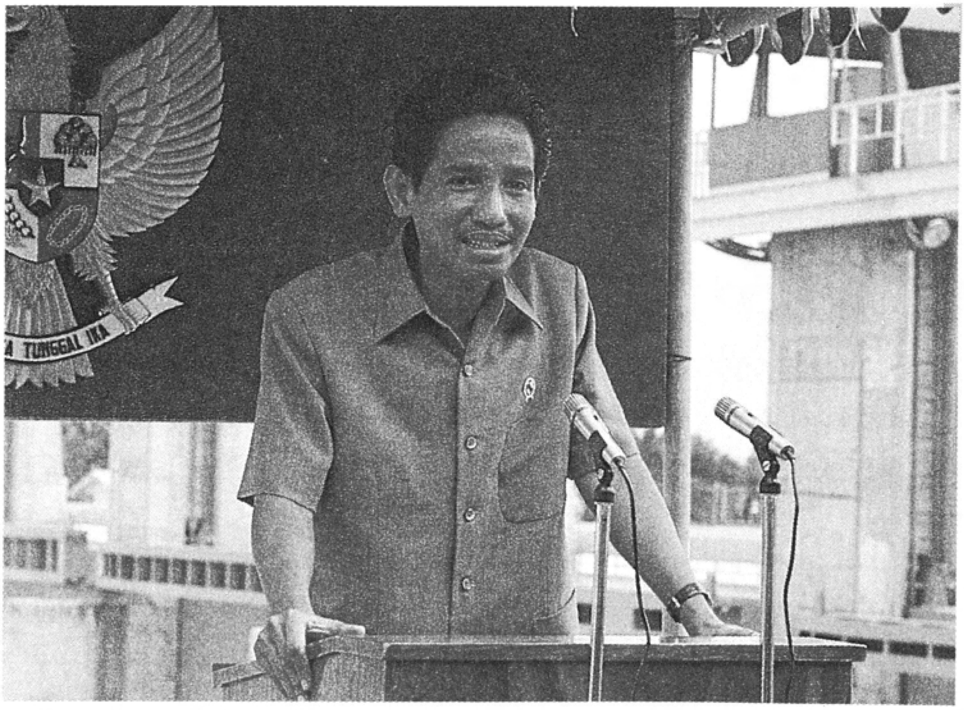
Chapter 3

Evaluation of the Brantas River Basin Development Project



Minister of Public Works, Ir. Sutami, giving a congratulatory speech at the Lodoyo Dam completion ceremony. He regarded the Brantas River Basin Development Project as "The first river development project in Indonesia to be comprehensively executed based on rational planning." (1983)

To numerically evaluate the economic effects of the Brantas River Basin Development Project at regional or national levels, systematic monitoring and analyses based on the project's results are required. No such surveys have been conducted to date, making it difficult to express the effects quantitatively. This is an issue for future study.

This chapter gives a qualitative description of: 1) effects the project had on the Brantas Basin's economic development and residents' livelihood due to the development of infrastructure; 2) contribution to the achievement of national and regional economic development plans; 3) Japan's assistance, which made a considerable contribution towards the project's success; and 4) consulting services.

1. Effects of the Project

The development of Brantas River Basin is a comprehensive multipurpose project which uses dams for the development of water resources ("to create water"), resulting in power generation, flood control, and supplies of irrigation, city and industrial water. As described in an earlier chapter, the master plan has generally been reviewed once every ten years. The current master plan which was established in 1985, is the third such plan. Reviews are made in order to address the future needs of a society which can be assumed at that point in time (including a project execution plan up to the year 2000).

In the third master plan, although the basic development concept of the first master plan remains unchanged, visions of development by sector have become more concrete based on the consideration of the functions of implemented projects. Projects were carried out to their respective objectives, while at the same time each project was implemented as part of the multipurpose development plan as their functions naturally related to one another.

In this section the function of multipurpose dams is described first, followed by an analysis of the effects, by project, created by the dams function.

(1) Multipurpose dams

The climate of the Brantas River Basin is marked by a fairly clear distinction between the dry season (mid-May to mid-November) and the rainy season (the rest of the year). According to the records for 1950-83, at Jabon (situated just upstream of the New Lengkong Dam where Brantas branches off to the Surabaya and the Porong River), the annual average runoff was 260 m^3/sec. However, during the rainy season the average monthly maximum runoff became approximately 520 m^3/sec and dropped to approximately

51 m^3/sec in the dry season. The primary objective of multipurpose dams is to stabilize these seasonal variations in runoff.

Dams with the function of annual flow control in the Brantas Basin are all multipurpose dams intended for city, industrial and irrigation water supplies, flood control, and power generation. Table 3-1 and Fig. 3-1 show the active storage capacities of dams completed to date and those currently under construction; including the estimated increase in dry season runoff resulting from their construction.

Table 3-1 Active storage capacity of multipurpose dams in the Brantas Basin

Dam	Completion date	Active storage capacity (1 mil. m^3)	Cumulative total (1 mil. m^3)	Estimated increase in dry season runoff (m^3/s)
Selorejo	Oct. 1972	54.6	54.6	5.3
Karangkates	Dec. 1973	253.0	307.6	29.7
Lahor	Nov. 1977	29.4	337.0	32.5
Bening	Nov. 1984	24.8	361.8	34.9
Wonorejo	Oct. 1999 (scheduled)	106.0	467.8	45.1

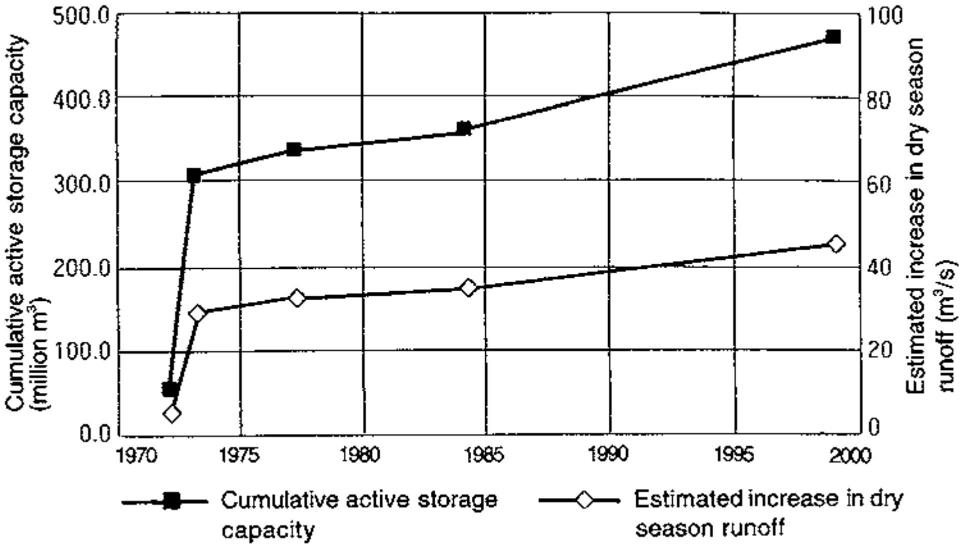
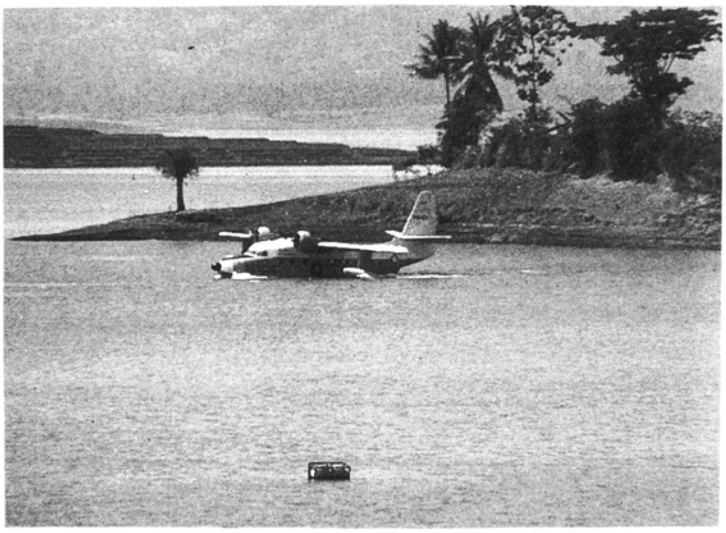


Fig. 3-1 Multipurpose reservoirs in the Brantas Basin

The active storage capacity of dams completed to date totals 361 million m^3, so the resultant increase in dry season runoff is estimated at 34.9 m^3/s. The drought runoff at Jabon in the 1960's was some 35 m^3/sec, from which it follows that a flow increase equivalent to this amount was achieved by these dams. A further increase of about 10 m^3/sec can be achieved when Wonorejo Dam is completed. To meet the ever-increasing demand for water; including irrigation, city and industrial supplies, the efforts to increase drought runoff have been and are still being carried out.



Hydroplane on Karangkates Dam Lake

Of these multipurpose dams, Karangkates and Selorejo reservoirs are also used for fresh water fisheries and recreation. For fishing, these dams produce a combined average catch of 50 tons per month; serving as a valuable source of protein for the local people who, in the 1970's, still had a poor local economy. On average 300 tourists per day visit this area to enjoy boating and fishing, there is also a golf course nearby which was constructed along with the dams, thus providing a space of rest and relaxation for local people. As a special note, the Karangkates reservoir provides a space for hydroplanes to take off and land. Its three runways are under control of Surabaya Airport and are for private use as well as commercial. The above examples prove the versatility of these dams.

(2) Flood prevention

Around 1958, when the Brantas River Basin Development was initiated, debris produced by the eruption of Mt. Kelud caused the beds of the Brantas main stream and its tributaries to be heightened. This sediment deposition decreased the river discharge capacity for carrying flood. This incurred flooding almost every year, resulting in personal injury, crop damage, and loss of assets. Accordingly flood prevention was given top priority in the initial stages of the development.

In light of such a situation, the basic concept for the entire Brantas Basin flood prevention plan was formulated as follows:

1) Planned flood runoff was determined as below, taking into consideration the importance of the Brantas main stream and its tributaries, the flood prevention level of other Indonesian rivers, and the scale of assumed flood damage.
   - Brantas main stream:
     10-year probable floods in Phase I and 50-year probable floods in Phase II.
   - Tributaries:
     For initial stage, 10~25-year probable floods, in accordance with the national flood prevention level. For the Widas River, 25-year probable floods.
2) Multipurpose dams are to be constructed in the upper reaches, flood control functions of which will be used to decrease the flood runoff in the lower reaches. The following are major dams with flood control functions, both existing and under construction.
   - Brantas main stream: Karangkates Dam, Lahor Dam, Wlingi Dam
   - Konto River (right bank tributary): Selorejo Dam
   - Widas River: Bening Dam
   - Ngrowo River: Wonorejo Dam

   In addition, there are many other small-scale dams planned with limited flood control functions.
3) Flood waters of the upper Brantas and its tributaries are to be partially discharged into the Indian Ocean.
   - Flood waters of the Ngrowo River are to be discharged into the Indian Ocean through Tulungagung Diversion Tunnel (Nejama Diversion Tunnel).
   - Part of the flood waters of the main Brantas are to be discharged into the Indian Ocean using a diversion tunnel from the vicinity of Lodoyo (a point near the Wlingi Dam) (Lodoyo Diversion Tunnel).

4) Natural retarding basins in the middle reaches of the main Brantas are to be converted to artificial ones for more efficient reduction of the flood runoff in the lower reaches. The following are to be included in this work:
   - Ngrowo retarding basin (in the vicinity of the Ngrowo / Brantas junction near Tulungagung).
   - Widas retarding basin (near the Widas / Brantas junction. Consisting of three basins the Widas, Ulo, and Kedungsoko jointly called the Widas retaining basin).

5) The Porong River is to serve as a floodway for the Brantas, not allowing flood waters from the Brantas to the Surabaya River.
6) A short-cut channel is to be provided at the lower end of the Porong to prevent rise of the riverbed. This is intended to enhance the discharge capacity of the Porong.
7) For flood prevention in the Surabaya urban area, measures are to be taken for floods that occur in the Surabaya River Basin, independently of the Brantas River.
8) River channels of the main stream and its tributaries are to be improved by diking system and dredging of riverbeds to increase flood discharge capacity.
9) A system of flood forecasting, warning, and water management including a low flow control function is to be established in order to allow flood prevention measures to be executed speedily and effectively.

Based on the concepts described above, the planned flood runoff was determined to be 1,500 m^3/sec (50-year probable flood) at the end of the main Brantas (at New Lengkong Dam). Incidentally, if this plan was developed only in terms of river channel improvement, the planned flood runoff at this point would be 2,070 m^3/sec. This would increase costs, making the project economically unfeasible.

Most of the flood prevention measures listed above have been completed except for Ngrowo retarding basin, Lodoyo Diversion Tunnel, small-scale dams, and part of the tributaries improvement work. As a direct result, there has been a considerable decrease in flood damage to both the main stream and its tributaries. A distinctive contrast between the Solo River, Java's largest, and the Brantas can be seen in the local newspapers, articles claim "no damage to Brantas" while practically every year flood damage is still being reported on the Solo.

The total project cost of flood control work is estimated to be approximately ¥85 billion in terms of 1988 prices. On the other hand, the estimated savings in flood related damages to residential, agricultural, and capital overhead is ¥13.5 billion annually. From these figures, the flood control project can be considered very effective, even looking at only the direct benefits. In addition to monetary savings, there are invaluable effects brought about by this project such as the stabilization of livelihoods, improvement of living environments, sophistication of land usage, urban development, and promotion of industrialization. In recent years the Brantas River Basin Development has made further progress, therefore it is assumed that additional effects have been realized.

Although the flood prevention plan has been launched, it only covers 10~50-year probable floods. Someday, the necessity to increase the safety factor for floods will arise, as economy grows and infrastructures improve. Also sediment deposition will continue to be a problem due to Mt. Kelud's eruptions. Therefore the need for continuous flood control work is required.

New Lengkong Dam under construction

(3) Irrigation and agriculture

Agriculture is the key industry in the Brantas Basin and one important issue in the first 25-year long-term development plan was to achieve self-sufficiency of rice through increased production. The basin has prospered as Java's granary since the 1800's, largely due to the advanced irrigation system established by the Dutch colonials. These facilities, however, were devastated during the interval from Japan's 1942 occupation in WWII to Indonesia's independence in 1945. In the subsequent period of political and economic disorder almost no maintenance was performed on existing irrigation systems. In addition, irrigation in the past depended on the natural runoff of rivers, as there were no large reservoirs in the Brantas Basin. In view of this situation, irrigation work was carried out under the following basic principles:

1) Rehabilitation of existing irrigation systems (water intake and irrigation canal facilities)
2) Development of new paddy fields where possible
3) Guaranteed irrigation water through the construction of multipurpose dams in the upper reaches (to increase dry season runoff)

Table 3-2 shows the status of land use in the Brantas Basin.

Table 3-2 Land usage in Brantas Basin

Unit: 1,000 ha

	1970	1993
Paddy fields	314	324
Farms	393	293
Plantations	65	19
Forests	185	294
Residential	210	227
Other	13	23
Total	1,180	1,180

The total available area for irrigation in the basin is estimated at 345,000 ha including non-technical irrigation areas (areas that have simple water intake facilities made up of cobbles, gabion, etc. that are often swept away in floods or are not useful in the low flow of the dry season). Of this land area, 324,000 ha (94%) were developed as rice fields as of 1993, equipped with technical irrigation systems for the most part, precluding new irrigation development.

Trends in rice yields and unit yields are shown for the years 1970 through 1993 in Table 3-3 and Fig. 3-2. During these 23 years the area of paddy fields increased only 3.2% (10,000 ha), but the rice production jumped 86.8% and the yield per unit area 81%. This was partially due to the use of fertilizers and improved rice species, however the main factor was the improved dry season runoff. This improved runoff was due to the water resources development, which contributed significantly to the increased rice yields. The cropping intensity was approximately 80-90% in the 1960's, reaching over 130% (230% in some areas) by 1993.

Table 3-3 Unit yields of rice

	Area of paddy fields (1,000 ha)	Rice yield (1,000 tons)	Unit yield of rice (tons /ha)
1970	314	1,428	4.5
1975	312	1,970	6.3
1980	316	2,290	7.2
1985	317	2,535	8.0
1990	325	2,426	7.5
1993	324	2,667	8.2
Increase over 23 years	1.03	1.87	1.81

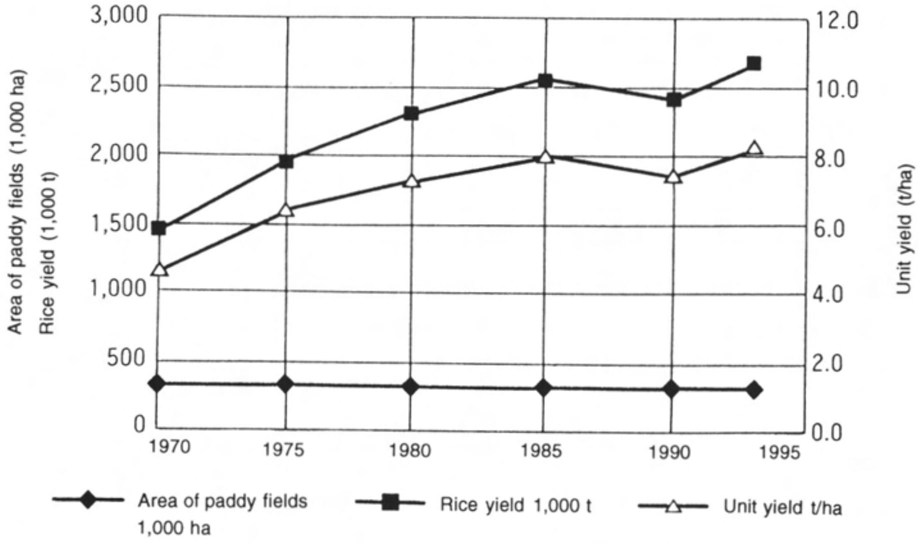
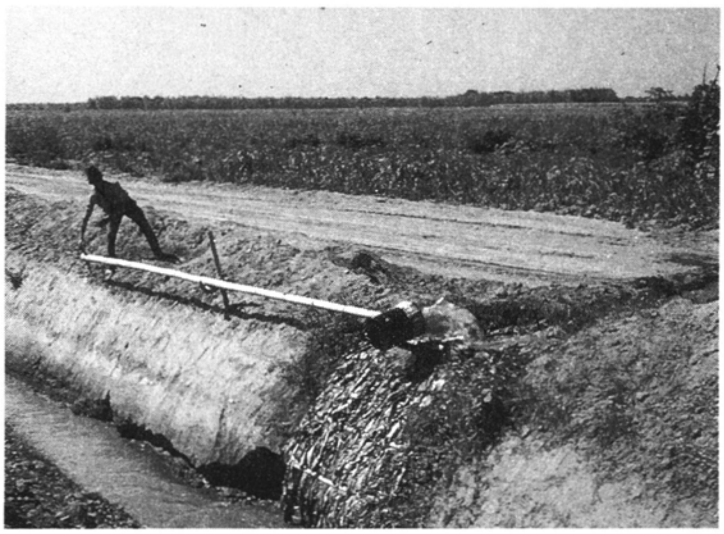


Fig. 3-2 Rice yields in Brantas Basin



Pre-development irrigation: a man drawing water by hand from the canal up to the field

At the planning stage of the irrigation development project an assessment found that a 15-20% economic internal rate of return was estimated for most irrigation plans. This was partially due to the availability of existing facilities. Thus, every project was found to be beneficial. Actual post project figures show that the considerable increase in unit yields has brought about even better economic effects than originally planned.

Although it cannot be expressed numerically, due to the lack of readily available data on the increased annual income of farmers, the Lodoyo Irrigation Project (13,500 ha, including 7,400 ha of newly irrigated land) demonstrated that the improvement in irrigation facilities could help to rapidly enhance the living standards of farm households. The Lodoyo Project was one of a few new irrigation development projects in the Brantas Basin. In the days before the completion of irrigation facilities the local people wore almost no shoes or clothes. Their houses were generally made of bamboo or were simple wooden structures. In 1988, just three years after the construction of irrigation facilities in September 1985, a big difference could be seen throughout most of the village. A greater majority of the houses were made of brick with TV antennas on the roofs, showing even at a glance that living standards had been raised.

Fig. 3-3 shows the trends in rice production for Indonesia, Java, East Java, and Brantas Basin.

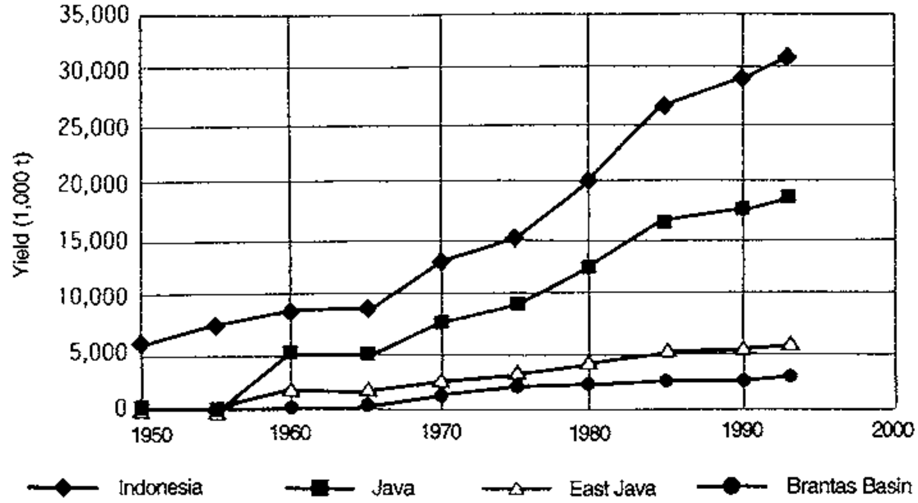


Fig. 3-3 Rice yields in Indonesia

In 1975 Indonesia's rice yield came to 15,190,000 tons. In comparison, East Java's yield was 2,800,000 tons, accounting for about 18% of Indonesia's entire yield. A little over 70% of East Java's yield, 1,970,000 tons, were produced in the Brantas Basin. At this time the Karangkates and Selorejo Dams had been completed increasing the irrigation water. Later, irrigation projects were implemented throughout Indonesia, resulting in an increased arable area. Therefore, 1993 yields showed Indonesia producing 31,300,000 tons; East Java, 5,600,000 tons; and the Brantas Basin, 2,670,000 tons, falling to a little less than 48% of East Java's entire rice yield. From this information we can see that of Indonesia's farming areas the Brantas River Basin was a leader in irrigation development.

The objective aimed for in the first 25-year development plan being realized, the government announced the attainment of nation-wide self-sufficiency of rice production in 1984. The Brantas Basin, however, had accomplished this objective six years earlier, in 1978.

(4) Electricity

The two basic principles of planning hydroelectric generation for the Brantas Basin are:

1) Hydroelectric generation is to be introduced where possible, as part of multipurpose development, along with water resources development.
2) Mini-hydroelectric development is to be included where economically feasible even in the case where intake weirs have lower head.

Hydroelectric stations currently developed are listed in Table 3-4.

Table 3-4 Hydroelectric stations developed

Power station	Installed capacity (MW)	Start up
Selorejo Power Station	4.5	1972
Karangkates Power Station (Phase I)	70.0	1973
Karangkates Power Station (Phase II)	35.0	1975
Wlingi Power Station (Phase I)	27.0	1978
Wlingi Power Station (Phase II)	27.0	1979
Lodoyo Power Station	4.5	1983
Bening Power Station	0.7	1984
Sengguruh Power Station	29.0	1988
Tulungagung Power Station	36.0	1991
Wonorejo Power Station	6.5	Scheduled for 1999

The power generation facilities existing in the basin in 1961, when the Brantas River Basin Development started full scale, produced a total of 31.7 MW for hydroelectric and 21.6 MW for thermal power (53.3 MW total). Later hydroelectric power was developed as part of the Brantas River Basin Development Project and as of 1993 it had increased eight fold to a total of 263 MW. Progress of industrial development further boosted the demand for electricity in the basin, so in response, thermal power stations were also constructed. At present the installed capacity of power generation has reached 1,613 MW. Furthermore, the Wonorejo Dam is now under construction and a 6.5 MW hydroelectric plant is scheduled to go into operation in 1999; this will cause the hydroelectric generation installed capacity to increase to 269.5 MW.

The installed capacity trends in the Brantas Basin for both hydroelectric and thermal power are shown in Fig. 3-4. The total hydropower potential of the Brantas River is estimated at 1,000 MW. After completion of the Wonorejo Dam, approximately 27% of the hydropower potential will be developed.

The State Electric Power Corporation is in charge of transmission line and substation development. Although East Java was once equipped with an independent network of transmission lines in the early 1960's, today it is connected to Central and West Java Provinces through a network of 150 kV primary transmission lines.

The development of hydroelectric power stations is performed as one of the sectors of multipurpose projects. The economic assessment at the time of planning was that the economic internal rate of return would be higher than 15%. The trends in generated energy of East Java were, as shown in Appendix 1, only 200,000,000 kWh in 1960 soaring to 9,660,000,000 kWh in 1993, with an annual growth rate of 12.4%. The Karangkates Power Station has well-equipped facilities as a station intended for peak operation should have. It is the only large-scale and peak power station in the Brantas Basin.

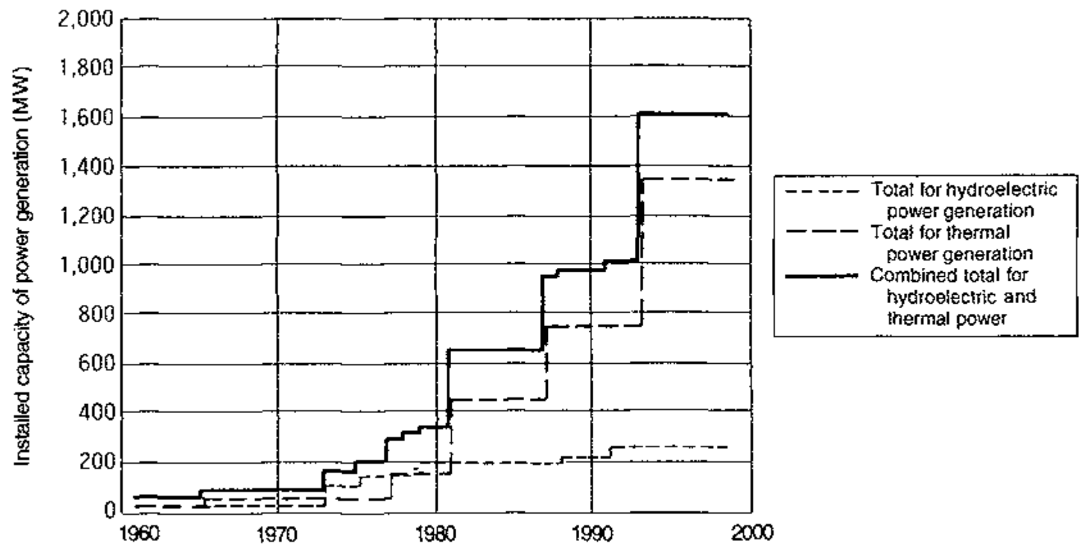


Fig. 3-4 Installed capacity of power generation in Brantas Basin

The total installed capacity of electricity of East Java was just 52 MW in 1960 (of which 31 MW was hydroelectric). This translated into 2.4 W per capita. It made a jump in 1993 to 3,632 MW or 108 W per capita. In terms of generated energy, this was an increase from 9.4 kWh annually per person in 1960 to 289 kWh in 1993.

The electrification rate of Brantas Basin villages was below 10% in the 1960's whereas it reached 85% or higher in 1993. While the effects of this are impossible to be expressed numerically, there is no doubt that such progress has remarkably enhanced the local living standards. Even so, the amount of power consumption in the basin is far less than that of advanced countries.

(5) Volcanic disaster prevention

Mt. Kelud is like a bomb buried in the middle of the Brantas Basin, with an average of one eruption occurring every 15 years. They say that a single eruption yields 100,000,000-200,000,000 m^3 of ejecta, which does a great deal of damage to the lives and assets of the local people. To deal with this, long term measures have been taken for volcanic disaster prevention.

The eruption damage falls broadly into two steps. First, an eruption causes the water that has collected in the crater's lake to run down rivers mixed with ejecta, and the resultant mud flow hits farm fields and houses, causing direct damage (primary damage). Secondly, volcanic ashes accumulate on mountainsides and are then washed down by rainfall. This causes a rise in the riverbeds of the lower regions over time, eventually causing floods (secondary damage). With these two separate forms of damage in mind, the volcanic disaster prevention work was planned concerning the following two items:

1) Construction of a diversion tunnel to reduce the amount of water in Mt. Kelud's crater lake
2) Construction of sand pockets to check erupted earth

Reportedly the lake had 40,000,000 m^3 and 20,000,000 m^3 of water at the time of the 1919 and 1966 eruptions, respectively. Following the vast primary damage, ejecta flowed into the main stream of the Brantas River, raising the riverbeds as much as 1-2 m in places, which consequently caused floods in the Brantas main stream and the Porong. The years of 1951 and 1990 saw less primary damage since the lake was being drained through a diversion tunnel before the eruptions, reducing the water to reportedly 1,800,000 m^3 and 2,500,000 m^3, respectively. The 1990 eruption occurred after sand pockets and sabo dams had been completed at the foot of Mt. Kelud. This successfully checked the flow of ejecta into the main stream of Brantas with only a slight rise in riverbeds.

Now that economic activities have become accelerated in and around Surabaya City, the opportunity to dredge the Brantas main stream for riverbed materials, such as aggregate, used in construction work is increasing. This has lowered the riverbed, which may be favorable from the viewpoint of flood control. On the other hand, it has produced the adverse effects of making irrigation water intake difficult and has scoured the river bank foundation as well. To cope with these problems measures have been taken, such as the ban on dredging riverbed materials and encouraging dredging from the sand pockets.

Thus the Brantas Basin needs continued volcanic disaster prevention work semi-permanently until volcanic activities cease. There is a need to build sand pockets and keep the water level of the crater lake low as prevention measures against the next possible eruption. Such projects are still under way.

(6) Water supply to Surabaya urban area

The mission of the Brantas River is to meet the growing demand for water supply to the Surabaya urban area resulting from industrialization and increased population. Figure 3-5 indicates the trends in population for Indonesia, Java, East Java, Brantas Basin, and the cities of Jakarta and Surabaya.

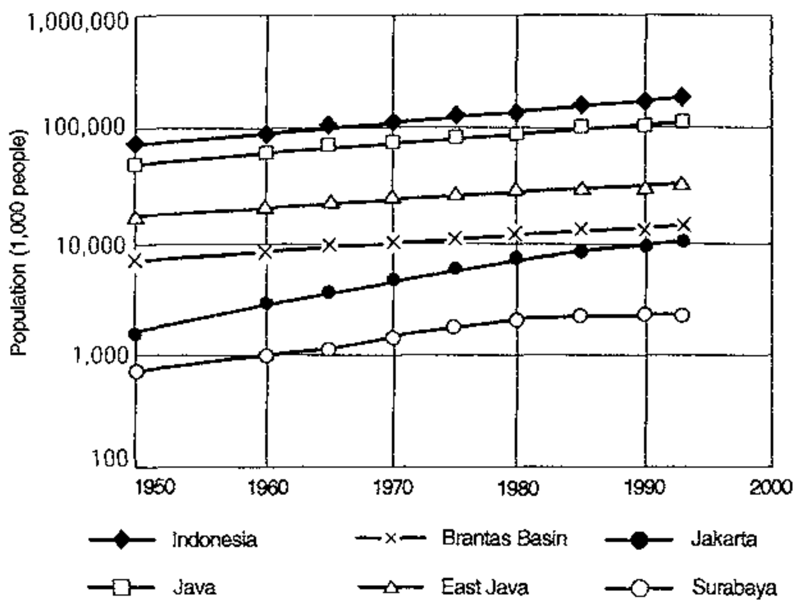


Fig. 3-5 Population of Indonesia

The total population of Indonesia increased at an average rate of 2.1% during the 43 years from 1950 to 1993. Compared with this, Java and East Java showed a lesser rate of increase, 1.88% and 1.47% respectively. This is supposedly due to the Indonesian government's immigration policy and efforts to develop external territories other than Java Island. The increased rate of population for the Brantas Basin was much lower at 1.51% during the same period and has stayed approximately 1.0% for the past decade. Surabaya City however has increased its population at an average rate of 2.71% annually.

The population density as of 1993, for Indonesia was 100.5/km^2 while Java was 864.9/km^2 and the Brantas Basin, very densely populated, was 1,141.9/km^2. No considerable rise is expected in agricultural production for the entire basin area and it can be said that there is no room for population increase in the area. On the other hand, industrialization is still rapidly growing in Surabaya City and its surrounding area with a corresponding increase in population. Because of this situation, the demand for water supply is on a sharp upswing. Accordingly, the water resources development of the Brantas River Basin has been conducted to meet this demand.

With the population increasing and industrialization progressing, river pollution has become noticeable especially in Surabaya River and its branches (Mas River and Wonokromo Channel) and the need has arisen for river maintenance flow for Surabaya River. Currently environment maintenance flow is discharged from the Brantas into the Surabaya at 10 m^3/sec. A 1980 survey found that the diffusion rate of water service was 50.6% for the urban area and little more than 3.3% in provincial areas. No data is available for the diffusion rate as of 1993, however there is a plan to improve it to 90% and 45% respectively by the year 2000.

In 1982, Brantas Basin had the worst drought in Indonesian history. At this time muddy water reportedly came out of taps for a while in houses, hotels, public facilities, and other buildings in Surabaya City. To cope with this situation an extra discharge of water was released, at the risk of temporarily suspending hydroelectric power generation, from the Karangkates Dam. It was fortunate that the situation was brought under control without the need for power generation suspension. This large-scale dam is thus making a large contribution to the maintenance of economic activities and people's lives in the Brantas Basin.

The Wonorejo Dam is now under construction for the purpose of supplying water to Surabaya district. The Indonesian government is planning the development of Madura Island, expecting to supply water from Brantas, Solo, and surrounding groundwater. Further water resources development will be needed.

2. Local Economy and Contribution to National Policy

The Indonesian Government has three basic policies concerning development they are: 1) development of human resources, 2) enhancement of national life, and 3) correction of economic disparity and eradication of poverty. It can be said that the Brantas River Basin Development was carried out in accordance with these policies. This section deals with the specific characteristics that made it so.

(1) Development of human resources

The Nejama Diversion Tunnel Project, the first project of the Brantas River Basin Development, was commenced under the jurisdiction of the Irrigation Service of the Ministry of Public Works. Its appropriate government office was the Surabaya municipal Irrigation Service. Dams of Karangkates and Selorejo were initially put under the control of The State Electric Power Corporation (PLN)

It was, however, suggested that the Brantas Project, being a multipurpose project, would be difficult to control within the framework of a single project. Therefore, the Brantas River Basin Development Executing Office (the Brantas Office) was created in 1965 as a body under the direct supervision of the Ministry of Public Works, with Prof. Ir. Suryono appointed as the first General Manager. The Office was vested two years later in 1967 with authority broadly covering the office operations and the project execution including hiring of personnel and laborers, the decision of their treatment, and the budget administration. The Brantas Project has been pursued since then under the "one management" system established at that time.

The trends in the number of office personnel are as shown in Table 3-5 (excluding general laborers).

Table 3-5 Number of Brantas Office personnel

Year	Clerical	Technical	Total	College graduates
1967	30	1,570	1,600	
1970	74	4,027	4,101	39
1975	367	6,928	7,295	49
1980	346	6,154	6,500	74
1985	249	2,751	3,000	55
1990	227	1,573	1,800	65
1995	140	908	1,048	73

The Brantas Project was in its heyday in the 1970's, when government-run projects were performed with a large number of employees of up to about 7,300. Of them, approximately 7,000 were technical personnel. Even taking the numbers in the table literally, the difference between the maximum number of personnel and the minimum can translate into the number of technical personnel who were transferred to other development projects, although the executive engineers of government offices may have shifted to other roles such as contractors or consultants. At present the government budget for development is about Rp40 trillion. Assuming that the scale of one project is Rp10 billion, then 400 projects can be under way simultaneously. It is estimated that these projects need a total of some 20,000 management personnel, as one project requires not less than 50. The current number of engineers in Indonesia is estimated at some 30,000, in a society with a shortage of college graduates. Of these engineers, 7,000 are from the Brantas Project, which accounts for over 20% of the national total of engineers . From this information, it follows that the Brantas Project has fostered a great number of engineers.

Many of these "Brantas-men" were graduates of the Engineering Department of Brawijaya University in Malang City. The Brantas Office is located in the same city. Although the department has more than 500 students (it is basically a four-year university), only some ten students are able to graduate annually. It is said that Indonesian universities are easy to enter but difficult to graduate from. The low income level of the students' families, however, seems to be one of the deciding factors for the high dropout rate. The number of Indonesian educated engineers should be increased in the future.

The Brantas Office was divided into the following three organizations in 1985: 1) the existing consulting company, P.T. Indra Karya, 2) the newly established contracting company, P.T. Brantas Abipraya, and 3) the Brantas Office.

Later a Public Water Service Corporation (Perum Jasa Tirta), mainly in charge of post-completion maintenance and operation of projects, was founded in 1990, to which some of the Brantas Office personnel were transferred. The number of personnel per office is listed in Table 3-6 (1993 data).

Table 3-6 Number of personnel in each organization (1985 data)

Organization	Number of personnel
Brantas Office	1048
Jasa Tirta	439
Brantas Abipraya	519
Indra Karya	500 (estimated)
Others	494 (estimated)
Total	3000

Jasa Tirta had 435 personnel and Brantas Abipraya 474, as of 1995. Table 3-7 shows their breakdown.

Figure 3-6 shows the number of foreign consultants who joined the Brantas River Basin Development Project. This data includes only those who were engaged in water resources development, not urban related development. Guidance engineers for construction work are also included.

Nearly 50 consultants from abroad were included in the early stages of the project, but now the number has reduced to four or five. Although the vast difference in scale between major projects prevents simple comparison, the Karangkates Dam Project executed from 1962-73 had a total of 318 foreign consultants and construction guidance engineers, an average annual number of approximately 32. The Wlingi Dam from 1972-77 had fewer employees, 44 in total, or 4.4 people per year. This reduction in personnel means that local consultants, now having acquired considerable technical skills, have replaced foreign consultants. Today it has reached the level where local people are able to deal with at least the management work of design and construction under a foreign supervisor.

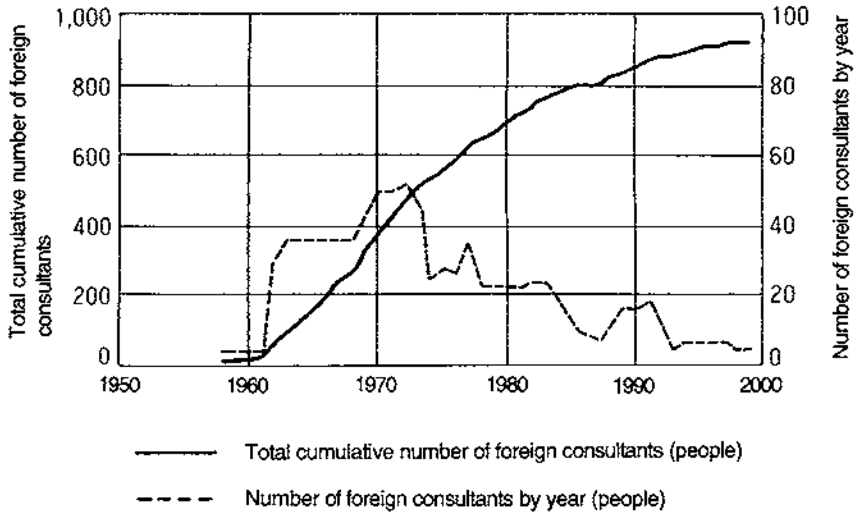


Fig. 3-6 Number of foreign consultants

Table 3-7 Breakdown of office personnel

	1990	1993	1995
Jasa Tirta	482	439	435
(college graduates)	(101)	(104)	(103)
Clerical	414	376	372
Technical	68	65	63
Brantas Abipraya	423	519	474
(college graduates)	—	—	(182)

(2) Improved standard of living for local citizens

(a) Regional GDP

An aim of the Brantas River Basin Development Project was to develop basic social infrastructure, which in turn accelerated urban development and industrialization, promoted private investment, and raised the GDP. In these ways the Project contributed considerably to the improvement of economic standards for the entire Brantas Basin. In the 1960's the Indonesian economy was largely dependent on oil production. Although after the oil crises and the drop in oil prices, the government began to pursue industrialization to establish a non-oil dependent economy. Figure 3-7 shows regional GDPs (non oil) from 1970 through 1993.

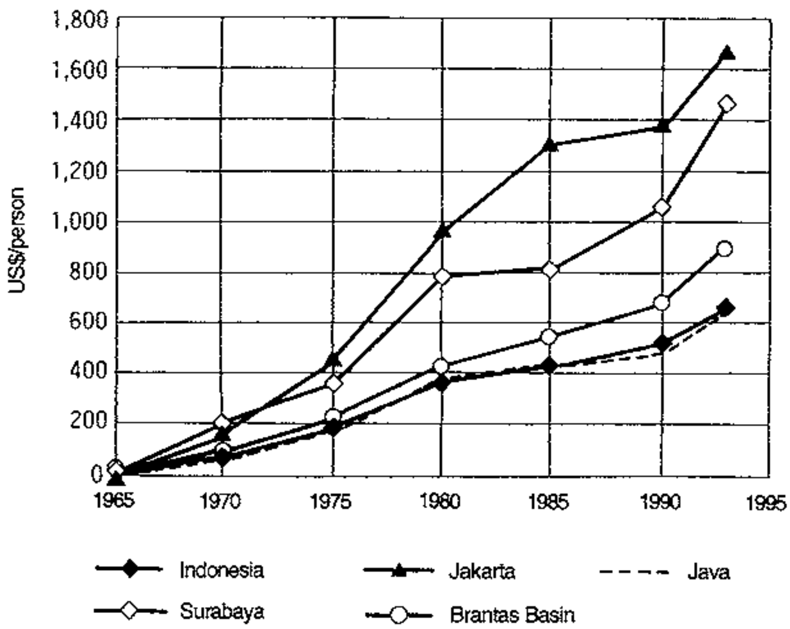


Fig. 3-7 Per capita GDP of Indonesia (non-oil)

The Indonesian GDP for 1993 was US$674 per capita, with that for Java coming near the national average. In comparison, the GDP for the Brantas Basin was $884, well above the national average. Recent years have seen a sharp rise in GDP for urban areas such as Jakarta and Surabaya. For Surabaya, whose industrial sector has been increasing since 1985, the per capita GDP went up to US$1,464 in 1993, coming close to that of Jakarta. It is believed that the development of water resources, which in turn assisted the development of basic infrastructure, has made possible such increases in the GDP.

(b) Inflation and the creation of employment opportunities

Figure 3-8 shows the fluctuations in the exchange rate of the Indonesian rupiah, GDP deflators, and the rate of price increases.

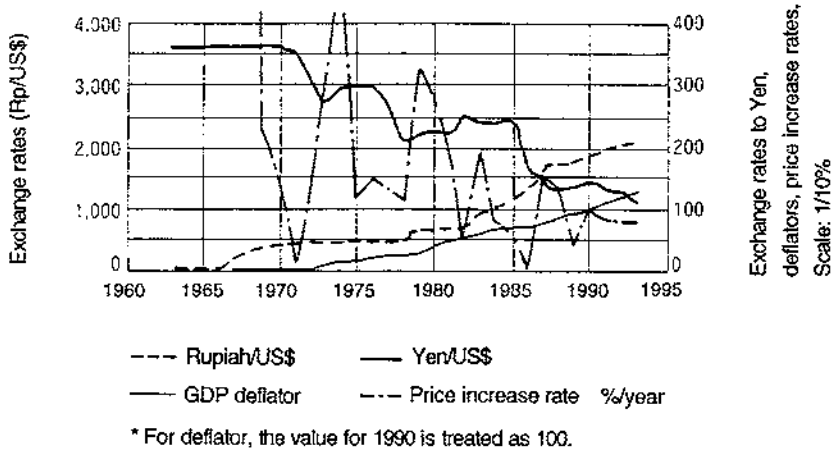


Fig. 3-8 Exchange rates and GDP deflators of Indonesia

Indonesia suffered from heavy inflation at an annual tenfold rate during the period before and after the 1965 coup d'etat. The newly established Suharto administration implemented economic rehabilitation plans that lead to the halt of inflation in 1968. This was followed by a period of constant economic growth. Although some of the subsequent years saw 10% or higher inflation until 1990, the price increase control policy has recently been keeping it to 10% or lower. However, any acceleration of economic activities tends to quickly spark fears of inflation as the nation's gross production scale is low compared to that of advanced countries, and also there is still the possibility for inflation near 10% to occur.

In the 1960's when the Brantas Project was started, a large portion of the local residents did not wear shoes and many did not wear underwear. Of course, in subsequent years, this situation has improved, and since the 1970's is seldom seen.

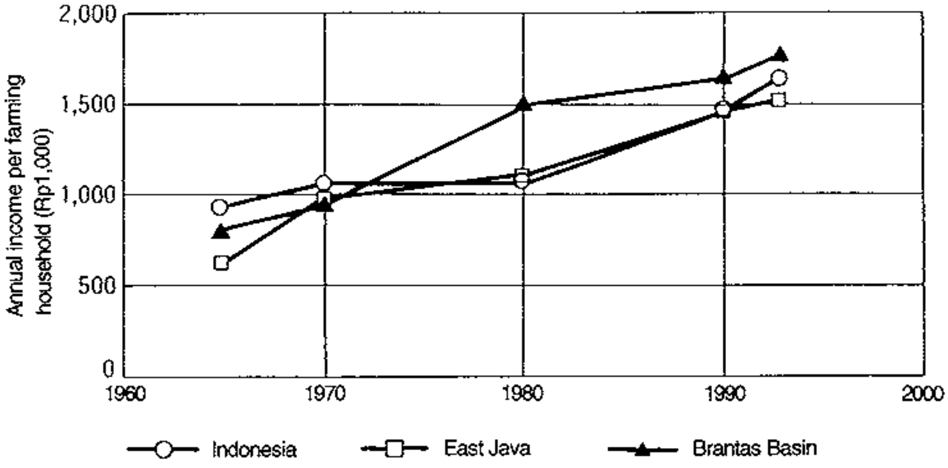
The Brantas Project hired more than 20,000 workers in the 1970's, contributing to the creation of employment opportunities. It is believed that the local residents benefited from this and that it helped create stability in their lives.

Local residents gathering to watch at a construction site.

(c) Household income

The average annual incomes per farming household are shown in Fig. 3-9 for Indonesia, East Java, and the Brantas River Basin.

In 1993 the average annual income per farming household was Rp1,633,000 for Indonesia, Rp1,518,000 for East Java, and approximately Rp1,762,000 for the Brantas Basin, exceeding the national average. The 1970's, especially, saw a low annual increase rate for Indonesia and East Java in the range of 0.1 and 1.0%, whereas Brantas Basin saw a remarkable growth at 4.5%. Although no accurate data for individual annual income of residents is available for the Brantas Basin, the past decade in East Java was marked by a 14.1% increase from Rp0.36 million in 1983 up to Rp1.35 million in 1993. In case of the Brantas River Basin, development projects including the dams of Karangkates and Selorejo, were completed in the 1970's, contributing largely to this growth.



Unit: Rp1,000

	1965	1970	1980	1990	1993
Indonesia	917	1,053	1,064	1,476	1,633
East Java	620	984	1,090	1,454	1,518
Brantas Basin	814	966	1,499	1,653	1,762

(1994 price)

Fig. 3-9 Average annual income per farming household

(3) Correction of economic disparity and eradication of poverty

The second long-term development plan is aimed at balanced development of the entire nation with a focus on future regional development of the eastern part of Indonesia. Also an important issue to be addressed is the economic disparity emerging and existing in smaller communities. If a development project is judged too uneconomical to be executed, then alternative measures should be proposed as part of government policies such as industrial development of local cities, education of local residents, and transfer of local people. The World Bank states that: "The 23 countries of East Asia achieved growth at a faster pace than other countries during the years between 1965 and 1990. This was due to the seemingly miraculous development of Japan, Hong Kong, South Korea, Singapore, Taiwan, Indonesia, Malaysia, and Thailand." This evaluation was made using income disparity and poverty levels as criteria. The ratio of 20% of the low income bracket to that of the high income is approximately 4.3 for Indonesia, which ranks low among other developing countries. The World Bank thus has a high opinion of Indonesia's economic development.

The third master plan for Brantas Basin's development has focused on the balanced development of that area. Development projects executed to date have focussed on the efficiency and urgency of economic development, at that point in time, based on the review of the master plan once every ten years. Many local people benefited from the Brantas Project that commenced in 1958 while at the same time it was impossible to achieve perfectly balanced development, accordingly producing a disparity in development level and living standards of the residents within the basin area. Once development work has started for any river basin, well-balanced and sustainable development within the basin will inevitably be urged from the viewpoint of stabilizing people's livelihood.

One of the irrigation canals which helped improve livelihood of residents

In the Brantas Basin, whose key industry is agriculture, mainly the development of agriculture and irrigation has been pursued. Although most of the economically practical irrigation development projects have already been carried out, the regions behind in development are, among others, those of Ngrowo, Widas basin, the upper regions of Lesti, and surrounding areas. The third master plan has recommended the formulation of development plans for these areas because development is indispensable for creating stability in the lives of local residents. At present the Wonorejo Dam is under construction at the Ngrowo River basin, which is included in the plans. For Widas River, flood control and irrigation works are in progress, and the Brantas Office has begun to embark on the Lesti River basin development.

3. Japan's Assistance

The Brantas River Basin Development Project is highly valued by the Indonesian government as its first ever successful development project for the whole basin and by the Japanese government as a successful aid project as well. It is mainly because the Indonesian government provided management and responded to the project appropriately. In addition to this, the Japanese government's approach to the project should also be noted, which is characterized by the following four points: the large scale of aid value, the consistent involvement from the master plan through the implementation, the continuity of assistance, and the devotion to technology transfer. These points will be examined in this section.

(1) Investment on the Brantas River Basin Development

Financing for the Brantas Project was largely provided by the Japanese government, while assistance was also provided by the Asian Development Bank, the World Bank, and many bilateral funds.

As described earlier, the Project began with the construction of a Nejama Diversion Tunnel. Japan's war reparations to Indonesia were allocated to the Project at its execution stage; these were later followed by Japan's economic cooperation assistance. The funds invested on the Project up to now are as shown in Fig. 3-10 (for water resources development projects only).

Investment in the Project (except for urban-related development projects) has amounted to approximately ¥216.9 billion including local funding as of 1996. Of this, foreign currency is equivalent to ¥103.7 billion, and Japan's grants and loans (including the reparations offered at the early phase of the development) account for approximately 73%. Further, it is estimated that a sum almost equal to the Brantas Project funding was invested in the urban related development of Surabaya (see Appendix 1). With no data on private investment available, it is supposed that investment became accelerated as the industrialization progressed. The investments made up to 1996 on the Brantas Project are less than approximately US$250 per resident in terms of the current price value. This means, though unable to be expressed exactly in terms of numeric values, as it were, that an investment of as little as US$250 provided the foundation for acceleration of the economic activities of the entire basin, which lead to the development of basic infrastructure, resulting in the current growth. The World Bank's analysis of the relationship between "infra stock" (cumulative investment value) and GDP concludes that the efficiency of investment on infrastructure in Indonesia ranks higher. Japan's assistance partly contributed to this.

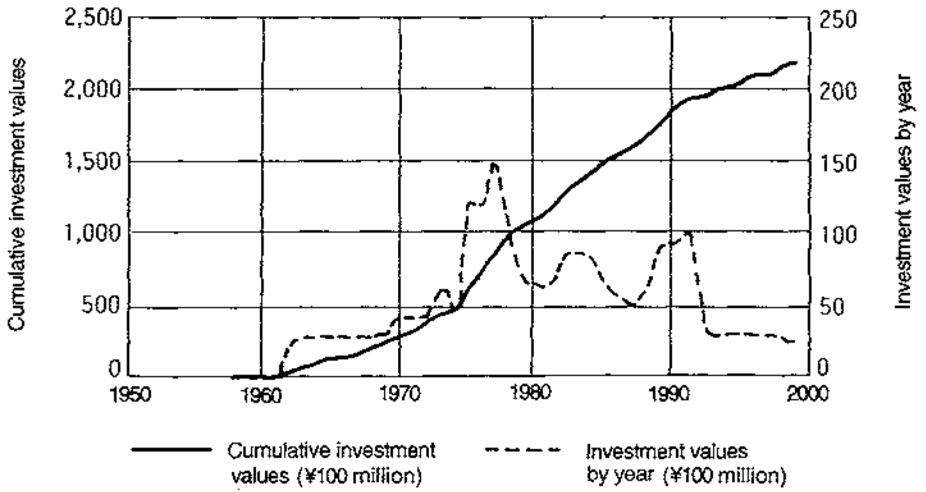


Fig. 3-10 Investment values for Brantas River Basin Development (water resources development)

(2) Consistent involvement from master plan through implementation

The first master plan in 1962 worked out the basic concept for water resources development of the entire Brantas Basin. The master plan was reviewed once every decade to develop the subsequent, or second and third, plans with the basic concept remaining unchanged. The projects proposed in the master plan were subjected to selection for implementation in order of precedence considering urgency, economic effects of the development, environmental impacts, etc., in addition to the changing situation of the basin. The basin development began with the construction of basic infrastructure, that is, flood control work and water resources development, and then, based on such foundations, proceeded to irrigation, agricultural, and water supply work. Based on all of these, it finally advanced to urban and industrial development. The results of the master plan were contained in the following plan. Thus the Brantas Project found itself in an ideal cycle.

(3) Continuity of assistance

The Japanese government provided assistance continuously from one project to the next. This approach made it easy for the recipient country to stably secure development resources (personnel, materials, equipment, and a management system), making for more efficient development. The practice was that engineers and other personnel came aboard one project and became familiar with the details and then engaged in the operation and maintenance of the completed project.

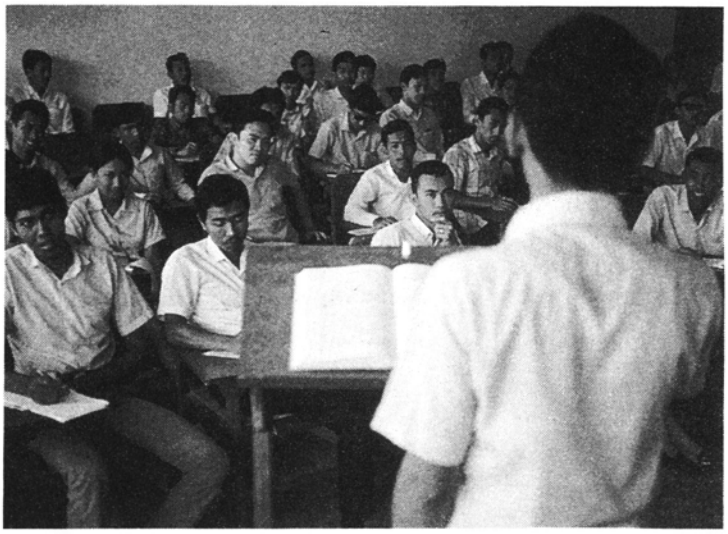
The Project experienced a shortage of funds, or a shortage of local currency, due to heavy inflation in its early stages. The government responded flexibly to this situation by executing multiple projects simultaneously. The local currency distribution policy that gives priority to foreign aid projects was also helpful in efficiently coping with such issues as local currency shortage and drop in the currency value.

(4) Devotion to technology transfer

Effective technology transfer marked the Brantas Project. All the technical materials were provided to local engineers and the project reports and result products were all published, unlike the case of Western countries' assistance. Additionally in recent years, lectures, seminars, and forums were provided for local engineers aiming at more effective technology transfer.

The Jatiluhur Dam was constructed in West Java at almost the same time as the Karangkates Dam. A French consultant designed the dam based on a novel idea (whether it is good or not is another matter), however design drawings or hydraulic experiment reports were not left behind. It can be said that the construction of the dam provided almost no technology transfer.

As mentioned earlier, time has seen an increase in Indonesian engineers and a decrease in Japanese engineers, which proves the success of the technology transfer offered by Japan in the Brantas Project.



A class for personnel who work at the dam

4. Consulting Services

The Brantas River Basin Development Project is the only case in which a single consultant comprehensively and continuously joined the development project for a river basin. The Nejama Diversion Tunnel Project that started in 1958, and the formulation of the first master plan in 1962 provided valuable experiences in the respect that a consultant could take the initiative in carrying them out. The heyday of the Brantas Project in the 1970's had five to six projects under way simultaneously. A very good relationship was established with the Brantas Office, during the 1950's to 1960's through interchanges of personnel, helping to realize efficient implementation of the Project. The consulting services for the Project were roughly divided into the following categories:

1) Brantas Office operational advice
2) New project development and promotion
3) Survey, planning, design, and construction management for projects
4) Post-completion maintenance and operational advice

(1) Brantas Office operational advice

At the early stages of the development, the Consultant went so far as to give advice on work not directly related to the Project because the operation system of the Brantas Office had not yet been established. The advice included matters of the structure, system and rules related to the office operation, including personnel and fund planning.

Working hours of the personnel were even altered to construct a project-oriented system. In those days, the normal working hours for an Indonesian government office were from 07:00 to 14:00 without a lunch break. However, heavy work is expected at any construction site so workers cannot do without meals. The request for a change of duty hours was very difficult for the local personnel to accept, but eventually the hours were modified to start at 08:00 and finish at 17:00, after many hours of discussion with the Brantas Office and Mt. Kelud and Mt. Semeru Volcanic Disaster Prevention Project Office. For very basic routine office workers, instructions were also given in a meticulous manner, including documentation forms, filing system, and the circulation system for memos. These efforts are believed to be a first step in the Brantas Project and to have provided a key to its success. The consultants are greatly indebted to the then General Manager Ir. Suryono for the realization of these efforts. He, a man of character, listened carefully to the advice and comments given by the consultants and responded appropriately.

At the request of the Brantas Office a consulting office was established in 1967 within the Office in Malang for more effective execution of comprehensive consulting services. The consultants were stationed in the office as Project Coordinators. This coordinator method lasted for 26 years, through 1993, when the Middle Region River Improvement Project was completed. The activities of Project Coordinator included the coordination of technical matters, personnel, and funds among the Brantas Office, the Consultants, and the Contractor for many ongoing, new and completed projects. The Project Coordinator sometimes acted as adviser to the General Manager of the Brantas Office in negotiations with third parties and other consultants. It can be evaluated that part of this task was also helping in negotiations of the Brantas Office with the central government.

(2) New project development and promotion

The Brantas River Basin Development was through a master plan oriented approach. Before anything else the Consultant concentrated on the realization of all the projects contained in the master plan rather than handling the Brantas Project as an independent project. The first master plan was developed at the completion of the Nejama Diversion Tunnel Project. Then Japan's reparations were allotted to the Brantas Project, when the construction of Karangkates and Selorejo Dams began.

From Indonesia's economic situation in those days, it was judged that the Brantas Project would be difficult to complete unless it was continuously executed, and therefore the Consultant undertook activities to promote new projects in cooperation with the Brantas Project, in consideration of provision of funds. The request to the Japanese government for review of the master plan once every decade was a joint strategy of the Brantas Office and the Consultant. Giving consideration to the situation of the Basin, the Project was pushed forward while continuously checking the needs of the Indonesian government and local people. The Brantas Project has been under way, without break up to present, since the 1958 commencement of the Nejama drainage project as shown in Appendix 1.

(3) Execution of project

The Brantas River Basin Development Project was characterized by its execution approach: it adopted the Contractor method at first, shifted to the government force account system, and lastly returned to the Contractor method. This was done at the request of the Indonesian government which had a strong wish for technology transfer, especially the General Manager of the Brantas Project Ir. Suryono. Among others in force account system, Japanese firms sent their construction guidance engineers and technicians to the site to teach the local people how to operate and maintain construction equipment such as bulldozers and dump trucks, how to plan construction work, procure materials and equipment, and secure workers. Thus the Project progressed in a unique and efficient system of technology transfer. We heard that local technicians who acquired skills under this system were eagerly sought after for subsequent projects.

Japanese consultants conducted surveys, hydrological measurements, geological surveys (boring), etc., at the early stages of the Project before the local engineers of the Brantas Office had come to manage them independently. This was also true of design and construction management. At the beginning, Japanese consultants did the calculations, drawings, site inspections, and the management of work process, quality, and cost, now these duties are mostly handled by engineers of the Brantas Office and local consultants under the assistance of Japanese consultants.

(4) Post-completion maintenance and operational advice

Japanese Consultant gave advice on the maintenance and operation of completed projects. Instructions were given in a specific manner on how to perform them using maintenance manuals that were prepared by the Consultant for each project. Guidance was also given on-site including periodic inspection of completed structures, continuous measurement of the sediment in reservoirs, measurement of dams behavior, and inspection for water seepage.

Civil works will involve troubles, and in the case of the Brantas Project, of special note was the water seepage of Selorejo and Wlingi Dams after completion. For the Selorejo, various measures were taken including those of water seepage prevention, and over the ten years after the measures were taken, the problem has not recurred. The Wlingi Dam, whose foundation is composed of limestone, has incurred criticism and heated arguments with specialists from a third party country over the amount of seepage. Eventually solutions were found by taking seepage measurements and carrying out seepage prevention work. Prompt and appropriate actions were taken against both these problems, probably because Japanese consultants were stationed in the Brantas Office and Project Office as these projects were being carried out. After experiencing these kinds of events, the current Brantas Office engineers have great confidence in their own abilities.

It is not an exaggeration to say that what Indonesia benefited the most from the Brantas Project is the technology transfer through the various consulting services described above.

The Brantas Office branched off to a Consulting Company and a Contracting Company in 1985, and a State Water Service Corporation in 1991, as explained earlier. The establishment of these bodies, of course, resulted from the Indonesian government's own efforts, which may also be viewed in the way that our long-term consulting activities bore fruit for both technical and clerical operations. We did not start on the Brantas Project with a perfect outlook for the future, however thinking in hindsight, technology transfer was achieved very systematically. It ranged from survey, planning, and design to single-handed execution of construction work, construction management, post-completion maintenance and operation, operation of the Brantas Office and accounting procedures, and partial guidance on running of the Brantas Office. It can be said that such systematic technology transfer provided foundations for the development of the three organizations above.