eruptions since the latter half of the 19th century. 21 of these 75 volcanoes are concentrated in the densely populated island of Java, and are spaced at approximately 70 km intervals from east to west.

For this reason, 35% of the total area of Java is covered with the new volcanic soil which emerged from these volcanoes.

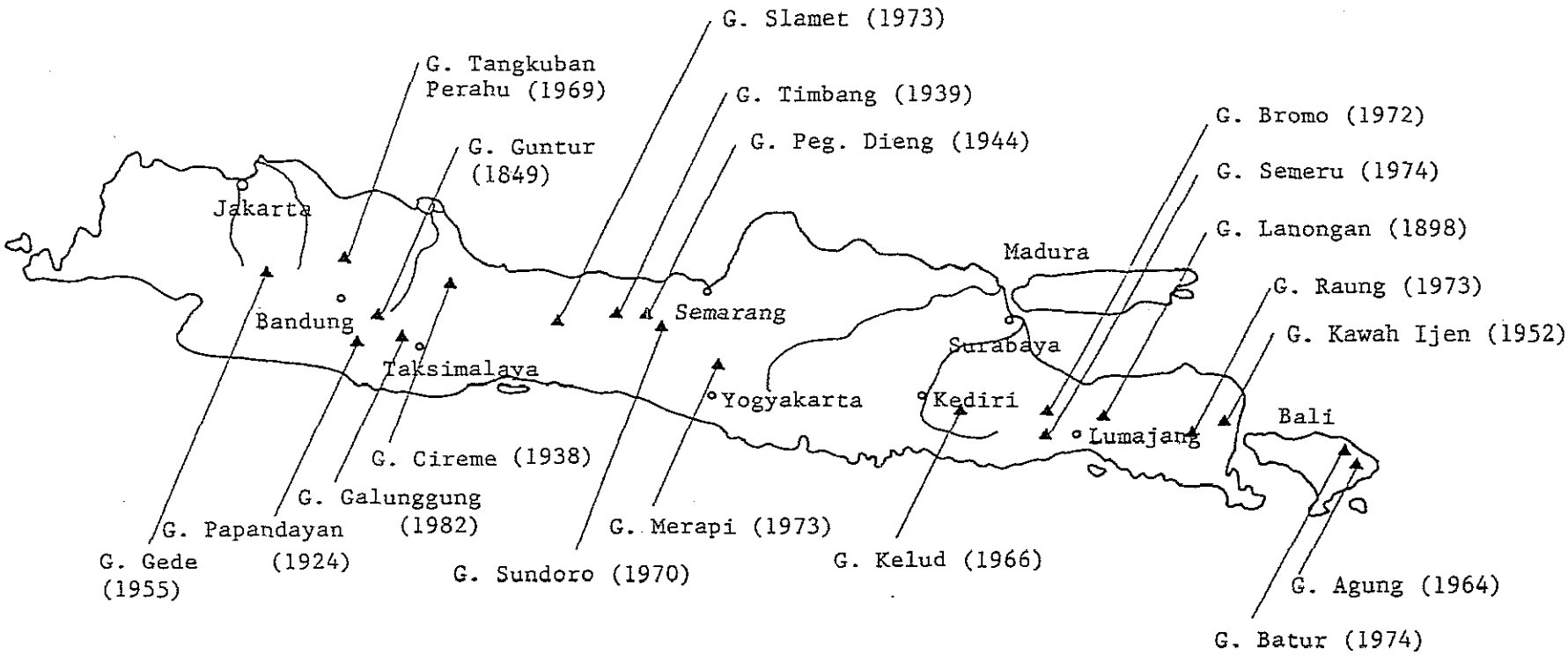
2-1-3 Weather Conditions

The weather in Indonesia is tropical and, as the country is located near the equator, the annual average temperature is around 27 deg. C, with almost no temperature variation throughout the year.

The seasons are divided into the dry season (April to September) and the rainy season (October to March), approximately 80% of the annual average rainfalls (about 2,250 m/m) being concentrated in the rainy season. The type of rainfall is characterized in that in many cases rain is localized and continues for a short period with a high hourly precipitation.

Notable active volcanoes in Java and Bali Sx 1/5,000,000

Figures in parentheses are the years when volcanic eruptions were recorded



Source: A Collection of Basic Data on Volcanoes in Indonesia (1979)

2-2 VOLCANIC DISASTERS

2-2-1 Structure of Occurrence of Disaster

The disasters attributable to volcanic activities can be divided into disasters brought about directly by volcanic activity and secondary damage caused even after the cessation by volcanic activity. The former includes the following:

(1) Descent of volcanic bombs and ash and outflow of lava during the eruption.

(2) Nuee ardente generated by the eruption.

The fumes flowing from the crater pick up the torrent fines and flow down the slope like water.

(3) Primary lahar (hot lahar).

The water in a crater lake is mixed with the eruption products and streams down the slope in the form of a high-temperature debris flow.

The above phenomena strike living creatures, rice paddies and farms directly to produce damage.

There is also a phenomenon called secondary lahar in which the eruption products accumulated at the skirt of a mountain become a debris flow when subject to heavy rain, and flow down the mountain. Such a flow can be generated even after volcanic dormancy, causing secondary damage and making the damage caused by the volcanic activity still more serious.

2-2-2 Volcanic Damage in Indonesia

In the Republic of Indonesia, particularly in densely populated Java, as the land has been highly utilized right up to the skirts of the volcanoes, direct damage due to volcanic eruptions is often aggravated by the damage caused by torrent generated when localized rain hits the accumulated volcanic products.

Table-1 shows the records of volcanic damage from 1963 to 1982.

Table-1 Disasters due to volcanic eruptions and sediment flow

Year	Volcano	Level of damage		
		Death and missing	Completely destroyed house	Buried rice paddy and farm
		(man)	(unit)	(Ha)
1963	Agung	1,148	7,723	16,500
1966	Kelut	286	2,620	11,600
1969	Merapi	6	322	Unknown
1976	Merapi	29	386	Unknown
1978	Semeru	14	Unknown	4,000
1981	Semeru	450	535	600
1982	Galunggung	27	22 villages damaged	

In the case of Mt. Agung, which without prior warning burst into a mighty eruption in 1963 for the first time in 300 years, 54 villages or 1,963 units were completely destroyed by nuee ardente with a death toll of 820, 59 injured, 2,277 hectares of rice paddies and farms damaged, 1,560 units destroyed by volcanic bombs and ash, 165 dead, 201 injured, and as much as 54,000 hectares of rice paddies and farms damaged.

In addition to the above mentioned tolls and damages, records indicate that lahar struck 21 villages or 4,200 units, killed 165, wounded 36, and damaged 2,200 hectares of rice paddies and farms.

With another lahar which was generated in May 1981 at the foot of Mt. Semeru, 450 lives were lost.

With Mt. Galunggung which burst into a mighty eruption in April 1982 for the first time in 160 years, even after the cessation of the volcanic activity, damage by lahar is still reported. Records indicate that lahar occurs every rainy season at the skirts of Mt. Semeru and Mt. Merapi.

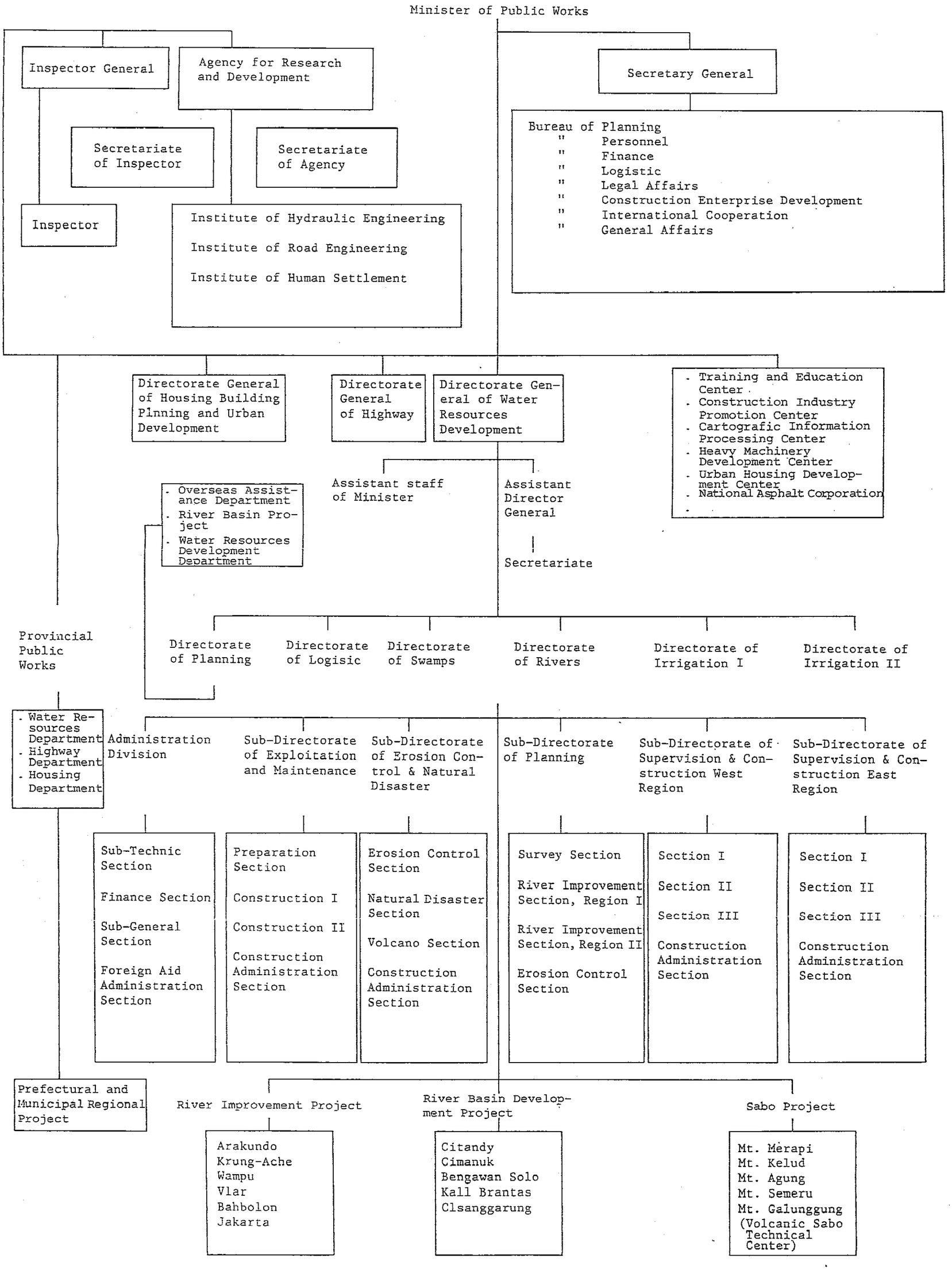
Thus, under such circumstances, where disasters frequently occur and there is a high probability of the occurrence of distaster, sabo has become a necessary and highly urgent project for the Republic of Indonesia.

2-3 SABO SITUATION

2-3-1 Sabo Administration Organization

The administrative authority having jurisdiction over the planning and implementation of sabo undertakings is the Directorate of Rivers, reporting to the Directorate General of Water Resources Development, the Ministry of Public Works. The organization of the Ministry of Public Works, including the details of the Directorate of Rivers, is shown in the Organization of the Ministry of Public Works.

The Erosion Control Section of the Sub-Directorate of Planning of the Directorate of Rivers is in charge of sabo planning related operations, while the Sub-Directorate of Supervision & Construction is in charge of the construction related operations.


Minister of Public Works
Inspector General
Agency for Research and Development
Secretary General
Secretariate of Inspector
Secretariate of Agency
Bureau of Planning
" Personnel
" Finance
" Logistic
" Legal Affairs
" Construction Enterprise Development
" International Cooperation
" General Affairs
Inspector
Institute of Hydraulic Engineering
Institute of Road Engineering
Institute of Human Settlement
Directorate General of Housing Building Plinning and Urban Development
Directorate General of Highway
Directorate General of Water Resources Development
. Training and Education Center
. Construction Industry Promotion Center
. Cartografic Information Processing Center
. Heavy Machinery Development Center
. Urban Housing Development Center
. National Asphalt Corporation
. Overseas Assistance Department
. River Basin Project
. Water Resources Development Department
Assistant staff of Minister
Assistant Director General
Secretariate
Provincial Public Works
Directorate of Planning
Directorate of Logisic
Directorate of Swamps
Directorate of Rivers
Directorate of Irrigation I
Directorate of Irrigation II
. Water Resources Department
. Highway Department
. Housing Department
Administration Division
Sub-Directorate of Exploitation and Maintenance
Sub-Directorate of Erosion Control & Natural Disaster
Sub-Directorate of Planning
Sub-Directorate of Supervision & Construction West Region
Sub-Directorate of Supervision & Construction East Region
Sub-Technic Section
Finance Section
Sub-General Section
Foreign Aid Administration Section
Preparation Section
Construction I
Construction II
Construction Administration Section
Erosion Control Section
Natural Disaster Section
Volcano Section
Construction Administration Section
Survey Section
River Improvement Section, Region I
River Improvement Section, Region II
Erosion Control Section
Section I
Section II
Section III
Construction Administration Section
Section I
Section II
Section III
Construction Administration Section
Prefectural and Municipal Regional Project
River Improvement Project
River Basin Development Project
Sabo Project
Arakundo
Krung-Ache
Wampu
Vlar
Bahbolon
Jakarta
Citandy
Cimanuk
Bengawan Solo
Kall Brantas
Clsanggarung
Mt. Merapi
Mt. Kelud
Mt. Agung
Mt. Semeru
Mt. Galunggung
(Volcanic Sabo Technical Center)

2-3-2 Scale of Budget

The scales of the budgets of the sub-agencies of the Ministry of Public Works and the budget for the Sabo Project, including the construction of a new volcanic sabo technical centre, are detailed below.

Breakdown of Budget of the Ministry of Public Works

Authorities	1985 Budget (Share)	1986 Budget (Share)
	Rp bil. (%)	Rp bil. (%)
1. Directorate General of Water Resources Development	368.0 (49.4)	162.8 (44.3)
2. Directorate General of Highways	282.1 (37.9)	133.7 (36.4)
3. Directorate General of Housing, Building Planning and Urban Development	73.3 (9.8)	51.7 (14.1)
4. Agency for Research and Development	7.5 (1.0)	5.8 (1.6)
5. Secretariate General	12.5 (1.7)	11.9 (3.2)
6. Inspectorate General	1.5 (0.2)	1.4 (0.4)
Total	744.9 (100)	367.3 (100)

Breakdown of Budget of the Directorate General of Water Resources Development

Authorities	1985 Budget (Share)	1986 Budget (Share)
	Rp bil. (%)	RP bil. (%)
1. Directorate of Rivers	87.395 (23.8)	37.581 (22.5)
2. Directorate of Irrigation I	171.985 (46.7)	80.586 (48.2)
3. Directorate of Swamps	24.416 (6.6)	10.150 (6.1)
4. Directorate of Planning	6.333 (1.7)	1.550 (0.9)
5. Directorate of Logistics	4.390 (1.2)	2.500 (1.5)
6. Institute of Hydraulic Engineering	5.321 (1.4)	4.242 (2.5)
7. Secretariate of Agency	1.659 (0.5)	0.950 (0.6)
8. Directorate of Irrigation II	66.492 (18.1)	29.544 (17.7)
Total	367.991 (100)	167.023 (100)

Directorate of Rivers Annual Budget (From 1979 to 1984)

Unit: Rp 1 million

Classification	1979	1980	1981	1982	1983	1984
River Improvement Project	8,750	10,187	11,367	14,251	18,378	19,574
River Basin Development Project	25,747	28,985	41,480	69,312	59,558	53,514
Sabo Project	2,657	3,586	4,324	5,208	4,989	5,061
Provincial Public Works	6,677	3,436	6,572	7,974	7,295	9,171
Total	38,831	46,194	63,744	96,745	90,221	87,124

Sabo Project Annual Budget (From 1981 to 1986)

Unit: Rp 1 million

Project	1981	1982	1983	1984	1985	1986
Merapi	1,538	1,918	1,265	1,389	1,392	642
Kelud	1,266	1,290	933	888	897	345
Agung	706	780	640	695	650	253
Semeru	814	1,220	1,175	1,000	984	403
Galunggung	-	(3,000*)	975	893	1,000	389
V.S.T.C.				196	174	82
Total	4,324	5,208	4,989	5,061	5,097	2,114

* President's Special Work Budget for Countermeasures Against Natural Disasters

2-3-3 Sabo Undertakings

Of the sabo undertakings, the undertakings of national level have been implemented by the field offices established from time to time to deal with the respective volcanoes, and those of province-level have been implemented by the Provincial Public Works stationed in each province. The agencies which have been implementing the projects currently in progress and the reasons for their establishment are as follows.

Outline of Sabo Projects Under Direct Supervision of Directorate of Rivers

Project office	Location	Year established	Remarks
Mt. Merapi project office	Yogyakarta	1969	Mt. Merapi burst into mighty eruptions in 1969 and 1973, resulting in damage. A master plan was prepared through technical cooperation from Japan extended between 1976 and 1978.
Mt. Kelud project office	East Java	1969	Mt. Kelud's eruptions took the lives of 10,000 persons in 1586, 5,160 persons in 1919, 7 persons in 1951, and 210 persons in 1966.
Mt. Agung project office	Bali	1969	1,148 persons died and 296 persons were injured due to the nuee ardents and lahar generated when Mt. Agung burst into a mighty eruption.
Mt. Semeru project office	East Java	1977	Large scale lahars occurred in November 1976 and May 1985. A feasibility study was commenced in 1981 through Japan's technical cooperation, and an emergency restoration undertaking was commenced in 1982 with the aid of a year credit.

Project office	Location	Year established	Remarks
Mt. Galunggung project office	West Java	1982	The lives of 4,011 persons were lost in the 1822 eruption of Mt. Galungung. The mountain burst into a mighty eruption in April 1982 for the first time in 160 years, resulting in an enormous volume of sediment being discharged in the surrounding area.
Volcanic sabo technical centre	Yogyakarta	1982	In August 1982, as a centre-type project, the volcanic sabo technical centre was established, with the aim of training sabo engineers and developing sabo technology.

Operation of the Volcanic Sabo Technical Centre established in 1982 has been positioned as one of the direct supervision projects of the Indonesian government with the title of "Volcanic Sabo Technical Centre Project, BTA-9".

2-3-4 Sabo Technology

In the Republic of Indonesia, the sand pocket method is a typical disaster prevention method based on volcanic sabo technology. This method was devised and planned, after the disastrous 1966 eruption of Mt. Kelud, to prevent the recurrence of the outflow of accumulated sediment as well as to deal with future eruptions. The sand pocket method is such that a huge U-shaped earth embankment is constructed in the downstream direction to hold the debouching sediment and protect the downstream area.

To develop a more economical and effective sabo undertaking in conjunction with this method, the Indonesian government recognized the necessity of improving the sabo technology, and, on the occasion of the mighty 1969 eruption of Mt. Merapi and the subsequent disaster, the Indonesian government established volcanic field offices in several places, while placing a request to Japan for technical cooperation, Japan being a country with advanced sabo technology.

With the elapse of a decade since that time, through the technical cooperation of Japan's sabo experts, based on the request of the Indonesian government, and the subsequent local operations performed, as a JICA technical cooperation project, to plan an overall Mt. Merapi sabo project, and by participating in the training program in Japan, Indonesian engineers have almost completely learned Japan's highly systematized sabo research, planning, design and performance methods. From now on, these methods will be extensively domestically propagated among Indonesian engineers to improve the level of Indonesian sabo technology as well as to develop and establish a sabo technology befitting the local condition.

2-4 COOPERATION FROM JAPAN

2-4-1 Technical Cooperation

Confronted with frequently occurring volcanic disasters, the Indonesian government recognized the urgency of providing disaster countermeasures and the necessity of improving the level of sabo technology, and has placed a request to Japan, a country with advanced sabo technology, for its technical cooperation. Responding to this request, the Japanese government, since September 1970, has been despatching, based on the Colombo Plan, long-term specialists to the Ministry of Public Works and both the Mt. Merapi and Mt. Kelud field offices, and, whenever required, despatching short-term specialists to give instructions on sabo technology, thus contributing to the advancement of sabo technology in the country. In this regard, the number of long-term specialists despatched to date, including those currently staying in the country, has been as many as 22.

Also, in 1976, a "research for drafting a basic plan on volcanic sabo for Mt. Merapi" was commenced as one of JICA's research plans, and in 1980 a "master plan for Mt. Merapi volcanic sabo" which advocates the importance of establishing a "volcanic sabo technical centre" was submitted to the Indonesian government.

2-4-2 Volcanic Sabo Technical Centre

Based on the "master plan for Mt. Merapi volcanic sabo" mentioned in the preceding paragraph, the Indonesian government drafted a project for establishing a "volcanic sabo technical centre" while making a request to the Japanese government for its technical cooperation.

In response to this request, the Japanese government despatched a preliminary research mission in October 1981, which was followed by an implementation study team in August 1982. On August 26, a record of discussion was signed, and the technical cooperation for this project was commenced for an estimated period of five years.

From 1982 to date, a period of about 3 years and 6 months, the Japanese government has contributed, through the despatch of long- and short-term experts and the furnishing of necessary equipment, to the training of sabo engineers, improvement of sabo technology, development of adequate sabo technology, and establishing of sabo technology standards.

2-4-3 Provision of Equipment

As part of the countermeasures for the lahar disaster brought about as a result of the 1982 eruption of Mt. Galunggung, the Indonesian government made a request to the Japanese government for its urgent assistance on a lahar alarming and evacuation system. Responding to this request, the Japanese government decided to extend its grant aid for provision of equipment for a forecasting and alarming system as technical cooperation for disaster countermeasures.

The various types of equipment required and furnished between 1982 and 1985 for the activities and management of the Volcanic Sabo Technical Centre include surveying equipment, audio/visual equipment, volcanic lahar forecasting and alarming system unit, concrete and soil testing equipment, office equipment, and vehicles.

CHAPTER 3. VOLCANIC SABO TECHNICAL CENTER AND MUDFLOW ALARM SYSTEM

CHAPTER 3 VOLCANIC SABO TECHNICAL CENTRE AND MUDFLOW ALARM SYSTEM

3-1 VOLCANIC SABO TECHNICAL CENTRE

3-1-1 Outline

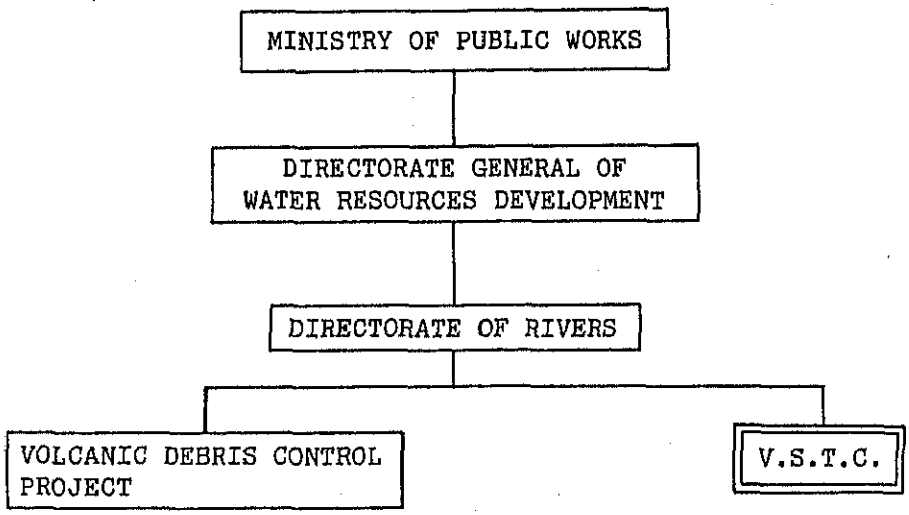
In response to the request from the Indonesian government for technical cooperation relating to this Volcanic Sabo Technical Centre (hereafter called "the Centre"), the Japanese government despatched a preliminary research team in October 1981 to study a feasibility for technical cooperation. On August 26, 1982, a record of discussion relating to the "Indonesian Volcanic Sabo Technical Centre" was signed between the two governments to commence a 5-year technical cooperation undertaking.

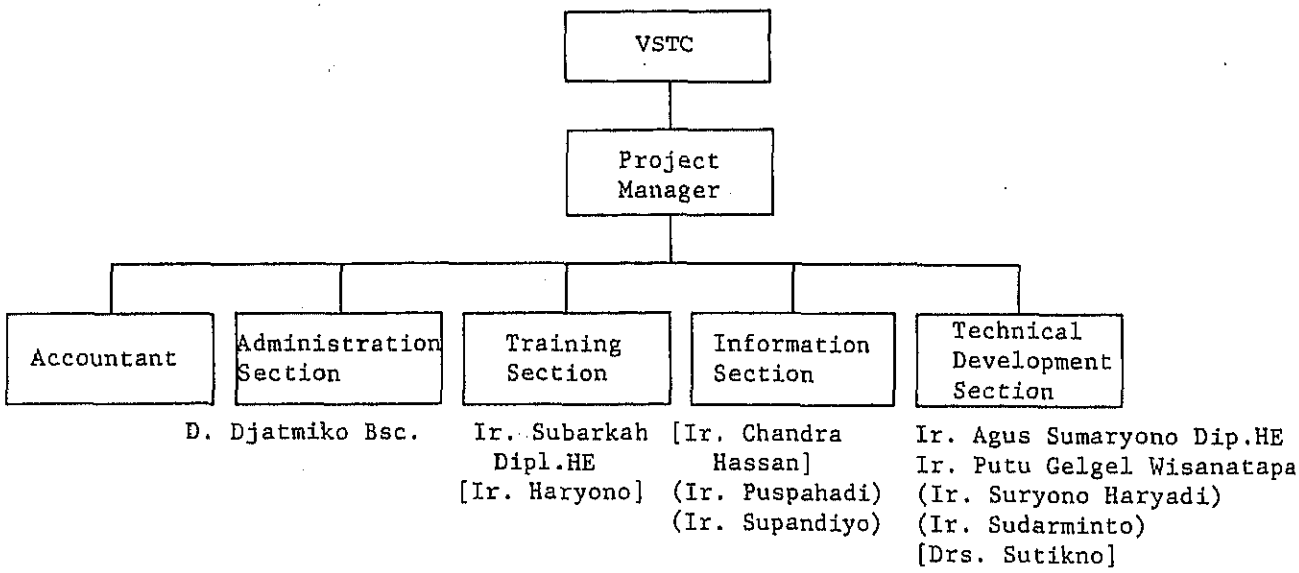
From 1982 to date, a period of about 3 years and 8 months, the Japanese government has contributed, through the despatch of long- and short-term experts and the furnishing of necessary equipment, to the training of sabo engineers, improvement of sabo technology, development of adequate sabo technology, establishing sabo technology standards, and development of volcanic lahar forecasting and alarming technology.

3-1-2 Organization and Operation

(1) Organization

The organizational position of the Volcanic Sabo Technical Centre (VSTC) and its organization at the time the research was performed are as shown below. However, the VSTC's attachment was changed as from April 1, 1986. The position of the VSTC within the Ministry of Public Works after that change is shown in Chapter 4.





Clerk: 16 pers Ir.: 2 pers, Sub.: 2 pers Ir.: 3 pers, Sub.: 0 pers Ir.: 5 pers, Sub.: 7 pers

Notation:

[ ] Studying in Nederland
( ) Attending S-2, UGM

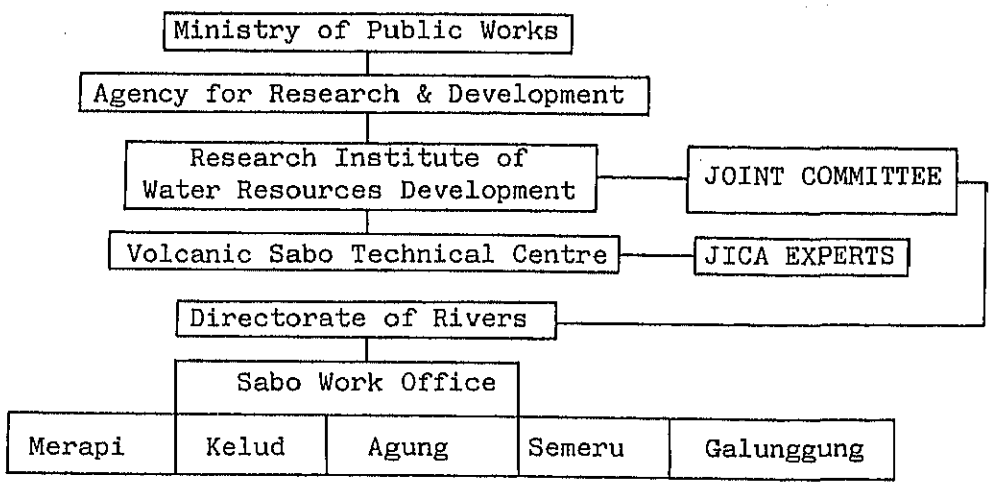
(2) Operation

The VSTC reports directly to the Directorate of Rivers, Directorate General of Water Resources Development, Ministry of Public Works, and is independent of and parallel to the five volcanic sabo projects and other projects also under its direct supervision.

A joint committee comprising members of the Directorate of Rivers and the Institute of Hydraulic Engineering will be established to study the operation methods, policies, etc., of the VSTC.

The steering committee is headed by the director of Directorate of Rivers and is composed of representatives of the Directorate of Rivers, the Institute of Hydraulic Engineering, the respective volcanic sabo projects for Mts. Merapi, Kelud, Agung, Semeru and Galunggung, as well as the managing staff of the VSTC and visiting Japanese experts.

The position of the steering committee in the organizational structure is as shown below.



3-1-3 Targets of VSTC

With short- and long-term targets being set as shown below, the VSTC has been developing its activities.

(1) Short-term targets

1) Training of sabo engineers, to perform feasibility studies and detailed designs of sabo projects.
2) Training of engineers to perform sabo work by means of new methods, new technologies and new machines.
3) Development of lahar forecasting and alarm technologies.

(2) Long-term targets

1) Improvement of the technical ability of Indonesian sabo engineers.
2) Establishment of sabo standards.
3) Development of Indonesia's unique sabo technology.

3-1-4 Contents of Activities

(1) Contents of activities

The training of engineers and development of technologies are the two major activities currently being promoted by the VSTC. Their contents are as follows.

1) Training of engineers

(a) Annual training program

Course	Capacity (Person)	Frequency	Total frequency	Period	Time (4 5 6 7 8 9 10 11 12 1 2 3)
General	20	3	60	1 mo.	
Intensive	15	1	15	4 mos.	
Comprehensive	5	1	5	2 yrs.	

(b) Objectives of respective courses

General course

Sabo undertakings are extensively introduced to Indonesian civil engineers so that they understand its necessity, basic concepts, and performance procedures.

Intensive course

Engineers are trained in the promotion of sabo undertakings in the Republic of Indonesia.

Comprehensive course

Engineers are trained to perform feasibility studies and detailed designs for sabo undertakings.

2) General Course

(a) Training participants

Staff who majored in civil engineering in their college or technical high school and have been engaged for two or three years in river improvement works or are undertaking training in their places of employment.

(b) Lecturers

The staff employed by the VSTC and the trainees receiving lectures at the comprehensive course receive the training chiefly from Indonesian lecturers by means of texts prepared in the Indonesian language.

(c) Curriculum

Training hours are as follows:

Basic subject	44 hrs
Applied subject	114 hrs
Others	34 hrs
Total	192 hrs

Concrete engineering and computer programming are also desired to be added to the above subjects when the associated training equipment has been made available.

The curriculum of the general course is shown below.

CURRICULUM OF GENERAL COURSE

No.	Subject	Number of Hours	Code	Lecturer
A.	Basic Subjects:			
	1. Hydraulics	14	HS	Ir. Subarkah Dipl.He
	2. Sediment Transport	18	ST	Ir. Kunsatwanto Dipl.HE
	3. Hydrology	12	HY	Ir. Puspahadi
	Subtotal	44		
B.	Applied Subjects:			
	1. Sabo Survey	10	SS	Ir. Putu Gelgel W
	2. Sabo Plan	16	SP	Mr. T. Hirozumi Mr. Koresawa Ir. Subarkah Dipl.HE
	3. Sabo Design	14	SD	Ir. Puspahadi
	4. Sabo Implementation	12	SI	Mr. T. Hirozumi Ir. Darmadi
	5. Debris Flow	14	DF	Ir. Darmadi
	6. Quality Control	16	QC	Drs. Biyarto Ir. Suryono Haryadi
	7. Sediment Control Dam	12	SC	Ir. Subarkah Dipl.HE
	8. Land Slide	8	LS	Ir. Agus Sumaryono Dipl.HE
	9. Land Slide Control	8	LSC	Ir. Sudarminto
	10. Land Conservation	6	LC	Ir. Puspahadi
	Subtotal	114		
C.	Others:			
	1. Closing/Opening Ceremony	12		
	2. Film Performance (3 x 2 jam)	6		
	3. Field trip	16		
	Subtotal	34		
	Total	192		

(d) Training costs

All costs, including expenses for accommodation and travel, and for a daily allowance, is to be borne by the VSTC. This stipulation is common to all courses.

3) Intensive Course

(a) Training participants

Staff with post-graduate qualifications currently employed by any of the agencies under the Directorate of Rivers.

(b) Lecturers

The basic subject is taught by lecturers from the University of Gadjak Mada and other outside institutes, and the applied subject is taught by long- and short-term Japanese experts plus experienced Indonesian staff of the Directorate of Rivers and the VSTC.

(c) Training of lecturers

The table below shows that, in the 5-year VSTC Project, after the transfer of technologies to the Indonesian staff, training is to be performed only by Indonesian lecturers. With the 5-year Technical Cooperation Project being midterm, Indonesian lecturers have already completed their training, and as shown in the table, the Intensive course for fiscal 1986 has been taught almost solely by

Indonesian lecturers. It is certainly expected that by the end of the Project, all lectures will be given by Indonesian lecturers.

SHIFTING SCHEDULE OF INTENSIVE COURSE

Subject	'83/84	'84/85	'85/86	'86/87	'87/88
Sabo Survey	L.E	L.E	L.E	I.I,S.E*1	I.I
Sabo Plan	L.E	L.E	L.E	L.E	I.I
Sabo Implementation	L.E	L.E	L.E	I.I	I.I
Sabo Design	L.E	L.E,I.I*2	L.E,I.I	L.E,I.I*3	I.I
Torrent Hydraulics		L.E	I.I	I.I	I.I
Hydraulic Model Test	S.E	S.E	S.E,L.E*4	S.E.I.I.*5	I.I

Notes:

*1 Only aerophoto interpretation by short-term expert

*2 Lecture by Indonesian, practice by long-term expert

*3 Only practice of channel work by long-term expert

*4 Lecture by long-term expert, practice by short-term expert

*5 Only practice by short-term expert

Notation:

L.E: Long-term Expert

S.E: Short-term Expert

I.I: Indonesian Instructor

(d) Curriculums

Since the beginning of training, intensive course curriculums have from time to time been reviewed to add improvements. As many trainees studied most of the basic subjects in their university days, much of the basic subject time has been appropriated to the applied subjects. Consequently, the curriculums for fiscal 1986 are as follows:

1.	Basic subjects	170 hrs.
2.	Applied subjects	398 hrs.
3.	General lectures	40 hrs.
	Total	508 hrs.

In addition to the above, a total of 184 hours is alloted for outdoor training and seminar/debate. The details of the curriculums are shown in the following table.

CURRICULUM OF THE FOURTH INTENSIVE COURSE "SABO WORKS"
IN FY 1986/1987

NO.	SUBJECT	CODE	NUMBER OF HOURS	LECTURER	ASSISTANT	REMARKS
	A. Basic Subject					
1.	Hydrology	HY	18	Drs. Sudarmadji M.Sc	Drs. Sutikno HS	
2.	Engineering Geology	EG	20	Ir. Soeharto Tjojudo M.Sc	Ir. Soeryono Harjadi	
3.	Hydraulics	HS	18	Ir. Nur Yuwono Dipl. HE	Ir. Subarkah Dipl.HE	
4.	Sediment Transportation	ST	22	Prof. Ir. Pragnjono Mardjikoen	Ir. Chandra Hassan	
5.	Land Conservation	LC	14	Ir. Soedarjo	Ir. Puspahadi	
6.	Structural Mechanics	SM	14	Ir. H. Daroeslan	Ir. Soeryono Harjadi	
7.	Soil Mechanics	SM	14	Ir. H. Daroeslan	Ir. Soepandijo	
8.	Volcanology	VO	14	Dr. Ir. Irwan Bahar		
9.	Concrete Engineering	CE	12	Prof. Ir. Achmad Antono	Ir. Soeryono Harjadi	
10.	Meteorology	MT	12	Ir. Sukardi W		
11.	Computer Programming	CP	12	Ir. Eko	Ir. Sudarminto	
			170			
	B. Applied Subject					
1.	Sabo Survey :	SS	56			
	- Sabo Survey			Ir. Djoko Legowo	Ir. Haryono	
				Ir. Putu Gelgel Wisanatapa	Ir. Puspahadi	
	- Aerophoto Interpretation			Short term expert		
2.	Sabo Plan	SP	52	Mr. K. Koresawa	Ir. Haryono	
				Ir. Subarkah Dipl.HE	Ir. Puspahadi	
3.	Sabo Design	SD	60	Mr. K. Koresawa		
				Ir. Agus Sumaryono Dipl.HE		
				Ir. Puspahadi		
4.	Sabo Implementation	SI	38	Ir. Darmadi		
				Ir. Supandiyo	Ir. Putu Gelgel Wisanatapa	
5.	Sabo CM	CM	18	Ir. Darmadi	Ir. Supandiyo	
6.	Debris Flow	DF	18	Ir. Darmadi	Ir. Putu Gelgel Wisanatapa	
7.	Torrent Hydraulics	TH	20	Ir. Subarkah Dipl.HE	Ir. Sudarmainto	
8.	Hydraulic Model Test	MT	52	Ir. Agus Sumaryono Dipl.HE	Ir. Soeryono Harjadi	
				Short term expert	Ir. Sudarminto	
9.	Landslide and Slope Failure	LS	22	Ir. Agus Sumaryono Dipl.HE	Ir. Sudarminto	
10.	Quality Control Dam	QC	22	Ir. Agus Sumaryono Dipl.HE	Ir. Soeryono Harjadi	
					Drs. Biyarto	
11.	River Engineering	RE	24	Ir. Siswoko Dipl.HE	Ir. Chandra Hassan	
12.	Sediment Control	SC	16	Ir. Sarwono Sukardi Dipl.HE	Ir. Haryono	
				Ir. Subarkah Dipl.HE		
			398			
	C. General Lecture					
1.	Population	PO	4	Dr. Peter Hagul		
2.	Psychology	PY	4	Dr. Djamaluddin Ancok		
3.	Erosion Control	EC	4	Ir. Djoko Legowo Dipl.HE		
4.	Organization of Dept.PU	PU	4	Ir. Moerwanto Martodinomo		
5.	Engineering Economy	EE	4	Ir. Bambang Waluyono Dipl.HE		
6.	River Basin Development	RB	4	Ir. Graita Sutadi M.Sc		
7.	Education and Training	ET	4	Ir. Djoko Wahono		
8.	Project Management	PM	4	Ir. Darmadi		
9.	Warning System	WS	4	Ir. Agus Sumaryono Dipl.HE		
10.	Sabo Project Evaluation	SV	4	Ir. Subarkah Dipl.HE		
			40			
	TOTAL		508			

4) Comprehensive Course

(a) Training participants

The Directorate of Rivers will select appropriate members for participating in this course. In the case of the first course, members were selected from among the participants of the Intensive Course.

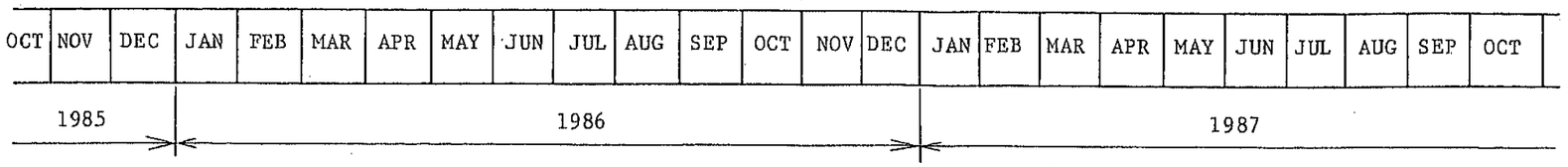
(b) Lecturers

The Comprehensive course is taught mostly by Japanese long-term experts with the aid of Japanese short-term experts.

(c) Lecturers

As opposed to the lecturing styles for the general and intensive courses, the Japanese experts choose a model river basin from those included in the Mt. Merapi Master Plan, giving the participants the themes for the feasibility study and the detailed design in the practice style. The second course to be commenced as from March 1986 is as shown in the following table.

SCHEDULED OUTLINE OF THE SECOND COMPREHENSIVE COURSE IMPLEMENTATION



THE 2nd COMPREHENSIVE COURSE DURATION PERIOD

▽ TERMINAL OF THE PROJECT

RECRUITING

PRELIMINARY STAGE *

1. Orientation
2. Field Study
3. Data collection
4. Geography
5. Basic exercise

SECOND STAGE

merged into 4th Intensive C

THIRD STAGE (CASE STUDY)

ADVANCED STAGE

if any,

* Objective area of study is to be introduced at first, and then followed by other preliminary study such as field study of Sabo Works, data collection as to the objective area etc.
Inter-relationship between geographical conditions and Sabo Works shall be focussed at.

1. Sabo-Survey
2. Sabo-plan
3. Sabo-Design
4. Sabo-implementation
5. Land conservation
6. Sediment Transportation
7. River Engineering
8. Geology/Geomorphology
9. Soil Mechanics (Applied)
10. Hydraulics (Applied)
11. Debris Flow
12. Landslide/Slope failure
13. Model-test
14. Vegetation etc.

(FIELD SURVEY)

_____ Reconnaissance

_____ Land-use

_____ Devastation (Sediment Scurse)

(STUDY)

_____ Sabo Basic Point _____ Estimation of Sediment yield & runoff _____ Allowable amount of sediment runoff _____ Naturally detained amount of sediment.

_____ Objective amount of sediment _____ Evaluation of Sabo facilities

_____ Formulation of Sabo Plan ___ Disposition of Planned facilities

(DESIGN/DETAIL DESIGN)

_____ Dam, Groundsill, Groin, "Kantong-pasir", Channel works etc.

(SOCIO - ECONOMIC STUDY)

_____ Benefit evaluation _____ Cost estimation
_____ B/C _____ IRR.

_____ Intangible benefit _____ Justification of the Sabo project

_____ Inevitability of Sabo works etc.

5) Preparation of English Texts

Texts are important and essential teaching materials for training. However, the availability of Indonesian texts is very low, and therefore, the use of English texts was unavoidable in the early stages of the training courses. However, in order for the Indonesian lecturers to give their lectures at ease, as the translation of English texts into Indonesian versions was considered both necessary and essential, Indonesian texts are now being prepared with the cooperation and efforts of Japanese experts. As shown in "List of Printed Texts", Indonesian texts covering 21 items have been completely prepared, with the remaining items presently being translated into the Indonesian language.

LIST OF PRINTED TEXTS

No.	Title	No. of Pages	Language	Printing progress (as of)
1.	Sediment Transportation	142.p	I&E	59/7(20)
2.	Hydraulics	42.p	I	"
3.	Soil Conservation (Vegetation)	153.p	I	"
4.	Engineering Geology	148.p	I	"
5.	Engineering Geology	38.p	I	"
6.	Geodetic Survey (I, II)	216.p	I	"
7.	Computer Programming	135.p	E	"
8.	River Engineering	223.p	E	"
9.	Sabo Survey	83.p	E	"
10.	Sabo Plan	98.p	E	"
11.	Sabo Design	57.p	E	"
12.	Hydraulic Model Test	394.p	E	"
13.	Debris Flow	254.p	I	"
14.	Land & Slope Failure	122.p	I	"
15.	Sediment Control Dam	222.p	I	"

16.	Torrent Hydraulics	63.p	E	"
17.	River Basin Development	88.p	I	"
18.	Hydraulics (Mt. Barokah)	272.p	I	"
19.	Concrete Engineering			
20.	Surveying for Sabo (JICA)	91.p	E	"
21.	Hydrology	21.p	I&E	"
22.	Soil Mechanics	54.p	I	"
23.	Beton	59.p	I	"
24.	Sabo Facilities Planning	39.p	E	"
25.	Hydrology	56.p	E	"
26.	Hydrology	60.p	E	"
27.	Volkanologi Indonesia	54.p	I	"
28.	Volkanologi Indonesia	254.p	I&E	"
29.	Pedoman Pereabaan Beton	25.p	I	" (3)
30.	Construction of Dam-Conc.	68.p	I	" (3)
31.	JIS Concrete (GSC)	240.p	E	" (3)
32.	Proceeding of Symposium	285.p	E	" (5)
33.	Pedload Transport in Steep Channel	121.p	E	" (5)
34.	Damage and Failures of Fill-Typ Dams	49.p	I	" (20)
35.	Bendungan Pengendalian Dampit	56.p	I	"
36.	Geologi Teknik untuk pekerjaan Sabo	68.p	I	"
37.	Easy calculation method of bjir/ lahar and basic idea of volcanic Debris Control	18.p	E&I (Symmetric)	59/8 (20)
38.	Referent for Aerophot Interpretation	47.p	E	"

Note: I: Indonesian Language
E: English

6) Training Performance Records

The training of engineers, which is one of the two major activities of the VSTC, has been steadily yielding excellent results over the 3.5 years since the establishment of the VSTC. The number of promising sabo engineers, the training programs of the VSTC, and the training performance records attained to date are shown below.

Number of sabo engineers with promising future

Projects	Engineers required to be in the leading positions for sabo undertaking		Engineers required for implementation of sabo undertakings	
Public undertaker				
Directorate General of Water Resources and Development	Manager (2) Assistant manager (4)	6	Assistant manager	14
Volcanic Sabo Technical Centre	Counterpart (6)	* 12	Helper (6)	6
Sabo project (4)	Project manager (4) Assistant project manager (4) Manager (12)	20	Assistant manager (12) Assistant (24) Supervisor (20) Inspector (4)	60
River improvement project (14)	Project manager (14)	14	Assistant manager (14) Assistant (14) Supervisor (28)	56
Local province (17)	Assistant manager reporting to the Ministry of Public Works	17	Assistant reporting to the Ministry of Public Works, assistant manager reporting to the local agency, and officers	68
Total		69		204

Total 273

* The numbers affixed with asterisk are the engineers capable of performing feasibility studies and detailed designs.

Fig. 1 is a chart showing the number of those to be trained as sabo engineers in the future (about 275 engineers in 20 years). The training of those to fill leading positions (223 men - 35 men - 100 men)/20 years = 14.4 men ≒ 15 men/yr. and of those who can perform feasibility studies and detailed designs, 50 men/20 yrs. = 2.5 men/yr. is required.

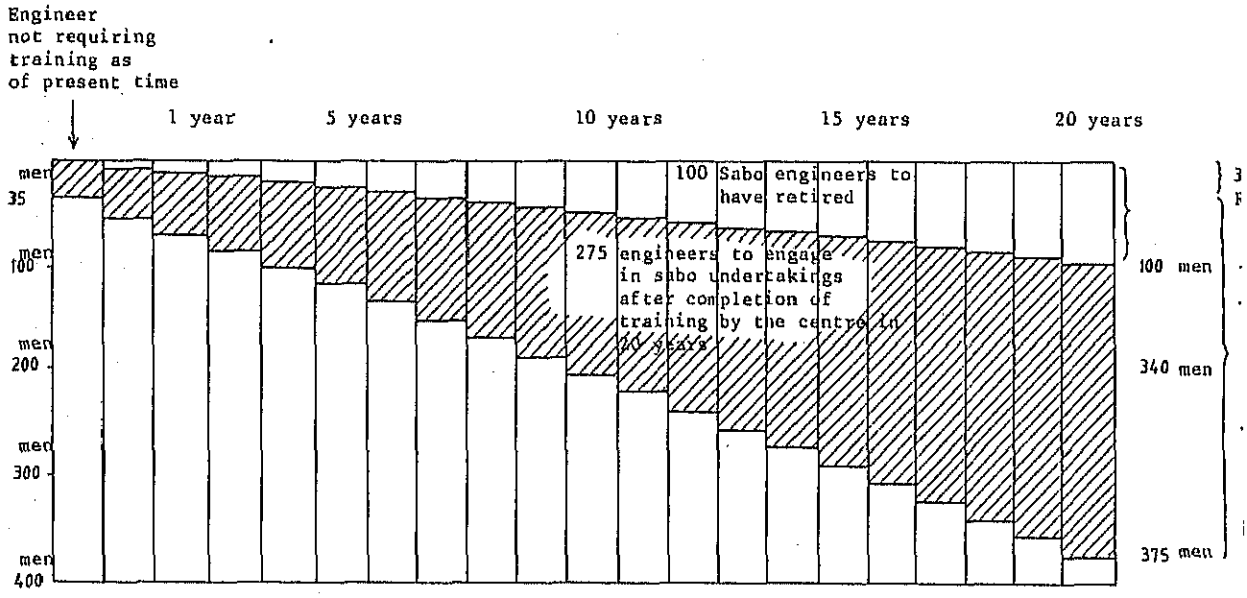


Fig. 1 Centre Training Program

Training of counterparts (12 trainess for the carrying out of F/S and D/D)	12 trainees
Training of supervisory personnel and future supervisors of sabo operations	223 trainees
Training of engineers to take charge of F/S and D/D	50 trainees

Table of Consolidated Actual Training Records

VSTC

	R/D		(A) Total number of trainees who completed training in 5 years	(B) Number of trainees who completed training from August 1982 to February 1986	(C) Breakdown of qualifications for (B)	(D) Number of trainees expected to complete training from March 1986 to August 1987	(E)=(B)+(D) Number of trainees expected to complete training at the end of August 1987	$\frac{(E)}{(A)}$ (Men)
General Course	Period	1 - 2 wks	400 men	146 men (The 1st through the 8th)	Ir.=21 men BE =83 men STM=42 men	80 men (The 9th through the 12th)	226 men	(*1) $\frac{226}{400}$
	Frequency	4 times/yr						
	Number of trainees	20 men/time						
	Coverage	Including private company personnel						
Intensive Course	Period	6 months	75 men	(*2) 39 men (The 1st through the 3rd)	Ir.=39 men	30 men (The 4th through the 5 th)	69 men	$\frac{69}{75}$
	Frequency	Once/yr						
	Number of trainees	15 men/time						
	Coverage	Ir.						
Comprehensive course	Period	2 yrs.	10 men	7 men (The 1st)	Ir.=7 men	5 men (The 2nd)	12 men	$\frac{12}{10}$
	Frequency	Once/2 yrs.						
	Number of trainees	5 men/time						
	Coverage	Ir.						

* 1. In R/D, the general course is held 4 times a year, 1 to 2 weeks at a time. From the 3rd course, 3 times a year, 1 month at a time.

* 2. The intensive course is intended for the training of those who in the future can implement sabo undertakings and who will be standing in leading positions. At a result of a follow-up survey as to the 39 men who completed the training, 29 men (minus 10 men) were found to be actively engaged in sabo undertakings. Also, of the 146 men who completed the general course, 36 men out of the 104 Ir and BE who are qualified to fill leading positions are currently engaged in sabo undertakings. The above 36 men who completed the general course are equivalent in capability to the 9 men who completed the intensive course.

(2) Development of Technologies

1) Important items for technical development

The following have been implemented as the most important items for development.

(a) Development of optimum methods

Sabo planning and construction methods best suited to the actual situation of Indonesia are currently under development.

(b) Establishment of lahar forecasting and alarm system and emergency evacuation system

2) Current situation

An advanced telemetry system will be installed at the experimental river basins to attempt to grasp how a lahar flow actually occurs, and, based on this understanding, an emergency evacuation system will be developed.

Sabo methods to be developed must be suitable for the sabo of Indonesia to make up for the weak points of conventional methods. Such a new sabo method must be more durable and economical.

As the first development stage, a survey has been implemented to grasp the status of the existing sabo facilities in Indonesia and to assess their performance. This survey will be useful in developing optimum methods for sabo undertaking.

Abreast of this survey, a case study on sediment flow control methods and the adaptability of new technology to the implementation of the control method has been conducted. Also, a debris barrier yard scouring test (also used as a practice item) has been conducted.

With respect to the development of a lahar forecasting and alarm system as a countermeasure against frequently occurring volcanic lahars, efforts have been exerted toward the development of a lahar forecasting system, and an alarm and evacuation system based on the former system, so as to enable countermeasures by means of sabo structures, and an alarm and evacuation organization.

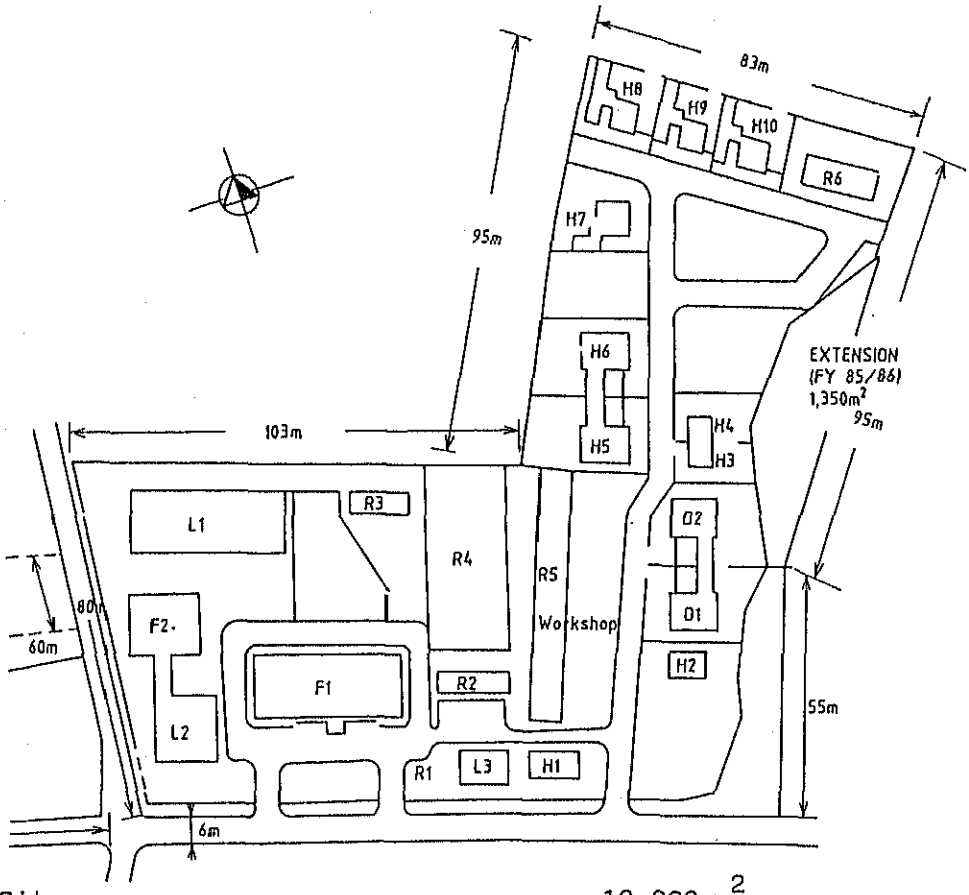
To date, in order to correctly grasp the distribution of the intensity of rainfall in the surroundings of Mt. Merapi and the movement of that rainfall, a radar rain gauge has been installed in the Centre with telemetry rain gauges being installed wherever necessary in the river basins. This data will assist in understanding the relationship between the future occurrence of lahars and rainfall characteristics.

These facilities and equipment were effectively used in the issue of an alarm and evacuation announcement when a lahar occurred in 1984.

3-1-5 Existing Facilities and Equipment

(1) Actual Status of Existing Facilities

All the existing facilities in the VSTC were constructed under the supervision of and at the expense of the Indonesian government. Their present status is summarized below.



Site area		19,000 m^2
Buildings	Q'ty	Overall floor area
Office Buildings (F1 to 2)	2	804 m^2
Experiment Buildings (L1 to 3)	3	840 m^2
Trainee Dormitory (D1 to 2)	1	300 m^2
Staff House (H1 to 10)	9	1,060 m^2
Others		
Radar Tower, workshop, etc. (R1 to 6)	6	

(2) Current situation of machines

Machines and instruments used for training and experiment a supplied by the Japanese side and their current situations as follows.

List of Machines and Instruments Supplied (for fiscal 1982)

No.	Product Name	Spec	No. of Units	Location	Us
57/1	Micro-bus	Isuzu TLD-54	1	Garage	Trip/Fi Survey
57/2	Copy machine	ZEROX-2830	2	Main Bldg.	Data us Field S
57/4	Elec. Typewriter	IBM-Select/II	1	Main Bldg.	Data us Field S
57/5	Land Cruiser	Toyota FJ60RV	2	Garage	Field E tion
57/7	Data locker	Plus A3-3	10	Main Bldg.	Office
57/17	Drawing locker	Lion,HAI-701	10	Main Bldg.	Office
57/27	Locker	Lion, 73	2	Main Bldg.	Office
57/29	Locker	Lion, 72	2	Main Bldg.	Office
57/31	Locker	Lion, 71	2	Main Bldg.	Office
57/33	Punching machine	Lion, 170	3	Main Bldg.	Office OJT
57/36	Paper shredder	Lion, 600	3	Main Bldg.	Office
57/39	Micro-reader	Cannon,NP-600	1	Main Bldg.	Office
57/40	Air-conditioner	SANYO	3	Main Bldg.	Equipme storage
57/43	Measurement staff	L:5 m	3	Main Bldg.	Measure OJT
57/46	Measurement staff	L:3 m	3	Main Bldg.	Measure OJT
57/49	Drawing tools	Shimizu	5	Main Bldg.	Drawing

No.	Product Name	Spec	No. of Units	Location	Use
57/54	Planimeter	Tamaya	5	Main Bldg.	OJT
57/59	Stereoscope	Ushikata, T22	2	Main Bldg.	OJT
57/61	Altimeter	Tommen	3	Main Bldg.	OJT
57/64	Theodolite	NT-5, Nikon	1	Main Bldg.	OJT
57/65	Transit	Topkon	3	Main Bldg.	OJT
57/68	Auto-level	Topkon	3	Main Bldg.	OJT
57/71	Compass	Tamaya	3	Main Bldg.	OJT
57/74	Hand level	Tamaya	3	Main Bldg.	OJT
57/77	Plane-table set	Tamaya	3	Main Bldg.	OJT
57/80	Drawing table	Mutoh,RLG-12	5	Soil quality room	OJT
57/85	Video	Sony, SL-F1E	1	Main Bldg.	Training use
57/86	Video camera	Sony, HVC300P	1	Main Bldg.	Training use
57/57	Video rack	Sony, SU50, 65	1	Main Bldg.	Training use
57/88	AC adaptor	Sony, AC-220	1	Main Bldg.	Training use
57/89	Video lens	Sony, VCR-4	1	Main Bldg.	Training use
57/90	Video tripod	Sony, VCT-100	1	Main Bldg.	Training use
57/91	Video light	Sony, HVL-300	2	Main Bldg.	Training use
57/93	8 mm camera	Fujika, P-500	1	Main Bldg.	Training use
57/94	Screen	Elmo, HW-4	1	Main Bldg.	Training use
57/95	Screen	Elmo, HW-2	1	Main Bldg.	Training use
57/96	8 mm projector	Fujika, SD	1	Main Bldg.	Training use
57/97	16 mm projector	Elmo, 16CL-MO	1	Main Bldg.	Training use
57/98	Slide projector	Cabin, Zoom-1	1	Main Bldg.	Training use
57/99	Slide projector	Cabin, 900A	1	Main Bldg.	Training use

No.	Product Name	Spec	No. of Units	Location	Use
57/100	Radio cassette	Natio, RX2700	3	Main Bldg.	Training use
57/103	Camera	Nikon, FM-2	3	Main Bldg.	Recording use
57/106	Flashlight	Nikon, SB-15	3	Main Bldg.	Recording use
57/109	Lens	Nikon, F4S	2	Main Bldg.	Recording use
57/111	Lens	Nikon, F5S	2	Main Bldg.	Recording use
57/113	Lens	Nikon, F3.5S	2	Main Bldg.	Recording use
57/115	Transceiver	Natio, RJ570	6	Main Bdlg.	OJT
57/121	Telescope	Nikon, 9x30D	3	Main Bldg.	OJT
57/124	Desk-top calculator	Casio, FX502P	5	Main Bldg.	Training use
57/119	Computer	NEC, SYST-100	1	Main Bldg.	OJT
57/134	Supersonic water level meter	NAKAASA, WW21	3		OJT
57/137	Self-recording rain gauge	NAKAASA, B432	6		OJT

List of Machines and Instruments Supplied (for fiscal 1983)

No.	Product Name	Spec	No. of Units	Location	Use
58/1	Voltage stabilizer	SOLA, 3.5KVA	1	Main Bldg.	CP use/ Field survey
58/2	TV receiver	Sharp, C2003	1	Main Bldg.	VT use/ Field survey
58/3	Slump cone	Tanifuji,TC-211	3	Concrete Room	OJT
58/6	Fine aggregate sieve	Tanifuji,TC-205	2	Concrete Room	OJT
58/8	Coarse aggregate sieve	Tanifuji,TC-213	1	Concrete Room	OJT
58/9	Air meter	Tanifuji, TC-518a	2	Concrete Room	OJT

No.	Product Name	Spec	No. of Units	Location	Use
58/11	Air meter	Tanifuji, TC-518a	2	Concrete Room	OJT
58/13	Concrete mixing platform	Tanifuji,C-34b	3	Concrete Room	OJT
58/16	Electric uniaxial machine	Tanifuji,TS-212	1	Soil quality room	OJT
58/17	Recorder for above	Tanifuji,TS-601	1	Soil quality room	OJT
58/18	Mitre box	Tanifuji,S-151a	5	Soil quality room	OJT
58/23	Mitre box	Tanifuji,S-151e	5	Soil quality room	OJT
58/28	Timer	Tanifuji,S-153	2	Soil quality room	OJT
58/31	Blue ring	Tanifuji,PRC-35	2	Soil quality room	OJT
58/32	Blue ring	Tanifuji,PRC-100	2	Soil quality room	OJT
58/34	Dial G	Tanifuji,DG-18	2	Soil quality room	OJT
58/36	Physical explorator	OYO,SEIS-150	1	Soil quality room	OJT
58/44	Refrigerator	Hitachi,R-816H	1	Main Bldg.	For recording paper
58/45	Radar rain gauge	JRC	1	Main Bldg.	Training use
58/46	Telemeter base station	JRC	1	Main Bldg.	Training use
58/47	Telemeter field station	JRC	1		Training use
58/48	Telemeter field station	JRC			Training use
58/49	VTF wireless	JRC	5	Main Bldg. and official car	OJT
58/50	UHF telephone		1	Main Bldg.	OJT

Equipment and apparatus furnished in 1984

No.	Items	Q'ty	Installation location	purpose of use
59/1	Wide Flume & Test Equipment	1 unit	Hydraulic experiment room	Training
59/2	Narrow Flume & Accessories	1 unit	- " -	- " -
59/3	Conveyor Belt	2 units	- " -	
59/4	Portable Generator	1 unit	- " -	
59/5	Electric Pump	2 units	- " -	
59/6	Portable Air Compressor	2 units	- " -	
59/7	Electric Oven	3 units	- " -	
59/8	Vaccum pump	1 unit	- " -	
59/9	Compression Test Machine & Accessories (Electric and manual)	2 units	Concrete room	- " -
59/10	Concrete Mixer	1 unit	- " -	- " -
59/11	Cylinder Mould/Mortar Mould	64 sets	- " -	- " -
59/12	Slump Test & Accessories	4 sets	- " -	- " -
59/13	Los Angeles Abrasion Test Machine	1 unit	- " -	- " -
59/14	Vicat Apparatus with Damper	1 unit	- " -	- " -
59/15	Air Meter	3 sets	- " -	- " -
59/16	Save Shaker (Electric and manual)	2 units	- " -	- " -
59/17	Air Compressor	1 unit	- " -	- " -
59/18	Sieve Apparatus			
	a. Sieve size ϕ300 mm	5 units	- " -	- " -
	b. Hand sieve (sieve wood)	2 units	- " -	- " -
59/19	Hammer Tester	1 unit	- " -	- " -

No.	Items	Q'ty	Installation location	purpose of use
59/20	Motorized Direct Shear Apparatus	2 units	Geological room	Training
59/21	Constant Head Permeability Test Apparatus	1 unit	- " -	- " -
59/22	Variable Head Permeability Test Apparatus	1 unit	- " -	- " -
59/23	Other Accessories for above mentioned	1 set	- " -	- " -
59/24	Sand Cone	1 unit		- " -
59/25	Analytic Balance	1 unit		- " -
59/26	Liquit Limit Apparatus	1 set		- " -
59/27	Proctor	2 sets		- " -
59/28	Post Hole Hand Auger Set	1 set		Outdoor experiment use
59/29	Portable Cone Penetometer	1 set		- " -
59/30	Swedish Sound Apparatus	1 unit		- " -
59/31	Other Accessories for above mentioned	1 unit		- " -

3-2 ACTUAL CONDITIONS OF FORECASTING AND WARNING SYSTEM

3-2-1 Mt. Merapi Mudflow Forecasting and Warning System

To establish a reliable forecasting and warning system, the VSTC has been carrying out various activities, using the existing Mt. Merapi mudflow forecasting and warning system as a practical experimental system.

The actual operational status and maintenance conditions of the system, determined through various studies, are explained below.

(1) Outline of the System

Mt. Merapi is one of the 128 active volcanoes sporadically located throughout the Indonesian Archipelago. The mountain, with a height of 2911 m above sea level, is located on the border of the Central Province and the Special District of Yogyakarta.

On the southern and southwestern slopes of Mt. Merapi, there are nine rivers, including the Blongkeng, Krasak, and Putih rivers, all of which have potential danger for mudflows. During Indonesia's rainy season (starting in November and ending in April with a precipitation of approximately 80% of the annual total), the suburban area of Yogyakarta and some villages such as Salam and Muntilan are subjected to the danger of mudflows.

The VSTC has been engaged in the education and training of sabo engineers and the development of mudflow forecasting and warning technologies as well as of sabo technologies suitable for Indonesia since its establishment in October 1982. The Japanese government has been furnishing the VSTC with various equipment and apparatuses for its studies and for

establishing a forecasting and warning system since this time.

The Mt. Merapi mudflow forecasting and warning system mainly consists of equipment and apparatus furnished by the Japanese government. With radar rainfall gauges, telemetry stations for rainfall and water level measurements, emergency communication wireless telephone systems, and other auxiliary apparatus installed along the experimental basin of the Putih river, part of the forecasting and warning system commenced operation in November 1984. The system has since then been substantially expanded with the addition of mudflow sensing stations and reinforcement of the previously installed telemetry stations.

Based on the data collected by these systems, the VSTC investigates the relationship between the occurrence of mudflows and the rainfall, observes the trends of the rainfall area transition, and analyzes the mutual relationship between the rainfall and the water level of the river, so as to enable forecasting of the degree of danger that a mudflow may occur.

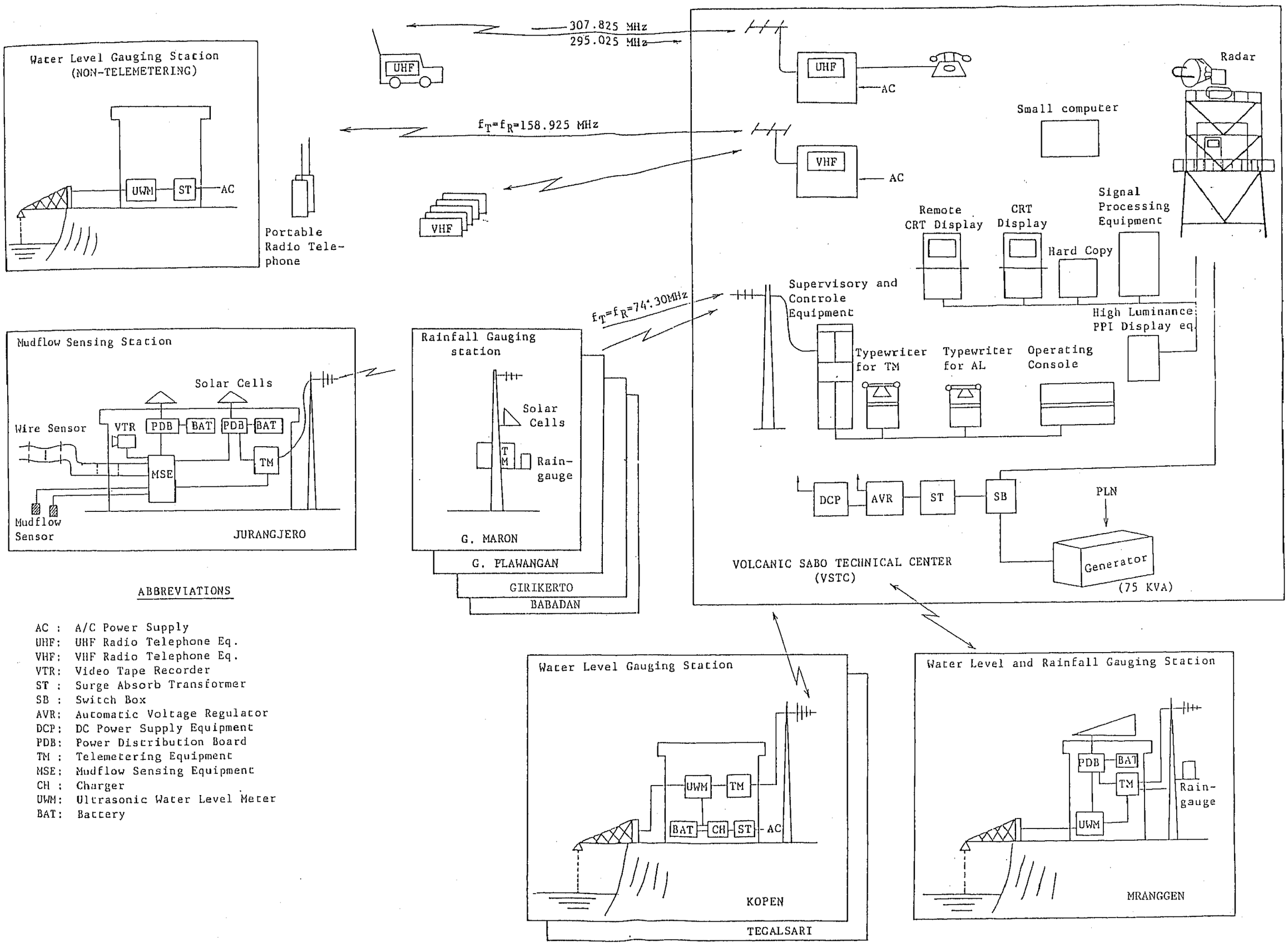
The VSTC, based on the results of their forecasting reviews, gives warnings and other relevant information to the related agencies and evacuates the local residents so as to prevent a disaster or casualties due to mudflows from occurring.

(2) Actual Status of the System

The Mt. Merapi mudflow forecasting and warning system consists of several types of equipment and apparatus. The list given below indicates the types of the equipment and apparatus and their functions.

Equipment	Functions
(1) Radar rainfall gauge	By reflecting radar waves off the raindrops, the intensity of the rainfall is calculated and displayed on a TV monitor. Without installing any solid structures along the river basin, the rainfall conditions over a wide area (40 km radius) can be established.
(2) Telemetry station	The rainfall and the water levels of the rivers are telemetrically observed using rainfall and water level gauges.
(3) Mudflow sensing station	Mudflow sensors detect the occurrence of a mudflow and transmit this information to the VSTC. At the same time, the mudflow is videotaped at the site.
(4) Emergency warning wireless telephone communi-system	The VHF/UHF wireless telephone system is used to transmit emergency warnings to the necessary points.
(5) Computer	Basic data on general sabo technologies are stored. The computer is also used to make scientific calculations.

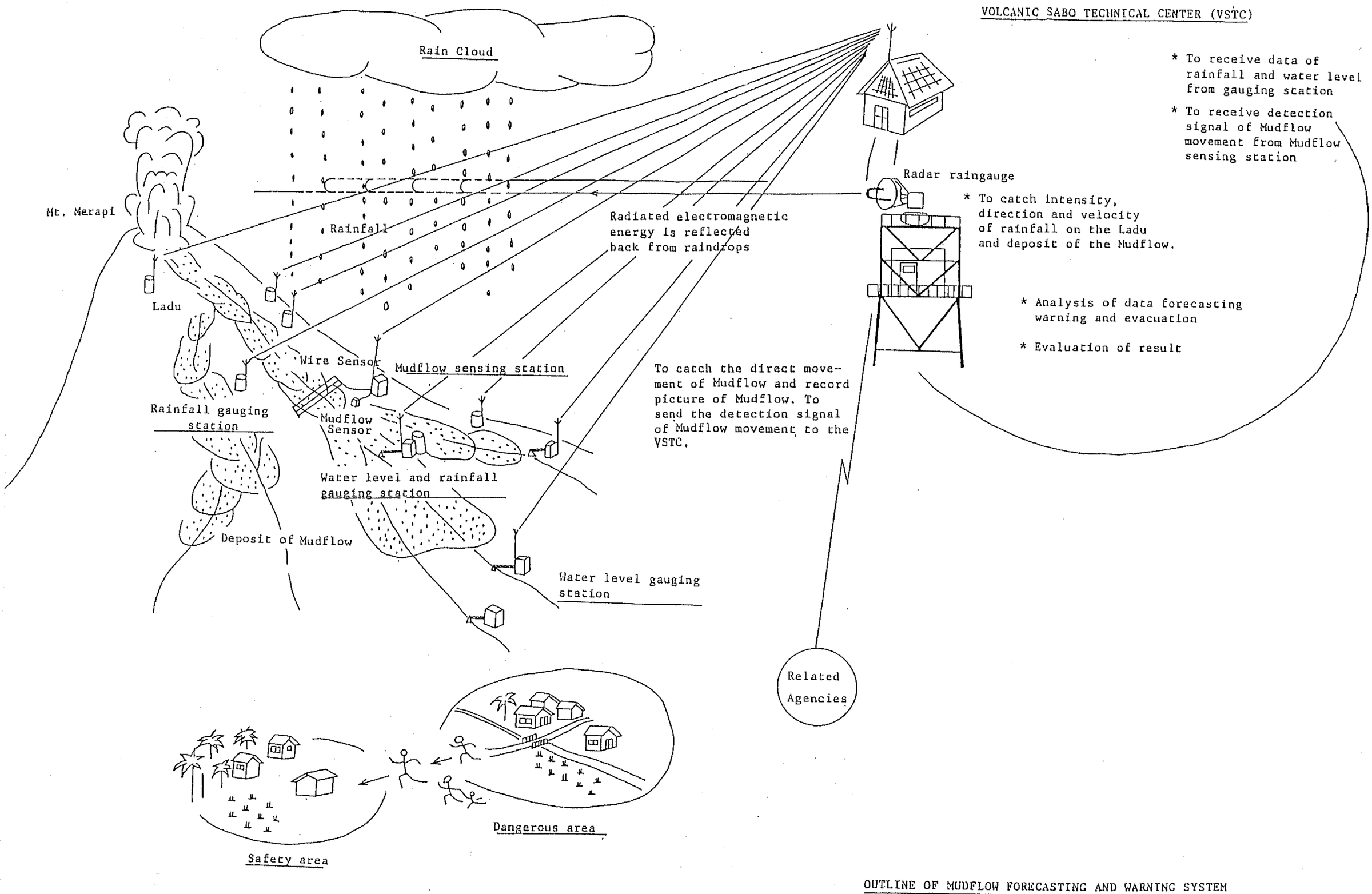
Refer to the attached Mt. Merapi Mudflow Forecasting and Warning System Configuration Drawing.



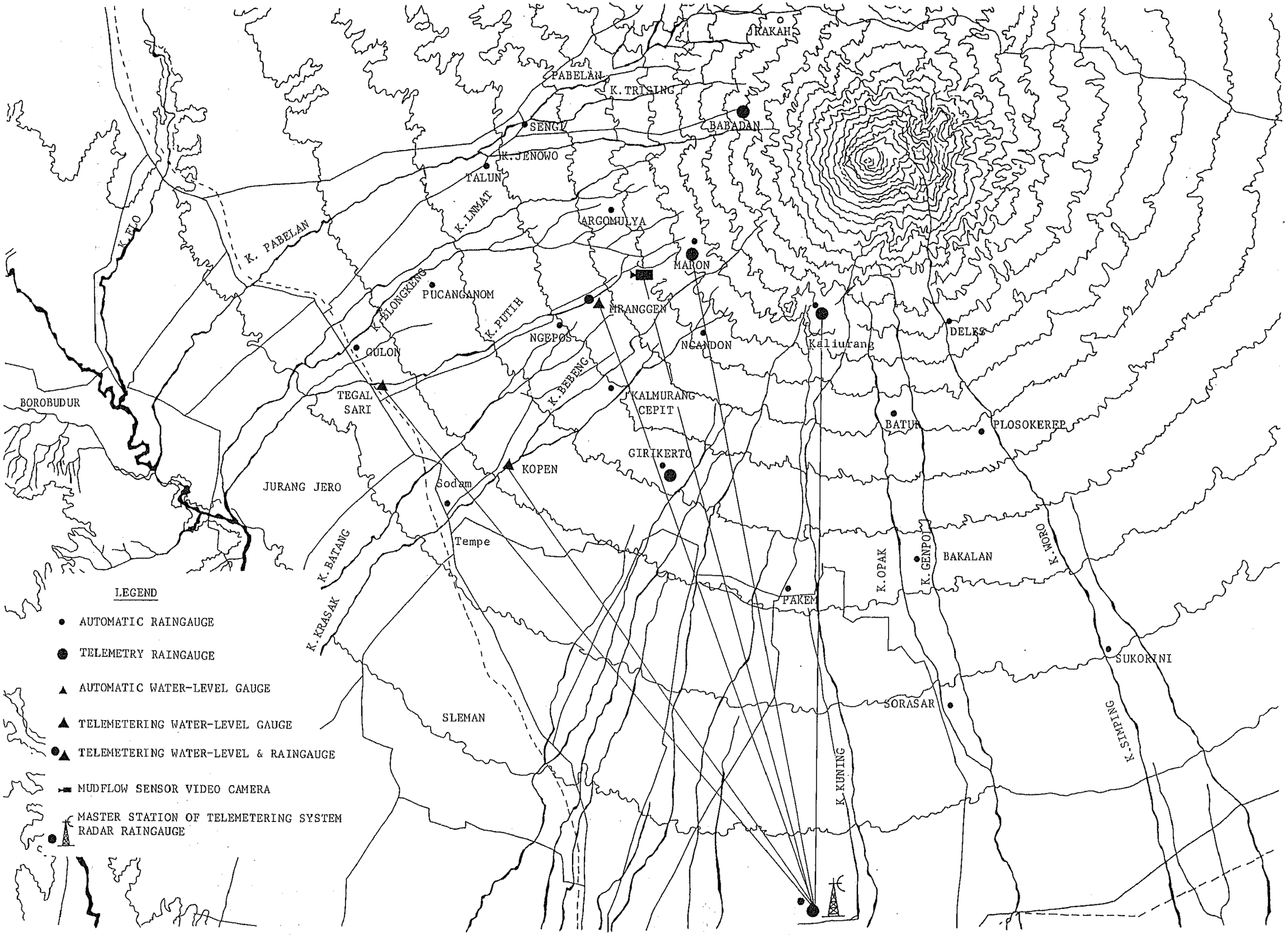
ABBREVIATIONS

AC : A/C Power Supply
UHF: UHF Radio Telephone Eq.
VHF: VHF Radio Telephone Eq.
VTR: Video Tape Recorder
ST : Surge Absorb Transformer
SB : Switch Box
AVR: Automatic Voltage Regulator
DCP: DC Power Supply Equipment
PDB: Power Distribution Board
TM : Telemetering Equipment
MSE: Mudflow Sensing Equipment
CH : Charger
UWM: Ultrasonic Water Level Meter
BAT: Battery

Mt. MERAPI MUDFLOW FORECASTING AND WARNING SYSTEM CONFIGURATION



OUTLINE OF MUDFLOW FORECASTING AND WARNING SYSTEM


PABELAN
K. TRISING
SENGI
BABADAN
K. JENOWO
TALUN
K. LNMAT
K. PABELAN
K. ELO
ARGOMULYA
MARON
PUCANGANOM
K. ELONGKENG
K. PUTIH
NGEPOS
MRANGGEN
NGANDON
Kaliurang
DELES
GULON
TEGAL SARI
K. BEBENG
KALMURANG
CEPIT
BATUR
PLOSOKEREP
BOROBUDUR
GIRIKERTO
KOPEN
JURANG JERO
Sodam
Tempe
K. BATANG
K. KRASAK
PAKEM
K. OPAK
K. GENPOL
BAKALAN
K. WORO
SUKORINI
SORASAR
SLEMAN
K. KUNING
K. SIMPING
LEGEND
AUTOMATIC RAINGAUGE
TELEMETRY RAINGAUGE
AUTOMATIC WATER-LEVEL GAUGE
TELEMETERING WATER-LEVEL GAUGE
TELEMETERING WATER-LEVEL & RAINGAUGE
MUDFLOW SENSOR VIDEO CAMERA
MASTER STATION OF TELEMETERING SYSTEM
RADAR RAINGAUGE

(3) Actual Maintenance Conditions

1) The system is almost the same as that provided for Mt. Galunggung in terms of scale, and is managed and maintained by two electronic communication engineers, Mr. Bambang and Mr. Djantsk.

2) The operation and maintenance of the equipment and apparatus forming the system are satisfactory. For example, it is prohibited for personnel to wear shoes in the areas where the equipment or apparatus are installed, i.e., the VSTC office and the stations at the sites. The fundamental knowledge that dust may cause problems with electronic apparatus which use a numerous number of connectors or IC chips is fully understood by these personnel.

In addition, the maintenance control is effectively and systematically carried out. For example, when the hours of sunshine are drastically reduced during the rainy season, power supply by means of solar cells becomes insufficient. As the operational status of each piece of equipment and apparatus is regularly checked, however, it has been determined which stations need to be electrically supplemented with storage batteries.

3) The opinion has been voiced that "as the radar gauges and telemetry systems are high-tech electronic apparatus, there will be problems in its maintenance." This statement, however, does not apply to the VSTC. It should be noted that steady self-supporting maintenance efforts have been made at the VSTC, although the government's budget for maintaining the system is very low (e.g. even synchroscopes have not yet been provided).

3-2-2 Mt. Galunggung Mudflow Forecasting and Warning System

Much has been expected of the mudflow forecasting and warning system belonging to the Mt. Galunggung Project Office, not only by the authorities of the Indonesian government but also by the local residents. The system is also expected to demonstrate the results of the training courses and the technical transfer of the mudflow forecasting and warning systems technologies offered by the VSTC to the Indonesian counterparts. The system, however, has not been fully functional for several months as it was struck by lightning, and the Indonesian staff have been unable to restore its operation.

In response to the urgent request by the Indonesian government for assistance in the restoration of the system, the Japanese staff have investigated the system damage. The summary of the investigations will be described later.

(1) System Outline

Mt. Galunggung is a volcano with a height above sea level of 1236 m, and is located in the Western Java Province of Java Island. The mountain is topped by a crater which extends approximately 1.5 km in the east-west direction.

To the north of the crater stands a row of mountains of around 2,000 m height. The southeast slope, on the other hand, forms an extensive mountain skirt, on which Taskmalaya and Singaparna towns have been developed.

Since its unexpected eruption in April 5, 1982, Mt. Galunggung has erupted several hundred times to varying degrees. These eruptions caused approximately 40,000 persons to suffer due to the torrents of lava, volcanic ash, and earth and sand running down the slopes of the mountain. During the rainy season from November to April, the towns at

the foot of the mountain are threatened with the danger of innundation by volcanic ash and deposits flowing down the slopes.

On the southeastern slopes of Mt. Galunggung are the Ciloseh, Cibanjaran, and Cikunir rivers, these being the most dangerous sources of earth and sand flows.

The Mt. Galunggung mudflow forecasting and warning system was introduced under Japan's Grant Aid scheme in disaster countermeasures by Exchange of Notes on 9 July 1983 between the Indonesian and the Japanese governments.

The system consists of radar rainfall gauges which were installed at the earliest stage, a telemetry system for rainfall and water level measurements, mudflow sensing stations providing TV pictures, and emergency warning communication systems. The latter three types of equipment have been subsequently installed for reinforcement of the system.

Based on the data and information collected by the various equipment and apparatus, the system can forecast when a mudflow will occur, thus protecting human lives and preventing unexpected disasters.

(2) Actual Status of the System

The Mt. Galunggung mudflow forecasting and warning system consists of several types of equipment and apparatus. The list given below indicates the types of equipment and apparatus and their functions.

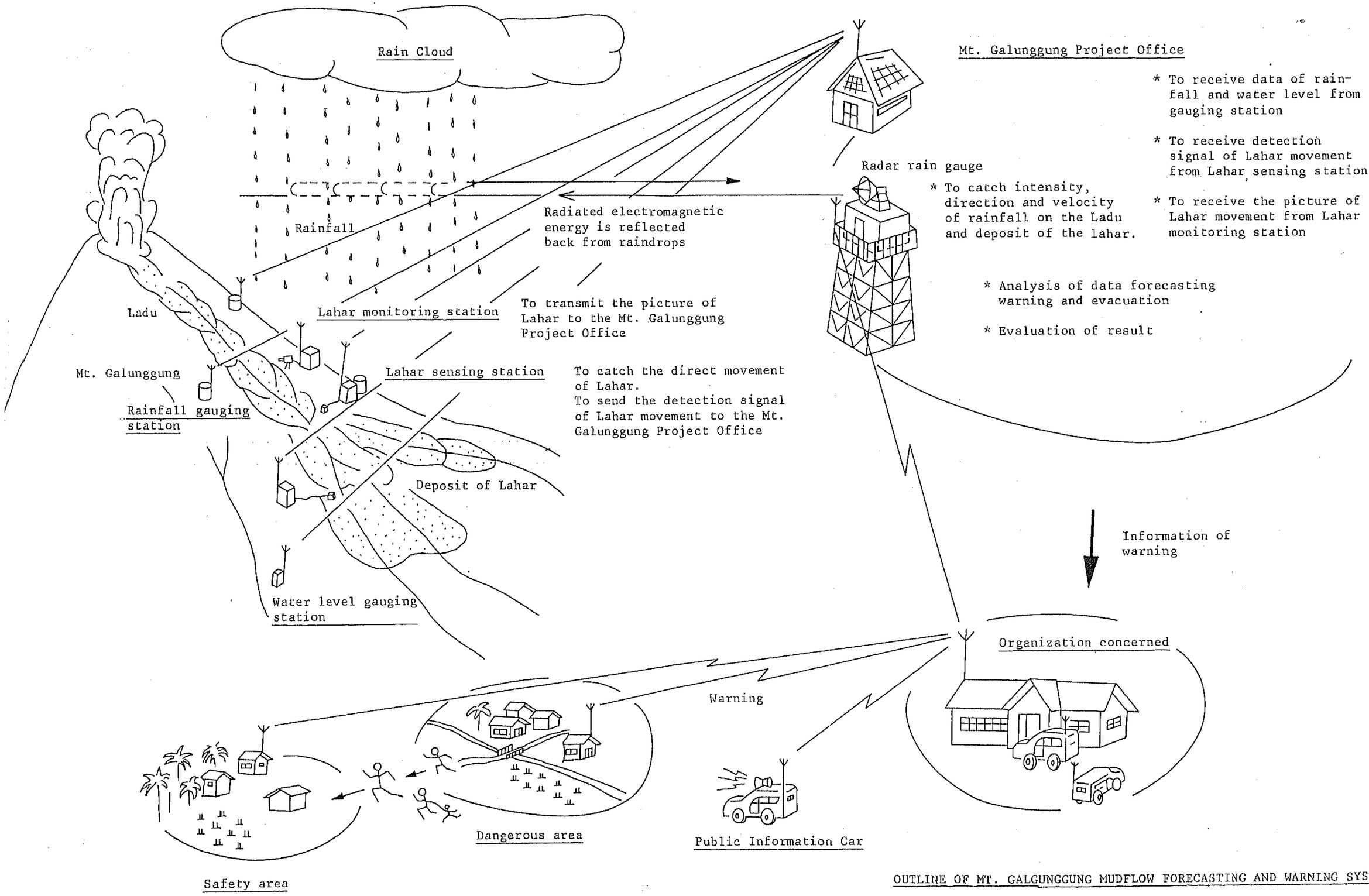
Equipment	Functions
(1) Radar rainfall gauge	By reflecting radar waves off the raindrops, the intensity of the rainfall is calculated and displayed on TV monitors. Without installing any solid structures along the river basin, the rainfall conditions over a wide area (40 km radius) can be established.
(2) Telemetry station	The rainfall and the water levels of the rivers are telemetrically observed using rainfall and water level gauges.
(3) Mudflow sensing station	Mudflow sensors detect the occurrence of a mudflow and transmit this information to the office. The office also receives videotaped images of the mudflow occurrence conditions at the site.
(4) Emergency warning wireless telephone communi-system	The VHF/UHF wireless telephone system is used to transmit emergency warnings to the necessary points.
(5) Computer	Basic data on general sabo technologies are stored. The computer is also used to make scientific calculations.

Refer to the following attached drawings.

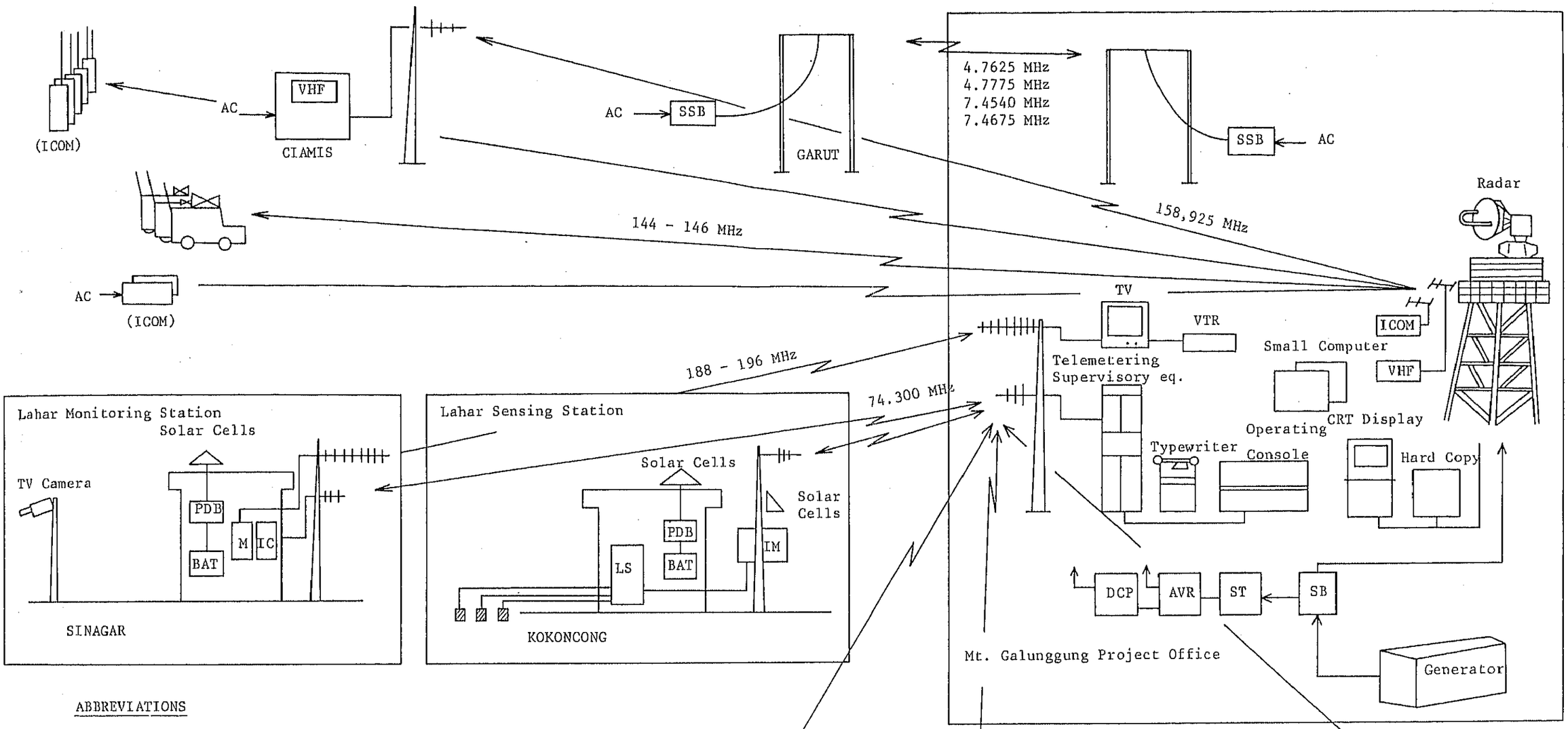
Fig. 1 Outline of Mt. Galunggung Mudflow Forecasting and Warning System

Fig. 2 Mt. Galunggung Mudflow Forecasting and Warning System Configuration

Fig. 3 Layout of Mt. Galunggung Mudflow Forecasting and Warning System

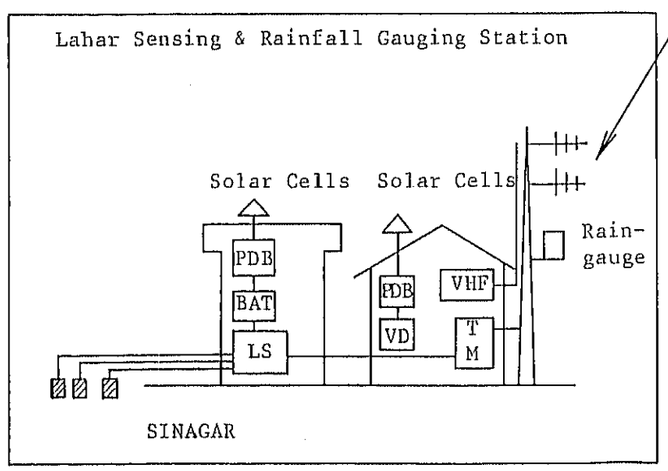


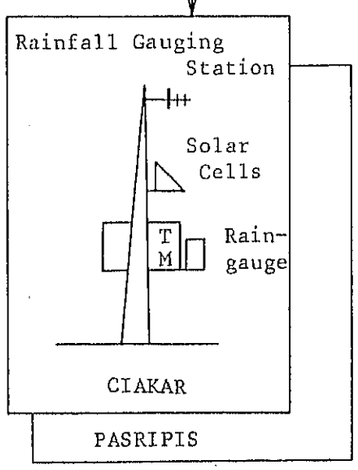
OUTLINE OF MT. GALGUNGGUNG MUDFLOW FORECASTING AND WARNING SYSTEM

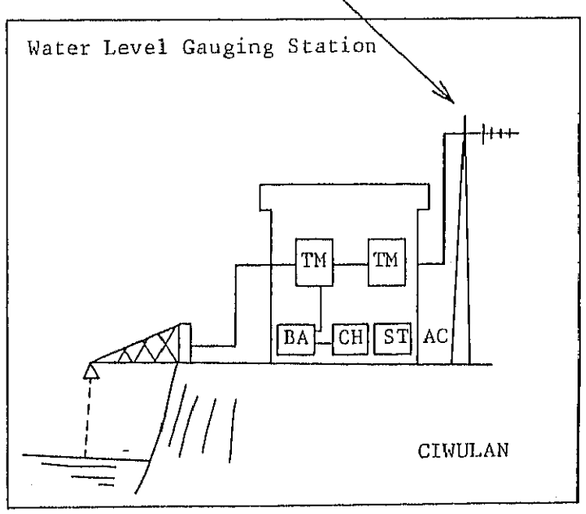


ABBREVIATIONS

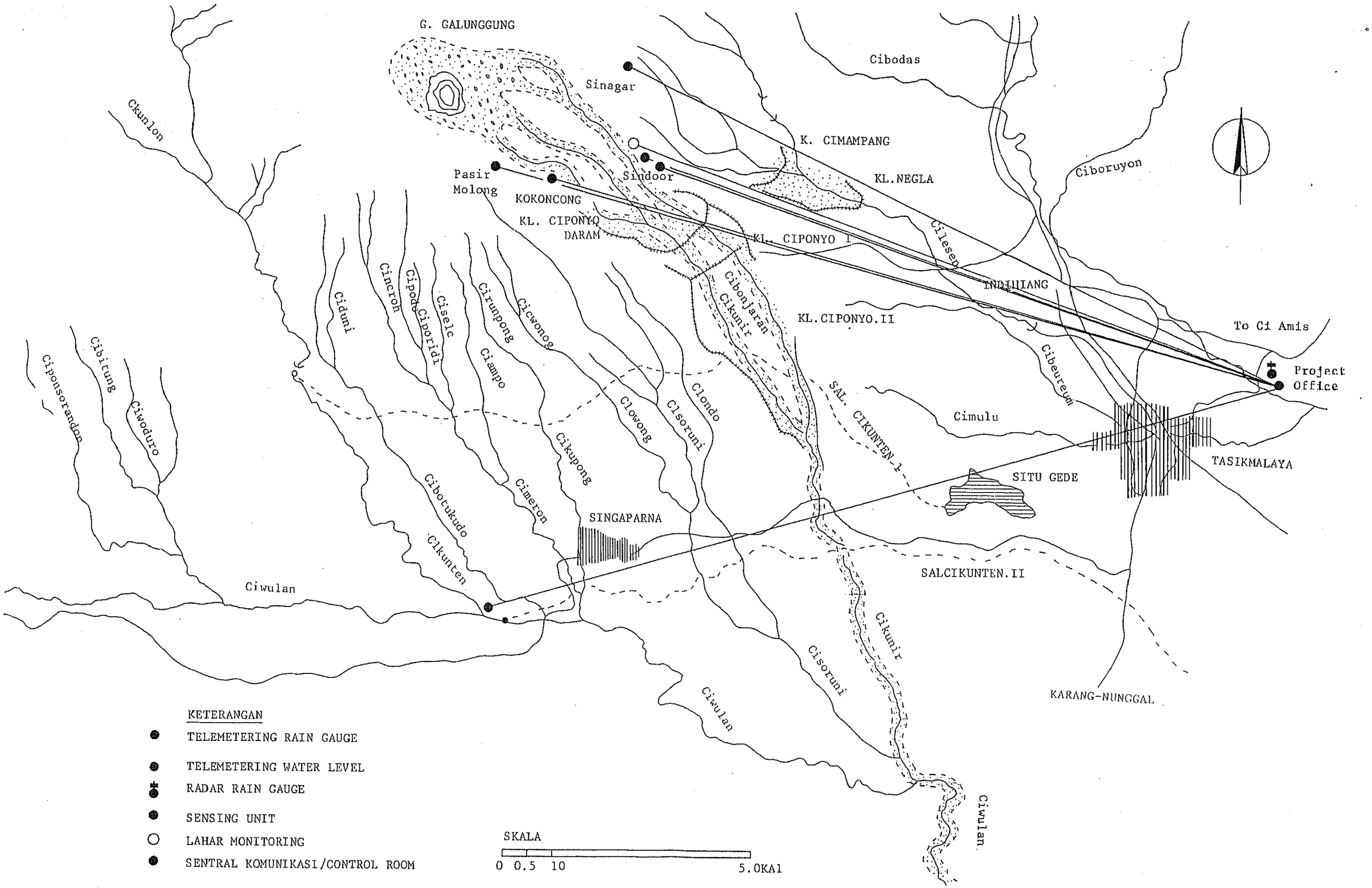
AC : A/C Power Supply
SSB : HF Radio Telephone Eq.
VHF : VHF Radio Telephone Eq.
VTR : Video Tape Recorder
ST : Surge Absorb Transformer
SB : Switch Box
AVR : Automatic Voltage Regulator
DCP : DC Power Supply Equipment
PDB : Power Distribution Board
TVT : TV Transmitter
TM : Telemetering Equipment
TC : Telecontrolled Equipment
LS : Lahar Sensor
CH : Charger
UWM : Ultrasonic Water Level Meter
BAT : Battery







MT. GALUNGGUNG MUDFLOW FORECASTING AND WARNING SYSTEM CONFIGURATION

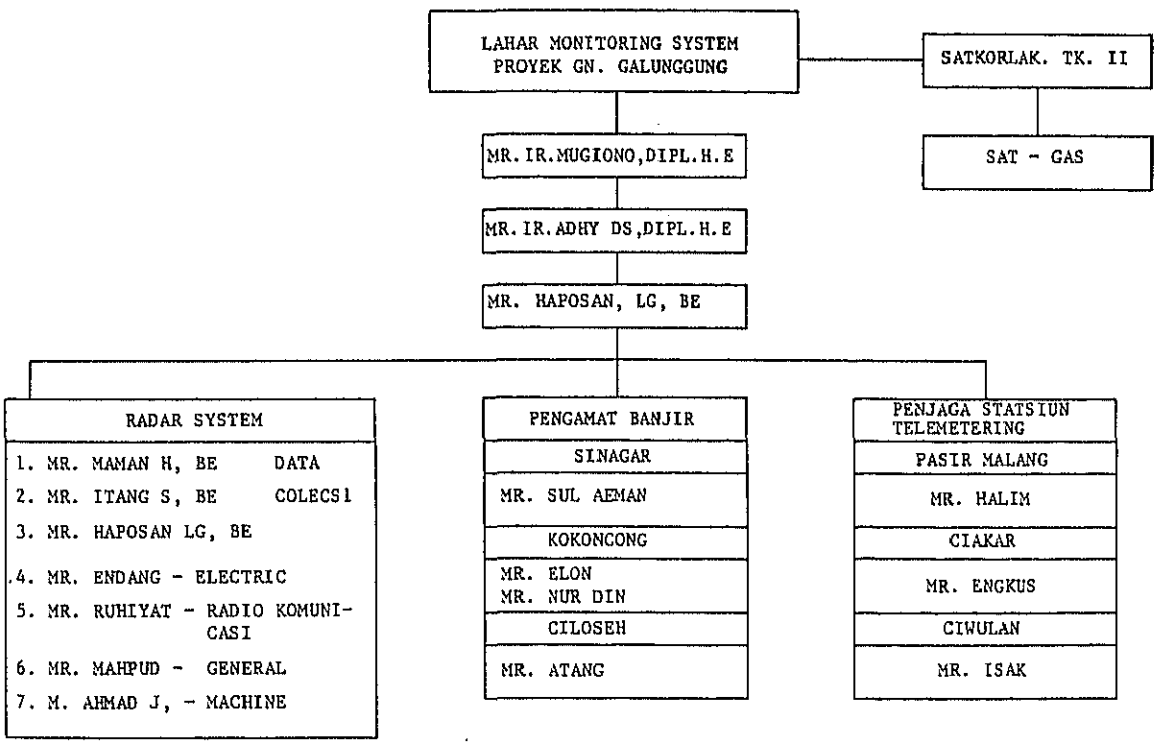


LAYOUT OF MT. GALUNGGUNG MUDFLOW FORECASTING AND WARNING SYSTEM

(3) Actual Management Status of System Organization

An organization, as indicated below, has been established to manage the mudflow forecasting and warning system at the Galunggung Project Office. The entire system is managed by and operated under the supervision of Mr. Mugiono, Mr. Adhy, and Mr. Haposan, all of whom are project office managers. The radar rainfall gauges and the telemetry stations are each supervised by seven persons. Three debris flow watchmen have been assigned to each river and in addition observers have been assigned at each telemetry station. Civilians fill the positions of the watchmen and observers.

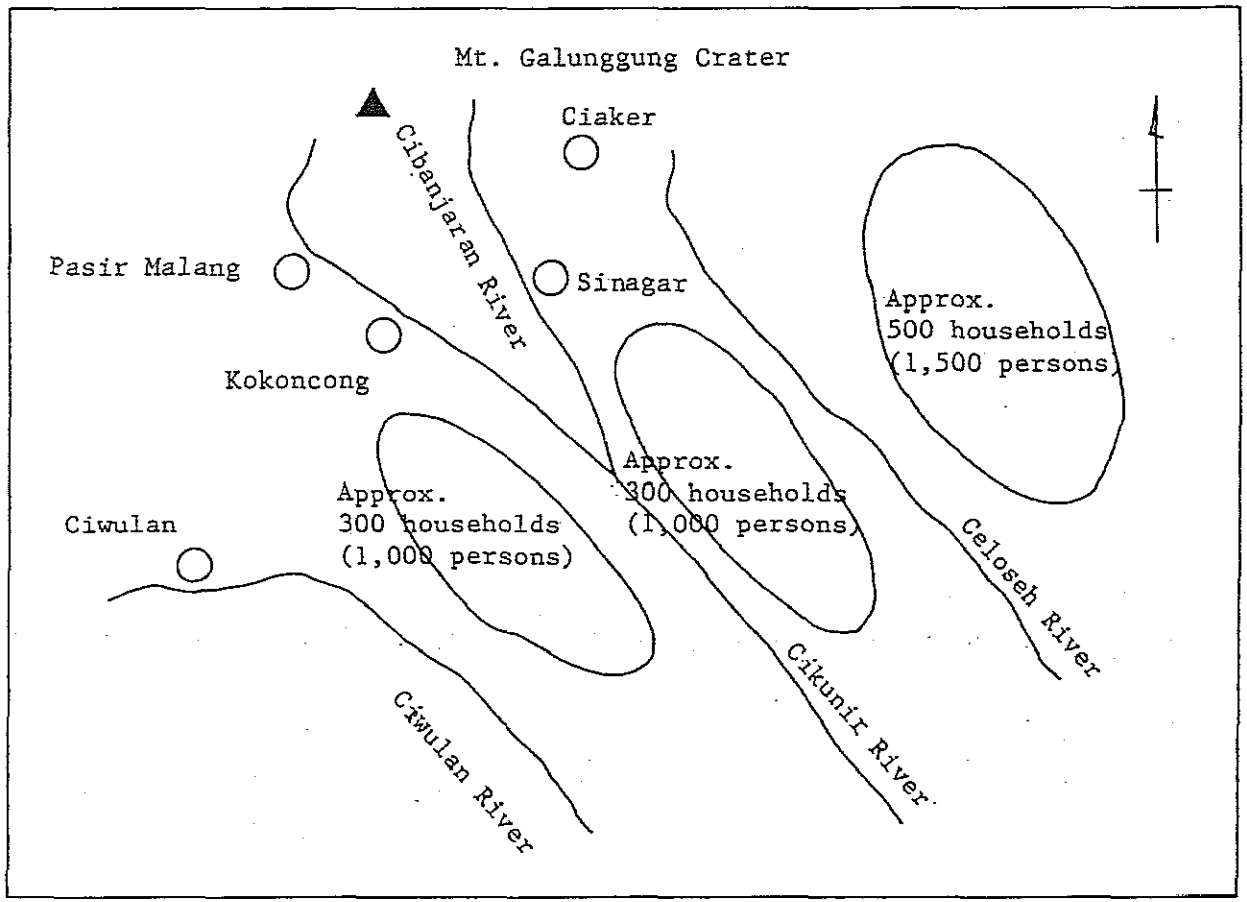
When they are on duty the three debris flow watchmen carry portable radios rented by the project office and, if a warning is issued by the project office, relay it to the local residents.



(4) Background of Request for Restoration of the Mt. Galunggung Mudflow Forecasting and Warning System

1) In April 5, 1982, Mt. Galunggung became active for the first time in 160 years and has since erupted several hundred times. The volcanic deposits, with a total estimated volume of approximately 50,000 m^3, accumulated around the upper tributaries of the Cikunin, Cibajanan, and Ciloseh rivers which flow down the southeastern slopes of the mountain. In the three or four years since the first eruption, it is estimated that approximately 15,000 m^3 of volcanic material has already flown down the mountain in the form of mudflows. As 30,000 to 35,000 m^2 of material still remain at the upper tributaries of these rivers, however, the possibility that these deposits may form mudflows with earth and sand is still considerably high.

2) Due to the eruptions, the southeastern slopes of the mountain were covered with lava and volcanic ash, and the vegetation systems on some portions on the slopes were completely destroyed by the muddy soils flowing down the rivers. In some areas, however, the vegetation system has been gradually recovering and the local residents evacuated from the site are one after another returning to their homes. The estimated number of households already re-established is approximately 1,100, comprising about 3,500 persons in total, according to the Mt. Galunggung Project Office. The distribution of these households is as illustrated below.


Mt. Galunggung Crater
Ciaker
Cibanjaran River
Pasir Malang
Sinagar
Kokoncong
Approx.
500 households
(1,500 persons)
Approx.
300 households
(1,000 persons)
Approx.
300 households
(1,000 persons)
Ciwulan
Celoseh River
Cikunir River
Ciwulan River

3) In these areas, however, the possibility of secondary disasters appears to be increasing.

In order to prevent the lives of the returned residents from being threatened with these secondary disasters, the Mt. Galunggung Project Office has been undertaking a sabo project. The development of a mudflow forecasting and warning system is an absolute necessity, however, until the danger that mudflows may occur has been completely eliminated, based on verifiable facts. The Mt. Galunggung Project Office has, therefore, established a policy of fully utilizing the system to forecast the occurrence of mudflow, thereby protecting human lives from disaster.

4) During the rainy season, the rainfall conditions observed by the radar rainfall gauges and displayed on TV monitors are used as a guide to provide warning of an impending disaster. If rainfall with an intensity of 100-150 mm/h continues for more than two hours in the upper tributaries of the Cikunir, Cibajaran, or Ciroseh rivers, or rainfall with an intensity of more than 70 mm/h continues for more than four hours in the same area, a warning is issued.

(5) Operational Condition of Mt. Galunggung Forecasting and Warning System

The operational conditions of the system were investigated over a three day period from March 9 to March 11, 1985. The results of the investigation are given below.

1) Radar Rainfall Gauge (Tasikmalaya)

Equipment		Operational Condition	
-1.	Radar transmission and receiver equipment	x 1	Good
-2.	Radar antenna	x 1	"
-3.	Signal processing equipment	x 1	"
-4.	Tower side CRT	x 1	"
-5.	Remote CRT	x 1	"
-6.	CRT hard copy	x 1	Out of order

(a) The CRT hard copy machine has not been operational since October 29, 1985 when it was damaged by lightning. The machine outputs the message "unable to operate" and its operation is prohibited.

(b) The radar transmission and receiver equipment, and other equipment and apparatus are operating satisfactorily. In the three years and two months since the radar transmission and radar equipment were installed at the Mt. Galunggung Project Office, the radar operation time has totalled approximately 5,600 hours.

2) Telemetry Station for Rainfall and Water Level Measurements (Tasikmalaya)

Equipment		Operational Condition
-1. Telemetric monitoring and control system	x 1	Good
-2. Wireless radio equipment	x 1	"
-3. Switchboard	x 1	Partially damaged
-4. Printer	x 1	Out of order
-5. Antenna (VHF 3 elements)	x 1	Good
-6. Panzer mast	x 1	"
-7. Coaxial lightning conductor	x 1	"

(a) The switchboard consists of an operation panel, indication panel, and power supply equipment. The DC12 V unit of the power supply equipment was damaged by lightning in October 29, 1985. The unit was partially repaired by the manufacturer in November 15, 1985 and electricity has been tentatively supplied from the DC 12 V unit incorporated in the power supply equipment of the telemetric monitoring and control system. Other necessary control functions and indication functions of the switchboard have been restored.

(b) The power supply unit and the printer control unit were damaged by lightning in October 29, 1985 and the printer itself has not been operational since then. The printer outputs the message "unable to operate" and its operation is prohibited.

(c) The telemetric monitoring and control system and other equipment and apparatus have been operating satisfactorily. As no printing function has been available, there are no records. With the data indication function of the switchboard restored,

the operation conditions and observation data will become available.

3) Rainfall and Water Level Observation Stations

Items	Ciakar Station		Pasirips Station		Sinagar Station		Ciwulan Station	
	Q'ty	Operational condition	Q'ty	Operational condition	Q'ty	Operational condition	Q'ty	Operational condition
1. Observation equipment	1	Good	1	Good	1	Good	1	Unable to be confirmed
2. Wireless radio equipment 70MHz, 3W	1	"	1	"	1	"	1	"
3. Rainwater gauge (tipping bucket type)	1	"	1	"	1	"	1	
4. Automatic rainwater recorder	1	"	1	"	1	"		
5. Solar cell 12V	8.5Wx1	"	8.5Wx1	"	40Wx1	"		
6. Lead battery 12V	45AHx1	"	45AHx1	"	170AHx1	"	40AHx1	Unable to be confirmed
7. Distribution board	1	"	1	"	1	"		
8. Antenna (VHF 3 elements)	1	"	1	"	1	"	1	Unable to be confirmed
9. Panzer mast, 10 m	1	"	1	"	1	"	1	"
10. Coaxial lightning conductor	1	"	1	"	1	"	1	"
11. Ultrasonic wave type water level gauge								
. Exchanger							1	Unable to be confirmed
. Recorder							1	"
. Transmitter /receiver							1	"
12. Battery charger								"
Input 100V Output 12V50A								
13. Inverter								"
Output AC100V							1	
100VA							1	
14. Lightning resistance transformer 1ø50Hz								"
Input 220V Output 100V							1	
15. Enclosed cubicle	2	Good		Good		Good	1	Not confirmed

(a) The Sinagar Station has two functions; as a rainfall observation station and as a mudflow sensing station. Refer to Item 5) for its function as a mudflow sensing station.

(b) The Ciwulan Station is a water level station at which water levels are measured by an ultrasonic wave type water level gauge and the data telemetered to the station. The station, however, has not been operated as the power supply lead-in work, which was to have been undertaken by the Indonesian government, has not yet been carried out. The work was to provide AC 220 V, 50 Hz single phase commercial power to the station.

The actuation of the station has, however, been confirmed by the actuation test conducted in September 1984 using a temporary power supply, according to the manufacturer's report. It will still be necessary, however, to confirm whether the station actuates satisfactorily or not after the commercial power supply mentioned above has been provided.

4) Mudflow Sensing Monitoring and Control Equipment

The mudflow sensing monitoring and control system is not an independent system, being integrated into the telemetric rainfall and water level monitoring. The wireless radio equipment, switchboard, printer, and antenna associated with the telemetric rainwater and water level monitoring and control system are also used for the mudflow sensing system. Refer to Item 2) for the operational conditions of the equipment and apparatus.

5) Mudflow Sensing Station

	Items	Kokoncong Station Q'ty	Kokoncong Station Operational condition	Sinagar Sation Q'ty	Sinagar Sation Operational condition
1.	Observation equipment	1	Good	Common be used by the rainfall and water level observation station	
2.	Wireless radio equipment VHF 3W	1	"		
3.	Solar cell 12V, 8.5W	1	"		
4.	Lead battery 12V, 45AH	1	"		
5.	Switchboard	1	"		
6.	Antenna (VHF 3 elements)	1	"		
7.	Panzer mast	1	"		
8.	Coaxial lightning conductor	1	"		
9.	Solar cell (for mudflow detection) 12V, 16.4W	1	"	1	Good
10.	Alkaline cell (for mudflow detection) 12V 60AH	1	"	1	"
11.	Battery over-charging prevention type switchboard	1	"	1	"
12.	Mudflow sensor (sound pressure type)	3	Two buried	2	One buried
13.	Mudflow sensor cable	3	One buried	2	"
14.	Mudflow warning equipment	1	Requiring installation	1	Requiring installation

(a) The mudflow sensors belonging to the Kokoncong and the Sinagar Stations have been buried and do not function when a vibration is applied to the sediments accumulated on them. The sensors have been set so that they will sense approximately 5 gals when the dead weight of a person (approximately 60 kg) is applied to them under normal operating conditions. The restoration of these sensors by excavation is doubtful.

(b) As there are no signs prohibiting trespassing over the areas where the mudflow sensors are installed, detection errors, probably due to artificial vibrations, have occasionally been observed. This frequently happens at the Sinagar Station.

(c) Other telemetric communication apparatus and power supply equipment are operating satisfactorily. The calling control function of the mudflow sensing monitoring and control system is also satisfactory. As the typewriter function of the telemetry system has been out of order, no printed records are available.

6) Mudflow Monitoring System

	Items	Sinagar Station Q'ty	Sinagar Station Operational condition	Tasikmalaya Station Q'ty	Tasikmalaya Station Operational condition
1.	TV picture transmit-timer and receiver	1	Good		
2.	Camera equipment	1	"		
3.	Controlled equipment (for telemeter)	1	"		
4.	Wireless radio equipment (for telemeter)	1	"	Actuated by the telemeter system starter	
5.	Solar cell 24V, 320W	1	"		
6.	Lead battery 24V, 500 AH	1	"		
7.	Distribution board	1	"		
8.	Aerial cables (one each for TM and TV)	1	"		
9.	Panzer mast	1	"		
10.	Color TV monitor			1	Good
11.	VTR, VHS, NTSC			1	"
12.	Aerial receiving cables with 8 elements			1	"

7) Radio Warning System

	Items	Station	Q'ty	Operational condition
1.	VHF wireless TV equipment	Galunggung Station	1	Good
2.	VHF wireless ICOM type equipment	" "	1	"
3.	SSB wireless radio equipment	" "	1	Not confirmed
4.	VHF wireless tele-	Camis Station	1	Good
5.	- ditto -	Sinagar Station	1	"
6.	VHF wireless ICOM type equipment	Stationary installations	2	"
7.	- ditto -	Official communication car	3	"
8.	- ditto -	Portable Radio	5	"
9.	SSB wireless radio equipment	Garut Station	1	Not confirmed

(a) The communication link with the Garut Station has not yet been confirmed.

8) Compact Computer

	Items		Q'ty	Operational condition
1.	IBM-5160	System Body	1	Under repair
2.	"	Display	1	"
3.	"	Keyboard	1	"
4.	"	Printer	1	"

(a) This computer was installed to analyze the various data collected by the radar rainfall gauge and the telemetry system. The computer was damaged by high voltage electrical surges, however, and is now undergoing repair by IBM Jakarta.

9) Power Supply System (Galunggung Office)

	Item	Q'ty	Operational condition
1.	Generator equipment (for radar rainfall gauge)	1	Good
	1. Engine generator 220V, 50kVA	2	
	2. Lead battery for starting 24V, 150 AH	1	
	3. Battery charger Output: 26V, 10A	1	
	4. Oil tank, 3 kilolitres (200 H combustion)	1	
2.	DC power supply equipment for telemetry monitoring equipment and switchboard Input AC 100V Output AC 24V, 30A	1	"
3.	Automatic voltage stabilizer for typewriter, remote controlled CRT, and hard copy machine Input AC 100V Output AC 100V, 50A	1	"
4.	Lightning resistant transmitter for Items 2 and 3 above Input AC 220V Output AC 100V, 10kVA	1	"
5.	Lightning resistant transmitter for radar Input AC 220V Output AC 100V	1	"
6.	Distribution board for radar room		"
7.	Arrestor box for power supply room		"
8.	Automatic voltage stabilizer for radar room Input AC 100V Output AC 100V		"

(a) In principle, the private power generation equipment is operated 24 hours a day during the rainy season (from October to March) and for 8 hours a day during the dry season (from April to September)

(b) The private power generation equipment has sometimes been subject to mechanical failure. Whenever the equipment was to be restored, the radar operations were interrupted. The abnormal voltage generated by the private power generation equipment on October 7, 1985 interfered with the CRT unit of the radar equipment. It is considered necessary, therefore, to have maintenance staff available whenever the private power generation equipment is under operation.

(c) To date, the total operating time of the private power generation equipment amounts to 3750 hours.

10) Spare Parts for Measuring Instruments

Spare Parts - Measuring Instruments

Items		Condition
10.1 Measuring Instruments		
-1 Calling Tester	x 1	Good
-2 Code Checker	x 1	"
-3 Through Line Power Meter	x 1	"
-4 Termination Power Meter	x 1	"
-5 Multitester	x 1	"
-6 Synchroscope	x 1	"
-7 Portable Type OSC	x 1	"
-8 Level Meter	x 1	"
-9 Frequency Counter	x 1	"
-10 Signal Generator	x 1	"
-11 Output Tester	x 1	"
-12 Program Checker	x 1	"
-13 Field Strength Meter	x 1	"
10.2 Consumable Parts/Station		
a. Rainfall Gauging Station	x 1 set	
-1 Spare Pen		To be supplemented
-2 Ink		"
-3 Spuid		"
-4 Recording Paper		"
b. Water Level Gauging Station	x 1 set	
-1 Cartridge Pen red		To be supplemented
-2 Cartridge Pen green		"
-3 Recording Paper		"
c. Master Station	x 1 set	
-1 Recording Paper		To be supplemented

Items			Condition
d. Spare Parts			
-1	Transmitting X'tal	x 1	To be checked
-2	Receiving X'tal	x 1	"
-3	Arrester 300%	x 180	To be repaired
-4	Fuse 300%	x 12	"
e. Power Supply Unit			
-1	NBA-4000	x 1	To be repaired
f. Radio Equipment			
-1	Transmitter NSE-701/3	x 1	To be checked
-2	Receiver NRE-701	x 1	"
g. Printed Circuit for Master Station			
-1	PC Board CDC-4202A	x 1	To be checked
-2	" CDC-4205A	x 1	"
-3	" CDC-4206	x 1	"
-4	" CDC-4207	x 1	"
-5	" CDC-4216D	x 1	"
-6	" CDC-4211	x 1	"
-7	" CDC-4212	x 1	"
-8	" CDC-4208A	x 1	"
-9	" CDC-4220A	x 1	"
-10	" CDC-4209A	x 1	"
-11	" CDC-4210	x 1	"
-12	" CDC-4219A	x 1	"
h. Printed Circuit for Gauging Station			
-1	PC Board CCC-4027	x 1	To be checked
-2	" CMD-4002	x 1	"
-3	" CDB-4035	x 1	"
-4	" CDA-4323	x 1	"

Items		Condition
h. Printed Circuit for Gauging Station (cont'd)		
-5 " CGK-4001	x 1	"
-6 " CCA-4002B	x 1	"
-7 " CDF-4059A	x 1	"
-8 " CDC-4147B	x 1	"
i. Spare Parts for Lahar Monitoring Station		
-1 Coaxial arrester	x 6	To be supplemented
-2 Arrester	x 12	"
-3 Modulation	x 1	To be checked
-4 VHF Transmitter	x 1	"
-5 VHF Local OSC	x 1	"
-6 VHF 10W Amp	x 1	"
-7 TV Camera KV-100B	x 1	"
-8 Lens	x 1	"
-9 Video Tape Recorder VT-9900ET	x 1	"
j. Spare Parts for Radar Rain Gauge		
-1 Floppy Disc	x 100	To be supplemented
-2 Magnetron M1337	x 3	"
-3 TR Limiter TL374	x 1	"
-4 Modulator CSA-96	x 1	To be checked
-5 PC Board CDF-4004	x 1	"
-6 " CDG-4045	x 1	"
-7 " CDT-4001	x 1	"
-8 " CHT-4007	x 1	"
-9 " CHT-4008	x 1	"
-10 " CHU-4007	x 1	"
-11 " CHU-4008	x 1	"
-12 " CMH-4038	x 1	"
-13 Hard Copy Paper	x 10	To be supplemented

(6) Results of Investigation of Required Items

1) Restoration of Radar Rainfall Gauge

(a) The damage due to the lightning strike on October 29, 1985, extended to the signal processing equipment, the CRT indication equipment, and the hard copying machine. With the immediate repair of the damaged equipment and machine by the manufacturer the following month, all the damaged equipment except the hard copying machine has been restored by the replacement of damaged parts with spare parts.

(b) The damage to the hard copying machine seems to extend to the power supply unit, the signal input circuit, and the central electronic circuit. It appears to be difficult to completely restore the machine to its original state at the site, therefore it is necessary to replace it with a new machine.

(c) The restoration of the hard copying machine is extremely urgent as the Mt. Galunggung Project Office uses hard copies for the collection and storage of radar related data.

2) Restoration of Telemetric Rainfall and Water Level Measurement System

(a) The damage due to the lightning strike on October 29, 1985, extended to the telemetry control unit, console, and typewriter. With the immediate repair of the damaged equipment and apparatus by the manufacturer the following month, all the damaged equipment except for the power supply unit of the

console and the typewriter have been restored by replacement of damaged parts with spare parts.

(b) The power supply unit of the console must be replaced with a new one.

(c) With regard to the typewriter, the electronic circuits for the printer control and the power supply unit were damaged by high voltage electrical surges. It seems difficult to completely restore the typewriter to its original state at the site, therefore, it is necessary to replace it with a new one.

(d) The restoration of the typewriter is quite urgent for the storage of telemetry-related data.

3) Restoration of Mudflow Sensing Station

(a) Kokoncong Station

a) Two of the three vibration sensors have been carried away or buried under muddy soil. As the river bed conditions have changed from the state when the sensors were originally installed due to mudflows, it will be difficult to install new vibration sensors in the same locations as the old ones.

b) To restore the functions of the vibration sensors, it is necessary to select positions in which they will be able to sense a mudflow without being carried away or buried under muddy soil.

c) In selecting these new installation points, the vibration levels should be tested on site.

(b) Sinagar Station

a) The route of the Cibangjaran River has shifted slightly to the west as compared to the route that existed when the mudflow vibration sensors were originally installed. The fact that the river route has shifted slightly is considered to be attributable to the sabo weir constructed for the purpose of preventing debris from flowing toward Tasikmalaya City.

b) In selecting these new installation points, the vibration levels should be tested on site.

4) Reinforcement of Lightning Measures

(a) Based on the damage to the equipment and apparatus due to the lightning strike on October 29, 1985, it is judged that the lightning entered through the power supply line, although most of the energy passed to earth via the lightning arrestor provided at the site.

(b) In Tasikmalaya City, where the Galunggung Project Office is located, lightning occurs quite frequently. Particularly during the rainy season, lightning strikes at least once a day. According to the radar rainfall gauge observations, although the rainfall region is relatively small, being between 5 and 15 km in diameter, the rainfall intensity, on the other hand, is quite high, with

the rainfall in many cases exceeding 100 mm/hour. Thus torrential rains attack the river basins of Mt. Galunggung sequentially, with accompanying lightning.

(c) In order to protect the equipment and apparatus provided at the Mt. Galunggung Project Office from the danger of lightning, reinforcement of the lightning preventive measures is considered to be an urgent task.

The radar tower, private power generation equipment and office building belonging to the Mt. Galunggung Project Office are not concentrated in the same location but are sporadically located approximately 30 m apart from each other. Each building is equipped with an individual lightning arrestor. Facilities for storing this equipment are located approximately 30 m apart, and there exists a possibility of lightning induction between them.

(d) To reinforce the lightning preventive measures it is planned to connect all these structures with a ground bus to form a grounding network. The radar tower, telemetry station, power supply station, and generator room should have individual earth gathering boards, to which the equipment and apparatus installed in each structure should be connected.

It is considered necessary to reroute the signal line which connects the equipment and apparatus at a certain distance from the grounding bus to prevent secondary induction of energy from the grounding bus.

5) Reinforcement of Back-Up Measures for the Power Supply of the Radar Rainfall Gauge

(a) The radar rainfall gauge is the nucleus of the forecasting and warning system. The Mt. Galunggung Project Office determines and gives a warning based on the data collected by the radar rainfall gauge. During the rainy season, in particular, any run down or interruption of the rainfall gauge equipment is critical.

(b) To date, however, the equipment has often had to be run down or had to be operated with frequent interruptions due to an inadequate supply of power. This is attributable to the fact that its power supply system is completely dependent on the energy generated by the private power generation equipment. In addition, electrical failures due to the shortage of fuel and insufficient maintenance technology have also resulted in interruptions to the operation.

(c) To cope with these situations, it is considered to be absolutely essential to provide a commercial power supply (PLN power supply) to back up the present capacity and thereby to allow stabilized operation.

6) Spare Parts Supply

To improve the operational efficiency of the forecasting and warning system, it is necessary to supply the following spare parts.

		Q'ty
-1.	Consumable Parts	
a.	Rainfall Gauging Station (4)	20 sets
b.	Mudflow Sensing Station (2)	10 sets
c.	Master Station (1)	5 sets
-2.	Check and Test of existing spare parts	
a.	Transmitter/Receiver	1 lot
b.	PC Board for TM master sation	1 lot
c.	PC Board for Gauging Station	1 lot
d.	PC Board for Radar Raingauge	1 lot
-3.	Consumable Parts for Radar Raingauge	
a.	Floppy disc 50/Year	250 sets
b.	Magnetron 8/Year	40 sets
c.	TR tube	1 set
d.	Hard Copy Paper 5/Year	25 reams

(7) Requested Items

Clarification of requested details

With regard to the request to quickly restore the Mt. Galunggung Mudflow Forecasting and Warning System, which is presently non-functional, the causes of and measures against the failure have been established, and the present overall system status has been evaluated. The table below describes the actions required for restoration and improvement of the system.

	Requested Items	Reasons, purposes, etc.
(1)	Restoration of radar rainfall gauge	Damaged by lightning on October 29, 1985. Stopgap measures were made the following month but the hard copy machine is still out of order.
(2)	Restoration of telemetry station for rainfall and water level measurements	Damaged by lightning on October 29, 1985. Stopgap measures were made the following month but several machines including the console, typewriterr and telemetry device are still out of order.
(3)	Restoration of mudflow sensing station	Some of the mudflow sensors installed at the Kokoncong and Sinagar stations do not function properly.
(4)	Reinforcement of anti-lightning measures for the equipment and apparatus belonging to the Mt. Galunggung Project Office.	The route taken by the lightning should be investigated and anti-lightning measures should be taken.
(5)	Back-up measures for the radar rainfall gauge power supply	The radar rainfall gauge power is currently supplied only by generator. This should be backed-up with a PLN power source.

Requested Items	Reasons, purposes, etc.
(6) Spare parts supply for:	
a. Radar rainfall gauge	- Magnetrons, hard copy papers, floppy disks,etc.
b. Power generator	- Battery charging fluid, and oils.
c. Telemetry station	- Recording papers, VHS cassette tapes, battery charging fluid, automatic rainfall recording papers, ink, etc.
d. Stand-by PC boards for each piece of equipment and apparatus	- Various PC boards.
e. Mudflow sensing station	- Battery charging fluid, recording papers, etc.
(7) Dispatch of specialists	Electronic communication specialists should be dispatched.
(8) Inspection and maintenance	Each piece of equipment and apparatus should be inspected and maintained in a favorable working condition.

With regard to the spare parts supply, the stocks of magnetrons, hard copy paper, and floppy disks for the radar rainfall gauges are almost exhausted. The supply of these materials is, therefore, an urgent necessity.

CHAPTER 4. PROJECT CONTENT

CHAPTER 4 PROJECT CONTENT

4-1 PROJECT OBJECTIVES

As described in the preceding chapters, the activities of the VSTC have steadily yielded excellent results, with 39 persons having been installed in the leading engineering positions for sabo undertakings, 29 of whom have previously been engaged in the sabo undertakings. It is doubtless that these numbers will continue to increase steadily in the future, and the firm belief is held that the propagation and improvement of sabo technology in the Republic of Indonesia, including the development of new sabo technologies, will certainly be promoted by the activities of these engineers.

Today, with still half the 5-year plan remaining, the ground on which much further technology can be transferred to the Republic of Indonesia has taken shape, and the volition for technical improvement on the Indonesian side has been notable.

Abreast the transfer of the basic technology, the Indonesian side has been making self-efforts toward technical improvement and development. It is, however, almost impossible, with the VSTC's current experimentation equipment, to perform experiments on the debris flows generated by the localized rains inherent to tropical zones, and on the soil inherent to the Republic of Indonesia relating to volcanic lahar. These experiments also urgently require study, development, experimental data accumulation, analysis, and public announcement.

Private houses have been modified to provide accommodation for the trainees, coming from all parts of Indonesia, and the lecturers from Jakarta and Bandung. The provision of a minimum required accommodation creates a better environment for the training activities.

The objective of the cooperation provided through the present grant aid is to contribute, by assisting the VSTC from the side, to the "training of sabo engineers", "improvement of sabo technologies", "establishing optimum sabo technologies", and "establishing sabo technology standards", these being the long-term targets of the VSTC.

4-2 FUTURE DIRECTION OF VSTC

4-2-1 Organization and Staffing Program

The upper organization of the VSTC has been changed as from April 1, 1986. In the former organization, the VSTC was positioned under the Directorate of Rivers, Directorate General of Water Resources Development, both reporting to the Ministry of Public Works.

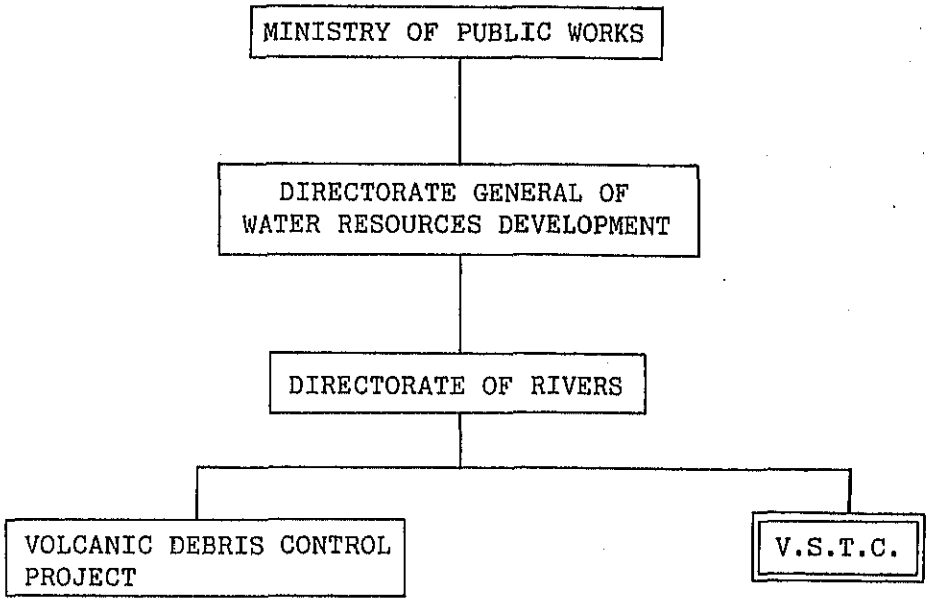
In the new organization, the VSTC is positioned under the Research and Development Centre for Water Resources, alias the Institute of Hydraulic Engineering, Board for Research and Development, Ministry of Public Works, thus increasing its efficiency by centralizing the ministry's research and development machinery.

The main reason for the change in organization is that in the former organization, greater importance was attached to the administrative aspect, making it difficult for the VSTC engineers to ascend to higher positions. In this regard, the change in the organization was implemented to enhance the consciousness of the engineers by providing them with the opportunity to ascend to leadership of the organization.

Also, in the Research and Development Centre for Water Resources (RDCWR), a plan has been established in which the groups of competent engineers fostered in the respective centres reporting to the RDCWR will, in the future, be organized to form a base for giving technical instruction.

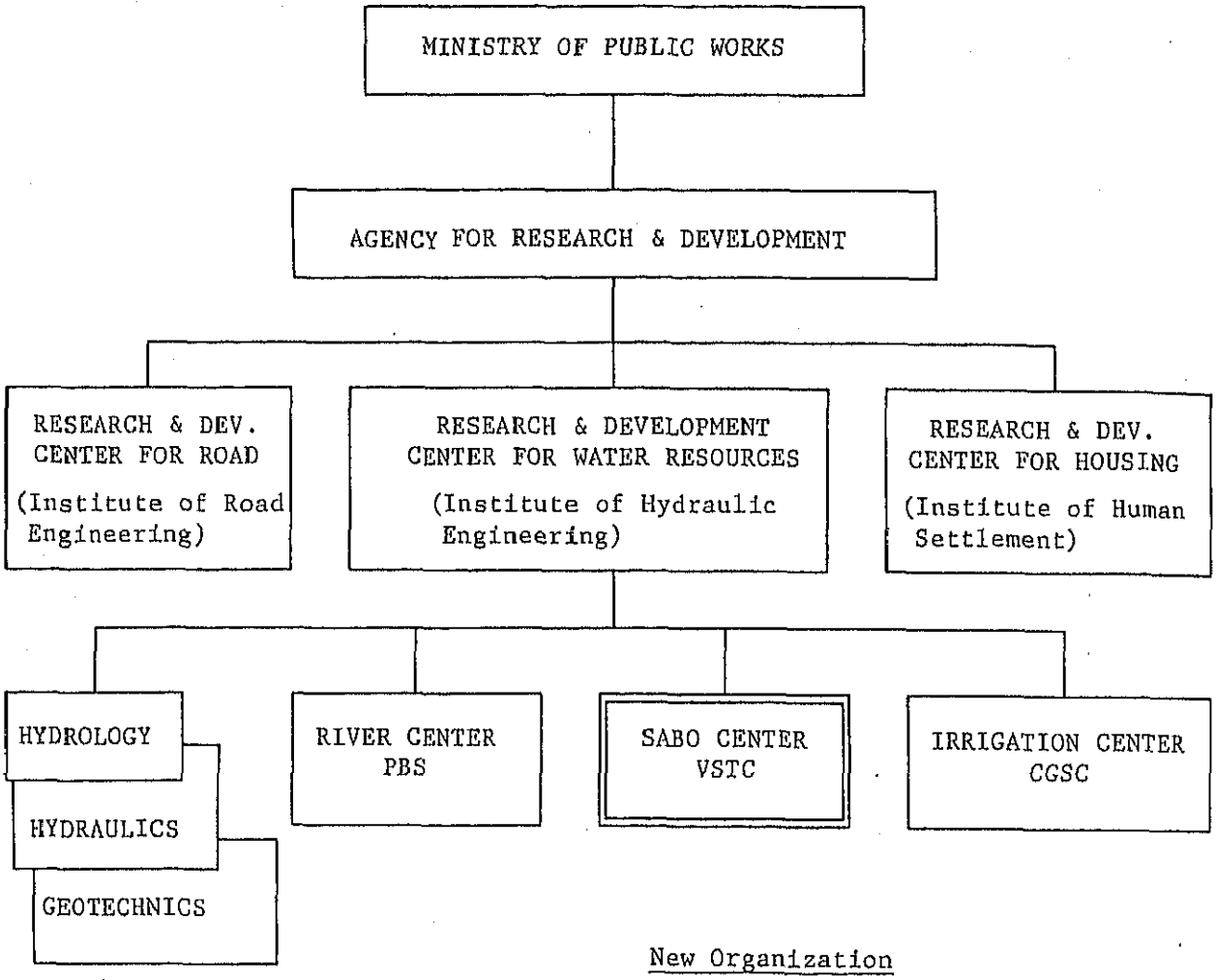
With regard to the VSTC's staffing program, only 35 persons were assigned in fiscal 1985, but this was increased to 40 in fiscal 1986. When the strengthened Volcanic Sabo Technical Centre has been completed in fiscal 1988, this number will be increased to 55.

The former and new organization charts are shown below.



Former Organization

The VSTC previously reported to the Directorate of Rivers, a sub-organization of the Ministry of Public Works.



New Organization

The VSTC is responsible to the Institute of Hydraulic Engineering, which is in turn responsible to the Board for Research and Development, a substructure of the Ministry of Public Works.

ORGANIZATION OF THE MINISTRY OF PUBLIC WORKS

REPUBLIC OF INDONESIA

(Ministry of Public Works)

CHIEF EXECUTIVES

ASSISTANTS OF THE CHIEF EXECUTIVES

PRIMARY EXECUTIVES

SERVICES EXECUTIVES

REGIONAL EXECUTIVES

MINISTER

INSPECTOR GENERAL

SECRETARY GENERAL

ASSISTANTS TO THE MINISTER

DIRECTOR GENERAL OF WATER RESOURCES DEVELOPMENT

DIRECTOR GENERAL OF ROADS & BRIDGES

DIRECTOR GENERAL OF HOUSING, BUILDING, PLANNING & URBAN DEVELOPMENT

(Agency for Research & Development)

HEAD OF AGENCY FOR RESEARCH AND DEVELOPMENT

INSTITUTES AND STATE ENTERPRISES

INSTITUTES AND STATE ENTERPRISES

INSTITUTE OF ROAD ENGINEERING

INSTITUTE OF HYDRAULIC ENGINEERING

INSTITUTE OF HUMAN SETTLEMENT

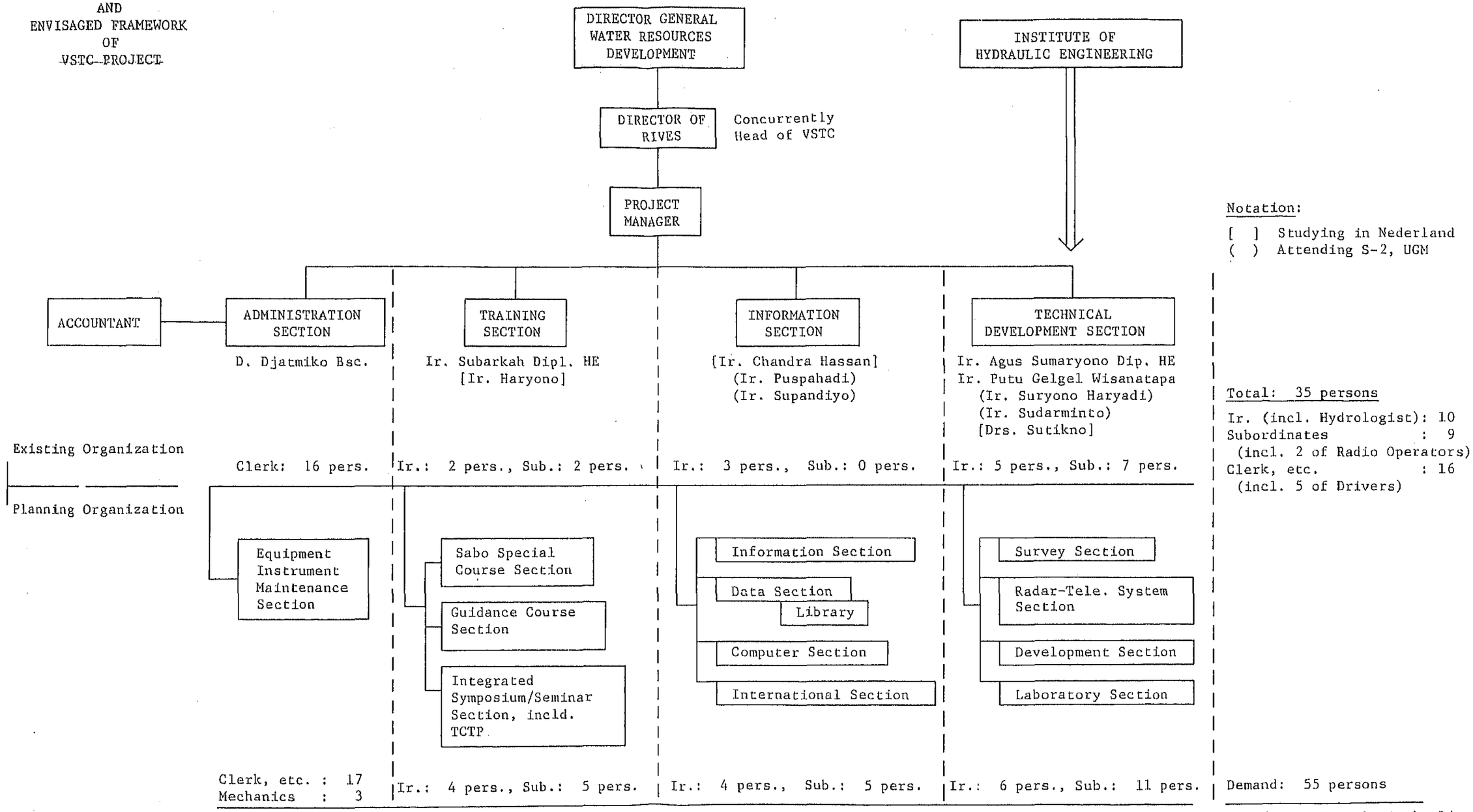
VSTC

PROVINCIAL AND DISTRICTS PUBLIC WORKS

New Organization

The VSTC now reports to the Institute of Hydraulic Engineering, Agency for Research and Development, Ministry of Public Works.

CURRENT ORGANIZATION
AND
ENVISAGED FRAMEWORK
OF
~~VSTC PROJECT~~



Notation:

[ ] Studying in Nederland
( ) Attending S-2, UGM

Total: 35 persons

Ir. (incl. Hydrologist): 10
Subordinates : 9
(incl. 2 of Radio Operators)
Clerk, etc. : 16
(incl. 5 of Drivers)

Demand: 55 persons

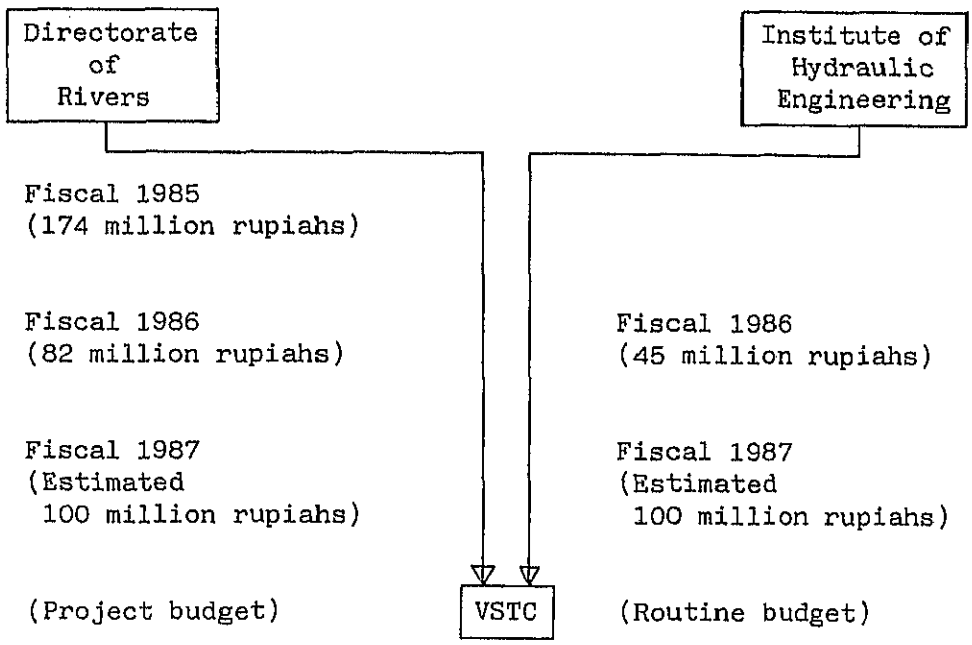
Ir. (incl. Hydrologist): 14
Subordinates : 21
(Incl. Radio Operators)
Clerk, etc. : 20
(incl. Drivers and Mechanics)

VSTC

4-2-2 Budgetary Measures

After fiscal 1986, a project budget to cover training costs will be appropriated by the Directorate of Rivers, and a routine budget to cover material and equipment costs, transportation fees, and maintenance and management costs will be appropriated by the Institute of Hydraulic Engineering.

The annual budgets of the Directorate of Rivers and the Institute of Hydraulic Engineering are shown below. Budgeting has been completed for 1986, but has yet to be determined for 1987.



4-2-3 Programs for Undertakings

(Policy for Organization Activities and Programs for Activities)

The Indonesian government plans to continue to develop and maintain this project even after the 1987 completion of the VSTC Technical Cooperation Project, started in 1982.

(1) Policy for activities

Items to be taken over continuously in the future include "Training of sabo engineers and improvement of sabo technologies" and "Development of optimum methods and development of other technologies for the establishment of a forecasting and alarm system." The conventional activity policies will remain as they are, but the programs will be expanded and developed.

(2) Activity programs

1) Contents of activities

The contents of activities referred to so far are as described in "Contents of Activities by the VSTC", Chapter 3.

2) Future activities

(a) Training activities

a) Drill course (for middle-management engineers)

A course intended to further instill and develop sabo technology awareness in

middle-management engineers, formed by consolidating the existing intensive and general courses. The consolidated course will have a capacity of 15 persons, biannually, each for two months.

b) Guidance course (patrol and guidance)

Intended to give guidance on the planning of an overall temporary project (medium term) as to individual rivers under sabo construction or requiring a project. This course will be a version of the existing comprehensive course except that the latter's curriculum will be transferred to the guidance course. This course will have a capacity of five persons and will run for a period of one year.

c) *Holding of comprehensive domain security* seminar and symposium

Intended to improve the domain securing technologies, through seminars and symposiums relating not only to volcanic sabo countermeasures, but also to the determination and control of sediment outflow, with the participation of personnel from relevant forest and agricultural farm land agencies. This seminar or symposium will have a capacity of *fifteen persons for a duration of one week*, annually and seventy to eighty persons for a duration of a few days, annually.

d) Implementing of various short-term classes

Intended to improve the levels of relevant engineers through training classes on research, planning and implementation relating to the domain securing technologies. Individual classes will have a capacity of twenty to twenty-five persons for a duration of a few days, annually.

(b) Information activities

a) Collection of data on natural disasters caused by sediments, etc.

The objective of this data collection is to prevent the scattering and loss of valuable data left unsorted, so that these data can be effectively utilized in establishing disaster countermeasures, preparing construction plans, and maintaining facilities.

b) Data exhibition and storage, library and reading room.

Intended for the collection and assortment of books, academic publications, reports, etc., relating to the security of the domain, and for enabling people to utilize them.

c) Computer (data)

Intended for the storage of basic data relating to the various sabo technologies and for enabling prompt applied practical calculations by means of computer.

d) Information exchanging function

Intended for the maintenance of an information exchanging function with relevant organizations, including international organizations, and for the aim of establishing a system capable of attracting international symposiums.

(c) Technology development activities

After completion of this improvement plan, technological development activities will be commenced.

a) Provision of facilities for basic experiment.

Intended for the provision of a basic material testing facility, etc., relating to sabo technology associated problems characteristic and inherent to the Republic of Indonesia.

b) Model experiment facility chiefly for sediment hydraulic.

Intended for the performing of laboratory model tests, essential to technological development, on model debris and sediment flows, landslides, and slope surface collapses, and to perform outdoor experiments on the construction of flow channels.

c) Promotion of developing optimum technology.

Intended to expansively develop extensive and diverse sabo technologies optimal to the Republic of Indonesia.

d) Establishing of a lahar forecasting and alarm system.

A pilot project intended for the standardization of, by means of a radar telemetry system, a lahar forecasting and alarm system, capable of issuing public announcements for warning, evacuation, release and practice.

4-3 DETAILED STUDY OF REQUEST

4-3-1 Details of Requested Facilities

(1) Dormitory — 1 building

An accommodation for engineers to stay at VSTC for the purposes of giving training and performing research work.

This building, two-storied with a total floor area of 1,200 m^2, will consist of twenty bedrooms (each with a bath and toilet), a dining room, a recreation room, a study room, a guard room, a laundry, a lobby, etc.

(2) Accommodation (for long-term lecturers) — 4 buildings

An accommodation for the lecturers and researchers expected to stay at VSCT on a long-term basis. Each building, single-storied with a total floor area of approximately 80 m^2, will consist of three bedrooms, a kitchen, a dining room, a reception room, baths and toilets, etc.

(3) Accommodation (for short-term lecturers) — 1 building

An accommodation for the lecturers and researchers staying at the VSTC on a short-term basis to give lectures and to attend meetings.

The building, single-storied with a floor area of approximately 500 m^2, will consist of five bedrooms, each with a bath and toilet, a kitchen, a dining room, a hall, etc.

(4) Data storage 1 building

A building including a library in which documents and materials relating to sabo technologies are stored and arranged. Information for perusal and a computer room for data analysis are also provided.

The building, two-storied with a total floor area of approximately 400 m^2, will consist of a book storage, a material room, a reading room, an office, a computer room, a data analysis room, a small conference room, etc.

(5) Conference hall 1 building

The conference hall is to be used for meetings related to sabo technologies and presentation of research works.

The building, single-storied with a total floor area of approximately 400 m^2, will consist of a training auditorium (capacity for 70 to 80 people), a small conference room, a hall, etc.

(6) Outdoor experiment yard 1 place

An outdoor sabo technology experiment yard for carrying out hydraulic flow model tests and the large scale hydraulic channel tests.

This will include a reservoir, pumps, a water tank, water supply pipe, a sedimentation basin, a return channel (sedimentation basin --- reservoir) and a control room.

(7) No. 2 hydraulic test building 1 building

A building, single-storied with a floor area of approximately 800 m^2, for storing the hydraulic model test

equipment, such as an artificial rainfall apparatus, a mudflow generator, a mudflow model flume and a hydraulic model test flume.

4-3-2 Detailed Study of Facilities

In studying the details of the facilities, a plan for their usage was proposed based on the total planning of VSTC as a whole, taking into consideration the existing facilities and facilities to be constructed in this project.

(1) Dormitory

1) Current situation and problems

(a) At present, only one building is available for the accommodation of trainees at VSTC, this being a remodelled private house providing eight single rooms. Currently, two trainees are accommodated in each room, the capacity of which is supposed to be one person, making the total number of people in the building 16.

In the case of the general training course, 4 to 9 trainees cannot be accommodated within the VSTC premises due to the fact that 20 to 25 trainees normally participate in this course. They are therefore forced to stay in a hotel during the course.

In the case of trainees for the first comprehensive course, only one out of the seven trainees was given accommodation in the Staff House within the VSTC premises, and remaining six had to rent a house. The situation is not expected to improve, and the five trainees who

will take the 2nd course have no choice but to stay in a rented house.

There is no accommodation available for the long- and short-term lecturers within the VSTC premises, and in the past, everyone had to stay in rented houses or in hotels. Therefore, it is important that accommodation be provided within the VSTC premises for all lecturers.

2) Specific planning

(a) In this plan, facilities requested by Indonesia to be built, such as a dormitory - 1 building, accommodation for the long-term lecturers - 4 buildings and accommodation for the short-term lecturers - 1 building, will be combined in a three-storey building, taking into consideration the conditions of the premises and economy. On the 3rd floor, twenty single rooms accommodating twenty people will be provided for the trainees participating in the general and advanced courses.

On the 2nd floor, four three-DK units are planned for the long-term lecturers. Three to four lecturers will be dispatched for the advanced and comprehensive courses from the Institute of Hydraulic Engineering in Bandung, the Directorate of Rivers in Jakarta and the University of Gadjah Mada.

Six single rooms are planned on the 1st floor for the short-term lecturers. In the case of the advanced course, six lecturers are scheduled to give 33 lectures.

As stated in the VSTC's future prospectus, in addition to training lectures and volcanic sabo technologies, lectures in broader areas, including forests and field and agricultural land management are being considered for inclusion in the training plan, and invitations to lecturers from the relevant agencies are also planned.

The building currently being used as the dormitory will be remodelled by Indonesia to become the accommodation for comprehensive course trainees, who will stay for a longer period of time. Since women trainees also participate in the general courses from time to time, this building will be used to accommodate them.

(2) Sabo Information Center

1) Current situation and problems

In the training currently given at the VSTC, the lecture room in the existing administration building is used for the general course lectures. According to the curriculum, 1/3 of the total number of hours in the advanced course is allocated to the general lectures, with all trainees participating, 1/3 to group study, for which the trainees are divided into three groups, and the remaining 1/3 to the field experiments.

While the lecture room is used for the general lectures, as in the cases of the general course, a regular training room is not provided for the group study. Thus, either the conference room in the existing administration building or a temporary venue is provided in the Soil Testing Building for group study lectures. Therefore, because meetings are given

priority when schedules for both lectures and meetings coincide, trainees must find another place for their study.

When the 1st comprehensive course was held, although desks were provided for each trainee, locations allocated for research were unsatisfactory due to the fact that three trainees were assigned to the Soil Testing Building, three to the remodelled reception room currently used by the Information Section, and the last group to a room belonging to the Training Section. It is important, therefore, to improve the training and conference room situation.

With regard to data control and storage, as books, documents and drawings are kept separately in many rooms, filing and arrangement is unsatisfactory, use of materials is inconvenient, and provision of a material room and a reading room is urgently required.

Although the conference room in the existing administration building, having a floor area of 100 m^2, is capable of seating about 35 to 40 trainees, it is not large enough for meetings or opening ceremonies of courses, which all trainees, lecturers and VSTC staff attend, and for symposiums at which 70 to 80 people, including two delegates from each of the 27 states in Indonesia, are expected to assemble.

2) Specific planning

In this plan, a two-storey building including a data storage and a conference hall, as requested by Indonesia, will be constructed taking into consideration the conditions of the premises and economy.

On the 2nd floor, a material room and a reading room for the storage and filing of materials, a computer room and a data room for data processing, a working room to be used by the Information Section and finally a room for the chief of the Center will be provided.

On the 1st floor, a training and conference room with a movable partition allowing division into two rooms when necessitated by the group studies of the advanced courses will be provided. Of the three groups, two will study in this building, and the remaining group will have to consider effective use of the existing lecture room.

One room will be allocated to the comprehensive course trainees for academic study and research work.

A training auditorium with an elevated stage capable of seating 80 people will be arranged at the center of the building, and projections will be made from a projection room to be located on the 2nd floor.

Seats in the training auditorium will not be fixed so that the auditorium can be used for multiple purposes.

A drawing room will be provided for the preparation of drawings and for the use of the VSTC staff and comprehensive course trainees.

(3) Lahar Laboratory

As the result of a study made on the equipment layout plan with consideration of the existing facilities, it was found to be impossible to house an artificial rainfall apparatus, a mudflow model generator and a hydraulic model test flume

in the existing facilities, thereby confirming the necessity of this new building.

This laboratory will be single-storied with a floor area of 18 by 45 m, in accordance with the layout plan of equipment described later in this paper. The minimum height clearance of this building will be 9 m due to the expected storage of equipment requiring a high ceiling.

In order to effectively recycle the water used for experiments, an 80 m^3 water tank will be provided beneath the floor, with provision for a sedimentation tank and a return water channel.

On the mezzanine floor, a passage for observation and photographing various experiments by the trainees is planned.

(4) Outdoor experiment yard

According to the site acquisition plan of the VSTC, the new site area will be approximately 7,000 m^2, making future re-arrangement of this outdoor testing yard possible. In this plan, therefore, among the equipment and facilities required for experiments, pumps, a water tank, a water supply pipe and a control room, all of which are to be installed within the already acquired site, will be provided.

The plan, including the existing facilities, is illustrated as follows.

		Present	Planned
1	Administration building (Existing)	Forecasting and alarm system, Administration office	Administration office
2	Hydraulic Model Testing Building (Existing)	Test Flume (L = 6.0 m)	Test Flume (L = 6.0 m) Store F and G
3	Engineers' office (Existing)	Completed in April, 1986	Engineers' office, store Existing measuring equipment
4	Soil and concrete testing laboratory (Existing)	Concrete compression machine, Engineers' office	Concrete compression testing machine, store H
5	Dormitory (Existing)	Accommodating 16 trainees	Accommodation for trainees
6	Lahar Laboratory (New building)		Store A, B, C and D
7	Information Center (New building)		Training auditorium, testing and conference room, computer room
8	Dormitory (New Building)		Accommodation for trainees and lecturers

Equipment Supply List

A - Artificial Rainfall Apparatus

B - Mudflow Model Generator

C - Mudflow Model Flume

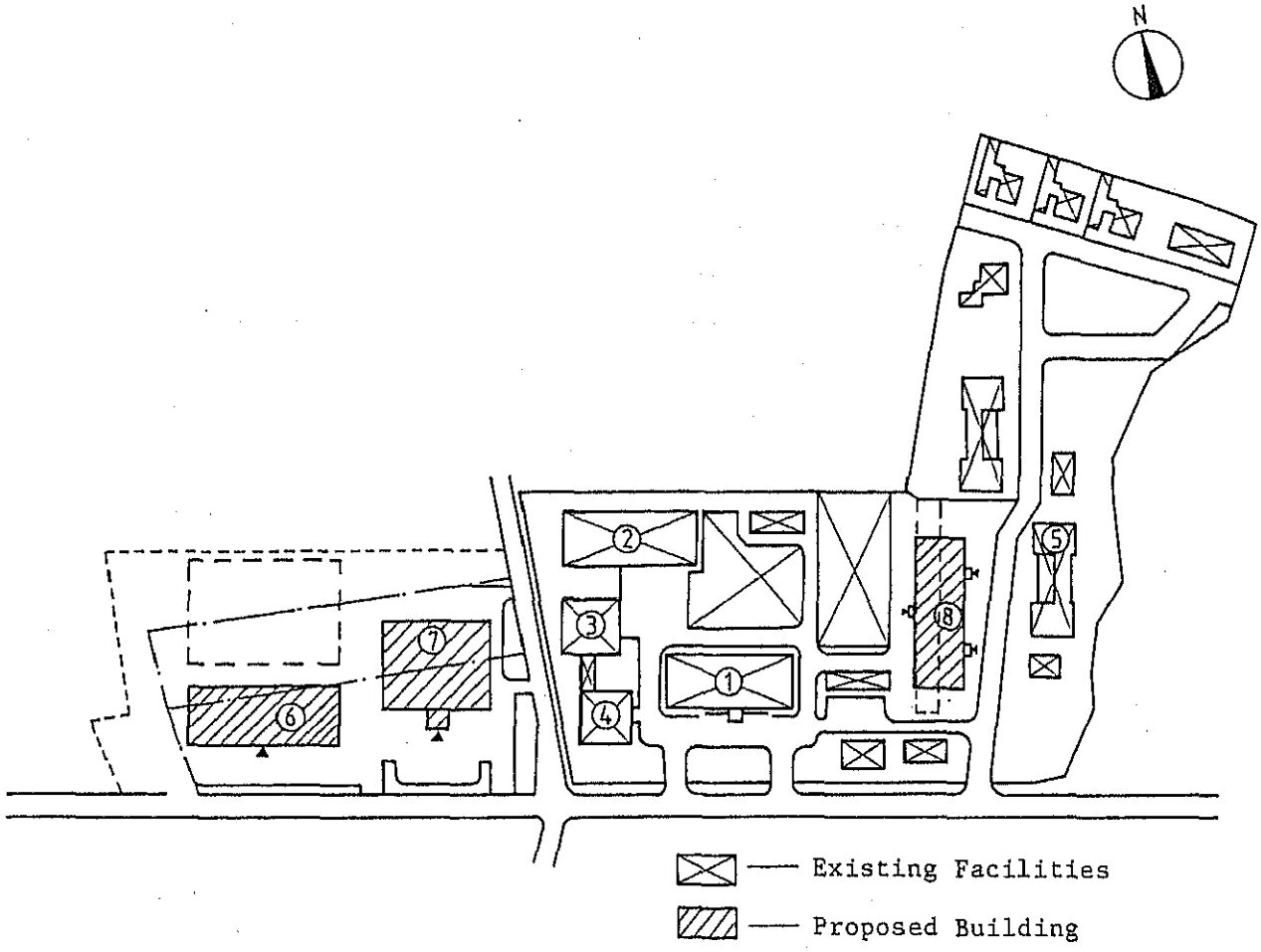
D - Hydraulic Model Test Flume (L = 20 m)

E - Water supply equipment for outdoor hydraulic model testing

F - Concrete Abrasion Testing Machine

G - Concrete Impact Testing Machine

H - Triaxial Compression Test Apparatus


N
1
2
3
4
5
6
7
8
Existing Facilities
Proposed Building

4-3-3 Details of Requested Equipment

Supply of the following equipment has been requested.

(1) Sabo Equipment

1)	Artificial Rainfall Apparatus	1 set
2)	Mudflow Model Generator	1 set
3)	Mudflow Model Flume	1 set
4)	Hydraulic Model Test Flume	1 set
5)	Mudflow Observation Equipment	1 set
6)	Concrete Abrasion Testing Machine	1 set
7)	Concrete Impact Testing Machine	1 set
8)	Triaxial Compression Test Apparatus	1 set
9)	Ring Shear Apparatus	1 set
10)	Echo Sounding Apparatus	1 set
11)	Natural Selection Analyzer	1 set

(2) Materials requested for Forecasting and Alarm System

1)	Mudflow Observation Equipment	1 set
2)	Electric-wave Current Meter	3 sets
3)	Ultrasonic Water-level Gauge	4 sets
4)	Additional Radar Raingauge Functions	1 set

(3) Equipment for Data Processing and Office Supplies

1)	Word Processor	1 set
2)	Blue Printing Machine	1 set
3)	Offset Printing Machine	1 set
4)	CRT Display for Computer	3 sets
5)	Audio-visual equipment for Convention Hall	1 set
6)	Copying Machine	1 set

(4) Vehicles

1)	Bus (40 persons)	1
2)	Mini Bus (11 persons)	2
3)	Jeep	4

(5) Equipment for restoration of the Mt. Galunggung Mudflow warning system — 1 set

4-3-4 Study of Equipment Details

The following results were obtained after confirmation of the type, specifications and quantity of the currently possessed equipment to ensure that there would be no duplication by the equipment to be supplied under this plan, as well as to confirm its necessity, usage and specifications.

(1) Sabo Equipment

1) Artificial Rainfall Apparatus

The major factors in the generation of sediment flows are volcanic activities and rainfall. Rainfall directly triggers the generation of mudflows and sediment avalanches.

This system artificially creates natural rainfall conditions, allowing the following experiments to be performed.

- Hydraulic function experiments (infiltration, reservoirs, flow, etc.)
- Surface erosion experiment
- Slope degradation and landslide experiments
- Mudflow and sediment avalanche generation of experiments
- Experiments to determine the effect of rainfall on the surrounding environment during rainfall

The requested size of 10m x 10m corresponds to the smallest equipment available in Japan. If equipment smaller than this is used for the model tests, it is unreasonable to expect effective results.

2) Mudflow Model Generator

This equipment is used to generate a highly viscous volcanic mudflow including lots of fine particles for experimental purposes.

In order to carry out a mudflow model test, it is necessary to generate a high viscosity waterflow.

This equipment agitates the fresh water and the fine particulates to create a flow (mudflow condition) with a high concentration of sand particles. It is always associated with a Mudflow Model Flume.

3) Mudflow Model Flume

Generally speaking, a Hydraulic Model Test Flume of constant slope (linear slope) is used. In reality, however, the slopes of the actual river bed sections where mudflows are generated change drastically. Therefore, carrying out of experiments using only constant slope flume is not sufficient to reproduce the actual phenomenon.

With this flume, determination of the slope can be made in a short period of time by dividing it into two sections, allowing the shapes to correspond as closely as possible to the actual river bed slope. Also, viscous flow can be developed by connection with a Mudflow Model Generator. That is, this flume will be used to carry out highly accurate experiments under

conditions corresponding extremely closely to those of the actual phenomenon, and an associated facility to clarify the generation, flow and sedimentation mechanisms of mudflows is necessary.

4) Hydraulic Model Test Flume

A hydraulic model test using a water flume is one of the most effective methods for the study of river bed configurations in gentle slope rivers and alluvial fan rivers.

The existing linear flume is 1 m in width and 6 m in length. Although it is useful for carrying out studies for the protection work of the areas in front of Sabo-dams and research on the sedimentation mechanisms of sabo-dams, because of its relatively short length, it cannot be used for experiments like the aforementioned, where it is necessary to assume that the length of the modelled section is 2 km. To carry out a 1/50 to 1/100 scale model test on such a section, therefore, the proposed flume length of 20 m is required.

5) Water Course Engineering Observation System

This system will not be supplied under the present grant as a suitable installation site has not yet been secured.

6) Concrete Abrasion Testing Machine

Because it is necessary to consider measures for the use of either special concrete or abrasion-resistant concrete in the crests of sabo-dams due to the high degree of abrasion damage caused by the water flow, the abrasion resistance of test pieces will be studied by using this machine to determine the optimum concrete mix ratios.

7) Concrete Impact Testing Machine

A concrete mix design will be required to determine the optimum measures for the prevention of damage to dams by the impact of sediment avalanches. This machine will be used to collect data for these measures.

8) Triaxial Compression Test Apparatus

This machine will be used to collect necessary data on soil shearing strength characteristics, and for the designing of sabo structures.

9) Ring Shear Apparatus

This apparatus will be used to collect data on the viscosity and the frictional force of clay on the sliding surface of a landslide. However, this equipment will be assigned the lowest priority.

10) Echo Sounding Apparatus

This apparatus will be used to investigate the underwater conditions of sedimentary sand upstream of dams and to confirm the volume of sand expected to be

accumulated in the future. However, this equipment will be assigned the lowest priority.

11) Natural Selection Analyzer

This device will be used to study the properties of fine suspended particulates which are characteristic of Indonesia, and to confirm their flow and deposition conditions for utilization in the designing of sabo structures. However, this equipment will be assigned the lowest priority.

(2) Equipment for Mudflow Warning System

1) Mudflow Observation Equipment

The Krasak river has a very high frequency of mudflow generation, 30 people being reported killed by mudflows in 1976. This system will be used for real-time observation of the generation of sediment avalanches, and, by the development of prediction technologies, a warning system will be established.

2) Electric-wave Current Meter

Although analysis of mudflow generation is presently made according to the water levels measured by telemetry and by calculation of the flow rate of the river, it is necessary, in order to obtain higher accuracy calculations of the flow rate, to perform real-time observation of the river velocity. By doing so, the technology for predicting the size and time of mudflow generation will be systematized.

3) Ultrasonic Water Level Meter

Observation of water levels is currently done by means of telemetry connected to the existing water level meters of 2 locations in the Putih river and 1 location in the Krasak river. However, the generation of mudflows due to the Mt. Merapi volcano takes place not only in these two rivers but over a wider area from Blongkeng river on the southwestern slopes of Mt. Merapi to the Gendol river on the southern slopes.

In order to understand the whole mudflow generation situation of Mt. Merapi and to further improve the accuracy of warning for mudflow generation, observation of the water levels must be extended.

4) Additional Radar Raingauge Functions

(a) Change of area division

As a result of repeated collection and analysis of data after the installation of a small radar in November 1984, a reorganization of the divisions for mudflow generation, except for the crater section, has become necessary. This is because of the aim of directly relating these divisions with the corresponding division of the warning system. The critical data collecting divisions will be further expanded for the provision of more accurate warnings.

(b) Change of screen display steps during playback

As the rainfall analysis operation of the Radar Raingauge at the VSTC progresses, the volume of data accumulated by hard copies steadily

increases. Thus, to increase the operational efficiency, it is necessary to reduce the time spent searching for a targeted rainfall by playback of these hard copies. It is proposed to change the display renewal step from 1 line/1 step to 48 lines/1 step so that the search time will be significantly reduced.

(c) Display of spot rainfall

Rainfall data obtained by the radar raingauge is calibrated by the ground telemetry raingauge, and comparison with the actual rainfall is carried out on a regular basis. At present, however, as calculation of the rainfall recorded by the Radar Raingauge is done manually, the operation is slow. Therefore, a reduction in analysis time for the calibration is planned by displaying spot rainfalls (10 and 60 minutes), automatically calculated using the calculation function of the Radar Raingauge processing system.

(d) Display of observation point names

As the data on rainfall conditions obtained by the Radar Raingauge, the observed values of rainfall, the observed water levels and the observed mudflow conditions are gradually becoming integratedly and organically used, the necessity of frequently displaying the telemetry observation points over the rainfalls obtained by the Radar Raingauge has increased. This type of display is planned for the near future.

(3) Equipment for Data Processing and Office Supplies

1) Word Processor

This word processor will be used at the VSTC for education of the Indonesian sabo engineers in the preparation of educational texts and research reports.

2) Blue Printing Machine

This machine will be used at the VSTC for education of the Indonesian sabo engineers in the preparation of educational texts and drawings, etc., for designs relating to the development of technologies.

3) Offset Printing Machine

This machine will be used at the VSTC for education of the Indonesian sabo engineers in the preparation of eductional texts and research reports. However, this equipment will be assigned the lowest priority.

4) CRT Display for Computer

In addition to the NEC 100/45 computer currently being used at the VSTC for scientific calculations for technological development, further two CRT displays will be connected for use. The purpose is to enable preparation of computer programs and to provide training for general handling as educational equipment for sabo engineers at the VSTC. This equipment will be such that it can be used simultaneously by two trainees.

5) Audio-visual Equipment for Convention Hall

This equipment will be used at the VSTC for audio-visual education of Indonesian sabo engineers, and consists of the following.

	Equipment Name	Q'ty	Purpose
i.	Sound System	1 set	Education/training, conferences, ceromonies
ii.	TV Monitor System	1 set	"

6) Copying Machine

This machine will be used at the VSTC for the education and training of Indonesian sabo engineers, its purpose being the preparation of educational texts and research reports.

(4) Vehicles

1) Bus (40 passengers)
To be used during the field training of the general course.

2) Mini Bus (11 passengers)
To be used during the field training of the advanced and comprehensive courses. However, this vehicle will be assigned the lowest priority.