ANNEX – 2

WATERSHED CONSERVATION, SABO AND FLOOD CONTROL

ANNEX - 2 WATERSHED CONSERVATION, SABO AND FLOOD CONTROL

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1.1 Watershed Conservation

1.1.1 Land Use

(1) Whole Brantas River Basin

The land use in the Brantas river basin is surveyed by the authorities concerned for their own purposes. Those authorities are 1) Agrarian office, 2) Balai Rehabilitasi Lahan dan Konservasi Tanah (BRLKT, Land Rehabilitation and Soil Conservation Agency), and 3) Perum Perhutani (Forestry Public Corporation) and Pemerintah Propinsi Daerah Tingkat I, Jawa Timur (Provincial Government of East Java, hereinafter East Java Province).

Based on the latest surveys by Perum Perhutani and East Java Province as of 1990, land use in the Brantas river basin is presented in Figures A2-1. The Brantas river basin has been developed to its maximum extent for agriculture. Most of the paddy field extends over the flat alluvial plain formed by the Brantas river and its tributaries. The upland fields are located in the foot area of Mt. Semeru, Mt. Kawi, Mt. Kelud and Mt. Wilis, which have steep slope lands. The upland fields extend over the land enclosed by paddy field in the lower portion and forest in the higher portion. The homestead areas are scattered to all over the basin.

Although there are some difference of the land classification between the surveys and the plans, the breakdown of those land use are estimated as shown in Table A2-1.

Figure A2-2 presents the land use plan in 2008, based on plans by Perum Perhutani and East Java Province. Table A2-1 show estimated breakdown of the land use in 1990 and those in 2008.

Although there are some difference of the land classification between the surveys and the plans,

Although it is difficult to compare the land use in 1990 and land use plan as 2008 because of the difference of the land classification, the following matters can be recognized.

- The homestead area will increase. This tendency is remarkable in the surrounding area of Surabaya City.
- The homestead area in the upper and middle basin will not increase.
- The industrial area will increase in the areas of Surabaya City and its outskirts.

(2) Mountainous Area

With regard to the watershed conservation, the most important area is the mountainous area. In this study, the Mountainous area is defined as the area of which elevation is higher than 200 m of SHVP, based on the consideration described below.

- Generally, a slanting surface is classified into i) 0° to 15°: gentle slope, ii) 15° to 35°: steep slopes and iii) more than 35°: extreme slope. Mountainous area is a land on the higher slope area above 15°in general.
- In the Brantas river basin, area of a higher 15° in slope is the area surrounded by 200-m counter line based on the longitudinal profile of the basin. Then, the mountainous area in the Brantas basin is defined as the area surrounded by 200-m counter line.

The boundary of mountainous area in the Brantas river basin is shown in Figures A2-1 and A2-2. The breakdown of the land use in the mountainous area is presented in Table A2-2.

At present, the mountainous area is mainly used to the forest and upland fields. In future, however, the upland field will decrease and be improved as the forest and the homestead area.

(3) Forestry

Generally, it has been recognized that forest has a very important function to reduce flood discharge, to retain water resources and to prevent soil erosion in mountainous area.

In and around the Brantas river basin, Perum Perhutani, Unit. II Jawa Timur (Second Unit of Forestry Public Corporation of East Java) mainly manages the forestry areas. And the Brantas River basin is included in eight Kesatuan Pemangkuan Hutan (KPH, Forestry management unit) of the Unit II.

According to Dalam Angka Jawa Timur 1995 (Statistic table of East Java 1995), the forest areas in KPH are divided into four based on their function, those are, productive, preserved, TBP/LDTI (Tidak Baik untuk Perusahan / Lahan Dengan Tujuan Istimewa, No good estate / Land for special purpose) and other forests. Other forest includes national forest park, great forest park, recreation forest park, natural preserve and wildlife reserve. Breakdown of the forest areas in eight KPHs related to the Brantas River basin is presented in Table A2-3 and summarized below.

Forest area in KPH related to the Brantas River Basin		
Function of Forest	Forest Area (ha)	%
Productive	302,087	63.4
Preserved	134,812	28.4
TBP/LDTI	8,760	1.8
Others	30,671	6.4
Total	476,330	100.0

Source: Perum Perhutani, Unit II Jawa Timur.

The forest area in the Brantas River basin mainly ranges in KPH Kediri and KPH Malang. Those are 29.6 % and 28.3 % of the forest area in the Brantas river basin in 1990, respectively.

Trees of the productive area consist of Agathis, Teak, Mahogany, Pine, Sengon, Sonokeling and others. Annual deforestation areas in the East Java reached 50,773 ha in total, which

occupy 6.4 % of the whole productive forest area in 1995. Among the deforestation areas, those of Teak and Pine occupied 60.8 % and 18.2 %, respectively. The deforestation areas in the Brantas River basin are not clear yet.

Wood production of the forest area in the eight KPHs is as shown Table A2-4 and summarized below.

Kind of Wood		1994	1995
Sawn Wood (m^3)	Teak wood	93,204	100,542
	Others	166,777	153,254
Fire Wood (m^2)	Teak wood	17,984	15,350
	Others	51,382	37,533

Source: Perum Perhutani, Unit II Jawa Timur

According to the future land use plan in East Java 2008 as shown in Table A2-5, preserved and production forest area are planned to be increased by 1.4 % and 0.1 % per annum, respectively, while other forest area will be same as that of the present situation.

1.1.2 Geology and Soils

The geology of east Java is mostly comprised of tertiary deposits with many volcanic members such as basalts and andesite and some coral limestone. The Brantas river basin is genrally comprised of agglomerate, tuff breccia, tuff and coral limestone accompanying volcanic ashes with varying degrees of consolidation (Figure A2-3).

The flat lowland terrain is composed of alluvial soils of loam, silt and clay, which are mostly suitable for paddy cultivation. The weathered materials of volcanic origin cover the hilly and mountainous area.

A general broad-scaled soil survey was conducted over the Brantas river basin by the Central Soil Research Institute of Bogor in 1967 (Figure A2-4). Generally, the soils of the Brantas river basin can be categorized into 9 groups of which the following 6 groups account for 96% of the area.

Alluvial Soils	347,000 ha	29.4%
Mediterranean Soils	129,000 ha	10.9%
Lithosols	95,000 ha	8.1%
Regosols	288,000 ha	24.4%
Andosols	93,000 ha	7.9%
Latosols	185,000 ha	15.7%

In additions, broad-scale land capability classification for the Brantas river basin had been conducted as part of the 1973 master plan. Land classification is shown in Table A2-6.

In relation to soil erosion, the Andosols, or soils derived from volcanic ash, are particularly problematic. They are concentrated in the upland areas where slope gradients are steepest and the soils are characterized by a dominance of amorphous materials in the clay fraction, a low bulk density, friable consistency, and high sorption capacity. These characteristics contribute to the erosive nature of these soils

1.1.3 Sediment Yield

(1) Critical Land of Erosion

According to the report of the Kali Konto Project, Phase III, in 1988, Ministry of Forestry, "critical land" was estimated in the Brantas river basin in order to upgrade the "Pola RLKT" (land rehabilitation and soil conservation manual) as the integrated watershed management study.

In the report, "critical land" is defined as follows.

"The critical land is an area with reasonably similar reoccurring critical limitations of the physical, social or economic resources (conditions) which result in degradation, damage or misuse to the environment. The damage may be either reversible or irreversible. Critical lands are generally associated with subsistence or below subsistence farming very high land reclamation or maintenance inputs and costs, degraded environment or land unusable for productive exploitation."

The critical land is further classified as shown in Table A2-7 and Figure A2-5.

Based on the above results, the Study team selects the critical lands of erosion that are critical lands except areas of volcanic crater, inundation area, swamp/marsh and flooding area. Selected lands in the basin are estimated at 3,240 km^2 as shown below.

Basin	Critical Area of Erosion (km^2)
Lesti	412.0
Upper Brantas	308.0
Kelud	453.5
Ngrowo	725.4
Widas	295.6
Others	545.5
Around crater	55.5
Total	3,295.5

Watershed conservation works are necessary for such lands.

(2) Sediment Yield

The critical land of erosion described above seems to be a source of sediment yield. The most extensive critical lands of erosion exist in the Ngrowo river basin with 22 % of the whole critical lands of erosion, and those of the Lesti river basin and the upper Brantas river basin are about 13 % and 10 %, respectively.

The following table shows the sediment yields at major reservoirs. The sediment yield varies from 1.13 mm/year/km^2 to 2.50 mm/year/km^2.

Dam	Catchment Area (km^2)	Completed Year	Survey Year	Sedimentation	
				(million m^3/yr)	(mm/yr/km^2)
Sengguruh	1,659	1988	1996	3.14	1.89
Lahor	160	1977	1995	0.18	1.13
Selorejo	236	1970	1993	0.59	2.50
Bening	89.5	1981	1993	0.10	1.12

Another source of sediment yield is Mt. Kelud. Mt. Kelud is an active volcano located in the center of the Brantas river basin. The volcano has erupted approximately once in 15 years basis as shown in Table A2-8 and the average amount of erupted materials is estimated at 200 million m^3 per an eruption.

The latest eruption occurred in February 10-14, 1990 and resulted in the filling of the Wlingi reservoir up to the low water level due to a lahar. The lahar volume in the past eruption is also estimated at 142 million m^3 over an area of 2003.3 km^2.

1.1.4 Experimental Research of Watershed Conservation

To clarify the relations between forest coverage, land use, soil condition, vegetation, runoff and soil erosion in the Brantas river basin quantitatively, Sub-BRLKT has being performed the experimental research projects.

Locations of the research projects are at Dampit and at Blitar and those areas are 10 ha each. Annual cost is about 15 to 17 x 10^6 mil.rupiahs/site.

Results are shown below. However, areas of the experimental research are rather small and the results of research are limited to use.

Alley Cropping — Location: Blitar

Observation	Unit	Kind of Wood			Control
		Lamtoro	Kalianda	Glirisida	
Run-off Volume	m^3/year	585	518	575	989
Erosion	t/year/ha	7.6	6.3	6.8	11.7

Grass Barrier — Location: Dampit

Observation	Unit	Kind of Wood			Control
		Lamtoro	Kalianda	Glirisida	
Run-off Volume	m^3/year	209	270	232	433
Erosion	t/year/ha	4.0	5.5	3.8	5.6

1.1.5 Present Operation, Maintenance and Rehabilitation

At present, three (3) authorities, consisting of Sub-BRLKT, DPKT and Perum Perhutani, mainly conduct the watershed conservation in the Brantas river basin. Activities of those authorities are as follows.

(1) Sub-BRLKT Brantas

Sub-BRLKT Brantas belongs to BRLKT Wilayah IV and tasks are as follows.

- Establishment of 25-year long-term plan and 5-year short term plan for land rehabilitation and soil conservation in the Brantas river basin except Perum Perhutani area.
- Engineering consultant activities for farmers.
- Experimental study on relation among vegetation, runoff and erosion. (Pilot plot: Dampit and Blitar)

Organization structure of Sub-BRLKT is illustrated in Figure A2-6 and total staffs are 78 persons. Annual budget in 1996/1997 is 2,263 million rupiahs by APBN. Within this budget, cost of experimental study is 47.6 million rupiahs.

(2) DPKT

DPKT was established in 1 March 1994 by separating from Sub-BRLKT Brantas and there are nine (9) DPKT in the Brantas river basin. Duties and tasks of DPKT are as follows.

- Guidance of forestation and land conservation in the Brantas river basin except Perum Perhutani area based on the 5-year plan by Sub-BRLKT.
- Preparation of material for forestation and land conservation.
- Training and education of farmer.
- Production of natural silk.
- Production of honey.

Organization structure of DPKT Kabupaten Malang, one of a DPKT (Kabupaten), is illustrated in Figure A2-7. Annual budget in 1997/1998 is 50 million rupiahs by APBN and INPRES (for Greening project).

(3) Perum Perhutani (DAS Brantas Unit II Jawa Timur)

Perum Perhutani performs planning and implementation of reforestation, production of woods, watershed conservation, etc. in 8 KPHS (forestry management unit) of the Brantas river basin. Area managed by Perum Perhutani is 474,593 ha. Organization, budget and activities of Perum Perhutani cannot be clarified because of no information.

1.2 Sabo

1.2.1 Existing Sabo Works

At present, the sabo works in the Brantas river basin have been being implemented in Mt. Kelud basin , the Upper Konto basin and the Upper Brantas and Lesti Basin. Existing sabo works in those basins are presented below.

(1) Mt. Kelud Basin

The sabo master plan in the Mt. Kelud basin was formulated in 1990 by PGK (Proyek Gunung Kelud, former of PGKS). In the master plan in 1970, the following construction works are considered for the target sediment discharge control volume of 70.8 million m^3, and sediment capacity of the facilities completed before the 1990 eruption was 19.4 million m^3.

Disaster Prevention Works	Unit	Nos. of Unit	
		Plan	Completed before 1990
- Sabo dams	Place	19	4
- Check dams	Place	34	23
- Step dams	Place	42	3
- Consolidation dams	Place	138	29
- Sand pockets	Place	11	9
- River improvement	Km	82	-
- Restoration of channel	Km	170	-
Capacity of facilities	Million m^3	70.8	19.4 (27% of the plan)

Source: Proyek Gunung Kelud (PGK)

After the eruption of Mt. Kelud in 1990, urgent works had been carried out by DGWRD with local fund. The major works were rehabilitation of Sabo facilities to restore their original capacity. It was completed in November 1991. Total restored capacity was estimated at around 5 million m^3. The sediment storage capacity of the facilities increased from 27 % to 34 % of the target of the master plan in 1970.

After the said project, the following works were constructed up to 1996 as shown in Figure A2-8, and the capacity of the facilities increased up to 50 % of that of the Master Plan in 1970.

- Check dams: Badak river, Putih river, Semut river, Jari river, and Puncu river
- Consolidation dams: Semut river
- Sand Pockets: Badak river, Putih river
- Cross Dikes: Badak river, Putih river, and Semut river
- Gabions for existing cross dike: Putih river, Semut river
- Crater lake drainage tunnel improvement
- Access Roads for maintenance of facilities
- Putih river diversion channel improvements
- Sumbersari diversion structure and irrigation intake on Termas river (Badak river)

- Damarwulan dam rehabilitation (Konto River)

Sediment volumes in the existing sand pockets of G. Kelud basin are shown below. All sand pockets are fully silted up by sediment deposits.

as of 1996

Sand Pocket	Name of River	Catchment Area (Km^2)	Constructed Year	Sediment Volume ($x\ 10^3m^3$)	Remarks
Rolag 70	Konto	65	1979	1,000	Full
Badas	Konto	185	1977	3,000	Full
Serinjing	Puncu	30	1975	900	Full
Pulo	Ngobo	90	1970	3,800	Full
Salam	Badak	600	1970	14,200	Full
BA-KL2	Badak	48	1996	(2,6590)	-
Jagoan	Termas	113	1994	1,600	Full
Putih	Putih	400	1971	7,000	Full
PU-KL2	Putih	13	1996	(137)	-
Semut	Semut	320	1972	3,300	Full
Total				34,800	

Source: G. Kelud Project, Note, ( ) : Proposed sediment capacity

At present a diversion channel (L= 7.24 km in length) from Glondong site to the downstream site of the Lodoyo dam have been being constructed as extension of the existing diversion channel. This channel aims to reduce the sediment discharge flown into the Lodoyo reservoir. At present, PGKS has a plan that 50% of the remaining works of the master plan in 1970 will be executed until the year 2003.

(2) Upper Konto River

Location of the existing sabo facilities is shown in Figure A2-9. For these facilities, rehabilitation works of 5 check dams had been done by PJT in 1997, and 3 check dams had been re-constructed by PKB in 1997.

(3) Upper Brantas River and Lesti River basins

The existing sabo facilities in this basin are shown in table below. Five check dams had been constructed and one check dam have been being constructed by PJT.

Name of River	Name of Check dam	Catchment area (km^2)	Constructed Year	Sediment capacity ($x\ 10^3m^3$)	Cost ($x\ 10^6$ Rp.)
Ampong	Belung	23.0	1996	22.0	253
Ampong	Kedungrejo	74.0	1996	72.5	194
Cokro	Sumber Pasir	14.0	1996	52.5	204
Lesti	Bokor	175.0	1996	16.0	200

Name of River	Name of Check dam	Catchment area (km^2)	Constructed Year	Sediment capacity ($x\ 10^3 m^3$)	Cost ($x\ 10^6$ Rp.)
Lesti	Talok	312.5	(1997)	11.5	250
Lesti	Wonokerto	-	1989	645.0	-

Note; ( ) : under constructing

The check dams have been silted up and no excavation works of sediment have been done.

1.2.2 Present Operation, Maintenance and Rehabilitation

Three authorities are responsible for the sabo facilities in the Brantas river basin. Among them, PGKS is responsible for construction and the OMR works in Mt. Kelud basin, PKB for construction and large-scale rehabilitation works in the area except Mt. Kelud basin and PJT for construction and OMR works in the area except Mt. Kelud. PKB and PJT perform the works in cooperation. Organizations and activities of PKB and PJT are described in ANNEX-7, ANNEX-12 and ANNEX-13.

OMR activities by PGKS are presented below.

- Preparing O & M manuals.
- Planning annual budget of O & M
- Inspecting the sabo facilities
- Making inventory of infrastructures
- Guiding sand mining activity
- Repairing the damaged structures for lahar control and preparing the improvement program
- Performing administration and filing the work records.

Organization structure and members of PGKS are described in Annex 12 and 13.

Annual O & M cost of PGKS is 150 million rupiahs in average by APBN. This cost is used to direct cost of repairing facilities.

1.3 Flood Control

1.3.1 River System

In the Brantas river basin, there are 40 major rivers managed by PJT. Locations of those rivers are shown in Figure A2-10.and listed below.

Brantas River		
New Lengkong -- Ngrowo R.	Ngrowo R. – Sengguruh Dam	Sengguruh Dam -
1. Brantas	10. Putih	2. Amprong
32. Brangkal	9. Jari	3. Lesti
31. Watudakon	7. Lekso	
30. Beng	8. Semut	
23. Konto	11. Ewuh	
22. Srinjing	6. Bambang	
24. Kedak	5. Lahor	
21. Badak	4. Metro	

Surabaya River	Porong R.	Widas R.	Ngrowo R.
37. Surabaya	35. Porong	25. Widas	15. Ngrowo
40. Mas	34. Kambing	26. Kedungsoko	20. Song
39. Wonokromo	33. Sadar	27. Ulo	19. Boding
38. Kedurus		28. Kuncir	16. Ngasinan
36. Marmoyo		29. Bening	17. Tawing
			18. Tugu
			12. Dawir
			13. ParitAgung
			14. Parit Raya

For the rivers managed by PJT, they are categorized into the Brantas main river, tributary and sub-tributary. Those dimensions are as follows.

River	Total Length (km)	Total Catchment Area (km^2)
Brantas river	320	11,800
Tributaries	620	7,500
Sub-tributaries	370	-

* estimated by the Study team.

1.3.2 Flood Control

(1) Master Plan

Flood control works of the Brantas river Basin has been being implemented based on the comprehensive development plan (referred to as the Master Plan) firstly formulated in 1961, reviewed in 1973 and renewed in 1985.

In the 1973 Master Plan and the 1985 Master Plan, the safety level of 50 years return period was applied to the flood control works. In the 1973 Master Plan, the design discharge distribution was set as shown in Figure A2-11. Afterwards, during study stage of the 1985 Master Plan, the probable flood discharges for the probable rainfall patterns were estimated as

shown in Table A2-9, by storage function method. Base on the estimated results, the design discharge distribution of the Brantas river was renewed as presented in Figure A2-12.

Figure A2-13 shows the design discharge distribution in the whole Brantas river basin based on the 1985 Master Plan. Flood control measures of the Brantas river basin consist of channel improvement including construction of the Lodoyo diversion channel, flood control by Sutami and Selorejo reservoirs and natural retarding basin at the upstream side of Kediri and in the Widas river basin.

(2) Existing Flood Control Works

Flood control works of the Brantas river basin have been being implemented by PKB and the main stream of the Brantas river has been almost improved with a safety level of 50 years return period.

At present, the Widas flood control project has been being proceeded and its progress is around 65 % as of 1997 for the scope of first phase (10 year return period) formulated in the Feasibility Study of the 1985 Master Plan.

On the other hand, the Lodoyo diversion tunnel project has not yet commenced up to date.

1.3.3 Present Condition of River

(1) Present Situation on Flood Damage

Flood records in the past are summarized in Table A2-10 and Figure A2-14. Almost of the flood are reported in the tributaries. From these results, it is recommendable to proceed improvement of the tributaries.

Flood records are very important and basic one in order to study flood control project. However, collected data are insufficient because of lack of information such as inundation area, inundation depth, inundation period, inundation map, etc.

(2) Discharge Capacity

The discharge capacities of the main channels are estimated applying non-uniform flow method to check safety level of the channel capacities against the present design discharges.

(a) Condition of Calculation

- Object river: Porong river (river mouth to new Lengkong dam)
  Brantas river (new Lengkong dam to KB 160, Jeli Bridge)
- River cross-section: surveyed in 1991, 1993 and 1996.
- Longitudinal interval of section: 1,000 m
- Channel capacity: capacity below the HWL
- Manning's coefficient of roughness (n): The following are adopted
  River mouth- new Lengkong dam; n= 0.025
  New Lengkong dam- 59 km; n= 0.025
  60 km- 89 km; n= 0.028

90 km- 139 km; n= 0.032
140 km- 160 km; n= 0.035

(b) Result

Estimated results are shown in in Figures A2-15 and A2-16. The river channels in the whole reaches have sufficient capacities against the present design discharges.

(3) Sand Mining in River Channel

Sand- mining in the Brantas, Porong and Surabaya rivers has been prohibited since October 1989 by the order of the Governor of East Java Province. However it has not been thoroughly followed by contractors due to its no alternative business other than river deposit extraction.

In the field, sand mining activities were surveyed by the PJT between the upstream site of the New Lengkong dam (KB 52) and the downstream site of the Kediri bridge (KB 138) in the period from March 26 to April 16, 1996. According to the survey results, sand mining volume are as shown in the Table A2-11. Total sand mining volume per day was estimated at about 5,500 m^3.

(4) Riverbed Variation

In order to grasp the river-bed variation, the following survey was conducted during the second works in Indonesia. Location of the river survey site is shown in Figure A2-17.

Location	Longitudinal Survey (m)	Interval of Cross-section Survey (m)	Number of Section	Survey Width (m)
(i) Porong R. (Porong Br.)	1,000 x 2	100	11	300
(ii) Brantas R. (Watudakon)	1,000 x 2	100	11	250
(iii) Brantas R. (Beng R. Conflu.)	1,000 x 2	100	11	250
(iv) Brantas R. (Kediri Old Br.)	1,000 x 2	100	11	250
(v) Brantas R. (Ngrowo R. Conflu.)	1,000 x 2	100	11	300
Total	10,000		55	

Riverbed variation is studied by superimposition of longitudinal and cross-sections surveyed in the past and newly surveyed above. Further, the variation is studied in view of sand-mining volume.

(a) Result by survey

The results of comparison of longitudinal section/cross-sections are shown in Figures A2-18 to A2-21. Based on the said figures, the following can be said.

The Porong River and Brantas River have tendency of degradation. The following reaches are remarkable.

- Porong river: downstream of the Porong bridge and KP.80 to KP.20.

- Brantas river : KB.74 to Jatimlerek rubber dam and confluence with Widas river to Mrican barrage.

(b) Result by Sand Mining

As explained above, inventory surveys on sand mining have been made at March 26 to April 16, 1996 at the end of rainy season. The mining volume per day is estimated at 5,500 cum. in total. Assuming this mining volume of 5,500 cum. per day and 365 working days for mining, an annual volume is estimated at 2,000,000 cum. According to PJT, mining volume per day further increase in the dry season.

Based on the annual sand-mining volume, the following are roughly estimated.

- Sand-mining stretches : KB 52 to KB 138
- Distance : 86.6 km
- Average width of low water channel : 177 m
- Annual lowering rate of river bed by sand-mining :
  2,000,000 ÷ 86,600 ÷177 × 100 = 13.0 cm

On the other hand, existing river bed in the same stretches is lowered at 9.5 cm/year in average as shown in Figure A2-20.

From the above results simply estimated, the following might be said.

- Channel bed of the Brantas River is forecasted to lower for the future in consideration of existing sand-mining activities.
- It is recommendable to carry out inventory survey of the sand-mining activities separately in the rainy season and dry season.
- It is recommendable to study the sediment control taking into consideration of Sabo works, sediment transport, sand mining and so on.

2 Problems and Recommendation

Based on the studies on the Present condition of the watershed conservation, sabo and flood control, the following problems are identified and recommendations are made.

(1) Problem

- At present, land use related to the Brantas River basin are surveyed by four authorities, namely Agrarian office, BRLKT and East Java Province, for their own purpose. As for future land use, BRLKT and East Java Province have respective plans. As a result, there is no responsible authority in an aspect of the watershed management.

- Sub-BRLKT is implementing the experimental research for the watershed management. However, areas of the experimental research are rather small and the results of research are limited to use for planning.

- The progress of the sabo works in Mt. Kelud is only about 50 % by the target storage capacity of the master plan in1970. On the other hand, it is forecasted that Mt. Kelud erupt in 2005.

- Three authorities, consisting of PKB, PGKS and PJT are carrying out the present sabo works in the basin based on the their own plans. Therefore, the present sabo works seems not to be coordinate each other, considering the whole Brantas River basin. For example, there are many critical areas located in the Lesti iiver basin and the Ngrowo river Basin. For these area, even though the sabo works are urgently needed.

- The riverbed degradation becomes a serious problem in the lower and middle stretches of the Brantas River. Sand-mining activities seems to be main cause of the degradation.

- At present, most of flood damage happens in the tributaries. However, the flood control works in tributaries except major tributaries are scarcely implemented.

(2) Recommendation

- Considering the PJT's Tasks, PJT shall be responsible to the watershed management and coordinate the watershed conservation activities among the authorities concerned.

- The experimental research should be implemented by PJT in cooperation with Sub-BRLKT.

- It is necessary to grasp urgently the present conditions of deposited sediment amount in the basin, to prepare a detailed sediment control plan for the next eruption and to execute the continuous sabo works.

- Three authorities should cooperate in establishing the basin-wide master plan of the sabo works and should adjust the implementation of their works. To carry out the sabo works efficiently and certainly, however, it is recommendable that three authorities be integrated into one authority.

- Considering the influence of the riverbed degradation on the river facilities, it is required to stop the sand mining activities immediately. However, it is difficult to stop the activities completely. Therefore, it is recommendable to carry out the following activities.

- To carry out inventory surveys of the sand mining activities separately in the rainy season and dry season.

- To study the sediment controls taking into consideration of the sabo works, sediment transport, sand mining and so on.

- It is recommendable to review the 1985 Master Plan considering needs of inhabitants and flood damage in tributaries.

3 Proposed Projects and Their Outlines

3.1 Watershed Conservation

(1) Reforestation and Terracing

The reforestation of 170 km^2 and construction of terracing works of 3,070 km^2 are proposed in the critical area of erosion as shown in Table A2-12 in order to mitigate soil erosion, decrease flood discharge and improve environment condition in the mountainous areas. Target year of this watershed conservation will be set on the year of 2020. Sub-BRLKT and Perum Perhutani would implement these projects.

(2) Experimental Research

(a) Necessity of Experimental Research

In order to grasp the relations among vegetation including forest and land use, soil condition, run-off and soil erosion quantitatively, many experiment and researches have been executed worldwide for so long. However, the results of the researches are applicable for the researched basins only and no comprehensive conclusion has been found applicable to other basins.

The tendencies of the relation among forest, soil condition, erosion, run-off from the past experimental results are presented below.

(i) Run-off

- Annual run-off

Annual run-off of forest area after deforestation is bigger than that of before. As an example, the result of research by Dr. Hideaki Nakano is shown below.

Research site	Rainfall (mm)	Increase of annual run-off (mm)
U.S.A	about 500 (mean annual)	About50
Kenya	about 2,090 (mean annual)	about 460
Japan	-	190 to 270 (correspondent to about 10 ~ 50% of annual discharge)

Source : Dr. Hideaki Nakano Water-Soil Conservation Function of Forestry and It's Applications, 1978

- Low flow

By Dr. Hideaki Nakano's speaking, in general, forest area in large basin becomes effective to increase low flow. On the other hand, forest area in small basin has opposite tendency. It is said that the effects of rainfall interception and transpiration cause this phenomenon.

(ii) Erosion

- Relations between deforested area and annual erosion volume

In general, annual erosion volume extremely increases according as increase of the deforested area. An example is shown below.

By Prof. Takeo Kawaguchi

Situation Of Area	Annual erosion Volume (ton/ha)	Rate of annual Erosion volume (no deforesting = 1)
Whole area: deforesting And grubbing	28.53	78
Whole area: deforesting	3.66	10
Upper part of slope: 3/4 deforesting	2.06	6
Upper part of slope 1/2 deforesting	1.14	3
Upper part of slope 1/4 deforesting	0.75	2
Non deforesting	0.35	1

Notes, Test field: 40 (slope length) x 20 (width) m, slope: 30°, natural pine forest: 30 years growth, annual rainfall: 1,746 mm, Okayama prefecture, Japan.

- Relation between soil erosion and land use

The following table shows summary of the relation between soil erosion and land use in Japan.

By Prof. Takeo Kawaguchi

Land use Erosion factor	Waste	Bare	Upland	Grass	Forest
Mean annual Erosion depth (mm)[1]	10^1 - 10^2	10^0 – 10^1	10^{-1} – 10^0	10^{-2} - 10^{-1}	10^{-2} - 10^{-1}
Annual erosion volume ($m^3/km^2.yr.$)[2]	10^4	10^3	10^1	10^1	10^1

Note: Slope more than 15°

Source : [1] Statistically Analysis on Soil Erosion in Mountainous Area, 1951.

[2] Prevention Function for Sediment Runoff from Forestry, 1962.

In general it is said that soil erosion in the grass area or forest areas is rather small.

- Relation between forest - non-forest area and landslide

By Norio Nanba

	Basin Area (km^2)	No. of Landslide (No.)	Area of Landslide (ha)	Volume of Landslide (10^4m^3)	Per landslide		Per km^2		
					Area (ha)	Volume (10^2m^3)	No. of Landslide (No.)	Area of Landslide (ha)	Volume of Landslide (10^2m^3)
Forest	1,270	10,400	1,564	2,893	0.15	28	8.2	1.23	228
Non-forest	121	2,216	289	362	0.13	16	18.3	2.38	298

Note, Forestland : artificial forest or natural forest

Non-forest land : deforested land (not yet re-forest), grass land, bamboo grass.

- Relation between Simple Forest-Mixed Forest and Landslide

By Norio Nanba

Forest	Basin Area (km^2)	No. of Landslide (No.)	Area of Landslide (ha)	Volume of Landslide (10^4m^3)	Per km^2		
					No. of Landslide (No.)	Area of Landslide (ha)	Volume of Landslide (10^2m^3)
Simple	1,104	8,874	1,404	2,623	8.1	1.27	238
Mixed	147	1,099	178	146	7.4	1.21	99

Note, Simple forest: Forestry mainly covered by coniferous trees or broad-leaved trees

Mixed forest: Forestry mixing of coniferous trees and broad-leaved trees

(b) Proposed Experimental Research

It is recommended that experimental research basin is established in the river basins of Konto, Lesti and Ngrowo to investigate land use, runoff and sediment yield for the river management in the future. Neighboring basic basin and basin having critical area of erosion will be selected and relationship of rainfall amount, runoff-rate and sediment yield is clarified. Then reforestation will be carried out stepwise in the critical area of erosion and effect of reforestation will be investigated compared with those of basic basin. PJT would implement these projects, in cooperation with Sub-BRLKT.

The outline of the experimental research basin is as follows:

a. Area : 1 km2 for a basin

b. Meteorology and Hydrology : Temperature and Humidity; 1 set,
Evaporimeter and Rain-gauge; 1set

c. Hydraulics : Water level gauge; 2 sets,
Temporary bridge for discharge observation (wood and bamboo); 2 bridges,
Current meter; 2 sets, Sediment sampler; 2 sets

d. Rented land : 25 ha

(3) Proposed Operation and Maintenance

At present, the greening plan of Sub-BRLKT, DPKT, PJT, etc., is executed primarily by inhabitants, so that the same method will be applied for the operation and maintenance of the watershed conservation.

The training for inhabitants with regard to the practical method of the above operation and maintenance will be executed by Sub-BRLKT and DPKT.

Review of watershed conservation plan will be done if it is necessary. For the purpose of reviewing the plan, it is necessary to update the basin's land use map.

At least once in 5 years, the conditions of forest and bare land will be evaluated by use of LANDSAT or aerial photographs.

3.2 Sabo

(1) Mt. Kelud Basin

Sabo works are proposed for next eruption assumed in 2005. The proposed volume to be controlled is estimated under an assumption of 1990 eruption scale as follows.

(1)Total eruption volume	142 million m^3
(2)Volume fly off basin	37 million m^3
(3)Volume to be transported into river channels	46 million m^3
(4)Volume to be transported into river for three years after eruption (short-term volume)	7 million m^3
(5)Long-term volume to be controlled: (5)=(1)-(2)-(3)-(4)	52 million m^3

The above (4) short-term volume 7 million m^3 is controlled by an urgent works immediately after eruption.

(2) Upper Brantas River and Lesti River Basins

In order to mitigate sediment transported to reservoirs of the Senggruh and Sutami dams, 17 sabo dams are proposed to construct in the upper basin of the Senggruh dam as presented in Figure A2-22. Total storage capacity is to be 15.1million m^3 and breakdown is shown Table A2-13.

(3) Proposed Operation and Maintenance

Necessary measures to be taken in the whole basin is as follows:

(a) Investigation of actual conditions on sedimentation deposited in tributaries and the basin.

(b) Excavation for increase in volume of sand pocket.

(c) Monitoring of sediment conditions of sabo facilities.

(d) Check in every year about control volume of sand pocket and check dam.

(e) Study for quality-up of deposited materials in sand pocket and repairing its transportation facilities (road and railway)

(f) Monitoring dangerous places of debris flow occurrence.

3.3 Flood Control

(1) Widas River

Since no remarkable change is observed in the Widas river basin, it is recommended that ongoing and remained flood control works be continuously carried out in accordance with the scheme developed in the 1985 Master Plan. The locations of proposed flood control works are presented in Figure A2-23.

Work Item	Unit	Upper Widas And Lower Ulo	Kuncir river	Upper Ulo
Excavation	1000 m^3	1,207	164	248
Embankment	1000 m^3	255	234	150
Treatment of old river	1000 m^3	280	-	51
Reclamation	1000 m^3	11	70	47
Wetmasonry	m^2	1,510	1,600	14,500
Gabion	m^3	755	800	1,800
Bridge	Bridge	6	7	1
Culvert	Nos	4	7	-
Sluice	Nos	1	1	1
Syphone	Nos	1	1	-
Drop structure	Nos	1	-	-
Overflow dike	m	550	-	-
Collector channel	m^3	6,000	-	-
Head works	Nos	-	2	-
Submergible weir	Nos	-	-	1

(2) Lodoyo Diversion Tunnel

The Lodoyo diversion tunnel project is indispensable one in the viewpoint of the present river channel improvement and disaster prevention measures of Mt. Kelud. It is recommended to commence this project after completion of the Widas project. The location of proposed diversion tunnel and its feature are presented in Figure A2-24.

- Design discharge : 600 m^3/s
- Length of open channel : 4,700 m
- Length of tunnel and diameter : 5,500 m, 7.5 m
- Control gate : 3 gates
- Excavation volume : 250,000 m^3
- Revetment : 13,000 m^2

Lodoyo diversion tunnel study was proposed to connect at site between upstream of the Lodoyo dam and Indonesian ocean in 1985 master plan.

Design discharge of the tunnel is as follows:

(a) Diversion discharge for flood control : 100 m^3/s

(b) Decrease of the discharge capacity after Mt. Kelud eruption (transitional rise of 1 to 2 m of the riverbed in the main Brantas river for several years) : 400 m^3/s

(c) Increment of peak discharge after Mt. Kelud eruption (decrease of storage volume in the river channel by sedimentation) : 100 m^3/s

Location of the tunnel proposed in the Master Plan is required to be review, due to change of site condition.

After establishment of the Master Plan, construction of the Putih diversion channel from the Putih river to the downstream site of the Lodoyo dam have been proceeding to avoid sediment discharge flowing into the Wlingi and Lodoyo reservoirs. Therefore, the proposed tunnel might avoid sediment problems.

If the purpose of construction includes drainage with sediment discharge by Mt. Kelud eruption, following construction are needed.

(a) Location of diversion point should be considered to construct the diversion tunnel at downstream from confluence of the Putih diversion channel and Brantas river.

(b) Some weir crossed the main Brantas river should be constructed.

(c) Detailed design with feasibility study should be done.

(3) Hazard Map

As a part of flood control project, non-structural measures are requisite. In this study, it is recommended to prepare the hazard map and to announce it to people. For reference, the Study team selects the Porong River as a model and the hazard map along the Porong river is prepared for 50 year probable flood as shown in Figure A2-25.

(4) Review of Flood Control Manual

There are several manuals related to the flood control in Indonesia as shown below, but so far PJT does not use these manual in actual works.

	Name of Manual	Published year	Published by
(1)	Pedoman Penanggulangan Banjir (Guidance of Flood Fighting)	1987	Ir.Sudaryoko DPU
(2)	Pedoman Siaga Banjir Kali Brantas	1997/1998	PJT
(3)	Flood Control Manual	1993	CIDA DPU
(4)	Irrigation Design Standards	1987	DPU
(5)	Irrigation Design Manual	1986	DPU

Note, CIDA: Canadian International Development Agency

There are some discrepancies in these manuals, therefore it is difficult to use. PJT should request to DGWRD to make flood control manual based on materials above and to standardize the technique of river works as a fundamental tool. In addition to the above, it is recommended that design standard on eco-friendly river works be described in the manual in order to restore the natural river functions.

(5) Retarding Basin

Natural retarding basins are located in the upstream reaches of Kediri City, and in the main stream of the Widas river. Storage capacities of the basins are shown below and those locations are presented in Figures A2-26 and A2-27.

Name of river	Location	HWL (m.SHVP)	Area (Km^2)	Volume (x 10^6m^3)	Remarks
Brantas	Kediri to Tulungagung	-	-	-	-
Ngrowo	Tulungagung	-	-	4.5×10^6	Confluence of Ngrowo and Brantas R.
Widas	Nganjuk	38.4	12.5	11.6	Confluence of Brantas and Widas R.
Ulo	Nganjuk	44.4	6.3	4.7	Confluence of Widas R and Ulo R.

The retarding basins are indispensable for the flood control in the Brantas river basin. Therefore, the precise management of land use is prerequisite. At present, natural retarding basins are not designated legally.

Natural retarding basins should be designated legally by DGWRD as soon as possible. PJT should perform to survey to drive in stakes and to set up signboards.

(6) Proposed Operation and Maintenance

The necessary operation and maintenance work except river structures is as follows:

(a) The Plan and the land use conditions along the mainstream and tributaries will be investigated by use of aerial photographs taken once per 10 years.

(b) Monitoring sand mining on riverbed, especially confluence, foot of levee and around structure.

(c) Investigating the actual flood damage to grasp major inundated areas.

4 Required Cost and Benefit

The required cost consists of construction cost including administration cost, engineering services cost, contingency, O/M cost, and land compensation.

The cost estimate is carried out based on the following condition.

(a) Condition of Cost Estimate

- Construction cost: unit construction cost basis
- Compensation cost : unit construction cost basis
- Consultant service cost : 5% of the above total
- O/M cost : 1% of construction cost
- Contingency : 15% of the above total

(b) Unit Cost of Construction and Compensation

The unit costs employed in the past flood control works are modified by converting price level in 1997.

4.1 Watershed Conservation

(a) Construction cost

Reforestation and terracing : Rp. 162,294 million
(implemented by Sub-BRLKT and Perum Perhutani)
Experimental research site : Rp. 6,984 million
(implemented by PJT in cooperation with Sub-BRLKT)

(b) Benefit

Benefit is counted as decrease of cost of riverbed excavation owing to decreased sediment discharge by watershed conservation measures. Benefit by watershed conservation is calculated at Rp. 1,643 million per year.

a. Critical land of erosion: 3,296 km^2
b. Specific sediment discharge in critical land: 3,200 $m^3/yr/ km^2$
c. Specific sediment discharge in standard area: 1,100 $m^3/yr/ km^2$
d. Effect: 2,100 $m^3/yr/ km^2$
e. Sediment load in total volume: 44%
f. Unit cost of excavation: 10,793 Rp/m^3
g. Benefit (a x d x e x f / 20 yr): 1,643 million Rp/yr

4.2 Sabo Works

(a) Construction Cost

Mt. Kelud basin : Rp. 470,373 million

Lesti and upper brantas basin : Rp. 133,235 million

(b) Benefit

Mt.Kelud basin:

Benefit is estimated at Rp. 29,539 million per annum as decrease of channel excavation for the design storage capacity (52 mullion m^3).

52 million x 10,793 Rp/m^3 / 19 yr = 29,539 million Rp/year

Upper Brantas and Lesti river basins:

Benefit is considered the reduction of dredging cost owing to decrease of sediment intlow into the of Sengguruh reservoir. The benefit is Rp.10, 600 million per year under an assumption that the total storage capacities of 17 dams are filled in 22 years.

Item	Unit	Quantity	Unit Cost	Amount
Sengguruh Reservoir				233,093,264,000
1. Land aquisision	Sqm	3,020,000	10,000	30,200,000,000
2. Dredging				202,893,264,000
2.1 Dredging around intake				
(1) Dredging incl. Transport	Cum	15,100,000	11,197	169,077,720,000
(2) Miscelaneous (20% of (1))	L.S			33,815,544,000
Per 22 year				10.6 mil.Rp/yr

4.3 Flood Control Works

(a) Construction Cost

Widas river : Rp. 135,761 million
Brantas and Lodoyo diversion tunnel : Rp. 421,998 million

(b) Benefit

The economic internal rate of return had been estimated at 15.0% in the 1985 Master Plan.

4.4 Project Implementation Plan

The implementation schedule is shown in Figure A2-28, and they are summarized below. Sabo works are firstly carried out, that is, those of the Lesti and Upper Branras river basins, and Mt. Kelud basin are proceeded.

Implementation Schedule

Project Name	Detailed Design	Land Compensation	Works Commence	Work Completion	Remarks
(1) Watershed Conservation					
- Reforestation	2000	-	2001	2020	BRLT, Perum Perhutani
- Experimental research	2000	2001	2002	2020	
(2) Sabo					
- Mt. Kulud	2000	2001	2002	2020	
- Brantas R. & Lesti R.	1999	-	2000	2006	
(3) Flood Control					
Widas River					
- Widas R. & Ulo R. down	1999	2000	2001	2003	
- Kuncir river	2002	2003	2004	2005	
- Ulo river Upstream	2008	2009	2010	2011	
Lodoyo diversion tunnel	2005	2016	2017	2020	

5 Action Program

In order to prepare New PJT by consolidation of PKB, PGKS and PJT in 2002 and change of status to Persero in 2005, the following activities will be required.

1999 – 2001

(a) Preparation for land use map which is drawn in detail erosion area and forestry zone, for the purpose of the watershed conservation.
(b) Preparation for sediment control master plan based on the detailed investigation on the debris run-off from the Mt. Kelud basin.
(c) Review of master plan on watershed conservation based on the recent basin conditions.
(d) Preparation of implementation program for watershed conservation plan and recommendation on its execution to administrator.
(e) Investigation on present condition of sabo facilities.
(f) Preparation on quality improvement and transportation measures for product made from deposit materials in sand-pocket.
(g) Preparation for the ledgers of the rivers.
(h) Survey and setting out the boundary sticks of retarding basin which was recommended in the 1985 master plan.

2002 – 2004

(a) Preparation of flood control manual by mutual consent with related agencies.
(b) Preparation and announcement of hazard map in the whole basin.

1999 – 2004 (continuous Investigation)

(a) Investigation on actual conditions of illegal sand mining on riverbed.
(b) Investigation on actual conditions of flood damage.

The required costs of the above action plan are shown in Figure A2-29.

Table A2-1 Land Use in Brantas Basin

Land Categories	Area (km^2)	
	Present (1990)	Plan (2008)
Farm land	6,772	6,038
Paddy field	4,315	4,371
Upland field	2,143	1,107
Plantation	314	560
Forest	3,094	3,411
Homestead/settlement	* 1,701	2,072
Industry	n.a	79
Fish pond/Lake	218	132
Waste land	15	68
Total	11,800	11,800

Source : Rencana Tata Ruang Wilayah Propinsi Daerah Tingkat I, Jawa Timur 2008.
Note,
* : Village area
n.a : Data not available.
Note : Area are calculated and adjusted by the Study Team based on the above land use map.

Table A2-2 Land Use in Mountainous Area of Brantas Basin

Land Categories	Area (km^2)	
	Present (1990)	Plan (2008)
Farm land	3,083	2,428
Paddy field	1,010	1,144
Upland field	1,852	823
Plantation	221	461
Forest	2,288	2,360
Homestead/settlement	* 319	834
Industry	n.a	13
Fish pond/Lake	23	30
Waste land	15	63
Total	5,728	5,728

Source : Rencana Tata Ruang Wilayah Propinsi Daerah Tingkat I, Jawa Timur 2008.
Note,
* : Village area
n.a : Data not available.
Note : Area are calculated and adjusted by the Study Team based on the above land use map.

Table A2-3 Forest Area by its Function, 1995

(Unit : ha)

KPH	Area in KPH					Area in the Brantas Basin		
	Productive Forest	Preserved Forest	TBP / LDTI	Wildlife Preserve/ Recreational Forest National Park	Forest Area	KPH	%	Forest
Blitar	40,263	15,139	1,634	-	57,036	157,900	64	29,600
Kediri	76,951	37,900	1,827	19	116,697	313,000	83	91,700
Malang	46,075	47,793	1,421	22,858	118,147	236,100	67	87,600
Pasuruan	19,352	25,574	401	7,794	53,121	77,100	37	23,000
Mojokerto	31,161	253	504	-	31,918	157,400	52	7,000
Jombang	35,103	4,283	818	-	40,204	169,600	100	38,300
Nganjuk	19,370	1,352	553	-	21,275	51,900	100	19,100
Saradan	33,812	2,518	1,602	-	37,932	17,000	22	13,100
Total	302,087	134,812	8,760	30,671	476,330	1,180,000		309,400

Source : Perum Perhutani, Unit II Jawa Timur
(Unit II of Forestry Public Corporation of East Java)

Note, KPH : Kesatuan Pemangkuan Hutan (Forestry Management Unit)

TBP/LDTI : Tidak Baik Perusahan / Lapangan Dengan Tujuan Istimewa
(No good estate / Land for special purpose)

Table A2-4 Production of Wood in KPH by Forestry Public Corporation

KPH	Sawn Wood (m^3)				Fire Wood (m^3)			
	Teak Wood		others		Teak Wood		others	
	1994	1995	1994	1995	1994	1995	1994	1995
Blitar	12,776	9,481	6,422	3,383	1,766	1,081	230	1,106
Kediri	3,798	5,263	112,323	106,153	609	353	27,750	16,461
Malang	8,608	11,593	22,185	23,885	317	854	6,776	2,396
Pasuruan	1,060	5,049	18,638	7,419	151	287	8,362	10,123
Mojokerto	3,740	5,370	2,034	1,437	659	376	566	1,485
Jombang	20,730	15,843	1,299	3,036	8,775	8,775	1,484	1,604
Ngaujuk	12,267	12,753	2,653	5,411	1,225	2,853	1,965	1,339
Saradan	30,225	35,190	1,223	2,530	4,482	771	4,249	3,019
Total	93,204	100,542	166,777	153,254	17,984	15,350	51,382	37,533

Source : Perum Perhutani Unit II Jawa Timur
(Unit No. II of Forestry Public Corporation of East Java)

KPH : Kesatuan Pemangkuan Hutan
(Forestry Management Unit)

Table A2-5 Land Use Plan in East Java

Land Categories	Area (ha)		%
	1993	2008	
Forest	1,346,425	1,421,870	28.10
a. Preserved forest	312,646	377,222	
b. Production forest	805,257	816,927	
c. National park	174,675	174,062	
d. Great forest park	24,813	24,726	
e. Natural preserve	10,866	10,828	
f. Wildlife reserve	17,874	17,812	
g. Recreation park	296	295	
Agriculture	1,157,092	1,156,213	24.15
a. Irrigation	905,988	961,464	
b. Non-irrigation	251,104	194,750	
Plantation	859,627	905,296	17.94
Industry	33,890	52,598	0.71
Housing	564,962	637,419	11.79
a. House	509,762	527,939	
b. Small industry	55,200	109,480	
Others	830,202	618,803	17.32
Total	4,792,198	4,792,198	100.00

Source : Rencana Tata Ruang Wilayah Propinsi Daerah Tingkat I, Jawa Timur 2008
(Land Use plan, East Java Province 2008)

Table A2-6 Land Capability Classification in the Brantas Basin

Class	Definition	Soil type	Land use at present	Acreage Ha	Acreage (%)
I	Very suitable for irrigated farming	Alluvial	Two crops of paddy, one crop of paddy and one upland crop of sugar cane	289,000	24.5
II	Suitable for irrigation farming, drainage is indispensable	Alluvial Grumsols Humus Gley Soils	Two crops of paddy or one crop of paddy and one upland crop	94,000	8.0
IIb	Suitable for irrigated farming of upland crops with irrigation	Latosols Mediterranean Regosols	One crop of paddy or upland crops	49,000	4.1
III	Usable for crop cultivation	Latosols Mediterranean Brown Forest Soils Andosols Regosol	Upland crops, forest or waste land	192,000	16.3
IV	Unusable for crop cultivation	Mediterranean Soils Lithosols Latosols Regosols Andosols	Waste land	556,000	47.1
	Total			1,180,000	100.0

Source : 1973 Master Plan Report

Table A2-7 Critical Land of Erosion

Class	Definition and Characteristics of Critical Lands	Selected Critical Land by the Team
C1	Critical aldn due to combination of presence of very shallow soils, very high inherent relative erodibility, localized occurrence of rock outcrops, stoniness and marginalty critical agroclimate. Non critical land is confined only to valley bottoms with deep soils. On the farm erosion causes a major hazard.	○
C2	Critical land due to combination of presence of very shallow soils, very high inherent relative erodibility, localized occurrence of rock outcrops, stoniness. Non critical land is confined only to valley bottoms with deep soils. On the farm erosion causes a major hazard. On recent volcanic terrain includes land with high occurrence of boulders (>60%by volume) and shallow soils.	○
C3	Critical land due to combination of presence of very shallow soils, very high inherent relative erodibility, localized occurrence of rock outcrops, stoniness and steep slopes. Non critical land is confined only to valley bottoms with deep soils. On the farm erosion causes a major hazard.	○
C4	Critical land due to presence of coarse texture soils with low water holding capacity restricting land use, very high inherent erodivility and low stability. On the farm, stream bank and river bank erosion cause a major hazard.	○
C5	Critical land due to presence of cinders, ashes, gravel, rocks and sandy soils associated with volcanic craters and very recent lava flows.	–
C6	Critical land due to very high stream bank erosion hazard and occurrence of flush floods during peak rainfall events of rainy season. Effects generally only land adjacent to streams and rivers only.	○
C7	Critical land due to permanent flooding or inundation and very poor drainage, swamp or marsh.	–
P	Potentially critical land consisting of C1 to C3 class conditions but under the present land utilization is not being degraded, damaged or misused. Generally forested, agroforestry, tree crops or soil conservation measures effective.	○
P1	Potentially critical land consisting of C4 class conditions but under the present land utilization is not being degraded, damaged or misused. Generally forested, agroforestry, tree crops cover or Soil Conservation measures generally effective.	○
P2	Potentially critical land consisting of C5 class conditions but under the present land utilization is not being degraded, damaged or misused. Use for recreation and as a national reserve.	–
SC	Seasonally critical land due to regular annual flooding and poor drainage restricting growing season and or causing crop damage during high water flows.	–
SC1	Seasonally critical land due to regular annual flooding and poor drainage restricting land utilization and or causing crop damage during high water flows. In dry season subject to salt water intrusion and effects of high salinity and alkalinity.	–

Source; Class, Definition and Characteristics: Screening Study Brantas Watershed, Volume III, Konto River Proejct, Phase III, 1988, DGRLR

Table A2-8 Chronicle of Eruption of Mt. Kelud

Date of Eruption/Project		Killed	Property Damage	Crater Lake Volume ($10^6 m^3$)	Eruption Materials ($10^6 m^3$)	Remarks
1586	-	-	-	-	-	-
1752	1-May	10,000	-	-	-	-
1771	10-Jan	-	-	-	-	-
1811	5-Jun	-	-	-	-	-
1826	13-Oct	-	65 villages	-	-	-
1835	-	-	-	-	-	-
1848	16-May	21	11 villages 100,000 coffee trees	-	-	-
1851	24-Jan	-	-	-	-	-
1864	3-Jan	Many	-	-	-	-
1901	22-May	Many	-	-	-	-
1919	19-May	5,110	104 villages 9,000 houses 1,600 animals 13,500 ha	40	323	-
1919	-	-	-	-	-	Construction of crater tunnel
1923 -1928	-	-	-	2	-	Drainage of the crater water. Lake water decreased 40 x $10^6 m^3$ to 2 x $10^6 m^3$
1951	31-Aug	7	7,000 ha	2	190	-
1966	26-Apr	286 (89 injured)	7 villages damaged 700 houses destroyed 2,200 houses damaged 2,400 ha. destroyed 9,200 ha. damage 1,300 animals	20	90	Establishment of Mt. Kelud Debris Control Project.
1970	-	-	-	-	-	Master Plan Study
1990	10-14 Feb.	31 (50 injured)	950 houses destroyed 200 buildings destroyed 200 buildings destroyed 13,000 refugees	4.5	125	AD 1811-AD 1991 11 time/179 yr.
1997	-	-	-	-	-	Completion of Mt. Kelud Volcanic Disaster Mitigation Project

Source : Mt. Kelud and Semeru Project, Feasibility Report on "Mt. Kelud Volcanic Debris Control Project", May 1969
: Mt. Kelud Urgent Volcanic Disaster Mitigation Project, Dec. 1993.

Note, -: Data not available

Table A2-9 Probable 50-Year Flood Discharge of Brantas River

(Unit : m^3/s)

Base Point		Return Period in Year					
		2	5	10	25	50	100
Karangkates	Inflow	760	1,250	1,460	1,880	2,180	2,480
		580	910	1,160	1,500	1,740	1,990
	Outflow	380	470	540	640	740	870
		330	390	450	520	570	630
Pakel		640	760	880	1,020	1,100	1,210
		980	1,120	1,220	1,430	1,620	1,830
Kediri		670	780	850	950	1,020	1,090
		670	720	760	820	910	1,090
Before the of Konto R.	Confluence	670	780	850	940	1,020	1,090
		640	700	740	830	900	1,010
After the of Konto R.	Confluence	870	970	1,050	1,130	1,200	1,260
		820	930	1,020	1,120	1,210	1,280
Before the of Widas R.	Confluence	860	960	1,050	1,120	1,190	1,250
		810	920	1,010	1,100	1,190	1,260
After the of Widas R.	Confluence	1,060	1,190	1,280	1,370	1,440	1,510
		1,020	1,170	1,250	1,370	1,460	1,550
Ploso		1,060	1,190	1,270	1,360	1,440	1,500
		1,020	1,150	1,230	1,330	1,420	1,500
Before the of Brangkal R.	Confluence	1,080	1,210	1,300	1,400	1,480	1,540
		1,050	1,170	1,260	1,370	1,460	1,540
Lengkong		1,200	1,340	1,420	1,520	1,600	1,660
		1,180	1,300	1,380	1,490	1,580	1,660
Porong		1,190	1,340	1,410	1,510	1,570	1,640
		1,200	1,300	1,380	1,490	1,570	1,650

Note : Upper : Jan. 1981 flood pattern
Lower : March. 1984 flood pattern

Source : Widas Flood Control and Drainage Project, 1985.

Table A2-10 Inundation Area in Brantas River Basin (1/2)

NO.	NAME OF RIVER	LOCATION	DATE	AREA (ha)	DEPTH (m)	PERIOD (hr)	REMARKS
*1	Ngoro	Candiharjo	Jan'86	18	0.70	72	
*2	Ngoro	Tambakrejo	Jan'86	4	0.80	72	
*3	Ngoro	Wates Negoro	Jan'86	13	0.70	72	
*4	Ngoro	Kembangsri	Jan'86	-	-	-	
5	Porong	Bangunsari	Mar.17 th, 1992	-	0.4	-	
6	Wonokromo	Medokan, Semampir	Mar.14 th - 17 th, 1992	-	0.2	-	
7	Ngasinan	Ngasinan Sub Basin	Aug. 31st - Sept. 1st, 1992	-	0.33	118	
8	Lesti	Upper reaches	Oct 7 th, 1992	-	-	-	
*9	Bangsal	Pekuwon	Jan'93	1	0.60	96	
*10	Bangsal	Jumeneng	Jan'93	5	0.50	96	
*11	Bangsal	Tingger	Jan'93	4	0.45	96	
*12	Bangsal	Salen	Jan'93	15	0.60	96	
*13	Bangsal	Mejoyo	Jan'93	20	0.60	96	
*14	Mojosari	Modopuro	Jan'93	14	0.60	96	
*15	Mojosari	Kebon Dalem	Jan'93	5	0.50	96	
*16	Mojosari	Kedung Gempol	Jan'93	10	0.50	96	
*17	Mojosari	Jotangan	Jan'93	1	0.60	96	
*18	Puri	Lengkong	Jan'93	22	0.60	96	
19	Konto	Lower reaches	Sep. 8 th, 1993	-	-	-	
20	Konto	Rolak 70 (Gate No. 70)	Dec. 8 th, 1993	-	-	-	
21	Termas Baru	Tunjung - Kraas District	Jan. 27 th - Jan. 29 th, 1994	-	-	-	
22	Termas Baru	Tumenggungan - Kraas Dist.	Jan. 27 th - Jan. 29 th, 1994	-	-	-	
*23	Bangsal	Jumeneng	Feb'94	14	0.50 -1.00	-	
*24	Bangsal	Salen	Feb'94	23	0.00 - 0.50	-	
*25	Bangsal	Mejoyo	Feb'94	51	0.00 - 0.50	-	
*26	Bangsal	Wunut	Feb'94	8	0.50 - 1.00	-	
*27	Bangsal	Sadar Tengah	Feb'94	10	0.50 - 1.00	-	
*28	Mojosari	Modopuro	Feb'94	66	0.50 - 1.00	-	
*29	Mojosari	Kebon Dalem	Feb'94	29	0.50 - 1.00	-	
*30	Mojosari	Jotangan	Feb'94	-	0.50 - 1.00	-	
*31	Puri	Lengkong	Feb'94	22	0.00 - 0.50	-	
*32	Puri	Sumber Jati	Feb'94	49	0.50 - 1.00	-	
*33	Puri	Gebang Malang	Feb'94	51	0.50 - 1.00	-	
34	Sadar	Mojosari District	Feb. 13 th, 1994	-	-	-	
35	Sadar	Pungging District	Feb. 14 th, 1994	-	-	-	
*36	Ngoro	Candiharjo	Mar'94	22	-	-	
*37	Ngoro	Tambakrejo	Mar'94	4	-	-	
*38	Ngoro	Kembangsri	Mar'94	14	-	-	
*39	Pungging	Kembangringgit	Mar'94	10	-	-	
*40	Pungging	Balongmasin	Mar'94	20	-	-	
*41	Pungging	Ngrame	Mar'94	30	-	-	
*42	Pungging	Jabontegal	Mar'94	5	-	-	
*43	Pungging	Watukenongo	Mar'94	25	-	-	
44	Konto	Purwoasri District	Mar. 2 nd, 1994	-	-	-	
45	Brantas	Purwoasri District	Mar. 2 nd, 1994				
46	Konto	Gambang - Gudo District	Feb. 28 th - Mar. 3 rd, 1994	-	-	-	
47	Konto	Janti - Perak District	Feb. 28 th - Mar. 3 rd, 1994	-	-	-	
48	Gunting	Sumobito - Mojoagung	Mar. 2 nd, 1994	-	0.50 - 1.00	-	
49	Buntu	Lengkong - Kertosono	Mar. 3 rd, 1994	-	-	-	
50	Manten	Pagu District	Mar. 3 rd, 1994	-	-	-	
51	Gunting	Sumobito - Mojoagung	Jan. 31st - Feb. 1 st, 1995	120 - 240	0.50 - 1.00	5	
52	Batan	Pesing - Purwoasri District	Jan. 31st, 1995	-	-	-	
53	Catak & Banteng	Janti - Mojoagung District	Jan. 31st - Feb. 1 st, 1995	-	-	96	
54	Catak & Banteng	Mancilan - Mojoagung Dist.	Jan. 31st - Feb. 1 st, 1995	-	-	96	
55	Termas Lama	Sumbersari Udanawu	Feb. 3 rd - Feb, 4 th,1995	150	-	72	

Source, * : Cabang Dinas Pengairan Brantas Mojokerto
Others : Perum Jasa Tirta

Table A2-10 Inundation Area in Brantas River Basin (2/2)

NO.	NAME OF RIVER	LOCATION	DATE	AREA (ha)	DEPTH (m)	PERIOD (hr)	REMARKS
56	Termas Lama	Sukorejo Wonodadi	Feb. 3rd - Feb. 4th,1995	-	-	72	
57	Termas Lama	Tumenggungan	Feb. 3rd - Feb. 4th,1995	-	-	72	
58	Termas Baru	Pelas	Feb. 3rd - Feb. 4th,1995	-	-	72	
59	Termas Baru	Bleber	Feb. 3rd - Feb. 4th,1995	-	-	72	
60	Termas Baru	Sumbersari Udanawu	Feb. 3rd - Feb. 4th,1995	-	-	72	
61	Brangkal	Sooko District	Nov. 20th., 1995	75	0.50 - 1.50	-	
62	Bunting	Ngrowo Basin	Nov'95	-	-	-	
63	Tawing	Ngrowo Basin	Nov'95	-	-	-	
64	Ngasinan	Ngrowo Basin	Nov'95	-	-	-	
65	Amprong	Lesanpuro	Dec. 3rd - Dec. 6th, 1995	7	0.6	-	
66	Amprong	Madyopuro	Dec. 3rd - Dec. 6th, 1995	-	-	-	
67	Lesti	Bokor, Turen	Dec. 3rd - Dec. 6th, 1995	100	-	-	
68	Lesti	Wonokerto, Bantur	Dec. 3rd - Dec. 6th, 1995	-	-	-	
69	Genteng	Sumber Kembar, Dampit Dist.	Dec. 5th - Dec. 9th, 1995	-	-	-	
70	Ulo	Mangundikaran	Dec. 14th, 1996	-	-	-	
71	Ulo	Ngrami, Sukomoro	Dec. 14th, 1996	-	-	-	
72	Beng	Plandaan	Feb. 2nd - Feb, 3rd,1997	-	-	-	
73	Beng	Bawangan, Ploso	Feb. 2nd - Feb, 3rd,1997	-	-	-	
74	Beng	Kampungbaru	Feb. 2nd - Feb, 3rd,1997	-	-	-	
75	Beng	Jatigedong	Feb. 2nd - Feb, 3rd,1997	-	-	-	
76	Grojokan & Gembyang	Gebangbunder - Plandaan Dist.	Feb. 2nd - Feb, 3rd,1997	-	-	-	
77	Marmoyo	Karangmojo	Feb. 2nd - Feb, 3rd,1997	-	-	-	
78	Marmoyo	Gebangbunder	Feb. 2nd - Feb, 3rd,1997	-	-	-	
79	Marmoyo	Jatimlerek	Feb. 2nd - Feb, 3rd,1997	-	-	-	
80	Marmoyo	Tanggungkramat	Feb. 2nd - Feb, 3rd,1997	-	-	-	
81	Marmoyo	Rejoagung	Feb. 2nd - Feb, 3rd,1997	-	-	-	
82	Marmoyo	Ploso	Feb. 2nd - Feb, 3rd,1997	-	-	-	
83	Marmoyo	Losari	Feb. 2nd - Feb, 3rd,1997	-	-	-	
84	Marmoyo	Jatigedong	Feb. 2nd - Feb, 3rd,1997	-	-	-	
85	Marmoyo	Bawangan	Feb. 2nd - Feb, 3rd,1997	-	-	-	
86	Konto	Santrean	Feb. 2nd, 1997	-	-	-	
87	Konto	Kudu	Feb. 4th, 1997	-	-	-	
88	Konto	Tembelang	Feb. 4th, 1997	-	-	-	
89	Song	Kauman	Feb. 12th, 1997	-	-	-	
90	Song	Gondang	Feb. 12th, 1997	-	-	-	
91	Song	Boyolangu	Feb. 12th, 1997	-	-	-	
92	Song	Karangrejo	Feb. 12th, 1997	-	-	-	
93	Song	Kedungwaru	Feb. 12th, 1997	-	-	-	
94	Song	Kalidawir	Feb. 12th, 1997	-	-	-	
95	Wudu	Ngrowo Basin	Feb. 12th, 1997	-	-	-	
96	Song	Ngrowo Basin	Feb. 12th, 1997	-	-	-	
97	Bokor	Manyar Tirtoyoso	Feb. 12th - Feb. 13th, 1997	-	-	-	
98	Dami	Sukolilo (ITS)	Feb. 16th, 1997	-	-	-	
99	Makmur	Kedurus	Feb. 18th, 1997	-	-	-	
100	Makmur	Wiyung	Feb. 18th, 1997	-	-	-	
101	Makmur	Kebraon	Feb. 18th, 1997	-	-	-	

Source, * : Cabang Dinas Pengairan Brantas Mojokerto
Others : Perum Jasa Tirta

Table A2-11 Estimation of Sandmining Volume by Field Survey (1/2)

Survey: March. 26 -- April.16, 1996

No.	Location	Sta. No.	Worker person/day	Truck (car/day)	Carrying capacity (m3/car)	Total volume (m3/day)
1	Terusan	KB 52 L	72	35	4	140
2	Watudakon	KB 54	32	15	4	60
3	Gempolkrep	KB 56 L	30	12	4	30
4	Blimbing	KB 57 R	30	26	4	104
5	Ngares. 1	KB 58-- L	80	25	11	275
6	Ngares. 2	KB 58-- L	45	28	4	116
7	Wuluh	KB 59 R	24	17	4	68
8	Bahudan	KB 60 R	19	11	4	44
9	Betro. 1	KB 61-- L	24	7	11	77
10	Betro. 2	KB 61-- L	25	20	4	80
11	Betro. 3	KB 61-- L	40	23	4	92
12	Kesamben	KB 61 R	21	14	4	56
13	Keboan	KB 63-- L	95	30	11	330
14	Podoroto	KB 63 R	17	15	4	60
15	Randuwatang	KB 68 L	30	9	11	95
16	Tapen	KB 69 L	15	5	11	55
17	Gumul	KB 70 R	12	4	4	16
18	Daditunggal	KB 71 L	45	13	11	143
19	Kepuhdoko	KB 71-- R	15	11	4	44
20	Jatigedong	KB 73-- L	102	25	11	279
21	Ploso	KB 76 L	31	20	4	80
22	Bedahlawak	KB 77 R	45	24	11	231
23	Rajoagung. 1	KB 78 L	35	25	4	100
24	Rejoagung. 2	KB 78 L	8	6	4	24
25	Tanggungkramat	KB 79-- L	8	8	4	32
26	Melik	KB 79 R	5	4	4	16
27	Pacarpeluk	KB 80-- R	16	8	4	32
28	Karangmojo	KB 81 L	45	30	4	120
29	Sumberagung	KB 82	13	4	4	16
30	Munung	KB 87 L	22	5	11	55
31	Munung	KB 87 R	80	70	4	280
32	Begendeng	KB 89 L	12	8	4	32
33	Tirtobinangun	KB 91 L	62	50	4	200
34	Ngrombot	KB 95 L	25	20	4	80
35	Brodot	KB 96 R	15	12	4	48
36	Kudu	KB 99 L	8	3	12	36
37	Pelem	KB 101 L	7	3	4	12
38	Mekikis	KB 101.4 R	25	10	11	110
39	Tembarak	KB 102 L	25	7	11	77
40	Bangsri	KB 103 L	16	3	4	12

Source : PJT(Perusahaan Umum Jasa Tirta)

Table A2-11 Estimation of Sandmining Volume by Field Survey (2/2)

Survey: March. 26 -- April.16, 1996

No.	Location	Sta. No.	Worker person/day	Truck (car/day)	Carrying capacity (m3/car)	Total volume (m3/day)
41	Purwodadi	KB 104 R	20	4	11	44
42	Purwoasri	KB 106 R	9	4	4	16
43	Mranggen. 1	KB 107-- R	4	2	4	8
44	Mranggen. 2	KB 107-- R	15	7	4	28
45	Kunti. 1	KB 108 R	22	5	12	60
46	Dadapan	KB 108 L	40	20	4	80
47	Kunti. 2	KB 108.6 R	33	8	11	88
48	Tanon	KB 109.4 R	25	7	12	84
49	Banjarsari. 1	KB 110 L	15	7	4	28
50	Banjarsari. 2	KB 110 L	25	6	12	72
51	Kelutan	KB 112-- L	14	3	12	36
52	Papar	KB 114.4 R	9	7	4	28
53	Juwet	KB 115--119 L	30	18	3.5	63
54	Minggiran	KB 116.6 R	30	6	12	72
55	Tanjungtani	KB 120 L	38	25	3.5	87
56	Wanengpaten	KB 122 R	15	7	4	28
57	Singkalanyar	KB 122 L	75	15	12	180
58	Gondanglegi. 1	KB 123 L	16	11	3.5	38
59	Gondanglegi. 2	KB 123 L	35	8	12	96
60	Ngebrak	KB 123.4 R	35	7	12	84
61	Gampeng	KB 125.4 R	21	4	12	48
62	Jampes	KB 126 L	37	6	12	72
63	Jongbiru	KB 128.6 R	106	18	12	210
64	Semampir	KB 130 R	35	20	3.5	70
65	Bandarlor	KB 132 L	13	15	2	30
66	Bandarkidul	KB 133 L	12	13	2	26
67	Banjarmlati	KB 134 L	13	8	3.5	28
68	Manisrenggo	KB 136 R	20	9	3.5	31
69	Bulu	KB 136 L	11	13	2	26
70	Petek	KB 138 L	15	10	2	20
Total			2,064	958		5.538

Source : PJT(Perusahaan Umum Jasa Tirta)

Table A2-12 Watershed Conservation Works for Critical Land of Erosion

Class	Definition and Characteristics of Critical Lands	Watershed Conservation Works Land Use near Critical Land			Remarks
		Upland field	Plantation	Forest	
C1	Critical land due to combination of presence of very shallow soils, very high inherent relative erodibility, localized occurrence of rock outcrops, stoniness and marginalty critical agroclimate. Non critical land is confined only to valley bottoms with deep soils. On the farm erosion causes a major hazard.	TE	-	TE	Reforestation: not implementation due to shallow soils, rock outcrops, stony. Terracing: to be controlled erosion at erodible area.
C2	Critical land due to combination of presence of very shallow soils, very high inherent relative erodibility, localized occurrence of rock outcrops, stoniness. Non critical land is confined only to valley bottoms with deep soils. On the farm erosion causes a major hazard. On recent volcanic terrain includes land with high occurrence of boulders (>60%by volume) and shallow soils.	TE	-	TE	ditto
C3	Critical land due to combination of presence of very shallow soils, very high inherent relative erodibility, localized occurrence of rock outcrops, stoniness and steep slopes. Non critical land is confined only to valley bottoms with deep soils. On the farm erosion causes a major hazard.	TE	-	TE	ditto
C4	Critical land due to presence of coarse texture soils with low water holding capacity restricting land use, very high inherent erodivility and low stability. On the farm, stream bank and river bank erosion cause a major hazard.	RF	-	TE	Reforestation: to be implemented at future forest area. Terracing: to be controlled erosion from present forest area.
C5	Critical land due to presence of cinders, ashes, gravel, rocks and sandy soils associated with volcanic craters and very recent lava flows.	-	-	-	No measures: due to volcanic crater area.
C6	Critical land due to very high stream bank erosion hazard and occurrence of flush floods during peak rainfall events of rainy season. Effects generally only land adjacent to streams and rivers only.	TE	-	TE	Reforestation: not suitable due to field condition. Terracing: to be controlled erosion at stream and river bank.
C7	Critical land due to permanent flooding or inundation and very poor drainage, swamp or marsh.	-	-	-	No measures: not erodible area and carried out flood control works.
P	Potentially critical land consisting of C1 to C3 class conditions but under the present land utilization is not being degraded, damaged or misused. Generally forested, agroforestry, tree crops or soil conservation measures effective.	RF	-	TE	Reforestation: to be implemented as same as near the critical area. Terracing: to be controlled erosion from present forest area.
P1	Potentially critical land consisting of C4 class conditions but under the present land utilization is not being degraded, damaged or misused. Generally forested, agroforestry, tree crops cover or Soil Conservation measures generally effective.	RF	TE	TE	Reforestation: to be implemented at future forest area. Terracing: to be controlled at future plantation and forest area.
P2	Potentially critical land consisting of C5 class conditions but under the present land utilization is not being degraded, damaged or misused. Use for recreation and as a national reserve.	-	-	-	No measures: not erodible area.
SC	Seasonally critical land due to regular annual flooding and poor drainage restricting growing season and or causing crop damage during high water flows.	-	-	-	No measures: not erodible area.
SC1	Seasonally critical land due to regular annual flooding and poor drainage restricting land utilization and or causing crop damage during high water flows. In dry season subject to salt water intrusion and effects of high salinity and alkalinity.	-	-	-	No measures: not erodible area.

Note ; TE : Terracing RF : Reforestation

Source : Class, Definition and characteristics : Screening Study Brantas Watershed, Volume III, Konto River Project, Phase III, 1988, DGRLR

Table A2-13 Proposed Sabo Dam in the Upper Basin of Sengguruh Dam

Basin	No.	1973 Dam Bed (EL.m)	1985 Sabo Bed (EL.m)	Apply Bed (EL.m)	Crest (EL.m)	I (1/?) bed	Sediment Area				Sediment Volume (m3)
							River Width	Hight (m)	Length (m)	Area (m2)	
Brantas	No.3	400	385	400	415	196	60	15	2940	22050	882,000
	(K.Amprong)			400	415	300	50	15	4500	33750	1,125,000
	(K.Bango)			410	415	200	20	5	1000	2500	33,000
	No.11	380		380	395	210	60	15	3150	23625	945,000
	No.2	353	340	340	355	222	45	15	3330	24975	749,000
	No.10	324		324	339	222	60	15	3330	24975	999,000
	No.1	305	295	295	310	222	70	15	3330	24975	1,166,000
Amprong	**No.14**	487		487	502	260	30	15	3900	29250	585,000
	No.13	455		455	470	124	30	15	1860	13950	279,000
	No.12	442		442	457	264	50	15	3960	29700	990,000
	(K.Julu)			445	457	260	35	12	3120	18720	437,000
	No.15	440		440	455	232	30	15	3480	26100	522,000
Lesti	No.8	385		385	400	120	45	15	1800	13500	405,000
	(North)			385	400	120	45	15	1800	13500	405,000
	No.7	349	345	345	360	180	68	15	2700	20250	918,000
	No.17	435		435	450	69	50	15	1035	7762.5	259,000
	No.6	375	390	390	405	84	60	15	1260	9450	378,000
	(K.Bambang)			395	405	79	35	10	790	3950	92,000
	No.5		345	345	360	149	90	15	2235	16762.5	1,006,000
	No.9		345	345	360	149	35	15	2235	16762.5	391,000
	No.16(Lesti 3)	330		325	340	152	80	15	2280	17100	912,000
	No.4	302	295	295	310	269	80	15	4035	30262.5	1,614,000
Total											**15,092,000**

Table A2-14 Cost for Proposed Works (1/4)

Work Item	Unit	Quantity	Unit Cost Rp.10^3	Amount Rp.10^6	Remarks
1. Watershed Conservation					
1.1 Reforestation and Terracing					
(1) Reforestation	km^2	3,070	35,100	107,757	
(2) Terracing	km^2	170	88,000	14,960	
1.2 Experimental Research					
Installation/Running	site	3	602,300	1,807	
2. Sabo					
(1) G. Kelud Basin					
Sediment volume	10^6 m^3	52	4.918	255,736	
Excavation of short term sediment volume	10^6 m^3	7	10.798	75,551	3 years
(2) Upper Brantas & Lesti Basin					
Brantas R.1	L.S	1	-	5,236	No.3
Brantas R.2	L.S	1	-	5,358	Tanbaksari (No.11)
Brantas R.3	L.S	1	-	4,629	Lumbanqsari No.2
Brantas R.4	L.S	1	-	5,358	Blobo (No.10)
Brantas R.5	L.S	1	-	4,352	Kepanjen No.1
Amprong R.6	L.S	1	-	3,714	Juli 2 (No.14)
Amprong R.7	L.S	1	-	3,714	Juli 3 (No.13)
Amprong R.8	L.S	1	-	4,803	Amprong (No.12)
Amprong R.9	L.S	1	-	3,714	Bango (No.15)
Lesti R.10	L.S	1	-	5,789	Genteng 1 No.8
Lesti R.11	L.S	1	-	5,789	Genteng 2 No.7
Lesti R.12	L.S	1	-	4,803	Lesti 1 (No.17)
Lesti R.13	L.S	1	-	4,352	Lesti 2 No.6
Lesti R.14	L.S	1	-	7,834	Lesti 2 No.5
Lesti R.15	L.S	1	-	3,869	Lesti 2 No.9
Lesti R.16	L.S	1	-	6,446	Lesti 3 (No.16)
Lesti R.17	L.S	1	-	7,834	Lesti 4 No.4
3. Flood Control					
(1) Widas River	refer Table A2-14 (2/4 - 4/4)				
(2) Lodoyo Diversion Tunel					
Excavation of channel	10^6 m^3	3.119	10.793	33,663	
Excavation of rock	10^6 m^3	0.585	223.251	130,602	
Concrete for tunnel	10^6 m^3	0.309	213.786	66,060	
Supporting	L.S	1	-	9,909	15% of concrete works
Gate	L.S	1	-	22,584	
Miscellaneous	L.S	1	-	52,564	20 % of total
4. Land Compensation Cost					
(1) Experimental Research	site	3	378,000	1,134	20 years 25 ha, rental
(2) Sabo G. Kelud	10^6 m^2	0.550	8.7	4,785	
(3) Flood Control					
Widas river & Lower Ulo river	10^6 m^2	0.798	15.0	11,970	
Kuncir river	10^6 m^2	0.570	15.0	8,550	
Upper Ulo river	10^6 m^2	0.545	15.0	8,175	
(4) Lodoyo Diversion Tunnel	10^6 m^2	0.467	8.7	4,063	

Table A2-14 Cost for Proposed Works (2/4)

Comprehensive Management Plan for the Water Resouces of the Brantas River Basin

Upper Widas and Lower Ulo

No.	Work Item	Unit	Quantity	Unit Cost		Amount			Remarks
				Yen	Rupiah	Yen	Rupiah	Total Equiv.(Rp)	
1	Excavation	Cu.m	1,207,000	310	4,155	374,170,000	5,015,085,000	13,022,000,000	
2	Embankment	Cu.m	255,000	410	5,497	104,550,000	1,401,735,000	3,639,000,000	
3	Fill up to abandaned river	Cu.m	280,000	236	4,305	66,080,000	1,205,400,000	2,620,000,000	
4	Reclamation	Cu.m	11,000	222	2,748	2,442,000	30,228,000	82,000,000	
5	Bank Protection - W.Masonry	Sq.m	1,510	2,394	70,187	3,614,940	105,982,370	183,000,000	
6	Bank Protection - Gabion	Cu.m	755	1,988	25,575	1,500,940	19,309,125	51,000,000	
7	Bridge R.C	Sq.m	2,607	102,324	1,371,196	266,758,668	3,574,707,972	9,283,000,000	6 bridges
8	Culvert - I (1.5 x 1.5 x 1)	Nos.	2	6,196,262	88,400,000	12,392,524	176,800,000	442,000,000	
9	Culvert - II (2.5 x 2.0 x 2)	Nos.	2	13,248,393	189,010,390	26,496,786	378,020,780	945,000,000	
10	Culvert - III (2.5 x 2.0 x 3)	Nos.	0	14,359,207	363,703,970	0	0	0	
11	Intake Sluice (1.5 x 1.5)	Nos.	1	6,035,495	86,106,400	6,035,495	86,106,400	215,000,000	
12	Syphone	Nos.	1	18,003,196	256,845,600	18,003,196	256,845,600	642,000,000	
13	Drop	Nos.	1	5,220,925	74,485,200	5,220,925	74,485,200	186,000,000	
14	Side Overflow Dike	m	550	68,704	2,398,842	37,787,200	1,319,363,100	2,128,000,000	
15	Collector Drain	Cu.m	6,000	318	4,533	1,908,000	27,198,000	68,000,000	
16	Irrigation Headwork	Nos.	0	-	-	-	-	-	
	Total					926,960,674	13,671,266,547	33,506,000,000	

Conversion Rate : ¥ 1 = Rp 21.40

Table A2-14 Cost for Proposed Works (3/4)

Comprehensive Management Plan for the Water Resouces of the Brantas River Basin

Kuncir River

No.	Work Item	Unit	Quantity	Unit Cost		Amount			Remarks
				Yen	Rupiah	Yen	Rupiah	Total Equiv.(Rp)	
1	Excavation	Cu.m	164,000	310	4,155	50,840,000	681,420,000	1,769,000,000	
2	Embankment	Cu.m	234,000	410	5,497	95,940,000	1,286,298,000	3,339,000,000	
3	Fill up to abandaned river	Cu.m	0	236	4,305	0	0	0	
4	Reclamation	Cu.m	70,000	222	2,748	15,540,000	192,360,000	525,000,000	
5	Bank Protection - W.Masonry	Sq.m	1,600	2,394	70,187	3,830,400	112,299,200	194,000,000	
6	Bank Protection - Gabion	Cu.m	800	1,988	25,575	1,590,400	20,460,000	54,000,000	
7	Bridge R.C	Sq.m	1,751	102,324	1,371,196	179,169,324	2,400,964,196	6,235,000,000	7 bridges
8	Culvert - I (1.5 x 1.5 x 1)	Nos.	5	6,196,262	88,400,000	30,981,310	442,000,000	1,105,000,000	
9	Culvert - II (2.5 x 2.0 x 2)	Nos.	1	13,248,393	189,010,390	13,248,393	189,010,390	473,000,000	
10	Culvert - III (2.5 x 2.0 x 3)	Nos.	1	14,359,207	363,703,970	14,359,207	363,703,970	671,000,000	
11	Intake Sluice (1.5 x 1.5)	Nos.	1	6,035,495	86,106,400	6,035,495	86,106,400	215,000,000	
12	Syphone	Nos.	1	20,543,916	293,093,200	20,543,916	293,093,200	733,000,000	
13	Drop	Nos.	0	5,220,925	74,485,200	0	0	0	
14	Side Overflow Dike	m	0	68,704	2,398,842	0	0	0	
15	Collector Drain	Cu.m	0	318	4,533	0	0	0	
16	Irrigation Headwork	Nos.	1	78,924,400	1,438,762,840	78,924,400	1,438,762,840	3,128,000,000	Kapas
17	Irrigation Headwork	Nos.	1	59,225,960	1,079,667,456	59,225,960	1,079,667,456	2,347,000,000	Kramat
	Total					570,228,805	8,586,145,652	20,788,000,000	

Conversion Rate : ¥ 1 = Rp 21.40

Table A2-14 Cost for Proposed Works (4/4)

Comprehensive Management Plan for the Water Resouces of the Brantas River Basin

Upper Ulo River

No.	Work Item	Unit	Quantity	Unit Cost		Amount			Remarks
				Yen	Rupiah	Yen	Rupiah	Total Equiv.(Rp)	
1	Excavation	Cu.m	248,000	310	4,155	76,880,000	1,030,440,000	2,676,000,000	
2	Embankment	Cu.m	150,000	410	5,497	61,500,000	824,550,000	2,141,000,000	
3	Fill up to abandaned river	Cu.m	51,000	236	4,305	12,036,000	219,555,000	477,000,000	
4	Reclamation	Cu.m	47,000	222	2,748	10,434,000	129,156,000	352,000,000	
5	Bank Protection - W.Masonry	Sq.m	14,500	2,394	70,187	34,713,000	1,017,711,500	1,761,000,000	
6	Bank Protection - Gabion	Cu.m	1,800	1,988	25,575	3,578,400	46,035,000	123,000,000	
7	Bridge R.C	Sq.m	201	102,324	1,371,196	20,567,124	275,610,396	716,000,000	1 bridge
8	Culvert - I (1.5 x 1.5 x 1)	Nos.	0	6,196,262	88,400,000	0	0	0	
9	Culvert - II (2.5 x 2.0 x 2)	Nos.	0	13,248,393	189,010,390	0	0	0	
10	Culvert - III (2.5 x 2.0 x 3)	Nos.	0	14,359,207	363,703,970	0	0	0	
11	Intake Sluice (1.5 x 1.5)	Nos.	1	6,035,495	86,106,400	6,035,495	86,106,400	215,000,000	
12	Syphone	Nos.	0	18,003,196	256,845,600	0	0	0	
13	Drop	Nos.	0	5,220,925	74,485,200	0	0	0	
14	Side Overflow Dike	m	0	68,704	2,398,842	0	0	0	
15	Collector Drain	Cu.m	0	318	4,533	0	0	0	
16	Irrigation Headwork	Nos.	1	125,801,880	2,293,321,768	125,801,880	2,293,321,768	4,985,000,000	Tiripan
	Total					351,545,899	5,922,486,064	13,446,000,000	

Conversion Rate : ¥ 1 = Rp 21.40

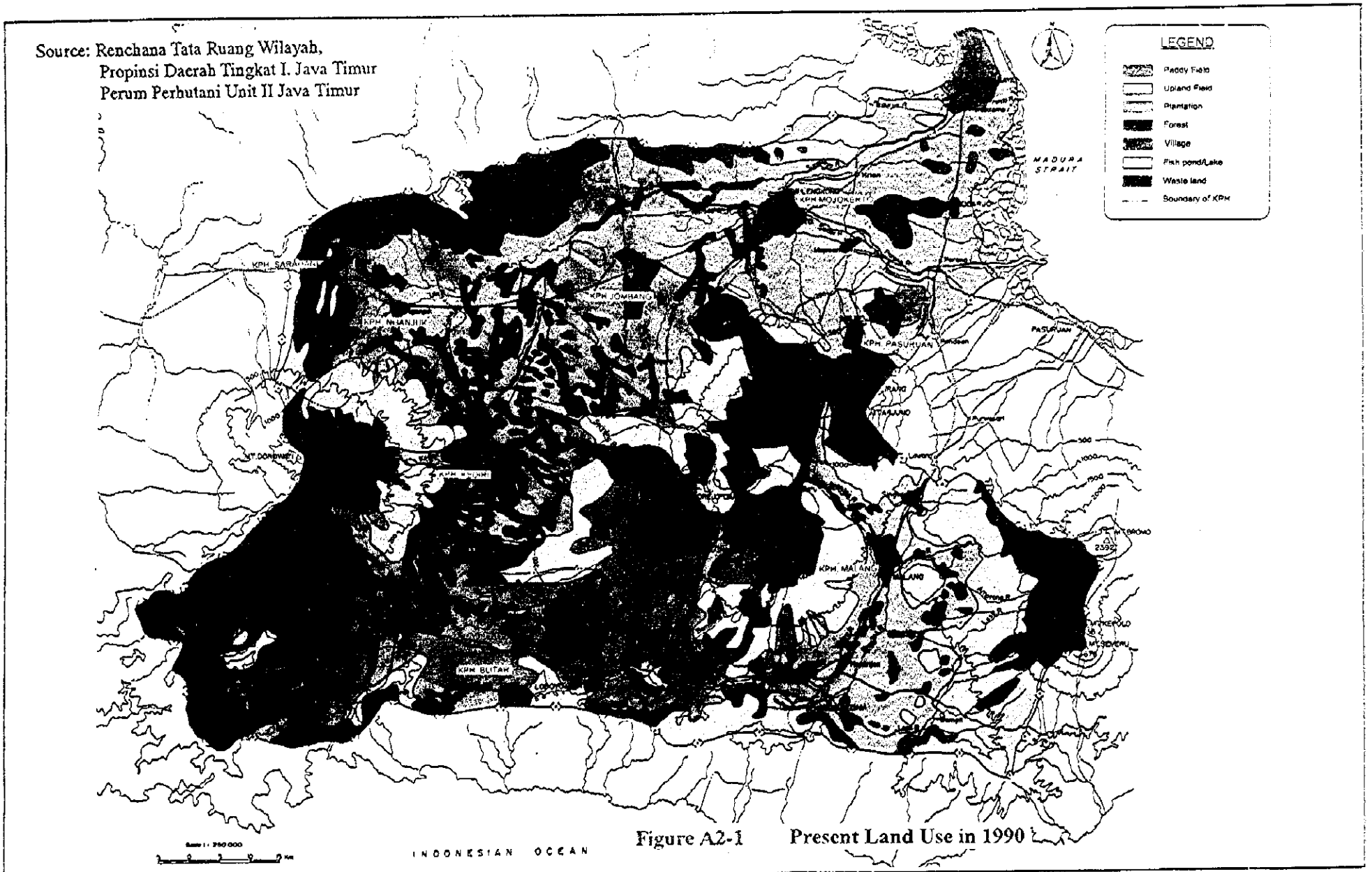


Figure A2-1 Present Land Use in 1990

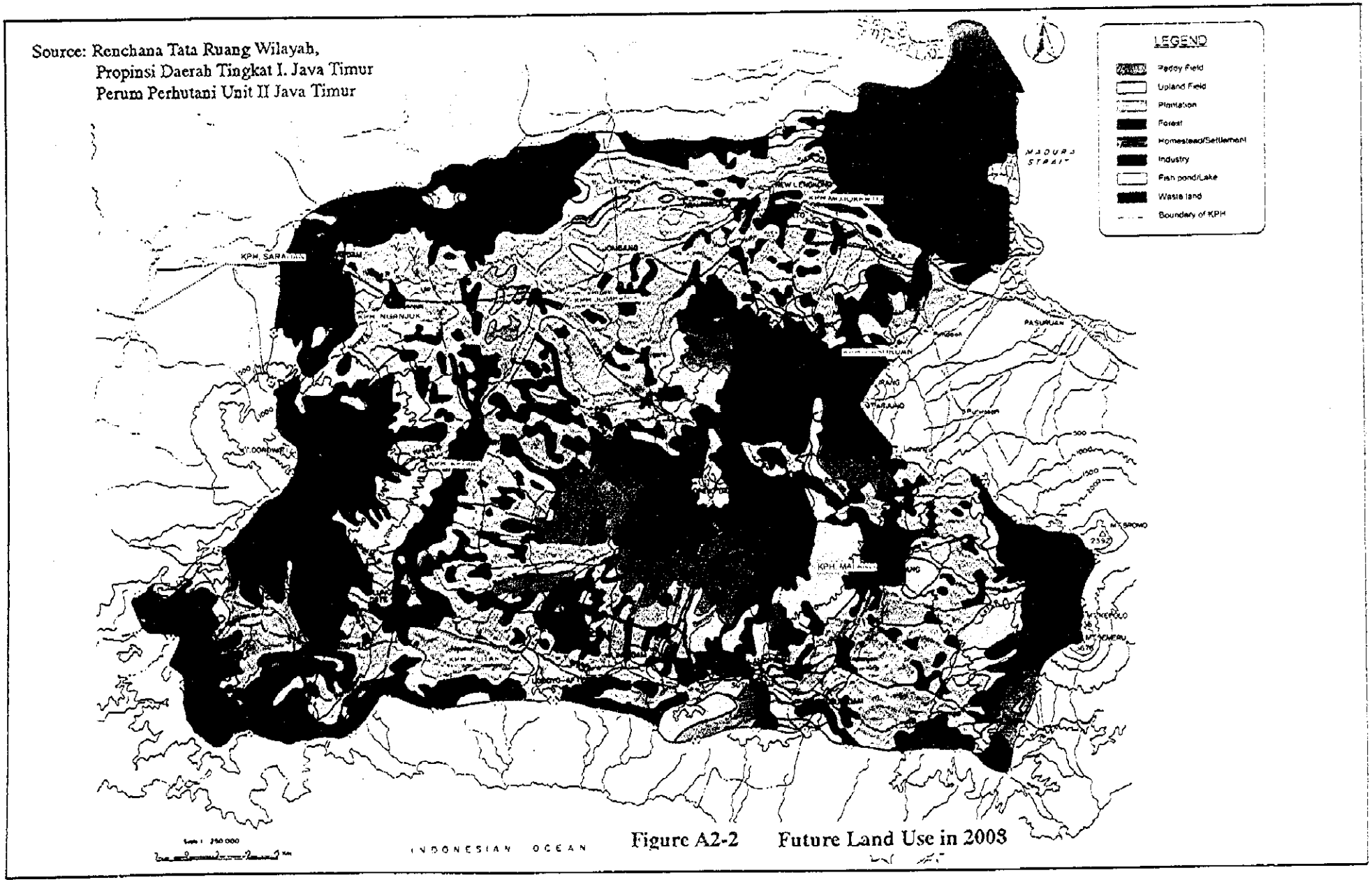


Figure A2-2 Future Land Use in 2008

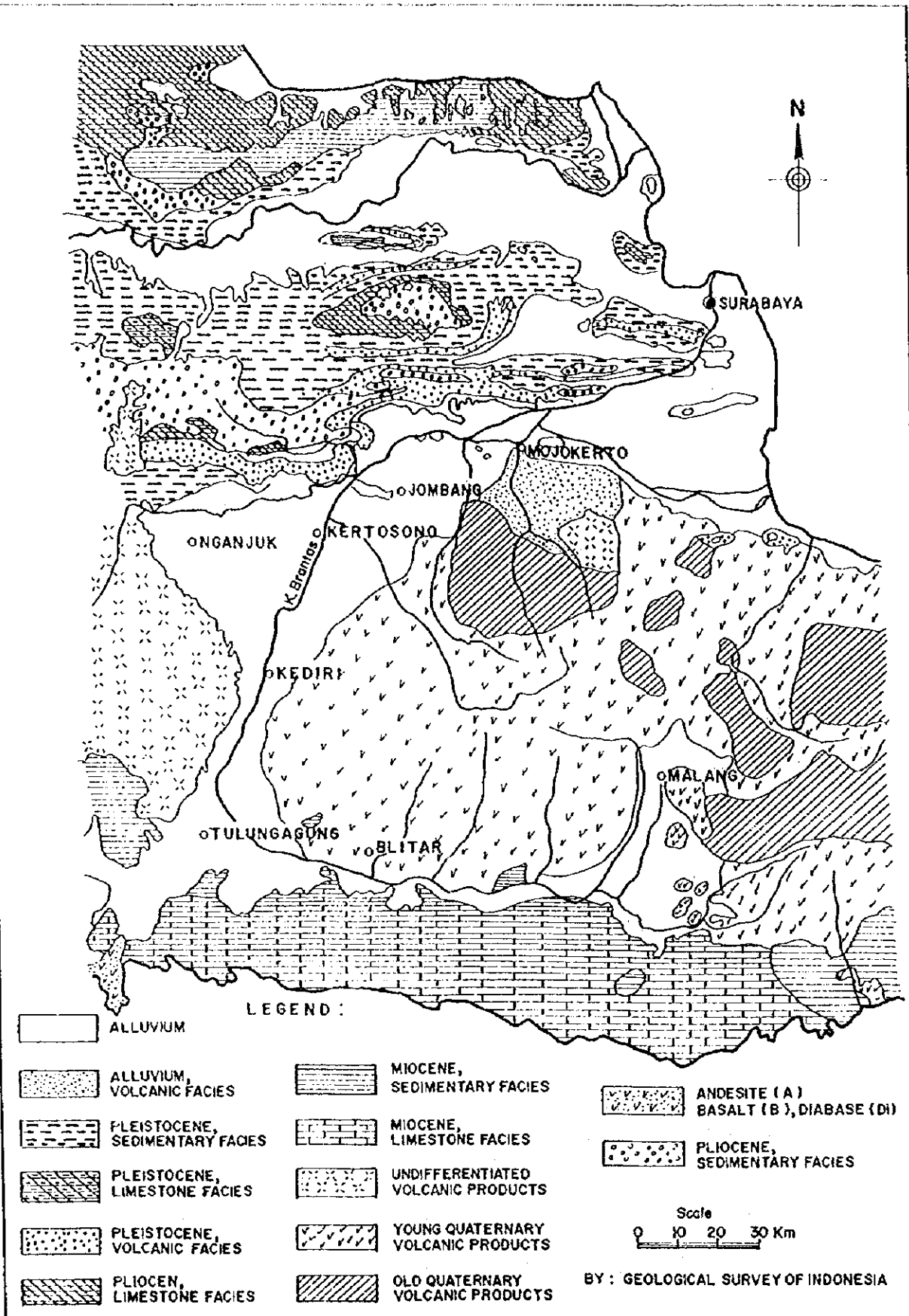
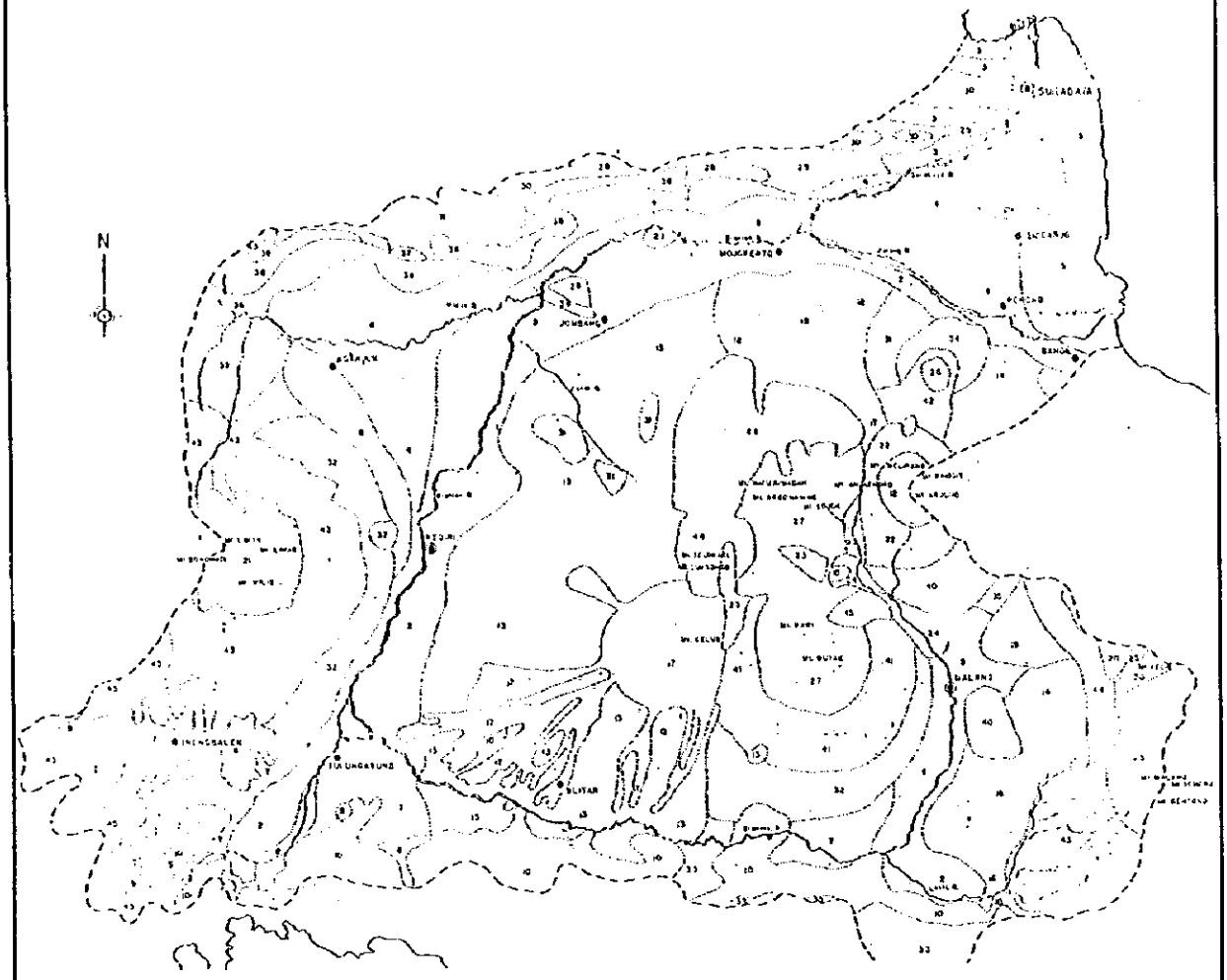


Figure A2-3 Geological Map in the K. Brantas Basin



FLUVISOL

1 Grey Alluvial.
2 Grey / Greyish brown Alluvial
4 - 5 Grey Dark Alluvial
6 - 7 Dark grey hydromorphic Alluvial

HISTOSOLS

8 Humic gley

LITHOSOLS

9 Lithosol
10 Association of Lithosol / reddish brown Mediterranean soil
11. Complex of Lithosol, Mediterranean soil / Rendzina

REGOSOLS

12 Yellowish brown Regosols.
13. Greyish brown Regosols.
14. Greyish brown Regosols.
15 - 16. Brown Regosols.
17. Greyish regosol / Lithosol.
18. Yellow brown regosol / Lithosol.

NON - CALCALEOUS BROWN FOREST SOILS

19. Brown forest soil

ANDOSOLS

20. Association of grey andosol / grey regosol.
21 - 22 Association of yellowish brown andosol / yellowish brown regosol.
23. Brown andosol.
24. Association of brown andosol / humic gley soil.
25. Association of brown andosol / brown regosol
26. Complex of yellowish grey andosol / Lithosol
27. Complex of brown andosol / Lithosol.

GRUMUSOL

28 Grey grumusol.
29 - 30. Dark grey grumusol.

MEDITERRANEAN

31. Association of brown mediterranean / grey grumusol.
32 - 33. Brown reddish brown mediterranean / grey grumusol.
34. Association of reddish brown mediterranean / grey grumusol
35. Reddish brown mediterranean
36. Association of reddish brown mediterranean / grey grumusol
37 - 38. Complex of brown mediterranean / Lithosol.

LATOSOL

40. Brown latosol.
41. Association of brown latosol / brown regosol.
42. Association of brown latosol / grey regosol.
43 - 44. Reddish brown latosol.
45. Complex reddish brown latosol / Lithosol.

SOURCE : Soil Research Institute Bogor 1966.

Figure A2-4 Soil in the Brantas River Basin

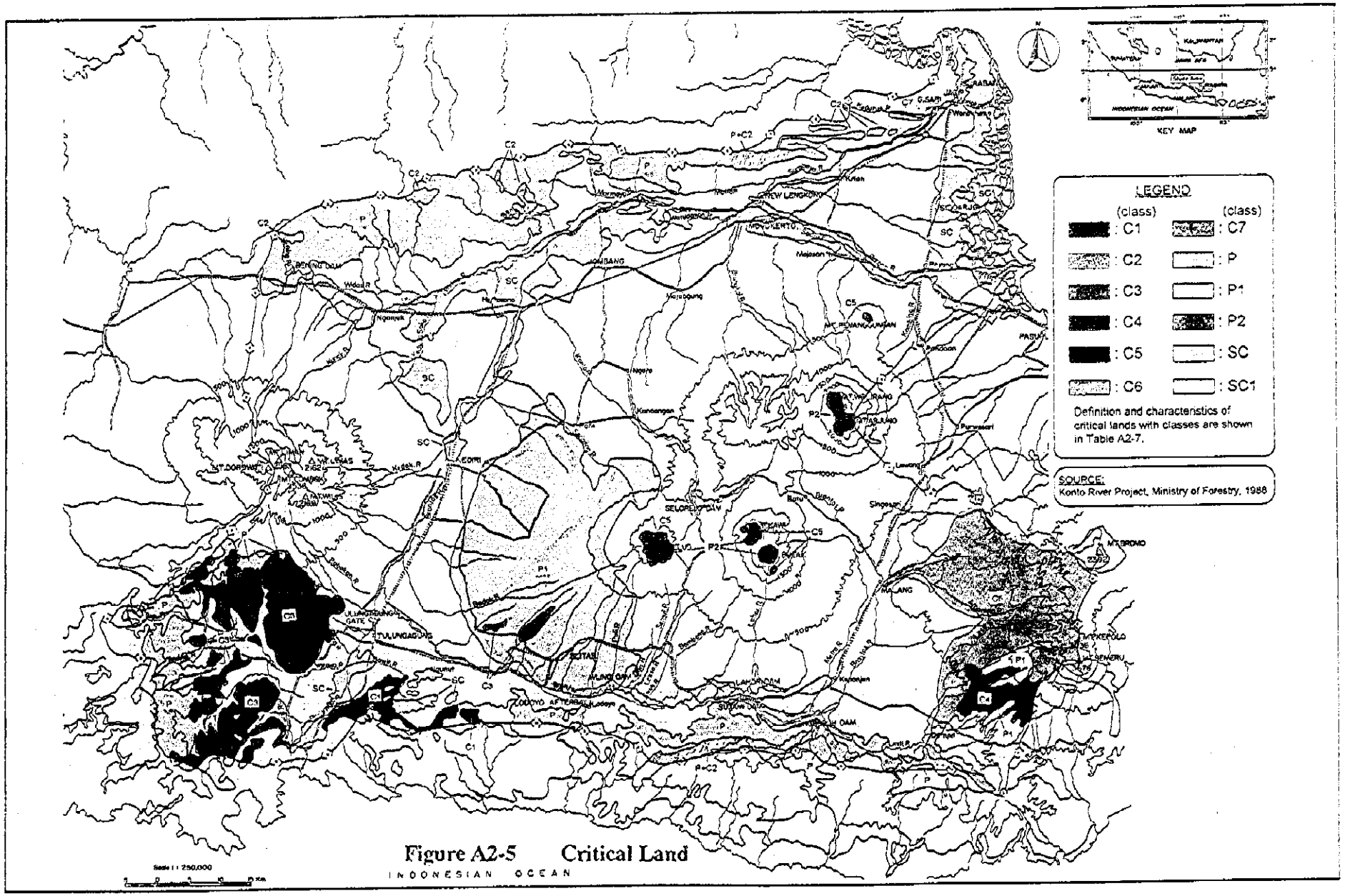
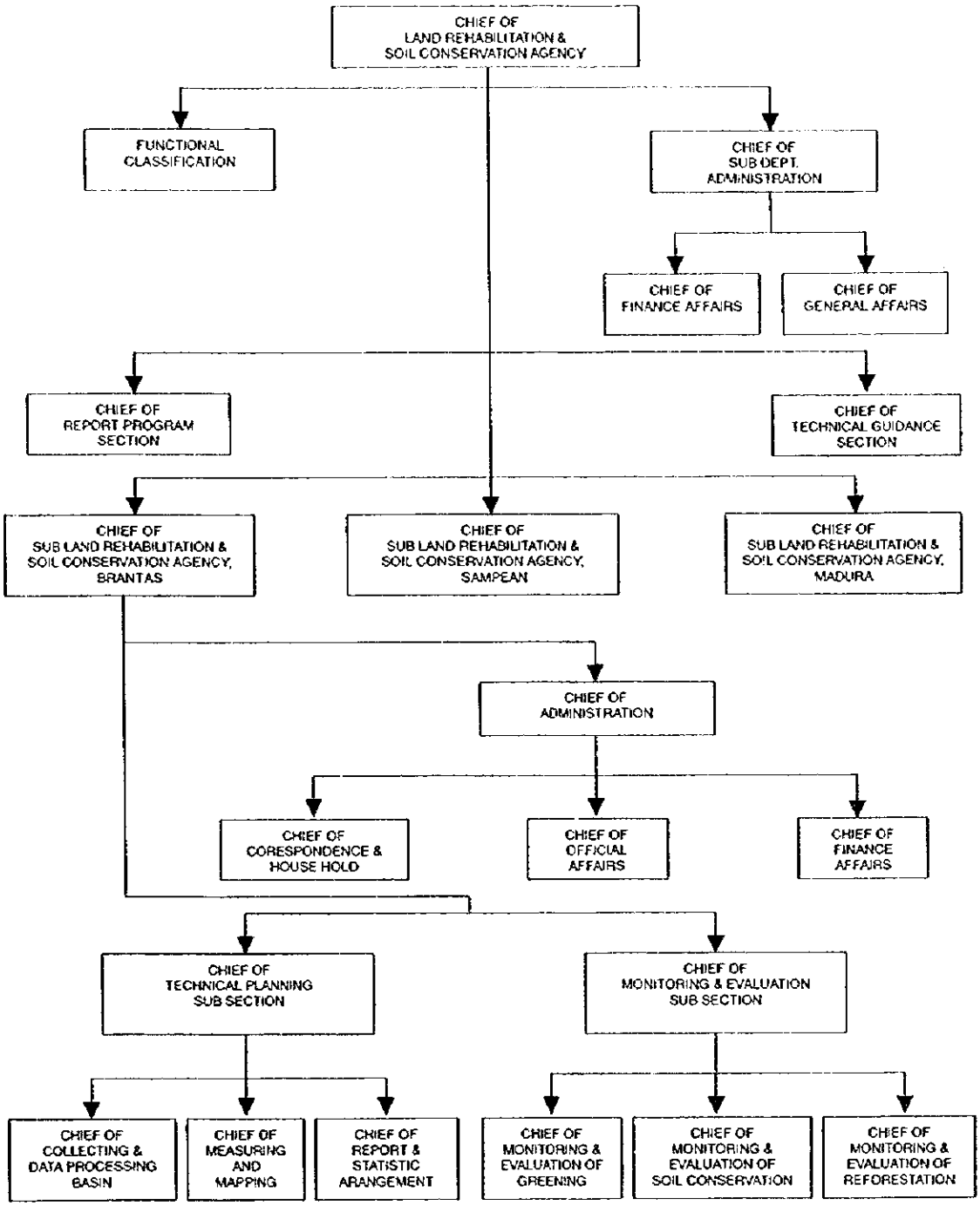
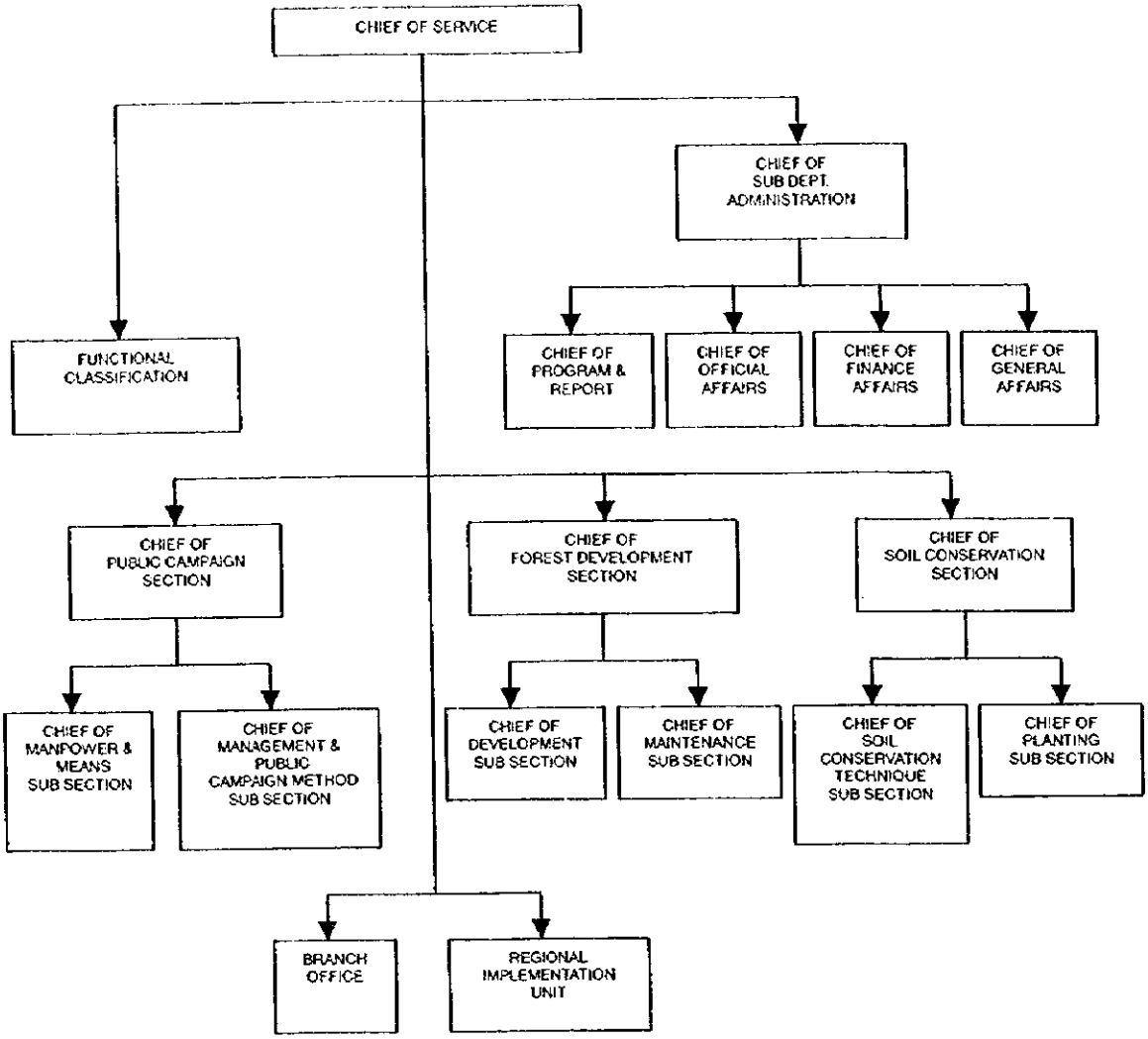


Figure A2-5 Critical Land



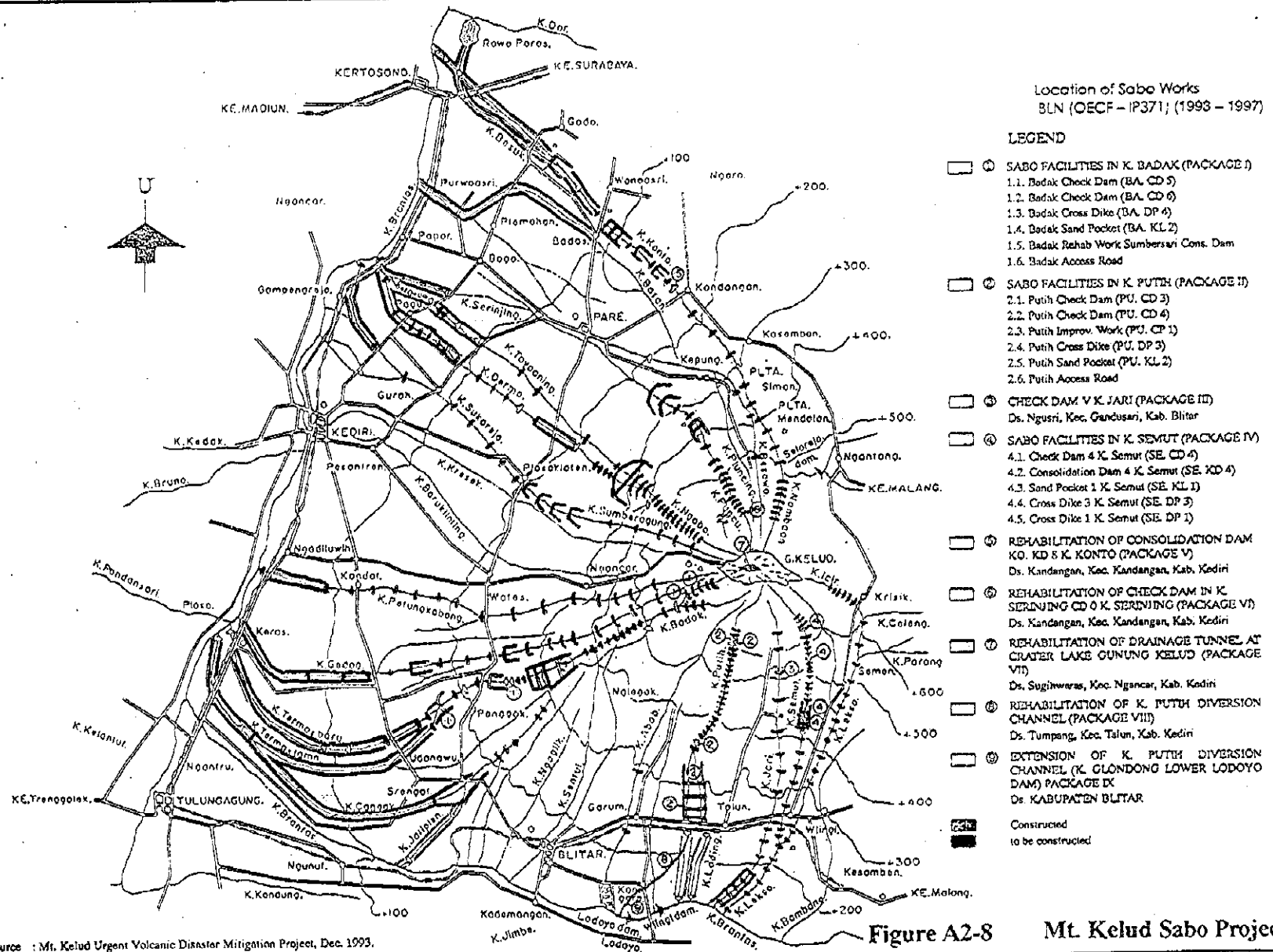
Source : Sub – BRLKT (Balai Rehabilitasi Lahan dan Konservasi Tanah, 1997)
(Sub Land Rehabilitation and Soil Conservation Agency, 1997)

Figure A2-6 Organization Structure of Sub – BRLKT Brantas



Source : DPKT (Dinas Perhutanan dan Konservasi Tanah) Daerah Kabupaten Daerah Tingkat II Malang, 1997
(Forestry Service and Soil Conservation of Municipality in Malang, 1997)

Figure A2-7 Organization Structure of DPKT



Source : Mt. Kelud Urgent Volcanic Disaster Mitigation Project, Dec. 1993.

Figure A2-8 **Mt. Kelud Sabo Project**

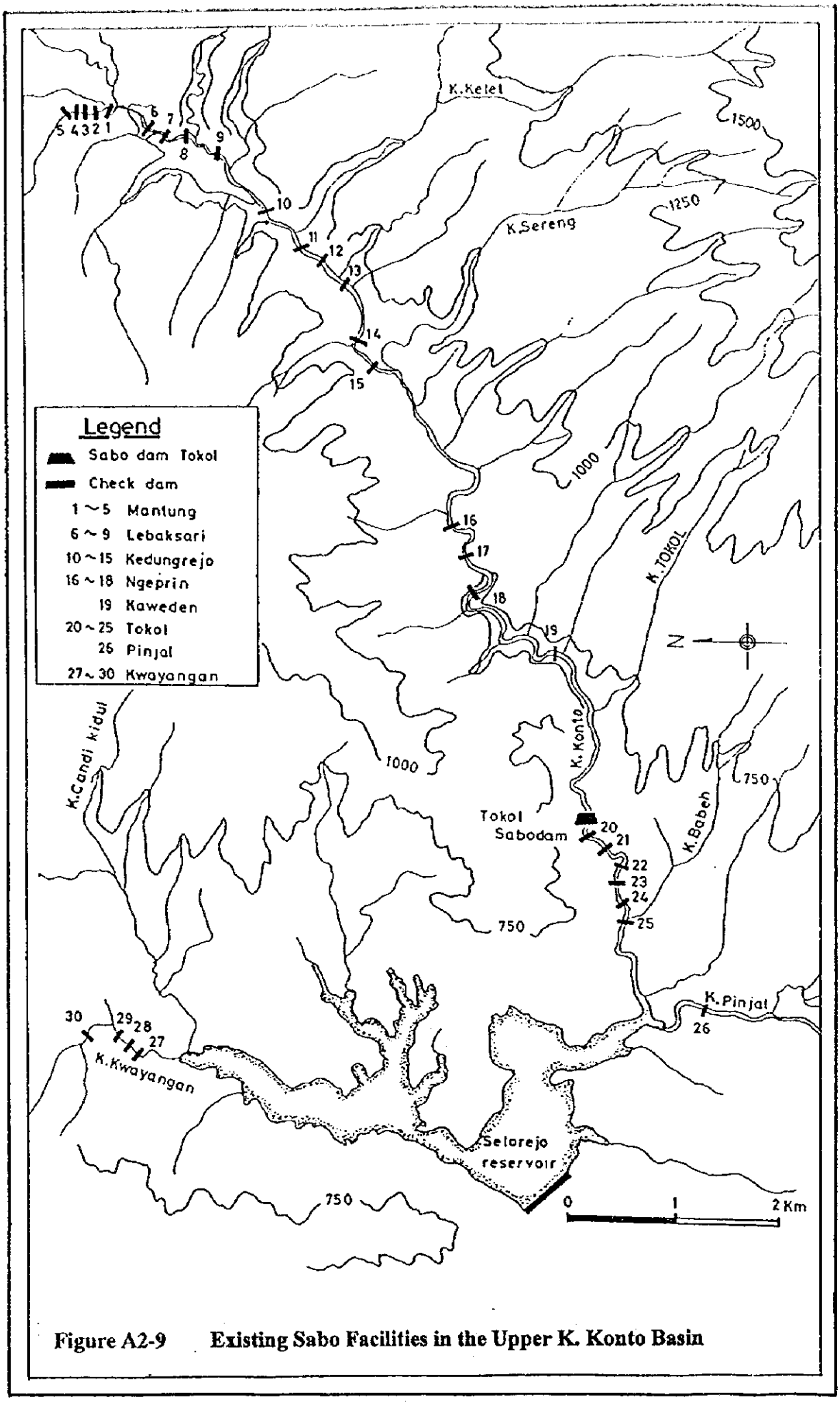


Figure A2-9 Existing Sabo Facilities in the Upper K. Konto Basin

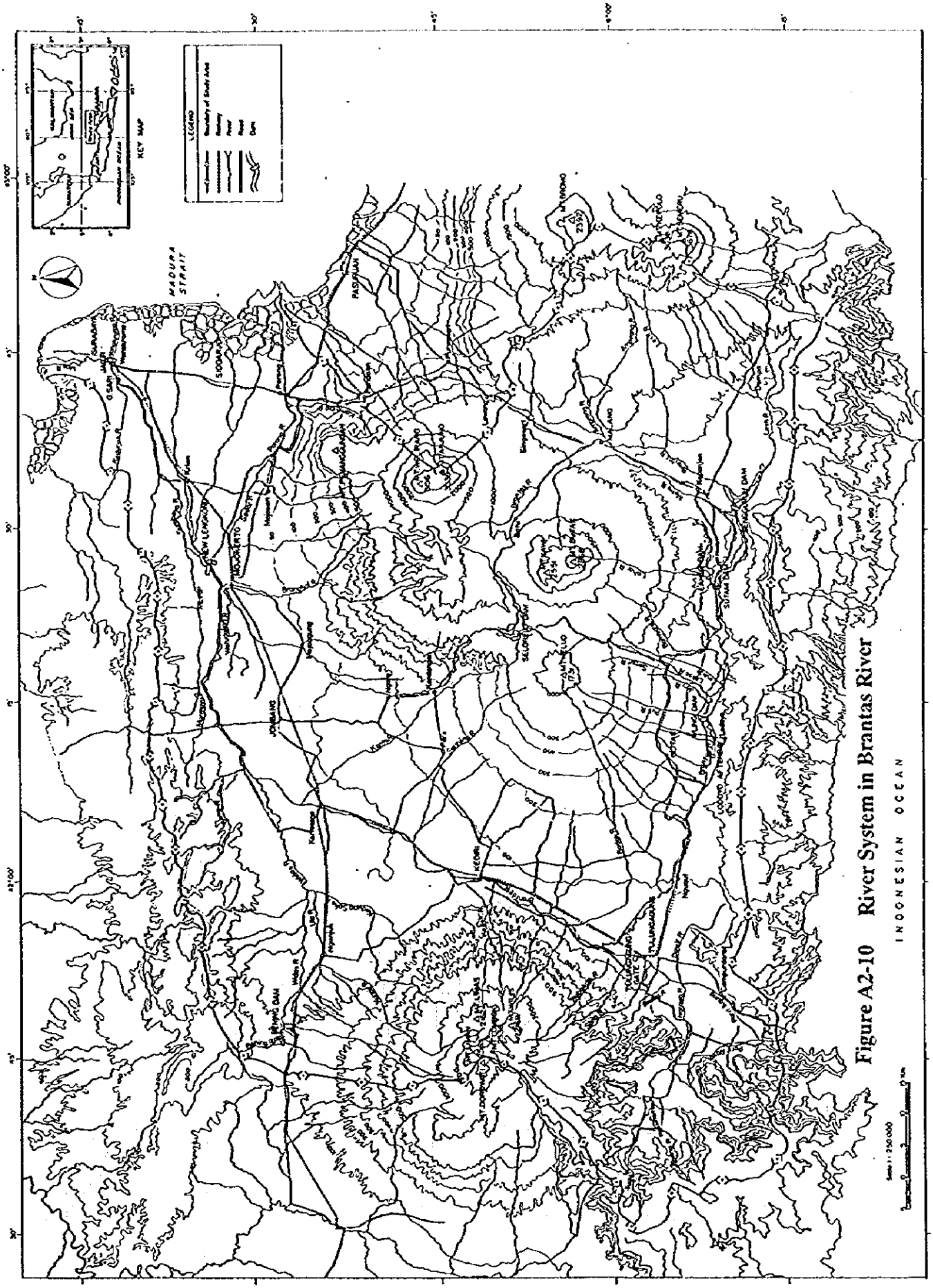
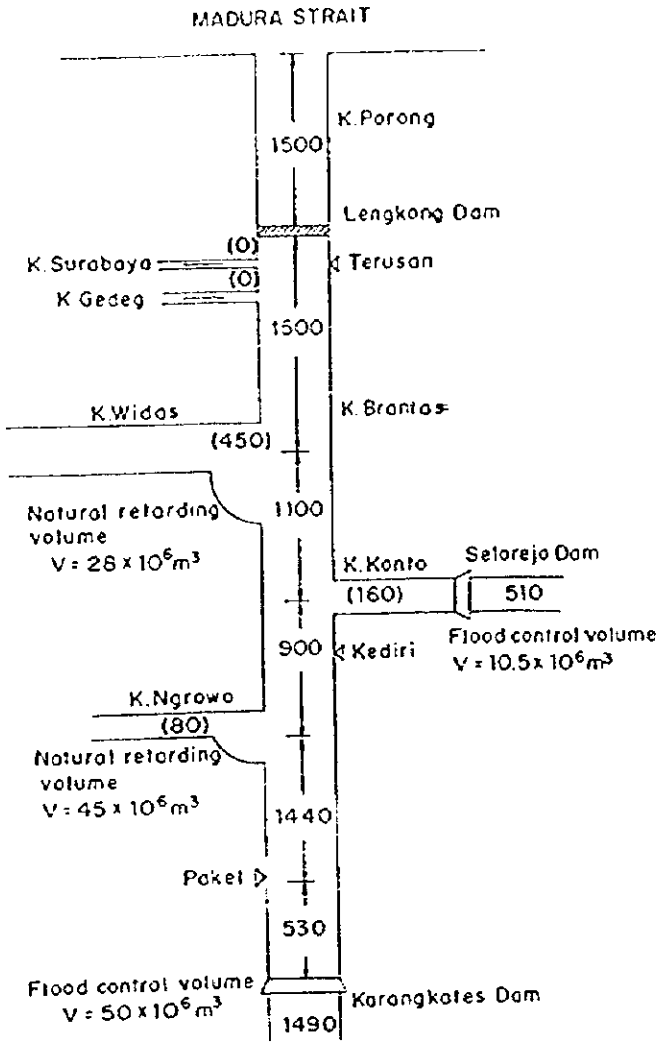


Figure A2-10 River System in Brantas River



Proposed by

The Brantas River Basin Development Plan

1973 Master Plan

Figure A2-11 Design Discharge Distribution in 1973 Master Plan

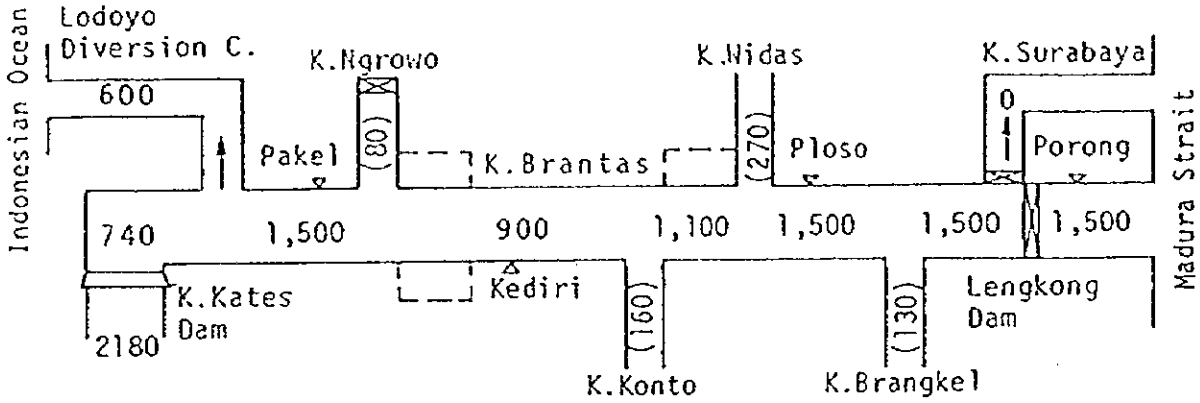


Figure A2-12 Design Discharge Distribution in 1985 Master Plan
(1985 Master Plan, Widas Project)

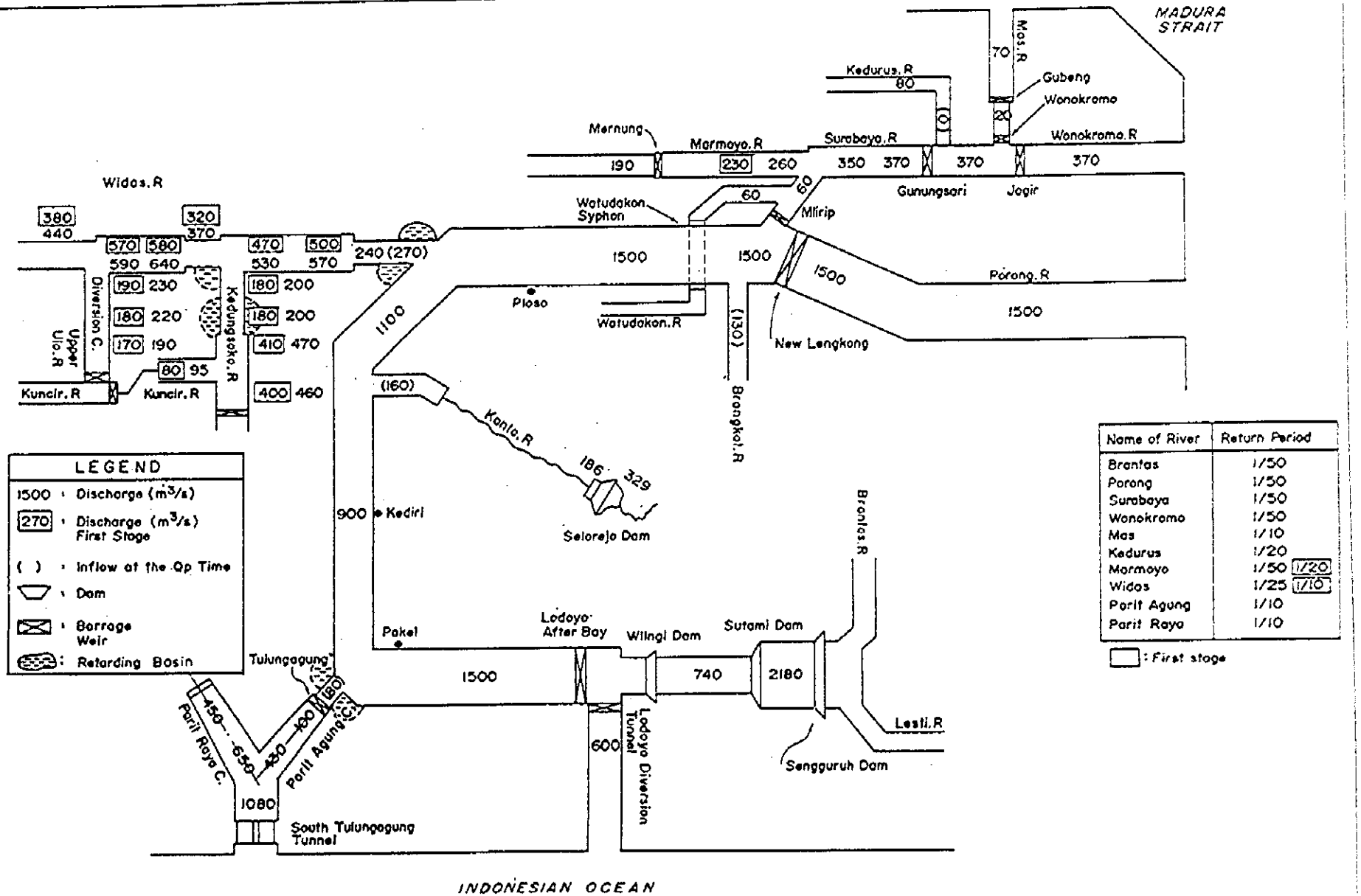


Figure A2-13 Design Discharge Distribution in Whole Brantas River Basin

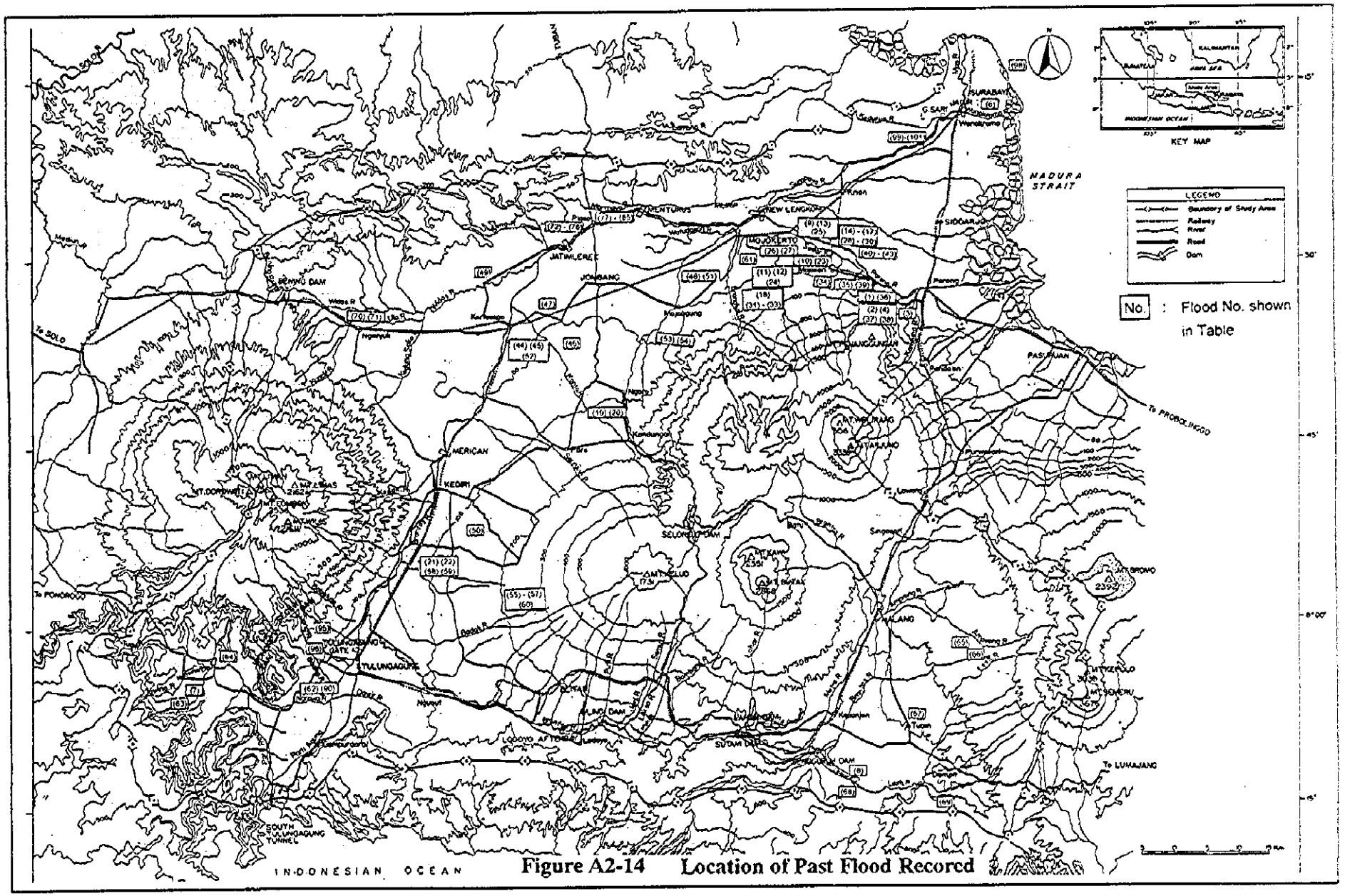


Figure A2-14 Location of Past Flood Record

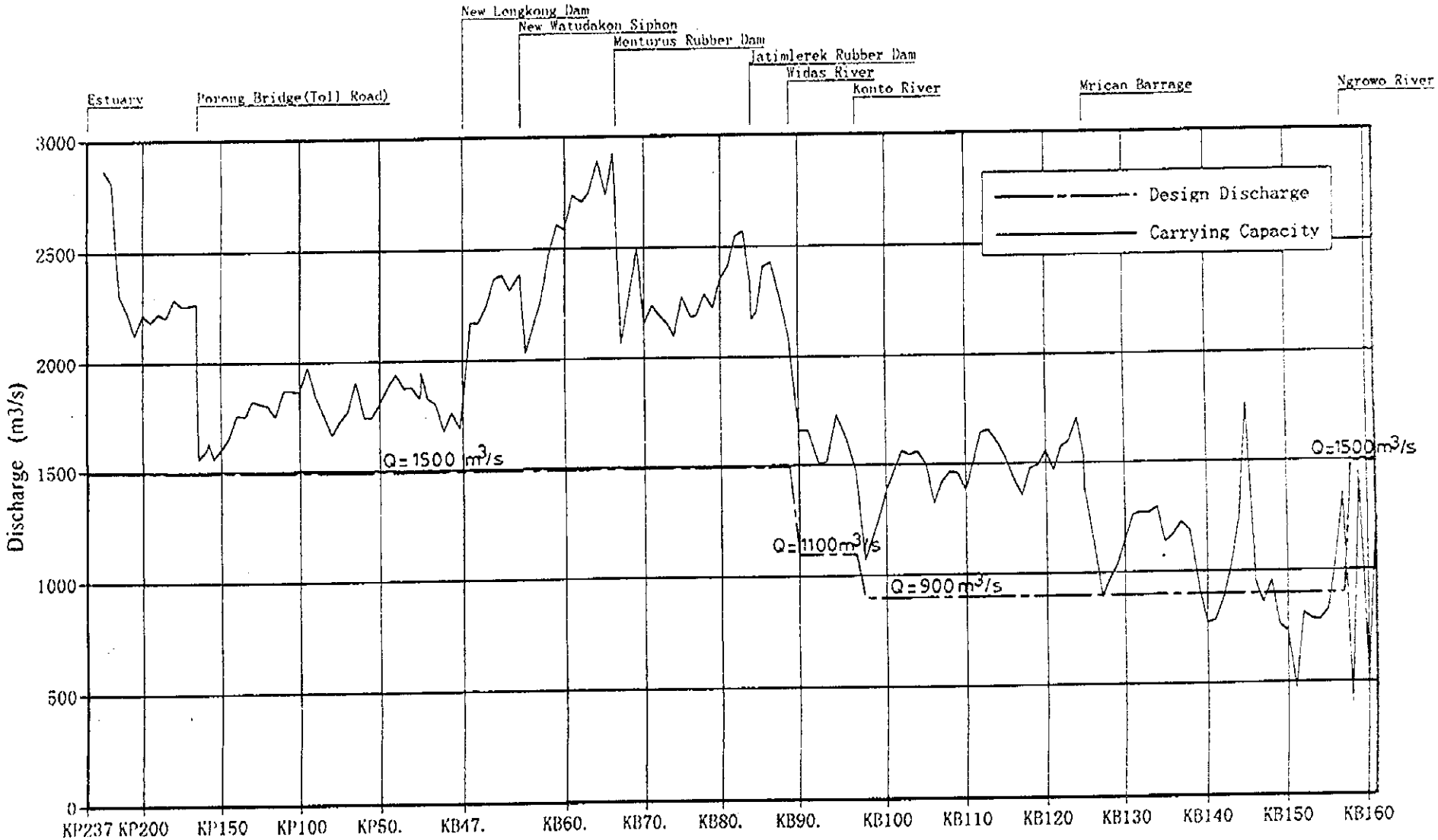


Figure A2-15 Discharge Capacity of Brantas River (1996)

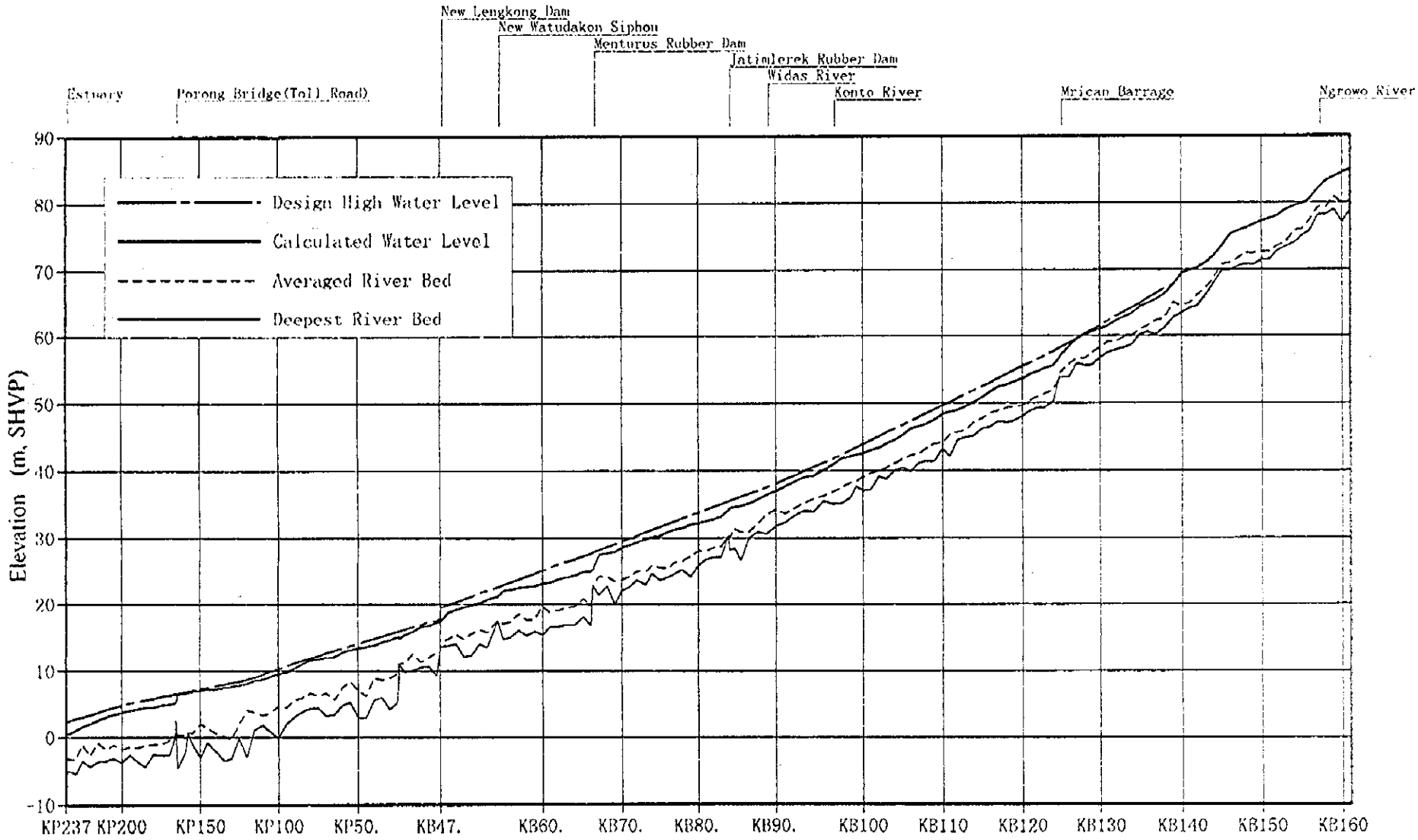


Figure A2-16 Calculated Water Level of Brantas River under Design Discharge Distribution

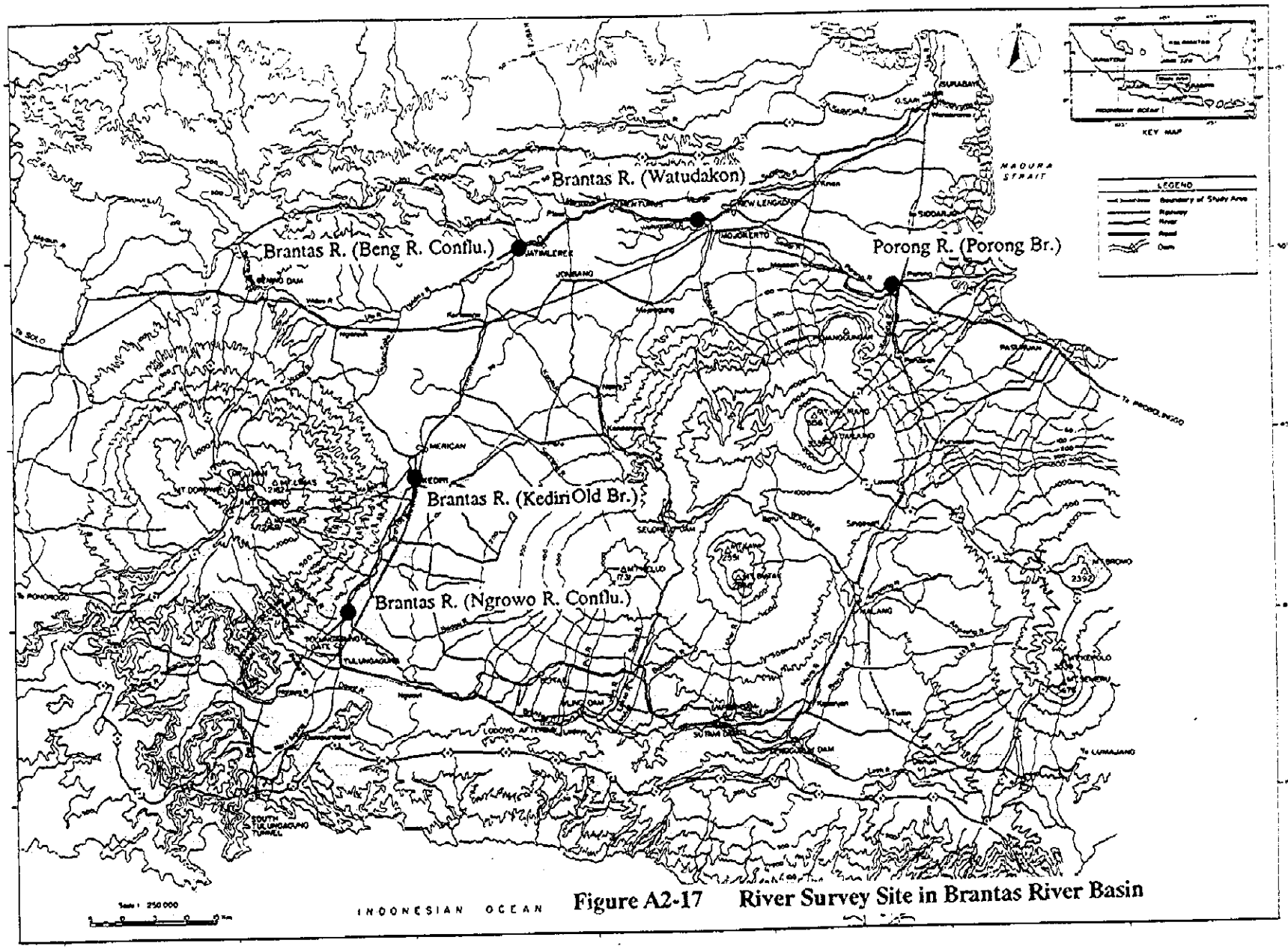


Figure A2-17 River Survey Site in Brantas River Basin