FAO
WATER
REPORTS

ISSN 1020-1203

Irrigation in Southern and Eastern Asia

Acknowledgements

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Several resource people contributed to the preparation of the country profiles: Lutfor Rahman Khan (Bangladesh), P.B.S. Sarma (Bhutan and India), Yusman Syaukat (Indonesia), Shahid Ahmad (Pakistan), Roger Concepcion (Philippines), Sacha Sethaputra (Thailand), Phong Nguyen (Viet Nam).

The authors wish to acknowledge the assistance of Thierry Facon, FAO Regional Office for Asia and the Pacific, and Jacob Burke, Land and Water Division, in reviewing the report. The assistance of Jean Margat in reviewing the information related to the water resources was highly appreciated. Francesca Greco and Jippe Hoogeveen contributed to the country profiles of India, Indonesia, Philippines, Thailand and Viet Nam in their earlier stages. Special thanks go to Pasquale Steduto, Deputy Director, and to Parviz Koohafkan, Director, of the Land and Water Division, for their continuous support during the preparation of the report.

English proofreading was done by Rosemary Allison. The country, river basin and regional maps were prepared with the assistance of Emelie Healy.

Publishing arrangements and graphic design: Stéfanie Neno, Paolo Mander, with assistance from Gabriele Zanolli and James Morgan.

Indonesia

GEOGRAPHY, CLIMATE AND POPULATION

Geography

Indonesia is a tropical archipelago composed of 17 504 islands. It extends over about 1.9 million km^2 and the coastline exceeds 54 000 km, which is more than the circumference of the globe making it the country with the second longest coastline after Canada. The major islands are Sumatra, Java, Nusa Tenggara (including Bali), Kalimantan, Sulawesi, Maluku, and Papua (previously Irian Jaya). Most of the major islands have a mountain range running their entire length. The mountains are of volcanic origin and some are still active. The elevations on the islands range from 0 to 5 030 m above sea level. Since 2005 the country has been divided administratively into 33 provinces. In 2006, the provinces were subdivided into 349 regencies (*kabupaten*) and 91 cities (*kota*), 5 656 subdistricts (*kecamatan*), and 71 563 villages (*desa/kelurahan*). Jakarta is the capital city of the country, located on the island of Java.

The total cultivated area in 2009 was 42.6 million ha, which is around 22 percent of the total area of the country. Arable land was an estimated 23.6 million ha and the area under permanent crops 19.0 million ha (Table 1). Farm holdings in Indonesia are relatively small: 34 percent are less than 0.25 ha and a further 25 percent are between 0.25 and 0.50 ha.

Climate

Indonesia is located in a wet tropical region with an average annual rainfall of about 2 700 mm, varying from 1 300 mm in East Nusa Tenggara to 4 300 mm in parts of Papua (Table 2) (Bappenas, 2004).

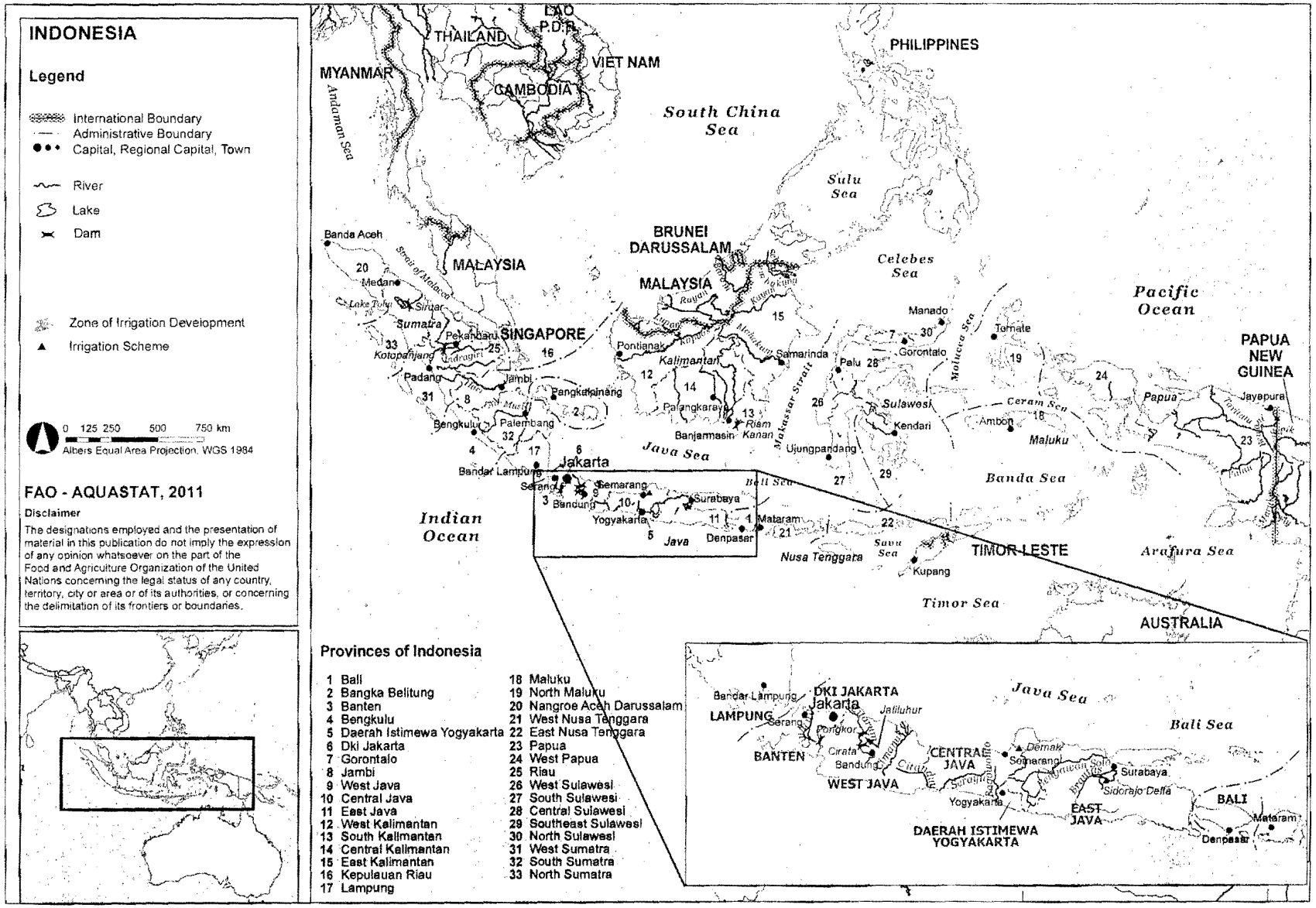
There are two seasons: the dry and the wet. The dry season is influenced by the Australia continental air masses and lasts from March to August. The wet season is influenced by the Asia Continental and Pacific air masses passing over the oceans and lasts from September to March. The heaviest rainfall is usually from November to February.

Temperatures range from 21 °C to 33 °C, but at higher altitudes the climate is cooler. Humidity is between 60 and 80 percent.

Population

In 2009, the total population was almost 237 million, of which 56 percent was rural (Table 1). There are four people in an average household. Population growth rate decreased sharply, from 2.1 percent per year during the period 1979-1989 to 1.2 percent per year from 1999 to 2009. Over time, Indonesia's population has been concentrated on Java Island, which contains 59 percent of the total population, while its land area is only 7 percent of the total land area of the country. Therefore, population density in Java was 1 019 people/km2 in 2009, while population density at the national level was 125 inhabitants per km^2.

In 2006, 80 percent had access to improved drinking water sources (89 and 71 percent for urban and rural population respectively) and sanitation coverage reached 52 percent (67 and


INDONESIA
Legend
International Boundary
Administrative Boundary
Capital, Regional Capital, Town
River
Lake
Dam
Zone of Irrigation Development
Irrigation Scheme
0 125 250 500 750 km
Albers Equal Area Projection, WGS 1984
FAO - AQUASTAT, 2011
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Provinces of Indonesia
1 Bali
2 Bangka Belitung
3 Banten
4 Bengkulu
5 Daerah Istimewa Yogyakarta
6 Dki Jakarta
7 Gorontalo
8 Jambi
9 West Java
10 Central Java
11 East Java
12 West Kalimantan
13 South Kalimantan
14 Central Kalimantan
15 East Kalimantan
16 Kepulauan Riau
17 Lampung
18 Maluku
19 North Maluku
20 Nangroe Aceh Darussalam
21 West Nusa Tenggara
22 East Nusa Tenggara
23 Papua
24 West Papua
25 Riau
26 West Sulawesi
27 South Sulawesi
28 Central Sulawesi
29 Southeast Sulawesi
30 North Sulawesi
31 West Sumatra
32 South Sumatra
33 North Sumatra
THAILAND
LAO P.D.R.
VIET NAM
CAMBODIA
MYANMAR
PHILIPPINES
BRUNEI DARUSSALAM
MALAYSIA
SINGAPORE
AUSTRALIA
TIMOR-LESTE
PAPUA NEW GUINEA
South China Sea
Sulu Sea
Celebes Sea
Pacific Ocean
Java Sea
Indian Ocean
Banda Sea
Timor Sea
Arafura Sea
Nusa Tenggara
Sumatra
Kalimantan
Sulawesi
Java
Maluku
Papua
Banda Aceh
Medan
Pekanbaru
Padang
Jambi
Palembang
Bengkulu
Bangkalanang
Palangkaraya
Banjarmasin
Pontianak
Samarinda
Manado
Gorontalo
Palu
Kendari
Ujungpandang
Ambon
Ternate
Jayapura
Bandar Lampung
Serang
Jakarta
Semarang
Surabaya
Bandung
Yogyakarta
Denpasar
Mataram
Kupang
DKI JAKARTA
LAMPUNG
BANTEN
WEST JAVA
CENTRAL JAVA
EAST JAVA
DAERAH ISTIMEWA YOGYAKARTA
BALI
Jatiluhur
Pangkor
Cirata
Demak
Sidorajo Delta

TABLE 1
Basic statistics and population

Physical areas			
Area of the country	2009	190 457 000	ha
Cultivated area (arable land and area under permanent crops)	2009	42 600 000	ha
• as % of the total area of the country	2009	22	%
• arable land (annual crops + temp fallow + temp meadows)	2009	23 600 000	ha
• area under permanent crops	2009	19 000 000	ha
Population			
Total population	2009	237 414 000	inhabitants
• of which rural	2009	56	%
Population density	2009	125	inhabitants/km^2
Economically active population	2009	117 635 000	inhabitants
• as % of total population	2009	50	%
• female	2009	37	%
• male	2009	63	%
Population economically active in agriculture	2009	49 513 000	inhabitants
• as % of total economically active population	2009	42	%
• female	2009	39	%
• male	2009	61	%
Economy and development			
Gross Domestic Product (GDP) (current US$)	2009	540 274	million US$/yr
• value added in agriculture (% of GDP)	2009	16	%
• GDP per capita	2009	2 276	US$/yr
Human Development Index (highest = 1)	2010	0.600	
Access to improved drinking water sources			
Total population	2008	80	%
Urban population	2008	89	%
Rural population	2008	71	%

37 percent for urban and rural population respectively). About 60 percent of households have their own toilet facilities. In 2006, there were about 30 million poor, which is equal to 18 percent of the total population. The level of urban poverty (13 percent) is lower than that of rural areas (22 percent).

ECONOMY, AGRICULTURE AND FOOD SECURITY

The total economically active population in 2009 was 118 million, of which 37 percent were women. The population that is economically active in agriculture is an estimated 50 million, approximately 42 percent of the economically active population. Of the population economically active in agriculture, 39 percent are women and 61 percent are men. In 2009, the gross domestic product (GDP) was US$540 274 million, with a value added in agriculture that was 16 percent of the GDP (Table 1).

Wetlands play a very important role in food production, including rice and secondary crops (maize, cassava, soybean, sweet potatoes, peanut). Total harvested area of paddy in 2005 was 11.8 million ha, composed of 10.7 million ha wetland rice (91 percent) and 1.1 million ha dryland rice (9 percent). Total paddy production was 54.1 million tonnes, of which 51.3 million tonnes were wetland paddy (95 percent) and 2.8 million tonnes dryland paddy (5 percent).

TABLE 2
Average rainfall and renewable water resources (Source: Adapted from Bakosurtanal, 2001)

Island	Area	Precipitation		Internal renewable surface water and groundwater resources (km^3/year)	
	1000 km^2	mm/year	km^3/year	IRSWR	IRGWR
Sumatra	464	2 600	1 206.4	481.4	85.8
Java	132	2 600	343.2	125.6	25.6
Nusa Tenggara	73	1 500	109.5	37.1	1.5
Kalimantan	572	2 800	1 601.6	594.2	125.1
Sulawesi	168	2 100	352.8	177.1	16.6
Maluku	75	2 200	165.0	63.5	5.9
Papua	421	3 200	1 347.2	493.7	196.9
Total	**1 905**	**2 700**	**5 125.7**	**1 972.6**	**457.4**
Overlap between IRSWR and IRGWR				**411.7**	
Total IRWR				**2 018.3**	

Productivity of dryland (rainfed) rice is just a little bit more than half of the productivity of wetland rice: 2.56 tonnes/ha against 4.78 tonnes/ha.

Though Indonesia produces a large quantity of rice, it is still a rice importer. In the past, it was the largest rice importer, reaching 1.8 million tonnes of rice in 2002. However, in 2006 import rates reduced significantly, to as little as 438 000 tonnes. Besides food crops, Indonesia is also producing a large number of perennial crops, including rubber, coconut, palm oil, coffee, cocoa, and tea, which are currently exported.

In terms of food security, national rice production is relatively safe and stable. In 2000, surprisingly, Indonesia had a rice surplus of more than 2 million tonnes (Suprapto, 2001). This surplus resulted from favourable weather, increased cropping intensity and rice planting area, and from a decline in the national per capita rice consumption. The domestic food availability has fulfilled the needs of the population; the average available calories are 2 200 kcal per capita per day.

WATER RESOURCES AND USE

Water resources

Total internal natural renewable water resources are around 2 018.3 km^3/year (Table 2). Surface water resources are an estimated 1 972.6 km^3/year and groundwater resources 457.4 km^3/year. Most of the groundwater, an estimated 90 percent or 411.7 km^3/year, returns as baseflow to the rivers. It is assumed that only 30 percent of groundwater resources, or 137.2 km^3/year, are consumable, called 'safe yield' (Table 3) (Bakosurtanal, 2001). Over-abstraction of groundwater in Jakarta has caused saline groundwater to reach about 10 km inland from the coastline and has led to land subsidence at a rate of 2-34 cm/year in east Jakarta.

TABLE 3
Safe yield of groundwater by Island (Source: Bakosurtanal, 2001)

Island	Groundwater (km^3/year)	
	Potential	Safe Yield
Sumatra	85.8	25.7
Java	25.6	7.7
Bali and Nusa Tenggara	1.5	0.4
Kalimantan	125.1	37.5
Sulawesi	16.6	5.0
Maluku	5.9	1.8
Papua	196.9	59.1
Total	**457.4**	**137.2**

Although water resources are abundant, the seasonal and spatial variation in the rainfall pattern and lack of adequate storage

create competition and conflicts among users. Municipal and industrial wastewater is discharged virtually untreated into the waterways causing rapid deterioration in the quality of river water.

Most of the lakes in Indonesia are of volcanic origin. Lake Toba is the largest volcanic lake in the world with an average surface area of 1 100 km^2 and an average volume of 1 258 km^3.

In 2006, total dam capacity reported was 22.49 km^3, but total capacity is higher because the capacity was unknown for some dams. In 1995 total dam capacity was an estimated 15.83 km^3. The dams with a capacity of over 1 km^3 are Jatiluhur (2.89 km^3), Siruar (2.82 km^3), Cirata (2.17 km^3), Pongkor (1.95 km^3), Batu Bokah (1.67 km^3), Kotopanjang (1.55 km^3) and Riam Kanan (1.20 km^3).

By developing large dams, Indonesia has progressively been able to extend its water resources utilization to support 2 200 MW of hydropower generation, representing 20 percent of the national generating capacity.

International water issues

Based on a recent river territory inventory, Indonesia has 14 rivers that exceed state boundaries: five rivers with Malaysia in Kalimantan island (Baram, Lupar, Sebuku, Sembakung, and Serundong), three rivers with Timor Lorosae in Timor island (Loes, Nitibe, and Wini), and six rivers with Papua New Guinea in Papua island (Bewani, Fly, Merauke, Sepik, Tami, and Tari) (Witoelar, undated). There are no records of major issues related to these transboundary rivers.

Water use

In 2000, total water withdrawal was 113 km^3 (Table 4 and Table 5). Water withdrawal for agriculture accounted for 93 km^3, or 82 percent, municipalities and industries accounted for

TABLE 4
Water: sources and use

Renewable freshwater resources			
Precipitation (long-term average)	-	2 702	mm/yr
	-	5 146 500	million m^3/yr
Internal renewable water resources (long-term average)	-	2 018 000	million m^3/yr
Total actual renewable water resources	-	2 018 000	million m^3/yr
Dependency ratio	-	0	%
Total actual renewable water resources per inhabitant	2009	8 500	m^3/yr
Total dam capacity	2006	22 492	million m^3
Water withdrawal			
Total water withdrawal	2000	113 290	million m^3/yr
- irrigation + livestock	2000	92 763	million m^3/yr
- municipalities	2000	13 129	million m^3/yr
- industry	2000	7 398	million m^3/yr
• per inhabitant	2000	531	m^3/yr
Surface water and groundwater withdrawal	2000	113 271	million m^3/yr
• as % of total actual renewable water resources	2000	5.6	%
Non-conventional sources of water			
Produced wastewater		-	million m^3/yr
Treated wastewater		-	million m^3/yr
Reused treated wastewater		-	million m^3/yr
Desalinated water produced	1990	19	million m^3/yr
Reused agricultural drainage water		-	million m^3/yr

TABLE 5
Total water withdrawal by Island in 2000 (km^3/year)

Island	Municipalities	Irrigation	Industry	Total
Sumatera	2.6	14.6	2.6	19.8
Java	7.9	54.1	2.9	64.9
Bali and Nusa Tenggara	0.3	5.5	0.8	6.6
Kalimantan	1.0	3.4	0.7	5.1
Sulawesi	0.9	15.0	0.4	16.3
Maluku	0.1	0.1	0.0	0.2
Papua	0.3	0.1	0.0	0.4
Total	**13.1**	**92.8**	**7.4**	**113.3**
Percentage of total	**12**	**82**	**6**	**100**

FIGURE 1
Water withdrawal by sector
Total 113.29 km^3 in 2000

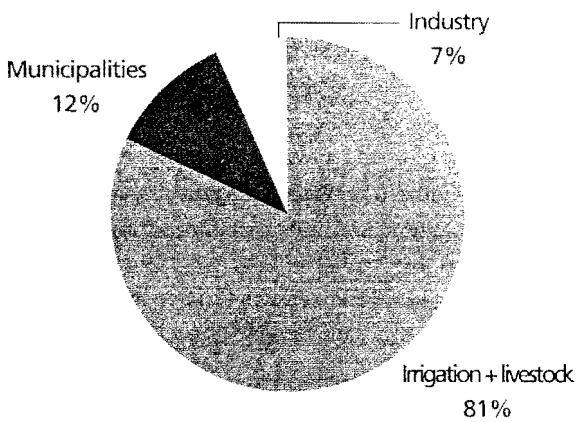
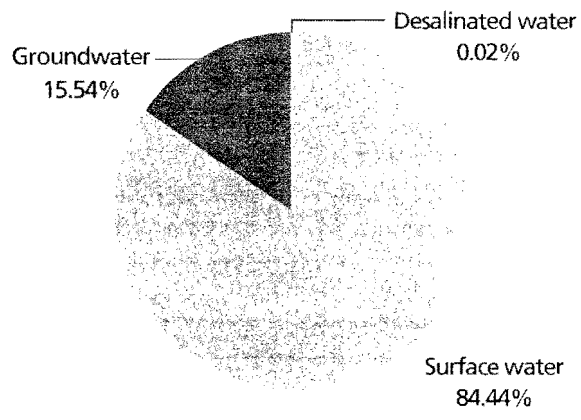


FIGURE 2
Water withdrawal by source
Total 113.29 km^3 in 2000



13 km^3 (12 percent) and 7 km^3 (6 percent) respectively (Figure 1). In 1990, total water withdrawal was about 74 km^3, of which 93 percent for agriculture, 6 percent for municipalities and 1 percent for industrial use.

In 2000 surface water and groundwater withdrawal was 84.4 percent and 15.5 percent respectively of total water withdrawal (Figure 2). In 1990 desalinated water was an estimated 19 million m^3.

Groundwater is used by 74 percent of households for their clean water sources, while the rest use river water (3.4 percent), piped surface water (21.2 percent), and other water sources (1.4 percent).

Industrial water demand has gradually increased over time. Since piped and open surface water supplies are relatively limited, where the industries are located, most use groundwater for their water source, particularly in the large cities of Java.

Both national and island-by-island water balances are positive, meaning that water availability is higher than consumption level. However, in Java and Nusa Tenggara a water deficit occurs during the dry season (July to October, varying by the province). Even some significantly large river areas in Java, including Bengawan Solo, Brantas, Ciliwung, Cimanuk, Citanduy, and Ciujung, are estimated to face water deficit problems during the dry season.

IRRIGATION AND DRAINAGE DEVELOPMENT

Evolution of irrigation development

The development of community irrigation systems started more than two thousand years ago. Modern irrigation systems were introduced in the middle of the nineteenth century. Small irrigation systems developed by the communities in Java covered a total of 1.1 million ha in 1880. This asset was very significant at that time since the total population of Java was only 19.5 million. The development of irrigation systems grew at a rate of 1.21 percent per year in the period 1880-1915, covering 1.62 million ha in 1915. The Dutch colonial government developed the first large irrigation system, 34 000 ha, in Sidorajo delta in East Java by using the Brantas river water flows.

A full-technological irrigation and drainage system was first developed during the 1880s in Demak, Central Java, on 33 800 ha. This system was developed to address the famine caused by drought and floods in the area. The *Burgerlijke Openbare Werken,* which later became the Department of Public Works, was developed in 1885, among other tasks, it was to develop irrigation systems. The *Departement van Landbouw,* which later became the Department of Agriculture,)was developed in 1905 in Bogor, West Java.

The development of irrigation systems became one of the priorities of the newly created Republic of Indonesia after the Second World War. The first multi-sector project was proposed in 1948 to develop Jatiluhur dam at Citarum river in West Java to allocate water for irrigation, hydropower, and domestic use. In 1969, Indonesia launched its first five-year development programme (Repelita I). Since then, there have been other rice intensification programmes, their main objective is to achieve self-sufficiency in rice. This includes supply of irrigation water, use of high-yield varieties, fertilizers, and pesticides, and is supported by agricultural extension programmes. The irrigation development programme includes rehabilitation of existing irrigation works, expansion of service areas in existing schemes, construction of new irrigation systems, upgrading of the existing irrigation systems, implementation of efficient operation and management programmes, strengthening of water user associations (WUAs), and many other initiatives.

In the first 25 years of development, spanning five Repelitas (1969-1993) termed 'Pembangunan Jangka Panjang I' (PJP I) or first phase of long-term development, water resources policies were directed to supporting the development of different sectors with the primary emphasis being on agriculture. About 1.44 million ha were provided with new irrigation systems and 3.36 million ha of existing irrigation systems were either rehabilitated or upgraded through special maintenance.

The second 25-year development period (1994-2019), termed PJP II, started in April 1993 with Repelita VI. The emphasis was on sustainable development and management of water resources. Water resources have been elevated to a full sector level and policies are directed to promoting a more effective and efficient management of water resources in an integrated manner. Greater emphasis is placed on sustaining self-sufficiency in rice and on the operation and maintenance of water resources infrastructure. In addition, the Government is implementing a crash programme in Repelita VI to improve one million ha of village irrigation systems and to develop a 600 000 ha rice estate by swamp reclamation in central Kalimantan.

The irrigation potential of the country is an estimated 10.9 million ha. In 1996, the total atea equipped for full control irrigation was 4.43 million ha. In addition, there were 0.70 million ha of 'simple' irrigation and 1.96 million ha of village managed schemes. It should be noted, however, that large discrepancies are observed between sources of information, leading to significant uncertainties about the areas under irrigation. It was reported that, in 1995, 638 reservoirs, 10 770 weirs, 1 017 barrages, 1 192 pumping stations and 6 792 intakes were used to supply

water to 4 600 000 ha. In 1995, irrigation from groundwater teportedly covered 44 209 ha, of which 36 784 ha were served by 834 deep tubewells, 4 204 ha by 363 intermediate tubewells and 14 807 ha by 471 shallow tubewells. In 2005 it was estimated that 99 percent of the total equipped area was irrigated by surface water and 1 percent by groundwater (Figure 3).

Total water managed area covered 9 855 616 ha in 2005 (Table 6). Full control irrigation areas covered 6 722 299 ha (68 percent), comprising technical, semi-technical, and simple irrigation, while non-equipped cultivated wetlands covered 3 133 317 ha (32 percent), of which 2 088 622 ha were village managed and 1 044 695 cultivated by the state. Of the total equipped area for irrigation 100 percent is irrigated using surface irrigation techniques.

Fields under water management are classed under five types: technical, semi-technical, and simple irrigation, and village-managed wetlands and cultivated swamps (Table 7). Usually the first three types belong to the public works system.

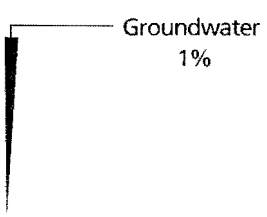
Technical irrigation is an irrigation system in which distribution of water can be fully controlled from the source to the field. It is characterized by permanent canals, control structures, and measuring devices. This irrigation system consists of primary, secondary, and tertiary canals, which are fully controlled by the government. In 2005 they served 4 781 860 ha while in 1996 they served 3 328 016 ha.

Semi-technical irrigation systems are characterized by permanent canals and few control or measuring devices. The government usually controls the primary canals, which are equipped with measuring devices, while the distribution systems next to those canals are not equipped with measuring devices. This system served 1 257 987 ha in 2005 and 1 099 906 ha in 1996.

Simple irrigation systems are characterized by only a few permanent control or distribution structures and may be managed by farmers. The government may provide a part of the system, for example building the required dam. Simple irrigations systems were serving 683 242 ha in 2005 and 697 194 ha in 1996.

Village-managed wetland cultivation is a basic wetland water control system, developed and managed spontaneously by farmers. This system served 2 088 622 ha in 2005 and 1 961 496 ha in 1996.

FIGURE 3
Source of irrigation water on area equipped for full control irrigation
Total 6 722 299 ha in 2005



Cultivated swampland is wetland where its watering mechanisms depend on river water, which is affected by seawater tides. Indonesia has an estimated 39 million ha of coastal and inland swamps. The extent of arable swampland has not been assessed in detail but is estimated to be 7.5 million ha. In 2005, the tidal and non-tidal swamp area mainly used for rice was about 1 044 695 ha and in 1996 1 182 760 ha in 1996.

In 2006, the average cost of developing a public scheme was US$1 630/ha, while the average operation and maintenance cost of a public irrigation system was US$390/ha per year.

TABLE 6
Irrigation and drainage

Irrigation potential			10 886 000	ha
Irrigation				
1. Full control irrigation: equipped area		2005	6 722 299	ha
- surface irrigation		2005	6 722 299	ha
- sprinkler irrigation			-	ha
- localized irrigation			-	ha
• % of area irrigated from surface water		2005	99	%
• % of area irrigated from groundwater		2005	1	%
• % of area irrigated from mixed surface water and groundwater			-	%
• % of area irrigated from mixed non-conventional sources of water			-	%
• area equipped for full control irrigation actually irrigated			-	ha
- as % of full control area equipped			-	%
2. Equipped lowlands (wetland, ivb, flood plains, mangroves)			-	ha
3. Spate irrigation			-	ha
Total area equipped for irrigation (1+2+3)		2005	**6 722 299**	ha
• as % of cultivated area		2005	18	%
• % of total area equipped for irrigation actually irrigated		-	-	%
• average increase per year over the last 10 years		1996-2005	4.3	%
• power irrigated area as % of total area equipped			-	%
4. Non-equipped cultivated wetlands and inland valley bottoms		2005	3 133 317	ha
5. Non-equipped flood recession cropping area			-	ha
Total water-managed area (1+2+3+4+5)		2005	**9 855 616**	ha
• as % of cultivated area		2005	26	%
Full control irrigation schemes	**Criteria**			
Small-scale schemes	< ha		-	ha
Medium-scale schemes	> ha and < ha		-	ha
Large-scale schemes	< ha		-	ha
Total number of households in irrigation			-	
Irrigated crops in full control irrigation schemes				
Total irrigated grain production (wheat and barley)			-	metric tons
• as % of total grain production			-	%
Harvested crops				
Total harvested irrigated cropped area		2005	13 388 358	ha
• Annual crops: total		2005	13 388 358	ha
- Rice		2005	10 733 600	ha
- *Rice-one*		2005	4 541 200	ha
- *Rice-two*		2005	3 869 200	ha
- *Rice-three*		2005	2 323 200	ha
- Maize		2005	1 269 100	ha
- Soyabeans		2005	279 900	ha
- Vegetables		2005	244 388	ha
- Tobacco		2005	198 200	ha
- Potatoes		2005	65 420	ha
- Sweet Potatoes		2005	178 300	ha
- Groundnuts		2005	324 000	ha
- Sugarcane		2005	95 450	ha
• Permanent crops: total			-	ha
Irrigated cropping intensity (on full control irrigation equipped area)		2005	199	%
Drainage - Environment				
Total drained area		1990	3 350 000	ha
- part of the area equipped for irrigation drained			-	ha
- other drained area (non-irrigated)			-	ha
• drained area as % of cultivated area			-	%
Flood-protected areas			-	ha
Area salinized by irrigation		1999	400 000	ha
Population affected by water-related diseases		2005	5 111 472	inhabitants

TABLE 7
Distribution of water managed areas by types, 2005 (ha)

Irrigation		**6 722 299**
- Technical	4 781 860	
- Semi technical	1 257 197	
- Simple irrigation	683 242	
Cultivated wetland		**3 133 317**
- Village management	2 088 622	
- Cultivated swamps	1 044 695	
Total		**9 855 616**

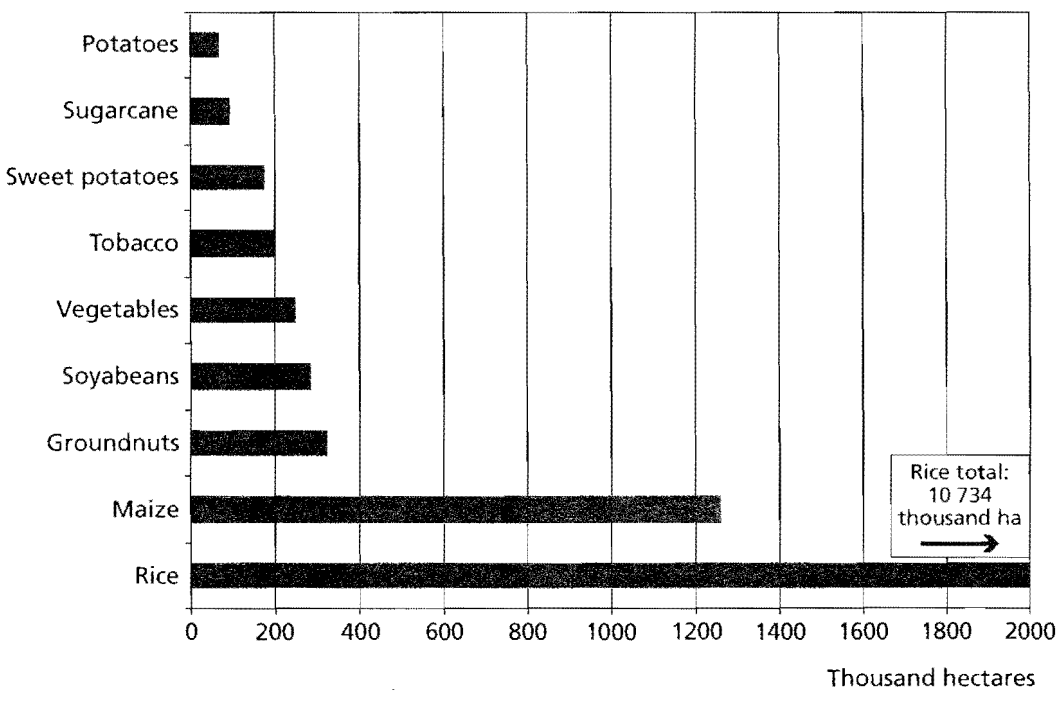
Role of irrigation in agricultural production, economy and society

One of the main objectives of irrigation development in Indonesia is to achieve food self-sufficiency, particularly rice; since 1969 rice cultivation has been expanding. By promoting this kind of rice production, combined with land development, irrigation rehabilitation and crop intensification programmes, the country achieved rice self-sufficiency in 1984. However, because of the rapid rate of fertile agricultural land conversion to non-agricultural use (at an average rate of 50 000 ha/year), a prolonged period of drought and flood, precipitous environmental degradation, reduced subsidies for agricultural inputs and extension activities, rice self-sufficiency became unstable.

Since 1994, Indonesia has been importing rice to meet demand or to maintain a national buffer stock, which is managed by the Bureau of Logistic (BULOG) for market operation, if there is a rice scarcity, especially during the dry season. However, as a result of continuous efforts to increase food production, Indonesia could achieve almost 100 percent of its rice requirements. The import level is significantly lower (about 2 percent of total national rice production) compared to the past records.

Water resources and related infrastructure development have contributed to agricultural, local and national development through their contribution to increasing farmers' average income and consequent alleviating poverty.

FIGURE 4
Irrigated crops on area equipped for full control irrigation
Total harvested area 13 388 358 ha in 2005 (cropping intensity on equipped area: 199% in 2005)



In 2005, the total harvested area of paddy was 11.84 million ha (90.7 percent irrigated and 9.3 percent rainfed) which produced 54.15 tonnes of paddy.

In 2005 the total harvested irrigated cropped area was 13.39 million ha (Table 6 and Figure 4). The major crops cultivated under full control irrigation are paddy, which account for 10.73 million ha, followed by maize, groundnuts and soybeans, which account for 1.3 million ha, 0.32 million ha and 0.28 million ha respectively.

Most irrigated areas are planted with rice twice a year and are left fallow or planted with secondary crops (such as maize or other) in the third season. Typical cropping patterns are rice-rice-fallow or rice-rice-secondary crop. In other areas, particularly those close to irrigation channels, rice can be planted up to three times. In general, rice is always available in the field, but in a smaller area in the third season.

Status and evolution of drainage systems

In 1990 the total drained area was an estimated 3 350 000 ha.

WATER MANAGEMENT, POLICIES AND LEGISLATION RELATED TO AGRICULTURAL WATER USE

Institutions

The Constitution of the Republic of Indonesia (Undang-Undang Dasar 1945) Article 33 states that, "production branches which are important to the country and which provide for the needs of the people must be controlled by the State. Earth and water and all natural resources contained in their bodies are managed under authority of the State and utilized in the interests of the welfare of the nation". This enshrines the concept that Indonesia's natural resources belong to the state and are to be used for the welfare of the Indonesian people. Operational policy of this basic rule is explained in Law (Undang-Undang) number 7 of 2004.

This law reiterates the constitutional principle that water resources have a social function: water exploitation should be used for the highest prosperity of the people and should be controlled by the state. This law promulgates the institution of two departments in association with water resources. The Department of Public Works is authorized to coordinate all efforts and activities for the planning, detailed engineering, supervision, business development, maintenance, as well as legislation and utilization of surface water resources, which also includes water springs. The Department of Mining and Energy is authorized to manage groundwater resources, which also includes thermal spring waters. The institutional framework is, in fact, relatively complex, because it involves many agencies and each agency might produce individual regulations (including Government Regulation, Presidential Decrees and Decisions, Ministerial Regulations, Directorate Regulations, Governor and District Regulations) to control water resources (Syaukat, 2000).

Water management

Issues of water resources management, both quantitative and qualitative, are increasingly important on Java and on other islands, including Kalimantan, Sumatra, Sulawesi, Papua, but with different types of problems and hence different approaches to be undertaken. Problems in Java are characterized by overpopulation, as well as water and other natural resources degradation and depletion. The other islands are mainly characterized by water and other natural resources degradation because of widespread deforestation and improper open mining practices and new plantations.

Overexploitation of groundwater has resulted in some critical problems, including contamination by pollutants entering groundwater, salinization of aquifers and land subsidence. Land subsidence

is mainly the result of a strong decrease in the levels of deep groundwater in areas with high groundwater extraction. Over-extraction of groundwater results in external costs including those related to the lowering of the shallow groundwater table and the table in deep wells, and costs related to land subsidence and pollution of shallow groundwater (Syaukat, 2000).

These conditions require an improvement in water resources management in Indonesia. There should be an integrated management and treatment of both surface water and groundwater. With this approach, a better water resources planning, development and management could be attained.

Finances

From the end of the 1960s, the government made large investments in land and water resources development to achieve food self-sufficiency. However, as Indonesia gained confidence in securing its national food supply, attention gradually began to include the industrial sector, to support export promotion and import substitution. Therefore, since the beginning of 1990, government investments in land and water resources have gradually decreased. In this period, investments in land and water resources focused on improved operation and maintenance of irrigation infrastructure and facilities.

Funding for the development of this sector came from national budgets and international donors. These includied the International Bank for Reconstruction and Development (IBRD), Japan International Cooperation Agency (JICA), Japan Bank for International Cooperation (JBIC), and the Asian Development Bank (ADB). For example, IBRD financed groundwater development projects in 11 provinces from 1993 to 1999, and integrated tidal swamp development in three provinces from 1994 to 2000. The ADB financed irrigation sector projects in four provinces in Sulawesi from 1994 to 2000. The main objective of all these projects is to increase land productivity and food crop production.

Policies and legislation

During the government period 2004-2009, the following five strategic policies on water resources management were determined:

- Water resource conservation: This policy is designed to conserve and maintain the availability and functions of water resources in order to meet the water needs not only for current genetation, but also for the future generations. The efforts are directed towards increasing water availability, to improving water quality, as well as to recovering and improving the capacity of the environment.
- Optimal use of water resources: This policy includes various efforts in the provision, use, development and management of water resources to meet the various water demands: household, agriculture, municipalities, industries, electricity, tourism and environment.
- Control of potential water-destructive capacity: This policy aims to reduce and copw with the potential impacts of flood, drought, erosion and abrasion on the atea of agricultural and industrial production, human settlement and other infrastructure. The efforts include preventive measures to protect production and settlement areas, and public infrastructure from floods, to recover environmental conditions, and to improve community alertness on the issues of floods and other potential damage caused by water.
- Empowerment and improvement of community, private and government participation: This policy includes increasing the cooperation and participation of all stakeholders, including government, private sector and community to achieve a productive, effective, efficient and equitable water resources management system, without sacrificing public interests, and to prepare effective and efficient government institutions in association with decentralization, democratization, synergy privatization, and conflict resolution in water resources management.

- Increasing transparency and availability of data and information on water resources management: This policy intends to push democratization in water resource management. Transparency in the processes of water resource management should be improved to provide more access to all stakeholders to participate in the implementation of water resources development programmes.

The laws and regulations concerning water resources and their management are as follows:

- Indonesian Law Number 7, year 2004: water resources laws
- Government Regulation Number 77, year 2001: irrigation
- Government Regulation Number 82, year 2001: water quality management and water pollution control
- Government Regulation on water resource management
- Government Regulation on management of water resources in river system
- Government Regulation on financing water resource development
- Government Regulation on rivers
- Government Regulation on groundwater
- Government Regulation on drinking water
- Government Regulation on Perum Jasa Tirta I
- Government Regulation on Perum Jasa Tirta II
- Presidential Instruction Number 3, year 1999: policy reformation on irrigation management
- Presidential Decree Number 9, year 1999: coordination team on river water use and development policies
- Presidential Decree Number 123, year 2001 (renewed by President Decree Number 83, year 2002): coordination team on water resources management
- Decision of the Coordinator Ministry on Economy, Finance, and Industry
- Decision of the Coordinator Ministry on Economy
- Decision of the Ministry of Settlements and Regional Infrastructures (Dept of Public Works)
- Decision of the Ministry of Internal Affairs
- Decision of the Ministry of Environment
- Provincial Regulations on formation of the agencies for water resources development (8 provinces)
- Provincial Regulations on water pollution control (4 provinces)
- Governor Decisions on development of the Coordination Teams for Provincial Water Resources Management (8 ptovinces)
- District and Municipality Regulation concerning water resources for domestic, agricultural and industrial use.

ENVIRONMENT AND HEALTH

The strategic geographical location, accompanied by high rainfall, mountainous geography, as well as large forest resources, have led Indonesia to be rich in water resources. However, environmental changes are influencing the water cycle, which causes uneven distribution of water supply. The imbalanced water supply is a serious problem, since it might lead to a number of natural disasters. Flooding occurs duting the tainy season, while drought is frequent in the dry season.

Massive deforestation and environmental degradation have been caused by these extreme conditions. Massive deforestation in the upper parts of the watershed has caused the rainfall to runoff more freely, and to concentrate more rapidly into the waterways, thus causing flash floods. Owing to the high level of municipal and industrial waste, many rivers are significantly or

seriously polluted. It has not been possible to quantify the costs of pollution to the economy, but major costs have been identified in sickness and the resulting loss of work; pollution is so severe in major cities, such as Jakarta and Surabaya, that industries have been forced to close during dry years because of raw water shortages. Costs have also been accounted by calculating the losses in fisheries and aquaculture, and by the damage suffered by mangroves and fragile coastal areas.

Water pollution poses an immediate threat to human welfare and industrial growth. This problem is exacerbated by water shortage in the dry season, which prevents waste from being flushed away from the inhabited centers. The most excessive pollutant in Indonesian rivers is faecal coliform from human waste. This element exceeds the recommended standards in key cities by a thousand-fold or more. Water-borne diseases such as cholera, dysentery, gastroenteritis, typhoid, paratyphoid, hepatitis A, and parasitic intestinal infection, are transmitted by the ingestion of water contaminated with human feces. The transmission of these diseases is frequently related to lack of available safe water. Improvement of water and sanitation can be expected to reduce diarrheal mortality and morbidity.

The number of people with AIDS and HIV infection is reported to have increased over time. In 2004, the number of people with AIDS was 2 682, of these 700 people have died. This showed that the AIDS rate was about 1.33 cases per 100 000 people. In 2005, there were 5 560 people infected with HIV/AIDS.

PROSPECTS FOR AGRICULTURAL WATER MANAGEMENT

Issues of water resources management will be increasingly important in the years ahead, especially in Java, which covers only 7 percent of the total area of the country, but has 59 percent of the population, 70 percent of irrigated agriculture, and 75 percent of the industry. Issues of water quantity include emerging conflicts between competing uses (agricultural, industrial and municipal), and between surface water and groundwater in rapidly growing urban areas. While Java is endowed with rainfall, it is highly seasonal. Dry season flows in the main rivers are only 20 percent of the annual flows. River basins on Java are relatively steep and short, and most of the wet season water runs unused into the sea. Reservoirs hold less than 5 percent of total river flows.

During the wet season, river flows bring high rates of sedimentation resulting from excessive erosion in the upstream part of the basin. This causes very fast sedimentation rates in reservoirs and lakes, making the lifetime of reservoirs shorter than planned, as well as reducing storage capacities. Most of the reservoircapacity of major river basins in Java (Bengawan Solo, Brantas, Citarum, Serayu-Bogowonto) was planned to meet the water demand for various uses up to 2010. While additional sites have been identified for future dams, implementation will be constrained by high population densities and the social and economic costs of resettlement.

Though industrial and municipal water use is still relatively low, it will increase over time. Meeting this demand will require a transfer of water in dry season from agriculture to municipal and industrial use. Minimizing the social and economic costs for farmers and potential disruption to agricultural output will require that water resources will be managed according to the integrated river basin principle. The challenge of meeting the water demand during the dry season is becoming even more complex if the pollution from growing urban and industrial waste is considered.

Based on the above conditions, an integrated action is needed to reverse the present trends of over-consumption, pollution, and increasing threat of drought and floods. To support water resources development and management, the government has proposed an Integrated Water Resources Management Policy framework to support and guide development and conservation

effort. The policy is addressing water quantity and quality for both surface water and groundwater in the context of river basins, including the upper parts of the basins and estuarine areas. A specific component of the policy is dealing with environmentally and socially sensitive swampland development issues.

The future of irrigation should be considered as an integral framework to increase human welfare, to provide social justice, and to maintain ecosystem sustainability. Along with overcoming water and land resources problems, some national action should be taken, including: improving agricultural infrastructure, increasing the quality of intensification, improving the institutions, conducting reforestation and re-greening programmes.

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