INDONESIA

1. PHYSIOGRAPHY

Indonesia is an archipelago forming a highway between two Oceans – The Pacific Ocean and the Indian Ocean – and a bridge between two continents, Asia and Australia. The whole territory lies between 94^0 and 141^0 E longitudes and extends from about 6^0 N latitude to 11^0 S latitude; stretching 5,120 km from east to west and 1,888 km north to south.

The gross area (including inland water surfaces) of Indonesia is 1,904,350 km^2, though the gross country area including the domestic seas is about 9,600,000 km^2.

Indonesia has 17,000 islands, of which only about 931 are inhabited. The principal islands are Java and Madura, Sumatra, Kalimantan (Borneo), Sulawesi (Celebes), West Irian (West New Guinea) and Maluku (Moluccas).

The island of Java including Madura (132,200 km^2 in area) is crossed by a chain of volcanic mountains, the highest of which is the Semeru in Eastern Java rising to a height of about 3,675 m. From the foot of the mountains, at an elevation ranging from 500 to 1,500 m extensive tablelands slope down to the lowlands of the coast. These tablelands and lowlands comprise 70 per cent of the land area. Only 20% area of the islands is under forests. Up to an elevation of about 400 m the land is used for wet cultivation of paddy.

Sumatra (473,600 km^2) straddles the Equator and contains a long mountain range called the Bukit Barisan. The mountainous portion is small and there are vast stretches of lowland, consisting principally of marshy alluvial plains covered with forests and low vegetation.

Kalimantan (539,500 km^2), the largest island in the archipelago, has a vast terrain of lowlands, consisting principally of alluvial and swampy plains. The area occupied by mountains is relatively very small.

Sulawesi (189, 200 km^2), in contrast to Sumatra and Kalimantan, is mountainous and hilly with the exception of the central portion of the island where is a large expanse of lowland of recent alluvial mountains.

Nusa Tenggara or Lesser Sunda Islands (Bali, Lombok, Sumbawa, Sumba, Flores, West Timor and others, total area 148,100 km^2), rise out of the Indian Ocean in what was considered once a wide strait separating the continents of Asia and Australia. Skirting the coastline of these islands, a narrow shelf exists from where steep mountains containing numerous volcanoes arise. These islands, particularly Bali and Lombok, are very fertile owing to the great quantities of volcanic ash.

The Irian Jaya islands have an area of 422,200 km^2.

2. CLIMATE AND RAINFALL

Being situated between two continents and two oceans, Indonesia is characterized by high temperature, high humidity and abundant rainfall. The daily mean temperature ranges between 22^0 C and 31^0 C. The mean annual temperature at se level is somewhat above 26^0 C and the mean humidity is 80 per cent. At Bandung, 730 m above the sea level, the mean annual temperature is 21^0 C. At each rise of 1,000 m, the decrease in temperature is between 5.5^0 C to 6^0 C.

Because of its position astride the Equator, Indonesia has no real seasons. However, the period from September to March can be called the rainy season and that from April to August the dry season. The

rain is typically tropical-frontal, convectional and orographic. Most of it falls with great intensity and thunder. In Java the mountains receive very large amounts of rain, the mean exceeding 4,000 mm on the windward slopes. Sumatra and the western half of Java tend to have good rain all the year around with no determinate dry season. The eastern part of Java has less rain and a relatively pronounced dry season from July to October. In these islands the rainfall decreases eastwards to less than 1,000 mm; in the driest district the dry season is longer. This the only part of Indonesia with marked dry season.

Most of Kalimantan has heavy rainfall throughout the year with totals exceeding 2,500 mm in the middle and north, 2,000 to 2,500 mm in the lowlands of the south and east, and 4,000 mm in the mountains. There is rally no dry season.

Thus, nearly everywhere in Indonesia, the total yearly rainfall is high; it exceeds the potential evapotranspiration and surplus water is available. Rainfall varies widely between 700 and 7,000 mm per year (average rainfall for the whole country being about 2,600 mm), while actual evapotranspiration is generally within the range of 1,200 to 1,400 mm per year which can be considered constant all over Indonesia, apart from its decrease with altitude and the supply limits in dry seasons.

3. POPULATION AND SIZE OF HOLDING

The population of Indonesia was 97 million in 1961; about 135.2 million in 1975; about 151.9 million in 1980; and about 210 million in 2000. In 2000 the islands of Java and Madura, which comprise 6 per cent of the land area, were inhabited by 60 per cent of the population with density of population 1000 persons/km^2, while Sumatra occupying 25 per cent land area was inhabited by 18 per cent population with density of population of 80 persons/km^2 .

In 2000 out of the total economically active population of about 70.5 million, the percentage engaged in agriculture was 55.6.

Small holding in Indonesia seldom exceed one hectare in area. Estate management of agriculture is widely practiced in Java and Sumatra, while only a small number of management undertakings operate on the other islands. These estates usually cover about 2,000 ha in Sumatra where more land is available, and 1,000 ha in Java.

4. LAND RESOURCES

The gross area of Indonesia is 1,904,350 km^2 (including inland water surfaces), out of which the lands area is 181,135,000 ha. Land use statistics of 2000 are as follows :

Arable land	10,992,000	ha
Permanent crop	6,340,000	ha
Permanent pasture	12,679,000	ha
Forest and woodland	109,587,000	ha
Other land	41,537,000	ha

In Java the tablelands as well as the lowlands comprise over 70 per cent of the land area and consist of rich volcanic silt carried down by streams and these are, therefore, extremely fertile.

In Sumatra there are vast stretches of lowland consisting principally of marshy alluvial plains, covered with forest and low vegetation. The terracings bordering the rivers are alluvial.

In Kalimantan there is a vast terrain consisting principally of alluvial and swampy plains and make good farming land when reclaimed.

In Sulawesi the central lowland portion of the island consists of recent alluvial deposition which is very fertile.

The islands of Bali and Lombok are very fertile owing to the great quantities of volcanic ash.

Thus, Indonesia has stretches of fertile soils; in Kalimantan, Sulawesi and Sumatra the soils are poor due to excessive leaching caused by heavy precipitation. Irrigation is needed in cases where annual rainfall is less than 1,000 mm, while the extensive swampy soils of the alluvial plains of Sumatra, Kalimantan and West Irian require drainage before they can be brought under successful cultivation.

5. WATER RESOURCES

SURFACE WATERS

Numerous streams are found in all parts of Indonesia; the biggest streams are in the large islands of Sumatra, Kalimantan, Java and Irian with discharges ranging over 2,000 m^3/s in the rainy season. During the dry season the discharge may be only a fraction, say, 10 m^3/s or less. In Java the rivers nearly dry up in the dry season. The important rivers are the Kali Brantas, the Bengawan Solo, the Serayu, the Cimanuk, and the Citarum in Java, the Krueng Aceh, the Asahan, the Batanghari, the Musi and the Way Sekampung in Sumatra; and the Barito, the Kapuas, the Mahakam, the Kayan and the Kahayan in Kalimantan, the Jeneberang and the Walanai in Sulawesi, and the Memberamo, the Ajkwa, and the Kamoro in Irian Jaya.

The average annual runoff in the country is estimated to be of the order of 2,530,000 million m^3; the equivalent depth of runoff is 1,250 mm and the annual runoff coefficient is 0.48.

The run-off-the-river flow has already been used in Indonesia for irrigation, and further exploitation of the river flows depends on the storage of river supplies during rains, for which suitable dam sites exist in many parts of the country.

GROUND WATERS

Good water-bearing formations exist in several parts of the country. The best aquifers are lava streams, restricted to the vicinity of volcanoes and limestones; yields of over 2,000 liters per second have been recorded.

Karst areas are found in the southern mountains in Central Java and in Ajamaru region in Irian Jaya.

Most of the alluvial plains along many coasts and rivers, and also those found near sites of lakes may be regarded as good water-bearing formations, even though the yield varies.

Ground water is at present mainly used for domestic water supply.

Until 1999, more than 148 thousand ha in high ground water potential spread in many locations have been identified and 38,442 wells have been operated. Some 58 thousand ha have been developed for irrigation and rural water supply of 660 thousand peoples.

6. BRIEF HISTORY OF IRRIGATION AND DRAINAGE

IRRIGATION

Irrigation in Indonesia, particularly in the Java island, has been practised for the cultivation of rice from ancient times. The old irrigation works were, of course, crude and unsophisticated. The Netherlands Colonial Government, first represented by the East Indian Company, began taking interest in the irrigation works as early as the 18th century. The first canal built during years 1739 to 1758 was the "Oosterlokkans". Since the, the Government has continued to take active interest in irrigation development, but a regular Public Works Department was established only in 1854.

Probably the most modern scheme of the 19th century is that on the Brantas River of eastern Java constructed in 1857, but significance progress was made only after World War I. As irrigation facilities were extended, the rice production in Java and Madura increased from 2.9 million tonnes in 1920 to 4.4. million tonnes in 1940.

Irrigation is well developed in Java and Bali, but much less on the other islands of Indonesia. Practically all the irrigation works are designed to supply water to the rice fields. The three types of irrigation works constructed are designated, "technical", "semi-technical", and "people's irrigation". "Technical" irrigation schemes are large works of a permanent nature, constructed and operated by a government agency. "Semi-technical" irrigation schemes are minor works, either permanent or temporary, constructed by Government and operated by the farmer themselves. "People's irrigation schemes" are minor works with temporary or no weirs, constructed by the farmers.

The important works constructed in Java consist of diversion weirs, storage works, pumps, etc. At the turn of the last century, diversion projects were considered quite adequate. But subsequently the importance of a second crop to meet the need of the growing population became apparent : this led to the construction of reservoirs to store the west monsoon flows for use during the dry monsoon period for irrigation of a second crop.

The important projects include the Krueng Jreu and Krueng Aceh Rivers Improvment Projects (irrigated area 20,000 ha), the River Ular Improvment Project (irrigated area 18,000 ha), the Teluk Lada Irrigation Project (irrigated area 31,000 ha), the Karawang Diversion Project (irrigated area 78,000 ha), the Cimanuk Diversion Project (irrigated area 37,000 ha), the Citanduy River Project (irrigated area 24,400 ha), the Cacaban Storage Project (irrigated area 41,000 ha), and the Bali Irrigation Project (irrigated area 11,630 ha). The two multipurpose projects underway in 1969 were the Jatiluhur in West Java to irrigate 240,000 ha and the Karangkates in East Java to irrigate 84,000 ha. And, in first long term plan priod, the other multipurpose projects have been constructed several reservoirs, as the Batutegi in Sumatra; the Cirata and Saguling in West Java; the Kedung Ombo in Central Java; the Lodoyo, Wlingi, Sengguruh, Lahor, Lodoyo, and Wonorejo in East Java, and the Bili-bili in South Sulawesi.

Irrigated rice culture on the island of Bali differs from that in the other islands. The irrigation schemes are constructed, operated and managed by co-operative societies, called *Subaks* (or water boards) rather than by Government aid.

The extremely rugged terrain of Bali makes construction of irrigation schemes difficult. Every patch of land, even in the mountainous areas, to which water can be brought is utilized by an elaborate system of canals, tunnels, barrages, bamboo pipes and dykes that make possible to inundate or drain the area at will. Double cropping is the rule.

A systematic and planned development of irrigation (rehabilitation and improvement of existing irrigation systems and construction of new ones) was undertaken in 1969 with the launching of the country's Fisrt Five-Year Development Plan (*Pelita I*).

The progress of irrigation development in the First, Second, Third, Fourth, Fifth, and Sixth *Pelita* is as follows :

First *Pelita* (1969 – 1974) – About 60 per cent of the existing irrigation systems did not function well because of the deteriorating physical conditions of the structures caused by improper maintenance in the last 25 years. Following World War II many of the major projects were so heavily damaged that much of the irrigation water was lost at the intake structures and in the conveyance distribution networks. As a result of the program of rehabilitation and improvement undertaken in the Firs Five-Year Development Plan (1969 – 1974), 953,000 ha served by irrigation facilities were rehabilitated exceeding the plan target of 830,000 ha. New irrigation systems targeted to cater to an area of 430,000 ha were also undertaken. However because of financial constraints only about 191,000 ha of new land could be provided with new irrigation facilities. The country produced 13,8 million metric tonnes at the end of the First Plan.

Second *Pelita* (1974 – 1979) – Envisaged rehabilitation and improvement of irrigation facilities for catering to an area of about 430,000 ha. However, the actual realization at the end of the Plan was rehabilitation and improvement of 532,000 ha and development of new irrigation schemes to cater to an area of 273,000 ha. The actual rice production at the end of Second Plan was estimated to about 16.3 million metric tonnes against a target of 18.6 million metric tonnes, the shortfall being mainly due to the long drought period of 1974 – 1976 which caused serious shortages of irrigation water for dry season cultivation.

Third and Fourth *Pelita* (1979 – 1989) – A major initiative was taken to support transmigration and regional development through the construction of the new systems in less developed regions. Even in Java new systems such as Lodoyo-Tulungagung, Sampean Baru, Citanduy Irrigation and Teluk Lada, and other works were started to supply previously rainfed areas. In parallel with this, conservation of forest. Land and water was incorporated as a separate program within Directorate General of Water Resources Development (DGWRD). It has been estimated that rehabilitation and improvement works covered, about 515,000 ha from 1979 to 1989 (including Madiun and Kali Progro basins), new irrigation accounted for 570,000 ha and conservation programs were extended to basins such as Cimanuk, Bengawan Solo, Brantas, Krueng Aceh, Arakundo, Jambu Aye, Sungai Ular, Bah Bolon and Jeneberang. The Kedung Ombo, Wadas Lintang and some other reservoir were also constructed during this period. By 1986 the total of Public Works Provincial Services (*Dinas PU Propinsi*) managed irrigation systems has risen to a functional area of 3.7 million hectares out of a much larger potential area served by irrigation and drainage infrastructure (excluding swamps reclamation). A major program of tertiary development, provision of drainage infrastructure and small and medium scale irrigation was also started during this time.

Fifth dan Sixth *Pelita* (1989 – 1999) – Policy reform on irrigation development and management in fifth and sixth *Pelita* was focused on to keep achievement of self-food sufficiency (rice) by increasing operation and maintenance the irrigation schemes, finishing some and on-going projects, and rehabilitating schemes. In this era, Government has been introducing a bottom-up approach system for the development.

During Sixth *Pelita*, some 300 thousand new irrigation schemes have been developed; 700 thousand ha irrigation schemes have been rehabilitated;150 thousand ha new irrigation fields (sawah) have been established.

In 1994 rice production decreased 3.2 per cent compared with total production in 1993 (about 48.1 million tonnes). This condition led to fail in self-food sufficiency, so the Government has to import rice to meet the demand more than 2 million tonnes.

The irrigation area up to the end of the first-long term period was 5.7 million ha, including swamp reclamation (1.2 million ha). Some 2.9 million ha of irrigation schemes have been rehabilitated in that period.

The mission of second long-term (staring in Sixth *Pelita*) is to continue measures for increasing rice production in order to keep self-food sufficiency. An objective of the program is to increase production in order to meet increasing demand due to increasing of the population.

DRAINAGE

As mentioned under Section 1 "Physiography", swampy lands are found in several islands of Indonesia, particularly a large area in Kalimantan and Sumatra. For decades the people of southern Kalimantan living in the tidal regions have used their own method of opening up new rice fields. The land in these regions is flat and almost at sea level. It is the practice to open up new rice fields by digging channels connecting the land with a tidal river. When the river rises at high tide the water flows into the channels and inundates the surrounding rice fields for about two or three hours (natural irrigation), and when the river falls at low tide the water in the channel flow back to the river, and as it does so, it carries with it oxides which are harmful to plants. In about two years time what was formerly marsh land is transformed into fertile soil. With this "drainage and reclamation" technique, new rice lands have been developed in a belt extending 5 km on either side of the channel.

The extent of swmps cultivated in 1966 was about 150,000 ha and a scheme for reclaiming 5.25 million ha of land in Kalimantan and Sumatra was in hand.

First *Pelita* (1969 – 1974) – The government used low cost simple technology to develop swamps for human settlements. The method was usually to carry out the minimum of works required to enable settlement to be established for agriculture to be started. About 27,000 ha of non-tidal land was opened in North Sumatra, South Sumatra and South Kalimantan (average of 5,500 ha per propvince). About 33,000 ha of tidal was opened in this manner in Riau, Jambi, South Sumatra, West Kalimantan, Central Kalimantan and South Kalimantan.

Second *Pelita* (1974 – 1979) – The areas rapidly increased in Second *Pelita* to 248,800 ha of tidal land, as follows :

Riau	73,700 ha
Jambi	32,300 ha
South Sumatra	78,300 ha
West Kalimantan	36,000 ha
Central Kalimantan	28,500 ha,

and 20,300 ha of non tidal land in North Sumatra, West Sumatra, South Sumatra, Lampung, West Kalimantan, Central Kalimantan and South Kalimantan (average of less than 3,000 ha per province with the largest area being 6,050 ha in South Sumatra). In the Second *Pelita*, 272,000 ha of tidal areas and swamp lands were reclaimed.

Third *Pelita* (1979 – 1984) – Reclamation of tidal land was carried out at about 25 locations in Riau, Jambi, South Sumatra, West Kalimantan, Central Kalimantan and South Kalimantan for the total of 352,800 ha.

The Largest area (190,000 ha) was in South Sumatra followed by (73,359 ha) in Central Kalimantan. Some of the larger schemes constructed during this time are :

Air Saleh Sugihan	44,100 ha
Air Sugihan	22,600 ha
Pulau Reman	41,000 ha
Karang Agung	20,300 ha
Padang Sugihan	51,100 ha.

Non tidal swamps were reclaimed in Aceh, North Sumatra, West Sumatra, Riau, Jambi, South Sumatra, Bengkulu, Lampung, West Kalimantan, Central Kalimantan, South Kalimantan, and East Kalimantan.

More than 40 schemes were started for a total area of 65,200 ha giving an average of less than 2,00 ha per scheme.

The largest was Rawa Sragi with 10,200 ha (total area in this project has been expanded to 23,000 ha and it is considered to be one of the most successful in terms of land consolidation and integrated rural development involving the participation of the provincial government and the beneficiaries). Others like Ogan Kramasan were also part of on-going larger schemes.

Fourth *Pelita* (1984 – 1989) – In Fourth *Pelita* total of new schemes (non-tidal) was more than 50 with average area per scheme less than 1,000 ha (total 45,600 ha). 85,800 ha in existing schemes were rehabilitated and 22,600 ha were upgraded. 20,000 ha of tidal swamps were constructed and 12,400 ha were rehabilitated.

The larger schemes constructed or upgraded in Fourth *Pelita* included Ogan Kramasan 20,800 ha, Mesuji Tulangbawang 12,400 ha and Rawa Sragi 23,000 ha. Tidal irrigation systems were constructed, rehabilitated or upgraded on 65 schemes for a total of about 365,000 ha. The largest scheme in the category was Karang Agung (more than 50,000 ha). Rawa Anai in West Sumatra is 6,300 ha and is at the lower end of an irrigation system on Batang Anai. The lowlying land is no longer inundated and will form part of the future irrigation and drainage development.

Fifth Pelita (1989 – 1994) – In Fifth *Pelita* other schemes which have been started and finished in South Sumatra are, as follows :

Air Babak	28,400 ha
Delta Upang	10,000 ha
Delta Saleh	11,800 ha
Sugihan	47,500 ha.

In first long-term (PJP 1) there are some 3.7 million ha of the swamps has been developed. The objective of this projects is to achieve self-food sufficiency as well as to support transportation and reclamation tidal and non tidal swamps in Sumatera and Kalimantan.

To Compensate food deficit, in 1995, former President Soeharto has had an idea about reclamation of 1 million ha of peat soil in Kalimantan for food crops. Development of this projects finally was terminated in 1998, the technical and economic as well as environmental feasibility reasons. This projects was not prepared well and so the standard procedures for the swamp reclamation.

8. STATISTIC RELATING TO IRRIGATION.

The increase in the cultivation with time has been as follow :

Area cultivated in 1966	14,000,000 ha
Area irrigated in 1966	3,797,000 ha
Area irrigated in 1968	4,230,000 ha
Area irrigated in 1976	4,900,000 ha
Area irrigated in 1979	5,360,000 ha
Area irrigated in 1999	6,869,000 ha.

9. IMPORTANT PROJECTS

SUMATRA ISLAND

ACEH – Two project in Aceh were Krueng Jreu and Krueng Aceh Rivers Improvement Projects. This was followed by Krueng Aceh Irrigation, Baro Raya Irrigation (20 thousand ha), Arakundo and Jambu Aye Irrigation and Flood control, and North Aceh Irrigation. There are more than 40,000 ha in small and medium scale irrigation and drainage systems and these were taken up for rehabilitation, upgrading and turnover to Water Users Associations (WUAs)

NORTH SUMATERA – River Ular Improvement Project was started in First Pelita which control flooding of 40,000 ha area including 18,000 ha rice field and 11,000 ha of oil palm plantation. The project continued by constructing of irrigation system (18,500 ha in 8 schemes) and drainage system covering 55,000 ha (in 8 blocks). Some other schemes constructed in First long-term development are Sira-sira (6,300 ha), Batang Illung (4,200 ha), Batang Gadis (6,600 ha) and Bah Bolon (10,000 ha).

WEST SUMATERA – The main works completed form First to Fourth Pelita were the Sungai Dareh Sitiung and Pasaman Irrigation. Sungai Dareh irrigate about 12,000 ha in West Sumatra and Jambi to support transmigration settlements. In Fifth Pelita several project were completed including Padang area flood control, Batang Selo, Batang Tongar.

SOUTHERN SUMATRA – The Way Seputih and Sekampung irrigation areas were developed from about 1935 with the construction of the Argoguruh weir on the Sekampung river to serve 20,600 ha. In 1953, the Garongan weir was constructed on Batanghari river to serve an area 7,680 ha. The Raman Utara weir and irrigation systems was constructed in 1956 to serve an area 6,300 ha. In 1963, government started to construct Punggur Utara irrigation system to serve area of 31,500 ha. In First Pelita, these works were continued to increase the wet season irrigation from Sekampung to about 51,000 ha and the dry season irrigation to over 18,000 ha. The Seputih system was rehabilitated to irrigate 20,200 ha. At full development the total irrigated area within the Seputih – Sekampung basin increase to about 120,00 ha.

The Batutegi reservoir on the Way Sekampung to provide additional supplies to 24 MW. The dam is 133 m high and has live storage about 500 MCM. Way Jepara (6,650 ha), Way Tulung Mas (3,200 ha), Way Ketabung (1,550 ha) and Way Curup (2,020 ha) have been completed in Fifth Pelita. The Way Rarem project is one of the key projects for the economic development of the North Lampung Region. It was started during Third *Pelita* to provide modern irrigation facilities to a net irrigation area of 22,000 ha. The project includes the construction of reservoir with catchment area of 328 km^2 and effective storage capacity of 56.9 MCM.

The Umpu and Way Pengubuan Projects are also in North Lampung and have been completed to serve irrigation areas of 7,500 ha and 5,00 ha respectively.

JAVA ISLAND

BANTEN – The irrigation system in Ciujung Basin were taken up for rehabilitation during the first and second Pelita. Teluk Lada Irrigation Project originally intended to serve 31,000 ha in four separate systems has been constructed in second Pelita to provide irrigation water to rain fed area. A reservoir to store about 110 MCM from 100 km^2 of the Ciliman river catchment was studied in first and second Pelita to provide supplementary supplies to the Teluk Lada project. The Pamarayan barrage on the Ciujung river was constructed as the old structure was in imminent danger of collapse.

WEST JAVA – **Cisadane basin** is considered as one basin with the catchment area of the Ciliwung river, although in practice, the basin complex consists about fifteen large and small rivers draining to the Java sea through and around the city of Jakarta. Starting from about 1966 a number of polders and pumping stations have been constructed and existing drains and control structures have been rehabilitated or improved. The Cengkareng floodway to extend relief on the western side was completed in 1983. Dykes have been constructed along the Cakung drain to contain flood of 100 year return period. The Cideng pumping station with a capacity of 6 x 6.7 m^3/s, was constructed in 1989 to pump storm water from 750 ha in Central Jakarta into the western drainage canal. The others important projects include : Grogol river improvement; Grogol interceptor drain; Pluit darinage improments; Improvement of Cideng-Thamrin, Lower Krukut and Melati reservoir.

Citarum basin is one of the larger basin in Java with a catchment area of 11,440 km^2 and support about 10 million within its boundaries. The Jatiluhur multi-purpose dam has been built on the Citarum River with a reservoir capacity of 3,000 million m^3 . The installed capacity for hydro-electric power is 150 MW, and on full development the irrigation system will cater to an area of 300,000 ha not only in the Citarum basin but also in the Bekasi, Ciasem, and Cipungara basins. The project is of strategic importance in supply of water for domestic and industrial use to the City of Jakarta and the surrounding areas. The Saguling reservoir (storage of 880 MCM and 700 MW of electric power) and the Cirata reservoir (storage of 1470 MCM and 500 MW of electric power) are upstream of Jatiluhur reservoir and therefore part of the Citarum River Basin Complex.

In Cimanuk basin, there was the flood control project implemented from first Pelita and included the construction of dykes along the Cimanuk river (2x70 km) and a 21 km long channel of 900 m^3/s capacity to divert the flows away from Indramayu. Jatigede is the largest and most important reservoir which has been constructed. It is a 110 m high and store about 800 MCM. The dam has a generating capacity of 175 MW yielding a power supply of over 800 million kWh per annum. Jatigede reservoir can provide additional irrigation supply to 131,000 ha of land and enable industrial and tourism development.

Citanduy basin, Citanduy River Basin Project was started in first Pelita which Weir Manganti was constructed on the Citanduy river to serve an irrigation area of about 24,400 ha in Central Java. The irrigation and drainage system were rehabilitated from 1981 to 1990 including flood banks, tidal protection, and flap gates. The South Lakbok system was completed in 1992 (19,900 ha in Sidorejo – Cihaus and 4,500 ha in South Lakbok). The Citanduy irrigation project has new irrigation areas totally about 28,540 ha (13,740 ha in West Java and 14,800 ha in Central Java). In particular unique environment has developed around Segara Anakan (Cilacap District) tidal channel and lagoon and the new lands created through sedimentation. The Cilacap town is an important port and has a petrolium refinery and distribution network. Therefore domestic and industrial demand for water is likely to rise and it is anticipated by constructing some reservoir as follows : Matenggeng on Cijolong (40 to 140 MCM), Pengasinan (40 MCM) and Benangan (90 MCM) on Ciseel and Cikembang (60 MCM).

CENTRAL JAVA – **Serayu basin** includes two major project areas; namely Serayu – Gambarsari and South Kedu. The northern area is managed by Serayu – Gambarsari project based in Purwokerto and Southern part is managed by the South Kedu Multipurpose Project based in Sempor (Kebumen

District). The functional irrigation area within the whole basin is about 175,000 ha of which about 115,000 ha described as technical and semi technical irrigation. Tajum irrigation project was constructed in first Pelita to provide new irrigation facilities to 3,200 ha in the lower catchment of the Serayu river. The Serayu barrage is a major structure 120 m long by 9 m high and incorporated with radial gates 10.7 m wide x 9.0 m high mounted on four independent concrete blocks 28 m wide each.

Jratunseluna basin, Kedung Ombo dam on the river Serang is a 60 m high and 1,600 m long dam of rockfill type with clay core and filters. The reservoir has a gross storage of 723 MCM and an active storage of 634 MCM. 22.5 MW of electric power generation has been provided at structure. The dam was completed in 1989. The total functional irrigation area within the Jratunseluna complex is 127,000 ha.

Other major structures completed within this basin are the following : Klambu barrage, Dumpil barrage, Sidorejo weir, Lanang weir, and Kumpulan rubber dam.

Bengawan solo basin, The Wonogiri Multi-purpose dam and reservoir was constructed from 1973 to 1982. The dam is store 730 MCM. Other major dams which finished within the basin are the Jipang (920 MCM) down stream of Ngawi on Solo River, the Bendo (86 MCM) and the Badegan (138 MCM) on tributaries of Madiun River. The latest dam has been constructed is the Gondang which provides water for irrigation of about 6,000 ha. The basin has also potential for generating hydropower.

YOGYAKARTA – **Progo basin**, A 90 m wide weir was constructed across the Progo river at Karangtalun in 1978, together with new intakes for the Mataram canal (20 m^3/s) and the Kalibawang canal (7 m^3/s) and associated sand traps and scour sluice. The main canals were remodeled and extended to 32 km in the east and 24 km in the west. New and extended systems of canals and drains were provided for a total irrigation area of 32,000 ha.

EAST JAVA – **Brantas Basin,** The Brantas River Basin Development Project is located in East Java. The river basin is highly developed and densely populated. The two big problems are the spreading of erupted materials over villages, towns and fields at the foot of the mountain Kelud during floods, and the very quick rise of the riverbed of the Brantas after an eruption of the Kelud due to silting. Therefore, priority is given to flood control. The reservoirs, mainly for flood control, are also used for the generation of hydro-electric power (total capacity 108,000 kW) and for the irrigation of some 28,000 ha of rice fields. The main works include : the Karangkates Dam (reservoir capacity 343,100 m^3) for flood control, irrigation and hydropower (326 GWH); the Selorejo Dam (reservoir capacity 62.3 million m^3) for flood control, irrigation and hydropower (49 GWH); the Wlingi Dam (reservoir capacity 24.1 MCM and 164 GWH), the Lahor Dam (36.1 MCM and 72.2 GWH), Lodoyo Dam (vertical roller gates with 36.7 GWH), the Bandak Dam for flood control; the Jatilengger, Dermo and Kali Putih debris checking basins for debris control.

Kali Porong Improvement was completed in 1977. The Tulungagung irrigation and drainage works were constructed from 1975 to 1986 to serve a new irrigation area of 15,000 ha. The first phase of the Brantas Middle Reaches River Improvement Project was completed in 1986. Sengguruh dam for hydropower generation was completed in 1988. Mrican barrage which serve 56,000 ha of existing and new system was completed in 1991. Wonorejo dam and Tulungagung hydropower are also finished in 1995.

LESSER SUNDA ISLANDS

BALI – **Bali Irrigation Project** seeks to reduce rural poverty in Bali. In entails improvement of small irrigation schemes (for 11,630 ha); watershed rehabilitation; erosion control; coconut stemwood utilization; construction of rural roads; and construction of village water supply systems. Labor-

intensive measures are used for the improvement of existing irrigation facilities, road construction and rural water supply systems. Shallow well pumps and other appropriate equipment are incorporated.

WEST NUSA TENGGARA – Works carried out from first Pelita include the construction or rehabilitation of the Babak-Renggung High Level Diversion (HLD), the Jangkok-Babak HLD, the Batujai reservoir, the expansion of the Jurang Sate Irrigation, and the complete rehabilitation and improvement of 26,000 ha of irrigation and drainage systems in South Lombok.

Other important structure in Lombok such as : Pengga Dam, Pandanduri-Swangi reservoir, Mujur . The capacity in totally all of these are only 50 MCM, but very strategic importance in view of Lombok as a tourist destination to the east of Bali.

To optimise the use of water for agriculture and to meet the growing demand of domestic, industrial, and tourism sector, then a computerized water operation center (WOC) has been started in Lombok since 1993.

On Sumbawa island, Mamak dam has been structured in fifth Pelita to provide irrigation to over 5,000 ha of existing and new lands. The whole of irrigation and drainage system has been rehabilitated and expanded, including the construction of weirs, canals, and structures. Tiu Kulit dam and irrigation system to serve 2,500 ha of new lands has been finished. The others reservoirs that have been constructed are in Batubulan and Pelaparado in Sumbawa.

SULAWESI ISLAND

In second Pelita new irrigation was started in the northern part of Sadang for an area of about 7,000 ha. Other irrigation projects started in Sulawesi were Wawotobi in South East Sulawesi, Dumogo-Gumbasa and Parigi-Poso in Central Sulawesi and Luwuk and Kalaena in South Sulawesi. These were followed by many smaller schemes in South Sulawesi such as Langkame-Sanrego, Jeneberang River Maintenance, Bila Irrigation and Bili-bili.

10. WATER AND IRRIGATION MANAGEMENT POLICY

Government regulation (PP) No. 22 of 1982 on Water Management, and following PP No. 23 of 1982 on Irrigation expand the management and planning functions and the implementation methodology originally defined in the Law 11/1974. Under Regulation No. 22/1982 the rights to drinking water for every person and their livestock are set out a basic prior right as long as due care and attention are paid to the surrounding environment, without the need for any permit. The rights to water for all other uses however are said to require a permit. Authority to issue permits was lodged with Ministry of Public Works (MPW) together with the authority to prioritise the use of water by category and coordinate its overall management. PP No. 22/1982 also states that the authority and functions of the Ministry may be delegated to the regions through the Minister's office.

The two main regulations regarding irrigation and maintenance policy (IMP) are INPRES No. 2/1984 on 'Guidance to Water Users Associations (WUAs)', Irrigation Operation and Maintenance Policy (1987), an INPRES No. 42/1989 on 'System of Turnover of Small Scale Irrigation System and Management Authority to WUAs'. These were the basic regulation which provided guidelines for the establishment of WUAs in tertiary unit or village irrigation area; the introduction of efficient the operation and maintenance, special maintenance and irrigation service fee (ISF); and the turnover of responsibility for operation and maintenance to WUAs of small scale schemes. Irrigation schemes were divided into three categories depending on their condition and management responsibility : A, B, and C.

This concerns the hand over of responsibility for the operation and maintenance of irrigation schemes from the government to the WUAs, starting with irrigation schemes smaller than 500 ha. Initially the program targeted irrigation schemes were grouped together into large block and turned over to WUAs en-masse. There was, however, usually a considerable delay before turnover was actually carried out, due to lack of coordination (central, provincial, and district/kabupaten levels) and too many procedure for processing program.

In 1992 important legislation was released from the Ministry of Home Affairs (MOHA). Two MOHA regulations on irrigation Service Fees No. 6/1992 and No. 19/1992 indicated the government's determination to raise revenue from the water users to provide funds for maintenance above the tertiary turnouts and place more responsibility on the farmers to care for the supply system.

Responsibility for the collection of the ISF was placed on the local revenue service (DISPENDA) whose task was to rise the revenue directly from the WUAs. The amount to be collected complicated issue, as it was individually assessed by Chief of District (*Bupati*), having, in the theory, taken regard of a number of location specific factors, such as the socio-economic condition of the area, the condition of the existing water supply and the actual calculated requirement. Following an initial and expensive three-years attempt to implement the law it has now been abandoned under the latest Autonomy for local government, Law No. 25 of 1999, Fiscal Balance Central to Region Government.

During the same period a new MOHA regulation, No. 12 of 1992 on the Establishment and Development of Water Users Associations was released. This regualtion is based on number or previous laws regarding village structure and responsibilities and classic President Instruction No. 2/1984 on Guidance to the Water Users Association. The MOHA regulation was released to improve and clarify the status of WUAs; that it was really time to enforce the regulation of WUAs, one of which is the obligation to pay service fee for maintenance.

IBRD and World Bank had independently concluded that further assistance was required to support the development of reform in water resources sector, and recommended a program that closely matched the BAPPENAS agenda. Consequently a USD 300 million water sector adjustment loan (WATSAL) was proposed by the World Bank, conditional on specific indicators being achieved within an agreed time frame. A Polocy Matrix was developed jointly by WB and BAPPENAS; following this, the WATSAL task force was established by decree issued by Minister of Planning (November 1998).

Further to this, owing to the multi-ministerial involvement in the reform, a Presidential Decree was issued on 9/1/99 creating a Coordination Team from nine concerned Minister whose duties were based on the following principles;

- Management would be based on beneficial and sustainable principles for the welfare of the nation and its living environment,
- Consideration should be given to all habitat conservation and environmentally sustainable needs for all natural resources and living creatures,
- Where possible, corporate basin management organizations such as state owned enterprises (SOEs) and regional owned enterprises (BUMD) should be utilized,
- Public, community and NGO participation in basin management institution should be promoted.

The specific aspects to be reviewed and requiring reformed policies were: a) improved water pollution control regulation, b) Irrigation Management Policy Reform, c) ISF reviewed in terms of self-financing capacity, d) WUAs Empowerment, and e) curtailment of the million hectare swampland/peat-land (Gambut) project expenditures. These aspects and the various issues they encompass were used to define the reform objectives, address policy, legislative, and institutional readjustments focusing on food security, sustainable water use, and improved water related environments. These consideration were defined in the four part WATSAL program.

Minister Decree No. 179/1996 issued by the Ministry of Home Affairs proscribes the organizational structure, the status, task and function of a number of Balai to be established under the Java loan program in all provinces of Java. It establishes that the Balai as 'technical implementation unit (UPTD)' under the Provincial Public Works Service, Provincial Water Resources Development Service (PSDA). A program of support for establishment of these Balai is currently being undertaken by the BWRM (Basin Water Resources Management Project), which is operating under the Java loan (IBRD, ADB, JBIC) supporting WATSAL.

The task and function of these Balai will vary according to the need of the basin(s) that within their management. It is envisaged, however, that they should have the capability of managing the resource base of all water related aspects, from coastal zone management to watershed management, according to the specific need. An institutional guideline to determine the task, function and operation is due to be produced to assist the administration of these offices. Some Balai are situated with the River Basin Management Authority areas (PJT 1 and PJT 2) and their operational procedure will be, necessary, have to be reviewed as part of the overall WATSAL agenda.

Capacity strengthening under the WATSAL agenda is vital for the proper functioning of these Balai and institutional coordination, through PPTPA to PTPA, is necessary to maintain effective purpose and function. The devolution of irrigation management to the district levels through the imposition of Law 22/1999 will require the Provincial Dinas and Cabang Dinas to examine their institutional roles and responsibilities. Criteria need to be developed to determine the relating of Balai to PPTPA and to PTPA and share of responsibility in the execution of the workload. The division of assets, infrastructure for operation and maintenance, jurisdiction in water resources management and coordination of management all need critical examination.

12. FIELD WATER MANAGEMENT

A tertiary development program has been introduced to enable better water management and water distribution at the farm level. While the construction of tertiary networks is, in principle, considered as the responsibility of the farmers, the Government assists in these networks with a view to expediting and improving water management at farm level. Also for the operation and management of tertiary networks water users associations have been organised. Improved operation and maintenance schemes of the main irrigation networks aim to achieve a more effective use of irrigation water (rotational irrigation, etc) and, in the result, an increased cropping intensity.

Irrigation Committees at the country level and Sub-Committees at the district level have been established to deal with water management and the distribution of irrigation water in relation to the planned cropping pattern.

INPRES No. 2 of 1984 on Guideline to Water Users Associations (WUAs) and the consequent No. 42/PRT/1989 System of Turnover of Small Scale Irrigation System and Management Authority to WUAs, are the basic regulations effecting the establishment of WUAs and their function in accepting the turn over of management authority of small scale schemes (below 500 ha) to the WUAs. The scope of the turn over is detailed as :

- the turnover of assets of small scale irrigation comprising structures and canal built by government, and
- the jurisdiction, duties and responsibilities of operation and maintenance registered in the Inventory book of the Public Works irrigation area, under the condition that such operation continues to be supervised, directed and monitored by government agencies.

The criteria for turn over, were based on the following factors :

- the usage of the irrigation water,
- the physical condition of the irrigation system, which must be in good condition,
- the institutional condition of the WUAs,
- the WUAs must be registered by the Chief of District (Bupati),
- the WUAs must be qualified organizationally, technically, and financially to take the duties and obligations.

In 1996 a new project, the Irrigation Development and Turn Over (IDTO), a component of the JIWMP (Loan 3762-IND), set out to determine more participatory methodology in preparing WUAs and Federated WUAs to accept responsibility and management for their irrigation schemes. After some teething problems related to the selection of sample sites, the project has developed a methodology, which use Participatory Rural Appraisal (PRA) at the block level, where farmers are given the chance to voice their opinions before being they encouraged to form a WUA.

12. PROBLEM RELATING TO IRRIGATION AND DRAINAGE

(1) Since third Pelita, the development approach/objective in Indonesia have changed become to maintain self-food sufficiency. Irrigation development that oriented only for self-food sufficiency, lead to lack in food diversification and very high depending on rice.

(2) Highly land conversion from irrigation area to business, industrial, and settlement area in Java threaten self-food sufficiency. During first long-term period (1969-1994), there are more than 500 thousand ha land conversion from irrigation area to other utilities (20 thousand ha per year).

(3) Irrigation development out Java could not been implemented optimally due a few farmer in the irrigation cultivation, mostly local culture of society not as irrigation farmer, not sufficient in infrastructure to support that activities.

(4) Previously, implementation of development did not take into account appropriately some aspects such as water quantity and quality, schemes sufficiency, as well as farmers involvement in planning, implementation, and operation and maintenance of irrigation.

(5) The performance of the irrigation schemes decrease because of deterioration of the system, lifetime, and lack of operation and maintenance due to very limited of the government finance.

(6) The real cost for operation and maintenance in 1998 is about IDR 60 thousand per ha, but availability of the budged from central government is only IDR 30 thousand per ha. The rest one is expected coming from the local (provincial) government. Unfortunately, local government mostly have prosperity not more than half from the need.

(7) The problems of the operation and maintenance become more seriously in when allocation of the budged not only for the operation and maintenance (40%) but also for the local official payment (40%) and journey (20%).

(8) Most of the irrigation schemes take water directly from the stream (with out reservoir). There are only 12 per cent (750 thousand) of the schemes serviced by reservoir. So, the reliability of the scheme is very low because the scheme very depend of the season. This condition has an impact on the low production growth for the paddy in the lowland.

8. STATISTIC RELATING TO IRRIGATION.

The increase in the cultivation with time has been as follow :

Area cultivated in 1966	14,000,000 ha
Area irrigated in 1966	3,797,000 ha
Area irrigated in 1968	4,230,000 ha
Area irrigated in 1976	4,900,000 ha
Area irrigated in 1979	5,360,000 ha
Area irrigated in 1999	6,869,000 ha

The distribution of agricultural land in Indonesia is presented in the Table, as follow :

AGRICULTURAL AREA IN INDONESIA

No.	Provinces	Irrigation Scheme						Rain	Swamp				Upland	
		Technical	Semi Technical	Simple	Total	Village	Total (inc. Village)	Fed	Tidal	Non Tidal	Pond	Total		TOTAL
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	D.I. Aceh	99320	60689	129945	289954	67991	357945	57746	00000	05452	05740	11192	00000	426883
2	North Sumatera	128531	131705	57857	318093	93307	411400	188323	69786	04983	06506	81275	00000	680998
3	West Sumatera	106043	70750	65958	242751	80017	322768	28239	00000	13591	00000	13591	00000	364598
4	Riau	00000	30238	52162	82400	76283	158683	05075	73404	01190	00000	74594	00000	238352
5	Jambi	14179	10331	05154	29664	52824	82488	29395	35532	02601	00020	38153	00000	150036
6	South Sumatera	83008	87755	22738	193501	64574	258075	102644	145011	125212	00000	270223	00000	630942
7	Bengkulu	42553	28762	16103	87418	29268	116686	05769	00000	12484	00100	12584	00000	135039
8	Lampung	187953	11497	00000	199450	51790	251240	68327	39478	21510	18815	79803	00000	399370
	Western Region	**661587**	**431727**	**349917**	**1443231**	**516054**	**1959285**	**485518**	**363211**	**187023**	**31181**	**581415**	**00000**	**3026218**
9	DKI Jakarta	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000
10	West Jawa	694442	113489	59297	867228	339404	1206632	117378	00000	00000	00000	00000	00000	1324010
11	Central Jawa	583011	84313	164227	831551	108301	939852	194800	00000	00000	00000	00000	00000	1134652
12	D.I. Yogyakarta	23921	28064	04665	56650	17459	74109	10684	00000	00032	00000	00032	110991	195816
13	East Jawa	737094	94861	91855	923810	95941	1019751	249805	00000	00000	00000	00000	1180940	2450496
14	Bali	33309	56809	00000	90118	22055	112173	00188	00000	00000	00000	00000	00000	112361
15	West Kalimantan	07049	23849	04586	35484	32795	68279	50644	27318	33282	00000	60600	00000	179523

16	Central Kalimantan	15866	01141	03368	20375	29965	50340	21527	108229	20916	00000	129145	00000	201012
17	South Kalimantan	45421	02467	08721	56609	40331	96940	117428	24041	56630	00000	80671	00000	295039
18	East Kalimantan	00200	03180	02620	06000	51744	57744	51793	00000	11902	00000	11902	00000	121439
												00000		
	Central Region	**2140313**	**408173**	**339339**	**2887825**	**737995**	**3625820**	**814247**	**159588**	**122762**	**00000**	**282350**	**1291931**	**6014348**
19	North Sulawesi	41453	27369	05087	73909	23524	97433	12704	00568	00078	00430	01076	00000	111213
20	Central Sulawesi	56257	37670	17216	111143	31947	143090	22654	04634	03819	02874	11327	00000	177071
21	South-east Sulawesi	94535	26750	00000	121285	50467	171752	34255	00681	05677	25382	31740	00000	237747
22	South Sulawesi	247270	82478	18288	348036	98739	446775	231810	00000	36024	60789	96813	00000	775398
23	Maluku	19607	04127	00225	23959	12057	36016	05967	00000	00000	00000	00000	00000	41983
24	West Nusa Tenggara	86106	58614	01362	146082	46892	192974	39285	00000	00000	00000	00000	00000	232259
25	East Nusa Tenggara	17684	31139	15671	64494	82666	147160	121452	00000	00000	00000	00000	00000	268612
26	Irian Jaya	37350	01029	05403	43782	05500	49282	11202	18868	27706	00227	46801	00000	107285
	Eastern Region	**600262**	**269176**	**63252**	**932690**	**351792**	**1284482**	**479329**	**24751**	**73304**	**89702**	**187757**	**00000**	**1951568**
	TOTAL	**3402162**	**1109076**	**752508**	**5263746**	**160584 1**	**6869587**	**1779094**	**547550**	**383089**	**120883**	**1051522**	**1291931**	**10992134**

Source : Directorate General of Water Resources (1998)