

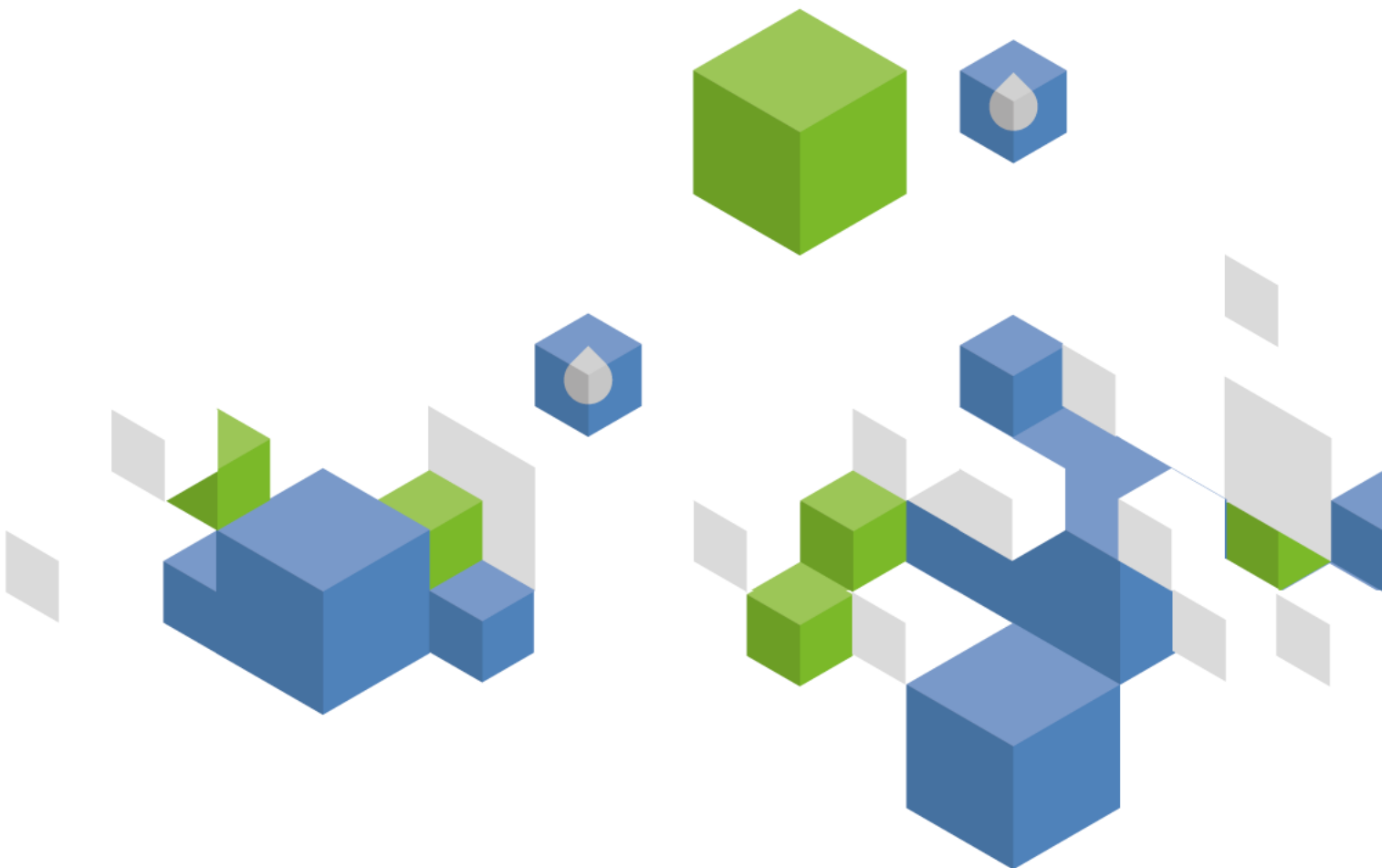


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Viet Nam

GEOGRAPHY, CLIMATE AND POPULATION

Geography

Viet Nam is located in the eastern part of the Indochina peninsula, bordered by China in the north, the South China Sea in the east and south, the Gulf of Thailand in the southwest, and Cambodia and Lao People's Democratic Republic in the west. The total area of the country is 331 052 km² (Table 1). The country is divided into 64 provinces including the capital Hanoi. Based on topographic, climatic and socio-economic conditions, these provinces are grouped into eight regions from north to south: North West, North East, Red river delta, North Central Coast, South Central Coast, Central Highland, South East and Mekong river delta.

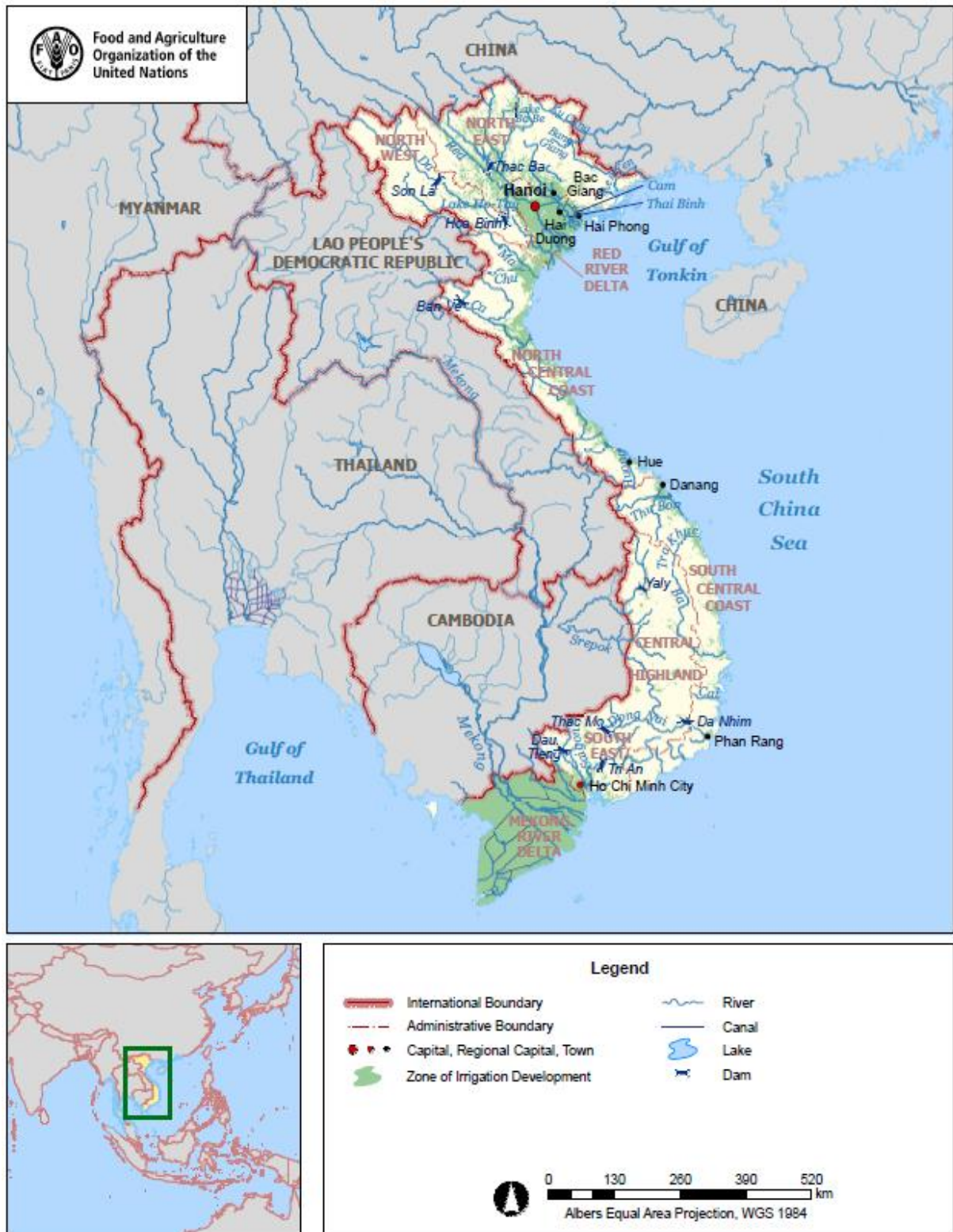
TABLE 1
Basic statistics and population

Physical areas:			
Area of the country	2009	33 105 200	ha
Cultivated area (arable land and area under permanent crops)	2009	9 630 000	ha
• as % of the total area of the country	2009	29	%
• arable land (annual crops + temp fallow + temp. meadows)	2009	6 280 000	ha
• area under permanent crops	2009	3 350 000	ha
Population:			
Total population	2009	86 901 000	inhabitants
• of which rural	2009	70	%
Population density	2009	263	inhabitants/km ²
Economically active population	2009	46 076 000	inhabitants
• as % of total population	2009	53	%
• female	2009	49	%
• male	2009	51	%
Population economically active in agriculture	2009	29 301 000	inhabitants
• as % of total economically active population	2009	64	%
• female	2009	49	%
• male	2009	51	%
Economy and development:			
Gross Domestic Product (GDP) (current US\$)	2009	90 091	million US\$/yr
• value added in agriculture (% of GDP)	2009	21	%
• GDP per capita	2009	1 037	US\$/yr
Human Development Index (highest = 1)	2010	0.572	
Access to improved drinking water sources:			
Total population	2008	94	%
Urban population	2008	99	%
Rural population	2008	92	%

Mountains and hills cover more than three-quarters of the territory, although over 70 percent of the country lies below 500 m above sea level. Viet Nam has a dense hydrographic network. About 25 percent of the total land area is covered by plains, the most important being the Bac Bo in the north and Nam Bo in the south, corresponding to the courses of the Red river and Mekong river respectively.

In 2009, the total cultivated area was 9.63 million ha, of which 6.28 million ha was arable land and 3.35 million ha under permanent crops. Rice is by far the largest crop, followed by amongst others maize, coffee, rubber, tubers, vegetables and coconut.

FIGURE 1
Map of Viet Nam



VIET NAM

FAO - AQUASTAT, 2011

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Climate

Viet Nam is located in a complicated climatic zone: hot, humid and rainy. It is characterized by a subtropical climate with four separate seasons – spring, summer, autumn and winter – in the north and a tropical climate with only two seasons – dry and wet – in the south. Average annual precipitation is around 1 820 mm. It varies from an average 1 600 to 2 200 mm in the midlands and plains and 2 000 to 2 500 mm in the mountainous areas. A minimum of 650 mm can be found in Phan Rang in the South Central region and a maximum of 4 760 mm in Bac Quang in the North East region. The rainy season lasts from April-May to October-November.

The driest periods are either from December to February or from January to March depending on specific location. Central Viet Nam is often affected by hurricanes and storms and very large waves from the South China Sea. Annual average evaporation is 953 mm. Average temperature varies from 15°C in winter to 25°C in summer. Temperature during the hottest days is 38-40°C and, during the coldest days, 11-14°C in the north.

Population

The total population in 2009 was around 86.9 million, of which 70 percent lived in rural areas (Table 1). The estimated average annual population growth rate for 1999-2009 was an estimated 1.1 percent. Population density in 2009 was about 263 inhabitants/km².

In 2008, the rate of urban population with access to improved water supply was 99 percent whereas that of the rural population was 92 percent.

ECONOMY, AGRICULTURE AND FOOD SECURITY

In 2009, gross domestic product (GDP) of Viet Nam was US\$ 90 091 million, with a value added in agriculture reaching the 21 percent of the GDP. The total economically active population was about 46.1 million inhabitants (49 percent female) of which 29.3 million are active in agriculture (49 percent female). The average annual unemployment rate was 5.8 percent during the period 2001–2005.

Agriculture plays a very important role in socio-economic development, in poverty alleviation and in food security. Recently, the country has become one of the three top countries in the world for rice exports, together with Thailand and the United States.

The production of cereals, sugar, roots, tubers and meat is large enough to ensure both domestic consumption and provide a surplus for export. However, the country's production capacity for vegetable oils and milk does not meet domestic demand.

About one-fifth of all rural households are headed by women. Gender inequality between male and female headed households in the agricultural sector, identified on the basis of the 2006 rural, agriculture and fishery census, includes inequalities related to access to land, land size, irrigated land cultivated land. National level results show that access to agricultural land in rural areas by households headed by women is 13 percent lower than that for households headed by men.

The average area of land accessed by households headed by women is 27 percent smaller than that of male headed households. Further, the size of irrigated land among female headed households is 41 percent less compared to that of male headed households. Less than 10 percent of all commercial farms in Viet Nam are owned by households headed by women. Other gender inequalities include access to information and communication, access to loans and livestock production (FAO, 2010).

WATER RESOURCES

The distribution of water resources is highly variable during the year owing to unevenly distributed monsoon rainfall. High variations, combined with limited storage and flood control infrastructure, result in devastating floods in the wet season and extreme low flows in the dry season. About 70-75 percent of the annual runoff is generated in three to four months.

Viet Nam has a dense network of 2 360 rivers with a length of more than 10 km each. There are 16 river basins that are larger than 2 000 km², eight of which have a catchment area larger than 10 000 km² (Table 2). Other basins are either have a small area, such as Tien Yen and Muc, or have several small coastal rivers grouped together, such as Giang/Huong, Tra Khuc and Cai-Luy. The eight major basins represent 77 percent of the country's area. The largest basins are the Mekong and the Red river/Thai Binh, covering 45 percent of the territory.

TABLE 2
Eight large river basins in Viet Nam

River basin	Total area of basin (km ²)	Area of basin in Viet Nam (km ²)	% of basin in Viet Nam	% of Viet Nam in basin
Mekong	795 000	63 600	8	19
Red River-Thai Binh (includes Da River basin)	155 000	85 250	55	26
Dong Nai	44 100	37 485	85	12
Ma-Chu	28 400	17 608	62	5
Ca	27 200	17 680	65	5
Ba	13 900	13 900	100	4
Ky Cung-Bang Giang	11 220	10 547	94	3
Thu Bon	10 350	10 350	100	3
Total	1 086 170	256 420	-	77

Almost 60 percent of the total water resources are generated outside the country, making the country susceptible to decisions made about water resources in upstream countries. The total area of all international basins in and outside Viet Nam is to 1.2 million km².

Viet Nam has abundant surface water resources in terms of total runoff, which accounts for 848 km³/year on average, but the shortage of water is aggravated during the 6-7 months dry season when the runoff is only 15-30 percent of this total. About 323 km³/year (38 percent) of the total runoff are generated within the country.

More than 90 percent of the Mekong river basin and 45 percent of the Red river basin lie outside Viet Nam. The Ma and Ca rivers both have about 40 percent of their basin area outside the country and the Dong Nai 15 percent. The average annual contribution from neighbouring countries to the runoff in Viet Nam is around 524.71 km³, including 470.1 km³ (Mekong) and 1.41 km³ (Dong Nai) from Cambodia, 44.1 km³ (Red) from China, and 9.1 km³ (Ca and Ma) from Lao People's Democratic Republic.

Internal renewable groundwater resources are abundant, an estimated 71.418 km³/year. Over 50 percent of these resources are in the central part, about 40 percent in the north and 10 percent in the south. A large amount of water is stored in unconsolidated alluvial sand and gravel geological formations found in plains and valleys. An estimated 35 km³/year returns to the rivers as base flow and can be considered to be the overlap between surface water and groundwater. Therefore, total Internal Renewable Water Resources (IRWR) are an estimated 359.418 km³/year (=323+71.418-35). By adding together the internal and external water resources, the total renewable water resources are an estimated 884.128 km³/year.

The exploitable groundwater resources are about 6-7 km³/year. In some areas, over-exploitation has caused water tables to fall, which has contributed to further land subsidence and salinity intrusion, especially in the Mekong river delta.

Viet Nam is rich in freshwater and marine wetlands, which are mainly distributed in the Red river and the Mekong river deltas and along the 3 260 km coastline. The Directory of Asian Wetlands lists over 25 wetland sites in Viet Nam that meet the criteria for ‘Wetlands of International Importance’. Despite this the only designated site under the Ramsar Convention is the Xuan Thuy National Park, a 12 000 ha mangrove in the Red river delta region. However, there are plans for additional Ramsar sites, including the Tram Chim National Park in Dong Thap province in the Mekong river delta.

In 2000, Can Gio mangrove forest was designated as ‘Man and Biosphere Reserve’ by the United Nations Educational, Scientific and Cultural Organization (UNESCO), Viet Nam’s first protected area. More wetland sites are being proposed for inclusion in a list of protected areas. Also, to fulfil the government commitments to the Ramsar Convention, the Ministry of Natural Resources and Environment (MONRE) has submitted a government decree on wetland conservation and sustainable utilization to the Prime Minister. A national strategy on wetland management and conservation was approved in 2003.

There are two natural lakes in Viet Nam: Lake Ho-Tay with a surface area of 4.13 km² and a volume of 8 million m³, and Lake Ba Be with a surface area of 4.5 km² and a volume of 90 million m³.

Viet Nam has 800 medium and large dams and reservoirs, and 1 967 reservoirs with a storage capacity of at least 0.2 km³. In 2009, total dam capacity was about 28 km³. Seven dams have a capacity of more than 1 km³: Hoa Binh (9.5 km³), Thac Ba (2.9 km³), Tri An (2.8 km³), Tuyen Quang (2.2 km³), Dau Tieng (1.6 km³), Thac Mo (1.4 km³) and Yaly (1.0 km³). Another four dams of over 1 km³ are under construction: Son La (9.3 km³), Phuoc Hoa (2.5 km³), Ban Ve (1.8 km³) and Cua Dat (1.4 km³). Most reservoirs are multipurpose: hydropower, flood control, navigation, irrigation and fisheries.

Viet Nam has an estimated hydropower potential of about 14 000 to 17 000 MW of which nearly 3 600 MW have been developed, and about 800 MW are under construction. The National Hydropower Plan Study plans a possible installation of an additional 5 045 MW. Hydropower is a non-consumptive use of water, but the need to maintain a certain water level may negatively affect availability downstream. This may cause local drought and water use conflicts between hydropower and agriculture downstream, and sudden releases may cause flooding and river erosion. Therefore, the operation of hydropower plants needs to be coordinated with other water using sectors, mainly agriculture.

In 2003, out of a total of 1 100 million m³ of wastewater produced, about 250 million m³ were treated, of which 70 percent (175 million m³) were reused (Table 3).

TABLE 3
Water resources

Renewable freshwater resources:			
Precipitation (long-term average)	-	1 821	mm/yr
	-	603 000	million m ³ /yr
Internal renewable water resources (long-term average)	-	359 400	million m ³ /yr
Total actual renewable water resources	-	884 100	million m ³ /yr
Dependency ratio	-	59.4	%
Total actual renewable water resources per inhabitant	2009	10 174	m ³ /yr
Total dam capacity	2009	28 038	million m ³

INTERNATIONAL WATER ISSUES

Viet Nam is a downstream riparian state for most of its transboundary rivers, of which the six major ones are: the Bang-Ky Cung and Red rivers, coming from China; the Ma and Ca, coming from Lao People’s Democratic Republic; and the Dong Nai and Mekong, coming from Cambodia. Most of the rivers flow to the Gulf of Tonkin and the South China Sea. The Bang-Ky Cung flows to China, and the Srepok to the Mekong in Cambodia.

The government has obtained many agreements with the neighbouring countries related to the exploitation and management of these rivers, such as water allocation, pollution management, flood control and others. The agreement established in 1995 by the four lower Mekong riparian countries offers new opportunities for regional collaboration in developing the basin's water and related ecological resources. Some examples of promising collaboration are related to flood control in the Mekong delta with Cambodia, and the possible importation of hydropower from upper riparians.

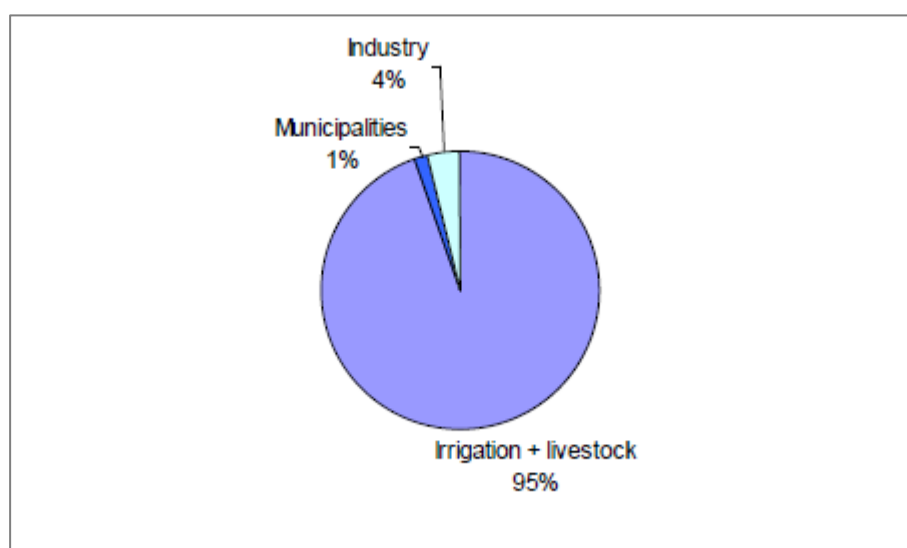
WATER USE

In 2005, the total annual water withdrawal for agriculture, industries and municipal purposes was an estimated 82.03 km³. Irrigated agriculture uses the most water, accounting for 77.75 km³ or 94.8 percent of total water withdrawals (Table 4 and Figure 2). Industrial and municipal sectors account for 3.07 km³ (3.7 percent) and 1.21 km³ (1.5 percent) respectively. In 1990, total annual water withdrawal was around 54.3 km³, of which agriculture accounted for 86 percent, industrial use for 10 percent and municipal use for 4 percent.

TABLE 4
Water use

Water withdrawal:			
Total water withdrawal	2005	82 031	million m ³ /yr
- agriculture	2005	77 751	million m ³ /yr
- municipalities	2005	1 206	million m ³ /yr
- industry	2005	3 074	million m ³ /yr
• per inhabitant	2005	986	m ³ /yr
Surface water and groundwater withdrawal	2005	82 031	million m ³ /yr
• as % of total actual renewable water resources	2005	9.3	%
Non-conventional sources of water:			
Produced wastewater	2003	1 100	million m ³ /yr
Treated wastewater	2003	250	million m ³ /yr
Reused treated wastewater	2003	175	million m ³ /yr
Desalinated water produced		-	million m ³ /yr
Reused agricultural drainage water		-	million m ³ /yr

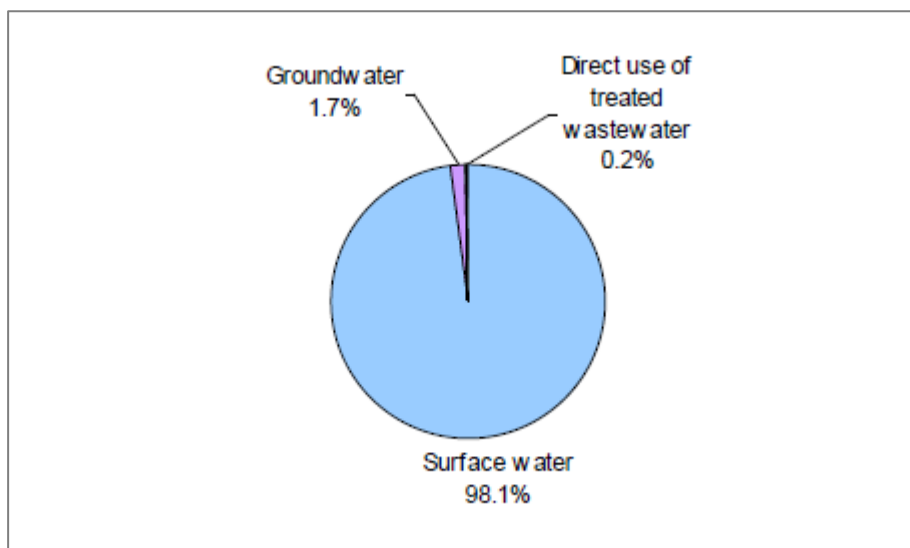
FIGURE 2
Water withdrawal by sector
Total 82.031 km³ in 2005



In 2005, primary surface water withdrawal was around 80.45 km³ (98.1 percent of total water withdrawal), while primary groundwater withdrawal accounted for only 1.40 km³ (1.7 percent) (Figure 3). Groundwater is mainly used for municipal water supply in urban areas. In 2003, reused

treated wastewater was about 175 million m³, which represents 0.2 percent of total water withdrawal. In 1990, it was estimated that less than 1.5 percent of the water withdrawal was met by groundwater.

FIGURE 3
Water withdrawal by source
Total 82.031 km³ in 2005



IRRIGATION AND DRAINAGE

Evolution of irrigation development

Small indigenous irrigation systems have long been employed in Viet Nam. Modern irrigation development stagnated until reunification of the country in 1975.

Early post-1975 growth was in small and medium irrigation schemes, while during the period 1985-1990 growth was concentrated in large irrigation and multipurpose schemes. The total irrigated area expanded at a rate of 2.9 percent/year in the period 1980-1987, while between 1988 and 1994 it was 4.58 percent/year. In 1994, there were about 3 million ha of irrigated land in Viet Nam.

The irrigation potential has been evaluated as 9 400 000 ha (Table 5). In 2005, the total equipped area for irrigation accounted for 4 585 500 ha or 48.8 percent of the potential. The actually irrigated area was 100 percent of the area equipped for irrigation. Although the potential for irrigation development is large, upgrading the existing and constructing new irrigation systems requires a huge amount of capital. This, indeed, is a considerable challenge for the country because of limited national budget and external assistance.

TABLE 5
Irrigation and drainage

Irrigation potential		9 400 000	ha
Irrigation:			
1. Full control irrigation: equipped area	2005	4 585 500	ha
- surface irrigation	2005	4 584 400	ha
- sprinkler irrigation	2005	1 100	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	2005	4 585 500	ha
- as % of full control area equipped	2005	100	%
2. Equipped lowlands (wetland, ivb, flood plains, mangroves)		-	ha
3. Spate irrigation		-	ha
Total area equipped for irrigation (1+2+3)	2005	4 585 500	ha
• as % of cultivated area	2005	49	%
• % of total area equipped for irrigation actually irrigated	2005	100	%
• average increase per year over the last 11 years	1994-2005	3.9	%
• power irrigated area as % of total area equipped	2006	47	%
4. Non-equipped cultivated wetlands and inland valley bottoms		-	ha
5. Non-equipped flood recession cropping area		-	ha
Total water-managed area (1+2+3+4+5)	2005	4 585 500	ha
• as % of cultivated area	2005	49	%
Full control irrigation schemes:		Criteria:	
Small-scale schemes	< 5 000 ha	2005	1 638 297 ha
Medium-scale schemes	> 5 000 ha and < 50 000ha	2005	1 202 390 ha
large-scale schemes	> 50 000 ha	2005	1 744 813 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	8 728 192	ha
• Annual crops: total	2005	7 743 297	ha
- Rice	2005	6 842 127	ha
- Maize	2005	265 540	ha
- Sweet potatoes	2005	99 532	ha
- Cassava	2005	167 920	ha
- Groundnuts	2005	139 304	ha
- Soyabeans	2005	97 119	ha
- Sugarcane	2005	105 800	ha
- Cotton	2005	14 790	ha
- Tobacco	2005	8 600	ha
- Other annual crops	2005	2 565	ha
• Permanent crops: total	2005	984 895	ha
- Bananas	2005	54 626	ha
- Citrus	2005	46 068	ha
- Coffee	2005	259 607	ha
- Tea	2005	62 551	ha
- Rubber	2005	253 690	ha
- Coconuts	2005	25 041	ha
- Other permanent crops	2005	283 312	ha
Irrigated cropping intensity (on full control area actually irrigated)	2005	190	%

TABLE 5 (continued)
Irrigation and drainage

Drainage - Environment:			
Total drained area	2006	2 538 844	ha
- part of the area equipped for irrigation drained		-	ha
- other drained area (non-irrigated)		-	ha
• drained area as % of cultivated area	2006	27	%
Flood-protected areas		-	ha
Area salinized by irrigation	1999	300 000	ha
Population affected by water-related diseases			inhabitants

In 2005, surface irrigation accounted for 99.98 percent of the total area equipped for irrigation, while sprinkler irrigation accounted for 0.02 percent (Figure 4). In 2005, 99 percent of the area equipped for irrigation was irrigated by surface water, while groundwater accounted for 1 percent (Figure 5).

FIGURE 4
Irrigation techniques on area equipped for full control irrigation
Total 4 585 500 ha in 2005

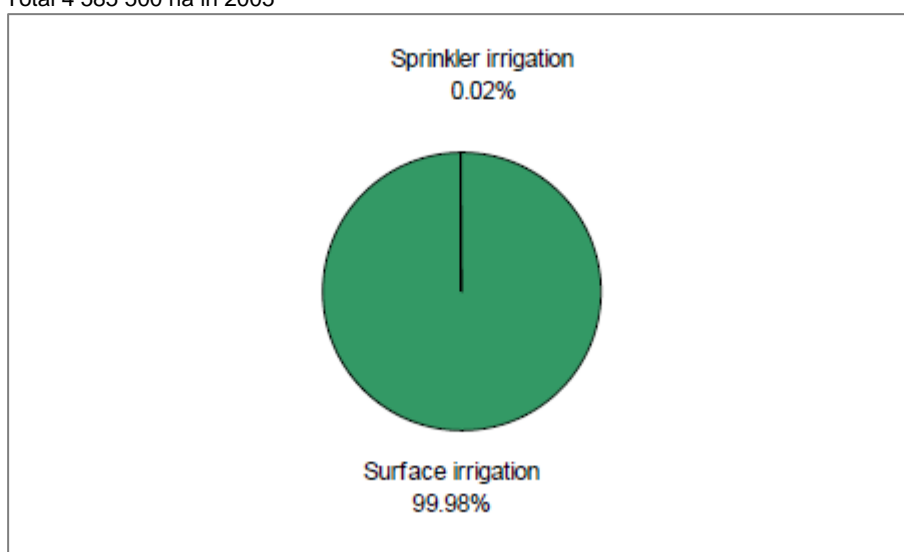
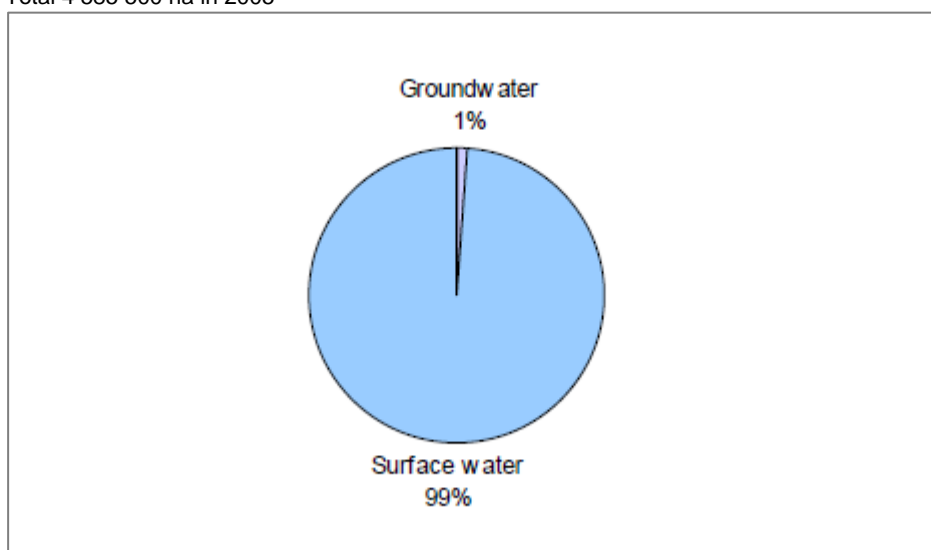


FIGURE 5
Source of irrigation water on area equipped for full control irrigation
Total 4 585 500 ha in 2005



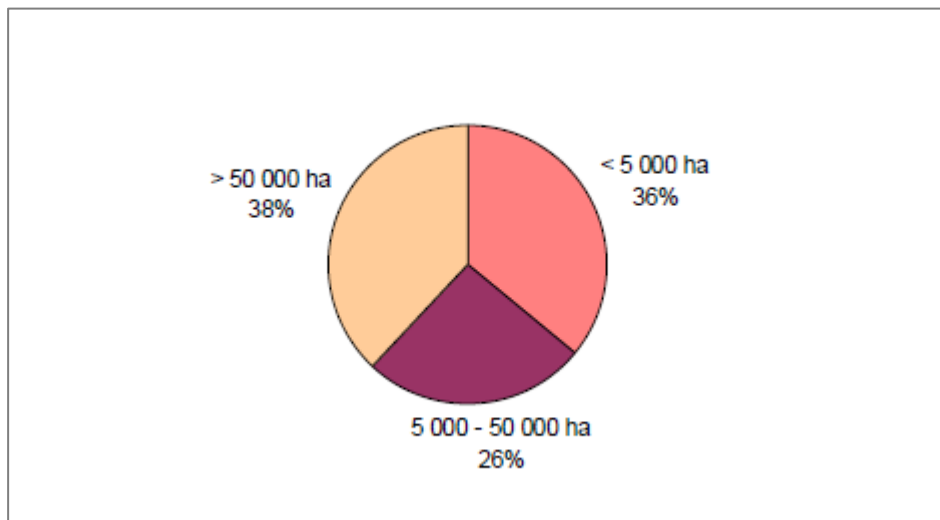
The average yearly increase during the period 1994-2005 was around 3.9 percent. During this period Viet Nam invested in the water sector, which included construction of new infrastructure and rehabilitation of existing works especially irrigation and drainage systems.

There are 1 638 297 ha of small irrigation systems (< 5 000 ha), 1 202 390 ha of medium irrigation schemes (5 000 – 50 000 ha) and 1 744 813 ha of large irrigation schemes (> 50 000 ha) (Figure 6). About 2 148 140 ha were power irrigated. In 1994, two-thirds of the total irrigation area was in the two large deltas (37 percent in the Red delta, and 27 percent in the Mekong delta).

FIGURE 6

Type of full control irrigation schemes

Total: 4 585 500 ha in 2005



In 1994, of the total irrigated area, formal government schemes covered about 54.4 percent, equipped with pumped or gravity irrigation. The remaining area was private land, which was irrigated by swing baskets, buckets, small private pumps and small gravity diversion systems. This type of irrigation is concentrated in the Mekong delta and, to a much lesser extent, in the Red delta. Some 59 percent of the pump irrigation capacity is electrically driven, the remainder relies on oil powered engines.

Currently, Viet Nam has 75 large hydraulic works, 5 000 irrigation culverts and drainage sewers (large), and over 10 000 pumping stations (large and medium) with the total capacity of 24.8 million m³/h.

Role of irrigation in agricultural production, the economy and society

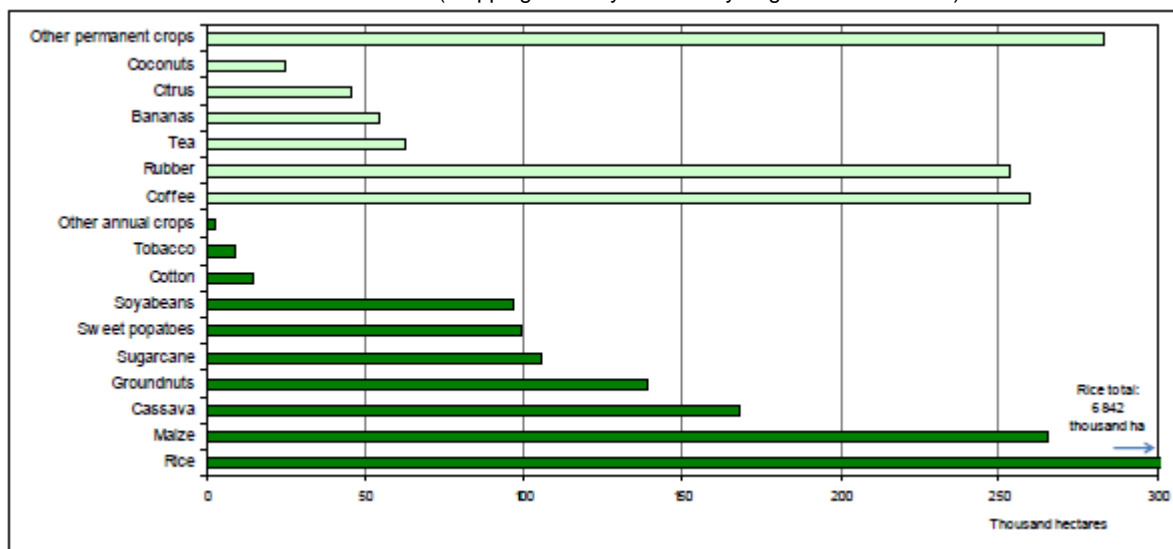
Irrigated agriculture plays a very important role in the socio-economic development of the country for poverty reduction, food security, gender equity improvement in rural areas, and the improvement of cropping patterns and the environment. Areas relying on full irrigation attained an average paddy yield of 4.89 tonnes/ha for the entire country. The highest paddy yield of 5.44 tonnes/ha was in the Red River Delta and the lowest paddy yield of 3.58 tonnes/ha was in the North West.

In 2005, the value of cereals produced was about US\$ 7 000 million. As reported in 2005, the total harvested irrigated cropped area was around 8 728 192 ha. The main crops are cereals, such as rice (6 842 000 ha) and maize (265 540 ha), and industrial trees such as coffee (259 600 ha) and rubber (253 700 ha) (Table 5 and Figure 7). In 1994, the harvested irrigated rice area was 5 460 000 ha on a physical area of 2 100 000 ha, giving an irrigated rice cropping intensity of 2.6.

FIGURE 7

Irrigated crops on area equipped for full control irrigation

Total harvested area 8 728 192 ha in 2005 (cropping intensity on actually irrigated area: 190 %)



In 2004, the average cost of irrigation development on public schemes was about US\$ 3 875/ha, while in 2006, on-farm installation of sprinkler irrigation was almost US\$ 4 700/ha. The cost of operation and maintenance (O&M) on public schemes was US\$7/ha.

Status and evolution of drainage systems

In 2006, the drainage systems covered 2 538 000 ha, mostly in the northern and central parts of the country, particularly the Red river delta (Table 5). Interestingly, almost all pumping irrigation stations in Viet Nam, particularly in the Red river delta, are responsible for drainage. In 2004, the average cost of drainage development on public schemes was US\$ 620/ha.

WATER MANAGEMENT, POLICIES AND LEGISLATION RELATED TO WATER USE IN AGRICULTURE

Institutions

According to the Water Law, the government is responsible for the state management of water resources through the Ministry of Natural Resources and Environment (MONRE), which was transferred from the Ministry of Agriculture and Rural Development (MARD), while the service function of irrigation and rural water supply remains with MARD. However, the National Water Resources Council (NWRC), which manages water resources, is above the ministries and below the Prime Minister's Office. At province and district level, the Provincial Peoples Committees, which is directly controlled by the central government, are responsible for implementation in their own jurisdiction. Specific functions of water resources management and water use are allocated to ministries and non-line agencies are as follows:

- Ministry of Natural Resources and Environment is responsible for water resources management.
- Ministry of Agriculture and Rural Development is responsible for the management of flood and typhoon protection systems, hydraulic structures, wetland management, and rural water supply and sanitation.
- Ministry of Industry is responsible for the construction, O&M of hydropower facilities.
- Ministry of Construction is responsible for the spatial planning and construction of urban water supply, sanitation and drainage facilities.
- Ministry of Transport is responsible for the planning, construction and management of waterway transport systems.
- Ministry of Fisheries is responsible for the protection and exploitation of aquatic resources.
- Ministry of Health is responsible for the management of drinking water quality.

- Ministry of Planning is responsible for the planning and investment in the water and investment resources sector.
- Ministry of Finance is responsible for the development of policies on taxes and fees for water resources.

Water management

In Viet Nam the water sector has no overall integrated strategy and action plan at national or regional basin level. However, strategies and action plans exist for a number of the subsectors. In 2000 the NWRC and in 2001 three Boards for River Basin Planning and Management were established to work under the government as advisory, coordination and planning units. With the creation of MONRE in 2002, the responsibilities of the state management of water resources were assigned to the Agency of Water Resources Management within MONRE. This important change shows a separation of state management and service functions for water resources. Previously, both water resources management and service functions were the responsibility of the Agency of Water Resources and Hydraulic Works Management under MARD.

A national strategy of participatory irrigation management (PIM), together with an action plan approved in 2004 is being implemented. Many water user organizations have been established to take over management of irrigation at the local level (tertiary system of canals and intakes) for the entire country, besides the conventional model of irrigation management, which is by agricultural cooperatives responsible for irrigation and drainage. Management of O&M for secondary and main systems and headworks falls under irrigation management companies/enterprises (IMCs/IMEs), defined as public units providing public goods.

The existing environmental information and reporting system is comprised of a national network of environmental monitoring stations, as well as environmental monitoring at the provincial level. The Environmental Monitoring Network is managed by the National Environmental Agency (NEA) of the Ministry of Science, Technology and Environment (MOSTE). By 2002, the network had expanded to 21 stations, which conduct monitoring at 250 locations in 45 provinces. Since the establishment of MONRE, the responsibility of producing the state of environment (SOE) reports lies with the Department of Environment and data collection is a mandate of the Office of Data and Information under Viet Nam Environmental Protection Agency (VEPA).

The objective of the 1999 to 2007 Mekong Delta's Water Resources Project, was to increase agricultural production, reduce rural poverty, improve living conditions in the project area, and facilitate sustainable water resources development and management in the Mekong Delta.

Finances

The proportion of government expenditures on water-related activities, as part of the total national budget expenditure has declined. Public expenditure for the water sector has increased at an annual average of 8.9 percent during the period 1996-2001. Although spending on water resource management is far too little compared to investment (less than 1 percent) and accounts for less than 10 percent of the current budget expenditure, public investment in the water sector comprised a considerable proportion of the national budget investment from 1996 to 1998 (about 33 percent). This has declined since 1999 owing to a shift in the focus of the national budget 'towards banking systems and improvement of state-owned enterprises. The main investments are made in irrigation, clean water supply and drainage. In 2001, Viet Nam spent about US\$560 million in the water sector, which was 6.8 percent of total budget expenditure.

Irrigation fees were first established in 1984 in some provinces, such as Vinh Long in the Mekong River Delta Region. Funds are received as payments from farmers who are water user for irrigation fees and

the government budget subsidy. The method of cost recovery for irrigation is stipulated in Decree No. 43/2003/NĐ-CP.

According to this decree, the basic fees decided for the specific regions are based on the levels of irrigation services provision and fully irrigated area, and other fees of the various levels of partly irrigated areas are decided based on the basic fees that depend on the natural features and socio-economic development of the regions. In the Red river delta, for example, the irrigation and drainage fee for pumping irrigation services is from US\$ 33/ha to US\$ 50/ha in the spring, and from US\$ 30/ha to US\$ 47/ha in the summer.

Policies and legislation

Viet Nam has a relatively comprehensive framework of institutions and policies for managing water, irrigation and drainage, such as Water Law (1998, effective from 1/1/1999), Ordinance No. 32/2001/PL-UBTVQH10 on the exploitation and protection of hydraulic works (2001), Decree No. 31/2005/NĐ-CP on the production and supply of public services, Circular No. 90/2004/ TTLT/BTC-BNN on guidelines or financial management of the State Enterprises in the exploitation of hydraulic works, and Decree No. 43/2003/NĐ-CP on the specific regulation of enforcing some articles of the Ordinance No. 32/2001/PL-UBTVQH10.

The Water Law is a major step towards integrated water resources management. Currently, only partial progress has been made in implementing the reforms it embodies. The secondary legislation necessary for implementing many of the law's objectives have not yet been developed. The law is basically formulated as a flexible legal framework and a number of decrees were subsequently added. These decrees define the roles, functions, and responsibilities of the institutional bodies for carrying out the water law. The legislative framework is described in circulars on guidance, proceedings of licensing exploitation and utilization of surface water, and licensing of discharging wastewater into water sources.

The 'Socio-Economic Development Strategy for 2001-2010' proposed a number of water-related strategies/objectives. With the approval in 2005 of a National Water Resources Development to 2020, the water sector has an overall integrated strategy and action plan at the national and regional basin level. In addition, strategies and action plans exist for a number of subsectors:

- Strategy for Rural Agriculture Development in the Industrialization and Modernization Period to 2010 (MARD, July 2000);
- Agriculture and Rural Development Plan (2001- 2005) (MARD, August 2000);
- National Strategy for Rural Water Supply and Sanitation (NRWSS);
- Second National Strategy and Action Plan for Disaster Mitigation and Management in Viet Nam from 2001 to 2020 (MARD and Central Committee for Flood and Storm Control, December 2001).

ENVIRONMENT AND HEALTH

Although data on water quality are poor, recorded evidence shows the pollution level is increasing for surface water, groundwater and coastal waters. Although the quality of the upstream river water is generally good, downstream sections of major rivers reveal low water quality. Most of the lakes and canals in urban areas are fast becoming sewage sinks. Groundwater shows pockets of contamination and intrusion of salinity. Rapid urbanization and industrialization in coastal areas, port and marine transport development, expansion in coastal tourism, and an increase in the number of oil spills contribute to the deterioration of coastal water quality.

The National Monitoring Network (NMN) covers four rivers running through the main urban areas the: Red (Hanoi), Cam (Haiphong), Huong (Hue) and Saigon (Ho Chi Minh City). Other rivers are being monitored in the various regions. Trends indicate that the levels of two primary pollution indicators,

Ammonia-nitrogen (NH₄-N) and biochemical oxygen demand (BOD), vary considerably and exceed national water quality class A standards. The problems are worse during the dry season, when river flows are reduced. Industrial and other pollution adds to the human waste from the households areas. Around 70 industrial parks have been developed, with more than 1 000 hospitals nationwide some million m³ of untreated wastewater is discharged from these sources per day.

According to MONRE, about 4 000 enterprises discharge wastewater, of which 439 enterprises are the most serious and have been reallocated or closed or will have to adapt cleaner technologies and treatment of their wastewater. Rivers in urban areas, especially major cities, are seriously polluted by untreated industrial wastewater. Surveys conducted by the Institute of Tropical Techniques and Environmental Protection show that the content of contaminants in rivers in Hanoi, Ho Chi Minh City, Hai Phong, Hai Duong, Bac Giang, Hue, Da Nang, Quang Nam and Dong Nai, are much higher than permissible levels.

Untreated industrial wastewater discharging into rivers is the main source of pollution. According to the institute, industrial parks (IPs) and export processing zones (EPZs) in the Southern Key Economic Zone discharge over 137 000 m³ of wastewater containing nearly 93 tonnes of waste into the Dong Nai, Thi Vai and Saigon rivers each day. Meanwhile, 2 out of 12 IPs and EPZs in Ho Chi Minh City, 3 out of 17 in Dong Nai, 2 out of 13 in Binh Duong, and none of the IPs and EPZs in Ba Ria-Vung Tau province (South East Region) have wastewater treatment facilities. According to environmentalists, the Southern Key Economic Zone needed US\$ 380 million in 2005 and US\$ 867 million in 2010 to deal with environmental pollution.

Within cities, lakes, streams, and canals increasingly serve as sinks for municipal and industrial wastes. Most of the lakes in Hanoi are seriously polluted with high BOD levels. Similarly, four small rivers in Hanoi and five canals in Ho Chi Minh City have levels of dissolved oxygen (DO) as low as 0-2 mg/litre, and BOD levels as high as 50-200 mg/litre.

Groundwater is emerging as an important source of water for municipal, industrial, and agricultural use. While the quality of groundwater remains good, there are some pockets of contamination. There is evidence of pollution from poorly maintained septic tanks, garbage dumping, and industrial effluents and overexploitation in parts of Hanoi, Ho Chi Minh City and the Mekong river delta.

Although there have been improvements in the provision of safe water to urban and rural populations, water-borne diseases are still a major problem. Dysentery and diarrhoea are widespread. In four years, recently, there were 6 million cases requiring treatment for water-borne diseases, which incurred a cost of US\$27 million for treatment of cholera, typhoid, dysentery and malaria.

The cost of treating polluted water varies considerably depending on the quality of the raw water, which either comes from rivers, reservoirs or groundwater. However, typical treatment costs vary from US\$ 1/m³ to US\$ 1.5/m³. The tariffs consumers pay depend on the use of the water. Typically, municipal tariffs vary from US\$ 1.2/m³ to US\$ 1.7/m³. Factories and other business users may pay up to US\$ 5.6/m³.

In early September 2001, a major oil spill occurred off the coast of Ba Ria-Vung Tau province (South East Region) after a collision between a Vietnamese tanker and a Taiwanese ship. As a result, some 900 m³ of DO oil poured into the Ba Ria-Vung Tau coastal area, causing extensive environmental damage at nearby tourist beaches, shrimp farms and mangrove forests. Total financial losses caused by the disaster were an estimated US\$ 17 million and costs for cleaning up polluted waters and beaches reached US\$4 million.

Flooding is an annual event in northern Viet Nam and the cause of enormous losses. With as much as 80 percent of the population living on the coastal plains and deltas, costs incurred from floods and typhoons are colossal. For the seven years from 1995 to 2002 the costs were US\$ 1 250 million. Also the loss of lives, homesteads and general suffering of the people are immense. During 1995-2002 the

human losses from typhoons and floods totalled 3 342 persons. In a study undertaken by United Nations Development Programme (UNDP), it was estimated that the average annual losses in the Red river delta and along the central coast could be substantially more than US\$ 130 million. In a study undertaken by the Asian Development Bank, it was found that the average annual damage from flooding for the area protected by the dyke around Hanoi alone amounted to well over US\$ 50 million per year.

The number of adults with HIV/AIDS was 0.5 percent of the total population. In 2005 the estimated number of people needing antiretroviral therapy (0-49 years) was 25 000 people (WHO/UNAIDS, 2005).

PROSPECTS FOR AGRICULTURAL WATER MANAGEMENT

According to the national strategy of water resources development, as a result of climate change total annual runoff could decrease by 2025 to 807 km³ (89 km³ in the dry season); by 2070 to 765 km³ (76 km³ in the dry season) and by 2100 to 722 km³ (72 km³ in the dry season).

The government has enacted laws, created institutions, expanded investments and decentralized authority to manage the country's vast water resources efficiently and sustainably. However, rapid economic development, high population growth, worsening environmental conditions and frequent natural disasters are overwhelming the capacity of the existing policy and institutional framework and in turn are undermining the effectiveness of numerous government interventions. Given this history and context, the management of water resources is one of the most critical issues in Viet Nam.

To achieve the objective of sustainable management of the country's vast water resources, these key challenges need to be addressed:

- strengthening of institutions and policies for integrated water resources management;
- expanding and diversifying investment in infrastructure for the water sector, while paying more attention to financing for the management side;
- improving compliance and enforcement; and
- deepening community (users) participation.

The core issues in tackling the challenges are adopting an integrated river basin approach, greater and more sufficient adaptation to the water-related vulnerability and susceptibility, expanded and more efficient services for irrigation and municipal water supply, and curbing water pollution and its health impacts on the poor. More proactive engagement in regional riparian cooperation, improving information management, complete separation of the water management and service functions, further decentralization of management authorities, and strengthening of institutional capacity would provide Viet Nam with the required management tools that will address equity, efficiency and environmental sustainability of its water resources.

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