

Chapter 1 The Brantas River Basin

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Chapter 1

The Brantas River Basin



The mouth of the Porong River is advancing out to sea an average of 150 m yearly due to sand sedimentation. The coast around its mouth is a rich fishing area including shrimp, crab, milkfish and various other forms of marine life. (1972)

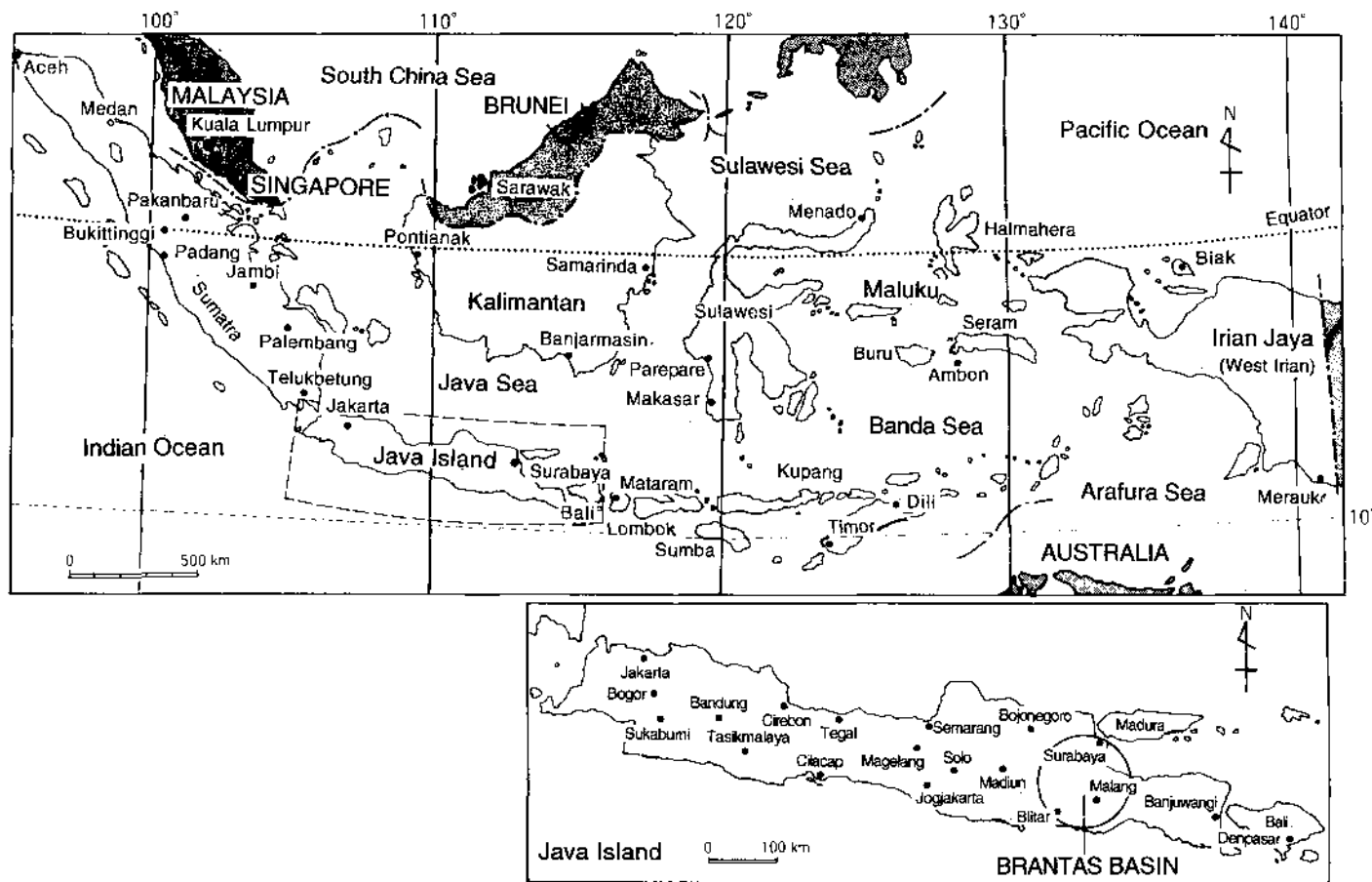


Figure 1-1 Republic of Indonesia

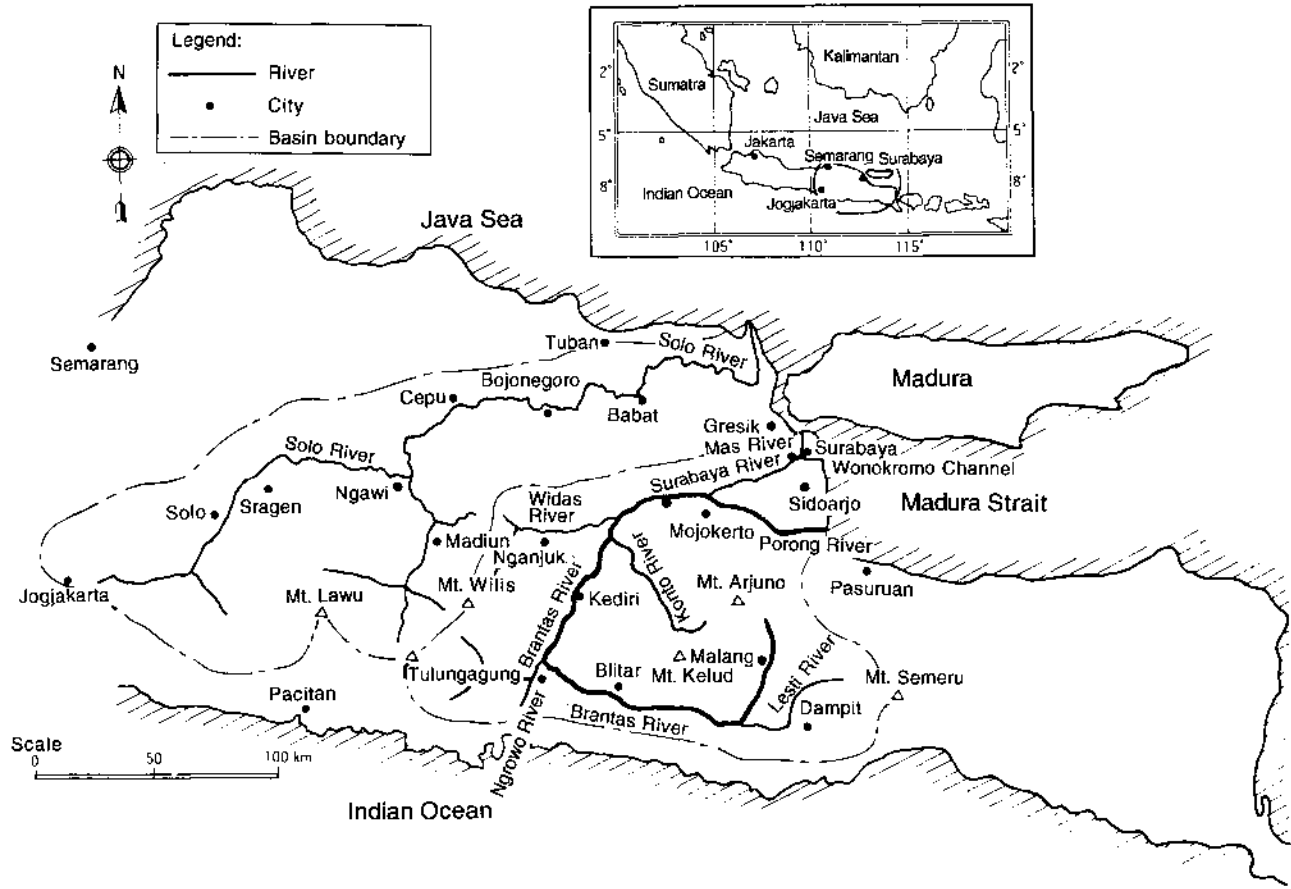


Figure 1-2 Brantas River Basin

1. Geography

(1) Location

The Brantas River is located on the Island of Java, of the Republic of Indonesia (hereafter Indonesia). It runs through the western section of the East Java Province.

Indonesia is the largest archipelago nation in the world consisting of approximately 13,700 islands, large and small, broadly ranging from Sumatra Island in the west to Irian Jaya in the east. Situated on the equator, from Lat. 6° N to 11° S and from Long. 95° to 141° E, the nation stretches 4,500 km east to west and 1,700 km north to south. The total national land area covers 1,920,000 km². The major islands are Sumatra, Java, Bali, Kalimantan, Sulawesi, Timor, and West Irian. Volcanoes are located on most of the larger islands.

Java is located from Lat. 5°52' to 8°47' S and from Long. 105°13' to 114°37' with an area of 132,000 km² including Madura Island (see Fig. 1-1).



Surabaya Port, a center of foreign and domestic trades

Java Island is divided into three provinces: East, Central, and West Java. East Java covers the area to the east of the Solo River, which includes 29 regencies and 8 municipalities (including Surabaya City). The Solo, largest river on the Island, and the Brantas, second largest, both run in East Java and flow into the Java Sea (Madura Strait). The Brantas Basin is situated from Lat. 7°1' to 8°15' S and Long. 110°30' to 112°55' E.

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The basin traverses 9 regencies and 5 municipalities. Starting at the upper regions of the river they are Malang, Blitar, Tulungagung, Kediri, Nganjuk, Jombang, Mojokerto, Sidoarjo, and Surabaya City, including portions of Pasuruan, and Gresik. A general view of the Solo and Brantas river basins is shown in Fig. 1-2.

The Brantas River originates from the active volcanic range of Mt. Kelud (1,731 m). The ejecta from this range causes serious damage to the basin while at the same time contributing to the formation of a fertile alluvial plain. The capital of East Java, Surabaya, is Indonesia's second largest city and is located at the mouth of the Mas River, a terminal branch of the Brantas. With a population of 2,280,000, Surabaya is the biggest commercial and industrial city next to Jakarta. Also, being a port city equipped with modern facilities, it serves as a hub of domestic trade.

(2) Population

The total population of Indonesia in 1960, shortly after initiation of the Brantas River Basin Development Project, was 94,510,000, and as of 1993 it had reached 192,930,000. It doubled during these 33 years with an average annual growth rate of 2.17%; estimated to reach 209,500,000 in the year 2000. The population is, however, remarkably unevenly distributed. The island of Java, while constituting only 6.9% of the national land area, is densely populated with 59% of the total population. Java's population density is as much as 864.8 people per km², whereas the national average is only 100.5 per km². In contrast, Kalimantan has 17.8 per km² and West Irian a scant 4.2 per km², showing an extremely sparse population (see Table 1-1).

Table 1-1 Area and population of Indonesia (1993)

	Area (km ²)	Population	Population density (per km ²)
Kalimantan	539,000	9,616,000	17.8
Sumatra	474,000	41,154,000	86.8
West Irian	422,000	1,778,000	4.2
Sulawesi	189,000	13,546,000	71.7
Java (incl. Madura Island)	132,000	114,147,000	864.8
(West Java)	(48,000)	(48,111,000)	(1,002.3)
(Jakarta City)	(590)	(10,320,000)	(17,491.5)
(Central Java)	(36,000)	(32,656,000)	(907.1)
(East Java)	(48,000)	(33,380,000)	(695.4)
(Brantas Basin)	(11,800)	(13,475,000)	(1,141.9)
(Surabaya City)	(300)	(2,286,000)	(7,620.0)
Others	164,000	12,694,000	77.4
Total	1,920,000	192,935,000	100.5

Source: Statistical Yearbook of Indonesia 1994, issued by Central Bureau of Statistic Jakarta-Indonesia

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Indonesia is a multiracial country consisting of 62,000,000 Javanese making up the largest section, 25,000,000 Sundanese, 19,000,000 Chinese, and a variety of other races.

It is estimated that Java Island, which is densely populated even at an international level, has a population of 114,150,000 (as of 1993), making up approximately 59% of the national total. Of this, 33,380,000 people, 29%, live in East Java. It mainly consists of three races; 66% Javanese, 19% Madurese, and approximately 800,000 Chinese, along with fewer than 10,000 Arabs. They all play a big part in urban and commercial activities.



Agricultural land in mountainous region

The reason for Java's dense population is its abundance of fertile plains. On the northern coast of the Java Sea side there are good ports including Jakarta, Semarang, and Surabaya with a hinterland of rich alluvial plains. The past saw active investment in cash crops such as coffee, pepper, and tea by Dutch colonists who paid attention to this highly productive land of Java. In addition to rice, sugarcane and tobacco were added as rotation crops on plains, making the irrigation facilities for them one of the world's most advanced techniques early in this century. In mountainous areas, tea and coffee plantations were developed on a large scale. The vigorous planting of cash crops, accordingly, pushed rice growing into isolated mountainous areas. By this overview we can see that Java is a highly intensive agricultural island.

With the availability of a plentiful labor force, the Brantas River Basin around Surabaya City has become industrialized and urbanized, thereby creating a sharp increase in economic activities. The population in the basin in 1993 (13,480,000) was more than 1.61 times that

of 1960 (8,370,000), shortly after the Brantas River Basin Development Project started. Surabaya City alone showed a remarkable increase of 2.27 times compared to the 1.84 times for Java Island during the same period. This is good proof of Surabaya's rapid growth as a commercial and industrial city (see Table 1-2).

Table 1-2 Indonesia's Population Trend

Area	Population (1,000 people)					Average annual increase rate (%)			
	1960	1970	1980	1990	1993	61-70	71-80	81-90	91-93
Republic of Indonesia	95,116	116,425	147,490	179,322	192,935	2.04	2.39	1.97	2.47
Java Island	61,884	75,033	91,220	107,574	114,147	1.95	1.97	1.66	2.00
East Java	21,427	24,838	29,169	32,488	33,380	1.49	1.66	1.08	0.91
Brantas Basin	8,367	9,917	12,010	13,073	13,475	1.71	1.93	0.85	0.30
Surabaya City	1,008	1,403	2,028	2,192	2,286	3.00	2.96	2.06	0.42

Source: Statistical Yearbook of Indonesia 1972-1975, issued by Central Bureau of Statistic Jakarta-Indonesia

(3) Topography and geology

Java Island is a part of an archipelago where the Alps and Himalayan orogenic zones meet the southern edge of the Pacific rim volcanic zone, in other words one of the Greater Sunda Islands.

According to the plate tectonics developed from A.L. Wegener's continental drift theory, the area from Indochina to Sulawesi partially consists of the Eurasian plate, including the South China Sea and the Java Sea. Especially the area south of Laos and Vietnam is sometimes called the Indochina plate, at the southeastern edge of which lays the Island of Java.

Parallel to the Island of Java, the Java Trench runs approximately 200 km offshore to its south, where the Australian plate slips under the Indochina plate, the matrix of Java Island. This has pushed Java Island up, forming the world's largest volcanic front, called the Java ridge. There are 35 konides (composite volcanoes) on the island, one third of which have a height of 3,000 m or more. A few of the currently active are Mt. Tangkubanperahu (2,084 m, West Java), Mt. Merapi (2,911 m, Central Java), Mt. Kelud (1,731 m, East Java), Mt. Bromo (2,392 m, East Java), Mt. Semeru (3,676 m, East Java).

The Krakatau volcanic island in the middle of the Sunda Strait is well known for its historic eruption of 1883. It claimed several tens of thousands of lives as well as changing the world climate.

The topography of Java Island is characterized by a mountainous area composed of a Tertiary formation running east and west in two rows with high volcanic ranges in-

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between. Governed by these, major rivers often run in a specific direction such as from east to west, or around the bases of these volcanoes. In the lower regions of the river, sediment is made up of weathered sand and mud due to the tropical climate and newly generated volcanic ashes carried down river. This varied mixture forms the alluvial plains and deltas of the island.

East Java has a broad distribution of sea sand, mudstone and limestone of mainly coral-origin (Miocene Era in Neogene Period) in its mountainous areas. The formation of these mountains was caused by upheavals due to the above-mentioned plate movements. In the central area the contemporary volcanic rocks and pyroclastic rocks (andesites, basalts, tuff breccias, etc.) can be found, which are covered by ejecta from recent eruptions. This is a general description of East Java's geology.

Volcanoes within the Brantas Basin include Mt. Arjuno (3,339 m), Mt. Anjasmoro (2,282 m), Mt. Butak (2,868 m), Mt. Kawi (2,651 m), Mt. Kelud, Mt. Semeru, and others. Mount Semeru is constantly active. In this century, Mount Kelud has erupted on a large scale an average of once every 15 years: 1901, 1919, 1951, 1966, and 1990. The total volume of ejecta is estimated at 100-200 million m³, having a decisive effect on the local society as well as the environment.



Smoke rising from Mt. Kelud

The Brantas River is characterized by clockwise watercourse centering around Mt. Kelud. This is influenced by the process of mountain uplifts and the volcanic ranges as explained above. The Brantas originates from the southeastern side of Mt. Anjasmoro located in the center of its basin. The uppermost stream starts its course eastward, turns

south around the Semeru volcanic zone, and then runs to the west parallel to the Southern Mountains, which stretch east and west blocking the river's course. It changes its course again to the north to avoid older volcanoes and Mt. Wilis, and then runs past the foot of Mt. Wilis and Mt. Kelud to reach Surabaya City. Thus the Brantas travels past all the major volcanic ranges in the basin.

(4) Climate

Near the equator a northeasterly trade wind blows down from the northern hemisphere and a southeasterly trade wind up from the southern hemisphere, with the antitrades blowing in a westerly direction in between. This equatorial westerly wind zone changes its latitude north or south alternately by season. In summer the zone moves up to India, causing rainfall with a westerly wind, and moves down to the south in winter, causing dry weather with an easterly wind. This seasonal reverse in the wind's direction is commonly called the monsoons.

In summer (June to October) the antitrades zone moves up to the north away from South Indonesia (south of West Java), where the dry season prevails. In winter (November to May) the wind zone returns, bringing the rainy season with it. In contrast, North Indonesia (north of West Java) is caught in the westerly wind zone throughout the year with more, or less strong winds and rainfall, depending on the season (see Table 1-3).

The antitrades generate a large volume of rainfall when encountering the mountains due to their high moisture content and comparatively low temperatures. Even in the absence of mountains they sometimes cause thunderstorms, if an ascending current occurs due to heat rising from the land in the daytime. This is well known as a squall, peculiar to tropical zones. With little variation in day-to-day weather, squalls take place around the same time of day, in the afternoon. Although they do occur at other times of the day in areas affected by land and sea winds, the time of occurrence is almost constant in other areas. The annual precipitation of Indonesia is approximately 1,400-2,500 mm, and reaches up to 3,000-4,000 mm in some mountainous areas.

Belonging to the equatorial westerly wind zone, the Brantas River Basin is divided into a rainy season, from November to April, and a dry season, from May to October, due to the influence of tropical seasonal winds. It has an annual average precipitation of 2,000 mm in the basin, 3,000 mm in mountainous areas and 1,500 mm in the plains. A large amount of rainfall can especially be seen on the southern slopes of the Kelud-Arjuno massif, and in contrast little is seen in the plains through which the Widas River runs. During the rainy season the monthly average of rainy days is approximately 25. The dry season has little precipitation, only some seven days per month, and it is common to have

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two consecutive months or longer with no rain. Eighty percent of the annual precipitation occurs during the rainy season.

Table 1-3 Monthly precipitation

Unit: mm

City	Region	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Medan	North Sumatra	142	83	107	132	173	130	132	172	215	268	239	214	2,007
Palembang	South Sumatra	304	261	304	270	170	118	95	109	122	175	265	276	2,469
Jakarta	West Java	298	310	213	142	109	92	64	43	69	114	145	202	1,901
Semarang	Central Java	275	256	207	210	128	82	76	39	70	183	249	261	2,036
Wonogiri	Central Java	363	344	326	198	143	64	46	25	25	86	207	295	2,122
Kediri	East Java	324	380	316	144	117	27	37	21	23	69	140	250	1,848
Surabaya	East Java	293	205	193	159	91	51	16	6	15	60	121	228	1,438
Kupang	Timor	386	347	234	65	30	10	5	2	2	17	83	232	1,413
Manila	Philippines	23	11	17	33	128	255	416	435	349	194	141	69	2,071
Tokyo	Japan	56	66	122	132	153	163	140	163	226	191	104	56	1,572

Source: Statistical Yearbook of Indonesia 1974, issued by Central Bureau of Statistic Jakarta-Indonesia

The average temperature for Malang City in the upper region is 24.1°C; Porong City on the plains in the lower region is 26.6°C; and for Surabaya City which faces the Madura Strait is 27.6°C.

Now let us look at the relationship between climate and civilization. Up to now the Brantas River is the only river in Indonesia where comprehensive development has been successfully carried out yielding remarkable results. There are several reasons for this, including the topographically and geologically favorable conditions, the abundance of water resources, and a good port being established at its mouth. Sukarno, who was President at the beginning of the Brantas River Basin Development Project, was from its basin area.

In addition to these, there must be other reasons why this basin repeatedly saw the rise and fall of many dynasties, providing better conditions for people to live and take part in activities than other regions. There exists some relationship between man's mind, actions, and climate; man's working efficiency is closely related to temperature. His working efficiency is enhanced when any big change is generated in temperature, whether it rises above or falls below that of the previous day. It is also said that wind velocity affects humans; a low wind velocity causes efficiency to drop, while a high velocity produces more neurosis. Only slight variations in weather are seen in the low latitude zone near the equator. Although a westerly wind blows, deviation forces do not exist allowing it to blow

in at a right angle to isobaric lines. This keeps strong low pressure areas from developing; usually resulting in gentle winds.

In contrast, the temperature changes due to seasons (rainy and dry) in the Brantas Basin are obvious. The daily temperature difference is 5-6°C or more between night and day; and it is not unusual that strong winds blow throughout the year. A Japanese study* suggests that if optimum temperature, humidity, and wind conditions in relation to man's activities can be evaluated, a distribution map of working efficiency can be drawn in terms of climatic values. If such a map was created, it would indicate that the Brantas Basin shows a higher efficiency rating than its surrounding, or other areas. Thus one major reason for the success of the Brantas River Basin Development Project is that the basin is an area where people can easily and efficiently take part in activities, from a climatic viewpoint.

(5) Rivers

On a 1:500,000 scale map, you can find about 250 rivers with a basin area of 100 km² or larger, approximately 100 of which flow into the Indian Ocean. Five of these rivers, having the largest basins, all empty into the Java Sea (see Table 1-4). It is believed that Java Island was once connected to the Eurasian Continent. The Java Sea is mostly shallow for a good distance from the shore, where alluvial plains stretched in the past. Perhaps this is why the rivers flowing into the Java Sea generally have a longer and gentler course than those flowing into the Indian Ocean.

The average specific runoff of the Brantas (average runoff per 100 km²) is 3.4 m³/sec at the Karangates Dam on the upper river, and 2.7 m³/sec at Jabon on the lower river. These amounts are about two times those of the world's longest rivers, for example the Mississippi or Mekong. However as compared with that of Japan's rivers, 4.3 m³/sec in 1988, having almost the same average precipitation (see Table 1-5), they are low; the average specific yield at the Karangates Dam is 79% that of Japan's and at Jabon 62%. This seems to be due to a difference in evaporation.

Evaporation of Japan's rivers is 25-30% of rainfall (in upper and middle reach) while that of the Brantas is 40-50%. From the comparison of specific runoff among the Brantas and major rivers of the world and Japan (see Table 1-5), it follows that: Generally the runoff percentages of small and medium scale Indonesian rivers show trends similar to that of rivers in Japan, whereas large rivers such as Solo and Brantas tend to have the same characteristics as those in Asia, relating to high evaporation.

* "Fudo no Kozo" Structure of Climates by Hideo Suzuki

Table 1-4 Major rivers on Java Island

Rivers	Province	Basin area (km ²)	Length (km)	Run-off		
				Average (m ³ /s)	Specific runoff (m ³ /s/100 km ²)	Run-off gauging station
1. Solo	C-E	16,000	540	327	2.7	Bojonegoro (12,970 km ²)
				28	2.2	Wonogiri (1,252 km ²)
2. Brantas	E	11,800	320	259	2.7	Jabon (9,675 km ²)
				69	3.4	Karangates (2,050 km ²)
3. Cimanuk	W	9,650	182	69	3.6	Tomo (1,931 km ²)
4. Citarum	W	5,970	250	103	4.5	Saguling (2,283 km ²)
5. Serang	C	4,830	135	129	2.7	—
6. Serayu*	C	3,740	150	—	—	—
7. Citanduy*	C	3,560	130	78	—	Petaruman (1,163 km ²)
8. Progo*	C	2,480	130	23	6.7	Parakan (679 km ²)
9. Ciujung	W	2,050	110	106	3.4	Kragilan (1,858 km ²)
10. Cimandiri*	W	1,800	70	—	5.7	—

Source: Source: Statistical Yearbook of Indonesia 1976, issued by Central Bureau of Statistic Jakarta-Indonesia

Remarks: 1) W: West Java, C: Central Java, E: East Java
2) Rivers marked by * flow into the Indian Ocean.

Table 1-5 Major rivers of Japan and the world

Rivers	Basin area (km ²)	Length (km)	Runoff		Runoff gauging station
			Average (m ³ /s)	Specific runoff (m ³ /s/100 km ²)	
Brantas	11,800	320	259	2.7	Jabon (9,675 km ²)
			69	3.4	Karangates (2,050 km ²)
Ishikari	14,330	147	122	3.6	Inoh (3,379 km ²)
Shinano	11,900	367	507	5.2	Ojiya (9,719 km ²)
Tone	18,840	322	292	3.4	Kurihashi (8,588 km ²)
Chikugo	2,860	143	113	4.9	Senoshita (2,315 km ²)
Mississippi	3,248,000	630	19,000	0.6	River mouth
Mekong	800,000	4,200	12,000	1.5	River mouth
Ganges	795,000	2,500	12,000	1.5	River mouth
Niger	1,501,000	4,200	12,000	0.8	River mouth

Sources: Handbook (1990) and "Suimongaku" (Hydrology) by Isamu Kayane

Remarks: 1) Runoff for rivers in Japan in 1988 (Handbook of Rivers in Japan 1990)

2. Socioeconomy

(1) Society and culture

Indonesia is administratively divided into 27 provinces and three special districts, with their respective languages, manners and customs. Although Indonesian is the official language, 250 languages are spoken over the entire nation. Reflecting the history of Indonesia, religions range from 88% Islamic, 10% Christianity, and the remaining 2% include Hinduism, Buddhism, and others combined.

Although the Indonesian society is generally Islamic, it also has been influenced by Javanese mysticism as seen in Javanese mythology, by Hinduism and other religions, and by a variety of cultures, languages and traditions.

Wayang, gamelan, and Bali dance are typical examples of traditional Indonesian performing arts. Recently, however, young artists are very active in the creation of modern cultures, especially in the theatrical field.

Many ruins, large and small, are found scattered throughout Indonesia, including in the Brantas Basin. Those famous throughout the world are the Buddhist ruins of Borobudur, in the suburbs of Jogjakarta City, in Central Java and the Hindu ruins on Bali Island.

Indonesia has adopted an educational system of six-years of primary school, three-years of junior high school, and three-years of senior high school followed by 2-3-years of junior college or 4-5-years of university. A compulsory education system was started in 1850 for 7-12 year-old children (primary school). As of 1993, attendance at the primary level exceeded 99%, totaling 26,340,000 pupils. This is said to be the result of improved socioeconomic conditions brought on by the revised policies which promoted education and economic growth after gaining independence.

Of primary school students 7.6% or more go on to universities or academies, totaling 1,990,000 students in 1993. This is 2.5 times more than seven years before in 1986 (800,000 students), thus showing a sharp growth in higher educational studies. There are 44 national universities including University of Indonesia, Technology Institute of Bandung, and Brawijaya University (in Malang City, East Java), and 1,127 private ones. It is estimated that there are approximately 320,000 students in East Java, which is equivalent to approximately 16% of Indonesia's total university students.

Brawijaya University was founded in 1961 as a university of liberal arts. Later the Engineering Faculty was added in 1963, constituting mainly of 5 departments, including Mechanical Dept. (1963) and the Water Resources Engineering Dept. (est. 1976), in line with the Brantas River Basin Development Project, which was well utilized for educational

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field studies. This is the only state university in Indonesia that has a Water Resources Engineering Department.



Remains of Candi



Hydraulic model experiment at Brawijaya University

Approximately 2,000 students attended the university at the time of its foundation in 1961, and as of 1993 the attendance has risen to 14,300 students. Mr. Ir. Suryono, the first general manager of the Brantas River Basin Development Executing Office, was in office as the first dean of the Engineering Faculty until 1983. So that future generations

could benefit from the civil engineering technologies (civil, electrical and mechanical) offered by the river project, the Brantas office dispatched staff from the assistant and project manager levels as instructors. This dispatch system is still in effect, with the number of instructors sent totaling more than 30. These efforts in this area have borne fruit and many civil engineers have been fostered; a few of these graduates are employed every year for the project office. Actually many of their graduation theses deal with the Brantas Project, and the students say that their papers were prepared with the help of Nippon Koei engineers who were stationed in the project office.

(2) Politics and national defense

In August 1945, Indonesian Government was established. As a new republic, the Government was busy organizing its administration. It was known as the old sociopolitical order.

In 1965, a new sociopolitical order in Indonesia was developed and in 1969, the Government launched the first State Policy Guideline.

Indonesia is a constitutional republic based on the 1945 Constitution, with MPR as the highest body of state power. The 1945 Constitution cites that the Gov. of Ind. shall be ruled through three elements: legislative body (the Parliament), executive body (President), and the Supreme Court.

The local government system was defined by the Fundamental Law Concerning Local Administrative Governance issued in 1974 and amended in 1980. The whole nation is categorized into 27 provinces and three special districts (Jakarta City, Aceh, and Jogjakarta City). Their subordinate governments are regencies and municipalities which are divided into towns, villages, etc. The current administrative structure of Indonesia is shown in Table 1-3, which has basically remained unchanged since the 1960's when the Brantas Project was initiated. The Brantas River Basin Development Executing Office is under the direct control of the Ministry of Public Works that is coordinated by the Minister of Economic, Finance, Development Control.

The national armed forces are composed of the army, navy, air force, and the state police, having a combined force of approximately 420,000 people. The president holds supreme command of the national military forces. Directly responsible for the national defense and security are the Minister of National Defense and Security for military administration, and the commanding office of the national forces for military commands. Divided into the Jakarta Police Headquarters and 16 regional police headquarters, the national police have a total force of 142,000 people, which is under control of the Ministry of National Defense and Security as a wing of the national armed forces.

GOVERNMENT OF THE REPUBLIC OF INDONESIA ADMINISTRATION (DEVELOPMENT CABINET VI)

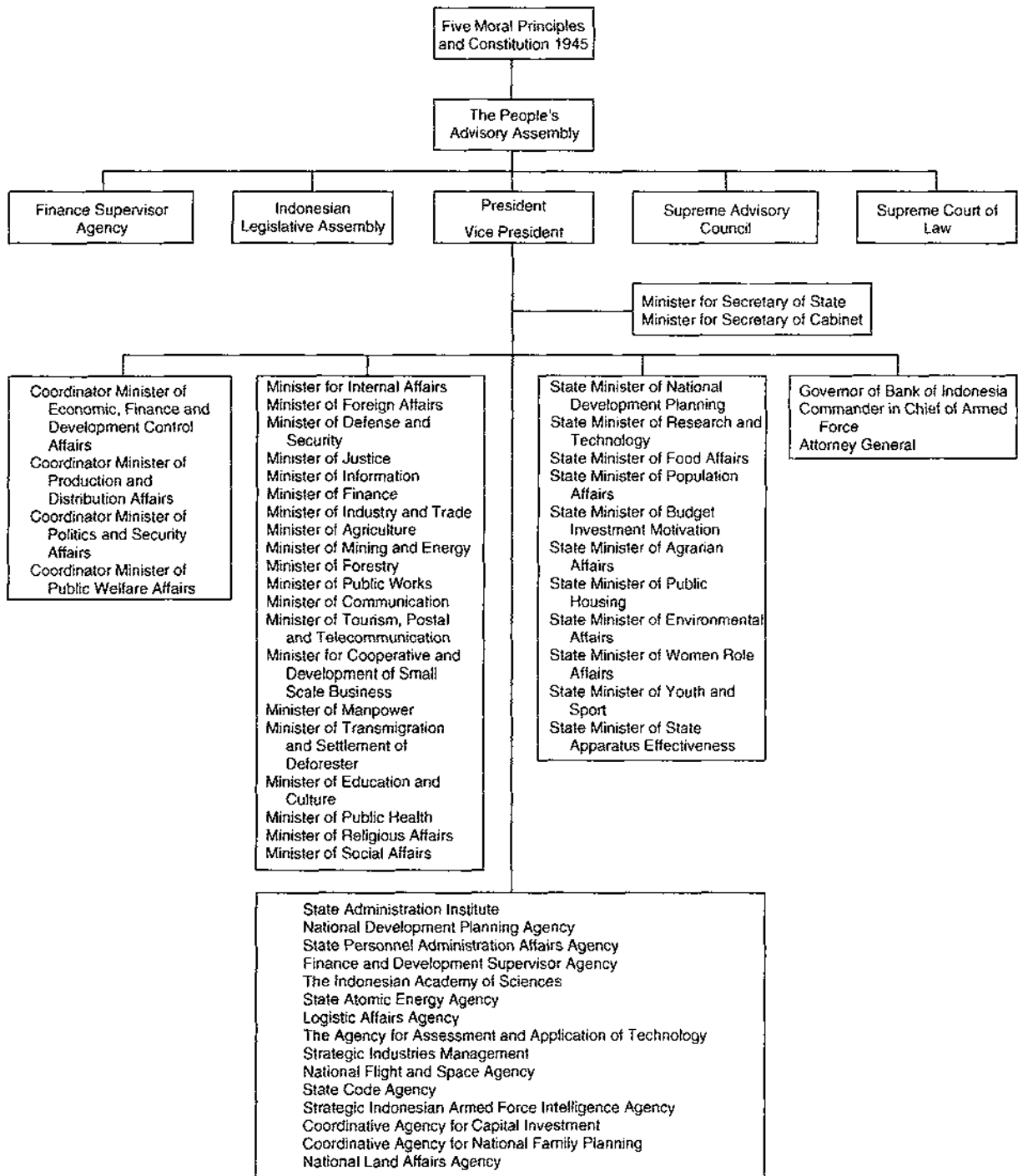


Fig. 1-3 Organization of Indonesian Government (March 31, 1993)

(3) Economy

The old socioeconomic order struggled for raising the economic condition, but it seemed that it was difficult to gain.

In 1965, Indonesia was put in plight with a gross domestic product (GDP) of Rp23.7 billion, which was almost the same as per capital national income 50 years before; an inflation rate of 600%; and a foreign debt balance of about US\$2.3 billion.

In the new socioeconomic order, an economic rehabilitation program to launch the first 25-year long term development plan in 1969, focusing on the establishment of the self-sufficient system of food and the development of infrastructure was laid out. In the meantime, the annual growth rate of real GDP reached 7.7% on average, with successful results including increased rice production, halted inflation, and others. Under the fifth 5-year plan that ended in March 1989, self-sufficiency of rice production was achieved and the export of non-oil and gas products doubled. Stress was placed on the development of industrial sectors to realize a balanced industrial structure. After the economic slump caused by the oil crisis in the early and mid 1980's, the export of non-oil and gas products steadily increased contributing to the economies strong growth, partly on the strength of the International Governmental Group on Indonesia (IGGI) support; council in charge of foreign debt repayment. Based on the growing trend of exports, the economic growth rate is still high with 6.1% for FY1992 and 6.7% for FY1993.

In 1993 GDP was Rp302,017.8 billion (about US\$144.8 billion) and GDP per capita was Rp1,570,000 (about US\$754). Table 1-6 shows the trend of GDP from 1969, when the first 5-year development plan began, through 1993. In terms of non-oil GDP, the GDP in the Brantas River Basin increased 7.82 times during a period of 13 years between 1980 and 1993. During the same period the national increase was only 7.62 times, an amount less than the Brantas River Basin alone. The ratio of the GDP in the Brantas Basin to that of the entire nation was 9.7% in 1980, rising to 10.0% in 1993, and is continuing on an upwards trend. This means that the Brantas Basin (including Surabaya City) plays a major role in the non-oil economy of East Java.

In 1993, the agricultural GDP was Rp55,745 billion (about US\$26.7 billion) and the industrial was Rp67,441 billion (about US\$32.3 billion). The composition ratio of GDP has an influence on the structure of Indonesia's economy (see Table 1-7). In 1970 the share of GDP in the agricultural sector was 44.6%; and industrial was only 7.9%. In 1993 however the former plunged to 18.3% while the latter soared to 22.1%. This reverse of shares was caused by a shift of the principal sector, of the Indonesian economy, from agriculture to industry. The key forces in this shift were the three industrial areas: Jakarta City and the Surabaya urban area on Java Island and Medan City on Sumatra Island.

Table 1-6 Gross domestic product (GDP)

		Unit: Rp1 billion					
		1970	1975	1980	1985	1990	1993
GDP	Entire nation	3,340.0	12,643.0	45,445.7	95,707.0	196,919.2	304,017.8
	Java	1,670.9	6,082.7	20,007.3	51,070.4	106,963.7	160,623.2
	East Java	623.9	1,853.4	5,958.2	14,016.8	29,160.9	39,166.8
	Brantas Basin	330.5	982.3	3,177.0	7,524.3	16,038.2	24,858.4
	Surabaya City	105.2	262.5	1,004.5	1,903.1	4,310.6	6,984.9
Non-oil GDP	Entire nation			32,720.9	73,694.4	159,701.5	249,466.7
	Java			20,632.3	47,179.8	100,860.9	151,177.3
	East Java			5,270.4	13,943.4	28,984.2	38,159.9
	Brantas Basin			3,177.0	7,524.3	16,038.2	24,848.4
	Surabaya City			1,004.5	1,903.1	4,310.6	6,984.9

Source: Statistical Yearbook of Indonesia 1971-94, issued by Central Bureau of Statistic Jakarta-Indonesia

Remarks: Non-oil GDP is available in and after 1980, when the non-oil policy started.

Table 1-7 GDP composition ratio by sector

		Unit: %					
		1970	1975	1980	1985	1990	1993
	Agricultural sector	44.6	34.8	24.8	23.2	21.4	18.3
	Industrial sector	7.9	11.5	11.6	13.6	20.3	22.1
	Others	47.5	53.7	63.6	63.2	58.3	59.6
	Total	100	100	100	100	100	100

Source: Statistical Yearbook of Indonesia 1971-94, issued by Central Bureau of Statistic Jakarta-Indonesia

In East Java, the ratio of industrial GDP to agricultural GDP was a mere 17.7% in 1970, it made a sharp increase to 120.7% in 1993.

The sixth 5-year development plan was initiated in April 1994. It aims at achieving an average growth rate of 6.2% (3.4% for agricultural and 9.4% for industrial) and a per capita national income of over US\$1,000 by the end of this period, March 1999.

(4) Industry

(a) Agriculture

The foundation of Indonesia's infrastructure, agriculture, was the policy to be promoted with highest priority in the first 25-year development plan. In the 1970's the major agricultural product, rice, tended to be in short supply, and as much as 2,000,000 tons were imported yearly from Thailand and other countries. There was a marked yield

increase in the 1980's and self-sufficiency was achieved in 1985 with 39,000,000 tons of rice.

Rice yield in the Brantas Basin in 1965 was 1.107 million tons. It went up to 2.667 million tons in 1993 even though there was only a slight increase in paddy field area (see Table 1-8). A comparison between 1965 and 1993 yields shows that the rate of increase in the Brantas Basin was 2.41 times in contrast to 2.39 times for the entire country. This can be said to be a direct result of advanced intensive agricultural methods, based on the availability of irrigation water in the dry season.

Table 1-8 Trend of major crop yields

Unit: 1,000 tons

Area		Year	1965	1970	1975	1980	1985	1990	1993
Rice	Entire nation		20,178	26,392	29,201	29,774	39,003	45,179	48,181
	East Java		3,302	4,664	5,376	6,277	7,595	8,234	8,628
	Brantas Basin		1,107	1,428	1,970	2,290	2,535	2,426	2,667
Maize	Entire nation		—	2,602	2,903	4,012	4,330	6,734	6,460
	East Java		1,351	1,049	1,289	1,693	1,701	2,578	2,363
	Brantas Basin		—	29	154	399	589	486	580
Cassava	Entire nation		—	10,690	12,546	13,532	14,057	15,830	17,285
	East Java		3,093	3,333	3,938	4,027	3,753	3,711	3,626
	Brantas Basin		—	89	125	1,025	1,140	861	1,211

The rice yield per unit area was 5.67 t/ha on the national average as of 1993, showing a considerable increase from 3.48 t/ha in 1965. The yield for the Brantas Basin was 3.69 t/ha in 1965 and 8.23 t/ha in 1993, well beyond the national averages (see Table 1-9). This was due to improvement of rice varieties, introduction of chemical fertilizers, and an increase in double cropping made possible by secured irrigation water in the dry season.

Table 1-9 Trend of rice yields per hectare

Unit: t/ha

	1965	1970	1980	1990	1993
Entire nation	3.48	3.95	4.22	5.49	5.67
Brantas Basin	3.69	4.55	7.25	7.46	8.23

Source: Statistical Yearbook of Indonesia 1971-94, issued by Central Bureau of Statistic Jakarta-Indonesia

Remarks: The 1960 unit yield of the Brantas Basin was 3.0 t/ha (Master Plan I, 1962).

The area of farming land in Indonesia is 32,010,000 ha; of this, farming land outside of Java Island totals 24,889,000 ha, that accounts for only 13.9% of the total land area outside of Java Island, while 54% of Java Island, 7,121,000 ha, is utilized as farm land. Most of

the land on Java Island has been developed; therefore other islands must be looked to for potential agricultural development (see Table 1-10).

Table 1-10 Area by land use (1993)

Unit: 1,000 ha

Land use	Brantas Basin	East Java	Entire nation		
			Java	Other than Java	Total
Total area of agricultural land	636	2,514	7,121	24,889	32,010
Paddy fields	324	1,175	3,426	5,073	8,499
Fields (farmland, orchard, slash-and-burn land)	293	1,181	3,080	8,395	11,475
Estates (plantation)	19*	158	615	11,472	12,087
Building lot, built-up area	227	581	1,722	3,421	5,143
Forest	294	41	330	8,362	8,692
Lake, breeding pond, etc.	23*	69	284	9,365	9,649
Uncultivated land	0	1,595	3,762	132,688	136,450
Total area	1,180	4,800	13,219	178,725	191,944

Source: Statistical Yearbook of Indonesia 1994, issued by Central Bureau of Statistic Jakarta-Indonesia

Remarks: * 1984 data.

Java Island's paddy fields, 3,426,000 ha, account for 40.3% of the national total. Of these, 34%, 1,175,000 ha are in East Java.



Reaping rice in the Brantas Basin area

CHAPTER 1

There has been almost no increase in agricultural land on Java Island since the 1960's, including East Java. In areas around large cities the trend is moving toward decreasing farming land as a result of industrial complex development.

(b) Electricity

The installed capacity for power generation was 13,600 MW as of 1993. Of these, hydroelectric power generation makes up, 2,179 MW, 16.0% of the total installed capacity for power generation. The total installed capacity in East Java is 3,682 MW; of which 275 MW are hydroelectric. The installed capacity for hydroelectric power generation in the Brantas Basin is 263 MW, which are 12.3% of the total in Indonesia and 97.8% of that in East Java (see Table 1-11).

The electrification ratio in villages reached 54.7% in 1993 at the end of the fifth 5-year development plan. In the sixth plan, the policy "further efforts for power development" was presented with a target value of 79%. The electrification ratio on Java Island was 76.1% as of 1993, exceeding the national average of 54.7% by over 11% (see Table 1-12). The Brantas Basin was among the areas on the island with the highest electrification ratio, being 15% in 1970 and more than 85% in 1993.

As of 1993, generated energy on Java Island reached 37.9 billion kWh annually, 40% of which was for household use. The average increased rate of power consumption was as high as 15.4% annually during the eight years between 1985 and 1993. It is estimated to reach an annual usage of 113.8 billion kWh in the year 2000, or an increase of 2.4 times.

Table 1-11 Trend of installed capacity for power generation

Unit: 1,000 kW

		1960	1970	1980	1990	1993
Entire nation	Thermal	201	336	2,134	7,023	11,421
	Hydroelectric	113	190	371	2,095	2,179
	Total	314	526	2,505	9,118	13,600
East Java	Thermal	21	70	230	938	3,367
	Hydroelectric	31	45	178	239	275
	Total	52	115	408	1,177	3,632
Brantas Basin	Hydroelectric	31	31	193	227	263

Source: PLN statistics (1980-94)

- Remarks: 1) Thermal power includes diesel, gas turbine, and geothermal power.
 2) For the Brantas Basin, there is Gresik Thermal Power station and others in Surabaya City, figures above show only hydroelectric power.
 3) Refer to Appendix 3 for details.

The power consumption pattern of Java Island is characterized by peak usage occurring in the evening between 18:00 and 23:00. The State Electric Corporation (PLN) has presented the basic policy that thermal power should be used for the base load during the

day and hydropower for peak night usage. So, to secure the base load, large-scale, high efficiency thermal power stations with such features as combined cycles have been under construction (Pasuruan Thermal Power Station: construction began in 1992 and it went into operation in 1995). Also for existing hydroelectric power stations in the Brantas Basin, a plan under the PLN policy for capacity increases as peak power stations was proposed in the third master plan in 1985. The construction of large-scale peak power stations is being envisioned for other river basins too.

Table 1-12 Electrification status by island (as of 1993)

island	Number of villages	Village electrification	
		Number of villages electrified	Electrification rate (%)
Sumatra	19,662	9,709	43.2
Java	23,234	16,788	76.1
Sulawesi	4,261	2,272	52.0
Kalimantan	5,655	1,950	30.4
Irian Jaya	2,126	157	12.2
Entire nation	59,736	32,649	54.7

PLN statistics (1994)

Remarks: 1) Village electrification means distribution lines have been laid throughout the entire village.

According to PLN's installation goals, the increase of 20,000 MW (4,500 MW hydropower) in the next ten years, and securing an installed capacity of 35,400 MW by the year 2005 is planned. From the current technological standards and demand scale, it is assumed that these capacity increase plans will involve large-scale thermal power stations. Along with this, hydroelectric power development, including peak power generation, is likely to see further consideration.

For hydroelectric power stations, only Wonorejo Dam (output: 6,500 kW) is under construction in the Brantas Basin as of 1995. The hydropower potential in the basin is estimated to be about 1,000 MW whereas present developed hydropower is only 263 MW, thus the potential for further development still remains. Easy access to any project sites can now be achieved due to the road network developed during basin development. If the plan formulated includes measures for water sources of Surabaya City, there is much room for further development as the conventional hydropower potential to be economically developed is thought to be over 200 MW for that area.

(c) Industry

It was after 1966, when shifting to the Suharto regime, that industrial development substantially began. Efforts were made towards the development of private industries as an

essential issue in the first 25-year socioeconomic plan. Economic growth was led by the industrial sector with increased export of non-oil products, and the spread of private industrialization, which contributed considerably to recovering from the depression that resulted from the oil crises in the late 1980's. Major export items were plywood, textiles, paper products, electrical goods, and glass products.

Regarding the iron and steel industry, which was the mainstay of heavy industries, Indonesia has one of the biggest production capacities in Asia except the advanced steelmaking nations; Japan, China, South Korea, Taiwan, and India. Its production in 1992 was a little over 4,300,000 tons, or 23 kg/year per capita based on the apparent consumed amount. This is still a low standard in comparison to approximately 700 kg/year for Japan.

As of 1993, the national output of industrial products was Rp148,293.5 billion (US\$71 billion) with an annual growth rate of 26.6%, during the eight years since 1985. The output of industrial products in East Java is Rp24,085.3 billion (US\$11.5 billion). Of this, Rp7,072 billion (US\$3.4 billion) is from the Brantas Basin, making up 28.5% of the national production. Their average annual growth rates since 1985 are 28.6% and 28.7% respectively, exceeding the national average. The industrial output in Surabaya City is Rp3,309.5 billion (US\$1.5 billion), which accounts for 47% of the basin's production. This growth of the basin's largest city, in the industrial as well as commercial areas, is prominent (see Appendix 3 for details).

There are approximately 18,000 large and medium scale enterprises in Indonesia, about 70% (12,000) of which are concentrated in Java Island. East Java is the base for 4,186 of them, which accounts for 23.0% of the national and 34.9% of Java Island enterprises. As shown in Table 1-13, East Java has a total of 478,000 businesses including small scale and household industries. Concentrated in Surabaya City are 803 large and medium scale companies, a little more than 19% of that in East Java (approximately 40% if surrounding areas are included), thus forming a big industrial area. Jakarta City has a huge industrial output of about five times Surabaya City's. Seen by business scale, the number of large and medium scale businesses with 20 employees or more is below 1% of the total companies in the entire country. In contrast, household industries with 4 or fewer employees makes up 94%. Thus it seems industrialization of Indonesia is supported by small and light industries.

After the rapid growth of Indonesian economy due to the sharp increases in oil revenue in the 1970's and the early 1980's, the subsequent drop in oil prices was a heavy blow. To deal with it, the Indonesian government fostered non-oil industrial fields in the private sector, especially light industries. Prompt response to this central government policy resulted in small businesses showing substantial growth in Surabaya City and its surrounding area (the Brantas River Basin).

Table 1-13 Number of enterprises by scale and number of employees (1993)

Company scale	Number	Entire nation	East Java	Surabaya City
Large and medium	Companies	18,219	4,186	803
	Employees	3,497,639	749,307	74,022
Small	Companies	124,990	86,152	8,326
	Employees	952,038	656,213*	119,710*
Household industry	Companies	2,350,984	388,252	118,500
	Employees	3,888,306	809,184*	196,000*
Total	Companies	2,496,768	478,590	127,629
	Employees	8,337,983	2,214,704	389,732

Source: Statistical Yearbook of Indonesia 1993, issued by Central Bureau of Statistic Jakarta-Indonesia, East Java statistics, Surabaya City statistics

- Remarks: 1) The figures were obtained from the ratio of the national number of people employed.
 2) Large companies: 100 employees or more, Medium: 20-99 employees, Small: 5-19 employees, Household industries: 4 or fewer employees

With rapidly progressing economic structural changes, Indonesia is likely to move toward industrialization concerning the manufacturing of technique-intensive products, which Indonesia has lacked, and products that require skilled laborers as well.