

Indonesia

Mt. Merapi and Mt. Semeru Volcanic Disaster Countermeasures Project(2)

Field Survey: July 2003

1. Project Outline and Japan's ODA Loan



Check dam on Mt. Merapi



Project location map



Consolidation dam on Mt. Semeru

1.1. Background

Indonesia has 129 active volcanoes (approx. 20% of the world total), and the pyroclastic flows (primary disaster), debris flows and mudflows (secondary disasters) caused by the activity of these volcanoes have brought severe damage in surrounding areas.

Mt. Merapi in Central Java (summit elevation: 2,968m) is located approximately 30km north of the city of Yogyakarta; Mt. Semeru in East Java (summit elevation: 3,676m) is located approximately 160km south-southeast of the city of Surabaya. Both are among the most active of Indonesia's volcanoes and mudflows formed from volcanic debris during the heavy rains of the rainy season have devastated areas on the flanks. In March 1980 a disaster prevention master plan was formulated for the two volcanoes with cooperation from the Japanese government; the Mt. Merapi Volcanic Disaster Countermeasures Project (Phase I) (L/A: 1985; completed: 1992) and the Mt. Semeru Volcanic Disaster Countermeasures Project (Phase I) (L/A: 1982; completed: 1991) were executed in line with this plan resulting in the development of soil-erosion control structures (hereinafter sabo facilities), predominantly on the high-risk sloping sides of the volcanoes.

A huge Mt. Merapi eruption in February 1992 resulted in the formation of a new lava dome on the western side of the volcano. Mt. Merapi subsequently erupted again in November 1994 producing debris flows on the southern flank, where erosion control structures were insufficient, which claimed 66 lives. Given the high risk of secondary disaster from the collapse of the lava dome and the considerable volume of volcanic debris remaining, further reinforcement of the sabo facilities on the southern flank was identified as a priority task. Meanwhile, the pyroclastic flows produced by strong eruptions at Mt. Semeru in 1992 and 1994 both claimed victims (3 fatalities in 1992, 8 fatalities in 1994). Predictions of secondary disaster on the southern-to-eastern flanks, which lacked sabo facilities, led to strong demands for the expansion of sabo facilities.

1.2. Objectives

To prevent / mitigate damage caused by mudflows of volcanic debris by constructing sabo facilities on Mt. Merapi and Mt. Semeru, thereby contributing to the security of societies in the region.

1.3. Output

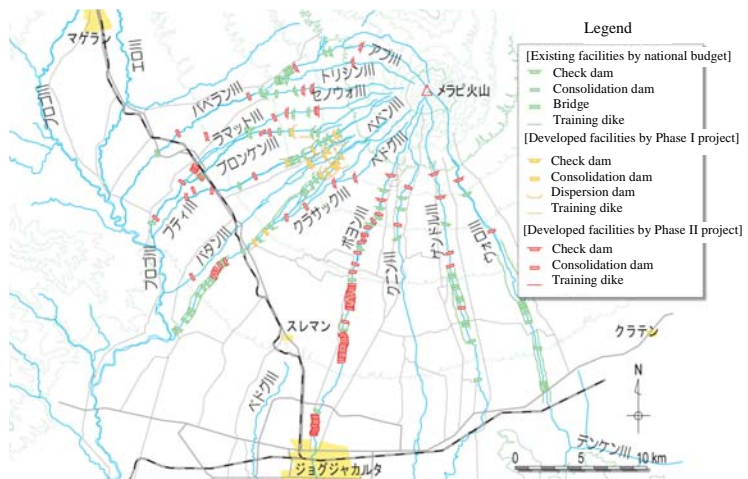
This project comprises civil engineering works, procurement and consulting services.

1. Construction of sabo facilities in areas peripheral to Mt. Merapi and Mt. Semeru (13 check dams, 12km of training dike, etc.)
2. Installation of debris flow warning system¹ for Mt. Semeru
3. Consulting services: detailed design, bidding assistance, supervision of civil engineering work

Figure 1: Areas covered by this project

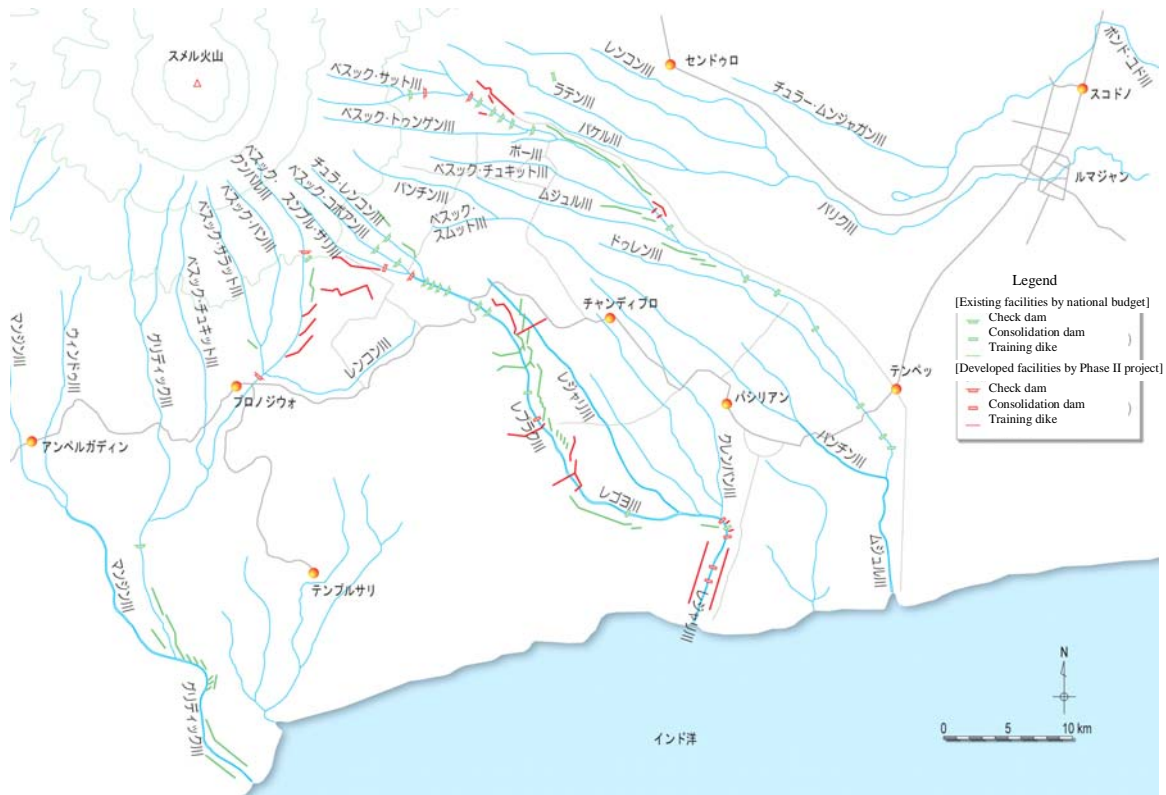
(The scale of the two maps is identical. Red sections indicate sabo facilities developed in this project.)

Mt. Merapi (above) and Mt. Semeru (below)



¹ Comprising a data system that collects the information needed to recognize debris flow predictions and analyze their mechanism, a system for managing and processing the collected data (central monitoring bureau), and a PR system for transmitting evacuation warnings to residents living in dangerous areas without delay on the basis of processed data.

Figure 1: Areas covered by this project (continued)



1.4. Borrower / Executing Agency

Republic of Indonesia / Directorate General of Water Resources (DGWR), Ministry of Settlement and Regional Infrastructure

1.5. Outline of Loan Agreement

Loan Amount	4,405 million yen
Loan Disbursed Amount	4,387 million yen
Exchange of Notes	December 1995
Loan Agreement	December 1995
Terms and Conditions	
Interest Rate	2.3%
Repayment Date (Grace Period)	30 years (10 years)
Procurement	General untied
Final Disbursement Date	December 2001

2. Results and Evaluation

2.1. Relevance

This project involved planning and executing the development of sabo facilities that were primarily designed to prevent the occurrence of secondary disasters in areas on the flanks of Mt. Merapi, located on the outskirts of the densely populated city of Yogyakarta in Central Java, and of Mt. Semeru, located in the Lumajang District on the outskirts of Surabaya in the province of East Java. The national development plan at the appraisal (REPELITA VI: 1994-1998) was focused on promoting agriculture under a broad policy of “developing and conserving national land” for the natural resources and environment sector and this project’s objective: “to prevent / mitigate damage caused by mudflows of volcanic debris” was highly relevant, in that the project was designed to support stable economic growth, including agricultural production.

The current national development plan (PROPENAS: 2000-2004) identifies “the reinforcement of sustainable and equitable development infrastructure based on promoting economic reconstruction and the national economic system”, with a focus on “conserving national land”. The aim of this project is to prevent / mitigate damage caused by mudflows of volcanic debris, thereby ensuring the relevance in terms of the current national plan.

2.2. Efficiency

2.2.1. Outputs

[Mt. Merapi]

The Mt. Merapi disaster prevention component of this project was planned and executed as a means of addressing the pyroclastic flows (primary disaster), debris flow and mudflows (secondary disasters) caused by recurrent eruptions during 1992 through 1994. Phase I was implemented in response to the eruption of 1984 and primarily covered the southwestern flank (Sleman District); however, this project focused on the regions situated on the southern and western side of Merapi (the city of Yogyakarta and the Magelang District) and was designed to cover four administrative districts, namely: Yogyakarta Special Region, the Sleman District, the Boyolali District and the Magelang District. Because the eruptions of 1997 and 1998 (i.e. during the implementation phase) produced greater sediment deposits than had been anticipated, a new check dam and consolidation dam² were added. (For details, refer to the “Comparison of Original & Actual Scope”.)

² A “consolidation dam” is primarily designed to prevent riverbed erosion and to stabilize the gradient / form of the riverbed along the course of the river; such dams are built across rivers. A “check dam” is a dam structure built on rivers with a steep gradient / mountain streams, and is designed to control sediment production caused by hillside collapse or the erosion of the river channel, to prevent unstable flows of sediment that has accumulated on the riverbed, and to avert debris flow. A “training dike” is an embankment structure that regulates the direction of mudflows, rendering them harmless. Their function differs from that of the training dikes that are built at the confluence or mouth of rivers.

Table 1: Major Facilities at Mt. Merapi: Planned & Actual

	Planned	Actual
Check Dams	11 sites	14 sites
Consolidation Dams	2 sites	29 sites
Training Dikes	2 sites	2 sites

Note: compiled on the basis of the project completion report



Check dam



Consolidation dam



Training dike

[Mt. Semeru]

The Mt. Semeru disaster prevention component of this project was planned and executed in order to deal with the pyroclastic flows, debris flow and mudflows caused by recurrent eruptions during the 1990s; the beneficiary area was the Lumajang District located on the southeastern side of the volcano. Mt. Semeru continued to erupt during the project implementation, producing greater sediment deposits than had been anticipated; accordingly, additional work was executed, including measures to prevent debris flow in the upper reaches of the Mujur River basin, the construction of sabo facilities on the Leprak River, and the construction of a consolidation dam to control the mudflows of volcanic ash into the Brantas River on the western side of the volcano (for details, refer to the “Comparison of Original & Actual Scope”).

Table 2: Major Facilities at Mt. Semeru: Planned & Actual

	Planned	Actual
Check Dams	2 sites	4 sites
Consolidation Dams	7 sites	13 sites
Training Dikes	3 sites	5 sites

Note: compiled on the basis of the project completion report

2.2.2. Project Period

The planned completion date for the project was June 2000, but the above additions to outputs pushed the schedule back by approximately one year, and work was finally completed in September 2001. However, all planned outputs at the appraisal were completed by June 2000.

2.2.3. Project Cost

Total project costs were budgeted at 5,196 million yen, but actually totaled 5,178 million³, with

³ According to the project completion report, the construction order for Mt. Merapi amounted to 166,953 million rupiah (2,186

the actual disbursement amounting to 4,387 million yen against a loan limit of 4,405 million. This underrun was principally due to the depreciation of the rupiah, a consequence of the Asian currency crisis that occurred during the implementation, which enabled foreign currency (yen-denominated) costs to be covered within the initial budget, despite the aforementioned changes / additions to project outputs.

2.3. Effectiveness

(1) Development Standard of Sabo facilities

Despite the differences in the frequency and direction of the eruptions, both volcanoes remain active and are continuing to produce sediment deposits (from debris flows and mudflows). In consequence, the volume of sediment that should be regulated by the sabo facilities, in short, the designed excess sediment volume⁴, is changing the course and increasing over time. The Phase I project covered the southwestern flank of Mt. Merapi, which was identified as requiring urgent countermeasures in the master plan, and has contributed to preventing debris flow disasters not just in surrounding areas but also on transport infrastructure, such as roads and railways. Correspondingly, this project covered a wide area spanning the south-to-western flanks that were not targeted by Phase I Project, and specifically, the Boyong River, which flows directly into Yogyakarta. Meanwhile, the Phase I project for Mt. Semeru covered the east-to-southeastern flank, where damage was concentrated at the time, whilst this project focused primarily on areas to the south due to the need to respond to a subsequent change in the direction of eruptions.

Table 4 shows the status of sabo facilities at the appraisal and after project completion (as of 2001).

million yen), whilst that for Mt. Semeru was 100,492 million rupiah (approx. 1,306 million yen).

⁴ The designed excess sediment volume, which equals the difference between the designed flow sediment volume and the designed allowable sediment volume, represents the volume to be regulated by sabo facilities. The projected allowable sediment volume represents the amount of designed flow sediment volume that can be allowed to flow into downstream areas – reflecting social / natural conditions, or the amount necessary to maintain downstream / coastal areas. Meanwhile, the designed flow sediment volume represents the amount of designed produced sediment volume that is forecasted to flow into downstream areas. The designed produced sediment volume represents the amount of sediment around sloping areas and/or riverbeds in the whole valley (including the sediment for this project) that flow into river channels and mountain streams for a certain period.

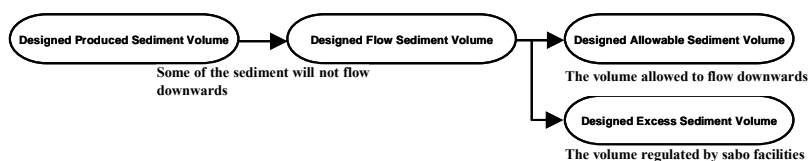


Table 3-1: Post-project improvements in the standard of sabo facilities

Target Rivers	Development targets at the appraisal (1995)					Post-completion status (2001) <i>After the 2001 review of the master plan</i>		
	Projected excess sediment Volume* (thousand m ³)	Pre-project		Post-project (planned)		Projected excess sediment Volume (thousand m ³)	Controllable sediment volume (thousand m ³)	Control rate (%)
		Controllable sediment Volume (thousand m ³)	Control rate (%)	Controllable sediment Volume (thousand m ³)	Control rate (%)			
Pabelan River	2,427	797	32.8	1,260	51.9	3,921	2,969	75.7
Blongkeng	--	--	--	--	--	6,304	3,126	49.6
Batang River	--	--	--	--	--	18,062	9,319	51.6
Krasak River	19,510	17,282	88.6	18,122	92.9	19,510	12,852	65.9
Boyong	4,110	1,400	34.1	2,860	69.6	4,360	3,608	82.8
Kuning River	4,548	445	9.8	883	19.4	2,274	1,535	67.5
Gendol River	2,480	250	10.1	443	17.9	2,480	1,608	64.8
Woro River	3,725	1,080	29.0	2,415	64.8	3,725	3,416	91.7
Total	36,800	21,254	57.6	25,983	70.6	64,976 (36,270)	38,433 (25,988)	63.4 (71.6)

Note 1: Compiled from appraisal data and the project completion report. *The designed excess sediment volume figures at the appraisal are revisions that were made after the eruption of 1994.

Note 2: Sabo facilities on the Blongkeng and Batang rivers were developed as additional project outputs, thus the figures for both rivers were not planned at the appraisal. The bracketed figures at the post-completion time point exclude the values for the Blongkeng and Batang rivers.

Note 3: During the implementation the Krasak riverbed was observed to be rising, thus the controllable sediment volume was dramatically reduced based on a review of the 2001 master plan.

Turning first to Mt. Merapi, the designed excess sediment volume was 36,800 thousand m³ at the appraisal, whilst the volume of sediment capable of being regulated by existing sabo facilities, i.e. the controllable sediment volume, was 21,254 thousand m³. Consequently, the control rate⁵, which expresses the ratio of designed excess sediment volume to the controllable sediment volume, was 57.6%. Due to the addition of the Blongkeng and Batang rivers during the project implementation, while the actual figures of designed excess sediment volume was 64,976 thousand m³, controllable sediment volume and control rate was 38,433 thousand m³ and 63.4%, respectively. However, excluding the Blongkeng and Batang rivers, which were developed as additional output components, although the projected excess sediment volume increased as the result of eruptions in 1998 and 2000, i.e. during the implementation phase, the control rate was 71.6% (the target figure: 70.6%) suggesting that this project has raised the standard of sabo facilities to planned levels.

⁵ This figure expresses the ratio of projected excess sediment volume to controllable sediment volume. Analyses of actual disasters demonstrate that in some cases, the sediment volume exceeds the control volume of check dams, etc. Accordingly, the control rate is no more than an index to be referenced in measuring safety and it is thus necessary to bear in mind that even if the control rate is 100% (or higher), this does not mean that an area is completely safe from damage.

Table 3-2: Post-project improvements in the standard of sabo facilities

Mt. Semeru	Development targets at appraisal (1995)					Post-completion status (2001) <i>After the 2001 review of the master plan</i>		
	Designed excess sediment Volume (thousand m ³)	Pre-project		Post-project (planned)		Projected excess sediment Volume (thousand m ³)	Controllable sediment Volume (thousand m ³)	Control rate (%)
		Controllable sediment Volume (thousand m ³)	Control rate (%)	Controllable sediment Volume (thousand m ³)	Control rate (%)			
Target Rivers								
Mujur River	--	--	--	--	--	5,040	1,800	35.7
Rejali River	5,220	2,550	48.9	3,280	62.8	5,220	4,851	92.9
Glikdik River	4,500	0	0.0	1,740	38.7	4,500	856	15.9
Total	9,720	2,550	26.2	5,020	51.6	14,760 (9,720)	7,507 (5,707)	50.9 (58.7)

Note 1: Compiled from appraisal data and the project completion report (some calculations have been revised).

Note 2: The sabo facilities on the Mujur River were developed as additional project outputs, thus the figures for the river were not planned at the appraisal. The bracketed figures at the post-completion exclude the values for this river.

For Mt. Semeru, the designed excess sediment volume was 9,720 thousand m³, the controllable sediment volume 2,550 thousand m³, and the control rate 26.2% at the appraisal. Meanwhile, the control rate at project completion was 29.5%, and if the Mujur River, which was developed as an additional output component, is excluded, then the control rate is 58.7%, which exceeds the projected value of 51.6%.

(2) Disaster Protection

Table 4 presents a history of major volcanic disasters caused by Mt. Merapi and Mt. Semeru eruptions to date. Since the major eruption of 1994, there have been no recorded disasters involving people, property or agricultural land around Mt. Merapi up to the evaluation (2003). According to residents of the beneficiary area and project personnel, there has been no damage to people, property or agricultural land, despite the fact that debris flow with the scale of having caused damage before the project occurred frequently. This suggests that the sabo facilities developed through this project are helping to protect the area from disaster. Mt. Semeru has also not caused damage to people, property or agricultural land since the eruption of 1994.

Table 4: History of Volcanic Disasters in the Target Areas

■Mt. Merapi		Fatalities / disappearances (people)	Houses affected (houses)	Affected area (hectares)	Remarks
Eruptions					
1930		1,869	1,109	-	2,140 cattle killed
1954		64	144	-	59 cattle killed
1961		6	103	-	19 cattle killed
1969		6	322	Fields: 125	18 bridges destroyed
1971		-	-	Fields: 10	-
1973		-	-	Fields: 10	(January)
		-	-	Fields: 19	(October)
1974		-	9	-	(January)
		9	6	-	(October)
		-	10	-	(November)
		-	4	-	(December)
1975		-	107	Fields: 30	10 bridges destroyed
1976		27	385	-	5 bridges destroyed
1986		1	-	-	Southwestern slope
1994		66	40	Fields: 295 Forest fires: 700	South slope 33 cattle killed

Note: Compiled from the Master Plan Review of 2001 and executing agency records (also applies to data in the table below)

■Mt. Semeru		Fatalities / disappearances (people)	Houses affected (dwellings)	Affected area (hectares)	Remarks
Eruptions					
1909		208	1,449	1,380	-
1976		119	200-300	880	-
1981		365	1,002	679	Rejali River, Glikdik River
1992		3	52	500	As above
1994		8	9	296	As above

(3) Examples of disaster protection by cases

The effects of this project are evidenced hereunder on the basis of actual examples in which the sabo facilities developed through the project prevented debris flow disasters.

[Mt. Merapi]

(a) Check dam on the Boyong River

The Mt. Merapi eruption of 1998 caused debris flows in the Boyong River. The check dam (see Fig. 6), which had retained available capacity, were filled with the sediment that flowed into the dam. This means that the check dam succeeded in breaking the momentum of the debris flow. In the interview with the headman of a local village, he mentioned that the biggest debris flow in living memory was produced by the eruption of 1969 and the check dam prevented the debris flow of 1998 from causing damage. Whilst it is difficult to estimate how much damage would have occurred if the check dam had not been installed, it is

Figure 2: Check Dam on the Boyong River (headwaters are on the right)



believed that this dam protected residents in neighboring areas from debris flow damage.

(b) Check dam on the Apu River

The debris flow in the Apu River in January 2003 completely filled the check dam. The force of the flow is suggested by the fact that the guard rail on the road running across the top of the dam was partially damaged. According to the project manager, had the check dam not been there, the village located down river (Muntilan) would likely have sustained considerable damage. This suggests that the check dam developed through this project produced the effects.

Figure 3: Check dam on the Apu River



[Mt. Semeru]

(c) Training dike on the upper reaches of Mujur River

This project involved the construction of a training dike on the upper reaches of the Mujur River. There has been a check dam nearby constructed from the national budget, which was full of sediment at the field survey. The project manager reports that the sediment had occasionally flowed as far as neighboring villages when floods occurred, while there has been no such damage since the construction of the training dike. In the interview with the local village headman, he mentioned that in former years flooding had resulted in sediment flows reaching the village, but that thanks to the training dike no such events now occurred.

Figure 4: Training dike on Mujur River headwaters



As mentioned above, it is considered that the check dams (and other sabo facilities) that were developed through this project are effectively preventing debris flow disasters.

(4) Recalculation of the Economic Internal Rate of Return (EIRR)

The EIRR for both volcano projects was recalculated in reference to the calculation conditions used at the appraisal and data obtained at the project completion, and both results exceeded the appraisal figures (see below).

Table 5: Result of EIRR recalculations

	Mt. Merapi	Mt. Semeru
Appraisal figure	12.0%	11.7%
Recalculated figure	20.8%	17.2%

In calculating project benefits, reductions in damages to assets and agricultural production, etc. caused by debris flows were added up, and the project life set as 50 years being the same as the life of structures. Since additional outputs were developed within the planned budget, the benefits of the project have increased, rendering the project more economical than had been initially forecast.

2.4. Impact

(1) Regional Economic Development

Population, households and gross regional product (GRP) indices in the regions covered by this project have a tendency to increase as a whole (GRP has recovered in recent years despite a temporary decrease due to the Asian currency crisis of 1997), and economic activity is increasing and intensifying in both regions. National economic growth averaged 1.2% annually (1995-2002) as compared to 1.2% for the Magelang and Sleman districts (Mt. Merapi) and 1.9% for the Lumajang district (Mt. Semeru); suggesting that this project is supporting economic activity in the two regions.

Table 6: Economic indices for the project regions (GRP are expressed in real terms on a 1993 price base)
Mt. Merapi Magelang District + Sleman District

Year	Population	Households	GRP (Billion Rp.)
1995	1,858,490	471,698	2,300
1996	1,877,090	469,273	2,500
1997	1,895,880	473,970	2,700
1998	1,914,860	478,715	2,400
1999	1,934,040	483,510	2,400
2000	1,953,430	488,358	2,400
2001	1,973,020	493,255	2,400
2002	1,992,810	498,203	2,500

Source: Statistical data of each district

Mt. Semeru Lumajang District

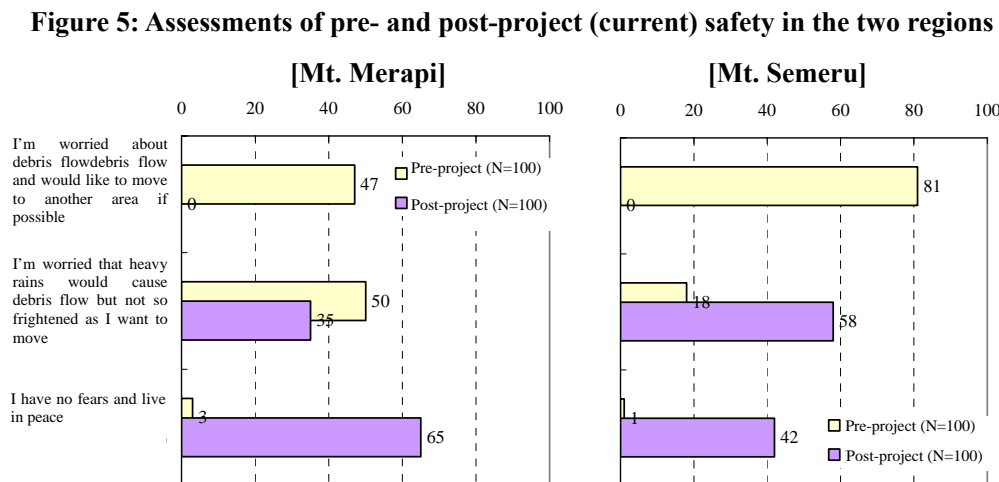
Year	Population	Households	GRP (Billion Rp.)
1995	927,363	185,473	756
1996	929,153	185,831	810
1997	930,075	186,015	890
1998	934,228	186,846	820
1999	941,609	188,322	810
2000	944,528	188,906	820
2001	947,456	189,491	850
2002	950,393	190,079	860

Source: Statistical data of each district

The number of beneficiary was estimated at around 2 million for Mt. Merapi (Magelang District + Sleman District) and at around 950,000 for Mt. Semeru.

(2) Case Studies

Beneficiary surveys⁶ were conducted targeting those living in the villages near the two volcanoes that were visited during the field survey (100 people in each area). The results showed that the completion of the projects is recognized to have increased safety in the two regions (see the table below).



Note: Data was sourced from the beneficiary survey conducted in the PEDACs 2003

According to the results of these surveys, prior to the project implementation almost half of the respondents in Mt. Merapi and 80% of those in Mt. Semeru were “worried about debris flows and would like to move to another area if possible”, while such serious problems was solved after the project completion. Although some people still tend to be concerned that heavy rains could cause debris flow, due to their vivid memories of past disasters, more than 60% of respondents in Mt. Merapi and upwards of 40% in Mt. Semeru stated that they “have no fears and live in peace”, suggesting that safety has improved to a remarkable extent in both regions.

In the surveys, evaluators inquired whether and what kind of economic impacts the project has had. Almost all respondents in both regions evaluated the project as “having had an economic impact on the region”. Concretely, most respondents cited increased employment and earning opportunities in the form of gravel collection and sales in the agricultural off-season (70-80% of the total), and increased use of agricultural land in areas near the check dams equipped with an irrigation function (approx. 70%), whilst others mentioned improved transport access (resulting from the development of roads for management purposes and those that are incidental to sabo facilities).

(3) Environmental Impact

Gadjah Mada University (Mt. Merapi) and Brawijaya University (Mt. Semeru) were commissioned by the project office to conduct environmental impact assessments (EIA) ahead of project implementation and the project was executed having confirmed that it would not pollute

⁶ Test subjects were selected from the four villages of Candibinagun, Purowbinagun, Somokaton and Merdikorejo for Mt Merapi, and from the three villages of Sumber Wuluh, Kertosari and Kelapa Sawit for Mt Semeru, and group-based interviews were conducted.

water or impact on local plant and animal habitats. The project has not produced any direct negative environmental impact since the project completion. Furthermore, this project did not involve any resettlement and although some land was acquired, primarily in the upper reaches of the two volcanoes, this did not generate any specific problems.

2.5. Sustainability

2.5.1. Executing Agency

(1) Technical Capacity

Both project offices are staffed by approximately 100 employees each, around half of which are technical staff. The staff carries out regular patrols and repairs where necessary, and according to the two project office managers, the technical skills of staff are sufficient for the current scope of activities.

(2) Operation and Maintenance System

The two volcanic disaster prevention projects were respectively implemented by the Mt. Merapi project office and the Mt. Semeru project office under central government supervision (ministry of settlement and regional infrastructure); the two offices are also responsible for post-completion operation and maintenance.

(3) Financial Status

O&M costs for the sabo facilities on both volcanoes totaled 343 million rupiah in fiscal 2001 (project completion) and 350 million rupiah in fiscal 2002. According to project staff, this budget is not necessarily sufficient to cover routine repairs and regular dredging, etc. There is a separate central government provision (300-400 million rupiah annually) to cover the costs involved in large maintenance, such as repairs to revetments, etc.

2.5.2. Operation and Maintenance Status

Details of the operation and maintenance of sabo facilities on Mt. Merapi and Mt. Semeru are given below.

[Mt. Merapi]

The project primarily involved the development of sabo facilities in areas on the southern flanks of Mt. Merapi, and all facilities in the area are basically in favorable condition. Sabo facilities were constructed on rivers (the Blongkeng and Batang rivers) that flow through southwest-to-western areas of the volcano as an additional output component. There is a brisk private-sector business in sand and gravel mining in the area. Although there is a miner damage to structures caused by illegal sand mining, appropriate repairs are being undertaken with funding allocated from the national budget.

[Mt. Semeru]

The check dams constructed in the upper reaches of the Mujur and Rejali rivers are almost full of sand and damage to some sabo facilities was observed. Although small-scale flooding is gradually washing the sand and gravel that has accumulated in the check dams downstream, there are concerns that the next big debris flow would cause a disaster. Traffic access in the upper reaches is poor and commercial sand mining companies are unable to reach these areas. The project office has requested the central government to rehabilitate damaged facilities and to construct new check dams and embankments.

In 1986, the Mt. Semeru project office purchased machinery for maintenance (bulldozers and dump trucks) using fund assistance from the Japanese government, but it has already exceeded its economic life. The project office has requested Japanese grant assistance for maintenance machinery purchases.

The debris flow warning system developed through this project was functional for two years after project completion, but has been out of order since January 2003, and the outsourcing of repairs is currently under investigation.

Mt. Semeru is showing signs of re-activation (volcanic debris at around 1,000 thousand m³ in December 2002) and debris flow into the Glidik River on the southern flank are increasing. In consideration of these circumstances, the project office is in the process of constructing an embankment on the lower reaches of this river using a national budget.

2.5.3. Sand mining and its initiatives

[Mt. Merapi]

Rain-induced debris flow accumulates in check dams, reducing their capacity over time, which means that the project office is required to remove accumulated sediment as necessary. However, since the sand and gravel produced by Mt. Merapi has market value, the project is attempting to reduce sediment volumes by extending political inducements to private sand miners.

On the other hand, given that the heavy equipment used by private-sector sand mining companies has the potential to cause damage to sabo facilities, mining activities by private sand miners must be appropriately monitored. Currently, sand mining on Mt. Merapi is governed by a licensing system⁷, which involves technical assessments and the issuing of licenses by the district government (for example, licenses are not granted when forest conservation issues exist or when there are concerns about the impact on control structures, etc.). In Magelang District, where sand mining is at its most vigorous, mining rights have been granted to twelve operators (excluding those mining zones with a surface area of 1ha or less). The mining companies are subject to a tax of 1,500Rp./m³. A part of the tax is assigned to the project office's O&M budget, which helps to strengthen its financial sustainability. Furthermore, the project office has formulated guidelines for sand mining and signboards standing near each structure indicate where sand mining may be undertaken (at least

⁷ Operators that have been granted sand mining rights are under the following obligations: to erect signboards indicating the area and duration (licenses are usually valid for 3 years) of their mining activities; to report extraction volumes; and to establish a local contact office.

100m and more from the headwater side of structures, etc.). Despite evidence that the guidelines are not being adhered to in some areas⁸, most operators are in conformity.

Most of the sand and gravel removed is transported to the city of Semarang (the capital of Central Java province) and traded in markets there (shipping price: 15,000Rp./m³, trading price in Semarang: 100,000 Rp./m³). As evidenced by the beneficiary survey, the mining and marketing of sand and gravel is believed to contribute to earnings increases for residents in the Merapi area. Moreover, the evacuation roads developed through this project are connected with national highways, being used to transport mined sand and gravel.

Figure 6: Sand mining at Mt. Merapi (left) and a signboard near a control structure (right)



However, illegal sand mining activities has been found in the forest conservation area in the upper reaches of the Putih River, giving rise to concerns over damage to forest areas. In response, the Mt. Merapi Mining Regulatory Bureau (Badan Pengendali Penambangan Pasir Merapi: BP3M; its director is an employee of the forestry commission) was established in September 2002 under orders from the district governor to manage licensed areas and strengthen the licensing system.

As mentioned above, the government has already taken various measures to ensure the sustainability of project effects and it is hoped that these efforts will be ongoing.

[Mt. Semeru]

Four companies have licenses to mine sand in the Lumajang District (one of which is the district government-owned PT. Perusahaan Pertambangan Semeru established in 1996). The mining sites primarily located in easily accessible down river areas of the Rejali. The project office has indicated that it would like sand to be removed from the headways of the various rivers in the area, but transport access is a problem.

The sand mined from Mt. Semeru has an extremely high quality as a construction material and is being used in the construction of giant concrete structures (electric power plants and bridges). It is generally traded for 80-90 thousand rupiah per cubic meter in Surabaya, which is higher than the general trading price of 50-60 thousand rupiah. While damage to sabo facilities and invasion into forest areas in the upper reaches of rivers on Mt. Merapi is problematic, no such problems have occurred on Mt. Semeru to date. By contrast, finding ways to promote sand mining activity represents an issue in ensuring the sustainability of project effects.

⁸ There is evidence of damage to sabo facilities due to illegal sand mining, but it is difficult to control. In order to crack down on such activity, it would be necessary to have 24-hour surveillance aided by the police. However, it is impossible to enforce under the current system / budget. Moreover, damaged structures are being appropriately repaired and measures are taken before the negative impacts due to the damage of sabo facilities occurs.

3. Feedback

3.1. Lessons learned

In case there exists a market for sand and gravel produced from volcanic eruptions, it is possible to reduce the financial burden of operation and maintenance, by inducing private sand miners to take away sand.

The Mt. Merapi project office has used policy-based inducements to private sand miners to reduce the operation and maintenance budget required for removing the sediment that accumulates in check dams. Demand for sand such as the existence of large local markets, and cheap mining and transportation costs from mining areas are the two prerequisites required to induce private companies to mine. In terms of the latter condition, developing access roads to sand mining areas has the potential to attract private sand miners. This enables the project office to further reduce operation and maintenance costs, to support the sustainability of project effects, and to contribute to the development of local industries. Moreover, by imposing a tax on the sand and gravel that are extracted, the revenues can be allocated to the construction of access roads that facilitate sand mining, and to the operation and maintenance budget for sabo facilities, environmental measures and so forth.

It is desirable that efficient operation and maintenance schemes such as sand mining legislation, policy-based inducements, organizational systems, and the construction of access roads and other facilities that would encourage commercial sand mining companies should be investigated from the planning stage (during the feasibility study) of similar future projects.

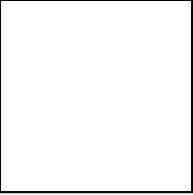
3.2. Recommendations

None.

Comparison of Original and Actual Scope

Item	Planned	Actual
1. Outputs		
<u>Construction for Mt. Merapi</u>		
1) Check dams	11 sites (AP-D3, TR-D4, KR-D3, KR-D5, BO-D8, BO-D7, BO-D5, KU-D3, GE-D5, GE-D7, WO-D6)	As left
2) Consolidation dams	2 sites (BO-C2A, BO-C4)	Essentially as planned (BO-C2A switched to BO-C2)
3) Training dikes	2 sites (BO-T1, BO-T2)	As left
4) Flow channels	1 site (BO-CW)	Essentially as planned (BO-CW switched to BO-CH)
5) Revetments	3 sites (WO-R13, WO-R11, WO-R7)	As left
6) Roads for excavation work	2 sites (KR-ER, AP-ER)	As left
7) Additional construction necessitated by eruptions during the implementation	---	<ul style="list-style-type: none"> - Consolidation dams (BO-C1A, GE-C7, BO-C5, -C6, -C7, PA-C2, BL-C10, -C10A) - Flow path construction (BO-CW2) - Improvement of existing dams (SE-D2, LA-C6) - check dam (SE-D3, LA-D0, LA-D3) - Dam for Discharge Measurement of LA-C7 - Bank protection work for wire sensors - Warning system
8) Additional work due to increased debris	---	<ul style="list-style-type: none"> - Consolidation dams (19 sites: KU-C1, GE-C10, -C12, BO-C8A, -C11A, KR-Kembang, KR-C1 to C4, C6, C7, PU-C0, -C8A, -C2, PA-D1, -C5, BL-C2, -C1) - Additional facilities (BO-11B, KR-C2, PU-D2, PA-C4) - Drilling roads (6 sites: BS-ER, BC-ER, PK-ER, JS-ER, GS-ER, MS-ER) - Dam reinforcement work (8 sites: BO-C8 to C11, BO GS 1A, 1B, 2A, 2B) - Rehabilitation work (KR-gedoyo, BA-C5) - Flow path construction (A-11, M-7 (remaining), LA-CW, BL-CW) - Bank protection work (BA-R3)
<u>Construction for Mt. Semeru</u>		
1) Consolidation dams	7 sites (RE SS KD-1, RE LE KD-2, RE RG KD-3, RE RE KD-4, RE RE KD-6, -7, -8, GL KL KD-1)	As left

2) Check dams	2 sites (RE CK CHD-5, GL BK CHD-1)	As left
3) Training dikes	3 sites (RE SS TG-1, RE RG TG-1/U, RE RG TG-1/L)	As left
4) Levee construction	3 sites (GL BK TG-1/U, -1/M, -1/L)	As left
5) Groin construction	21 sites (RE LE KR-1 to -6, RE RE KR-1, 2, 1A, 1B, RE CN KR-1 to -11)	As left
6) Revetments	1 site (RE LE PT-1)	As left
7) Flow paths	1 site (RE RE CN-1)	As left
8) Access roads	2 sites (RE CK AR-1, RE SS AR-1)	As left
9) Additional work due to increased debris	---	- Dispersion dams (RE LE DD-1, RE LE DD-3) - Access roads (RE LE AR-1, RE BK AR-1, MU BS AR-1) - Consolidation dams (RE RE KD-6A, RE RE KD-6B, MU BT KD-1, MU BT KD-2, BR LES KD-1, KD-2) - Check dams (U BS CHD-9, -5) - Training dikes (MU BS TG-1, MU BT TG-1)
<u>Debris Flow Warning System</u>		
1) Primary station	1 site for the project at Mt. Semeru	As left
2) Relay station	1 site for the project at Mt. Semeru	As left
3) Observatories	3 sites (G. Leker, Besuk Kembar and Besuk Kobo'an)	1 site added at G. Pakis
4) Warning stations	3 sites (Sembergesang, Supiturang and Sumberwuluh)	1 site added at Kertosari
<u>Consulting services</u>		
1) Foreign consultant A	109 M/M	256 M/M
2) Local consultant B	255 M/M	685 M/M
2. Implementation schedule		
L/A conclusion	Oct. 1995	Dec. 1995
Consultant selection	Jul. 1995 – Jun. 1996	Jul. 1995 – Jul. 1996
Contractor selection	Oct. 1996 – Jun. 1998	Jan. 1996 – Jan. 2000
Equipment procurement	Jul. 1996 – Mar. 1997	Jun. 1999 – Aug. 2001
Consulting services	Jul. 1996 – Jun. 2000	Jul. 1996 – Sept. 2001
Civil engineering work	Jan. 1998 – Jun. 2000	Oct. 1996 – Aug. 2001
Land acquisition	Apr. 1996 – Dec. 1997	Oct. 1996 – Mar. 1999
Project completion	Jun. 2000	Sept. 2001
3. Project cost		
Foreign currency	1,925 million yen	4,387 million yen
Local currency	3,271 million yen (72,690 million rupiah)	791 million yen (63,280 million rupiah)
Total	5,196 million yen	5,178 million yen
- ODA loan portion	4,405 million yen	4,387 million yen



Exchange rate	1Rp. = 0.045 yen (as of 1995)	1Rp. = 0.013 yen (as of 2001)
---------------	----------------------------------	----------------------------------

Third Party Evaluator's Opinion on Mt. Merapi & Mt. Semeru Volcanic Disaster Countermeasures (2)

Erna Witoelar
Chair, KEHATI Foundation

Impact

Positive social economic impacts are quite visible & felt by communities living around the project location, in the form of protection from future volcanic disasters, which relieves the villagers from worries. This in turn is increasing their productivities, as economic activities are increasing and intensifying. There are increased uses of agriculture lands, improved transportation access by project-built roads, and improved income from sand and gravel collection. The indirect impacts of these improved economic conditions are the increased capacity to access social services like education and health facilities for their families.

This project has no negative environmental-impact during construction; on the contrary it has a positive impact of preventing environmental disasters. But it has post-operation negative environmental impact caused by illegal & over mining, which also caused destruction of access roads, and overflow of check-dams. Both negative impacts can cause sudden floods or long droughts, which need to be controlled to prevent further damages.

All the positive impacts mentioned above will cease or slow down, or will be forgotten as new generation of villagers will grow, who did not experience previous worst conditions. Hence an effort to communicate to surrounding communities the history & rationale of this construction, and the positive impacts it has brought and will continue to bring, is quite needed. It is especially important to expose the figures of economic impact, as in the era of decentralization and local autonomy starting the year 2000 in Indonesia, people are very ignorant of the rationale for central government to borrow loans in the past, causing them very reluctant to share the burden of repaying these loans in the future. It can be in the form of small permanent exhibitions or information posters in village/sub-district centers. This will ensure the ownership of the local communities and maintain their appreciation of the past & present positive impacts of the project.

Sustainability

Local ownership and local capacity for Operation & Maintenance are very important to ensure the sustainability of this project. This project was built during the centralized government system, and it was quite natural that O & M responsibilities were still designed for being undertaken by the central government, but sooner or later this need to be reviewed and decentralized to the local levels. There are several options: either to a joint program of several districts, to a provincial program coordinating the districts, or to a private company jointly recruited by the local governments with clear terms of reference and time frame. An independent assessment is needed to find the best & workable option.

The central government project holder, if necessary with JBIC support, need to develop an exit strategy and implementation plan to hand over these responsibilities and build-in rights in due time when the local set-up is ready. A transition of continued central funding for a few years is probably needed to ensure a smooth process of capacity building and transfer.

This will motivate the district/provincial leaders to intensify the law enforcements of sand & gravel mining activities. Existing mining licenses need to be reviewed, and wherever feasible, "illegal" activities need to be "legalized" with better governance and control, with more transparent & logical fee systems for O & M cost recovery. Continued illegal actions need to be punished or heavily fined, if necessary more than their potential profit. Upstream and downstream different conditions, opportunities and needs should be accommodated as much as possible, to prevent injustice or unfair share of burden.