water Resources and The Regime of Water Bodies*, 2010, Vol 37, No 3, pp. 623-637
3. T, Anna; Straton; Jackson, Sur; Marinoni, Oswald; Proctor, Wendy; and Woodward, Emma, Exploring and Evaluating Scenarios for River Catchment in Northern Australia Using Scenario Development, Multi-criteria Analysis and a Deliberative Process as a Tool for Water Planning, *Journal of Water Resource Manage*, 2011 (25): 141-164
4. Predan, Dcepa; Ansev, Tihomir; Dryuan, Ross; and Harris, Michael, Management of Water Reservoirs (Embungs) in West Timoe, Indonesia, *Journal of Water Resource Manage*, 2011 (25): 339-356
5. Linsley, Ray K. and Franzini, Joseph B. 1986. *Teknik Sumber Daya Air*, Jilid 2, Erlangga, Jakarta.