

VIET NAM - STATE OF WATER ENVIRONMENTAL ISSUES

OVERVIEW

Viet Nam has a dense river network—2360 rivers with a length of more than 10 km. Eight out of these are large basins with a catchment area of 10,000 km² or more. This river network includes many international rivers that originate in catchments in other countries. About two thirds of Viet Nam's water resources originate outside the country, making Viet Nam susceptible to water resources decisions made in upstream countries.

The total area in- and outside Viet Nam of all international catchments is close to 1.2 million km², which is approximately three times the size of Viet Nam itself. The total annual runoff is 835 billion m³ but the shortage of water is aggravated in the 6-7 month dry season when the runoff is only 15 to 30% of this total.

All the rivers traversing Viet Nam provide an abundant supply of water (255 billion m³ annually). However, inadequate physical infrastructure and financial capacity results in a low utilization of only 53 billion m³ per year. In addition, the uneven distribution across Viet Nam of the average annual rainfall of 1,960 mm and the prolonged dry season result in serious shortages of water in many areas.

Groundwater resources are abundant with the total potential exploitable reserves of the country's aquifers estimated at nearly 60 billion m³ per year. However, despite the abundance of groundwater reserves, less than 5% of the total reserves are exploited for the country as a whole. In some areas, over-exploitation has resulted in falling water tables which contributes to further land subsidence and salinity intrusion, especially in the Mekong River Delta.

Water utilization: In Viet Nam, irrigation places the largest burden on water resources. Total irrigation demand in 2000 was 76.6 billion m³, representing 84% of total demand. Since 1998, total irrigated area has increased annually by 3.4% on average, but the irrigation systems can serve only 7.4 mill. ha (or 80% of total cropped land). The government expects irrigation demand to increase to 88.8 billion m³ by 2010, (representing an irrigated area of 12 mill. ha).

Clean drinking water is now provided to 60 percent of Viet Nam's population. The GoV's strategy is to increase this to 80% in 2005 and the urban coverage to 95% in 2010. Fisheries, aquaculture, industries and services also make increasing demands on the country's water resources.

Biodiversity: Viet Nam's freshwater and marine biodiversity is relatively high but threatened by domestic and industrial water pollution, dam and road construction, dredging, over-fishing and destructive fishing techniques, as well as intensive aquaculture.

The freshwaters of Viet Nam are rich in flora and fauna biodiversity including fish (544 species), shrimp, crab (52 species), 782 species of invertebrates (snail, mussels, amphibians, and insects) and plants (20 species of weeds, 1402 species of algae). Viet Nam's marine waters are home to more than 2000 fish species, of which about 130 species are economically important. Additionally, there are more than 1,600 species of crustaceans and 2,500 species of mollusks. Among them 101 freshwater and 131 marine species are listed in the 2002 Red Book as rare and endangered. The country is also rich in ecosystems like wetlands, mangroves, coral reefs and sea grass beds.

Water quality: There is increasing evidence of pollution of Viet Nam's surface, ground and coastal waters. Although the quality of upstream river waters is generally good, downstream sections of major rivers reveal poor water quality and most of the lakes and canals in urban areas are fast becoming sewage sinks.

Groundwater shows pockets of contamination and some salinity intrusion. 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.

Vulnerability: The geography and topography of Viet Nam makes the country extremely vulnerable to natural hazards. Heavily populated areas such as the Delta Regions of the Red River and the Mekong River along with the Central Coastal Regions are especially vulnerable to natural disasters. Each year natural disasters such as typhoons, storms, floods or drought have extreme effects on people, their livelihood, their agricultural lands, their livestock, and their infrastructure.

Economic costs: In Viet Nam over the last four years about 6 million cases of six varieties of waterborne diseases were registered and incurred direct costs of at least 400 billion VND for the treatment of cholera, typhoid, dysentery and malaria. In addition to the health costs, there are significant costs associated with the treatment of water resources and the cleanup after oil-spills. Total financial losses caused by a major oil spill in 2001 were estimated at 250 billion VND (17 million USD) while costs for cleaning up polluted waters and beaches reached 60 billion VND (4 million USD). The damage costs associated with water-related natural disasters like flooding have been estimated at 18,700 billion VND or 1.25 billion USD between 1995 and 2002.

Management capacity: In Viet Nam the water sector has no overall integrated strategy and action plan at the national or regional basin level. However, strategies and action plans exist for a number of the sub sectors. The Law on Water Resources, approved in 1998, represents a major step toward integrated water resources management. But only partial progress has been made in implementing the reforms embodied in it. Important secondary legislation necessary for implementing many of the law's objectives have not yet been developed.

In 2000 a National Water Resource Council at the national level and in 2001 three Boards for River Basin Planning and Management at a local level were established to work under the government as advisory, coordination and planning bodies.

With the creation of a new Ministry of Natural Resources and Environment (MONRE) in 2002, the state management of water resources was allocated to the Agency of Water Resources Management within MONRE. This important change represents 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.

Findings from a review to estimate GoV spending on the water sector activities showed that although its proportion in the total national budget expenditure has declined, the public expenditure for water sector has increased at an annual average of 8.9% during the period 1996-2001. Although spending on water resource management is far too little compared to investment (less than 1%) and accounts for less than 10% of the current budget expenditure, the public investment in water sector constitutes a considerable proportion of the national budget investment from 1996 to 1998 (about 33%), but this declined since 1999 due to the national budget's shift in focus toward banking systems and SOEs improvement. The main investments are made in irrigation, water supply and drainage.

Regional water resources profile: The eight economic regions are largely formed within the major river basins. However, they differ from each other in water availability, quality, biodiversity and vulnerability. Red River Delta, Mekong River Delta and Northeast of Mekong (Dong Nam Bo) regions are characterized by dense river networks and abundant surface water resources. In these regions rapid population growth,

urbanization and industrialization, intensive agriculture, and water transport have resulted in worsening water quality and declining groundwater levels. While the coastal regions with an increasing population density are becoming more vulnerable to natural disasters from global climate change and deforestation in the upstream areas, high mountain regions (Northwest and Central Highlands) have experienced more serious droughts and flashfloods. Inland biodiversity and freshwater fishery have declined in most of the regions. Coastal and marine resources have shown benefits to the coastal regions and the country's economy, but overexploitation is an eminent risk.

Responding to Vietnamese Water Resource Issues: The Government of Viet Nam has made impressive gains in tackling the water resources management issues in the country. This has been made possible through a rise in public investments in the water sector to 8,621 billion VND in 2001 from 5,682 billion VND in 1996.

Backed by increased investments, and improved capacity, the Government of Viet Nam has formulated and implemented several policies and programs that specifically address issues relating to water resources management. These issues include improving access to clean water and sanitation; curbing pollution; conserving biodiversity and protecting ecosystems; improving the sustainability of fisheries; addressing vulnerability to water-related disasters; and strengthening river basin management.

Challenges: To achieve the vision and targets of managing the country's vast water resources in a sustainable way, Viet Nam needs to address the following key challenges:

- Strengthening the policy and institutional framework 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;
- Deepening public participation and involvement.

The core issues in tackling these 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 domestic 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 Viet Nam's water resources.

SEA AREAS

Coastal and marine water: Viet Nam has a long coastline of 3260 km and more than 1 mill. km² of the marine exclusive economic zones. This provides Viet Nam with abundant marine resources and biodiversity, but at the same time makes the country extremely vulnerable to natural disasters, including the sea level rise as a result of the global climate changes.

Coastal and marine biodiversity: More than 2000 fish species are found in the sea waters of Viet Nam. Of these, approximately 130 species are economically important. Additionally, there are more than 1,600

species of crustaceans and 2,500 species of mollusks with an annual allowable catch of 50,000-60,000 and 60,000-70,000 tons respectively. Aside from marine fauna each year.

Rare and endangered species listed in the Red Book (2002) of Viet Nam include: 5 mammals, 6 waterfowls living in wetlands, 5 marine turtle species, 1 crocodile, 53 marine fish, 15 corals, 5 echinoderms, 1 horseshoe crab, 2 marine crabs, 6 shrimp, 6 species of Palinuridae family, and 26 mollusk species.

Coastal and marine ecosystems: The very diverse ecosystems distribute along the coastline (Table 1). Among these the most important are wetlands, coral reefs, and sea grass.

Table 1. Major coastal and marine ecosystems

Ecosystems	Distribution	Estimated existing area (ha)
Agro-systems	Concentrated in the Red and Mekong River Delta	5,500,000
Aquaculture	Entire coastline	10,000
Tidal wetlands	Mainly concentrated in areas of river mouths and around some islands	1,000,000
Lagoons	12 lagoons at the coast from Thua Thien Hue to Binh Thuan province	100,000
Sand beaches	Broad extent along coast	600,000
Mangroves	Estuaries, sheltered bays, primarily North and South coast	156,608
Sea grass	North to South, inshore and offshore	6,800
Coral reefs (in 6m depth)	Near shore and some offshore	7,532
Islands	About 2,779 inshore islands	1,630

Sources: Originated from Nguyen Chu Hoi, 1996. Viet Nam National Wetland Conservation and Management Strategy, Workshop Proceedings and ADB 5721-REG Project, 2000. Area figure for mangroves is provide by FIPI Report To the GoV, 2001.

Wetlands: Viet Nam is rich in freshwater and marine wetlands. These 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 of 'Wetlands of International Importance.' Despite this the only designated such site under the Ramsar Convention is the Xuan Thuy National Park, a 12,000 ha mangrove on the mouth of the Red River in Nam Dinh Province. However, there are plans for additional Ramsar sites, including the Tram Chim National Park in Dong Thap Province in the Mekong River Delta. Can Gio mangrove forest as Viet Nam's first protected area was designated as Man and Biosphere Reserve by UNESCO (2000).

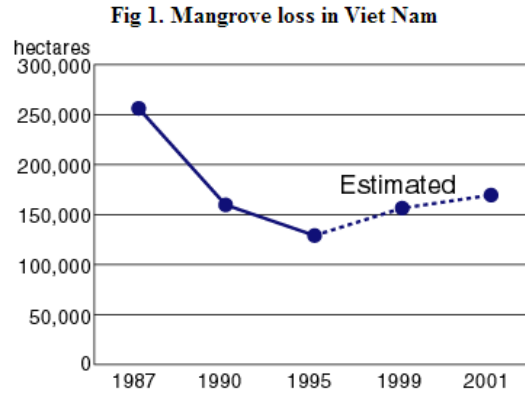
Mangroves: Over the last 50 years of development, Viet Nam has lost more than 80% of mangrove forest. The surge in shrimp farming emerges as one of the leading causes of mangrove forest destruction. The loss of mangrove forest area is largest in the Mekong (Cuu Long) Delta, Quang Ninh and Hai Phong provinces. Other causes for mangrove losses include conversion to agricultural and construction lands, war destruction, fuel wood collection.

Over the last three decades from 1960 to 1995, Quang Ninh and Hai Phong have seen the disappearance of close to forty thousand hectares of mangrove forest. Only 15,700 hectares remain in the two provinces. It was estimated that the annual loss in terms of forgone benefits of mangrove functions (e.g., fishery, forestry, and erosion) could be in the rage of 10-32 mill. USD per year 8.

Note 8:World Bank, (1999), %o The Quang Ninh and Hai Phong Coastal Region:

Options for Comprehensive Development, Seminar on Options for Comprehensive Development in the Quang Ninh and Hai Phong Coastal Region.

Estimated data compiled from various sources for 1999 and 2001 indicates some increase in mangrove areas (Fig 1).



Source: 1987-1995: Viet Nam Forest Resources Inventory and Monitoring Program, FIPI 2001, 1999 and 2001: Estimated data from various sources.

Coral Reefs: The coverage of coral reef in northern Viet Nam generally falls between 25 and 50%. Based on the IUCN criteria for assessing coral reefs, only 1.4 % of the reefs studied in southern Viet Nam are in excellent condition. The number of poor reefs occupied 37.3% and the reefs considered to be in fair and good condition occupied 48.6% and 31% respectively (Table 2). The total area of coastal coral reefs is about 40,000 ha. In general, coral reefs are found in three areas: in the west of Tonkin Gulf, in Central Viet Nam and in the eastern Siam Gulf. The marine areas with the largest coral reefs are in the Spratly and Paracel Archipelagos. The main threats to the reefs are destructive fishing methods, over-fishing, sedimentation, and pollution from territorial sources. Destructive fishing practices, such as the use of poison and dynamite, threaten as much as 85% of the country's reefs. Over-fishing is a pervasive threat to more than 60%, while sediment from upland sources is estimated to threaten 50% of Viet Nam's reefs.

Table 2a. Quality of Coral Reefs in Viet Nam

Category	Definition	%Area
Excellent	> 75% live coral	1.4
Good	50-75% live coral	31
Fair	25-50% live coral	48.6
Poor	< 25% live coral	37.3

Source: World Resources Institute, 2002, "Reefs at risk in Southeast Asia"

Table 2b. Live coral coverage in some sites

Location	Live coral cover (%)
Co To Archipelago	51.2
Ha Long Bay	34.2
Cat Ba Islands	47.7
Long Chau Archipelago	42.1
Bach Long Vi Island	31
Son Duong-Mui Ron Islands	50
Con Co Island	23.8
Son Tra-Hai Van	50.5

Source: Ministry of Fishery/IUCN, 2003

Sea grass: covers an area of 6,800 ha in Viet Nam (Table 3). 15 species of sea grass have been identified. The sea grass beds provide habitats of rare and endangered marine species such as dugong and sea turtles and support food for many species like fishes, shrimps, crabs and sea mammals. Phu Quoc and Con Dao have the most diverse sea-grass composition in Viet Nam. Sea-grass beds have also been severely degraded from inappropriate fishing, aquaculture production, and pollution from waste discharges.

Table 3. Top 10 largest seagrass beds in Viet Nam

Name of location	Area (ha)	Number of species
Tam Giang-Cau Hai lagoon	1,000	2
Thuy Trieu lagoon-Cam Ranh Bay (Khanh Hoa province)	800	7
Phu Quoc island	500	9
Nha Mac marsh (Quang Ninh province)	500	1
Cua Gianh estuary (Quang Binh)	500	1
Thu Bon river mouth (Quang Nam)	500	1
Phu Quy island (Binh Thuan province)	300	6
Han river mouth (Da Nang)	300	1
Cu Mong marsh (Phu Yen province)	250	5
Con Dao archipelago	200	8

Source: Hai Phong Institute of Oceanography, 2002

Coastal and sea water quality: In general, water quality in the coastal regions is within the national standards except in some estuaries. The threats to water quality include land-based pollution sources, fishing with poison (eg. Cyanide), unregulated tourism, transport and seaport development, and the oil and gas industry.

Land based pollution: The dominating land based sources of pollution to the coastal environment is the discharge from the river and sewage systems. The fluxes of some important pollutants have been estimated as presented in Table 4.

Table 4. Gross flux of pollutants in Six river mouths (Unit: tons/year)

Region (River systems)	Cu	Pb	Zn	As	Phosphate	Nitrate
North (Red and Thai Binh river system)	6790	885	5367	790	24748	35068
Central (Han and Thu Bon river system)	293	76	676	44	1253.1	4012
South (Sai Gon – Dong Nai or Mekong river system)	11000	1102	15696	1600	28220	191570

Source: Pham Van Ninh, 1998 Marine Water Pollution Assessment in Viet Nam. In the Proceedings of the Regional Workshop on Partnerships in the Application of Integrated Coastal Management, Thailand, November 1997.

Seaport development: There are a lot of small and big ports scattered along coastline of Viet Nam. Wastewater and residues of fish and marine products from fishing ports are a major source of organic pollutants in coastal waters. Apart from fishing ports, other marine ports are served for coal, oil and general products.

Oil spills: About 30% of the total cargo shipping through the ports carries petroleum products. Off-shore exploitation activities are increasing every year. From 1996 to 2002, the crude oil productions increased from 8.8 to 17 million tons/year. About 772,000 tons of oil is leaking into the East Sea from crude oil exploitation per year.

Between 1995 - 2002, at least 35 major oil spill incidents occurred in the sea. It was estimated that 92,000 tons of oil flowed into the coastal and marine environment during these incidents (Table 5).

Table 5. Statistics of Oil Spills 1995-2002

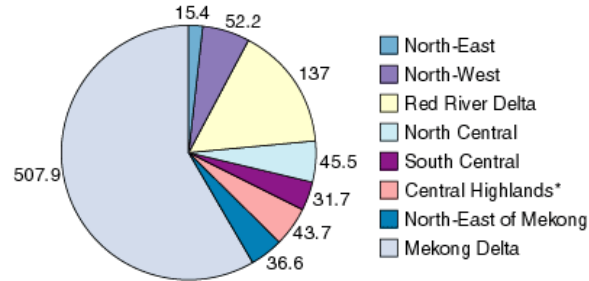
Year	Number of cases	Oil amount (tons)
1995	2	202
1996	7	68,300
1997	4	2,450
1998	6	12,900
1999	10	7,600
2000	2	45
2001	3	Approx. 900
June 2002	1	24

Source: NEA, SOE 2002.

SURFACE WATER

About two thirds of Viet Nam's water resources originate from catchments in riparian countries. Viet Nam is the lower riparian country in the Mekong and Red Rivers and is susceptible to water resource decisions made in upstream countries. This susceptibility exacerbates the highly variable seasonal (droughts in the dry season and flooding in the monsoons) and geographical distribution of water (Fig 2). Despite the total abundant water resources, the dependency on upstream countries and the uneven distribution have made Viet Nam's ranking low in Southeast Asia's water availability per capita (4170 m³/person compared to average 4900 m³/person in Southeast Asia and 3300 m³/person in Asia)

Fig 2. River run-off per Region (bill. m³/year)



Source: National Water Sector profile, 2002.

Surface water: Rivers Viet Nam has a dense river network of which 2360 rivers have a length of more than 10 km. Eight out of these are large basins with a catchment area of 10,000 km² or more (Table 6). The rivers flowing through Viet Nam include many international rivers. The total area in- and outside Viet Nam of all international catchments is close to 1.2 mill. km², which is approximately 3 times the size of Viet Nam itself. The total annual runoff is 835 billion m³ but the shortage of water is aggravated in the 6-7 month dry season, when the runoff is only 15 to 30% of this total.

Table 6. Water resources in major rivers

River Basin	Catchment area		Total Volume		
	Total Area in VN (km ²)	% in Viet Nam	Total (bill. m ³)	Total generated in VN (bill. m ³)	% generated in VN
Ky Cung-Bang Giang	11220	94	8.9	7.3	82
Red River-Thai Binh	155000	55	137	80.3	59
Ma-Chu	28400	62	20.2	16.5	82
Ca	27200	65	27.5	24.5	89
Thu Bon	10350	100	17.9	17.9	100
Ba	13900	100	13.8	13.8	100
Dong Nai	44100	85	36.6	32.6	89
Me Kong	795000	8	508	55.0	11

Sources: Based on data from Program KC-12

Of the international rivers, the Mekong and the Red rivers are the most important. The Mekong –the longest river in Southeast Asia –drains from China and enters the lower basin at the common Myanmar-Lao PDR-Thailand border point. The 'lower basin' covers some 600,000 km² and includes parts of four countries Lao PDR, Cambodia, Thailand and Viet Nam. The Red River basin is the largest in Viet Nam. The river rises in Yunnan Province in China and flows through the northern part of the country into the Tonkin Gulf, forming an extensive delta.

Reservoirs: Most dams and reservoirs in Viet Nam have been constructed for multiple purposes, including flood control, irrigation, hydropower, water supply and other flow management. Most are more than 20-30 years old. There are about 3600 reservoirs of various sizes, of which less than 15 percent are large or medium (capacity of over 1 mill. m³ or a height of more than 10 meters)¹. Siltation from degradation of watersheds is causing a decline in reservoir capacity – some with only 30% of the original capacity remaining. (Table 7)

Note 1: Nguyen Dinh Trong, Workshop on integrated water management for reservoirs, Hanoi Oct 1994.

Table 7. Major reservoirs in Viet Nam

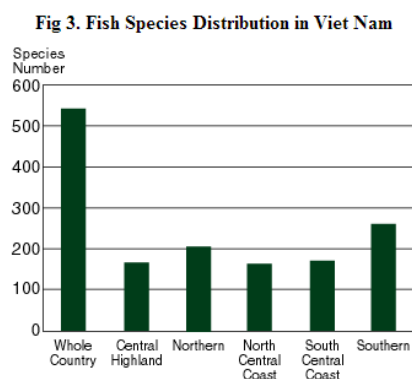
Reservoir	Catchment (km ²)	Volume (bill. m ³)	Irrigated Area (ha)	Hydro-power (MW)
Hoa Binh	51,700	9,450		1,920
Thac Ba	6,100	2,940		108
Tri An	14,600	2,760		420
Dau Tieng	2,700	1,580	72,000	
Thac Mo	2,200	1,370		150
Yaly	7,455	1,037		720
Phu Ninh	235	414	23,000	
Song Hinh	772	357		66
Ke Go	223	345	17,000	

Source: *National Water Sector Profile, 2002.*

Lake: There are several major natural lakes in Viet Nam, one of those is Ba Be lake with a surface area of 4.5 km² and a volume of 90 million m³. In addition, there are numerous other smaller lakes - including urban lakes in Hanoi.

Inland Ecosystem:

The freshwaters of Viet Nam are tropically rich in flora and fauna biodiversity including species of fish, shrimp, crab, snail, mussels, amphibians, insects and plants. In different fresh water systems, there are about totally 20 species of freshwater weeds; 1402 species of algae; 782 of invertebrates; 544 of fish species and 52 species of crabs. Distribution of fish species among the regions is presented in Fig 3.



Source: *Data based on different sources compiled by Fishery Research Institute I, 2003.*

Only scarce quantitative data are available for inland aquatic ecosystems, and the extent of the deterioration of freshwater biodiversity is still poorly known. However, there are indicators showing that many species are in danger of extinction or becoming rare (Box 1). Listed in the Red Book 2002 (forthcoming) are 6 wetland waterfowl birds, 24 reptiles, 14 amphibian, 37 fish, 19 mollusk and 1 insect freshwater species.

In a recent study by the World Bank 268 native freshwater fish species have been recorded only from the Ca River basin northwards, showing that a significant part of the northern Viet Nameese fish fauna is shared with southern China⁵. This study is particular concerned freshwater biodiversity in the context of the Viet Nam National Hydropower Study. The study shows that changes in the hydrological regime of river systems due to construction of dams for irrigation and hydropower causes loss of migrating routes for many species like the *Clupanodon thrissa* in the Red River and eels *Anguilla* spp. in various rivers in Viet Nam.

Box 1. Decline in freshwater fisheries and biodiversity

Decline is seen in various reservoirs and lakes in Viet Nam. In the Ba Be lake fish species have been disappearing at a rapid rate from 1998 to 2001. Over this short period 20 species have disappeared, out of which 15 are Cyprinidae.

This is a continuation of a steady decline over decades. The fish catches have gone down since the 1960s:

Period	Source	Production (t)	Yield
1961-62	Nguyen Van Hao (1964)	38	85.0
1962-67	Mai Dinh Yen, Bui Lai (1969)	20	45.0
1975	Nguyen Van Hao (1975)	15	33.4
1993-97	Nguyen Van Hao	11	24.5
2000	Nguyen Trong Hiep (2001)	7	15.0

Source: *Fish Fauna in Ba Be Lake, Nguyen Trong (kg/ha/yr)*

Surface Water Quality: In Viet Nam, data on surface water quality is poor. However, limited testing reveals rising pollution levels in downstream sections of the major rivers.

The upstream water quality of most rivers remains good, while downstream pollution mainly from urban areas and industries affects the water quality (Table 8).

Table 8. Water Quality Up-and Downstream Industries

Province	Positions	pH	COD	BOD	NO ₃	NH ₄ ⁺
Phu Tho	From Dien Hong to Viet Tri		10-24	15.3	0.014	0.1
	Bai Bang Paper Plant	7.8-9	20-50	2.7	0.01	0.01
	Dien Hong Pumping Station	7	4.5			
Thai Nguyen	Upstream of Thai Nguyen Industrial Area	6.9	3.5	2.0	0.03	0.02
	Shuice-gate of Hong Van Thu Paper Plant	7.3	32.5	15.3	0.05	0.4
Bac Giang	Phu Lang Thuong Hydrological Station	7.3	3.2	2.0	0.02	0.01
	Shuice-gate of Ha Bac Nitrogen Fertilizer Plant	9.2	0.55	50.4	5.3	5.6
Hai Phong	An Kim Hai Canal	7.0	3.6	2.1	0.11	0.15
	Shuice-gate of Chemical Plant (Cam River)	7.3	9.2	4.5	1.4	0.5

Source: (MoSTE-Documentation on Red River Delta (1997-1998), Scientific and technical Publisher 1998).

The National Monitoring Network (NMN) covers 4 rivers running through the main urban areas of Viet Nam, Red River (Hanoi), Cam River (Haiphong), Huong River (Hue) and Saigon River (HCM City). However, other rivers are monitored as well in the various regions (Table 9).

Table 9. Water Quality in Vietnamese rivers

Region	River	Exceedance of Class A
Red River Delta	Red River, Lao Cai	1.5-2/ NH_4
	Red River, Dien and Hanoi	3.8/BOD5
	Hong to Viet Tri	2/ NH_4
	Cau River	2/ NH_4
North Central Coast	Thuong River	2.7/BOD5 2-3/BOD5
	Hieu River	1.5-1.8/ NH_4
South Central	Huong River	2.5/BOD5 1-2/BOD5
Coast Northeast	Han River	1.4-2.6/ NH_4
	Sai Gon River	2-4/BOD5

Source: Compiled from various sources including SOE Report of 2001/2, and Results of DOSTE monitoring up to 2002

Trends indicate that the levels of two primary pollution indicators, Ammonia-nitrogen ($\text{NH}_4\text{-N}$) and Biochemical Oxygen Demand (BOD5) vary considerably and exceed national water quality class A standards by several fold (Fig 4 and Fig 5). The problems are worst during the dry season, when the flows in the rivers are reduced.

Fig 4. BOD levels in Vietnamese major rivers

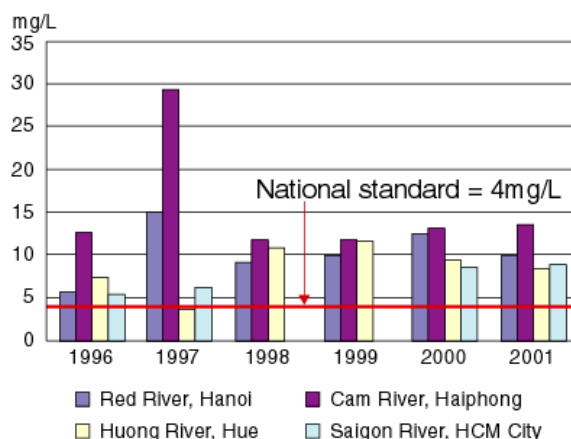
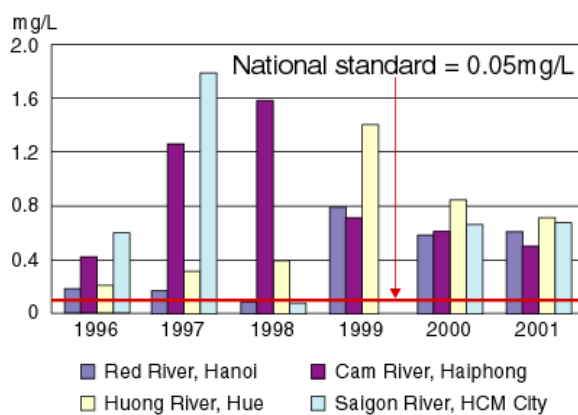


Fig 5. NH_4 levels in Vietnamese major rivers



Source: NEA, SOE reports 1997-2002.

Industrial and other pollution adds to the human waste from the population. Around 70 industrial parks have been developed, and with more than 1,000 hospitals nationwide some million cubic meters of untreated wastewater is discharged from these sources alone per day. According to MoNRE, there are about 4,000 enterprises discharging wastewater, of which 439 enterprises are the most serious, and are required reallocated, closed or will have to adapt cleaner technologies and treatment of their wastewater.

Rivers in Viet Nam's 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 levels⁹.

Untreated industrial wastewater discharging into rivers is the main source of the 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 tons of waste into the Dong Nai, Thi Vai and Saigon Rivers each day. Meanwhile, two out of 12 IPs and EPZs in Ho Chi Minh City, three out of 17 in Dong Nai, two out of 13 in Binh Duong, and none of the IPs and EPZs in Ba Ria-Vung Tau have wastewater treatment facilities. According to environmentalists the Southern Key Economic Zone needs investment of 5.7 trill. VND (380 million USD) in 2005 and 13 trill. VND (867 million USD) in 2010 to deal with environmental pollution.

Within cities, lakes, streams, and canals increasingly serve as sinks for domestic sewage, municipal, and industrial wastes. Most of the lakes in Hanoi are seriously polluted with high BOD levels. Similarly, 4 small rivers in Hanoi and 5 canals in HCM City have levels of DO as low as 0-2 mg/l, and BOD levels as high as 50-200 mg/l (Table 10).

Table 10. Water Quality in Urban Rivers, Lakes, and Canals

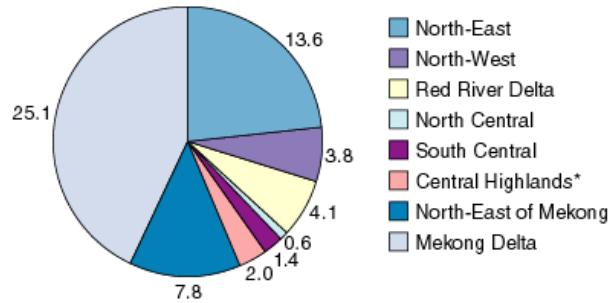
River/Lake/Canal	SS (mg/l)	BOD (mg/l)	COD (mg/l)	DO (mg/l)
Kim Nguu (Hanoi)	150-220	50-140		0.5-1.0
Set (Hanoi)	150-200	110-180		0.2-0.5
Lu (Hanoi)	150-300	60-120		0.5-1.5
To Lich (Hanoi)	60-350	14-120		0.5-7.9
Lakes Hanoi	100-150	15-45		0.5-2.0
Lakes Hai Phong	47-205	15-67	15-105	0.5-7.0
Shuice gates Hai Phong		60-390	80-500	< 1.0

Source: MoSTE- Documentation on Red River Delta (1997-1998), Scientific and technical Publisher (1998).

GROUND WATER

The groundwater resources in Viet Nam are abundant – with the total potential exploitable reserves of the country's aquifers estimated at nearly 60 bill. m³ per year. The availability varies from abundant resources in the Mekong River Delta to somewhat limited resources in the North Central Region (Fig 6).

Fig 6. Exploitable Groundwater Bill. m³/year



Source: National Water Sector profile, 2002.

However, despite the abundance of groundwater reserves, only less than 5% of the total reserves are exploited, for the country as a whole. The abstraction of groundwater also varies. For example, groundwater exploitation is difficult in the Northeast because the reserves are scattered and diverse. In the Central Highlands, on the other hand, groundwater is exploited heavily for irrigation of cash crops resulting in shortages of water in parts of this region. In the Red River and Mekong River Deltas groundwater is exploited beyond the recharge capacity around Hanoi and HoChiMinh City. This over-exploitation is resulting in falling water tables – further causing land subsidence and salinity intrusion, especially in the Mekong River Delta.

Mineral and thermal water resources are abundant in Viet Nam, good in quality and varied in types having great value for different purposes such as balneological treatment, bottled mineral water, geothermal energy, extraction of CO₂ gas etc. According to investigation there are about 400 mineral and thermal water sources in the country, of which 287 sources have been exploited and reliable data exist (Table 11).

Table 11. List of Mineral and Thermal Water Sources

Region	Number of Sources			
	Springs	Boreholes	Springs/ Wells	Total
Northeast	83	1	3	87
Northwest	7	5	2	14
Red River Delta	1	15	1	17
North Central Coast	14	4	4	22
South Central Coast	30	4	22	56
Central Highlands	18	6		24
Northeast of Mekong	1	11	1	13
Mekong River Delta		54		54
Total	154	100	33	287

Sources: MOI 1999. Mineral and Thermal water resources in Viet Nam

Groundwater quality:

Groundwater is emerging as an important source of water for domestic, industrial, and agricultural uses. While the quality of ground water 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, HCMC and the Mekong River Delta.

New investigations have shown potential problems related to the presence of arsenic in alluvial deposits in the Red River region and in tubewells pumping water from lower aquifer¹⁰. This requires further study and careful assessment. In addition nitrogen and iron levels above the admissible standards are found both in the Red River (Box 2) and Mekong River Deltas.

Box 2. Ground water pollution in Hanoi

A research project in Hanoi has shown an alarming sign of ground water contamination by ammonia in the South of Hanoi. The level of ammonia in the treated water at the three treatment plants is higher than the national standard by 2-8 times. All samples taken from the upper aquifer exceed ammonia standard many times. Scientists estimate that with the current abstraction rate of 700,000 m³/day, there will be a high risk of lowering the water table down to 114 m and the groundwater pollution would spread over the Hanoi city.

Sources: VEPA website <http://www.nea.gov.vn> (Jun 11, 2003).

Salinity intrusion: A pressing issue is the salinity intrusion taking place both in the Red River Delta, the Central Coastal Regions and in the Mekong River Delta. Salinity intrusion is a natural phenomenon in coastal areas. However, due to increased groundwater exploitation salinity intrusion increases and poses a threat to safe water supply e.g. in the Red River and Mekong River Deltas.

In the Red River Delta, salinities higher than 3‰ stretches more than 60 km inland to Hai Duong in the north and Nam Dinh in the south of the delta. In the Mekong River Delta, saltwater is registered in half of the delta area.

WATER QUALITY

The Northwest region has an area of 35,637 km² and a population of 2.3 mill. people, of whom only 03.4 thousand live in urban areas. The main economic activities are agriculture, forestry and mining. The region is mountainous, and soils are acidic and of low fertility. Intense rainfall from late May to October, combined with steep topography and frequent seismic activity make the region highly susceptible to erosion.

Water Quality Issues

Social and economic development has not had a significant impact on water quality in this region. Water quality data are limited. However, available data for the Da River show, though not systematically, that organic content is low and the dissolved oxygen levels are acceptable. Generally the water quality is considered to be good although some localized deterioration occurs near the few urbanized locations in the region. Ground water quality is reportedly good and well within the national standards.

Table 12a. Da River Water Quality, Lao Cai Province

	Class A	Class B	Out-of-range
COD (mg/l)	X		
BOD (mg/l)	X		
NH ₄ -N (mg/l)	X		
DO (mg/l)		X	
Coli (MPN/100ml)	X		
Overall		X	

Table 12b. Da River Water Quality, Hoa Binh Province

	Class A	Class B	Out-of-range
COD (mg/l)	X		
BOD (mg/l)	X		
NH ₄ -N (mg/l)	X		
DO (mg/l)		X	
Coli (MPN/100ml)	X		
Overall		X	

The Northeast region has a total area of 65,326 km² and a population of 9.0 mill. population, of which 1.7 mill. are in urban areas. The region is mountainous and hilly, with limestone. The coastal areas have port development and mining industries, but also have good fishing grounds and a high potential for mangrove plantations and aquaculture. The region is prone to typhoons mainly during June through August.

Water Quality Issues

Rivers of this region generally have good water quality. Upstream reaches of the Red River in the Lao Cai province fulfill Class A water quality criteria (Table 26a). To the north of Red River, the larger tributaries (the Lo, Gam, Cau, Thuong and Luc Nam) generally meet Class B standards (Table 26b). In dense urban and industrial areas, however, the water quality in these tributaries does not meet the standard. Hotspots include the section of the Red River around Viet Tri town, where COD and BOD₅ exceed national standards by 2.3 and 3.8 times respectively. The Cau river that runs through the Thai Nguyen industrial zone is heavily polluted with concentrations of NO₂, NH₄ and BOD₅ that exceed the standards by 10, 2 and 5 times respectively. TSS and H₂S exceed the standards by ten to hundred times.

Ground water quality is reported to be good and generally within the national standards, except in the coastal region where salinity causes a problem. The water quality is also affected in mining areas.

Table 13a. Red River Water Quality, Lao Cai Province

	Class A	Class B	Out-of-range
COD (mg/l)	X		
BOD (mg/l)	X		
NH ₄ -N (mg/l)	X		
DO (mg/l)	X		
Coli (MPN/100ml)	X		
Overall	X		

Table 13b. Cau River Water Quality, Bac Ninh Province

	Class A	Class B	Out-of-range
COD (mg/l)		X	
BOD (mg/l)		X	
NH ₄ -N (mg/l)		X	
DO (mg/l)		X	
Coli (MPN/100ml)		X	
Overall		X	

The Red River Delta covers an area of 14,788 km² with a population of 17.2 mill. people, of which 3.6 mill. live in urban areas. The capital city Hanoi and port city Hai Phong are located in this region. Major economic activities vary from industry and port transport to extensive services and intensive agriculture. The flat topography and alluvial soils are suitable for intensive agriculture.

Water Quality Issues

The water quality in the Red River–Thai Binh is generally acceptable and meets the standards of industrial and domestic use. However, near outlets from industries, Class A standards are exceeded (Table 27). The Nhue River, which receives effluence from Hanoi, is heavily polluted with oxygen levels down to 1-2 mg/l and NH₄ levels above 2.5 mg/l downstream from the confluence with the To Lich River. Cam and Tam Bac rivers (running through Hai Phong) are considerably polluted. Values of BOD₅ and COD parameters have increased gradually from 1995-1997 for the two rivers, especially for the Tam Bac river.

Ground water quality in the region is generally within the standards. However, salinity intrusion is becoming an increasing problem (Map 1 in Annex 2).

Coastal Waters

The coastal ecosystems are threatened by oil spills. Since 1997, as many as seven oil spills have been reported in the region. Except for oil, phosphates, and nitrates, other parameters of coastal water quality are within the national standards (Table 28).

Table 14a. Red River Water Quality.

	Class A	Class B	Out-of-range
COD (mg/l)		X	
BOD (mg/l)		X	
NH ₄ -N (mg/l)		X	
DO (mg/l)	X		
Coli (MPN/100ml)	X		
Overall		X	

Table 14b. Thai Binh River Water Quality.

	Class A	Class B	Out-of-range
COD (mg/l)	X		
BOD (mg/l)		X	
NH ₄ -N (mg/l)		X	
DO (mg/l)	X		
Coli (MPN/100ml)	X		
Overall		X	

Table 15. Quality of Coastal Water

	Phosphate	Nitrate	COD	BOD	Oil	Coliforms
1996	6.6	192	2.25	1.07	0.36	928
1997	17.75	30	4.3	1.3	0.34	804
1998	22.40	n.a.	n.a.	n.a.	0.56	866
1999	n.a.	n.a.	n.a.	n.a.	>0.05	>1000
2000	16.00	<50	n.a.	0.8	2.4	>1000
2001	>16.00	>50	n.a.	n.a.	1.12	<1000
National Standards	10 µg/l	50 µg/l	30 – 40 mg/l	10 – 20 mg/l	0.05 mg/l	1000 (MNP)

Source: NEA (1997-2002) and HIO (1999).

The North Central Coastal region has an area of 51,501 km² and a population of 10.2 mill. people, of which 1.35 mill. live in urban areas. The major cities Thanh Hoa, Vinh, Dong Ha, and Hue are areas of moderate economic activity. Agriculture and tourism are the main income earners. The population is generally poor and the region is prone to typhoons, floods, and droughts. Yellow-red soils are found in the uplands, alluvial in the lowlands and sandy soils at the coast. The land is not fertile and more than one third of it has medium susceptibility to deterioration and erosion.

Water Quality Issues

Monitoring of water quality has not been carried out in any extensive way in the North Central Region. However, the upstream river water quality where measured has been found to be good within class A and B for various parameters (Table 29). In urban and industrialized areas near the coast the water quality deteriorates. Hieu river (through Dong Ha town) has BOD₅ and COD concentrations exceeding class A standards by 2-3 times, NH₄ and PO₄ by 1.5-1.8 times. In the Huong river section running through Hue city the BOD₅ and COD concentrations exceed the class A standards by 2.5 and 1.6 times respectively.

In the plains the groundwater has a complex chemical composition with alternating contents of compounds and total dissolved solids. However, the general quality standards for consumption are adhered to, except in low land areas influenced by tides where salinity intrusion takes place.

Increasing economic development in this region may cause further water quality problems in the coastal regions from urban and industrial wastewater discharges, unless adequate treatment is undertaken.

Table 16a. Ca River Water Quality

	Class A	Class B	Out-of-range
COD (mg/l)		X	
BOD (mg/l)		X	
NH ₄ -N (mg/l)	X		
DO (mg/l)	X		
Coli (MPN/100ml)	X		
Overall		X	

Table 16b. Huong River Water Quality

	Class A	Class B	Out-of-range
COD (mg/l)		X	
BOD (mg/l)		X	
NH ₄ -N (mg/l)	X		
DO (mg/l)	X		
Coli (MPN/100ml)	X		
Overall		X	

The South Central Coastal region has an area of 33,100 km² and a population of 6.7 mill. people, of which 1.9 mill. live in urban areas. The major economic activities include industries in Da Nang and Quy Nhon cities, and fishery, aquaculture, and intensive tourism in all provinces. Sandy aquaculture is expanding rapidly in the region, especially in the Ninh Thuan province.

The region is characterized by high temperatures, heavy rainfall during the wet season, and a prolonged dry season. Yellow-red soils are dominant in the uplands and white sandy beaches are all along the coastline.

Water Quality Issues

The water quality of rivers is generally good, especially in the upstream reaches (Table 30b.). Some sections of rivers have oil content of 0.1 mg/l. Pollution hotspots include coastal cities such as Da Nang, Quy Nhon, and Nha Trang. Dissolved oxygen levels in the Han River are good. However, BOD5 and COD exceed Class A standards by 1-2 times and NH₄ by 1.4-2.6 times (Table 30a).

In mining areas, various heavy metals and other toxic substances constitute a problem. For example, cyanide in river waters exceeds the standard by 1.6-2 times in some mining areas. In the plains the quality of groundwater resources is good. In the estuaries saltwater intrusion is a problem.

Water quality in this region may deteriorate with increasing economic development and consequent urban and industrial waste water discharges, if not treated properly in future. Coastal water is contaminated mainly by oils, phosphates and nitrates (Table 31).

Table 17a. Han River Water Quality

	Class A	Class B	Out-of-range
COD (mg/l)		X	
BOD (mg/l)		X	
NH ₄ -N (mg/l)		X	
DO (mg/l)	X		
Coli (MPN/100ml)		X	
Overall		X	

Table 17b. Thu Bon River Water Quality

	Class A	Class B	Out-of-range
COD (mg/l)	X		
BOD (mg/l)	X		
NH ₄ -N (mg/l)	X		
DO (mg/l)	X		
Coli (MPN/100ml)	X		
Overall	X		

Table 18. Quality of Coastal Water

	Phosphate	Nitrate	COD	BOD	Oil	Coliforms
1996	48	331	5.05	2.66	0.21	1205
1997	30	90	10.7	2.0	0.13	78
1998	n.a.	n.a.	n.a.	n.a.	0.57	n.a.
1999	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
2000	n.a.	<100	n.a.	n.a.	0.45	n.a.
2001	n.a.		n.a.	n.a.	1.12	<1000
National Standards	10 µg/l	50 µg/l	30 – 40 mg/l	10 – 20 mg/l	0.05 mg/l	1000 (MNP)

Source: NEA (1997-2002) and HIO (1999).

The Central Highlands Region covers an area 54,476 km² and a population of 4.3 mill. people, of which 1.2 mill. are living in urban areas. With a population density of 80 people per km² this constitutes the least densely populated region in Viet Nam. Economic activity is mainly related to forestry and agriculture with widespread cultivation of cash crops such as coffee, cashew nuts, and tea.

The region is characterized by a very prolonged dry season with severe droughts from January to May, followed by heavy rainfalls. More than two thirds of the land is susceptible to deterioration. The region has 1.8 million ha of basaltic soils with excellent potential for agriculture development.

Water Quality Issues

Under the National Monitoring Program, water quality data for the Central Highland Region are scarce. However, some data is available through the MRC monitoring program.

River water quality in this region is generally good (Table 32). The ammonia concentrations in the rivers are generally low, but occasionally higher than the standard of 0.050 mg NH₄-N. No available measurements were identified for BOD₅, as this parameter is not part of the MRC program.

The ground water quality is generally within the national water quality standards.

Table 19a. See San River Water Quality

	Class A	Class B	Out-of-range
COD (mg/l)	X		
BOD (mg/l)			
NH ₄ -N (mg/l)	X		
DO (mg/l)	X		
Coli (MPN/100ml)	X		
Overall	X		

Table 17b. Thu Bon River Water Quality

	Class A	Class B	Out-of-range
COD (mg/l)	X		
BOD (mg/l)			
NH ₄ -N (mg/l)	X		
DO (mg/l)	X		
Coli (MPN/100ml)	X		
Overall	X		

Northeast of Mekong has a total area of 34,733 km² and a population of 12.4 mill. people, of which 6.5 mill. live in urban areas. The region is characterized by industrial development and high economic activity concentrated around HCMC, Binh Duong, Dong Nai, Vung Tau. Tourism is another main activity in Ninh Thuan, Binh Thuan and Vung Tau – Con Dao. Off-shore gas and oil industry is on the rise.

Water Quality Issues

Industrial and urban development characterize major parts of this region and significantly impact water quality. The downstream end of the Dong Nai river is relatively highly polluted (Table 33). Oil spills from shipwrecks and oil leakages from marine transportation are a major pollution problem. Hotspot areas include sections of Thi Vai and Sai Gon rivers. Thi Vai river is likened to a reservoir of industrial waste-water from Bien Hoa and Phu My industrial zones. Dissolved oxygen levels are under 2 mg/l over a 16 km stretch. In Go Dau BOD5 and COD exceed the standard by 10 to 15 times. Coliforms exceed standards by 50 to 100 times. Nitrogen and phosphorus also exceeds the standards. However, heavy metals including chromium, lead, mercury and arsenic are measured in concentrations within the standards.

The Holocene groundwater aquifers have the highest grade of pollution, mainly zones with high salinity in the seashore band and the zone between the Mekong and Dong Nai Rivers. The deep aquifers are less contaminated and can be used directly for water supply.

Table 20a. Sai Gon River Water Quality

	Class A	Class B	Out-of-range
COD (mg/l)		X	
BOD (mg/l)		X	
NH ₄ -N (mg/l)			X
DO (mg/l)		X	
Coli (MPN/100ml)			X
Overall			X

Table 20b. Dong Nai River Water Quality

	Class A	Class B	Out-of-range
COD (mg/l)	X		
BOD (mg/l)	X		
NH ₄ -N (mg/l)		X	
DO (mg/l)	X		
Coli (MPN/100ml)		X	
Overall		X	

Box 3. Pollution in Canals in Ho Chi Minh City

Nhieu Loc–Thi Nghe and Tan Hoa–Lo Gom drainage canals in HCMC are the two most polluted waterways and are comparable to the most polluted rivers and canals in other mega-cities around the world. The canals that eventually drain into the Saigon River are anoxic with 0 (zero) dissolved oxygen concentrations and BOD/COD levels up to 300/900 mg/l. The density of 350 persons/ ha in the catchments contributes to the organic pollution and odor that pose a health hazard to the population. Along Tan Hoa–Lo Gom canal there are more than 2,600 polluting enterprises (98% of which have no waste treatment facilities) that contribute more than 50% of the current pollution loads of the canal.

Source: EIA for HCMC sanitation project and Urban Upgrading

The Mekong River Delta region covers an area of 39,713 km² and has a population of 16.5 million people, of which 3 million live in urban areas. With a population density of 416 persons/km² this is one of the most densely populated coastal regions in the world. Agriculture and aquaculture dominate, along with the food processing industry.

Annual rainfall of 2000 mm arrives in late June and ends in November. The region is best known for its dense hydrological network and heavy waterway transport. Flooding is a permanent phenomenon in the delta. Soils are mostly alluvial, but there are extensive areas of acid sulfate and saline soils.

Water Quality Issues

Based on measurements provided by the national monitoring program and MRC, it can be concluded that the water quality in the major rivers of the Mekong River Delta is within the standard classes A-B (Table 34). The only parameter that exceeds standards is BOD₅, and occasionally NH₄.

However, in the smaller tributaries, especially in the urban and industrialized areas, the water quality will be found to be exceeding the standard. A notable feature is the low pH values in the rivers of the Mekong River Delta (3.8-5.0).

The ground water quality in the Mekong River Delta region is variable. Salinity intrusion is a major problem in the coastal parts of the delta (map 2 in Annex 2). In addition high concentrations of nitrogen compounds have been registered in bore holes in the Holocene aquifers.

Coastal water is deteriorating in most of the quality parameters, mainly due to the high intensity of economic activities in the region (Table 35).

Table 21a. MeKong River Water Quality

	Class A	Class B	Out-of-range
COD (mg/l)	X		
BOD (mg/l)		X	
NH ₄ -N (mg/l)	X		
DO (mg/l)	X		
Coli (MPN/100ml)		X	
Overall		X	

Table 17b. Thu Bon River Water Quality

	Class A	Class B	Out-of-range
COD (mg/l)	X		
BOD (mg/l)	X		
NH ₄ -N (mg/l)		X	
DO (mg/l)	X		
Coli (MPN/100ml)		X	
Overall		X	

Table 22. Quality of Coastal Water

	Phosphate	Nitrate	COD	BOD	Oil	Coliforms
1996	9.8	251	19.3	1.5	1.29	3796
1997	10	360	20.5	1.63	0.18	3650
1998	n.a.	n.a.	n.a.	n.a.	n.a.	4400
1999	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
2000	n.a.	n.a.	n.a.	n.a.	0.36	n.a.
2001	n.a.	n.a.	n.a.	n.a.	1.12	4500
National Standards	10 µg/l	50 µg/l	30 – 40 mg/l	10 – 20 mg/l	0.05 mg/l	1000 (MNP)

Source: NEA (1997-2002) and HIO (1999).

WATER RESOURCES SCORECARD

This scorecard attempts to evaluate the water resources availability in Viet Nam for the 8 regions, and highlight issues requiring attention.

A high score (+++++) means water is abundant or good quality, a low score (+) they are scarce or the water quality is unacceptable and out of range of standards.

Water Resource Availability

Region	Surface Water	Ground Water	Issues
Northwest Region	+++++	+++	Flashfloods, floods, seasonal drought Reservoir siltation and construction
Northeast Region	++++	+++	Flashfloods, floods, seasonal drought
Red River Delta	+++++	+++++	Floods, Cross-sectoral water allocation and use Intensive agriculture, groundwater over-exploitation
North Central Coast	+++	+++	Flashfloods, floods, Seasonal Droughts Low river flow during prolonged dry season in South of region
South Central Coast	++	+++	Flashfloods, floods, Severe Seasonal Droughts Low river flow during prolonged dry season entire region
Central Highlands	++++	++++	Flashfloods, Seasonal droughts Groundwater over-exploitation for irrigation, Reservoir construction
Northeast of Mekong	++++	+++++	Floods, Seasonal drought. Sector wise water allocation and use, Groundwater over-exploitation (HCMC)
Mekong River Delta	+++++	+++++	Flood, cross-sectoral water allocation and use Intensive agriculture/aquaculture, groundwater over-exploitation

Sources: VEPA website, Environmental Water Report, 2003

Water Quality

Region	Rivers		Ground water	Coastal Waters	Issues
	Upstream	Down-stream			
Northwest Region	+++++	++++	+++++	-	-
Northeast Region	+++++	++	++++	+++	Urban pollution, Saline intrusion, Marine transport pollution risks.
Red River Delta	++++	++	+++	+++	Urban and Industrial pollution, Saline Intrusion Agrochemical pollution, transport pollution risks
North Central Coast	++++	+++	++++	++++	Urban pollution, Saline intrusion
South Central Coast	+++++	++	++++	++++	Urban pollution, Saline intrusion
Central Highlands	+++++	++++	+++++	-	-
Northeast of Mekong	++++	+	+++	++	Urban and industrial pollution, Saline intrusion
Mekong River Delta	++++	++	+++	+++	Saline intrusion, Low pH in rivers (Acid soils) Agrochemical pollution, transport pollution risks

Sources: VEPA website, Environmental Water Report, 2003

Biodiversity Issues

This table highlights issues related to biodiversity requiring attention in Viet Nam for the 8 regions.

Region	Freshwater	Marine	Ecosystems
Northwest Region	Extinction of fish species in rivers.	Not applicable.	Effects of dam construction on natural function of river ecosystems.
Northeast Region	Fish overexploitation in Ba Be Lake. Disappearance of river fish species.	Halong Bay as a world heritage site.	Vulnerable wetlands, coral reefs and seagrass beds.
Red River Delta	Decline in river fish species composition.	Ramsar site at Xuan Thuy Mangroves missing to sustain marine biodiversity.	Vulnerable wetlands and remaining natural mangroves.
North Central Coast	Protected wetlands.	Degradation of marine areas and biodiversity.	Vulnerable seagrass beds.
South Central Coast	Decline in river fish species composition.	Degradation of marine areas and biodiversity.	Vulnerable wetlands, coastal lagoons, corals reefs, seagrass beds.
Central Highlands	Decline in river fish species composition.	Not applicable.	Effects of dam construction on natural function of river ecosystems.

Sources: *VEPA website, Environmental Water Report, 2003*

[http://wepa-db.net/policies/state/Viet Nam/overview.htm](http://wepa-db.net/policies/state/Viet%20Nam/overview.htm)