Economic feasibility analysis of Gintung Dam

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Abstract. Gintung Dam is a dam resulting from the post-disaster reconstruction and rehabilitation in 2009. In this study, economic feasibility analysis post reconstruction and rehabilitation is carried out. The feasibility analysis is reviewed based on economic value of the benefits of Gintung Dam and investment cost as well as Operational and Maintenance (O&M) costs. Economic valuation, which is an attempt to provide quantitative value to the goods and services produced by natural resources and the environment, is carried out for the benefits of dam. The method used is the investment criteria method which uses NPV, BCR, PB, and IRR as parameters in determining the feasibility of project. Based on the results, for Gintung Dam with its function as a flood control was obtained NPV = Rp.14,023,230,130.29, BCR = 1.88, PBP = 27 years, and IRR = 12% and as groundwater conservation was obtained, NPV = Rp. 87,704,518,835.06, BCR = 6.51, PBP = 2.7 years, and IRR = 46.25%. The results of the analysis shows that the Gintung Dam reconstruction and rehabilitation project is economically feasible with the value results NPV > 0, BCR > 1, PBP < project life span (100 years), and IRR > interest rate used (10%).

1. Introduction
The Failure of Situ Gintung was occurred on Friday, March 27, 2009 at 02.00 West Indonesia Time in the early morning and caused many casualties and caused extensive damage. After the disaster, in July 2009 the Puslibang SDA and the Ministry of PUPR issued a rehabilitation and reconstruction design for the Gintung Dam. The reconstruction and rehabilitation of the Gintung Dam can be assessed for its economic benefits, namely by conducting an economic analysis. The purpose of the economic feasibility analysis is to ensure the economic sustainability of a project related to the effectiveness, timeliness, use of funds, and resources for the design life of the project. Based on the description, the feasibility study was conducted by comparing the amount of investment costs and operational and maintenance costs (O&M costs) with the value of the benefits of the Gintung Dam. The value of benefits in a project / infrastructure is a comparison of the conditions or impacts received with the existence of infrastructure with no infrastructure. The value of Gintung Bendugan benefits is obtained by conducting an economic valuation of the two benefits of Gintung Dam [1-8].

Economic valuation is an effort to provide quantitative value to goods and services produced by natural resources and the environment, both on the basis of market value and non-market value (Hasibuan, 2014). The method used is the investment criteria method or can also be called an investment evaluation method. The investment criteria method is a method used to analyze whether an investment activity will promise a profit in the long run or not. This method uses Net Present Value (NPV), Benefit Cost Ratio (BCR), Payback Period (PBP), and Internal Rate of Return (IRR) as parameters. A project is
said to be feasible if the value of BCR (Benefit Cost Ratio) $\geq 1$, NPV (Net Present Value) $\geq 0$, PBP (Payback Period) < project life span, and the value of IRR (Internal Rate of Return) $\geq$ interest used. “1” is a minimum value of the ratio between the project’s annual benefit and the annual cost to be considered feasible. Based on the previous description, the purpose of this research is to conduct an economic feasibility analysis Gintung Dam which based on the calculation of investment costs and operation and maintenance (O&M), calculation of the economic value of the benefits of the Gintung Dam, and calculations using the Investment Criteria method [9-13].

2. Research Methodology

This study is conducted at Gintung Dam which located in Cirendeu, East Ciputat, Tangerang Selatan City, Banten Province. Gintung Dam is included in the Pesanggrahan river basin and managed by Balai Besar Wilayah Sungai Ciliwung Cisadane.

In this study there was no direct field measurement, so all the data were used is secondary data. The data are rainfall data, DEM map, Google Map 2019, technical data of Gintung Dam and Reservoir, hydrologic soil group data, river flow data, reconstruction and rehabilitation cost, operational and maintenance cost, report of loss due to flood JABODETABEK 2007, and water raw cost in Tangerang Selatan. Analysis can be conducted after the data is set. The flow of the analysis can be seen in the picture below.

![Figure 1. Location of Gintung Dam](image1)

![Figure 2. Flow Diagram](image2)
3. Results and Discussion

3.1. Gintung Dam as Downstream Area Flood Controller
The benefit from downstream area flood controller is obtained by calculating the damage value if there were no reconstruction and rehabilitation project. Since the project is conducted, hence the damage value is considered as benefit because the project preventing the flood to happen.

3.1.1. Flood Mapping
Flood mapping is conducted to identify the damage area for each rainfall period. Flood mapping is obtained by using HecGeo-RAS to modelling the river centre line, river banks, flow path, and to visualize the damage area and also using Hec-RAS to run the flood simulation. One of the flood mapping result is shown below.

![Figure 3. Example of Flood Mapping Resulted from HecGeo-RAS](image_url)

3.1.2. Economic Valuation
The benefit value of Gintung Dam as downstream area flood controller is determined by identifying the amount and the type of land use in the flood affected area for each rainfall period and multiplying it with the damage value for each land use type issued by document of Penjelasan Menteri Negara PPN/ Kepala BAPPENAS Tentang Hasil Penilaian Kerusakan dan Kerugian Pascabencana Banjir Awal Februari 2007 di Wilayah JABODETABEK. The table below shows the value of mild and severe damage for each rainfall period. Those values below in this study is considered as benefit.

| No. | Period  | Damage Mild       | Damage Severe     |
|-----|---------|-------------------|-------------------|
| 1.  | 2 years | Rp. 1,697,200,000.00 | Rp. 3,217,200,000.00 |
| 2.  | 5 years | Rp. 1,783,500,000.00 | Rp. 3,434,000,000.00 |
| 3.  | 10 years | Rp. 2,064,450,000.00  | Rp. 3,936,200,000.00  |
| 4.  | 25 years | Rp. 2,267,950,000.00  | Rp. 4,324,200,000.00  |
| 5.  | 50 years | Rp. 2,530,700,000.00  | Rp. 5,111,200,000.00  |
| 6.  | 100 years | Rp. 2,543,250,000.00  | Rp. 5,141,000,000.00  |
| 7.  | 1000 years | Rp. 2,749,850,000.00 | Rp. 5,608,600,000.00  |

3.2. Gintung Dam as Groundwater Conservation Area
The value of the benefit as groundwater conservation area is defined by assuming that the area which is influenced by groundwater resulting from conservation does not need to buy a raw water because they
can utilize its water. So, the amount of money which is allocated for buying the raw water everyday can be saved. It is considered as a benefit resulting from Gintung Dam as ground water conservation area.

3.2.1. Determination of Groundwater Beneficiary Area
Beneficiary area is assumed as far as 200 m from the outer boundary of water contact area in the Gintung Reservoir. This determination is based on Peraturan Menteri Energi dan Sumber Daya Mineral Republik Indonesia Nomor 31 Tahun 2018 Tentang Pedoman Penetapan Zona Konservasi Air Tanah, it is stated “The spring protection zone is done by outlining (delineating) with a radius of 200 meters from the location where the spring appears”. In this research, the analogy is reserved, so 200 m specified as the beneficiary area. The map as well as the identification of land use in beneficiary area is shown in picture and table below.

![Beneficiary Area of Groundwater Resulted from Conservation](image)

**Figure 4. Beneficiary Area of Groundwater Resulted from Conservation**

**Table 2. Identification of Land Use in Beneficiary Area**

| Category | Building Type       | Number of Buildings |
|----------|---------------------|---------------------|
| I        | Rumah Sangat Sederhana | 3                   |
|          | Rumah Sederhana     | 104                 |
| II       | Rumah Menengah      | 401                 |
|          | Instansi Pemerintah | 19                  |
| III      | Rumah Mewah         | 40                  |
|          | Niaga Kecil         | 57                  |
|          | Niaga Besar         | 209                 |

3.2.2. Economic Valuation
Economic valuation is conducted by multiplying the cost of raw water in Kota Tangerang Selatan (the usage is estimated 5 m³ per day) with the number of land use in the table above respectively. The result is Rp. 26.952.000,00 per day or Rp. 9.837.480.000,00 per year.
3.3. Investment and Operational and Maintenance (O&M) Cost

The investment cost of the project is the accumulation of direct cost and indirect cost. The direct cost was obtained from Balai Besar Wilayah Sungai Ciliwung Cisadane (BBWS Ciliwung Cisadane). The indirect cost was determined using Modul Kelayakan Ekonomi published by Badan Pengembangan Sumber Daya Manusia Kementrian PUPR.

The O&M costs were obtained from AKNOP document also issued also by BBWS Ciliwung Cisadane. For the periodic cost of 20th year is 500% of annual cost (based on the information from Modul Kelayakan Ekonomi published by Badan Pengembangan Sumber Daya Manusia Kementrian PUPR).

Table 3. Investment and Operational and Maintenance (O&M) Cost

| No. | Cost                              | Total Cost              |
|-----|----------------------------------|-------------------------|
| 1.  | Investment Costs                 | Rp 14,460,000,001.21    |
| 2.  | Operational and Maintenance Cost |                        |
|     | Annual                           | Rp 683,779,000.00       |
|     | 5th years                        | Rp 1,183,779,000.00     |
|     | 20th years                       | Rp 3,418,895,000.00     |

3.4. Investment Criteria Method

Based on the determination and calculation that have been done, the economic feasibility analysis can be conducted by comparing between the investment as well as the O&M cost and the economic value of Gintung Dam. The economic feasibility is determined using investment criteria method. This method uses Net Present Value (NPV), Internal Rate of Return (IRR), Benefit Cost Ratio (BCR), and Payback Period (PBP) as parameters to decide the feasibility of project. The interest rate that is used is 10% hence it refers to the Modul Kelayakan Ekonomi which was issued by Kementrian PUPR in 2017. The results are:

3.4.1. 1st Scenario (Bendungan Gintung as Downstream Area Flood Control)

NPV $= Rp. 14,350,354,177.67$

IRR $= 12 \%$

BCR $= 1.9$

PBP $= 27.2$ years

3.4.2. 2nd Scenario (Bendungan Gintung as Groundwater Conservation Area)

NPV $= Rp. 87,704,518,835.06$

IRR $= 46 \%$

BCR $= 6.51$

PBP $= 2.7$ years

4. Conclusion

Based on the economic valuation determination and calculation as well as the economic analysis that have been done, several aspects that can be concluded from this research are the results of economic analysis for Gintung Dam as flood controller in downstream area are Net Present Value (NPV) $= Rp.$
14,023,230,130.29, Internal Rate of Return (IRR) = 12%, Benefit Cost Ratio (BCR) = 1.9, and Payback Period (PBP) = 27 years and the results of economic analysis for Gitnung Dam as groundwater conservation are Net Present Value (NPV) = Rp. 87,704,518,835.06, Internal Rate of Return (IRR) = 46.25%, Benefit Cost Ratio (BCR) = 6.51, and Payback Period (PBP) = 2.7 years. Hence, based on the previous analysis, Gintung Dam post disaster reconstruction and rehabilitation project is economically feasible with the NPV > 0, IRR > used discount rate (10%), BCR > 1, dan PBP < project design life span (100 years). It means those parameter values have fulfilled the criteria of feasible project.

References
[1] Asdak C 2002 Hidrologi dan Pengelolaan Daerah Aliran Sungai (Yogyakarta: Gadjah Mada University Press)
[2] Badan Pengembangan Sumber Daya Manusia 2017 Modul 3 Kelayakan Ekonomi (Bandung: Kementrian PUPR)
[3] Balai Besar Wilayah Sungai Ciliwung Cisadane 2010 Rencana Anggaran Biaya Rehabilitasi Bendungan Gintung Jakarta
[4] Hasibuan B 2014 Valuasi Ekonomi Lingkungan Nilai Gunan Langsung dan Tidak Langsung Komoditas Ekonomi Signifikan 3 115
[5] Kementrian PUPR 2020 Formulir Perhitungan Angka Kebutuhan Nyata Operasi dan Pemeliharaan (AKNOP) Bendungan Kementrian PUPR Direktorat Jenderal SDA.
[6] Sugiyono 2016 Metode Penelitian Kuantitatif Kualitatif dan R&D (Bandung: Alfabeta)
[7] Zielinski J 2002 Watershed Vulnerability Analysis (Elicott City: MD 21043)
[8] U.S. Army Corps Of Engineers 2016 HEC-RAS, River Analysis System Hydraulic Reference Manual (California: U.S. Army Corps Of Engineers)
[9] United States Department of Agriculture, Natural Resources Conservation Service 2003 Hydrologic Soil Groups. Hydrologi National Engineering Book
[10] Scharffenberg W A 2013 Hydrologic Modeling System HEC-HMS User's Manual Version 4.0. (Washington D.C.: USACE-HEC)
[11] International Bank for Reconstruction and Development 2018 Meningkatkan Keamanan Bendungan dan Perlindungan Masyarakat Umum melalui Rencana Tindak Darurat dan Rencana Kontinjensi Berbasis InaSAFE (Washington DC: World Bank Publications.)
[12] Dobos R 2018 Hydrologic Soil Group United States Department of Agriculture Natural Resources Conservation Service. Retrieved from https://www.nrcs.usda.gov:/https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052731.pdf
[13] Chow V T, Maidment D R, and Mays L W 1988 Applied Hydrology (New York: McGraw-Hill)