

Republic of Indonesia

FY2016 Ex-Post Evaluation of Japanese ODA Loan Project

“Urgent Disaster Reduction Project for Mt. Merapi/Progo River Basin and Mt. Bawakaraeng”

External Evaluator: Masami Sugimoto, SHINKO Overseas Management Consulting Inc.

0. Summary

This project consists of two sub-projects that conduct both the structural and nonstructural disaster countermeasures against the eruption of volcanic Mt. Merapi at its foot and the Progo River Basin in Jogjakarta Special Region Province, as well as the large-scale landslide of Mt. Bawakaraeng at the Jeneberang River basin and the Bili-Bili Dam in South Sulawesi Province. The Mt. Merapi/Progo River Basin component was implemented to promote protection of human lives, public and private properties and to establish sustainable disaster protection systems, thereby contributing to the promotion of regional development. The Mt. Bawakaraeng component was conducted to protect human lives, public and private property including farmlands from debris flow and improve the dam function downstream by preventing sediment discharge from the landslide stricken area, thereby contributing to sustained social and economic activities in and around Makassar City by maintaining stable supply of water and other utility services.

This project is highly relevant corresponding to the Indonesia’s development policy, the international framework to cope with natural disaster prevention, people’s development needs and also to the Japan’s ODA policy at the time of appraisal. On the other hand, the efficiency is fair with its implementation period longer than planned due to the prolonged procurement process, while the project cost is lower than the plan.

For the Mt. Merapi/Progo River Basin component, the preset quantitative indicator “Sediment Control Ratio” became unusable due to the occurrence of unexpected violent eruption during the project implementation, however, the project effect on disaster prevention and promotion of regional development has been confirmed by reviewing past disaster statistics, result of the beneficiary survey and other evidential facts. For the Mt. Bawakaraeng component, the effect on disaster prevention and regional development has been identified as well by the achievement of preset quantitative indicators, result of the beneficiary survey and so forth. The project has been thus mostly producing planned effects, therefore effectiveness and impact of the project can be judged high.

Basically no problems were identified in the maintenance system for the developed sabo facilities as well as the technical and financial capacity of both of the River Basin Organizations (Balai Besar Wilayah Sungai, hereinafter referred to as BBWS) which are responsible under the Ministry of Public Works and Housing. However, unrealized optimal sand mining control system without the planned establishment of the Sand Mining Management Institution (SMMI)

and prevailing incomplete operation and management practices on the installed monitoring, forecasting and warning systems show some concern on the sustainability. Due to those minor problems in maintenance and prevailing conditions of the operation and maintenance practices, the sustainability of the project effects is fair.

In light of the above, this project is evaluated to be satisfactory.

1. Project Description



(Project Location)



(Consolidation Dam : Mt. Bawakaraeng Component)

1.1 Background

<Mt. Merapi/Progo River Basin>

Mt. Merapi with the height above sea level 2,986 m is one of the most prominent active volcanos in the world which is located 30 km north-northwest of the historical city Jogjakarta. It has erupted more than 40 times repeatedly since 1800 on record. Even after the 1990s, it continues erupting every two or three years in which debris flow is in increasing danger due to the large amount of accumulated unstable sediment. Additionally, sand mining was prevailing in the surrounding areas, and problems of uncontrolled acts causing damage on existing sabo facilities, change in river course, river bed degradation downstream, environmental deterioration by noise and dust and road damages by overloaded vehicles were urging comprehensive counter measures to prevent volcanic and sediment disasters and to develop effective sand mining management systems.

<Mt. Bawakaraeng>

A gigantic caldera-wall collapse occurred at Mt. Bawakaraeng located at the headstream region of Jeneberang River in the south of Sulawesi Island on March 26, 2004. The landslide sediment that reached villages 2.5 km downstream claimed 32 people dead and missing and

damage of totally 22 billion rupiahs in value (approximately 300 million yen <exchange rate at the appraisal: 0.012 yen/rupiah>. The total volume of sediment having being accumulated in the collapsed caldera was estimated at 200 - 300 million tons, and rainfall after the collapse brought sediment outflow estimated at about 14 million m³ during three months until June 2004. The debris flow completely buried a sabo dam 5km downstream, further, brought damages burying farmlands along the Jeneberang River basin and river-crossing traffic obstruction and others. Thirty-five km downstream the collapsed location, there exists the Bili-Bili Multipurpose Dam constructed under the Japanese ODA Loan which is supplying clean water and electricity to Makassar City, and providing irrigation water to areas in and around the city. The sediment inflow from the collapse and consequent water quality degradation threaten those dam functions. Those situations called for countermeasures to eliminate factors that hinder social and economic activities in and around Makassar City with 1.2 million population, and to secure the safety of the local residents.

1.2 Project Outline

<Mt. Merapi/Progo River Basin>

The object of this component of the project is to promote protection of human lives, public and private properties and to establish sustainable disaster protection systems by conducting both the structural and nonstructural disaster countermeasures at the foot of Mt. Merapi and Progo River basin located 30 km north-northwest of Jogjakarta City such as provision of sabo facilities, prevention of riverbed degradation, installation of monitoring, forecasting and warning systems, improvement of sand mining management and so forth, thereby contributing to the promotion of regional development.

<Mt. Bawakaraeng>

The object of this component of the project is to protect lives, public and private properties including farmlands from sediment flow and improve the dam function downstream arresting sediment discharge from the landslide stricken area by rehabilitating existing infrastructures including bridges as well as developing sabo facilities and monitoring, forecasting and warning systems at the Jeneberang river basin that has encountered sediment disasters from the great landslide of the Mt. Bawakaraeng in South Sulawesi Province in March 2004, thereby contributing to sustained social and economic activities in and around Makassar City by maintaining stable supply of water and other utility services.

<ODA Loan Project>

Loan Approved Amount/ Disbursed Amount	16,436 million yen / 16,385 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	March, 2005 / March, 2005
Terms and Conditions	Interest Rate 1.5% Repayment Period 30 years (Grace Period 10 years) Conditions for Procurement General Untied
Borrower/ Executing Agency	Government of the Republic of Indonesia/ Directorate General of Water Resources, Ministry of Public Works and Housing
Final Disbursement Date	July, 2014
Main Contractors (Over 1 billion yen)	PT. WIJAYA KARYA (Indonesia) / HAZAMA CORPORATION (Japan), PT. ADHI KARYA (Indonesia) / PT. BRANTAS ABIPRAYA (Indonesia) / PT.GUNAKARYA NUSANTARA (Indonesia), PT. WIJAYA KARYA (Indonesia) / SHIMIZU CORPORATION (Japan)
Main Consultants	Yachiyo Engineering Co., Ltd. (Japan) CTI Engineering International Co., Ltd. (Japan)
Feasibility Studies ,etc.	-
Related Projects	(Technical Cooperation Projects) <Mt. Merapi/Progo River Basin> -Master Plan for Land Erosion and Volcanic Debris Control in the Area of Mt. Merapi (1977-1980) -Integrated Sediment-related Disaster Management (2000-2006) -Multi-disciplinary Hazard Reduction from Earthquakes and Volcanoes in Indonesia (2009-2012) -Project for Integrated study on mitigation of multimodal disasters caused by ejection of volcanic products (2014-2019) (ODA Loan Projects) <Mt. Merapi/Progo River Basin> -Urgent Disaster Reduction Project for Mount Merapi

	<p>(1985-1993) <Loan Agreement (hereinafter referred to as LA): October, 1983></p> <p>-Mt. Mepapi and Mt. Semeru Volcanic Disaster Countermeasures (2) (1995-2001) <LA: December, 1995></p> <p>-Urgent Disaster Reduction Project for Mount Merapi 2 (Under implementation at the time of this ex-post evaluation) <LA: February, 2014></p> <p><Mt. Bawakaraeng></p> <p>-Bili-Bili Multi-Purpose Dam Project (1) (2) (3) (1990-2001) <LA: (1) December, 1990 (2) October, 1992 (3) November, 1994></p> <p>-Bili-Bili Irrigation Project (1996-2005) <LA: December, 1996></p> <p>-Multipurpose Dam Hydroelectric Power Plants Project (1996-2007) <LA: December, 1996></p>
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2. Outline of the Evaluation Study

2.1 External Evaluator

Masami Sugimoto, SHINKO Overseas Management Consulting, Inc.

2.2 Duration of Evaluation Study

This ex-post evaluation study was conducted with the following schedule.

Duration of the Study: October, 2016 – January, 2018

Duration of the Field Study: March 5 – March 21, 2017, July 20 – July 29, 2017

2.3 Constraints during the Evaluation Study

(1) The object of a disaster prevention project is massive natural phenomena including convulsion of nature themselves which are supposed to be excluded as external factor for measuring project effects and impacts in project evaluation in general. Occurrence of natural phenomena is irregular, therefore it is highly difficult to predict their frequency, timing and magnitude properly in advance. It is therefore difficult to set appropriate quantitative indicators, and even when they have been found, there is a constraint to quantitatively measure or identify existence of project effects and impacts by simply applying them. The case of Mt. Merapi's unforeseeable massive eruption in 2010 which broke a part of sabo facilities and disabled usage

of “Sediment Control Ratio” as a preset single quantitative indicator is an extreme example. So is the case of Mt. Bawakaraeng. In the light of that constraint, this ex-post evaluation made much of such other kinds of evidence as findings from the beneficiary survey, field observation, interview to related institutions and the result of reviewing past statistic records of disaster damages.

(2) Substance of this project is a package of two separate sub-projects under the Directorate General of the Ministry of Public Works and Housing respective implementation of which is independently managed by each River Basin Management Organization (Balai Besar Wilayah Sungai <BBWS>, hereinafter referred to as BBWS). However, they were not totally managed in an integrated way as a single ODA loan project. Therefore the information on total Man-months of the consulting services and project costs expended from the government budget was not available which limited the evidence for the efficiency judgement.

(3) Technical training for operation and maintenance of sabo facilities is mainly conducted by the Sabo Technical Center comprehensively. Because the record of the training practices was not submitted by the Center, there was a constraint in evidence partly to objectively support technical sustainability of the project.

3. Results of the Evaluation (Overall rating: B¹)

3.1 Relevance (Rating: ③²)

3.1.1 Consistency with the Development Plan of Indonesia

The Indonesian Government designated the peripheral area of Mt. Merapi as the most critical area in the National Disaster Management Program after the violent eruption in 1969. *The Master Plan for Land Erosion and Volcanic Debris Control in the Area of Mt. Merapi* was developed under the JICA Development Study Scheme in 1980, and additionally two phases of sabo projects were implemented from 1985 until 2001 under Japanese ODA Loans. The assistance for the Mt. Bawakaraeng component was requested by strong needs to urgently control the debris-avalanche and sediment outflow caused by the landslide. *The National Medium-term Development Plan (RPJMN: Rencana Pembangunan Jangka Menengah Nasional) 2005-2009* at the time of the appraisal also laid stress on infrastructure development to promote regional development.

The National Medium-term Development Plan (RPJMN) 2015-2019 at the time of the Ex-post evaluation incorporates nine priorities called “Nawa Cita” proposed by the republic’s

¹ A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory

² ③: High, ②: Fair : ①: Low

president Joko Widodo inaugurated on October 10, 2014. One of the nine priorities is “promotion of economic independence by developing each strategic sector in domestic economy” in which “countermeasures against disaster and reduction of disaster risks” are placed in a priority area. Thus, the relevance to the development plan of Indonesia is consistently high.

The Hyogo Framework for Action 2005-2015 adopted at the 2nd World Conference on Disaster Reduction of the United Nations in 2005 announces five priority actions; namely, (1) Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation, (2) Identify, assess and monitor disaster risks and enhance early warning, (3) Use knowledge, innovation and education to build a culture of safety and resilience at all levels, (4) Reduce the underlying risk factors and (5) Strengthen disaster preparedness for effective response at all levels. On the other hand, the 3rd World Conference on Disaster Reduction of the United Nations in 2015 addressed four priorities for action in its *Sendai Framework for Disaster Risk Reduction 2015-2030*; (1) Understanding disaster risk, (2) Strengthening disaster risk governance to manage disaster risk, (3) Investing in disaster risk reduction for resilience and (4) Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation and reconstruction. It may be pronounced that this project is in accordance with prevailing international frameworks to tackle natural disasters.

3.1.2 Relevance to the Development Needs of Indonesia

<Mt. Merapi/Progo River Basin>

Peripheral area of Mt. Merapi is a prominent tourist spot having historical Borobudur and Prambanan Temples, and the Jogjakarta district is the center holding population of 2.7 million people. At the time of the appraisal when the risks of pyroclastic and debris flow were increasing due to the intermittent eruptions of Mt. Merapi, it was therefore necessary for eliminating factors that hinder regional economic development to take structural countermeasures by constructing sabo facilities and developing such nonstructural measures as monitoring, forecasting and early warning devices and evacuation systems. In addition, it was also needed to improve sand mining systems to control excessive and improper mining activities under ineffective management which destabilize sabo facilities' conditions and cause degradation of riverbeds. Urgent countermeasures were also needed for stabilizing riverbeds at two bridges downstream of Progo River that was in danger of collapse due to the riverbed degradation.

In the circumstance that the eruption activity of Mt. Merapi will not cease in predictable future, needs for this project continues to be high. This project was implemented as the third phase following the preceding first (1985-1992) and the second (1995-2001) phase projects, and the fourth phase (Urgent Disaster Reduction Project for Mount Merapi 2, LA: February 2014

<IP-566>) is under implementation. Mt. Merapi repeated eruptions in 2006 and 2010, therefore the project needs are increasingly high.

<Mt. Bawakaraeng>

A risk of debris flow at the Jeneberang River basin was increasing at the time of appraisal due to the occurrence of massive landslide at Mt. Bawakaraeng. Existing infrastructure like bridges and sabo facilities had been damaged by already occurred debris flow, which necessitated their rehabilitation. If no countermeasures had not been taken, mass of soil might have flown into the Bili-Bili Dam downstream, which was expected to remarkably reduce its water supply function to irrigation, hydraulic power generation and production of clean water, consequently to seriously affect the social and economic activities in and around Makassar City which has a population of 1.2 million people. To cope with that situation, in addition to urgently removing the accumulated sediment, both the structural and nonstructural devices as long-run countermeasures were to be taken; namely sediment control by constructing sabo facilities (structural) and monitoring of sediment conditions, trend, etc. early warning, improvement of people's consciousness on disaster prevention and evacuation arrangements (non-structural).

Different from the Mt. Merapi component, this component is caused by the massive landslide of the caldera wall occurred on March 26, 2004. However, accumulation of enormous volume of surplus collapsed soil, possibility of extended collapse in future, necessity for continuous countermeasures against inflow of minute floating soil avalanche (Wash Load) into Bili-Bili Dam uncapturable by sabo facilities made this project in high need. Based on the proposal made in this project, the succeeding project is under preparation. No collapse has been occurred after 2004 yet, however, sediment by the 2004 landslide is still accumulated upstream and continuously flowing out by rainfall in the rainy season. Further, the additional study during this project warns possible landslide in future.

Thus, disaster risks that hinders development continues to exist at both the Mt. Merapi and Mt. Bawakaraeng regions, therefore it is judged that the needs of this project to alleviate and prevent them are consistently high.

3.1.3 Relevance to Japan's ODA Policy

3.1.3.1 Country Assistance Program for the Republic of Indonesia

The "Country Assistance Program for the Republic of Indonesia" (November 2004) of the Japanese government addressed assistance for "creation of a democratic and fair society," as a priority issue and area, and in its improvement of fundamental public services, it intended to assist in preparing preventive measures against high frequency of flood, sediment and other natural disasters. The Program also identified "sustainable growth driven by private sector" as one of the priority areas and emphasized the importance of "development of economic

infrastructure necessary for improving the investment environment” among others. This project aims to prevent volcanic and sediment disasters in Jogjakarta region which is a major economic area of Indonesia, and also to protect the area centering around Makassar from sedimentary disaster which harms regional social activities and avoid sediment inflow into the Bili-Bili Dam. This project is thus judged to correspond to the policy for aiming the “creation of a democratic and fair society” and “development of economic infrastructure necessary for improving the investment environment.”

3.1.3.2 Strategy for Overseas Economic Cooperation Operations

As a priority assistance area for Indonesia, JICA’s “Strategy for Overseas Economic Cooperation Operations” (April, 2002) identified “economic infrastructure development” necessary for endeavoring for the recovery path to sustainable growth through economic reform as well as “assistance for environmental improvement and antipollution.” It can be judged that this project corresponds to the JICA’s strategy above in terms of “economic infrastructure development.” For the Mt. Bawakaraeng component particularly, alleviation of environmental destruction in the Jeneberang river basin and the ill effect of urban environment worsening in Makassar City caused by the water quality degradation comply with the policy at the time of appraisal, “assistance to environmental improvement and antipollution.”

3.1.3.3 Country Assistance Strategy

JICA’s country assistance strategy (September, 2004) in the overseas economic cooperation works nominates “development of growth environment driven by private sector” as one of the key issues that includes “intensive assistance to develop disaster prevention infrastructure for major economic regions.” This project prevents volcanic and sediment disasters in Jogjakarta region which is one of the main economic areas in Indonesia and protect the area centering around Makassar City from sedimentary disaster which harms regional social activities and avoid sediment inflow into the Bili-Bili Dam. Therefore, the project is judged to correspond to the policy of “intensive assistance to develop disaster prevention infrastructure for major economic regions” at the time of appraisal.

Thus, this project is highly relevant to the Japan’s ODA policy at the time of appraisal.

In light of the above, this project has been highly relevant to the country’s development plan, international frameworks to tackle natural disasters and development needs at both appraisal and ex-post evaluation times. It is also relevant to the Japan’s ODA Policy at the time of appraisal. Therefore its relevance is high.

3.2 Efficiency (Rating ②)

3.2.1 Project Outputs

<Mt. Merapi/Progo River Basin>

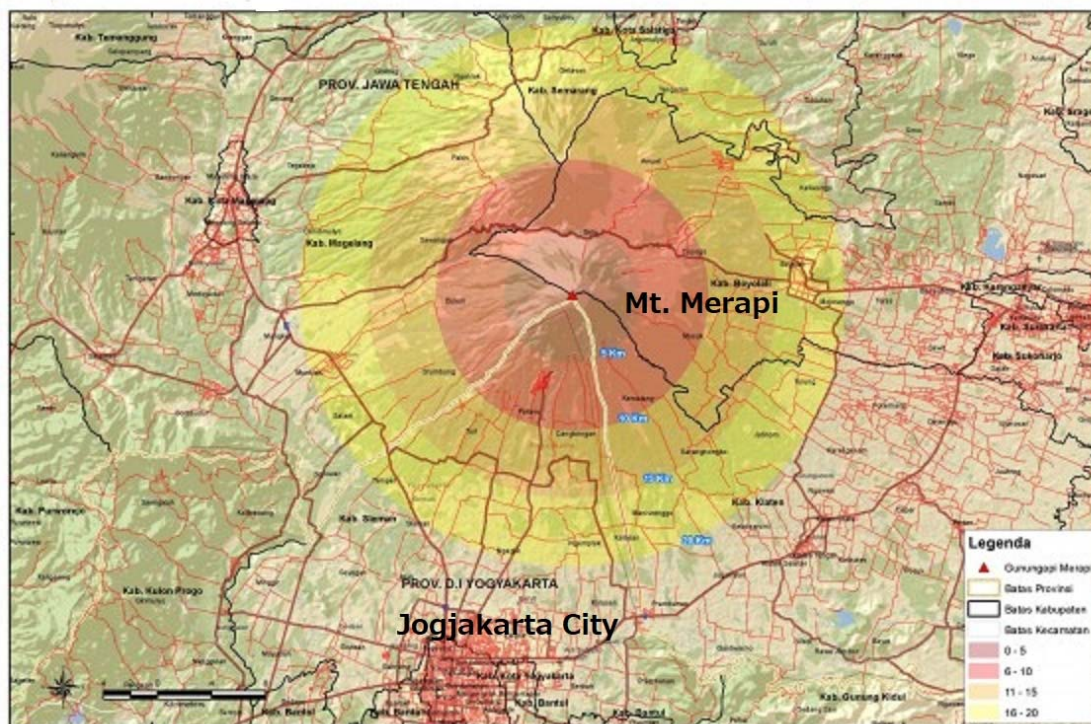


Figure 1: Mt. Merapi and Jogjakarta City

Source: Indonesian National Board for Disaster Management (BNPB)

3.2.1.1 Main Works of Mt. Merapi/Progo River Basin Component

The scope of this component consists of many works which can be categorized into four areas; namely, (a) countermeasures against debris flow, (b) Progo riverbed stabilization, (c) sand mining management, (d) regional development at the mountain foot, and urgent countermeasures for the 2006 earthquake and eruption during the project implementation (e) and 2010 eruption (f). The actual outputs and the main difference from the plan are as follows³.

³ The non-eligible items consisting of cost of land acquisition, general project administration and tax are borne by the government. A part of the physical contingency was also included in the government portion at the time of appraisal (estimated at 1.9%), but in actual implementation, entire amount out of the non-eligible portion above has been spent from the ODA loan portion.

Table 1: Main Contents of Actual Outputs <Mt. Merapi/Progo River Basin>

Items		Main Outputs
(a) Countermeasure against debris flow	Structural Countermeasures	<ul style="list-style-type: none"> ● Construction of sabo facilities (30 units)
	Non-structural Countermeasures	<ul style="list-style-type: none"> ● Installation of debris flow monitoring, forecasting and early warning systems (Rainfall observation station: 6 locations, Master station: 1 location, Control station: 1 location, Monitoring station: 3 locations) ● Evacuation shelter (3 units), Evacuation roads (5.82 km) ● Development of GIS system for volcanic disaster ● Procurement of heavy equipment for disaster recovery works, maintenance structure ● Assistance for capacity strengthening of regional disaster prevention ● Dissemination and education of disaster prevention knowledge in cooperation with educational institutions ● Evacuation drills <p style="text-align: right;">} Note</p>
(b) Progo riverbed stabilization		<ul style="list-style-type: none"> ● Construction of consolidation dam (2 units)
(c) Sand mining management		<ul style="list-style-type: none"> ● Preparation of sand mining management plan ● Implementation of community-driven monitoring activities
(d) Regional development at the mountain foot		<ul style="list-style-type: none"> ● Rehabilitation of irrigation facilities (14 units) ● Construction of consolidation dam (1 unit)
(e) Urgent disaster countermeasures for 2006 earthquake and eruption		<ul style="list-style-type: none"> ● Construction of sabo facilities (6 units) ● Rehabilitation of irrigation facilities (35 locations) ● Rehabilitation of water source facilities (20 locations)
(f) Urgent disaster countermeasures for 2010 eruption		<ul style="list-style-type: none"> ● Rehabilitation of sabo dam (5 units) ● Embankment, construction of training dykes (2 units)

Source: Prepared by the external evaluator based on materials provided by JICA and questionnaire answers by Executing Agency

Note: For enlightening and training people's disaster prevention awareness, participatory community activities (facilitator education introducing "Yonmenkaigi" system, action plan preparation, etc.), evacuation drills involving children (introducing "Bosai Dance," "Bosai Duck," etc.) and preparation of disaster prevention manual were conducted. (cf. photographs on page 30)

3.2.1.2 Consulting Services for Mt. Merapi/Progo River Basin Component

Following consulting services were provided for project implementation assistance and others.

1. Project implementation assistance (detailed design tender assistance, implementation supervision, operation and maintenance assistance)
2. Preparatory studies and assistance for establishing “Sand Mining Management Institution” (hereinafter referred to as “SMMI”)
3. Assistance for establishing sabo communities, enlightenment of people’s disaster awareness and establishment of evacuation system

Actual total Man-Months vis-à-vis the plan is shown below.

Table 2: Planned and Actual Man-months (MM) of Consulting Services

	Plan	Actual	Difference
International Consultants	187.00	317.68	130.68
Local Consultants	780.00	801.79	21.79

Unit: MMs

Source: Answers to the Questionnaire by Executing Agency

The main reason of increase compared to the plan is due to the following additional works caused by the great eruption in 2010.

1. Investigation and analysis of the facility damage and study for the most urgent counter measures
2. Works relating to the changed contents of the Packages 3 (sabo dam site 2) and Package 7 (procurement of monitoring and early warning equipment)
3. Works for rehabilitation of damaged sabo facilities and detailed designing of constructing diversion channels at Putih River

3.2.1.3. Main Changes from the Plan <Mt. Merapi/Progo River Basin Component>

3.2.1.3.1. Cancellation of Sand Mining Management Institution (SMMI) Establishment

It had been planned to establish SMMI which was supposed to be in charge of total maintenance of the project facilities. However, the change of the Indonesian government policy toward decentralization commenced in 1999 assigned Serayu-Opak River Basin Management Organization (Balai Besar Wilayah Sungai Serayu Opak, hereinafter referred to as BBWS-SO)

and sabo communities⁴ for facility maintenance and management, which consequently put more attention to community development instead of establishing SMMI. As the establishment of SMMI was obstructed, although all the planned preparation works had been completed for the establishment, BBWS-SO intended to internally organize the Public Service Board (BLU: Badan Layanan Umum) . Chronologically, after submitting application to organize BLU to the Ministry of Finance, BBWS-SO sent a notice to JICA that they would organize BLU which has the same function as SMMI and assign it to deal with sand mining management. In response to that proposal, JICA eventually agreed, after procuring additional information regarding preparation of the BLU establishment, to start detailed design of the office building construction subject to the realization of the creation of BLU in January 2010. However, the BLU has not been organized either up to the present time. Prevailing local opinion says that it is mainly due to the difficulty in coordinating various conflicting interests. In spite of that consequence, all the preparation works including public consultation meetings, provision of frameworks of SMMI and sabo communities based on the participatory rural appraisal, decision on operational rules and regulations and preparation of the sand mining management manual were all performed as planned.

3.2.1.3.2 Addition to the Original Scope

(1) Undertakings coping with the Bantul earthquake

Soon after the implementation has started, a great earthquake attacked the Bantul area and heavily damaged the local infrastructure facilities. Due to this unexpected disaster, the following most urgent works have been added to the original scope, and implemented.

- Rehabilitation of irrigation facilities at Bantul, Gunung Kidul, Kulon Progo and Jogjakarta City (35 locations)
- Rehabilitation of water source facilities at Sleman, Bantul, Kulon Progo and Jogjakarta City (20 locations)

(2) Measures against Mt. Merapi eruptions

① Eruption on June 3, 2006

The project took measures to cope with the volcanic disaster (additional package: DCME <Disaster Countermeasures for Mt. Merapi Eruption>) in which three units of sabo dams each were installed at the Gendol and Opak rivers by urgent works within three months.

⁴ Cleaning around sabo facilities, repair of minor physical damages and other light maintenance works which are within the people's capacity are conducted by the local community by themselves.

② Eruption in October- November, 2010 (100 year great eruption)

Sabo and other facilities which needed urgent rehabilitation reached 150 units (including irrigation: 42 units and water intake: 2 units). Though the physical construction works were mostly executed within the government budget, detailed designing for 16 facilities' rehabilitation/construction were implemented under this project. Detailed designing of both the water course repair of the Putih River and the construction of the sand pocket now under implementation in the succeeding "Urgent Disaster Reduction Project for Mount Merapi 2" was also made in this project. In addition, additional heavy equipment was procured for this massive eruption in 2010 utilizing unused loan balance of this project. The following are the added works.

(a) Study of damaged facilities and detailed designing of sabo dam rehabilitation (consulting services)

(cf. Section 3.2.1.2 above for detailed contents)

(b) Additional procurement of heavy equipment

- Vibratory roller compactor for embankment: 1 unit
- Mobile water tank truck for transporting potable water: 1 unit
- Pickup truck with double cabin for urgent works: 6 units

③ Capacity building of local governments

Capacity building on participatory development and others were provided to local governments including provincial water resource offices.

Implementation of volcanic disaster recovery and prevention projects requires flexible measures taking such steps as the occasion demands according to the progress of the affairs and occurrence of additional calamity. Added works in the expanded scope were judged appropriate to flexibly tackle disaster attacks during the project implementation which were not foreseeable at the time of project planning.

<Mt. Bawakaraeng>

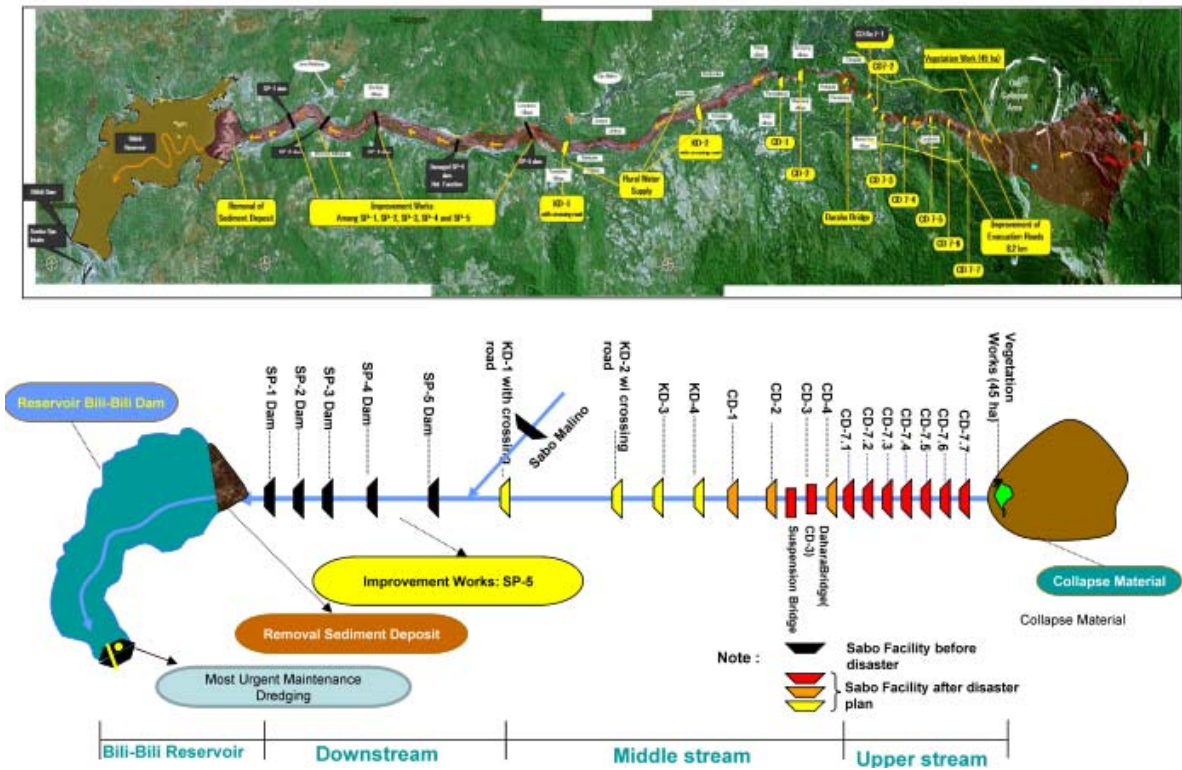


Figure 2: Overhead View of the Mt. Bawakaraeng Component

Source: Materials provided by the Executing Agency

Note: Sabo facilities in red, orange and yellow colors are those developed under this project.

3.2.1.4 Main Works of the Mt. Bawakaraeng Component

The scope of this component also consists of large variety of different works which can be categorized into three groups; namely, (a) countermeasures against debris flow, (b) development of region and community and (c) excavation/dredging. The actual outputs and the main difference from the plan are shown below⁵.

⁵ The non-eligible items consisting of cost of land acquisition, project general administration and tax are borne by the government. A part of the physical contingency was also included in the government portion at the time of appraisal (estimated at 1.8%), but in actual implementation, entire amount out of the non-eligible portion above has been spent from the ODA loan portion.

Table 3: Main Contents of Actual Outputs <Mt. Bawakaraeng>

Items		Main Outputs
(a) Countermeasure against debris flow	Structural Countermeasures	(Construction of Sabo Facilities Upstream) <ul style="list-style-type: none"> ● Sabo dam (7 units) ● Check dam (4 units including one bridge-cum-dam Daraha Bridge>) (Construction of Sabo Facilities in Midstream) <ul style="list-style-type: none"> ● Consolidation Dam (4 units including 2 river crossing structures)
	Non-structural Countermeasures	<ul style="list-style-type: none"> ● Installation of debris flow monitoring, forecasting & early warning systems (Rainfall observation station: 3 <including one that functions also as a Repeater station>, Water level observation station: 1, Debris flow vibration censor: 2, Master Station: 1) ● Improvement of Bili-Bili Dam telemetry system ● Evacuation roads ● Improvement of evacuation system ● Promotion of people's awareness of disaster prevention <div style="text-align: right;">} Note</div>
(b) Development of region and community		<ul style="list-style-type: none"> ● Village roads (15.6 km) ● Suspension bridge (1 unit) ● Village water supply system (1,000 households) ● Vegetation on debris mass at collapsed caldera (45 ha)
(c) Excavation/Dredging	Excavation of Reservoir end, River course/Riverbed	Total excavation volume (6.9 million m ³)
	Dredging to maintain function of Bili-Bili water intake	<ul style="list-style-type: none"> ● Procurement/production of dredge ● Installation of pipeline ● Construction of sedimentation pond ● Trial dredging

Source: Prepared by the external evaluator based on materials provided by JICA and questionnaire answers by the Executing Agency

Note: For improving awareness of people for disaster prevention and drills, the project implemented participatory community activities, distribution of such warning goods as gongs, sirens and installation of monitoring hut. However, being compared with the case of Mt. Merapi where local residents are permanently threatened by intermittent volcanic eruption, depth and density of the activities seemed to be relatively lower.

3.2.1.5 Consulting Services for Mt. Bawakaraeng Component

Following consulting services were provided for project implementation assistance and others.

1. Project implementation assistance (detailed design, tender assistance, implementation supervision, operation & maintenance assistance).
2. Promotion of people's awareness of disaster prevention by assisting sabo community operation, establishment of evacuation system.
3. Promotion of regional and community development

As pointed out earlier at the Section 2.3 Constraints during the Evaluation Study, respective project implementation management of both the Mt. Merapi/Progo River Basin and Mt. Bawakaraeng components were independently conducted by each BBWS, but they were not comprehensively managed by the Directorate General of Water Resources as Executing Agency. Especially, in case of the Mt. Bawakaraeng component whose consulting services were provided by two different consulting firms separately, no integrated record of total Man-Months was available, therefore it is unknown how many man-months have been actually devoted against the planned total man-months of 1,227 MM (International: 179 MM, Local: 1,048 MM). However it is known that additionally 143.5 MM for the feasibility study on countermeasures for Bili-Bili Dam sedimentation, and 30MM for the implementation supervision of the dredging were consumed for this component.

This component also consists of variety of works and each item is subject to minor changes in implementation volume according to the changes in conditions during the implementation, however, basically no significant modification was made from the plan except the followings.

3.2.1.6 Main Changes from the Plan <Mt. Bawakaraeng Component>

3.2.1.6.1 Countermeasure against Debris Flow

- (1) Addition of dredging works at the Bili-Bili Reservoir edge and nearby riverbed excavation replacing the construction of the sand pocket dams No.4 and 5 which had been transferred to the JICA grant aid scheme.
- (2) Addition of four consolidation dams
- (3) Urgent dredging at the Bili-Bili Reservoir near the water intake

3.2.1.6.2 Development of Region and Community

- (1) Construction of municipal water intake and water treatment facilities
- (2) Rehabilitation of existing access roads
- (3) Construction of primary school building at Sepakat

Fine debris naturally flows into the Bili-Bili Reservoir because the complete blocking by the sabo facilities is not possible, additionally it is not taken either in business sand mining. Therefore, continuous dredging at the both sites became necessary to maintain the dam functions: at the reservoir edge for flood control, and near the water intake for smooth water intake. Unused project fund saved by minimized riverbed excavation due to the local residents' appeal not to affect the irrigation intake was transferred to the necessitated reservoir edge dredging. The construction of consolidation dams were added based on the necessity identified in the new facility design reviewed in the project. The main objectives of this component are prevention of the debris inflow into the Bili-Bili Dam and regional socio-economic development for the local residents at the Jeneberang river basin. Regional infrastructure development was added for the latter purpose.



Dredging Works near the Water Intake of Bili-Bili Dam

3.2.2 Project Inputs

3.2.2.1 Project Cost

The total project cost was initially planned to be 19,337 million yen (out of which 16,436 million yen was to be covered by Japanese ODA loan, loan ratio 85%). Actually disbursed amount of the ODA loan was 16,385 million yen, but the actual amount of the total project cost is unknown because the accounting record of project expenditures from the Indonesian government side is incomplete. The comparative breakdown of the loan portion is as follows.

Table 4: Plan-Actual Project Cost Comparison of ODA Loan Portion

(Unit: million yen)

	Plan	Actual	Difference Actual - Plan
	Project Cost under ODA Loan	Loan Disbursed	
Mt. Merapi/Progo River Basin Component	6,050	6,174	124
Civil Works	4,099	4,313	214
Equipment Procurement	633	429	-204
Consulting Services	1,318	1,432	114
Mt. Bawakaraeng Component	10,386	10,211	-175
Civil Works	8,363	8,494	131
Consulting Services	2,023	1,717	-306
Total	16,436	16,385	51

Source: materials provided by JICA and questionnaire answers by the Executing Agency

<Mt. Merapi/Progo River Basin>

Although there needed additional works due to the occurrence of the Bantul earthquake and two-time volcanic eruptions of Mt. Merapi, additional construction, procurement and increased MM input of consulting services (studies, design works), the rate of cost increase was slight, and , the actual cost of equipment procurement turned out to be less than the plan. The main reasons are supposed to be the following two factors.

- (1) Because the planned establishment of SMMI was not realized as discussed earlier, such physical costs as building construction with relating facilities and access roads became disused.
- (2) The value of rupiah against Japanese Yen (JPY) at the time of appraisal, JPY1=Rp.83, remarkably depreciated during the project implementation down to JPY1=Rp.116 at project completion and it consequently reduced yen-converted rupiah expenditures drastically against the plan.

<Mt. Bawakaraeng>

The slightly lower amount of the actual project cost than planned in spite of the addition of the work scope is mainly due to the depreciation of the rupiah rate against yen during the project implementation.

Overall, the total project expenditure of the ODA loan portion reached 99.7% of the planned (loan approved amount). As discussed in Section 3.1.2 Relevance to the Development Needs of Indonesia, the disaster prevention needs of the project areas are constantly high, and succeeding projects are under implementation (Merapi) or in preparation (Bawakaraeng). Almost maximum use of the loan approved amount has been made successively checking current unused balance from time to time and applying it to add necessary works.

From what has been discussed above, it can be concluded, although the actual project cost in total is unknown⁶, the ODA cost portion is lower than planned. Incidentally, this project consists of two separate sub-projects being respectively comprised of a large number of components. They are subject to minor modification in implementation volume to fit individual requirement. Therefore it is difficult to consider the modified volume in the judgement of project cost.

3.2.2.2 Project Period

<Mt. Merapi/Progo River Basin>

The overall project period was planned from March 2005 to December 2011 (82 months). The actual period was from March 2005 up to October 2013 (104 months), which is 127% of the plan. The major reasons of the delay are the following. However, factors (2) and (3) below caused by convulsions of nature were not counted in the actual implementation period. All the works under the Mt. Merapi/Progo River Basin Component have been completed within the planned period until November 2013⁷.

(1) Selection of consultant

A procedure for consultant selection was supposed to be started before signing of LA in the plan. However it did not take place as planned. In addition, the preparation period was prolonged due to the protracted organization of the selection committee, coordination between the internal public procurement regulations and the JICA consultant employment guideline, Pre-Qualification (PO) for preparing the short list and so on. (commencement of selection: 16 months delay, completion of selection procedures: 6 months delay)

(2) Implementation of consulting services

Due to the following reasons, the period of consulting services was prolonged 31 months against the plan.

⁶ As reminded in the preceding footnotes 3 and 5, what has been actually expended from the government budget is only the non-eligible portion consisting of land acquisition, general project administration and tax, all of the main works and consulting services were financed from the ODA loan.

⁷ The completion of the implementation is defined as the time of facilities' handover, including the warranty period, to the Executing Agency.

- Remarkable changes required in the detailed designing, procurement plan and construction supervision works due to the earthquake and eruption in 2006 before the service commencement.
- Addition of investigation, evaluation and detailed designing for rehabilitation of the stricken sabo facilities and detailed designing for the rehabilitation of diversion channel of Putih River due to the 2010 violent eruption.
- Additions of procurement supervision of heavy equipment urgently needed.

(3) Implementation of construction

Construction period was prolonged for 26 months due to the addition of four contract packages to the original scope caused by the Batul earthquake and Mt. Merapi eruptions during the project implementation.

<Mt. Bawakaraeng>

The overall project period was planned from March 2005 to November 2013 (105 months). The actual period was from March 2005 up to June 2014 (112 months), which is 107% of the plan. However, urgent undertaking of countermeasures having been required against the giant collapse occurred on March 26, 2004, this component basically took speedy actions as follows.

- Project preparation and succeeding decision making to provide ODA loan were conducted in quite a speedy manner, and formulated in such a way to be incorporated into the forerunning Mt. Merapi/Progo River Basin Project which had already been designed.
- Removal of debris by dredging at Jeneberang River, construction of one sabo dam and consulting services that were most urgent were implemented in 2005 and 2006 ahead of the schedule at the time of appraisal, which produced earlier effect than expected.

Seven-month delay in project completion is mainly due to the constant dredging works near the water intake of Bili-Bili Reservoir among the additional works having become necessitated during the project implementation against the debris flow listed in the previous Section 3.2.1.6.1 Countermeasure against debris flow. All other work components were completed no later than November 2013 which was the planned time of completion.

From the results above, although the project cost was within the plan, the project period exceeded the plan. Therefore, efficiency of the project is fair⁸.

⁸ In rating efficiency, individual sub-rating of both the Mt. Mearapi & Progo River Basin and Mt. Bawakaraeng components was made respectively on project cost and period first, then combined them evenly weighing the sub-rating results.

3.3 Effectiveness⁹ (Rating: ③)

3.3.1 Quantitative Effects (Operation and Effect Indicators)

<Mt. Merapi/Progo River Basin>

At the time of appraisal, an operation and effect indicator, “Sediment Control Ratio” was set for two different cases; namely, Case 1: sediment control by sabo facilities and Case 2: sediment control by sabo facilities and sand mining management. Against the baseline at 26% (Case 1, 2004), the targets at two years after the planned facilities completion (2012) were set at 50% for Case 1 and 75% for Case 2. However, it turned out inappropriate for the effect measurement to use this indicator because of the following three occurrences.

1. As stated in Section 3.2.1.3.1 regarding “output,” the planned establishment of the Sand Mining Management Institution (SMMI) was not realized, so Case 2 became inapplicable.
2. In 2010 during the project implementation, the greatest eruption on record since 1872 occurred. It discharged volcanic ejecta of 140 million m³, twenty eight times the volume of 5 million m³ targeted to be tackled as the pyroclastic outflow under the probability of once in 10 years in the “Masterplan for Land Erosion and Volcanic Debris Control in the Area of Mt. Merapi” revised in 2001. Seventy seven units of sabo facility were damaged out of the total 250 structures. Urgent rehabilitation of the damaged facilities was added in this project implementation. The fact that the extremely larger scale in the disaster-stricken area compared to previous cases (cf. Table 5 below) occurred in the past indicates its unprecedented magnitude. The occurrence of such critical cases (violent eruption once in 100 years and consequent destruction of sabo facilities) was unexpected in the indicator setting at the appraisal, accordingly the premise of the estimation became inapplicable, which made the calculation of actual Sediment Control Ratio that can be reasonably comparable with the estimated figure difficult.
3. Since the sabo facilities had been developed by the government budget as well as under the 1st and 2nd Japan’s ODA loans (this project is regarded as the 3rd phase), it is difficult to measure the separate effect of the facilities developed under this project.

In light of the above, effects of a series of sabo facilities including ones under this project are estimated based on a review of the past records of eruption damages of Mt. Merapi and official views by the Indonesian Government about the 2010 great eruption.

⁹ Sub-rating for Effectiveness is to be put with consideration of Impact.

Table 5: Historical Record of Eruption Damages of Mt. Merapi

Year of Eruption	Toll of Dead and Missing (people)	Damaged Houses (houses)	Devastated Area (ha)
1930	1,869	1,109	
1954	64	144	
1961	6	103	
1969	6	322	125
1971			10
1973 (January)			10
(October)			19
1974 (January)		9	
(October)	9	6	
(November)		10	
(December)		4	
1975		107	30
1976	27	385	
1986	1		
1994	66	40	295
2001			1,200
2006	2		3,230
2010	341	3,722	31,470

Source: Ex-post Evaluation Report “Mt.Merapi and Mt.Semeru Volcanic Disaster Countermeasures (2)” and questionnaire answers by the Executing Agency

Compared to the indicators of the devastated area and the number of damaged houses which are proportional to the magnitude of eruption, the toll of dead and missing can be an indicator to better reflect the effectiveness of sabo facilities for disaster prevention. Against the 1872 eruption that took more than 1,400 toll of dead and missing and 1,869 people in the 1930 eruption whose volume of ejecta is considered smaller compared to the 2010 eruption¹⁰, the victims of 341 people are considerably fewer in the circumstances with the increased local population. It can indicate that the effect of sabo facilities is considerable (Sabo facilities under this project were constructed in the contract packages No. 2 and 3 in which the former was completed in July 2008. The latter was under construction during the 2010 eruption and the construction was temporarily suspended, but eventually completed in November 2012. Mr. Subandrio BPPTK also expressed his view that evacuation activities have proved effectual (Source: *ibid.*)¹¹.

¹⁰ According to the statement of Mr. Subandrio, head of Yogyakarta Volcanic Technology Development and Research Center (BPPTK) <November 6, 2010, Jakarta Shimbun>

¹¹ Refer to Section 3.4.1 Intended Impacts (Mt. Merapi: Effect on disaster management) for disaster prevention activities including evacuation drills.

<Mt. Bawakaraeng>

Actual figures of the operation and effect indicators specified in the material provided by JICA directly related to appraisal are as follows.

Table 6: Comparison by Operation & Effect Indicators (1) (Mt. Bawakaraeng)

Indicators	Baseline (2004)	Target (2013) (one year after sabo facilities completion)	Actual 2013
Stabilized Volume in the Constructed Sabo Dams (thousand m ³)	0	22,500	33,500
Excavated Volume of Debris from Sand Pockets *1*2 (thousand m ³)	0	15,000	15,800 (8,900)*
Secured Inflow for the Irrigation, Hydro-power Generation and Water-supply (thousand m ³)	0	14,200	No record

Source: Questionnaire answers

*1: This volume is mainly that of the removed debris deposit at the river portion not including that dredged at Bili-Bili Reservoir, and the target is the total volume to be removed not by this project only. (cf. *2 below)

*2: Although the dredging at the river portion was not executed as planned because of the residents' appeal not to affect the irrigation water intake through riverbed degradation to be caused by the excavation as well as high cost of dredging contracts, the same result was brought by excavation of private sand mining businesses. The targeted 15,000 thousand m³ is the appropriate volume of removal for which 8,900 m³ was achieved by spontaneous business sand mining. So the residual amount of 6,900 m³ was excavated under this project.

*3: The completion of the Mt. Bawakaraeng component was delayed till October 2013 due to the added scope of dredging works near the water intake of Bili-Bili Dam. However, the sabo facilities themselves have been entirely completed by 2012.

Other materials provided by JICA assign the following other effect indicators, and their actual achievements are shown below.

Table 7: Comparison by Operation & Effect Indicators (2) (Mt. Bawakaraeng)

Indicators	Baseline (2004)	Actual Achievement (2009)	Actual Achievement (2013)
Damage of Farmland by Sedimentation in 5 Years (ha)	4,500	2,500	0
Sediment Inflow into Bili-Bili Dam in 5 Years (thousand m ³) *	54,300	15,800	87,100

Source: Questionnaire answers

*: The figure of 2004 is the annual sediment inflow at the time of the landslide, while the 2009 figure is the actual total volume of inflow during five years after the landslide.

If the same volume of inflow as the note * has lasted annually, the estimated cumulative inflow would be 82,740 thousand m³ (54,300 + 15,800 x 9/5). Although the targeted volume of sediment flow itself is fluid affected by rainfall and other natural phenomena, actual result (cumulative volume up to 2013) a little bit exceeded the target. This is due to the considerable sediment flowed temporarily into Bili-Bili Dam through the sand pocket No.1 damaged (restored in 2012) by illegal sand mining. However, the excess rate is only 5% (87,100—82,740)/82,740) showing that the target has been almost achieved, and therefore that the sabo facilities of this project demonstrate their expected effect in principle.

Besides, although quantitative record to directly show secured inflow for the irrigation, hydro-power generation and water-supply is not available as indicated above, the management record of Bili-Bili Dam shows that its actual volume of water discharge from the reservoir to irrigation, hydro-power generation and water-supply in the latest year 2016 was 22.6 m³ per second, which is more than 33% higher than the planned volume of 16.9 m³ per second. It indirectly indicates that conservation of water capacity is being carried out enough to maintain the dam function to reach each service supply by the sabo facilities and sediment dredging. Thus, although the quantitative effects on conserved water capacity for irrigation, hydropower generation and water-supply are unknown, the targets of other indicators have been achieved. Therefore it is judged that the effect of this project is demonstrated.

3.3.2 Qualitative Effects

<Mt. Merapi/Progo River Basin>

(1) Protection of human lives, public and private property and establishment of sustainable disaster protection system

① Structural aspect

The damage mitigation effect of the sabo facilities during the large scale eruption in 2010 is recognized in various literatures. Only four out of fifteen rivers suffered from the debris flow caused by this eruption. Even in Putih River where the greatest damage occurred and occurrence of debris flow reached for eleven days, the sabo facilities arrested the flow until flood of the debris flowed over the sabo facilities more than a month later, which contributed to secure time for evacuation and



Arrested Debris Flow by Sabo Dam at Krasak River
(Source: Material provided by Executing Agency)

emergency measures¹². However, since the demonstrated effect has been achieved by a series of sabo facilities including ones developed under preceding ODA loan projects as well as by the government budget as a whole, it is difficult to measure individual contribution of this project separately from the others. Additionally, the temporary evacuation shelter constructed in this project played a remarkable role attracting special attention as the project's unique effect.



Evacuees in the Shelter Installed in this Project

(Source: Material provided by Executing Agency)

② Nonstructural aspect

Along with the preparation of manuals for disaster management and facility maintenance, participatory community-based activities of awareness-raising and drills were conducted. The activities were conducted with attention on disaster weak groups incorporating contents particularly targeting the elderly, children and women¹³. In addition to that, pilot activities for disaster prevention management were implemented in village-based communities in three villages among which one of them is still

continuing. Other two villages were stricken by pyroclastic and debris flow in the 2010 eruption. One had moved to another region and the other had stopped the activities. According to BBWS-SO, however, it is likely to be revived recently.

(2) Sand mining management

It has been already stated in the section of “outputs” that establishment of a system of comprehensive sand mining management (licensing, charge collection, activity supervision, etc.) by organizing the Sand Mining Management Institution (SMMI) had been planned, but failed only completing the preparation activities which include preparation of detailed sand mining management manuals and training. The function that was supposed to be taken on by SMMI became the responsibility of the Kabupaten (District) governments. The fact is, however, it has not led to material results in practice. Community-based sand mining management as piloted in the three villages above partly continues after the project completion, it has not been widely diffused throughout the region either. The voice of people who answered in the beneficiary survey also mentions its unsatisfactory performance in sand mining management in the field. In regards to this, the Kompas, a national newspaper, ran an article on July 13, 2017

¹² Mizoguchi Msaharu, Fukushima Junichi, Shimoda Yoshifumi, 2014. *The Disaster Damage of the 2010 Eruption of Mt. Merapi and Effect of Sabo Facilities*: Treatise presented at the “Japan Society of Erosion Control Engineering”)

¹³ cf. the photographs of disaster prevention drills and education on page 30.

on a warning of the governor Prawono of Central Java Province that urged immediate termination of illegal unlicensed sand mining and removal to permitted areas, because that had been damaging the sabo facilities developed by JICA assistance. However, residents' voice to expect its effect has not been heard much.

3. Regional development at region on the foot of Mt. Merapi

This project performed rehabilitation of irrigation and sabo facilities' multiuse development (bridge, road and water intake), and the effect of both on regional economic development is considerable (cf. Sections on impacts below).

<Mt. Bawakaraeng>

(1) Protection of human lives and public and private property

In addition to the strengthened measures against future possible collapse disaster by implementing disaster management activities at Lengkesa Village, the disaster victim of the giant collapse of the caldera wall in 2004, and at regions nearby, the following project effects were identified individually.

- Disaster prevention effect at the flood-prone area which had been often stricken by river backflow previously in the rainy season (Salo Malino area) by constructing training dykes <contribution to the no "damage on farmland," an indicator on Table 7 above>
- Effect on preventing river bank collapse by construction of a consolidation dam and slope protection works downstream

(2) Maintenance of sustained dam function of Bili-Bili Dam controlling sediment inflow into the reservoir

The following are the results of the field studies to respective operation bodies of water supply, hydraulic power generation and irrigation which depend on the Bili-Bili Reservoir as their water source.

① Water supply

Functional disorder brought by the sedimentation inflow is on both "quantity of water intake" and "water quality," but it is not seriously affecting both of the aspects maintaining smooth operation being protected by the controlled sediment inflow by the sabo facilities as well as the constant dredging works near the water intake meeting 60% of the total water supply demand of Makassar City without a hitch. The raw water from the reservoir which used to be transparent before the collapse has become muddy, but the quality of the processed clean water is maintained due to the effort of strengthened purification and a close water quality monitoring by the water supply institution; Penjernih Air V Somba Opu Water Treatment Plant.



Sedimentation Basin:
Raw water is on this side



Water Quality Monitoring:
From raw water front side to clean water inner side

② Hydraulic power generation

As the power station commenced in 2005 after the giant collapse, the operational condition cannot be compared with that before the incident. Adverse influence of the sediment inflow into the reservoir on the power plant function can be on both quantity and quality aspects of water, same as the water supply. There is no particular problem in the quantity aspect, while, in the aspect of the water quality, there are some cases to cause damages on the blades of turbines and some worries to affect the cooling system by the sediment inclusion. However, they can be dealt with and preventable by the station's routine operation and maintenance works. This hydraulic power plant is constructed under the Japanese ODA loan, and additional spare generators had been planned and installed to address this raw water pollution problem as well as equipped a cyclone separator as a part of the cooling system to remove underwater soil sedimentation. These self-efforts by the station have also contributed to the coping with this problem.

③ Irrigation

Reduction in the amount of water reserved in the dam due to the sedimentation does not directly affect the irrigation water supply. It is said that the volume of water intake is influenced by the water use of the power station. As water intake channel exclusively for irrigation is also available in case of need. Different from the water supply, the problem of water quality is not so influential for its operation.

(3) Establishment of sustainable disaster management system

The "countermeasure against sediment outflow" of the project includes improvement of the evacuation system and raising people's awareness of disaster prevention, and they have been implemented. However, according to the impression on the discussions with the Executing Agency and the interviews with the local residents, the activities being implemented seemed not as deep and extensive as the ones being carried out in the Mt. Merapi region where people are

faced with almost permanent threat of eruption damage and potentially having higher consciousness for disaster prevention. Incidentally, this region is as one of its model districts of the JICA's technical assistance project "Integrated Sediment-related Disaster Management (ISDM)", and receiving comprehensive technical assistance in nonstructural aspect.

3.4 Impacts

3.4.1 Intended Impacts

Impacts of this project are mainly evaluated by means of beneficiary surveys.

(Method of Beneficiary Survey)

Since the expected impacts of this project extends over a wide range including disaster prevention by sabo and other facilities as well as preventive activities, economic activation by regional infrastructure development (roads, bridges, water resource supply facilities, vegetation), each of which has different beneficiaries. Therefore, the survey was carried out by means of focused group discussions (FGD) and direct interviews visiting households in combination at respective benefited districts. Due to the difficulty to specify each statistical population for respective project facilities of various kinds and absence of reliable residents register, random sampling was not applicable, and judgement sampling was applied instead eliminating the bias in terms of gender, age and region as much as possible.

(Benefited Areas Surveyed by Facilities Developed)

- (1) Disaster Prevention (Sabo) Facilities
- (2) Roads, Bridges
- (3) Water Resource (Supply) Facilities
- (4) Irrigation Facilities

(Number of People Interviewed) <including both FGD and visiting interviews>

Mt. Merapi: 100 people (two villages) (Proportion of the respondents <Age: 20-30s (20%), 40-50s (80%) Gender: Male (59%), Female (41%)>)

Mt. Bawakaraeng: 125 people (three villages), (Proportion of the respondents <Age: 20-30s (17%), 40-50s and over (83%) Gender: Male (59%), Female (41%)>)¹⁴

Incidentally, the project carried out a survey on people's awareness (entrusted to Gajamada University) by Participatory Rural Appraisal (PRA) in 20 villages located at the hillslope of Mt. Merapi (hereinafter referred to as 20-village PRA) in 2008 separately from this beneficiary survey.

¹⁴ As the proportions of the participants in terms of age and gender were not recorded, the figures show only the percentages of the direct interviewees.

<Mt. Merapi/Progo River Basin>

(1) Disaster prevention (Sabo) facilities, equipment and disaster prevention drills

① Disaster prevention effect

People’s reliance on sabo facilities is high. According to the interview survey on disaster prevention facilities conducted in two villages, Kaliulang and Kepuharjo, almost all the residents answered that fear against eruption has reduced as shown in the survey results below. The disaster management training and drills have increased knowledge on eruption damages, countermeasures and consequently the sense of security. The disaster prevention activities conducted under this project has also rooted in the local community by continuous supports by the local governments (BBWS, Kabupaten, etc.). However it did not seem to be performed in the form of the “Sabo Community.”



Disaster Prevention Drill introducing Sabo Dance



Disaster Prevention Education (Sabo Facilities) at Kindergarten



Field Evacuation Drill for Local Residents

Source: Materials provided by Executing Agency

(Main questions¹⁵: Damages experienced at eruptions, Measures taken by this project and their respective effects, Sense of security against disasters after the measures, Intention to move)

(Answers of respondents: Effect of sabo facilities against disaster damage: Very effective <65%>, Effective <25%>, Sense of security: Sense of security increased, so absolutely no intention to move < 75%>, A little bit anxious to remain here, but no intention to move <25%>, Sense of usefulness: Evacuation road <90%>, Evacuation shelter <85%>)¹⁶

¹⁵ Main questions are omitted from the Mt. Bawakaraeng section, as the questions for each point are common with Mt. Merapi.

¹⁶ The “20-Village PRA” result also showed that 67% of the villagers wanted to remain at current residence and wished to have further knowledge about disaster prevention.

② Income generation effect

Sedimented sand and gravel arrested by sabo facilities are valuable as the materials for building construction and as sources of income (sales, wage earning by mining works) for local people.

However, such an attractive income effect has been on the other side of the coin, which is the improper sand mining management by Kabupaten governments to curb illegal activities. There is thus a dilemma among the locals between the advantage as the income source and the damage on the sabo facilities*.

*: If riverbeds near sabo facilities have been mined, even a small scale freshet can scour the facility basement that may cause damage on the facilities and collapse in extreme cases.

(Main questions: Relationship between sand mining at sabo facilities and family income, Recognition of adverse influence of illegal sand mining upon sabo facilities, Behavior when observing illegal sand mining)

(Answers of respondents: Family income has increased through sand mining works created by installation of sabo facilities <85%>, Already recognize adverse influence of illegal mining on sabo facilities and surrounding environment <99%>, Warn and advise to stop illegal acts and report to the authorities <61%>, Warn them only <23%>), Leave them because in vain <16%>)¹⁷

(2) Access roads, bridges

Varied and considerable regional economic and social development effects were observed in access roads as a part of the sabo facilities and the sabo facilities functioning as a crossing bridge over the river.

(Main questions: Whether sabo facilities functioning as a crossing bridge are effective for daily life and economic activities, Case examples when they are useful)

(Answers of respondents: Highly useful <100%>, Useful for attending school, clinics, daily life activities <all 100%>) Additionally, tourism business has been created for incoming people from outside¹⁸.

(3) Irrigation, water resource facilities

The project implemented rehabilitation of water resource including irrigation facilities damaged by the earthquake and eruption occurred during the project implementation. They have

¹⁷ The result of the “20-Village PRA” also indicates that sand mining constitutes an additional income source, and on the other hand, locals recognize adverse effect of uncontrolled sand mining as a damage risk on sabo facilities and surrounding environment and desire establishment of a control system by governments and community.

¹⁸ The result of the “20-Village PRA” also shows that the development of the multi-use infrastructures like sabo dams that concurrently function as roads is contributing to the regional economic activation.

impacted on family health and children education brought by income increase effect through agricultural production increase (including aquaculture).

(Main questions: Kinds of facilities rehabilitated and concrete positive effect induced from the rehabilitation.)

(Answers from respondents: Positive effect on children education and family health through income increase in irrigated agriculture <100%>)

Thus, disaster prevention effect of constructed sabo facilities under the Mt. Merapi component has been confirmed, and the arrested sediment at sabo facilities led to a creation of sand mining businesses which also have brought impacts of creation of income sources. However, considering the current situation where establishment of the planned sand mining management institution had been frustrated and the management of the Kabupaten government is not conducted optimally, occurrence of damages by illegal mining is a matter of concern. On the other hand, it was confirmed that the positive impact of the rehabilitation of irrigation and water resource facilities implemented along the construction of sabo facilities is remarkable on regional economic activation and improvement of regional social life.

<Mt. Bawakaraeng>

Since the project effects and impacts of the Mt. Bawakaraeng component grasped by the beneficiary survey are mostly common to the Mt. Merapi component, only characteristic points are presented below.

(1) Disaster prevention (sabo) facilities, equipment, disaster prevention drills

① Effects on disaster prevention

Different from the Mt. Merapi where its wide area is exposed to danger of intermittent volcanic eruptions, the disaster of Mt. Bawakaraeng was caused by a collapse of the caldera wall in March 2004 whose stricken area is restricted within a region around Lengkesa Village at the mountain foot where 33 lives were claimed. According to the survey result in Lengkesa Village, reliability to sabo facilities was also high. Village people who used to be too sensitive from fear even against sounds of wind and thunder increased their sense of security after the completion of the sabo facilities. It was proved by the fact that no respondents replied that they wanted to move to other location from anxiety against disaster. Further, the effect of disaster prevention education and drills are rooted (“Sabo Communities” have been established), and people’s awareness of disaster management is high being equipped with alarming tools (siren, gong radio, etc.). However, some of the respondents expressed their concern whether this consciousness can be succeeded long after the disaster to the next generation who did not experience the disaster.

(Answers of respondents: Sense of security increased, so absolutely no intention to move < 80%>, A little bit anxious to remain here, but no intention to move <20%>)

② Income generation effect

The income source generation effect by sand mining businesses is also prevailing, but the activities are not as active as in the Mt. Merapi area not leading to the big concern for damages on the sabo facilities. The vegetation on debris mass at the collapsed slope started under this project has not only brought collapse protection effect but also provided local population who lost previous income source due to the debris flow into their farmlands with extraordinary income opportunity from engagement in planting works. Further, the plants are contributing to the protection of local coffee trees.

2. Access roads, bridges

Roads improvement was performed in disaster-damaged Lengkesa Village. In addition to the bridge function prepared by the sabo facilities themselves, a new iron bridge was installed at Daraha area. Those transport infrastructures have been producing remarkable effect for regional economic activation as the Mt. Merapi component also did.



Daraha Bridge

(Answers of respondents: Highly useful <100%>, Improvement in attending school, clinics, daily life activities <100%>)

3. Irrigation, water resource facilities (water supply)

While there was rehabilitation of the facilities damaged by eruption and earthquake as components of the Mt. Merapi/Progo River Basin project, there was a component of newly constructing water supply facilities and irrigation water intake in the Mt. Bawakaraeng project. The impacts of those facilities on family health improvement and children education through increased income by agricultural production (including aquaculture) are significant. There are also answers from the respondents that opportunities have been created to earn supplementary income by peddling to markets utilizing saved hours being released from previous long distance water taking. Beneficiaries' answers for respective facilities developed are summarized as follows.

Irrigation: (Transition from single rice cropping to double-cropping with mung beans, transition from rice double-cropping to triple-cropping).
Water Supply System: (Previously, water had to be taken and brought from mountain with buckets. Children have been released from water taking (also at school) and river bathing, and have become able to concentrate on school learning



Simple Water-Supply System

<education effect>). Stomachache and itch previously caused by pruritus and other diseases have been alleviated <health effect>.

Summary: 100 % of respondents at every facility stated certain effects on children's education and family health including above mentioned statements. 70% of the respondents affirmed the income effect brought by the facilities.

3.4.2 Other Impacts

3.4.2.1 Impacts on the Natural Environment

<Mt. Merapi/Progo River Basin>

It was confirmed that this project carried no particular negative impacts on natural environment, rather brought on its preservation by preventing or alleviating environmental disruption. Environmental monitoring was carried out based on the environmental monitoring plan prepared in the Environmental Impact Assessment (AMDAL: Analisis Mengenai Dampak Lingkungan) during the project implementation, and the results were reported semiannually to the environmental department of the provincial government for which no particular problem had been raised. Various measures were attempted to alleviate environmental impacts including monitoring water flow into the intakes for irrigation and domestic water, measures to prevent inflow of muddy water and so forth. Monitoring of flora and fauna was also conducted to minimize destabilizing factor of the dredging. In the construction of the consolidation dams at the Progo River Basin, fish ways were installed to allow fish to ascend as well. The crest area of Mt. Merapi is a part of the national park, but the project area is not included, and the area does not fall under a habitat of rare species of wild animals.

<Mt. Bawakaraeng>

As with the case of Mt. Merapi, this component was confirmed to have carried no particular negative impacts either upon natural environment, bringing on its preservation preventing or alleviating environmental disruption. Environmental monitoring was executed based on the environmental monitoring plan prepared in AMDAL during the project implementation, and the results were reported semiannually to the environmental department of the provincial government for which no particular problem had been raised. For the dredging of riverbeds as well as at the Bili-Bili Reservoir, environmental impacts alleviation was attempted by dumping dredged sediment onto the stockyard prepared by the reservoir and growing plants on it. The project area is not located neither in a wilderness area nor a national park, and does not fall under a habitat of rare species of wild animals either.

3.4.2.2 Land Acquisition and Resettlement

<Mt. Merapi/Progo River Basin>

Total area of 254,000 m² was acquired with the total cost of 9,927 million rupiah. Acquisition of the land 150,000 m² planned to be used for the stockyard of the Sand Mining Management Institution (SMMI) became unnecessary because of its cancellation. According to the questionnaire answers, explanation of BBWS-SO and relating documents provided, the process was conducted based on the President Regulation No. 65, 2006 regarding land acquisition organizing land acquisition committee known as “Committee 9” led by the regional secretary (Sekretaris Daerah) with no particular problems during the course. Compensation was also made in accordance with related domestic regulations and the JBIC Guidelines for Confirmation of Environmental and Social Considerations (2002) without any significant problem. In accordance with the Water Resources Act (Law No.7, 2004) at the time, public consultation meetings were held several times at the detailed designing, before the commencement of construction works and other relevant occasions. No particular complaints or objections were manifested in the discussion and the constructions basically went smoothly without significant trouble. People’s requests expressed during the discussions were reflected in the designing and implementation if deemed necessary. No resettlement was executed.

<Mt. Bawakaraeng>

The planned land acquisition for the stockyard of dredged soil and sand turned out unnecessary because pieces of government-owned land could be used, instead, land acquisition and compensation for all the new sabo facility sites became necessary partly because of the change in river flow affected by debris from the land slide of caldera wall. That also went for the access roads construction. The record on total area of acquisition and its cost was not available. According to the questionnaire answers, explanation of BBWS-PJ and relating documents provided, all the procedures were processed following the regulation above with no particular problem. Compensation was also conducted in accordance with related domestic regulations and the JBIC Guidelines for Confirmation of Environmental and Social Considerations (2002) without any significant problem. The public consultation meetings were also held in the same way as the Mt. Merapi practice. Particular complaints or objections were not expressed either, and the construction works proceeded without any significant trouble also reflecting people’s requests in the designing and implementation as needed. No resettlement was executed.

3.4.3 Summary of Effects and Impacts

<Mt. Merapi/Progo River Basin>

Under the condition of the violent eruption occurred during the project implementation in 2010 with twenty eight times the volume of pyroclastic outflow assumed in the project plan and resultant damages on many sabo facilities including ones constructed under this project, the performance using “Sediment Control Ratio,” the quantitative indicator introduced at the appraisal, cannot be quantitatively measured properly. Alternative data such as statistics on past records of eruption damages and the result of academic studies does not show a strict quantitative effect. However, the beneficiary survey result directly indicates that the effect of disaster prevention is high. On the other hand, the beneficiary survey confirmed project’s satisfactory effects and impacts of such infrastructures as access roads, sabo facilities which also function as bridges as well developed under this project, rehabilitated irrigation and water resource upon economic and social activation of the region. Therefore, effectiveness and impact of this component is judged high.

<Mt. Bawakaraeng>

Although no performance record is available on “Secured water for the irrigation, hydro-power generation and water supply” which is one of the three operation and effect indicators set at the appraisal, it was confirmed that the water for respective operation in terms of quantity and quality has been maintained according to the results of direct field surveys to the three operating institutions. Quantitative targets of such other indicators taken at appraisal as “Stabilized Volume in the Constructed Sabo Dams” and “Excavated Volume of Debris from Sand Pockets” have been achieved. Among the supplemental two indicators, “Damage of Farmland by Sedimentation in 5 Years” was completely and “Sediment Inflow into the Bili-Bili Dam in 5 Years” was mostly achieved. Further, it was confirmed that the effects and impacts of access roads, bridges and water supply facilities developed in this project on economic and social activation of the region were satisfactory. Therefore, effectiveness and impact of this component is judged high.

From the results above, this project has largely achieved its objectives. Therefore, effectiveness and impact of the project are high.

3.5 Sustainability (②)

3.5.1 Institutional Aspects of Operation and Maintenance

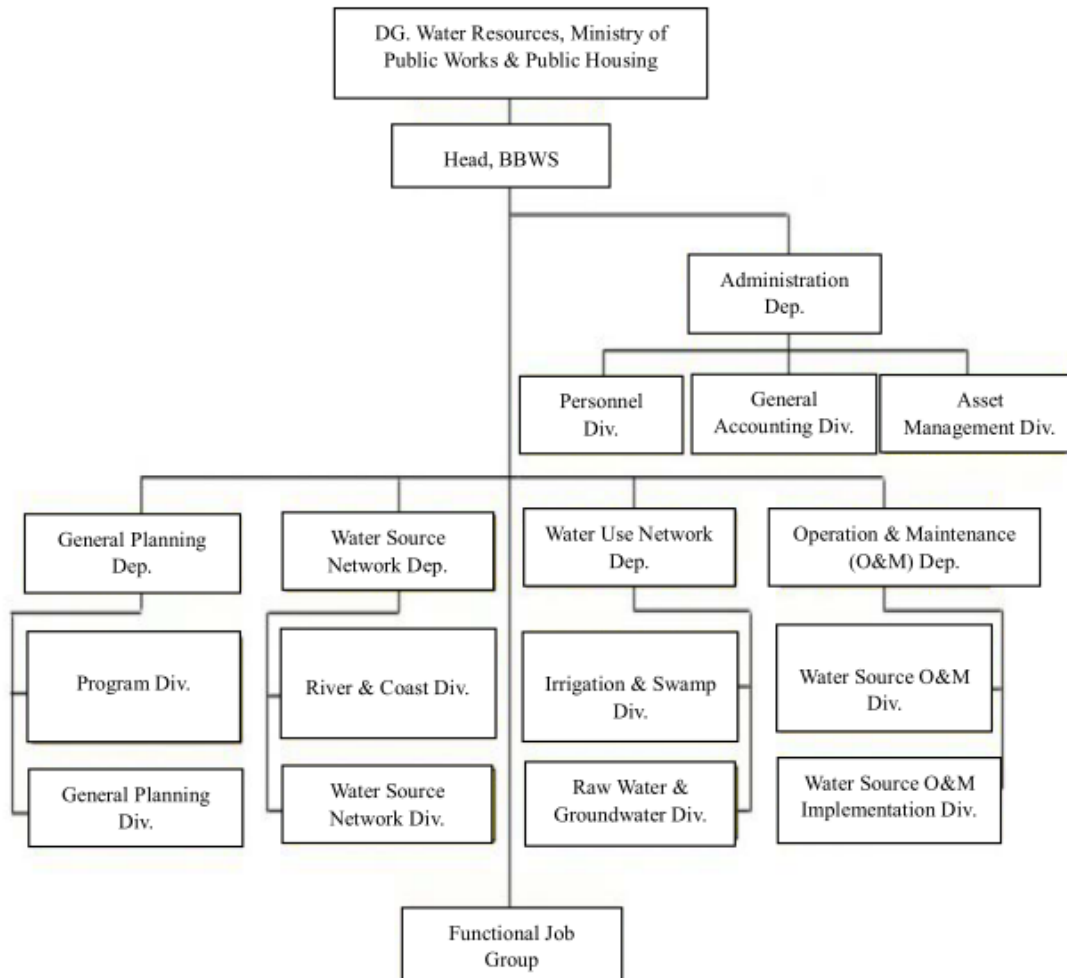


Figure 3: General Organization Chart of River Basin Management Organization (BBWS)

<Mt. Merapi/Progo River Basin>

Following the Regulation of the Minister of Public Works No. 20/PRT/M2016 regarding the ministry's organization and operational procedures enacted in May, 2016, and under the guideline of the Directorate General of Water Resources, Ministry of Public Works and Housing, the River Basin Management Organization Serayu Opak (BBWS-SO) has been in charge of maintenance and management of sabo and accompanying facilities (including consolidation dams against Progo riverbed degradation, monitoring and early warning equipment <excluding ones installed at Balai Sabo below>, water resource facilities, access/evacuation roads). Field maintenance and management are carried out by the Serayu

Opak Special Working Unit for Operation and Maintenance (Satuan Kerja Non Vertikal Tertentu Operasi & Pemeliharaan Serayu Opak).

The equipment for forecasting and early warning is installed at the Experimental Station for Sabo (Balai Sabo) and operated and maintained there. Balai Sabo is an institution constructively reorganized from the Sabo Technical Center (STC) established under JICA technical assistance (renamed from VSTC: Volcanic Sabo Technical Center in 1992) under the Research and Development Center for Water Resources of the Ministry of Public Works and Housing, and its responsible area extends throughout the country.

Sand mining management, and operation and maintenance of the regional infrastructures are performed under the responsibility of each Kabupaten government.

<Mt. Bawakaraeng>

Same as the Mt. Merapi component, the River Basin Management Organization (BBWS-PJ) basically maintains and manages the facilities development in this project. BBWS-PJ constantly examines conditions of sedimentation and the caldera wall, and based on the result, takes disaster prevention measures including rehabilitation of existing sabo dams and consolidation dams, etc. The maintenance of bridges and roads developed under this project are also under the responsibility of BBWS-PJ. As for the small-scale water supply and irrigation facilities, they are being self-maintained by Gotong Royong (Regional Reciprocity) system of local communities.

Thus, the operation and maintenance systems of sabo and other facilities of both Mt. Merapi and Bawakaraeng components of the project are basically prepared. However, since the planned establishment of SMMI was cancelled as pointed out in Section 3.2.1.3.1 Cancellation of SMMI Establishment and 3.3.2 Qualitative Effects, and consequently a unified management of sand mining is not performed under the present system, it should be said that the institutional aspect of the project sustainability is partly insufficient.

3.5.2 Technical Aspects of Operation and Maintenance

<Mt. Merapi/Progo River Basin>

BBWS-SO has collaborated with the consultants in every area in the project implementation and developed into a capable organization equipped with technical and managerial capacity.

The technical level for maintenance of the Serayu Opak Special Working Unit for Operation and Maintenance of BBWS-SO is satisfactory judging from the fact that sufficient technical staffs in terms of quantity and quality including 24 college graduate engineers (including five staffs with master's degree) are assigned. However, continued training in such area as property ledger management of existing facilities, GIS database and needs-based costing are further required, according to the organization. Detailed maintenance manual has also been prepared in this project and used in practice.

<Mt. Bawakaraeng>

Same as the Mt. Merapi component, BBWS-PJ has collaborated with the consultants in every area in the project implementation and developed into a capable organization equipped with technical and managerial capacity. The questionnaire answers also respond that the capacity strengthening of BBWS-PJ by the consulting services has achieved fruitful results. BBWS-PJ is also benefited by the technically leveled up competence grown by the education activities for engineers conducted as a part of the “Integrated Sediment-related Disaster Management (ISDM)” technical assistance project. Among the 20 staffs of the Serayu Opak Special Working Unit for Operation and Maintenance includes only one college graduate engineer. However BBWS-PJ is outsourcing rehabilitation works of sabo facilities except simple ones to outside contractors in principle.

Thus, no problems in sustainability of the both components in technical aspect was recognized.

3.5.3 Financial Aspects of Operation and Maintenance

<Mt. Merapi/Progo River Basin>

The BBWS-SO’s annual budget and cost of operation and maintenance are shown in the following table.

Table 8: Annual Required Rehabilitation Cost of Sabo Facilities and Budget Allocated
(Mt. Merapi/Progo River Basin)

(Unit: million rupiah)

Year	Budget Allocated	Required Rehabilitation Cost
2013	393	300
2014	97	103
2015	140	128
2016	20	20
2017*	148	*

(Source: Materials provided by JICA (Until 2016), Questionnaire answers (2017))

* The amount of required rehabilitation cost in 2017 was not included in the questionnaire answers.

Main works of maintenance of sabo facilities are removal of stones and rocks using heavy equipment, rehabilitation of damaged sabo dams and addition of supporting dams when deep erosion of rivers has occurred and so on. Maintenance budget is estimated by the Special Working Unit for Operation and Maintenance on required cost and requested by BBWS-SO to the central Ministry of Public Works and Housing. As shown above, almost the required

amounts are being allocated to BBWS-SO. The allocated amount of budget in 2014 was a little bit shorter than the required rehabilitation cost. However, timing of rehabilitation work is flexible not rigidly sticking to a particular year. The amounts of budget before and after that year exceeded the respective requirements and the rehabilitation works were performed without problems.

<Mt. Bawakaraeng>

BBWS-PJ's actual operation and maintenance (O&M) costs and allocated budget are shown in the following table.

Table 9: Annual Required Rehabilitation Cost of Sabo Facilities and Budget Allocated
(Mt. Bawakaraeng)

(Unit: million rupiah)

Year	O&M Budget	O&M Cost
2012	8	7
2013	147	138
2014	-	-
2015	67	67
2016	-	-
2017	200	189

Source: Questionnaire answers

Note: No rehabilitation was implemented in 2014 and 2016. The amounts of 2017 are estimation.

In case of BBWS-PJ, rehabilitation of sabo facilities except small-scale works is normally outsourced to outside contractors. The figures on the table above shows those payments and its corresponding budget allocated. Small-scale rehabilitation works which are no need to be contracted out are carried out by themselves with general budget, which is not included in the table above.

Thus, there are no specific issues with the financial sustainability of both Mt. Merapi and Mt. Bawakaraeng components.

3.5.4 Current Status of Operation and Maintenance

<Mt. Merapi/Progo River Basin>

Functionally disordered facilities and their recovery measures taken at the time of the ex-post evaluation are as follows.

Table 10: Functionally Disordered Facilities and Countermeasures
(Mt. Merapi/Progo River Basin)

Facilities (All at Gendol River)	State of Disorder	Countermeasures
Sabo Dam GE-D2	Damaged by pyroclastic flow of the 2010 eruption	Plan to be rehabilitated in succeeding IP-566 Project*
Sabo Dam GE-D3	Abrasion of abutment by frequent debris flow	Plan to be rehabilitated in succeeding IP-566 Project*
Sabo Dam GE-D4	Mostly buried in pyroclastic flow of the 2010 eruption	Repair work will be carried out after studying the damage situation.

Source: Questionnaire answers

* The project "Urgent Disaster Reduction Project for Mount Merapi 2." There is the "Mt. Merapi and Mt. Semeru Volcanic Disaster Countermeasures (2)" implemented prior to this project, therefore IP-566 is the third phase project in substance.

All of above are not due to poor maintenance, but mostly the aftereffect of the 2010 violent eruption, and are supposed to be rehabilitated in the succeeding IP-566 project.

It was observed during the site visit that temporary evacuation shelter which demonstrated a large effect was not well maintained (damages on the doors and windows).

<Mt. Bawakaraeng>

(1) Conditions of sabo facilities

Functionally disordered facilities and their recovery measures taken at the time of the ex-post evaluation are as follows.

Table 11: : Functionally Disordered Facilities and Countermeasures
(Mt. Bawakaraeng)

Facilities	State of Disorder	Countermeasures
Sabo Dam CD-3	Sub-sub Dam scouring	Construct groundsill facility at the downstream side of CD-3
Sabo Dam CD-1	Apron and Sub-sub dam Wing section broken and falling down	Re-construct and construct groundsill facility at the downstream side of CD-1
Sabo Dam No.7-1	Scouring at the end sill of Sub Dam	Construct Toe Block facility at the downstream of Sabo Dam No.7-1
Consolidation Dam KD-2	Broken at the sub-sub dam partially, and also its apron	Re-construct apron and strengthening of sub-sub dam by using steel rail facility

Source: Questionnaire answers

All of above are natural deterioration due to normal avalanche of debris not a result of poor maintenance, against which appropriate recovery measures are taken.

(2) Conditions of monitoring, forecasting and warning systems

The purpose of installing monitoring, forecasting and warning equipment in this project is to objectively forecast future occurrence risk of debris flow by accumulating fluctuation data on rainfall, water level, vibration and so forth, but not intending to catch occurrence of disaster risk itself in advance (Same for Mt. Merapi/Progo River Basin component). The direct observation of the equipment in the 2nd field evaluation study of the Mt. Bawakaraeng component revealed imperfect maintenance in which the PC server installed at the master station was out of order enforcing manual collection of data that are supposed to be automatically transmitted. According to the staff in charge, they have already placed an order to repair and it will be recovered at an early date. However, another fact regarding the maintenance failure was also observed at the field study to the Bili-Bili Control System. Almost all the equipment installed under the Bili-Bili Project was broken down and it was impossible to repair for revival because spare parts for repair were unavailable anymore because all the installed equipment were left un-updated for a long time. It is because of budget insufficiency for repair and renewals according to the staff explanation. The forecasting, monitoring and warning equipment introduced in this project is still new and operating without significant problems except the PC server pointed above. However, the above dormant pieces of equipment at the Bili-Bili Control System may hint the destiny of the equipment under this project in the near future. In light of

that, the sustainability particularly of the monitoring, forecasting and warning of this project is a matter of concern.

3.5.5 Summary

The maintenance of sabo facilities of this project is conducted under the responsibility of the River Basin Management Organizations (BBWS) of the Directorate General of Water Resources, the Ministry of Public Works and Housing having jurisdiction of respective regions. Basically, no significant problems were found in the institutional, technical and financial aspects of project sustainability. However, total sustainability is not completely free from concern due to the following points.

- (1) Under the conditions that the establishment of the planned Sand Mining Management Institution (SMMI) hit a setback and the alternative management by Kabupaten governments in charge has not been conducted sufficiently, illegal mining is still prevailing. There is a concern over the damage on sabo facilities caused by those actions.
- (2) Although there is such instability above, maintenance of sabo facilities is conducted properly in principle. However, it was observed in the field evaluation study at the site that a part of monitoring, forecasting and warning equipment was out of order and not timely repaired, and most of the equipment installed at the Bili-Bili Control Center under the preceding ODA loan project was left un-operated currently under improper maintenance. This fact implies as a possibility future lack of thorough implementation of proper maintenance for the monitoring, forecasting and warning equipment of this project.
- (3) Also in the field evaluation study, insufficient maintenance (broken doors and windows) of the temporary evacuation shelter of the Mt. Merapi component which had produced a large effect at the 2010 big eruption was confirmed.

Thus, although the institutional, technical and financial aspects of the operation and maintenance of the project has no major problems basically, there exists some concern in the future on sand mining management and conditions of the monitoring, forecasting and warning equipment. Therefore, sustainability of the project effects is fair.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

This project consists of two sub-projects that conduct both the structural and nonstructural disaster countermeasures against the eruption of volcanic Mt. Merapi at its foot and the Progo River Basin in Jogjakarta Special Region Province, as well as the large-scale landslide of Mt. Bawakaraeng at the Jeneberang River basin and the Bili-Bili Dam in South Sulawesi Province.

The Mt. Merapi/Progo River Basin component was implemented to promote protection of human lives, public and private properties and to establish sustainable disaster protection systems, thereby contributing to the promotion of regional development. The Mt. Bawakaraeng component was conducted to protect human lives, public and private property including farmlands from debris flow and improve the dam function downstream by preventing sediment discharge from the landslide stricken area, thereby contributing to sustained social and economic activities in and around Makassar City by maintaining stable supply of water and other utility services.

This project is highly relevant corresponding to the Indonesia's development policy, the international framework to cope with natural disaster prevention, people's development needs and also to the Japan's ODA policy at the time of appraisal. On the other hand, the efficiency is fair with its implementation period longer than planned due to the prolonged procurement process, while the project cost is lower than the plan.

For the Mt. Merapi/Progo River Basin component, the preset quantitative indicator "Sediment Control Ratio" became unusable due to the occurrence of unexpected violent eruption during the project implementation, however, the project effect on disaster prevention and promotion of regional development has been confirmed by reviewing past disaster statistics, result of the beneficiary survey and other evidential facts. For the Mt. Bawakaraeng component, the effect on disaster prevention and regional development has been identified as well by the achievement of preset quantitative indicators, result of the beneficiary survey and so forth. The project has been thus mostly producing planned effects, therefore effectiveness and impact of the project can be judged high.

Basically no problems were identified in the maintenance system for the developed sabo facilities as well as the technical and financial capacity of both of the River Basin Organizations (Balai Besar Wilayah Sungai, hereinafter referred to as BBWS) which are responsible under the Ministry of Public Works and Housing. However, unrealized optimal sand mining control system without the planned establishment of the Sand Mining Management Institution (SMMI) and prevailing incomplete operation and management practices on the installed monitoring, forecasting and warning systems show some concern on the sustainability. Due to those minor problems in maintenance and prevailing conditions of the operation and maintenance practices, the sustainability of the project effects is fair.

In light of the above, this project is evaluated to be satisfactory.

Role and Contribution

Generally, disaster prevention projects are required to make a prompt restoration from disaster damage already occurred or countermeasures against disasters that are occurring or will occur in the future, therefore the executing and assisting agencies must start the preparation and implementation as soon as they have recognized the necessity. Additionally, as the objective to be tackled is unpredictable changing natural phenomena, the contents and process of implementation need to be flexible to take such steps as the occasion demands. Those actions were properly taken in the Mt. Bawakaraeng project component making prompt preparation to quickly cope with the giant landslide of the caldera wall occurred in March 2004, formulating the project incorporating with the foregoing Mt. Merapi/Progo River Basin project under preparation succeeding to the preceding undertakings. After the commencement, it added such additional contents as construction of consolidation dams, additional dredging of the Bili-Bili Reservoir both at the edge and near the water intake based on appropriate review of the facility designing. Also in the Mt. Merapi/Progo River Basin component, proper supplemental countermeasures were promptly taken to cope with the damages caused by the unforeseen earthquake and eruptions occurred during the project implementation. To maximally implement those actions, the ODA loan fund was effectively used over the two components within the project. Since actions taken by the Executing Agency and JICA have thus fulfilled the requirement above, the project has successfully brought its effects

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

4.2.1.1 Continued Endeavor to Establish Sand Mining Management System

Because establishment of the Sand Mining Management Institution (SMMI) which was planned in the Mt. Merapi/Progo River Basin component has failed, field sand mining management is not properly operated currently in a systematic manner. While sand mining has been contributing to the regional economy and society by providing a source of income earning opportunity to the local people, activities without proper management may cause physical damages on sabo facilities. To prevent it, the Executing Agency should promptly come to grips with establishment of an effective sand mining management system.

4.2.1.2 Thorough Execution of Maintenance of the Project Facilities

For both the Mt. Merapi/Progo River Basin and Mt. Bawakaraeng components, sabo, infrastructure and other main facilities are basically well maintained, however, some problems

were observed in the maintenance of temporary evacuation shelter of the Mt. Merapi/Progo River Basin, the monitoring lodge and a part of monitoring, forecasting and warning equipment (Mt. Bawakaraeng). Both BBWS are requested to conduct thorough maintenance of all the facilities.

4.2.2 Recommendations to JICA

4.2.2.1 Encouragement of Establishing and Implementation of Sand Mining Management System

Considering that the problem involves local conflicts of interests, external pressure and encouragement is required to urge action taking. In addition to the expected role of the Executing Agency, JICA should strengthen the request to realize the establishment also in the course of implementing the succeeding project.

4.3 Lessons Learned

4.3.1 Quick and Flexible Measures for Disaster Recovery and Prevention Projects

To deal with projects that need prompt actions to cope with changing conditions like disaster recovery and prevention undertakings, the Executing Agency and JICA should immediately start mutual communications with related institutions after recognizing the needs and endeavor to make preparations and start implementation as soon as possible applying procedures elastically. The project implementation also needs flexibility to suit the occasion with adjustment of methods and contents as necessary.

4.3.2 Project Management during Implementation

Project management has to be conducted integrally by a project implementation unit or relevant institution charged with the project implementation management. This project was not comprehensively managed in a sufficient manner by the Executing Agency. Project accounting was not systematically maintained either, which gave constraint on the evaluation failing to provide information of the total project cost. Particularly for the management of a project consisting of multiple independent sub-projects like this project, a project management unit should be organized at the central Executing Agency to comprehensively manage whole of the project implementation. Individual management systems at respective sub-project sites and regular reporting systems to the central management unit must be organized at the stage of project formulation. JICA should monitor and supervise that the said two-layered management be working as expected.

Comparison of the Original and Actual Scope of the Project

Item	Plan	Actual (Existence and contents of performance by the government budget expenditure are unknown)
1. Project Outputs	<p>(Mt. Merapi/Progo River Basin)</p> <p><Main Works></p> <p>1. Countermeasures against debris and pyroclastic flow Construction of sabo facilities, rehabilitation of evacuation roads, development of debris flow monitoring, forecasting & early warning and hydrological observation systems, Improvement of evacuation systems, Promotion of people's awareness of disaster management, Human resource development for disaster management</p> <p>2. Countermeasures against Progo riverbed degradation Construction of consolidation dams</p> <p>3. Sand mining management Establishment of SMMI, Development of sand mining management method, construction of access roads and stockyards, Procurement of mining equipment, Promotion of community participation in sand mining management and O&M of facilities</p> <p>4. Regional development at mountain foot of Mt. Merapi Rehabilitation of irrigation facilities, Multiple use of sabo dams (bridge, road, water intake)</p> <p><Consulting Services> International: 187.0MM Local:780.0MM</p>	<p>(Mt. Merapi/Progo River Basin)</p> <p><Main Works></p> <p>1. Countermeasures against debris and pyroclastic flow Installation of additional 6 sabo dams for eruption damage in 2006, Rehabilitation of 5 sabo dams, 2 embankments and 2 training dykes for 2010 eruption damage Almost as planned except above additional works.</p> <p>2. Countermeasures against Progo riverbed degradation As planned</p> <p>3. Sand mining management Establishment of SMMI, construction of access roads and stock yards were not implemented. Almost as planned except the above.</p> <p>4. Regional development at mountain foot of Mt. Merapi For the 2006 earthquake, the following were added. Rehabilitation of water source facilities (20 locations at 4 areas) Rehabilitation of irrigation facilities (35 locations at 5 areas) As planned except the above.</p> <p><Consulting Services> International: 317.68MM Local:801.79MM</p>

	<p>(Mt. Bawakaraeng)</p> <p><Main Works></p> <p>1. Countermeasures against sediment outflow Construction of sabo dams, Dredging near the existing sabo dams, Rehabilitation of existing sabo dams, Development of monitoring, forecasting and warning systems, Improvement of evacuation system, Promotion of people's awareness of disaster prevention,</p> <p>2. Regional & community development Replacement of existing bridges, Improvement of access roads, Rehabilitation & improvement of other regional infrastructure, Vegetation</p> <p><Consulting Services></p> <p>International: 179.0MM Local: 1,048.0MM</p>	<p>(Mt. Bawakaraeng)</p> <p><Main Works></p> <p>1. Countermeasures against sediment outflow Construction of 4 consolidation dams instead of planned 2 sand pockets, Addition of dredging work near the intake of Bili-Bili Reservoir. Almost as planned except the above.</p> <p>2. Regional & community development Constructions of city water intake, water supply system and elementary school building. Almost as planned except the above.</p> <p><Consulting Services></p> <p>Total MM is not recorded by the Executing Agency</p>
2. Project Period	March 2005 – November 2013 (105 months)	March 2005 – June 2014 (112 months) (Existence and contents of performance by the government budget expenditure are unknown)
3. Project Cost		
Amount Paid in Foreign Currency	8,205 million yen	Cost information other than the Japanese ODA Loan portion is unknown
Amount Paid in Local Currency	11,132 million yen (927,667 million rupiah)	
Total	19,337 million yen	
Japanese ODA Loan Portion	16,436 million yen	16,385 million yen
Exchange Rate	1 rupiah=0.012yen (As of September 2004)	1 rupiah=0.010 yen (Average rate during the implementation period)
Final Disbursement	July 2014	