Ex-Post Project Evaluation 2016
Package IV-3 (Indonesia)

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JAPAN INTERNATIONAL COOPERATION AGENCY

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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 m^3 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

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

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: B[1])

3.1 Relevance (Rating: ③[2])

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

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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>

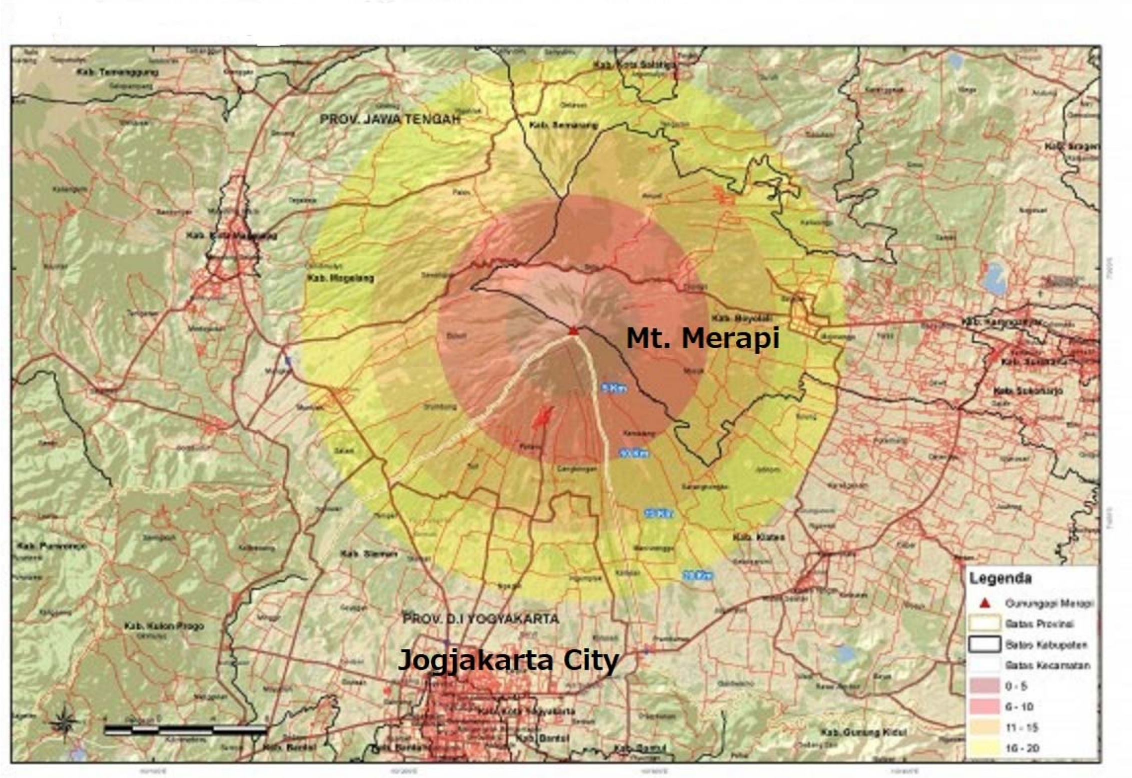

Figure 1: Mt. Merapi and Jogjakarta City

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 follows[3].

[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	● Construction of sabo facilities (30 units)
	Non-structural Countermeasures	● 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 } Note
(b) Progo riverbed stabilization		● Construction of consolidation dam (2 units)
(c) Sand mining management		● Preparation of sand mining management plan ● Implementation of community-driven monitoring activities
(d) Regional development at the mountain foot		● Rehabilitation of irrigation facilities (14 units) ● Construction of consolidation dam (1 unit)
(e) Urgent disaster countermeasures for 2006 earthquake and eruption		● 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		● 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

Unit: MMs

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

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 communities[4] 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>

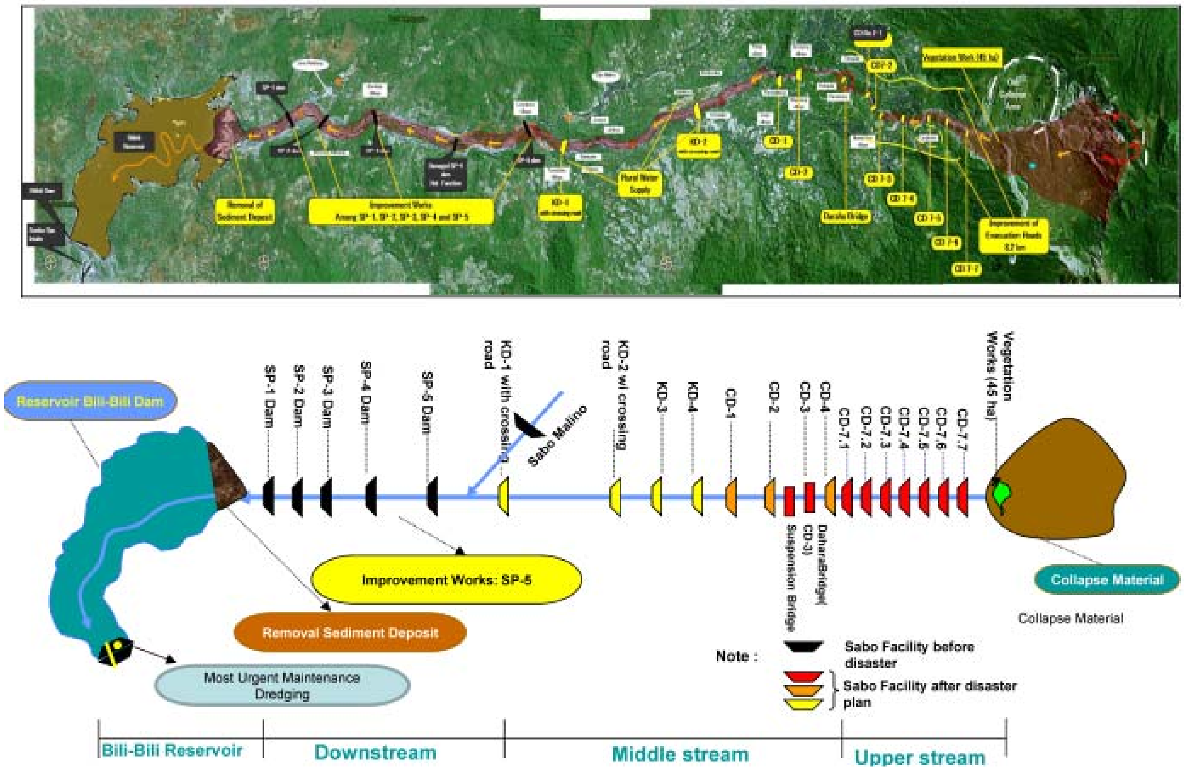

Figure 2: Overhead View of the Mt. Bawakaraeng Component

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 below[5].

[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) ● Sabo dam (7 units) ● Check dam (4 units including one bridge-cum-dam Daraha Bridge>) (Construction of Sabo Facilities in Midstream) ● Consolidation Dam (4 units including 2 river crossing structures)
	Non-structural Countermeasures	● 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 } Note
(b) Development of region and community		● 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	● 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
	Project Cost under ODA Loan	Loan Disbursed	Actual - Plan
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 unknown[6], 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 2013[7].

(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.

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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 fair[8].

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[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 Effectiveness[9] (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 m^3, twenty eight times the volume of 5 million m^3 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 eruption[10], 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].

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[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 m^3 is the appropriate volume of removal for which 8,900 m^3 was achieved by spontaneous business sand mining. So the residual amount of 6,900 m^3 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 m^3 (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 m^3 per second, which is more than 33% higher than the planned volume of 16.9 m^3 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

Arrested Debris Flow by Sabo Dam at Krasak River

(Source: Material provided by Executing Agency)

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 emergency measures[12]. 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 women[13]. 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 Lengkese 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; Penjernihan 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.

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[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 questions[15]: 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 outside[18].

(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. Bawakaeang was caused by a collapse of the caldera wall in March 2004 whose stricken area is restricted within a region around Lengkese Village at the mountain foot where 33 lives were claimed. According to the survey result in Lengkese 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 Lengkese 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 m^2 was acquired with the total cost of 9,927 million rupiah. Acquisition of the land 150,000 m^2 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

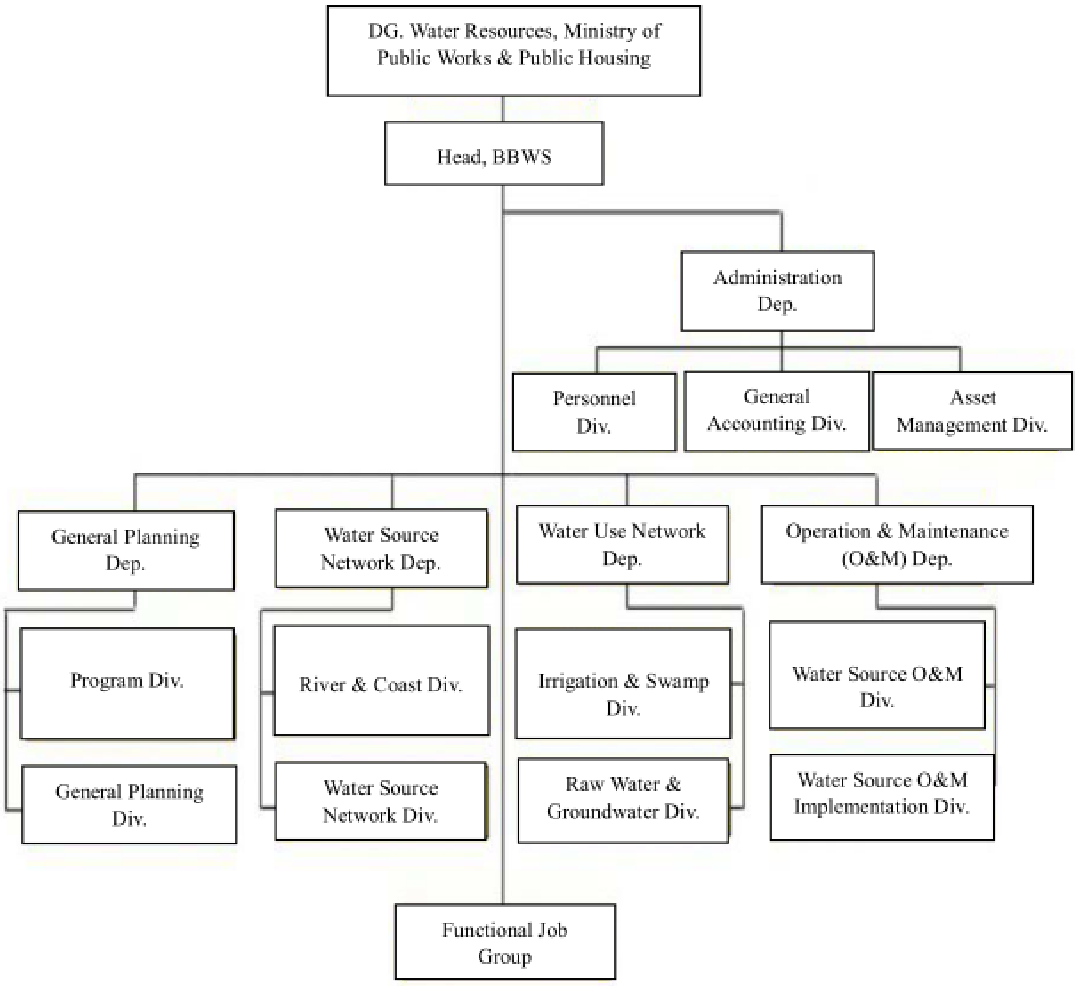

Figure 3: General Organization Chart of River Basin Management Organization (BBWS)

<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	(Mt. Merapi/Progo River Basin) <Main Works> 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 2. Countermeasures against Progo riverbed degradation Construction of consolidation dams 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 4. Regional development at mountain foot of Mt. Merapi Rehabilitation of irrigation facilities, Multiple use of sabo dams (bridge, road, water intake) <Consulting Services> International: 187.0MM Local:780.0MM	(Mt. Merapi/Progo River Basin) <Main Works> 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. 2. Countermeasures against Progo riverbed degradation As planned 3. Sand mining management Establishment of SMMI, construction of access roads and stock yards were not implemented. Almost as planned except the above. 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. <Consulting Services> International: 317.68MM Local:801.79MM

	(Mt. Bawakaraeng) <Main Works> 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, 2. Regional & community development Replacement of existing bridges, Improvement of access roads, Rehabilitation & improvement of other regional infrastructure, Vegetation <Consulting Services> International: 179.0MM Local: 1,048.0MM	(Mt. Bawakaraeng) <Main Works> 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. 2. Regional & community development Constructions of city water intake, water supply system and elementary school building. Almost as planned except the above. <Consulting Services> Total MM is not recorded by the Executing Agency
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	

Republic of Indonesia

FY2016 Ex-Post Evaluation of Japanese ODA Loan Project

"Ulubelu Geothermal Power Plant Project"

External Evaluator: Masumi Shimamura,

Mitsubishi UFJ Research and Consulting Co., Ltd.

0. Summary

This project constructed geothermal power generation plants in Ulubelu, Tanggamus Regency, Lampung Province with the aim of alleviating the tight power supply-demand balance and improving the stability of power supply of the Southern-Sumatra System[1] in Sumatra Island. The objective of the project which addresses the tight power supply-demand condition by supplying power through renewable energy is well consistent with electric power policy and development needs of Indonesia, as well as with the Japan's ODA policy in the sense that geothermal development – a stable and renewable energy –is promoted. Therefore, the relevance of the project is high. Although the project cost was within the plan, the project period exceeded the plan. Therefore, efficiency of the project is fair. Operation and Effect Indicators set at the time of appraisal have largely achieved the target figures. The project is located in Lampung Province where reserve margin is the lowest in Southern-Sumatra System and is playing an important role to reduce power loss and to maintain quality of power supply in this area. In addition, as a result of field interviews, it can be judged that the project has been contributing to the activation of economy and improvement of investment environment in Lampung area. Therefore, the project has largely generated its planned effects; thus, its effectiveness and impact are high. No negative impact on natural environment and land acquisition has taken place. Moreover, creation of local employment by the project and contribution to the community activities of local residents through CSR initiatives were confirmed. No major problem has been observed in the institutional, technical and financial aspects of the operation and maintenance system as well as in the current status. Therefore, sustainability of the project effects is high.

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

[1] It consists of three subsystems: Lampung Subsystem (Lampung Province), South Sumatra Subsystem (South Sumatra Province) and Bengkulu Subsystem (Bengkulu Province).

1. Project Description

Project Location

Ulubelu Geothermal Power Plant

1.1. Background

Development of new power sources was an urgent issue in the face of growing power demand in south area of Sumatra Island in Indonesia. Especially, peak demand in Lampung Province where the project is located was expected to increase at an average rate of 7% per year from about 300 MW in 2003 to about 450 MW in 2009 with the growing population and economy of the area[2]. However, reliability of power supply from the existing generating facilities was low and power supply-demand balance was extremely tight. Although development of power sources had been carried out, increase of demand exceeded the supply from the development and reserve margin was declining. Therefore, it was necessary to increase power supply and to improve its stability in the area. The project aimed to ease the power supply-demand tightness and to secure stability of power supply, by constructing geothermal power generation plants and related facilities in Lampung Province in south area of Sumatra Island.

1.2 Project Outline

The objective of this project is to alleviate the tight power supply-demand balance and to improve the stability of power supply of the Southern-Sumatra System[3] by constructing geothermal power plants (55MW x 2 units) connecting Lampung Subsystem in Southern

[2] Source: information provided by JICA.

[3] “South Sumatra System” referred in the project outline at the time of appraisal covers Lampung Province, South Sumatra Province, Bengkulu Province, Jambi Province, West Sumatra Province and Riau Province. Although Lampung Province where the project is located is covered by South Sumatra System, its range is too wide. For this reason, at the time of ex-post evaluation, discussion was conducted and agreement was made with the executing agency that “Southern-Sumatra System” which covers Lampung Province, South Sumatra Province, and Bengkulu Province would be taken up in the project outline.

Sumatra, thereby contributing to the economic development of the region through improving investment climate etc.

Loan Approved Amount/ Disbursed Amount	20,288 million yen / 16,068 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	March, 2005 / March, 2005
Terms and Conditions	Interest Rate 0.75% Repayment Period 40 years (Grace Period 10 years) Conditions for Procurement General Untied
Borrower / Executing Agency	Republic of Indonesia / State Electricity Company (PT. PLN)
Project Completion	October, 2013
Main Contractor (Over 1 billion yen)	Sumitomo Corporation (Japan)
Main Consultants (Over 100 million yen)	Sinclair Knight Merz (Australia) / PT. Amythas Experts & Associates (Indonesia) / PT. Connusa Energindo (Indonesia) / PT. Tata Guna Patria (Indonesia) / West Japan Engineering Consultants,Inc. (Japan) (JV)
Feasibility Studies, etc.	F/S (April, 2004)
Related Projects	Technical Cooperation ・ Study on the Optimal Electric Power Development in Sumatra (2004 – 2005) World Bank ・ Java-Bali Power Sector Restructuring and Strengthening Project (June, 2003 – December, 2013) Asian Development Bank ・ Power Transmission Line Improvement Sector Project (November, 2003 – September, 2013) ・ Renewable Energy Development Sector Project (November, 2003 – June, 2014)

2. Outline of the Evaluation Study

2.1 External Evaluator

Masumi Shimamura, Mitsubishi UFJ Research and Consulting Co., Ltd.

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: April 2 – April 13, 2017, August 8 – August 11, 2017

3. Results of the Evaluation (Overall Rating: A[4])

3.1 Relevance (Rating: ③[5])

3.1.1 Consistency with the Development Plan of Indonesia

At the time of appraisal of the project, *National Electricity General Plan* (hereinafter referred to as "RUKN[6]") *(April, 2004)* promoted geothermal development – development of a stable and renewable energy was anticipated for future utilization as one of energy resources. According to RUKN, Indonesia is endowed with a great deal of geothermal resource and it was estimated that potential geothermal resource of 10 GW exists in the whole country and 5.4 GW, about half of it, in Sumatra Island at the time of appraisal of the project. The Presidential Decree No. 76 of 2000 advocates the active utilization of geothermal power generation as a way of diversification of energy sources and a means of energy saving. In addition, the Geothermal Law aiming to promote utilization of geothermal power came into force in October, 2003. Accordingly, the project is consistent with the development policy of Indonesia.

At the time of the ex-post evaluation, government policy which encourages the maximum use of new and renewable energy including geothermal energy is also spelled out. Concretely, the Indonesian government sets the target to increase additional power generation capacity of 35 GW within five years between 2015 and 2019 in its *35 GW Program*. Among 35 GW, 3.7 GW, 10% to 15% of total additional power generation capacity is targeted for new and renewable energy including geothermal. Draft RUKN 2015-2034[7] is also in line with the Program. As regards actual volume of power generation, *Electricity Supply Business Plan* (hereinafter referred to as "RUPTL[8]") *2017-2026* of State Electricity Company (hereinafter referred to as "PLN[9]") sets the target that the share of power generation volume by new and renewable energy is to be raised to 22.5 % of the total volume of power generation by 2026 from 11% in 2016. Regarding the component of energy sources, capacity of geothermal power generation is targeted to be increased from 4% in 2016 to 9% in 2026. The implementation of the

[4] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory
[5] ③:High, ②:Fair, ①:Low
[6] Rencana Umum Ketenagalistrikan Nasional
[7] RUKN 2015-2034 has not been approved at the time of ex-post evaluation.
[8] Rencana Usaha Penyediaan Tenaga Listrik
[9] Perusahaan Listrik Negara

project is also consistent with the development policy of Indonesia at the time of ex-post evaluation.

3.1.2 Consistency with the Development Needs of Indonesia

At the time of appraisal of the project, it was a pressing issue to cope with the tight power supply-demand and to develop stable power supply system in south area of Sumatra Island. With the growing population and economy, the peak power demand in Lampung Province where the project is located was expected to increase to 1.5 times (at an average rate of 7% per year) from about 300 MW in 2003 to about 450 MW in 2009. On the other hand, reliability of power supply from the existing generating facilities was low because of aging of the facilities and operational stoppages due to their maintenance, and power supply-demand balance was extremely tight. Although development of power supply that replaced diesel power generation, which had high generation unit price and low economic efficiency as well as heavy environmental burdens, had been advanced, growth of power demand exceeded supply and reserve margin was falling. Given the situation, it was expected to respond to the tight power supply-demand, to improve stability and reliability of power supply and to enhance efficiency of power generation facilities in the area.

At the time of ex-post evaluation, according to the executing agency, increasing power generation capacity in south area of Sumatra Island continues to be an urgent issue. Especially, Lampung Province is one of the most serious areas facing power shortage. As shown in Table 1, reserve margin in Lampung is negative figures except in 2007, 2008 and 2011, having significantly lower figures than 25% [10], which is considered to be necessary reserve margin for stable power supply, thus alleviation of tight supply-demand balance is a pressing issue. Currently, supply and demand gap in Lampung Subsystem is complemented by power interchange from South Sumatra Subsystem, Bengkulu Subsystem etc. On the other hand, investment on the development of new power sources is planned in Lampung Subsystem and problem on the tight power supply-demand continues to be addressed, as shown in Table 2.

[10] Source: RUKN 2003-2022.

Table 1: Trend of Power Supply-Demand Balance and Reserve Margin in Lampung Subsystem

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
① Maximum Power Demand (MW)	373	394	365	413	467	517	582	613	696	732	891	736
② Power Supply at Peak Demand (MW)	217	414	407	383	433	516	577	549	671	600	719	736
Reserve Margin (%) = （②－①）／①	-42	5	12	-7	-7	0	-1	-10	-4	-18	-19	0

Source: Results from questionnaire survey of PLN

Note 1) Figures in 2017 cover from January to October, 2017

Table 2: Actual Data on Investment Capacity of Power Generation in Lampung Subsystem

(Cumulative total capacity of each year) (Unit: MW)

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Power Generation Investment by PLN															
Coal Fired	-	200	200	177	177	178	178	177	265	267	300	300	300	300	300
Combined Cycle	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydroelectric	115	117	118	118	118	118	118	118	118	118	118	118	118	118	118
Gas Turbine	16	16	18	18	18	18	18	17	16	16	75	175	360	360	360
Diesel	75	78	71	71	71	123	163	127	112	51	28	25	-	-	-
Geothermal	-	-	-	-	-	-	100	110	110	104	104	104	104	104	104
Others	11	3	-	-	50	80	-	-	50	44	44	44	44	44	44
Power Generation Investment by IPPs [11]															
Coal Fired	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Combined Cycle	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydroelectric	-	-	-	-	-	-	-	-	-	-	-	-	56	56	56
Gas Turbine	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Diesel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Geothermal	-	-	-	-	-	-	-	-	-	-	-	110	110	110	300
Others	-	-	-	-	-	-	-	-	-	-	50	-	-	-	-
Total Power Generation Investment by PLN and IPPs															
Total	217	414	407	384	434	517	577	549	671	600	719	876	1,092	1,092	1,282

Source: Results from questionnaire survey of PLN

Note 1) Figures until 2016 are the actual and figures in and after 2017 are the planned.

3.1.3 Consistency with Japan’s ODA Policy

At the time of appraisal of the project, *the Country Assistance Program for Indonesia (November, 2004)* put up “sustainable growth led by the private sector” as one of the priority areas and raised “economic infrastructure development” etc. for improvement of investment environment as assistance strategy. In *the Medium-Term Strategy for*

[11] IPP stands for Independent Power Producer. A wholesale power generation entity which only owns power generation facilities and not transmission system is called IPP collectively.

Overseas Economic Cooperation Operations (April 2002, JICA), the "economic infrastructure development", which was vital for recovery towards sustainable growth through economic reforms was put as priority areas for assistance to Indonesia. In addition, as part of "responding to global issues", which was one of priority areas in the Strategy, providing active assistance to introduce renewable energy was advocated. Furthermore, the assistance strategy for major sectors in the *Country Assistance Strategy for Overseas Economic Cooperation Operations* (September 2004, JICA), raised four issues; stabilizing electric power supply, making power sector more efficient, improving electrification rate, and advancing environmental measures. A policy to "actively provide assistance to develop and enhance power generation facilities as well as power grid expansion etc. in order to secure stable power supply in major economic zones in outer islands (Sumatra Island and Sulawesi Island)" was also laid out.

The project aims to alleviate the tight power supply-demand and improve stability of power supply of the Southern-Sumatra System, to contribute to economic development of south area of Sumatra Island, and to reduce load to a global environment through utilization of renewable energy. Thus the project is consistent with the above strategies.

This project has been highly relevant to the country's development plan and development needs, as well as Japan's ODA policy. Therefore its relevance is high.

3.2 Efficiency (Rating: ②)

3.2.1 Project Outputs

The project constructed geothermal power plant facilities of 55MW class x 2 units (total of 110MW class), 150kV transmission line, substation, and distribution lines. Table 3 shows the comparison of planned and actual project outputs. The development and supply of steam which are necessary for generating power were undertaken by PERTAMINA Geothermal Energy (PGE), a subsidiary company of PERTAMINA, a state-owned oil and gas company. The Steam Sales Contract[12] for this project had been signed between PLN, the executing agency, and PGE.

[12] Steam Sales Contract was concluded between the executing agency and PGE in February, 2010 (30-year contract). The initial plan was to conclude the Steam Sales Contract before effectuation of the loan agreement (but conclusion of Steam Sales Contract had not been set as a condition to effectuate the loan agreement). However in actuality, agreement was concluded about 5 years after the signing of the loan agreement. See footnote 15 for reasons for the delay.

Table 3: Comparison of Planned and Actual Project Outputs

Plan	Actual
Civil Works, Procurement of Equipments etc.	
• Construction of geothermal power plant facilities (55MW x 2 units) • Construction of 150kV transmission line • Expansion of substation etc. • Construction of distribution lines	• As planned • As planned • As planned • As planned (Note 1)
Consulting Services	
• Review of existing resource development study (related to steam) • Detailed design, assistance in tendering, construction supervision • Assistance in O&M, transfer of knowledge and technology, and human resource development • Assistance in environmental management	• As planned • As planned • As planned • As planned

Source: Results from questionnaire survey of PLN

Note 1) Although this is one component of the project, it was removed from the coverage of Japanese ODA loan and was developed utilizing PLN's own funds.

There was no change with respect to project outputs for civil works and procurement of equipments etc. However, according to PLN, construction of distribution lines was removed from the coverage of Japanese ODA loan and was developed utilizing PLN's own funds. This was because PLN had to cope with the urgent power supply needs of its distribution area in Tanggamus Regency. Thus, PLN has utilized its own funds from the FY 2006 and 2012 budget to develop distribution lines.

Consulting services were carried out as planned. As regards man-month (MM) of consulting services, while the initial plan was 526MM, it turned out to be 529.8MM in actuality – increased by 3.8MM. This was due to the delay in tendering process of contractors (the delay in tendering process includes the delay associated with PGE's delay of the plan – completion of tender documents and the start time of bidding were behind the schedule as described below). It was deemed necessary for consultants to be on board including prolonged project period, which resulted in increase of their MM.

Turbine and Generator

Cooling Tower

Main Steam Isolation Valve

Switch Yard

3.2.2 Project Inputs

3.2.2.1 Project Cost

The total project cost was initially planned to be 23,875 million yen (out of which 20,288 million yen was to be covered by Japanese ODA loan). In actuality, the total project cost was 19,095 million yen[13] (out of which 16,068 million yen was covered by Japanese ODA loan), which is lower than planned (80% of the planned amount).

The reason why the total project cost was lower than planned was due to the cost reduction as a result of competitive bidding for which bid price was below the estimate and the effect of depreciation of local currency, Indonesia Rupiah against yen during the project period[14].

[13] The figure includes the cost related with construction of distribution lines which the executing agency carried out utilizing its own funds.

[14] At the time of appraisal, it was estimated as 1 Indonesian Rupiah (IDR) = 0.012 JPY. However, the actual rate was a weak Rupiah trend as 1 IDR = 0.0102 JPY (average rate by IMF between 2005 and 2014)

3.2.2.2 Project Period

The overall project period was planned as 84 months, from March, 2005 (signing of Loan Agreement) to February, 2012 (completion of warranty period) as opposed to 104 months in actuality, from March, 2005 (conclusion of Loan Agreement) to October, 2013 (completion of warranty period), which is longer than planned (124% of the initial plan). Loan period was extended due to project delay. It was extended in December, 2012 and the final disbursement was on June, 2014.

Table 4 summarizes the comparison of planned and actual project period.

Table 4: Comparison of Planned and Actual Project Period

Item	Plan (At Project Appraisal)	Actual (At Ex-post Evaluation)
Selection of consultants	Apr. 2005 – Mar. 2006 (12 months)	Apr. 2005 – Nov. 2006 (20 months)
Consulting services	Mar. 2006 – Feb. 2012 (72 months)	Dec. 2006 – Oct. 2013 (83 months)
Detailed design and procurement	Apr. 2006 – Mar. 2008 (24 months)	Dec. 2006 – Feb. 2010 (39 months)
Construction of generation facilities(Unit 1)	Apr. 2008 – Aug. 2010 (29 months)	Feb. 2010 – Sept. 2012 (32 months)
Start of generation (Unit 1)	Aug. 2010	Jul. 2012
Construction of generation facilities(Unit 2)	Oct. 2008 – Feb. 2011 (29 months)	Feb. 2010 – Oct. 2012 (33 months)
Start of generation (Unit 2)	Feb. 2011	Sept. 2012
Warranty period	Mar. 2011 – Feb. 2012 (12 months)	Sept. 2012 – Oct. 2013 (14 months)

Source: Information provided by JICA, and results from questionnaire survey of PLN

Main reasons for project delay were as follows: (1) selection of consultants was delayed (contract negotiation between PLN and consultants took time; thus, contract signing and start of consulting services was delayed), and (2) tendering process for contractors was delayed (prequalification by PLN was behind the schedule and as a result of delay of the plan by PGE [15], a steam supplier, completion of tender documents and the start time of bidding were delayed – PLN could not receive geothermal resource data, which was necessary for the preparation of tender documents, from PGE on time). Period for consulting services was extended significantly as a result.

[15] According to the information obtained from the executing agency, the plan was delayed because PGE took a long time to drill the wells to secure steam volume necessary for ensuring power outputs of the power plants (because it took some time to drill the wells of sufficient steam volume). This led to a delay in concluding the Steam Sales Contract between the executing agency and PGE.

3.2.3 Results of Calculations for Internal Rates of Return (Reference only)

The financial internal rate of return (FIRR) calculated at the time of project appraisal was 8.0%, on the assumption that sales from power generated from the project to be considered as benefit, expenses for construction cost and operation and maintenance cost to be regarded as cost, and project life assumed to be 25 years. The FIRR recalculated at the time of ex-post evaluation based on the same assumptions as the appraisal turned out to be 6.0%. The main reason for the lower result in comparison with the figure at the time of appraisal can be attributed to the consideration of decrease of power sales due to reduced steam volume in future prediction. Recalculation of the economic internal rate of return (EIRR) is not carried out at the time of ex-post evaluation since it was not calculated at the time of appraisal.

Although the project cost was within the plan, the project period exceeded the plan. Therefore, efficiency of the project is fair.

BOX 1: Difficulties which the Contractors Faced and Countermeasures Undertaken in the Course of Project Implementation

The degree of difficulty was high and "race against time" was required to implement the project due to following reasons: the project site is located in the mountains, thus it was necessary to level the land fist by shaving the hillside slope so as to make construction works possible; the scope of the project was not just to construct power plants but to develop a new transmission line of about 26km to the existing transmission line as well as related new substations; and the contractors had to absorb the delay of construction of steam condensing system portion (*) in the project although this portion was outside the scope of this project (PGE was the responsible organization)[16]. The contractors facilitated project implementation by appropriately carrying out project management and securing a smooth interface for operations between each scope. Concretely, close communication and collaboration system between each operation unit was taken and unity of mixed teams consisting of multiple organizations (contractors, manufactures, Japanese and foreign consultants etc.) was strengthened through thorough discussion for the following tasks including; leveling the land of power plant construction site (hillside slope), timely

[16] This portion was a different project outside the scope of this power plant construction. Although PLN was responsible for coordination, its construction work was delaying. Unless the steam condensing system was developed, generation of electricity was not possible even the power plants were completed. Given the situation, the contractors aimed to absorb the delay of the steam condensing system development and to keep the delivery date so as to generate electricity within the construction period of the power plants.

procurement of equipments and materials, transportation of equipments and materials with due consideration to local residents, foundation work for installation of steel towers in the mountains, plant installation and so on. In addition, initiatives were carried out by the contractors to facilitate PLN's review and approval process – in collaboration with consultants, the contractors reflected the details into the drawings and thoroughly explained them to PLN which could not be covered in the contract document between PLN and the contractors. In this way, construction period was shortened for about 2 months by optimizing the overall project management including construction system, procurement, cost management etc. Thus; smooth start of power generation was realized by absorbing the delay of construction of steam condensing system by PGE, which was outside the project scope.

(*) This portion is the installation of condensing steam pipe that carries steam taken from excavated wells to the power plants.

3.3 Effectiveness[17] (Rating: ③)

3.3.1 Quantitative Effects (Operation and Effect Indicators)

Table 5 summarizes the operation and effect indicators set at the time of appraisal of the project and their actual figures between 2013 and 2017 (from January to June). (Since the end of warranty period, which is the definition of project completion, was in October 2013; the target year is 2015 – 2 years after completion.)

[17] Sub-rating for Effectiveness is to be put with consideration of Impact.

Table 5: Operation and Effect Indicators

Indicators	Target	Actual			
	2014	2014	2015	2016	January – June 2017
	2 Years After Completion	1 Year After Completion	2 Years After Completion	3 Years After Completion	
Operation Indicators					
Maximum Output (MW)	110	110	105	93	94
Plant Load Factor (%) Note 1)	85	93.27	93.18	81.13	82.9
Availability Factor (%) Note 2)	85	99.96	97.94	97.28	99.83
Auxiliary Power Ratio (%) Note 3)	Below 3%	3.4	3.5	3.7	3.7
Forced outage hours by Human Errors (hours)	0	0	0	0	0
Forced outage times by Human Errors (times)	0	0	0	0	0
Forced outage hours by Machine Errors (hours)	0	3.51	18.89	53.55	7.6
Forced outage times by Machine Errors (times) Note 4)	0	3 (1)	4 (3)	8 (6)	2 (1)
Planned outage hours by periodic inspection (hours)	720 hours per one inspection	0	323.3	370.3	0
Planned outage times by periodic inspection (times)	8 times in 30 years of operation	0	1	1	0
Effect Indicators					
Net Electric Energy Production (GWh/year) Note 5)	794	858.7	825.6	735.2	372.6

Source: Information provided by JICA, and results from questionnaire survey of PLN

Note 1) Plant Load Factor (%) = Annual energy production / (Rated output x Annual hours) x 100

Note 2) Availability Factor (%) = (Annual operation hour / Annual hours) x 100 (average of two power generation facilities). Annual operation hours include stand by hours.

Note 3) Auxiliary Power Ratio (%) = (Annual Power consumption in the power plant / power generating at sending-end) x 100

Note 4) Figures in parentheses are forced outage times by machine errors occurred within Ulubelu Geothermal Power Plant of the whole forced outage times by machine errors.

Note 5) Net Electric Energy Production (GWh) = Annual energy production – Power consumption in the power plant. The figure in 2017 is low since the data is for a half year (January to June).

In regard to indicators related to power generation capacity etc. in 2015, which is the target year of the operation and effect indicators, the figures have largely reached the target value. According to PLN, the power plants were operating smoothly after completion of the project, however, after the minor inspection conducted in early 2016, steam volume supplied by PGE decreased (out of 11 production wells supplying steam to the power plants, steam supply volume of 3 wells has decreased). As a consequence, figures of maximum output, plant load factor, availability factor, and net electric energy production have decreased. However, all these indicators exceeded 80% of the target value (maximum output: 85% of the target value, plant load factor: 95%, availability factor: 114%, and net electric energy production: 93%). In addition, PGE is focusing on recovering steam volume, and the maximum output in January to June 2017 is 94MW, slightly more than the volume in 2016.

According to PLN, the reason why the auxiliary power ratio exceeds the target value is because power supply to office buildings within Ulubelu Geothermal Power Plant as well as power supply to outdoor lights of access road and security facilities are included in the figures. PLN explained that if such power supply was excluded, the figures would be below 3%[18]. There is no forced outage due to human errors. According to PLN, machine errors are the total number of outages within Ulubelu Geothermal Power Plant and outages outside Ulubelu Geothermal Power Plant. The former are troubles related to electric system such as breakdown of circuit breaker and auxiliary transformers as well as troubles related to valves used for steam lines etc. PLN explained that both troubles can be handled by regular maintenance activities by Ulubelu Geothermal Power Plant. The latter are electricity faults caused by voltage instability of Lampung Subsystem and errors due to voltage collapse[19], which are cause by factors outside the control of Ulubelu Geothermal Power Plant.

As regards planned outage by periodic inspection, it was set as 8 times within 30 years of operation at the time of appraisal, which is equivalent to once in 3.75 years in simple calculation. On the other hand, when looking at the actual figures, as of 3 years after project completion, power plants have already stopped 2 times in total, once in 2015 and 2016, respectively. Therefore, as a result of confirming the definition of periodic inspection to PLN, PLN explained that while the actual figures are outages due to minor inspections, the target figure set at the time of appraisal may have assumed major inspections, and outages due to minor inspections may not have been included.

[18] According to PLN, the auxiliary power ratio set at the time of appraisal may have excluded these power supply.
[19] A phenomenon in which voltage rapidly drops in the entire system since frequency in electric power system cannot be maintained within a proper range due to collapse of power supply-demand balance.

The reason why only outages due to major inspection was assumed at the time of appraisal is unknown, however, according to PLN, it is necessary to shut down the generators etc. in minor inspection too, thus, minor inspections in 2015 and 2016 are reflected in the actual figures[20]. Therefore, there is no problem although the actual figures of outage times have been recorded more than expected.

3.3.2 Qualitative Effects (Other Effects)

According to PLN, the power plants play an important role to reducing power loss and maintaining power quality (voltage) in the Southern-Sumatra System and Lampung Subsystem since the power plants are located in Lampung Province, a high power demand area, and have been contributing to decrease power interchange from other areas. Currently, Lampung Subsystem adjusts its supply and demand gap through power interchange from other subsystems, which consist Southern-Sumatra System (South Sumatra Subsystem and Bengkulu Subsystem) (see Table 6). PLN pointed out that such power interchange across the areas would become inhibiting factors for stable and efficient power supply[21]and that it is important to supply power within the same area as much as possible so as to secure stability and appropriate power quality in the entire power system. In this regard, it is extremely significant that the power plants are located in Lampung Province which has high power demand.

It should be noted that power interchange from other subsystem to Lampung Subsystem is increasing according to Table 6. This is because the supply is running short of demand (see Table 1). However, when considering that power interchange could have happened for the volume of additional power supply from the project, it can be said that the project is contributing to the decrease of power interchange (if the project was not implemented, further power interchange would have been necessary).

Table 6: Data on Power Interchange from Other Subsystems to Lampung Subsystem

	2011	2012	2013	2014	2015	2016	2017
Power Interchange at the Peak Load (MW)	210	240	260	272	340	350	181
Power Interchange during Ordinary Times (MW)	180	234	252	260	310	320	350

Source: Results from questionnaire survey of PLN

Note 1) Figures in 2017 cover from January to October, 2017

[20] As described below (sustainability), major inspections are planned to be conducted every 4 years and minor inspections every 2 years.

[21] The executing agency explained the following as its logic: “When the place for power generation is far from power consuming area (when power transmission distance is long) ➔ electric resistance increases ➔ power loss increases ➔ power voltage reduces.”

3.4 Impacts

3.4.1 Intended Impacts

3.4.1.1 Improvement of Investment Environment

Table 7 shows the trend of electricity sales in Lampung area. Electricity sales to business and industrial sectors have been increasing. It can be considered that the project is contributing to the activation of economic activities and improvement of investment environment in Lampung area when also taking into consideration the results of interviews with local residents and companies (see below).

Table 7: Trend of Electricity Sales in Lampung Area

(Unit: GWh)

	Actual						Projection		
	2011	2012	2013	2014	2015	2016	2017	2018	2019
Residential	1,457	1,731	1,877	2,069	2,205	2,368	2,568	2,786	3,037
Business	306	383	427	399	401	438	482	534	600
Social	167	188	206	214	239	253	270	291	315
Industrial	395	491	671	709	726	775	840	924	1,042
Total	2,325	2,793	3,182	3,392	3,571	3,835	4,160	4,534	4,993
Growth Rate (%)	14	20	14	7	5	7	8	9	10

Source: Results from questionnaire survey of PLN

Note 1) Partial inconsistency of figures exists due to rounding error.

Note 2) Growth rate is a growth rate of electricity sales from the previous year.

Note 3) Figures in and after 2016 include some electricity sales by IPPs (share of IPPs are relatively small), however, it cannot be separated out from the electricity sales by PLN.

The results of interviews with local residents and companies have shown that the impacts regarding industrial development and job creation etc. have been generated after project completion. According to the interviews, local companies have expanded their operation due to stable power supply and herewith increased the number of employees from local residents as well as their salaries, enterprises newly entering in Lampung Province have increased, and employment of local residents during power plant construction and after the operation has been created.

3.4.1.2 Alleviation of Global Environmental Burdens through Utilization of Renewable Energy

At the time of appraisal, possibility to regard the project as a target of emissions reduction project (CDM[22] project) was explored, however, it did not result in a CDM project. According to PLN, this was because preparations for CDM application of the project were not ready within PLN (establishment of system and staffing could not take place sufficiently). The effect of CO_2 emission reduction by the project cannot be identified exactly since the available data is not sufficient. At the time of appraisal, contribution to the alleviation of global environmental burdens was expected as project effect. Therefore, it was desirable to confirm the system for data collection and calculation of reduction of greenhouse gas emissions.

3.4.2 Other Positive and Negative Impacts

3.4.2.1 Impacts on the Natural Environment

The project falls under A category of JBIC Guidelines for Confirmation of Environmental and Social Considerations (Environmental Guidelines) (April, 2002) because it is a development project of large-scale power plants. The Environmental Impact Assessment Report (hereinafter referred to as "AMDAL"), the Environmental Management Plan (hereinafter referred to as "RKL"), and the Environmental Monitoring Plan (hereinafter referred to as "RPL") of the project have been approved by the Environmental Assessment Committee of Tanggamus Regency in September, 2004 for power generation and in October, 2004 for transmission line.

PLN has conducted environmental monitoring[23] during and after completion of the project on a quarterly basis based on AMDAL, RKL and RPL, and no particular negative environmental impact has been reported at the time of ex-post evaluation. In addition, since project implementation up to now, no negative impact on natural environment such as air pollution, odor, and noise has been pointed out from the interview with the local residents carried out during the field study. PLN's monitoring results of the critical environmental indicators for geothermal power generation are shown in Table 8 (measured in December, 2016). Concentration of air pollutant – Sulfur Hydrogen (H_2S), and water quality in the reinjection wells – Arsenic (As) and Mercury (Hg) were significantly lower than the standards.

[22] CDM is a mechanism for which investment countries (developed countries) are allowed to implement projects that reduce greenhouse gas emissions in host countries (developing countries) and to apply its additional reduction volume of greenhouse emissions, compared to the case where there is no such project, as part of the reductions of greenhouse emissions by the investment countries. For CDM application, the implementing agency on the host country side needs to develop systems and human resources etc. in order to determine the emissions.

[23] Environmental monitoring was carried out on the items of: gas emission from the power plant, ambient air, water quality, industrial waste water, sanitary waste water treated through a septic tank, waste sludge disposal, noise and so on.

Table 8: Results of Environmental Monitoring

Indicator	Standard	Results of Monitoring
Air Quality: Sulfur Hydrogen (H_2S)	35 mg/Nm_3 Note 1)	7 mg/Nm_3
Water Quality: Arsenic (As)	1 mg/L Note 2)	0.005 mg/L
Water Quality: Mercury (Hg)	0.002 mg/L Note 2)	0.001 mg/L

Source: Results from questionnaire survey of PLN

Note 1) Regulation of State Minister of Environment Concerning Emission Standard for Geothermal Power Generation Activities (No.21, 2008)

Note 2) Government Regulation on Water Pollution Control and Water Quality Management (Government Regulation No. 82 of 2001)

As a result of interviews with PLN and local residents, although part of the transmission line passes through the protected forests, PLN minimized protected forest passage in detailed design and pruning of trees under the route was also limited to the height exceeding 8.5m as planned, and effect of installation of towers in the protected forests is also limited (as shown in Table 9, the actual land acquisition area (12.9ha) also decreased from the planned area (21.2ha)). Therefore, it is judged that there is no effect on the water/soil conservation function by logging the protected forest in this area.

3.4.2.2 Land Acquisition and Resettlement

Table 9 shows the comparison of planned and actual resettlement and land acquisition. Area for land acquisition was reduced from the planned area after concrete transmission route was decided during the detailed design stage. Relocation did not take place. According to interviews[24] conducted during the field study with PLN and local residents regarding resettlement and land acquisition during project implementation, the compensation process for land owners (farmers) who have given up part of their farm land for the project was carried out in accordance with the Indonesian Regulations (Presidential Decree No.36-2005 and No.65-2006 (revised regulation)) and no particular problem was pointed out. There was no objection regarding compensation amount from the farmers, either.

[24] As described later, interviews were conducted with 12 local residents living in 6 villages in the range of approximately 30km from the power plants. They were mainly rice farmers (including village chief) and 2 of them were working in the power plants. Interviewees were selected from those introduced by the village chief or persons of great influence from each village to whom PLN called out. They turned out to be all men.

Table 9: Comparison of Planned and Actual Resettlement and Land Acquisition

Plan		Actual	
Land	Resettlement Household	Land	Resettlement Household
21.2ha	0	12.9ha	0

Source: Results from questionnaire survey of PLN

3.4.2.3 Other Impacts

According to interviews with PLN and local residents, there was no electricity or limited power supply in the six villages[25] located in the range of approximately 30km from the power plants before the project (power supply time was limited to several hours in a day). In contrast, these villages were electrified and stable power supply was realized as a result of construction of distribution lines by the project. By this, villagers could use agricultural machineries such as rice huller, which resulted in improvement of work efficiency and increase of harvest. In addition, they can now transport harvested rice using the access road developed by the project by vehicles (before the project, they carried harvested rice passing through unpaved mountain roads on foot).

In addition, as part of the CSR programs, Ulubelu Geothermal Power Plant has been providing support for self-reliance of local residents in the surrounding areas including the six villages mentioned above. The programs include generation of biofertilizer through breeding of goat, promotion of maternal and child health care (vaccination), dissemination of child education for energy/power conservation and so on. Through these initiatives, Ulubelu Geothermal Power Plant is contributing to strengthening unity among residents and activation of interaction among residents.

This project has largely achieved its objectives. Therefore effectiveness and impact of the project are high.

3.5 Sustainability (Rating: ③)

3.5.1 Institutional Aspects of Operation and Maintenance

The operation and maintenance of the power plants after project completion is undertaken by Ulubelu Geothermal Power Plant under the supervision of PLN Bandar Lampung Sector (hereinafter referred to as “Regional Office”). Daily communication

[25] Six villages are: Muara Dua Village, Pagar Alam Village, Karang Rejo Village, Gunung Tiga Village, Data RajanVillage, and Ngarip Village.

between the Regional Office and Ulubelu Geothermal Power Plant are taken place and they have a close cooperation system. The Regional Office belongs to the Southern Sumatra Power Generation located in Palembang City. These organizations maintain good relationship and regular coordination meetings are carried out every quarter. In case discussion agenda arise, special meetings are convened, and exchanges of information and opinions are conducted as needed.

Ulubelu Geothermal Power Plant allocates division managers who take responsibility for operation (A-D)[26], maintenance and administration under the head of the plant. About 40 staffs work at the whole power plants. Of which more than 90% are engineers in charge of operation and maintenance (in addition to about 40 staffs, about 30 helpers[27] who have been employed from the local residents are providing support). According to power plant staffs, number of engineers necessary for operation and maintenance has been secured.

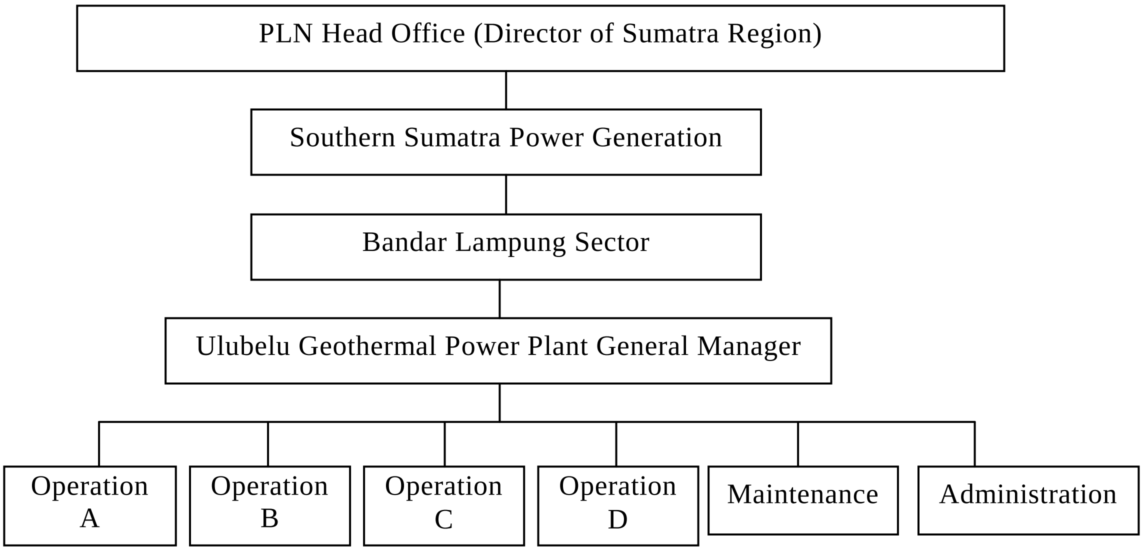

Figure 1: Organizational Structure of Operation and Maintenance of Ulubelu Geothermal Power Plant

Source: Prepared by the evaluator based on the information provided by PLN

Ulubelu Geothermal Power Plant has acquired ISO 90001 (quality management system), ISO 14001 (environmental management system), SMK3 (labor safety and sanitation management system), Security Management System, and operation and maintenance of the power plants has been taken place in conformity with these management systems. In addition, Ulubelu Geothermal Power Plant has introduced

[26] Operation Division adopts A to D four shift system a day.
[27] Helpers are mainly in charge of miscellaneous tasks as assistants of engineers.

Energy Management System, Supply Chain System on spare parts, Asset Management System, and Risk Management System, which are standardized within PLN, and has been carrying out operation and maintenance work.

Therefore, no particular problem has been identified regarding the institutional structures of operation and maintenance of Ulubelu Geothermal Power Plant.

3.5.2 Technical Aspects of Operation and Maintenance

As regards technical aspects of operation and maintenance, technical staffs who have acquired qualification as electricity engineers, authorized by the Indonesian Society of Power Generation Professionals (HAKIT) and the Indonesian Electrical Power Engineers Association (IATKI) as well as those who have gained sufficient experiences on operation and maintenance of power plants are deployed. In addition, during project implementation, consultants have provided training and technical transfer regarding operation and maintenance[28]. Furthermore, contractors have provided on-site operation and maintenance training to 33 PLN staffs during project implementation[29]. Engineers in charge of operation and maintenance have been receiving on the job training. They are also obliged to attend trainings on their own areas of responsibility and trainings according to the level of their own qualification at the PLN Learning Centers[30] once or more than once every year. In this way, appropriate human resource management system has been built in PLN. Ulubelu Geothermal Power Plant in coordination with the PLN Learning Centers is planning to establish training center on geothermal generation (on-site training as well as desk training) officially from 2018[31].

Manufacturers of generating facilities and turbines etc. have prepared manuals for operation and maintenance and they have been revised by Ulubelu Geothermal Power Plant as needed. The manuals are utilized for daily operation and maintenance work as well as periodic inspections.

Therefore, no particular problem has been identified regarding the technical aspects of operation and maintenance.

[28] 8 PLN staffs have received training regarding management of operation and maintenance technology for 10 days in Japan (May, 2011). In addition, 16 PLN staffs divided into two groups have received operation and maintenance training for 10 days each in Japan (October, 2011, November-December, 2011).

[29] Trainings were carried out in June-July, September, December 2011, January, July-August, September, 2012, October 2012-October 2013.

[30] PLN's training institutes are established in three places nationwide (Jakarta, Palembang and Surabaya).

[31] The power plant has so far received about 80 trainees and provided on-site training for 2 weeks to 1 month by experienced engineers.

Control Room

Transmission Line

3.5.3 Financial Aspects of Operation and Maintenance

The necessary operation and maintenance costs are estimated by Ulubelu Geothermal Power Plant, and the budget request will be made to the Regional Office directly supervising the power plants and then submitted to PLN Headquarter, via Southern Sumatra Power Generation which has jurisdiction over the Regional Office. After getting approval from PLN Headquarter, budget will be allocated to the power plants via Southern Sumatra Power Generation and the Regional Office.

Table 10 shows comparison of budget, actual allocation and actual expenditure of operation and maintenance cost of the power plants. The power plants' maintenance cost has been properly secured, and is also well operated and maintained on site.

Table 10: Operation and Maintenance Cost of Ulubelu Geothermal Power Plant

(Unit: million IDR)

	2014	2015	2016	2017
Budget (Requested Amount)	N.A.	615,689	657,756	497,203
Actual Allocation	N.A.	615,689	657,756	497,203
Actual Expenditure	490,290	615,809	507,669	81,907

Source: Results from questionnaire survey of PLN

Note 1) Actual expenditure in 2016 decreased because stem purchase cost from PGE dropped by approximately 15% compared with the previous year.

Note 2) Budget for 2017 decreased because the budget was prepared based on the steam purchase cost of the previous year. Actual expenditure of that year is up to February (expenditure for two months).

As regards financial situation of the entire PLN, recent income statement and balance sheet are shown in Table 11 and 12, respectively.

Table 11: Income Statement of PLN Note 1)

(Unit: billion IDR)

	2012	2013	2014	2015	2016
Total Revenues	232,656	257,405	292,721	273,900	283,263
Sale of Electricity	126,722	153,486	186,634	209,845	214,140
Government's Electricity Subsidy	103,331	101,208	99,303	56,553	60,442
Other Revenues	2,604	2,711	6,783	7,502	8,682
Total Operating Expenses	203,115	220,911	246,910	225,574	254,450
Fuel and Lubricants	136,535	147,634	170,488	138,408	109,492
Maintenance	17,567	19,839	20,207	21,861	21,227
Personnel	14,401	15,555	15,749	20,321	22,660
Other Operating Expenses Note 2)	34,612	37,883	40,466	44,983	101,071
Income Before Financial and Other Items	29,541	36,493	45,811	48,325	28,814
Net Financial and Other Items Note 3)	-28,509	-75,715	-35,387	-64,239	-12,837
Tax Benefit	2,174	9,654	-4,159	21,940	-5,428
Income (Loss) for the Year	3,206	-29,567	6,264	6,027	10,549

Source: PLN Annual Report

Note 1) Partial inconsistency of figures exists due to rounding error

Note 2) Power Purchase, Depreciation of Fixed Assets etc.

Note 3) Tax Revenue and Cost, Foreign Exchange Profit and Loss etc.

Table 12: Balance Sheet of PLN Note 1)

(Unit: billion IDR)

	2012	2013	2014	2015	2016
Total Assets	549,376	590,219	603,659	1,314,371	1,274,576
Total Noncurrent Assets Note 2)	472,066	505,382	518,235	1,235,026	1,173,609
Total Current Assets	77,310	84,837	85,424	79,345	100,967
Total Equity and Liabilities	549,376	590,219	603,659	1,314,371	1,274,576
Total Equity	159,270	150,331	164,671	804,791	880,798
Total Noncurrent Liabilities	315,503	350,582	351,430	389,441	272,155
Total Current Liabilities	74,603	89,306	87,558	120,139	121,623

Source: PLN Annual Report

Note 1) Partial inconsistency of figures exists due to rounding error

Note 2) Total noncurrent assets drastically increased in 2015 because reevaluation of assets (review) was carried out.

When reviewing the income statement, while electricity sales of PLN have been increasing smoothly every year, the organization is supported by a big amount of government's electricity subsidy[32]. Government's electricity subsidy substantially decreased in 2015 and 2016 because adjustment of electricity tariff was made in May, 2014 and January, 2015[33].

Main factors behind the high-cost structure are identified as the high financial burden for fuel and lubricants necessary for power generation, low electricity tariff, and so on. PLN aims to reduce government's electricity subsidies, raise the electricity tariff, increase self-financing ratio (issuance of corporate bonds), and introduce private funds aggressively (construction of power generation facilities etc. by combining PLN's self-financing and private funds), in order to improve its financial and management conditions. While the electricity pricing is a decision matter of Indonesian government, which is out of control of PLN, the government has been expanding the customer categories introducing the floating tariff system as a direction of reform. As regards balance sheet, current ratios are slightly low, but no particular problem is expected due to the certainty of tariff collection and government's electricity subsidy. On the other hand, the high-cost structure of PLN etc. will not affect the project because, as mentioned above, operation and maintenance cost for the power plants has been appropriately financed and the power plants have been well operated and maintained.

Therefore, no particular problem has been identified regarding the financial aspects of operation and maintenance.

3.5.4 Current Status of Operation and Maintenance

The power plant facilities constructed by the project have been maintained well and operated smoothly. The geothermal power plants have developed a maintenance plan (52 week maintenance plan) which sets down type of maintenance, budget, inspection schedule etc. and conducts maintenance activities appropriately based on this plan. Concretely, major inspection (every 4 years), minor inspection (every 2 years)[34], periodic maintenance (every week), daily maintenance, corrective maintenance, and

[32] The government subsidy to PLN is stipulated in the Article 66 of the Law on State Enterprises of 2001 on Public Service Obligation. (Financial compensation for state-owned enterprises.)

[33] Concretely, out of the entire 17 customer categories of electricity tariff, total of 10 categories including large customers for industrial use (4 categories in May 1, 2014 and 6 categories in January 1, 2015) were excluded from the target for the government's electricity subsidy and transferred to the floating tariff system from the previous fixed tariff system. Electricity tariff of these 10 categories are adjusted every month based on: (1) inflation rate issued by the central statistics office, (2) exchange rate of rupiah against dollars announced by the central bank, and (3) crude oil price in Indonesia. The fixed tariff is maintained as before to households with little power consumption (the poor).

[34] Minor inspection was conducted at the beginning of 2016. The first major inspection is planned on 2017. (Unit 1: planned on September, 2017 and Unit 2: planned on October, 2017).

preventive maintenance activities are carried out.

About the issue of decrease in steam volume which PGE supplies, PGE has: (1) repaired the three production wells which encountered decrease in steam volume after minor inspection in 2016[35] (implemented), (2) drilled one new production well in 2016 (implemented), and (3) planned to drill two more additional production wells in September, 2017 (scheduled) in order to restore steam volume as mentioned above. Information has been closely shared between PGE and PLN regarding PGE's countermeasures and the situation of production wells since problems occurred in the first place. (As regards (1), steam volume has not been restored to the original volume even after the repair. Regarding (2), observation of the situation is necessary until steam volume stabilizes (until the end of 2017).)

As regards spare parts, Ulubelu Geothermal Power Plant has introduced supply chain management system and inventory management system which have been standardized within PLN. Under the system, spare parts necessary for maintenance have been refilled and stored in the warehouse of Ulubelu Geothermal Power Plant on a timely basis. Spare parts have been categorized into three, based on their importance (A: spare parts with very high importance. In case spare parts under this category have not been procured in a timely manner, blackouts may occur, B: lack of spare parts under this category may create temporary problems, C: spare parts under this category are consumable items which would not create troubles to the point of affecting power outputs) and different procurement/storage management is carried out for each category. Especially, category A spare parts are indispensable for operating the power plants and usually take time for procurement. Thus, a system has been adopted to prepare in a structured way for more than one year ahead of time in order to procure them in a timely manner.

Therefore, no particular problem has been identified regarding the current status of operation and maintenance.

No major problems have been observed in the institutional, technical, financial aspects and current status of the operation and maintenance system. Therefore sustainability of the project effects is high.

[35] According to PLN, problem seemed to have occurred in the process of drawing steam and hot water from the geothermal reservoir using the production well.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

This project constructed geothermal power generation plants in Ulubelu, Tanggamus Regency, Lampung Province with the aim of alleviating the tight power supply-demand balance and improving the stability of power supply of the Southern-Sumatra System in Sumatra Island. The objective of the project which addresses the tight power supply-demand condition by supplying power through renewable energy is well consistent with electric power policy and development needs of Indonesia, as well as with the Japan's ODA policy in the sense that geothermal development – a stable and renewable energy –is promoted. Therefore, the relevance of the project is high. Although the project cost was within the plan, the project period exceeded the plan. Therefore, efficiency of the project is fair. Operation and Effect Indicators set at the time of appraisal have largely achieved the target figures. The project is located in Lampung Province where reserve margin is the lowest in Southern-Sumatra System and is playing an important role to reduce power loss and to maintain quality of power supply in this area. In addition, as a result of field interviews, it can be judged that the project has been contributing to the activation of economy and improvement of investment environment in Lampung area. Therefore, the project has largely generated its planned effects; thus, its effectiveness and impact are high. No negative impact on natural environment and land acquisition has taken place. Moreover, creation of local employment by the project and contribution to the community activities of local residents through CSR initiatives were confirmed. No major problem has been observed in the institutional, technical and financial aspects of the operation and maintenance system as well as in the current status. Therefore, sustainability of the project effects is high.

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

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

None

4.2.2 Recommendations to JICA

None

4.3 Lessons Learned

The importance of continuous survey on quantity and quality (pressure, temperature and components[36]) of steam as well as well-planned and prompt measures to prepare for future changes in geothermal power plants

In Indonesia, different organizations conduct geothermal power generation development – PGE undertakes heat source survey, development and steam supply in its geothermal field and PLN carries out development, and operation and maintenance of geothermal power plants, as in this project. Since geothermal energy is an element of nature, even if quantity and quality of steam was secured as planned based on the preliminary survey at the beginning of power generation, they may change over time with the operation of power plants. In this regard, when different organizations undertake geothermal power generation development like the case in Indonesia, it is important for the executing agency to monitor periodically that the steam supply organization continues the survey on quantity and quality of steam and promotes systematic heat source development even after starting operation of the power plants based on the Steam Sales Contract. Also, if there are indications of future changes in quantity and quality of steam, it is critical for the executing agency, in close collaboration with the steam supply organization, to identify the cause as soon as possible, and to carry out countermeasures such as additional drilling of production wells while gathering detailed information on the conditions of heat source etc. In particular, when additional drilling is going to be carried out, well-planned and prompt measures through collaboration between both organizations is the key since prior approvals from pertinent authorities including the Ministry of Environment are necessary. It is also important that JICA regularly grasps the situation and promptly urges the steam supply organization to take appropriate measures through the executing agency when there is a problem or sign of problem concerning quantity and quality of steam even after project completion, from the viewpoint of securing project sustainability.

End

[36] There was a problem of the amount of steam in this project, but regarding the problem of steam quality, refer to the ex-post evaluation report on Japanese ODA loan project in Indonesia, “Lahendong Geothermal Power Plant Project”, which was implemented almost in the same period as this project. https://www2.jica.go.jp/en/evaluation/pdf/2015_IP-517_4.pdf

Comparison of the Original and Actual Scope of the Project

Item	Plan	Actual
1. Project Outputs	1) Civil Works, Procurement of Equipments etc. ・ Construction of geothermal power plant facilities (55MW x 2 units) ・ Construction of 150kV transmission line ・ Expansion of substation etc. ・ Construction of distribution lines 2) Consulting Services ・ Review of existing resource development study (related to steam) ・ Detailed design, assistance in tendering, construction supervision ・ Assistance in O&M, transfer of knowledge and technology, and human resource development ・ Assistance in environmental management	1) Civil Works, Procurement of Equipments etc. ・ As planned ・ As planned ・ As planned ・ As planned 2) Consulting Services ・ As planned ・ As planned ・ As planned ・ As planned
2. Project Period	March, 2005 – February, 2012 (84 months)	March, 2005 – October, 2013 (104 months)
3. Project Cost Amount Paid in Foreign Currency Amount Paid in Local Currency Total ODA Loan Portion Exchange Rate	 15,747 million yen 8,128 million yen (677,375 million IDR) 23,875 million yen 20,288 million yen 1IDR=0.012 yen (As of September, 2004)	 12,233 million yen 6,862 million yen (672,711 million IDR) 19,095 million yen 16,068 million yen 1IDR=0.0102 yen (Average between 2005 and 2014)
4. Final Disbursement	June, 2014	

End