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Vietnam ENVIRONMENT MONITOR 2003

WATER

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Preface

The Vietnam Environment Monitor series, initiated in 2002, presents a snapshot of key environmental trends in the country. Its purpose is to engage and inform stakeholders of key environmental changes as they occur. The Monitor 2002 was jointly launched by the World Bank, the Ministry of Science, Technology and Environment, and the Royal Danish Embassy in October 2002 and has been placed on the Internet for wider distribution. It was well received by the Government agencies, the donor community and the civil society as a good overview of the Vietnam's environment over the last five years.

Specifically, the objectives of the Vietnam Environment Monitor 2003 are to (a) underscore the importance of water and environmental resources to Vietnam's social and economic development, (b) present the past and ongoing water resources development and management efforts, (c) highlight the emerging environmental management challenges and threats that face Vietnam and their social, economic and political implications and (d) summarize a set of indicators that could be used to monitor changes in the water environment.

Vietnam has a long history of water management that has developed in response to water shortages during the dry season, a monsoon climate that regularly causes extensive flood damage, and the desire to intensify agricultural production. About two thirds of Vietnam's water resources originate from catchments in riparian countries. Vietnam is the lower riparian country in the Mekong and Red Rivers, and is thus susceptible to water resource decisions made in upstream countries.

Vietnam is one of the most disaster-prone countries in the world; about 70 percent of the population is exposed to the effects of typhoons and torrential rains in combination with strong winds, floods, landslides and mud flows. Historically, droughts have been localized and seasonal, but they have become a more serious problem in recent years. Vietnam's extraordinarily long coastline is home to rich marine resources and biodiversity. However, much of the coastal environment is being degraded by the compounding factors of population growth, urbanization, rapid and largely uncoordinated economic development, and inadequate resource management.

Over the past decade, the Government of Vietnam has enacted laws, created institutions, expanded investments and decentralized authority to manage the country's vast water resources. However, rapid economic expansion, high population growth, worsening environmental conditions and frequent natural disasters are overwhelming the capacity of the existing policy and institutional regime, and in turn, are undermining the effectiveness of numerous governmentled interventions. Given this history and context, the management of water resources is one of the most critical issues in Vietnam today. On the global agenda, environmental and water management was discussed at the World Summit for Sustainable Development in Johannesburg as an emerging issue. For these reasons, Water Resources was chosen to be the focus of this year's Vietnam Environment Monitor.

The Vietnam Environment Monitor 2003 consists of two main sections. The first section provides an overview of Vietnam's water resources. Several sub-sections focus on different aspects such as surface water, groundwater and coastal resources including water resources availability, water utilization, aquatic biodiversity, water quality, vulnerability and economic costs. A discussion of water resources management that covers the legislative framework, institutions, expenditures and monitoring concludes the section.

The second section of this Monitor provides detailed water resources profiles in the context of the socioeconomic development of the eight economic sub-regions. They are the Northwest, Northeast, Red River Delta, North Central Coast, South Central Coast, Central Highlands, Northeast of Mekong (Dong Nam Bo), and Mekong River Delta sub-regions.

PREFACE

The Vietnam Environment Monitor 2003 is the outcome of a joint exercise that involved national agencies, civil society, academia and researchers, and donor agencies. Information has been obtained from a variety of sources including published reports of government agencies, universities, and non-governmental organizations, and documents of the World Bank and other donors. The maps printed in this report cover only those areas from which the information was collected for this report. The boundaries, colors, denominations and any other information shown on these maps do not imply any judgment on the legal status of any territory, or any endorsement or acceptance of such boundaries.

The Ministry of Natural Resources and Environment served as the lead government agency in the preparation of this report and coordinated the data collection and cooperation among government agencies. The Danish International Development Assistance (DANIDA) provided technical consultancy and financial support. The World Bank staff were responsible for data analysis and writing the report.

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Abbreviations and Acronyms

ADB	Asian Development Bank
AusAID	Australian Agency for International Development
AWRM	Agency of Water Resources Management
BOD	Biochemical Oxygen Demand
CG	Consultative Group
CO_2	Carbon Dioxide
COD	Chemical Oxygen Demand
CZMC	Coastal Zone Management Center
DOE	Department of Environment
DoNRE	Department of Natural Resources and Environment
DoSTE	Department of Science, Technology and Environment
EPZ	Export Processing Zone
EIA	Environment Impact Assessment
FIPI	Forest Inventory and Planning Institute
GoV	Government of Vietnam
GSO	General Statistical Office
HCMC	Ho Chi Minh City
HIO	Hai Phong Institute of Oceanography
ICZM	Integrated Coastal Zone Management
IP	Industrial Parks
IUCN	International Union for the Conservation of Nature
IWRM	Integrated Water Resource Management
JICA	Japanese International Cooperation Agency
LWR	Law on Water Resources
MARD	Ministry of Agriculture & Rural Development
MOF	Ministry of Fisheries
MOH	Ministry of Health
MOI	Ministry of Industry
MONRE	Ministry of Natural Resources and Environment
MOSTE	Ministry of Science, Technology and Environment
MOT	Ministry of Transport

ABBREVIATIONS & ACRONYMS

MPA	Marine Protected Areas
MPI	Ministry of Planning and Investment
MRC	Mekong River Commission
NDM-P	Natural Disaster Mitigation Partnership
NEA	National Environment Agency
NMN	National Monitoring Network
NWRC	National Water Resource Council
O&M	Operating and Maintenance
RBO	River Basin Planning and Management Boards
SEA	Strategic Environmental Assessment
SOE	State of Environment
SOEs	State-Owned Enterprises
TCVN	Vietnam National Standards
UNDP	United Nations Development Programme
USD	United States Dollar
VEPA	Vietnam Environment Protection Agency
VND	Vietnamese Dong
WB	World Bank
WUA	Water Use Associations

Foreign Exchange Rate (2002-2003): 1 USD = 15,300 VND

WATER RESOURCES SCORECARD

This scorecard attempts to evaluate the water resources availability in Vietnam 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. Assessment and scoring are based on the information of the report.

Water Resource Availability

Region	Surface Water	Groundwater	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

Water Quality

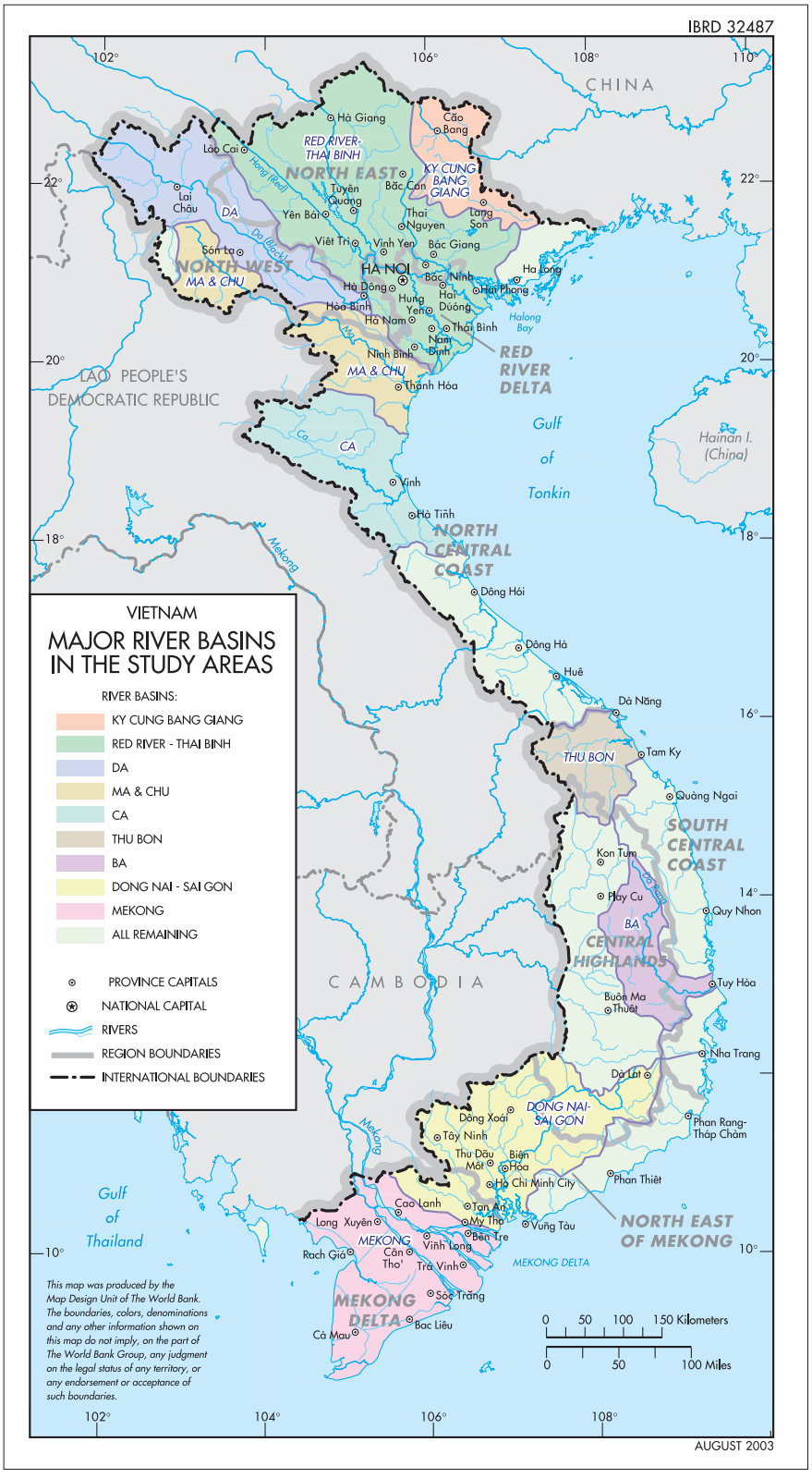
Region	Rivers		Groundwater	CoastalWaters	Issues
	Upstream	Down-stream			
Northwest Region	+ + + + +	+ + + +	+ + + + +	-	-
Northeast Region	+ + + + +	+ +	+ + + +	+ + +	Urban pollution, Saline intrusion, Marine transport pollution risks
Red River Delta	+ + + +	+ +	+ + +	+ + +	Urban and Industrial pollution, 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

Biodiversity Issues

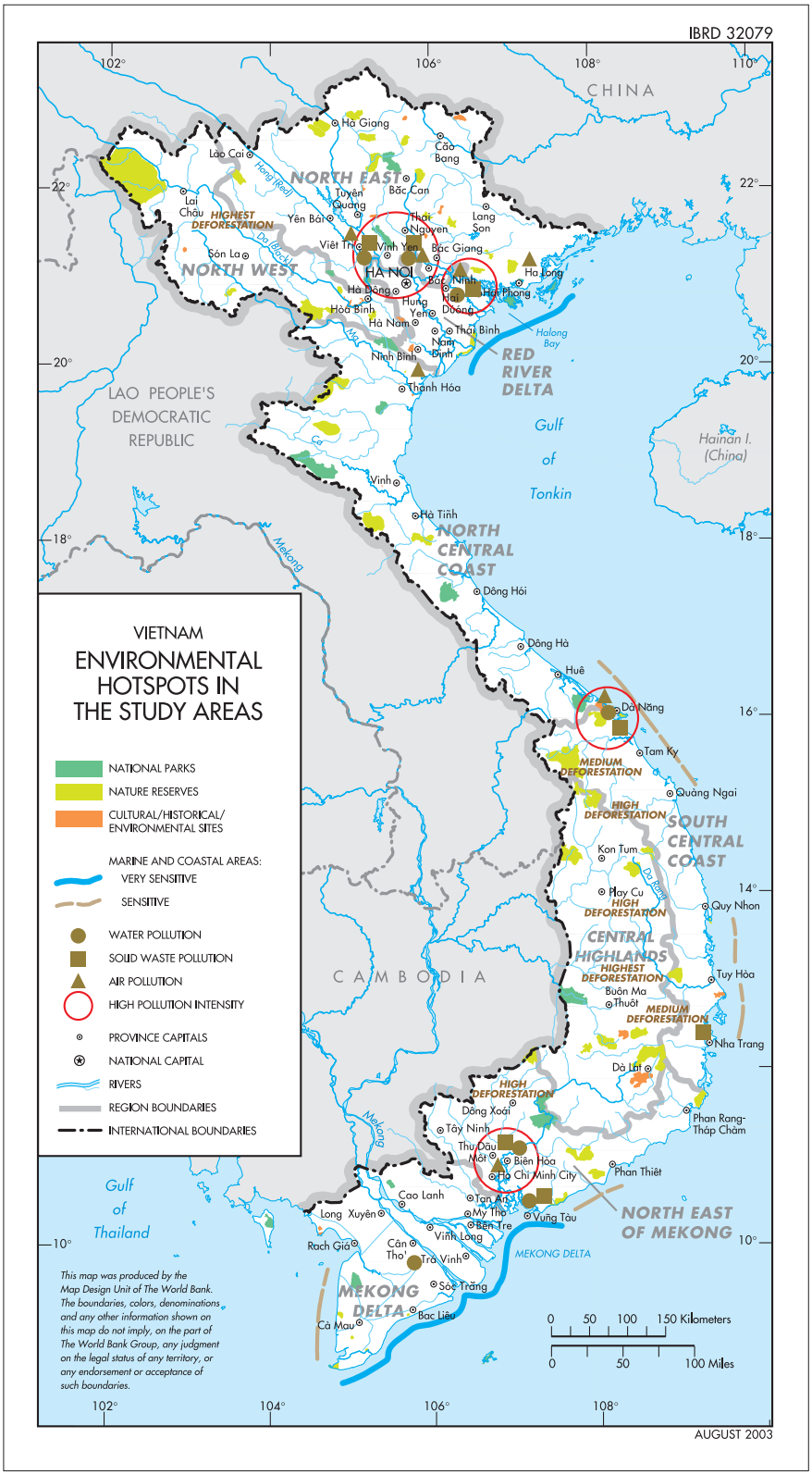
This table highlights issues related to biodiversity requiring attention in Vietnam for the 8 regions.

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 ThuyMangroves 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
Northeast of Mekong	Decline in river fish densities and species	UNESCO Biosphere Natural Reserve at Can Gio mangrove	Vulnerable wetlands Effects of dam construction on natural function of river ecosystems
Mekong River Delta	Decline in river fish species and density	Mangroves missing to sustain marine biodiversity	Vulnerable off-shore seagrass beds and coral reefs

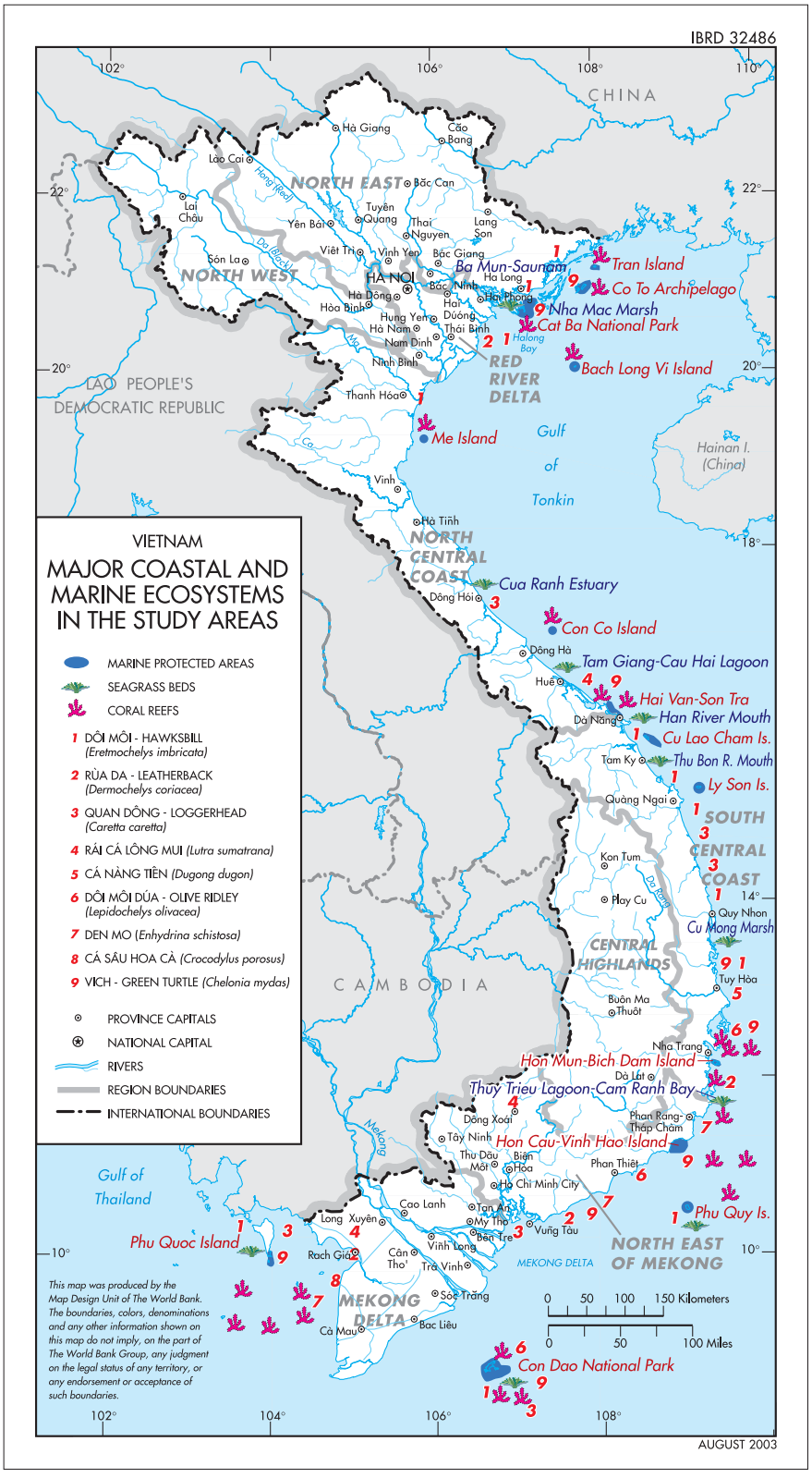
RIVER BASINS AND ECONOMIC REGIONS



ENVIRONMENTAL HOTSPOTS



MARINE AND COASTAL ECOSYSTEMS



Executive Summary

Vietnam 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 km^2 or more. This river network includes many international rivers that originate in catchments in other countries. About two thirds of Vietnam's water resources originate outside the country, making Vietnam susceptible to water resources decisions made in upstream countries.

The total area in- and outside Vietnam of all international catchments is close to 1.2 mill. km^2, which is approximately three times the size of Vietnam itself. The total annual runoff is 835 billion m^3 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 Vietnam provide an abundant supply of water (255 bill. m^3 annually). However, inadequate physical infrastructure and financial capacity results in a low utilization of only 53 bill. m^3 per year. In addition, the uneven distribution across Vietnam 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 m^3 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 Vietnam, irrigation places the largest burden on water resources. Total irrigation demand in 2000 was 76.6 billion m^3, 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 m^3 by 2010, (representing an irrigated area of 12 mill. ha).

Clean drinking water is now provided to 60 percent of Vietnam'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: Vietnam'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 Vietnam are rich in flora and fauna biodiversity including fish (544 species), shrimp, crab (52 species), 782 species of invertebrates (snail, mussels, amphibians, insects) and plants (20 species of weeds, 1402 species of algae). Vietnam'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 Vietnam'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.

EXECUTIVE SUMMARY

Vulnerability: The geography and topography of Vietnam 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 Vietnam 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 VDN or 1.25 billion USD between 1995 and 2002.

Management capacity: In Vietnam 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 subsectors. 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 necesary 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.

EXECUTIVE SUMMARY

Responding to VietnamŠs Water Resource Issues The Government of Vietnam 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 bill. VND in 2001 from 5,682 bill. VND in 1996.

Backed by increased investments, and improved capacity, the Government of Vietnam 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, Vietnam 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 Vietnam with the required management tools that will address equity, efficiency and environmental sustainability of Vietnam's water resources.

Part I

VIETNAMŠS WATER RESOURCES AVAILABILITY

About two thirds of Vietnam's water resources originate from catchments in riparian countries. Vietnam 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 1). Despite the total abundant water resources, the dependency on upstream countries and the uneven distribution have made Vietnam's ranking low in Southeast Asia's water availability per capita (4170 m^3/person compared to average 4900 m^3/person in Southeast Asia and 3300 m^3/person in Asia)

Surface water

Rivers Vietnam 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 km^2 or more (Table 1). The rivers flowing through Vietnam include many international rivers. The total area in- and outside Vietnam of all international catchments is close to 1.2 mill. km^2, which is approximately 3 times the size of Vietnam itself. The total annual runoff is 835 bill. m^3.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.

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-Laos-Thailand border point. The 'lower basin' covers some 600,000 km^2 and includes parts of four countries Laos, Cambodia, Thailand and Vietnam. The Red River basin is the largest in Vietnam. 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.

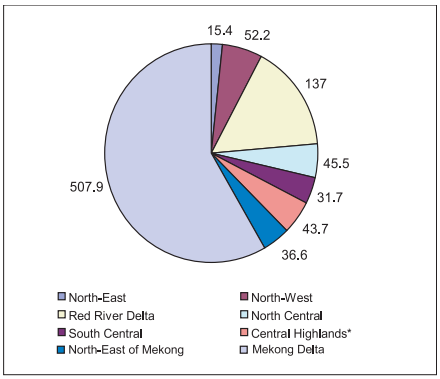
Reservoirs Most dams and reservoirs in Vietnam have been constructed for multiple purposes, including flood control, irrigation, hydropower, water supply and other flow management. Most are more than 20-30 years old. There are about 3600 reservoirs of various sizes, of which less than 15 percent are large or medium (capacity of over 1 mill. m^3 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 1. Water resources in major rivers

River Basin	Catchment area		Total Volume		
	Total area in VN (km2)	% in VN	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
Mekong	795000	8	508	55	11

Source: *Based on data from Program KC-12.*

Fig 1. River run-off per Region (bill.m3/year)



Source: *National Water Sector profile, 2002.*

Table 2. Major reservoirs in Vietnam

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 .*

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

Lake There are several major natural lakes in Vietnam, one of those is Ba Be lake with a surface area of 4.5 km^2 and a volume of 90 million m^3. In addition, there are numerous other smaller lakes - including urban lakes in Hanoi.

Groundwater

The groundwater resources in Vietnam are abundant – with the total potential exploitable reserves of the country's aquifers estimated at nearly 60 bill. m^3 per year. The availability varies from abundant resources in the Mekong River Delta to somewhat limited resources in the North Central Region (Fig 2).

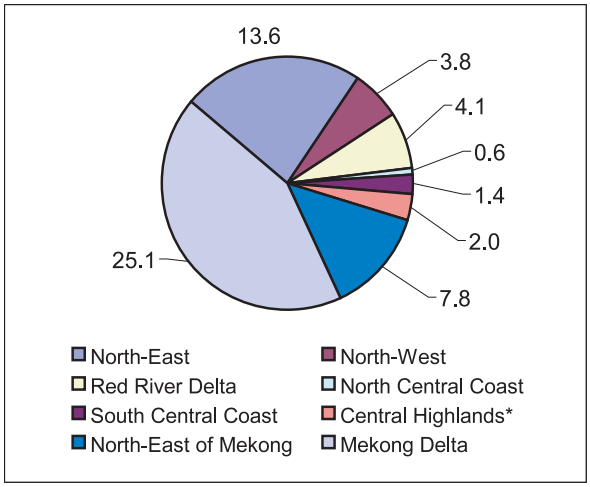
However, despite the abundance of groundwater reserves, only less than 5% of the total reserves are exploited, for the country as a whole. The abstraction of groundwater also varies. For example, groundwater exploitation is difficult in the Northeast because the reserves are scattered and diverse. In 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 HCMC. This over-exploitation is resulting in falling water tables (Fig 1 in Annex 2) – further causing land subsidence and salinity intrusion, especially in the Mekong River Delta (Maps 1-3 in Annex 2).

Mineral and thermal water resources are abundant in Vietnam, good in quality and varied in types having great value for different purposes such as balneological treatment, bottled mineral water, geothermal energy, extraction of CO_2 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 3).

Marine and Coastal water

Vietnam has a long coastline of 3260 km and more than 1 mill. km^2 of the marine exclusive economic zones. This provides Vietnam 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.

Fig 2. Exploitable Groundwater Bill. m^3/year



Source: *National Water Sector Profile, 2002.*

Table 3. 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

Source: *MOI 1999. Mineral and Thermal water resources in Vietnam.*

WATER UTILIZATION

In Vietnam, irrigation makes the largest demand on water resources (Fig 3). Supply of clean drinking water to households is now provided to 60 percent of Vietnam's population. In addition, sectors such as fisheries (including aquaculture), industries, hydropower, services and transport also make demands on the country's water resources. Detailed water demand per sector (livestock, irrigation, domestic supply, industry, aquaculture, and services) for each region provided in Table 2 in Annex 2.

In Vietnam, agriculture remains the largest consumer of water, while industry and domestic use is rising with population growth and economic development. For year 2001 the water consumption for agriculture is about three times higher than the other water uses.

Irrigation

Agriculture is by far the largest water-consuming sector. Total irrigation demand in 2000 was 76.6 bill. m^3, representing 84% of total demand. Since 1998, total irrigated area has increased annually 3.4% in average, but the irrigation systems can serve only 7.4 mill. ha (or 80% of total cropped land). The GoV expects irrigation demand to increase to 88.8 bill. m^3 by 2010, (representing an irrigated area of 12 mill. ha).

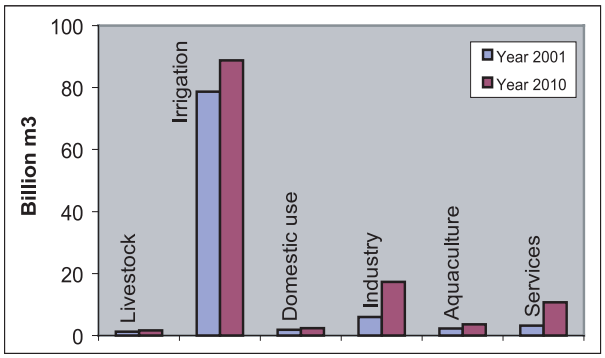
Of the direct water abstraction from groundwater and rivers nearly 84% are for agricultural purposes. However, the river minimum environment flow has to be secured (30% of mean annual flow)[2].

Domestic use

Domestic use of water by comparison is very small, accounting only for 2% of total demand. The consumption was only 1.341 bill. m^3 in 1990 but is expected to increase to 3.088 bill. m^3 in 2010 with population growth. At present nearly 60% of the population have access to clean water in Vietnam. The GoV's strategy is to increase this to 80% by 2005 and the urban coverage to 95% by 2010 (Fig 4). This strategy will bring Vietnam up to the level of its neighboring countries.

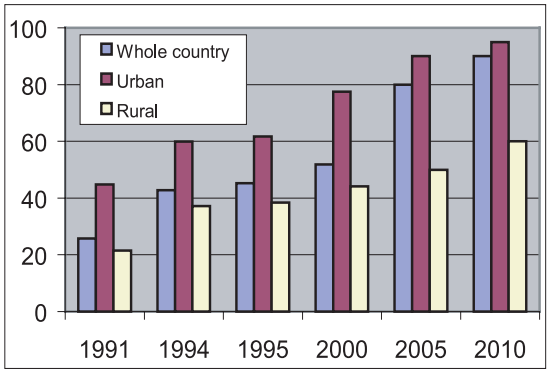
To achieve the ambitious target for water supply the GoV has put a lot of effort in providing safe water for domestic use. Although there is an overall increase in the percentage of the population that has access to safe water over the last decade, the supply of piped water is far from the demand, given the rapid growth of urban population. Most of rural and remote areas have not yet benefited much from the GoV Clean water supply and sanitation program (Fig 4). Detailed data of water supply urban and rural coverage in each economic region is provided in Part II: Regional Water Resources Profile, where the data presents access to safe water sources rather than to clean water.

Fig 3. Annual Water Demand



Source: *Program KC-12 and National Water Sector Profile, 2002.*

Fig 4. Percentage of Household with access to safe water



Source: *GSO-1991,1995, MICSII-2000.*

Note 2: *The percent of mean annual flow is assumed to roughly describe aquatic habitat conditions. For example, 10% of the mean annual flow offers 'poor' habitat conditions, 30% is 'fair' and 40% or more is 'good'*

The percentage of households that have sanitary latrines is only 44% in average for the whole country (Fig 5) and that has imposed a threat on the quality of water supply, provided that 60% and 20% of population are still using water from wells and surface sources respectively.

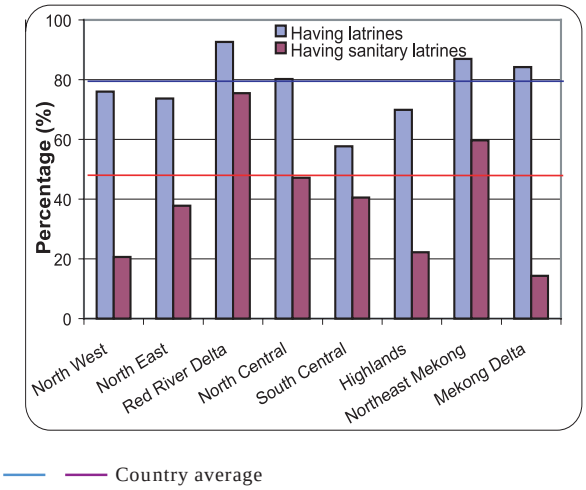
Household living standard surveys 1992 and 1998 indicate that the improvement in supplying safe water has been mainly made to the three highest quartile income groups. During the period 1992-1998, access to piped water for the lowest income group has increased from 0.34% to 1.97% while this figure for the highest income group is 22.94% to 73.98%. During the same period percentage of population with access to well water has increased from 2.06% to 11.28% for the lowest income group and from 7.49% to 27.47% for the highest income group.

Fisheries

Access to marine fisheries in Vietnam is fully open. Between 1990 and 2000, the number of registered fishing vessels increased by 86 percent, and all but about 10 percent of these vessels operate in coastal waters of less than 30 m depth[3]. While gross output from marine capture fisheries more than doubled from 1990 to 2001, the growth of the fishing fleet, combined with an increase in the size of vessels, led to a sharp decline in the catch per unit effort (Fig 6). Coastal fisheries' output has reached or surpassed sustainability limits. According to the latest evaluation, the marine fish stock in Vietnam's exclusive economic zone is 4.2 mill. tons, of which the annual allowable catch is 1.7 mill. tons. Thus off-shore fishing is still within allowable level.

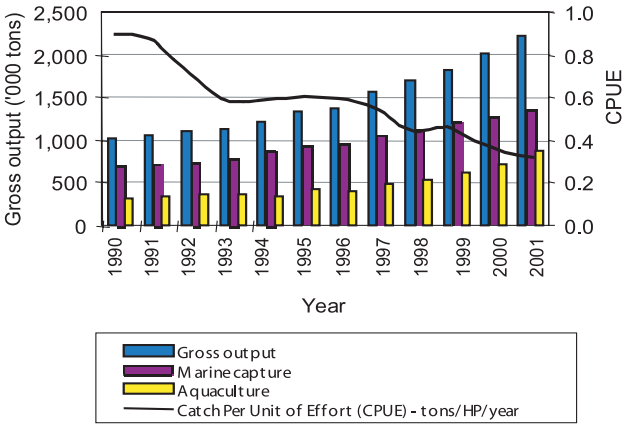
Aquaculture Vietnam has favorable conditions for both freshwater and coastal aquaculture. According to GSO, during the period 1995-2001 the gross output from aqua culture rose 180 percent, while the area of water surface used for aquaculture increased by 170 percent (from 453,583 ha to 755,178 ha). Thus the increase in aquaculture output is mainly due to the expansion, which has caused a decline in mangroves and wetlands. In addition, wastewater discharged from ponds has increasingly contributed to pollution loads in water bodies. On the other hand, there are more cases showing the heavy losses of aquaculture productivity due to water pollution.

Fig 5. Percentage of households with access to sanitation, 2000



Source: *MICSII-2000.*

Fig 6. Key FisheriesŠ Trends, 1990-2001



Source: *Ministry of Fisheries, 2002.*

Note 3: *Vietnam Investment Review, October 2 - 8, 2000.*

Shrimp are the primary aquaculture product, but catfish, lobster, crab and shellfish are also raised in large quantities. Shrimp farming in particular faces sustainability problems. Currently, the shrimp fry needed for stocking shrimp ponds comes both from the wild and hatcheries mostly in central Vietnam. Shrimp feed for more intensive culture comes largely from wild-caught "trash fish," or is imported.

Hydropower

Vietnam has an estimated hydropower potential of about 14,000 to 17,000 MW of which nearly 3,600 MW have been developed so far, and about 800 MW are under construction. The current hydro-power capacity constitutes about 55% of the total installed power generation capacity of the national interconnected system of 5,300 MW. The largest hydropower dams are the Thac Ba, Da Nhim, Tri An, Hoa Binh, Thac Mo and Yaly.

While hydropower is a non-consumptive use of water the storage may affect the availability of water downstream. In addition, sudden releases may cause flooding problems and river erosion downstream. Therefore, the operation of hydropower plants requires coordination with the need of water by other sectors. The National Hydropower Plan Study plans for a possible installation of additional 5,045 MW (Table 4).

Table 4. Hydropower Projects in Planning

Project		River System	Hydro-power MW
Short Term 2007-2008	Se San 3	Se San	305
	Buon Kop / Chu Pong Krong	Sre Pok	280
	Huoi Quang	Da	440
Medium Term to 2012	Son La	Da	2,050
	Dong Nai 3, 4	Dong Nai	510
	Nam Nhun	Da	1,200
	Upper Kontum	Se San	260
TOTAL	7		5,045

Source: *National Hydropower Plan Study,2001.*

Other water users

Industries Industry currently comprises about 6.5% of the abstracted amount of water, but the demand is ever increasing with the rapid economic development of Vietnam. The average annual increase in water demand for industry sector is estimated at 7% until 2010[4] but varying among different industries (Fig 2 in Annex 2)

Service sector including the tourist industry is another expanding water user, that is expected to increase water demands rapidly by an average of 9% annually to year 2010[4].

Water Transport Out of Vietnam's 41,900 km river network, 8,013 km are used for inland waterway transport. This transport plays an important role for economic activity, especially in the south. Development of deep-water ports has been a priority for the GoV to become competitive in the global market. Vietnam now has more than 60 seaports, and there are plans to construct 20 more. It is projected that inland water freight traffic will be doubled in 2010 and tripled in 2020 compared to the traffic in 2001. The water transport is an economic good, however port development affects the natural river flow, morphology and natural aquatic habitats. The increased traffic volume poses threats of pollution by oil spills, wastewater discharge and noise from vessels.

Note 4: *National Water Sector Profile 2002*

Vietnam's freshwater and marine biodiversity is relatively high but threatened by domestic and industrial water pollution, dam and road construction, dredging, destructive fisheries techniques, aquaculture and over-fishing.

Inland Ecosystem

The freshwaters of Vietnam 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 7.

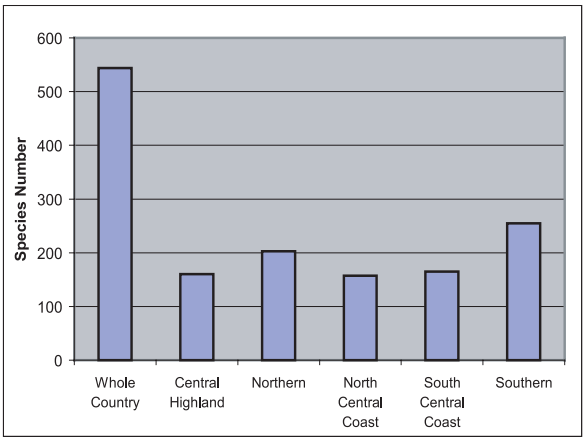
Only scarce quantitative data are available for inland aquatic ecosystems, and the extent of the deterioration of freshwater biodiversity is still poorly known. However, there are indicators showing that many species are in danger of extinction or becoming rare (Box 1). Listed in the Red Book 2002 (forthcoming) 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 Vietnamese fish fauna is shared with southern China[5]. This study is particular concerned freshwater biodiversity in the context of the Vietnam 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 Vietnam.

Coastal and marine biodiversity

More than 2000 fish species are found in the sea waters of Vietnam. 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 approximately 45,000-50,000 tons of seaweed such as Gracilaria verrucosa and Sargassum can be exploited[6]. Among marine mammals the most abundant are dolphin (14 species), then whale (8 species). The dugong (*Dugong dugon*) in Vietnam is under threat from hunting despite the GoV's prohibition: more than ten dugongs were killed last year. Vietnam now reports only 10 dugongs left in Con Dao sea-waters and another group of 100 dugongs around Phu Quoc island.[7]

Fig 7. Fish Species Distribution in Vietnam



Source: *Data based on different sources compilled by Fishery Reserach Institute I, 2003.*

Box 1. Decline in freshwater fisheries and biodiversity

Decline is seen in various reservoirs and lakes in Vietnam. 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 Cypranidae.

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

Period	Source	Production (t)	Yield (kg/h a/yr)
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*

Note 5: *WB | Kottelat M., 2001, Freshwater Fishes of Northern Vietnam.*

Note 6: *Dao Manh Son, 2001. Off-shore marine fishery resources of Vietnam. In workshop proceedings ‰Rational and Sustainable Utilisation of Marine Resources in Vietnam‹, November 2001.*

Note 7: *HCM City Youth Jul 7, 2003*

Rare and endangered species listed in the Red Book (2002) of Vietnam 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 5). Among these the most important are wetlands, coral reefs, and sea grass

Wetlands

Vietnam 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 Vietnam 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 Vietnam's first protected area was designated as Man and Biosphere Reserve by UNESCO (2000).

Mangroves

Over the last 50 years of development, Vietnam 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 has seen the disappearance of close to forty thousands 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].

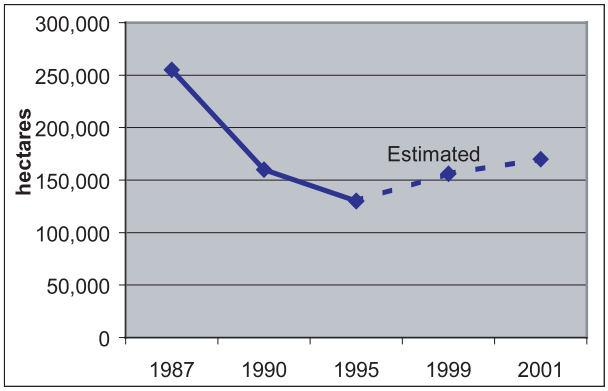
Estimated data compiled from various sources for 1999 and 2001 indicates some increase in mangrove areas (Fig 8).

Table 5. 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 recorded	1,630

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

Fig 8. Mangrove loss in Vietnam



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

Note 8: *World Bank, (1999), ‰ 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.*

Coral Reefs

The coverage of coral reef in northern Vietnam generally falls between 25 and 50%. Based on the IUCN criteria for assessing coral reefs, only 1.4 % of the reefs studied in southern Vietnam 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 6). 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 Vietnam 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 Vietnam's reefs.

Sea grass

covers an area of 6,800 ha in Vietnam (Table 7). 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 seagrass composition in Vietnam. Seagrass beds have also been severely degraded from inappropriate fishing, aquaculture production, and pollution from waste discharges.

Table 6a. Quality of Coral Reefs in Vietnam

Category	Definition	% Area
Excellent	>75% live coral	1.4
Good	50-75% live coral	31.0
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 6b. 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	31.0
Son Duong-Mui Ron Islands	50.0
Con Co Island	23.8
Son Tra-Hai Van	50.5

Source: *Ministry of Fishery/IUCN, 2003.*

Table 7. Top 10 largest seagrass beds in Vietnam

Name of location	Area (ha)	Number of species
Tam Giang – Cau Hai lagoon	1000	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

Sources: *Hai Phong Institute of Oceanography, 2002.*

WATER QUALITY : Surface, Ground and Coastal

There is increasing evidence of pollution of Vietnam's surface, ground and coastal waters. Downstream sections of major rivers reveal poor water quality, while lakes and canals in urban areas are fast becoming sewage sinks. Groundwater shows pockets of contamination, and some salinity intrusion. The coastal waters are being contaminated from land-based pollution sources, port development activities, oil spills and coastal erosion.

Surface Water Quality

In Vietnam, 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 1 in Annex 2). The National Monitoring Network (NMN) covers 4 rivers running through the main urban areas of Vietnam, 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 8).

Trends indicate that the levels of two primary pollution indicators, Ammonia-nitrogen (NH_4-N) and Biochemical Oxygen Demand (BOD_5) vary considerably and exceed national water quality class A standards (see Annex 5 for overview of standards) by several fold (Fig 9 and Fig 10). The problems are worst during the dry season, when the flows in the rivers are reduced.

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 Vietnam'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,

Table 8. Water Quality in VietnamŠs 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 / BOD_5
	Hong to Viet Tri	2 / NH_4
	Cau River	2 / NH_4
North Central Coast	Thuong River	2.7 / BOD_5
	Hieu River	2-3 / BOD_5
		1.5-1.8 / NH_4
South Central Coast	Huong River	2.5 / BOD_5
	Han River	1-2 / BOD_5
		1.4-2.6 / NH_4
Northeast	Sai Gon River	2-4 / BOD_5

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

Fig 9. BOD levels in VietnamŠs major rivers

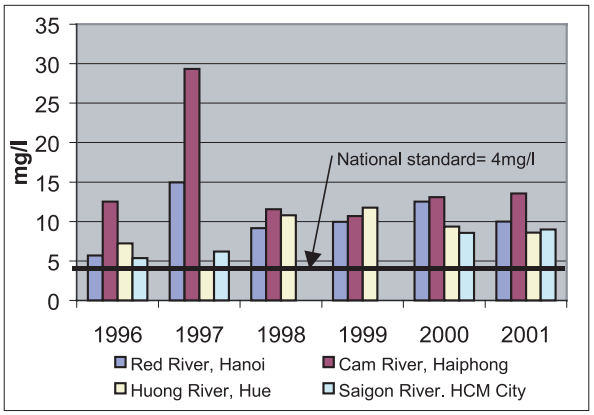
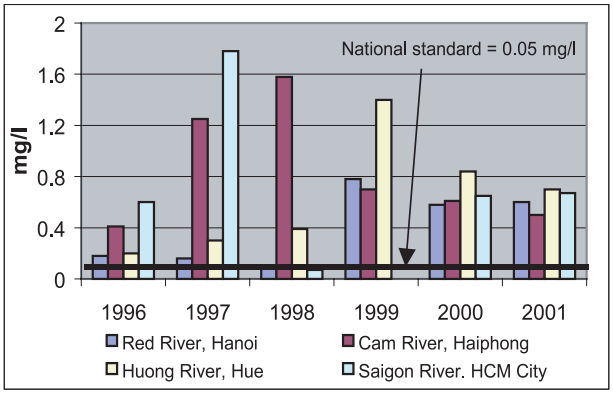


Fig 10. NH_4 levels in VietnamŠs major rivers



Sources: *NEA, SOE reports 1997-2002.*

Hai Duong, Bac Giang, Hue, Da Nang, Quang Nam and Dong Nai, are much higher than permissible levels[9].

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 m^3 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 mill. USD) in 2005 and 13 trill. VND (867 mill. 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 9).

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.

Table 9. 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
Sluice gates Hai Phong		60-390	80-500	<1.0

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

Box 2. Impacts of Hoa Khanh Industrial Zone on Bau Tram Rese

The Bau Tram reservoir close to Danang was constructed in 1961 to irrigate 120 ha of rice and dry crops. The number of crops increased from one to three producing 6 t/ha. Aquaculture developed an annual fish production of 100 tons. However, the Hoa Khanh industrial zone was established in the 1990s, releasing 436 m^3 of wastewater to the reservoir per day.

Water quality tests from the reservoir shows values higher than that permitted by the Vietnam Standard 1995; COD exceeding the standards 1.9-3.2 times, and BOD_5 and heavy metals also exceeding the standards permitted. Pollution of the reservoir now causes loss of rice output (155.6 tons of rice annually) to the community using water from the reservoir due to root decays and die-off in the autumn rice crop after planting. It is clarified the damage is not caused by any insect, and all areas irrigated with water from the reservoir are affected. Because water in the reservoir is severely polluted, the cultivation of fish is now prohibited in the Bau Tram reservoir in order to protect the consumers' health.

Source: *Chu Phuong Chi and Nguyen Hoang Thao, Center for Water Resources of Central and Highland. Proceedings of a Workshop on Wastewater Reuse in Agriculture in Vietnam: Water Management, Environment and Human Health Aspects, Hanoi,14 March 2001.*

Note 9: *Investment Aug 4, News Aug 1, Saigon Economic Times July 26, 2003.*

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 aquifer[10]. 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 3) and Mekong River Deltas.

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 (Maps 1-2 in Annex 2).

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 10.

Seaport development There are a lot of small and big ports scattered along coastline of Vietnam.
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.

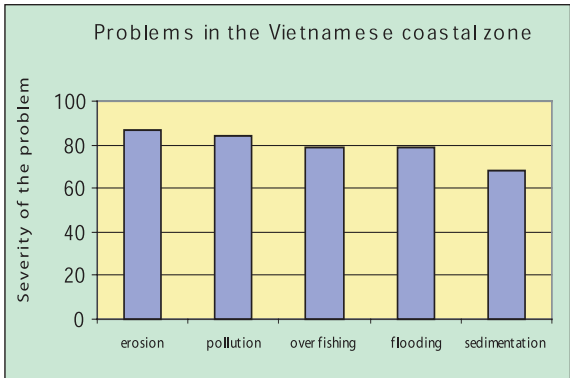
Oil spills About 30% of the total cargo shipping through the ports carry petroleum products. Off-shore exploitation

Box 3. 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 m^3/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).*

Fig 11. Problems in the coastal zones



Source: *CZMC Study 2002*

Table 10. 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 Vietnam. In the Proceedings of the ‰Regional Workshop on Partnerships in the Application of Integrated Coastal Management‹, Thailand, November 1997.*

Note 10: *Arsenic Contamination of groundwater and drinking water in Vietnam: A human health threat, M. Berg et. al., Env Sci & Tech, V.35, No 13, 2001, p. 2621.*

activities are increasing every year. From 1996 to 2002, the crude oil productions increased from 8.8 to 17 mill. 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 11).

Table 11. 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.*

VULNERABILITY

The geography and topography of Vietnam makes the country extremely vulnerable to natural hazards. Vietnam is subject to typhoons and tropical depression storms from June to November every year. In addition, the annual monsoon subjects Vietnam to heavy rains from September to December. But for the rest of the year, there is hardly any rainfall which can produce water deficiency and sometimes severe and prolonged drought.

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 (Map 4 in Annex 2). Each year these natural disasters such as typhoons, storms, floods or drought have an extreme impact on people, their livelihood, their agricultural lands, their livestock, and their infrastructure.

Detailed assessment of vulnerability in each region is provided in Table 3 in Annex 2.

Floods

Flooding is a major water management problem in Vietnam. Each year the monsoons' heavy rains result in the overflowing of rivers, causing death and devastation in many regions.

Recent data for the floods in the Mekong River Delta during 1991-2001 show a high intensity with 5 major floods in 11 years with an increased flooding water level (Table 12). This is an indication that floods may be intensifying. Similarly, numbers of over-flooding days in most of monitoring stations during the period 1984-2001 indicates an increase in the duration of floods (Table 13). However, longer time series of observations are needed to verify this trend.

In the Red River, there have been 26 extreme flood events, especially in 1945 and 1971. The 1971 flood caused dyke breaks at three locations and inundated 250,000 ha affecting the lives of 2.7 million people. The economic losses were estimated at around 78 mill. USD (1170 bill. VND).

Droughts

Droughts occur fairly frequently in Vietnam. While droughts are not as long in duration as in more arid countries, they are often quite severe and result in water shortages for irrigation, hydropower and water supply. Central Vietnam shows evidence of desertification and droughts have occurred frequently over the last decade. However, timing and crops affected vary, as do the provinces hit from year to year. The Southern Coastal Region is hit most frequently.

In 2001 the Phu Yen and Quang Nam provinces in the South Central Coastal Region and Quang Binh and Quang Tri in the North Central Coast Region were seriously hit by droughts.

Box 4. Vulnerability of Crops to Natural Disasters

The productivity of the food crops and cereal crops of Vietnam varies greatly. Crop productivity variations in the north are more marked than those of the south and cereal crop yields vary more distinctly than those of rice.

Crop losses are often caused by an accumulation of factors. The most serious losses are caused by typhoons (20-50%), although the area affected tends to be limited. Droughts, long periods of sunshine in winter and water-logging are also important (10-30%) and affect a wider area. Cold spells, dry spells and dry-hot winds causes less severe damage (5-20%) and affect a limited area. In the past, rainfall has been a more important factor than temperature.

Table 12. Flooding Water Levels (m) in Mekong River Delta

Station	1991	1994	1996	2000	2001
Moc Hoa	2.48	2.59	2.79	3.27	2.88
Kien Binh	1.9	1.17	2.29	2.66	2.47
Tuyen Nhon	1.6	1.73	2.03	2.41	2.06
Xuan To	3.99	4	4.22	4.67	4.34
Tri Ton	2.75	2.94	3.09	2.98	2.86

Table 13. Length of overflooding (days)

Station	water level (m)	1991	1996	2000	2001
Tan Chau	>4.5	10	18	33	46
Chau Doc	>4.3		13	34	38
Hung Thanh	>2.5	43	35	60	63
Moc Hoa	>2.5		20	50	48
Tri Ton	>2.5		59	65	63

Source: *Hydrometeorology Institute, 2002.*

The rainfall during the months of June and July was only 5 mm in 3 districts (Song Hinh, Son Hoa and Dong Xuan). In the Phu Yen province alone, 7,200 ha sugarcane, 500 ha maize, 225 ha paddy rice and 300 ha dry rice were lost.

During the first six months of 2002 serious drought hit Southern Central Coastal and Central Highland (Box 5) regions, as well as North East of Mekong. In addition to loss of crops, the drought caused widespread forest fires, including the large fire in the Upper and Lower U Minh natural forest[11].

Sea Level Rise

Coastal areas below one meter of elevation constitute much of Vietnam's 3,260 km coastline. Sea level rise presents a serious threat to the coastal areas, in particular to the Red River and Mekong River Deltas. It is estimated that the sea level rise at the coast of Vietnam for the coming decades will be around 3 mm / year. With an expected sea level rise of 15 cm by 2050 since 1990 serious effects may be foreseen, including: loss of land, increased vulnerability to flooding and storms, accelerated coastal erosion, increased salinization; and changes in the physical characteristics of the tidal rivers[12]. In response, increased expenditure will be necessary on flood protection and the planning and zoning of activities in coastal areas, including agriculture, industry, transportation and tourism, may have to be rethought.

Landslides

Heavy rainfalls create a risk for landslides in mountainous parts of Vietnam. Typhoon rains are especially dangerous. Torrential rains in the mountains often erode soils, causing severe landslides, and even flows of mud and stones downstream. These flows can arrive without warning, leaving little time for people to get out of the way, and often bury houses under soil and rock.

Typhoons

Situated close to the typhoon center of the South China Sea, Vietnam is also extremely vulnerable to typhoons. On an average it is hit by 4 to 6 typhoons per year. The typhoons raise sea levels and send storm surges up estuaries to inundate valuable croplands. Most typhoons occur between May and December. In the earlier part of the season the Northern part of the country is more affected; while after September the typhoon pattern shifts more to the South of the country's 3260 km coastline. The devastation by violent winds, torrential rainfall and accompanying phenomena including storm surges and floods often lead to massive community disruption.

Coastal Erosion

Coastal erosion is another emerging problem. It has been estimated that 300 km of Vietnam's coastline is currently eroding, and that coastal erosion is evident inalmost every coastal province (Table 15). In some areas, accretion is also occurring.

Box 5. Droughts in Central Highlands

The Central Highlands region has the highest drought index. Since 1980, droughts have occurred annually, with high severity every 5 years (in 1983, 1988. 1993, 1998 and 2003). In 2003, water flow in all rivers and streams were 20-50% less than the same period in 2002. Water level in the reservoirs was below the dead level. Ground water tables fell by 1.5-2 m on average (in many places by 3-4 m), resulting in the lack of domestic water supply for 100,000 households.

As of April 2003, Kon Tum had 300 ha of rice fields, Gia Lai had 3,000 ha and Dak Lak had 50,000 ha of cultivated lands seriously suffering from the droughts. The total loss estimated as 250 bill.VND only for Dak Lak.

Source: *VEPA website http://\www.nea.gov.vn.*

Table 14. Estimated Sea Level Rise Quang Ninh Province, North-East Region (cm)

Location/Year	1990	2020	2050	2080
Hon Dau	0.0	7.5	15.0	22.5
Cua Ong	0.0	8.1	16.2	24.3

Source: *Proceedings of National Programme in Climate Change, Hanoi, Nov. 1996.*

Table 15. Coastal Erosion

Time period	1930-1945	1975-1992	1998	2001
Numbers of eroding sections	35	61	243	249 with a total length of 300

Source: *NEA, SOE 1998, 2002.*

Note 11: *Report of Status of the Environment, 2002.*

Note 12: *Information from Nguyen Huu Ninh (Center for Environment Research Education and Development) and Phan Nguyen Hong (Mangrove Ecosystem Research Centre).*

ECONOMIC COSTS

Costs associated with poor access to clean water include health costs from waterborne diseases. In addition, there are significant costs associated with the treatment of water resources, as well as from the cleanup after oil-spills. There are also costs associated with water-related natural disasters such as flooding.

Health Costs

Although improvements are made in providing safe water to the urban and rural populations, waterborne diseases are still a major problem in Vietnam. Dysentery and diarrhea are widespread. Over the last four years about 6 mill. cases of six waterborne diseases were registered, incurring a direct cost of at least 400 bill. VND for treatment of cholera, typhoid, dysentery and malaria (Table 16).

Pollution-related costs

Treatment costs The costs of treating water for water supply varies considerably in Vietnam depending on the quality of the raw water, either coming from rivers, reservoirs or groundwater. However, typical treatment costs do vary from 1,500 to 2,500 VND / m^3.

The tariffs consumers pay depend on the use of the water (Fig 3 in Annex 2). Typically, domestic tariffs vary from 1,800 to 2,500 VND / m^3. Factories and other business users may pay up to 8,000 VND / m^3. [13]

Clean-up costs A major oil spill occurred off the coast of Ba Ria-Vung Tau Province after a collision between a Vietnamese tanker and a Taiwanese ship in early September 2001. Consequently, some 900 m^3 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 estimated at 250 bill. VND (17 mill. USD) and costs for cleaning up polluted waters and beaches reached 60 bill. VND (4 mill. USD). Costs of some other oil spills are presented in Table 17 and Box 6.

Table 16. Estimated health costs from water-borne dieases (bill. VND)

Disease	1995	1996	1999	2000	2001	2002
Cholera	1.075	0.108	0.048	0.039	0.004	0.070
Typhoid	12.360	9.324	2.750	1.747	3.846	2.836
Dysentery	7.253	8.679	20.739	22.377	25.442	26.208
Malaria	70.566	60.401	86.311	48.707	102.793	53.996

Source: *Number of cases provided by MOH Dept. Preventive health Cost of Malaria is Expenditure combined of State budget and ODA Cost of other diseases calculated on average direct treatment cost for each case of the disease (Bank staff estimate).*

Box 6. Recent Oil Spills on Sai Gon River

Just in the first half of 2003, two serious oil spills happened on the Sai Gon river. On January 12, an accident of the Fortune Freighter cargo and an oil tanker caused a leakage of 125 tones of oil and an amount of 2 Bill. VND spent for compensation and rescue effort. Two months later, the Hong Anh tanker carrying 600 tons of oil had sunk in the Ganh Rai bay of Can Gio district. This accident caused serious oil pollution in three communes affecting 5,000 ha of intensive aquaculture.

Source: *VEPA website http://www.nea.gov.vn.*

Table 17. Costs of Oil Spills

Year	Ship name	Venue	Spill (tons)	Damages USD
1994	Humanity	Can Gio	130	600,000
1994	Neptune	Cat Lai Wharf	1680	4,000,000

Note: *In addition to the spills listed a total of 35 more spills are recorded for*

Note 13: *Danida SPS on Water Supply and Sanitation.*

Disaster damages

Flooding is an annual event in northern Vietnam and the cause of enormous losses. With as much as 80% of the population living in the coastal plains and deltas, costs incurred from floods and typhoons are colossal.

For the seven years from 1995 to 2002 the costs were alone 18,700 bill. VND or 1.25 bill. USD. And of course, it is not alone the costs. The loss of lives, homesteads and general suffering of the people are immense. From 1995 to 2002 the human losses from typhoons and floods totaled 3342 persons (Table 18).

In other studies, such as one undertaken by UNDP, it was estimated that the average annual losses in the Red River Delta and along the Central coast could reach substantially more than 130 mill. USD. In a subsequent, more rigorous, Asian Development Bank study, it was found that the average annual damage from flooding for the area protected by the dyke around Hanoi alone amounted to well over 50 mill. USD per year.

Table 18. Cost of Flood Damage in Vietnam

Human Loss			Houses collapsed/ submerged (unit)	Agricultural field damaged* (ha)	Total Physical Loss (bill VND)
Year	Killed	Injured/ missing			
1995	255	47	360,538	106,018	755,913
1996	610	149	1,228,031	583,740	3,621,719
1997	79	71	17,923	296,622	237,693
1998	107	38	30,147	40,983	245,084
1999	776	533	1,064,846	304,081	5,122,634
2000	638	65	935,554	660,031	4,310,901
2001	545	63	457,613	146,071	2,481,705
2002	332	201	383,423	101,234	1,915,166

Source: *Disasters Management Unit/ Department for Dyke Management and Flood Control (MARD)*
** Paddy fields/ dry crops/cash crops area submerged or lost.*

Box 7. The 1999 Floods

The floods that inundated central Vietnam in November and December 1999 were particularly severe. The damage from these floods was considerable. More than 700 people lost their lives; and many more were injured or stricken with disease while coping with the floods. Tens of thousands of people had to be evacuated to higher ground. Many families lost their homes and their livelihoods, and had to be resettled to safer areas. There was immense destruction of and damage to homes, schools, clinics, and other public buildings. The cost of the damage in the Central Provinces was estimated to be more than 340 mill. USD.

MANAGEMENT : Legislative Framework

National Water Policy and Strategy

The broadest level of national policy and strategy development is provided in the "Socio-Economic Development Strategy for 2001-2010". A number of water related strategies / objectives are presented here.

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:

- Water Resources Development Plan to the year 2000 and Tentative Development Plan to the year 2010 (MARD, June 1998)
- Direction and Duties of Water resources development to the year 2010 (MARD, September 1999)
- Strengthening Environmental protection in the period of National Industrialization and modernization (Communist Party of Vietnam, Directive No. 36/CT-TW, 1998)
- Strategy for Rural Agriculture Development in the Industrialization and Modernization Period to the year 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 Vietnam 2001 to 2020 (MARD and Central Committee for Flood and Storm Control, December 2001.

Law on Water Resources (LWR)

The Law on Water Resources was passed in 1998 and came into effect on January 1999. At present only partial progress has been made towards implementing the reforms embodied in the LWR. The second legislation required to implement the LWR is being developed (licensing of groundwater extractions, licensing of surface water utilization, waste water permits etc.).

Unique to LWR is the coordinated and crosscutting approach to water management, this is expressed in the establishment of a National Water Resource Council (NWRC) working at a national level and Board for River Basin Planning and Management working on a local level. These organizations would work under the GoV as advisory, coordination and planning bodies.

The LWR is basically formulated as a flexible legal framework, and has a number of later developed decrees added subsequently.

These decrees define the responsibilities and duties of the institutional bodies for the implementing of LWR.

Role of MONRE

LWR defines the GoV as responsible for the management of water resources through the Ministry of Agriculture and Rural Development (MARD). This responsibility has now been transferred to the Ministry of Natural Resources and Environment (MONRE), while the service function of irrigation and rural water supply remains with MARD. The Peoples Committees, which are directly controlled by the central government, on province and district level are responsible for implementation in their own jurisdiction. Furthermore are specific functions of the water resource management and water use allocated to other ministries and non-line agencies Table 19.

Box 8. Change in strategy for operation and maintenance of irrigation and drainage systems

The prevailing institutional arrangements for the operation and maintenance of the irrigation and drainage systems do not provide an adequate framework for improving system performance. At present, water users have limited say in the overall system management and the management companies have little incentives to improve service delivery. The GoV has shifted its strategy and is now promoting autonomy for the irrigation companies and to strengthen water user's groups. Some provinces have started to transfer operation and maintenance of smaller systems to the water user's groups and local authorities. However, overall, limited progress has been made in following through with the new strategy.

The Law on Water Resources (LWR) represents a major step forward on integrated water resources management. But only partial progress has been made in implementing the reforms embodied in it. Important secondary legislation required to implement many of the objectives of the law has not yet been developed. Secondary legislation would cover, among other things, provisions for regulating the discharge of polluted wastewater to surface and groundwater, regulation of groundwater abstraction, and regulation of the consumption of surface waters.

However, the legislative framework is in progress, e.g. circulars on guidance proceedings of licensing exploitation and utilization of surface water and licensing of discharging wastewater into water sources are underway. A summary of the relevant legislation, regulations, and adopted directives and decisions is given in Annex 3.

In 2002, a new Ministry of Natural Resources and Environment (MONRE) was created in accordance with the Government Decree 91/2002/ND-CP. Following this creation, the state management of water resources was allocated to the Agency of Water Resources Management (AWRM) within MONRE. This change is important for the division of state management functions for water resources and water use. Previously, both water resources management and user functions were the responsibility of the Agency of Water Resources and Hydraulic Works Management under MARD. Other ministries responsible for specific issues related to water resources management are presented in Table 19 and anorganizational chart of the water-related institutions is provided in Annex 4.

The responsibility for management of mineral waters has now been transferred to the Agency of Geology and Minerals under MONRE. These changes will offer important opportunities to address environmental considerations into water resources management planning and decisionmaking.

Transfer of staff for water resources management from MARD to MONRE took place in June 2003. AWRM is also responsible for revising the LWR. The following institutional arrangements will be further defined

- Institutions such as the National Water resources Council (NWRC) and Boards for River Basin Planning and Management (RBOs) for the Red-Thai Binh, Dong Nai and Cuu Long (Mekong) river basins have been formed. However, they fall under the aegis of MARD rather than MONRE.
- The administrative reforms at the central level have not yet progressed down to the provincial level where there have been no moves toward IWRM and there is a severe lack of direction and capacity.

Finally, even when jurisdictional issue between MONRE and MARD is clarified, there will continue to be a substantial number of government agencies with responsibilities in the water sector. Coordination and collaboration among these agencies will require management and strong leadership from MONRE.

Table 19. Key Ministries and Roles in Water Resources Management

Agency	Responsibility
Ministry of Natural Resources and Environment	Overall water resources management
Ministry of Agriculture and Rural Development	Management of flood and typhoon protection systems, hydraulic structures, wetland management, and rural water supply and sanitation
Ministry of Industry	Construction, operation and management of hydropower facilities
Ministry of Construction	Spatial planning and constructing urban water supply, sanitation and drainage facilities
Ministry of Transport	Planning, construction and management of waterway transport systems
Ministries of Fisheries	Protection and exploitation of aquatic resources
Ministry of Health	Management of drinking water quality
Ministry of Planning and Investment	Planning and investment for the water resources sector
Ministry of Finance	Development of policies on taxes and fees for water resources

Box 9. MONRE: water-related departments / agencies

Department of Environment (DOE): preparation of environmental strategies, plans, standards and environmental permits, and for producing the Annual State of the Environment (SOE) reports.

Vietnam Environmental Protection Agency (VEPA): implementing state management functions. Three regional sub-agencies are under formulation.

EIA Department is responsible to prepare and issue the policy and legal framework for EIA and SEA, including post-EIA evaluation and environmental assessment of river basin development plans.

AWRM: state management of water resources, including NWRC; inventory and management of a database on water resources

Agency of Geology and Minerals: State management and geological survey of mineral resources including mineral waters

Department of Hydrology and Meteorology (HM): State management of HM including policies, criteria and procedures, baseline survey and data management

National Center of Hydrology and Meteorology: HM data analysis, provision of information and weather forecast

Mineral Resources and Geology Research Institute

Hydro-Meteorology Institute

The relevant provincial divisions and agencies are expected to be transferred to provincial DONREs in accordance with the Government Decision No 45/QD-TTg dated April 2, 2003.

MANAGEMENT : Institutions and Capacity

A review has been undertaken to identify the numbers of staff (state personnel) with environmental and water resources responsibilities in key ministries, departments and local authorities in Vietnam paid by the government budget. Although it was easy to define the number of personnel working in the central governmental institutions, it requires a comprehensive undertaking to obtain the corresponding number for the 61 provinces and cities accurately. Therefore, the staff numbers at the local level have been estimated. The review did not consider the level of equipment provided in agencies, staff qualification, training and competence. Tables 20 and 21 show a first cut at providing indicative institutional capacity indicators, using estimated data.

Table 20. Number of State Personnel with Water Resources Management Responsibilities (as of 2003)

Ministry/ Agencies	Department/Institutions	Staff # at central level	Staff # at local level
Ministry of Natural Resources and Environment (MONRE)	Department of Environment	12	1100* (including District officers)
	Vietnam Environmental Protection Agency	55	
	National Committee on Clean Water Supply & Sanitation	10	100*
	Agency of Water Resources Management	28	63
	National Center of Meteorology and Hydrology	63	2000*
	National Water Resources Council	5	0
	Agency of Geology and Minerals (mineral waters only)	100	1000*
Ministry of Agriculture and Rural Development (MARD)	Water Resources Development Department	85	852
	Office of Flood & Storm Prevent**	80	1000
	Center for Rural water supply and sanitation	35	550*
	Forest protection Department (wetland related)	5	60*
	Forest Development Department (upstream catchment afforestation)	5	60*
Ministry of Fishery (MoF)	Department of aquatic resources protection	30	980
	Department of fishing	17	56*** (in 25 provinces)
Ministry of Industry (MoI)	Electricity of Vietnam (for hydropower only)	22	100*
Ministry of Construction	Department of Architecture and Infrastructure	2	120*
Ministry of Transport (MoT)	Department of Vietnam inland waterways transport	110	4000*
	Vietnam maritime department	85	1600

Source: *Ministry of Home Affair and line Ministries. * Estimate; **An alliance organization; *** Only 25 provinces have fishery department*

Table 21. Indicative Institutional capacity indicators of water resources management

Capacity	Indicators	Value
Water resources and water environment protection nationwide Total staff 14400 (as from Table 20) for 79 mill. people	Staff / mill. people	182
Internal aquatic ecosystem protection MOF and MONRE / VEPA biodiversity staff (1065) with 2 mill. ha of internal land for aquatic resources	Staff / 1000 km2	53
Sea and coastal ecosystem protection With 3,260 km of coastal length and 1 mill. km2 of economic special-use zone	Staff / 1000 km2	1
Surface water resources protection* With total area of Vietnamese territory / all catchments is about 300,000 km2	Staff / 1000 km2	11
Ground water resources protection (MONRE: groundwater- related staff (209) from Agency of Geology and Minerals, clean water program, Dept of Environment, VEPA and local level, with the total number of regional monitoring station is 310	Staff / monitoring station	0.7
Marine protected areas (1050 staff for 59216 km2)	Staff / 1000 km2 MPA	18
Wetland protection (1429 staff from MARD-MOFish-MONRE / VEPA for 326453 ha)**	Staff / 1000km2 wetland	440

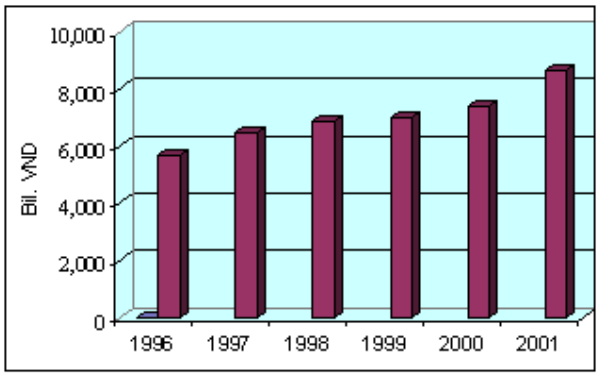
Note: **Total of MONRE staff with responsibilities for state management of surface water resources, including staff at local level is about 3500. ** Staff from MARD (wetland related), MOFish and one forth of staff (at best estimate) of VEPA/ Department of Environment including local level.*

Expenditures related to water resources management are not categorized separately in the State Budget but are listed under various Ministries such as MONRE and MARD. As described under the Institutional part, water resource management functions are spread among various Ministries, and consequently expenses are allocated accordingly.

A review have been undertaken to estimate the spending on activities in the water sector by the GoV. Due to the unclear yet division of the management and service functions in the water sector, this review has addressed only the water resources management and the management side of the service function. The relevant expenditures under items pertaining to water resources management from various ministries and departments have been assessed and aggregated. Current expenditures for water resources management consist of operating costs including salary of staff and research costs incurred by state institutions.

In addition to the small current expenditure for water resources management, the much larger investments in the water sector have been estimated. Although its proportion in the total national budget expenditure has declined, the public expenditure for water resources management has increased at an annual average of 8.9% during the period 1996-2001. The increase in current expenditures for water resources management is illustrated in Table 22. This increase is expected to continue with the creation of the MONRE.

Fig 12. Total expenditure for Water Sector



Source: *Ministry of Finance.*

The public investment in the water sector constitutes a considerable proportion at 33% of the national budget investment from 1996 to 1998, but this declined since 1999 due to a shift in focus of the national budget towards banking systems and SOEs improvement. The main investments are made in irrigation, water supply and drainage. Out of the total spending for the period 1996-2001, it is estimated that around 64% originated from official development assistance investments, while the remaining 36% came from domestic direct investments.

Table 22. Expenditures for Water Sector as a proportion of Total Public Expenditure (bill. VND)

	1996	1997	1998	1999	2000	2001
A. National Budget Investment	16,989	19,482	20,514	29,697	29,624	40,236
A1. Public investment for Water Sector	5,637	6,433	6,829	6,939	7,305	8,559
A2. As % of budget investment	33.2	33.0	33.3	23.4	24.7	21.3
B. Current National Budget Expenditure	42,414	49,270	50,885	52,077	61,823	71,562
B1. Current expenditure for Water Sector	44.9	46.2	45.1	50.5	58.0	62.2
B2. As % of current budget expenditure	0.10	0.09	0.08	0.09	0.09	0.09
C. Total Budget Expenditure	70,539	78,057	81,995	84,817	104,715	126,741
C1. Total expenditure (A1+ B1)	5681.9	6479.2	6874.1	6989.5	7363.0	8621.2
C2. As % of total budget expenditure	8.0	8.3	8.4	8.2	7.0	6.8

Source: *Ministry of Finance and GSO, 2002; MPI.*

MANAGEMENT : Monitoring and Information

The existing information and reporting system in Vietnam comprises of a national network of environmental monitoring stations, as well as provincial level environmental monitoring (Box 10).

Monitoring of the water resources involves a number of ministries and agencies. The Hydro-meteorological Services, which has recently become the National Center of Hydrology and Meteorology of MONRE, maintains a network of 232 hydrological monitoring stations. The responsibility for processing data lies with nine hydro-meteorological regional centers.

Groundwater monitoring is the responsibility of the Agency of Geology and Minerals (transferred from MOI to MONRE in January 2003) that maintains a National Groundwater Monitoring Network with 310 regional monitoring stations and more than 600 observation wells across Vietnam.

The Department of Water Resources and Hydraulic Works management (responsibility of water resources management transferred from MARD to MONRE in June 2003) has the mandate to monitor both surface and ground waters.

MOFish is monitoring water quality in aquacultural areas and MOH is responsible for monitoring quality of drinking water.

A "Plan for the National Network of Monitoring Stations to Year 2010" has been submitted by MONRE to GoV for approval (Table 23). The MONRE plan envisages a gradual increase in the number of monitoring sites and sampling frequency, and calls for a substantial increase of GoV investments and operational costs over the planning period. The plan implies a gradual increase of the Stations / Centers to 61 including 15 DONREs and a gradual increase of the sampling frequency and the number of monitoring sites.

Box 10. Vietnam's Environmental Monitoring System

The national Environmental Monitoring Network, managed by NEA of MOSTE, was established at the end of 1994. `By 2002, the network had expanded to 21 stations, which carry out monitoring at 250 locations in 45 provinces. These locations include environmental hotspots such as industrial zones, large cities, and environmentally sensitive ecological regions.

The parameters monitored are basic quality parameters for air, water, land, coastal environment, solid waste, noise, acid deposition, radioactivity and indoor working environment. Up to 2000 the monitoring frequency had been 4 times a year. In 2001 this was increased to 6 times per year.

During 1994 – 2002 NEA under MOSTE collected data from monitoring stations, DOSTEs and other ministries and produces a series of State of Environment (SOE) Reports every year according to the requirements of the government. With the establishment of MONRE the responsibility of producing SOE reports now lies with the Department of Environment and data collection is a mandate of the Office of Data and Information under VEPA.

Box 11. Donor support for improving Monitoring and Information

Initiatives are taken to establish systems for data and information management. AusAID is supporting establishing a National Water Resources Database System and DANIDA is launching an Environmental Information and Reporting project. Both projects will support environmental and water resource management and decision taking based on the best possible knowledge.

Table 23. Plan for Expansion of the National Environmental Monitoring Network 2001-2005

Type of stations/centers	Existing	Envisaged by 2005
Regional inland stations	3	3
Regional coastal / sea stations	5	6
Specialized stations	12	15
Laboratories	1	3
Local stations (DONREs)		15
Total	21	42

Source: *VEPA, 2003.*

Responding to VietnamŠs Water Resource Issues

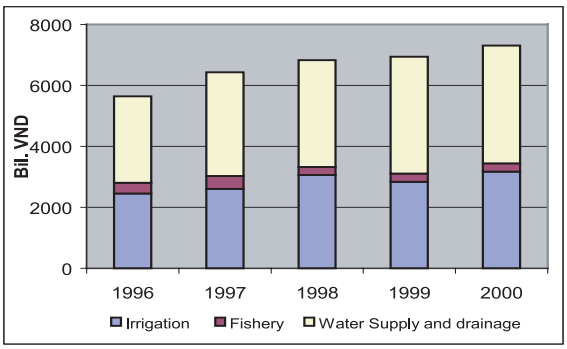
The GoV has made impressive gains in tackling water resources management issues in the country. This has been possible through a rise in public investments in the water resources sector –increasing from 5,637 bill. VND in 1996 to 7,305 bill. VND in 2000 (Table 22). Public investment in the water sector largely comprises investment for irrigation, fishery and water supply and sanitation. In the planning period 1996-2000, total water sector investments comprised 33,145 bill. VND, with more than a half going toward water supply and sanitation (Fig 13). Planned water sector investments for the next plan period (2001-2005) shows an increase to 58, 812 bill. VND (a 77% increase from previous plan)[14]. While the 1996-2000 plan emphasizes water supply and sanitation, the next plan period focuses on investing in fisheries (proportion increasing from 5% to 37 %). Proportional investment in irrigation remains almost unchanged at around 42%.

Backed by increased investments, and improved capacity, the GoV 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.

Improving water supply

Supplying water for irrigation and domestic consumption continues to get highest priority in national programs. The country now has 75 irrigation schemes that supply 60-65 bill. m^3 annually. More irrigation schemes are planned to meet the increasing demand (irrigated lands are increasing at 3.4% annually) as well as provide water for the remaining 20% of agriculture lands with no irrigation services[15]. MARD has estimated the costs of rehabilitating and expanding Vietnam's irrigation network (Box 12). However the investment program is probably much larger than is economically warranted.

Fig 13. Investments in Water Resources Sector 1996-2000



Source: *MOF, GSO, ,MPI, 1998- 2002.*

Box 12. Expanding VietnamŠs Irrigation Network

The Ministry of Agriculture and Rural Development estimates provinces and cities around the country will need 6,000 bill. VND (390 mill. USD) to build and upgrade 25,200 km of irrigation canals by 2004. The money would come from the State and provincial budgets and from private sources. Vietnam, which spends the largest amount of money on irrigation works in the Southeast Asia spent 300 bill. VND (19.6 mill. USD) into building 1,000 km of canals last year.

Source: *Countryside Today, Feb 11th.*

Box 13. Emphasis on rural areas

The GOV is now focusing on improving the quantity and quality of water supply for rural populations. A National Center for rural water supply and sanitation was established under MARD in 1995. In addition to the rural water supply program, which has been implemented by UNICEF, many donors have now started providing investment support for district level water supply plants.

A National Committee for Water Supply and Sanitation was established in 1996 to advise the GoV in developing policies, strategies, and national programs for improving domestic water supply and sanitation. In addition, the GoV has set targets for 2010 and 2020 to increase urban supply coverage to 95% and 100% respectively, with a doubled consumption standard of 150 liters / day per capita[16].

Note 14: *Information provided by MPI.*

Note 15: *Nguyen Trong Sinh, 2002.*

Note 16: *Seminar on Water supply and sanitation in provincial towns in Vietnam, Hanoi December 2000).*

Improving water quality

The GoV has set many ambitious targets and plans to reverse the declining trend of water quality. Specific targets for 2005 include: 50% rural households with sanitary latrines; 30% of husbandries and 10% of cottage villages with waste treatment facilities. Also 100% industrial zones are to have wastewater treatment systems. More than 1000 enterprises in Ho Chi Minh city will be relocated out of the city.

To achieve these targets, environmental authorities are using a range of tools for pollution management.

Pollution standards: New national environmental standards, based on pollution loads, are to be applied from 2003.

Market-based instruments:

- In the urban areas, many local governments have started collecting sewerage fees as 10% of water tariff.
- GoV Decree 67/2003/ND-CP on fees for wastewater was issued on June 13, 2003 to minimize water pollution, promote more efficient water use and mobilize funding for the Environment Fund.
- Amendment to the GoV Decree on administrative fines for environmental violation has been drafted to submit for GoV approval.
- The Vietnam Environment Protection Fund was set up in 2002 to assist pollution minimization, among other functions.

Public participation: Public disclosure programs on environmental rating of industrial polluters –mainly water polluters –have been carried out or planned in Hanoi, Hai Phong, Da Nang and Ho Chi Minh city. A national program on socializing environmental protection to better engage and mobilize funding from the business sector and civil society is also being prepared.

Box 14. PM approved Plan on complete treatment of the most polluting sources

The plan was approved by Prime Minister on April 22, 2003 to deal with 4295 most polluting sources. The most serious 439 hotspots will be cleaned up during 2003-2007 and the remaining sources will be treated until 2012. The owners of the sources will be responsible for the investment into treatment facility but are eligible for concessional loans from funding sources including the Vietnam Environment Protection Fund.

Source: *Official Gazette, May 2003*

Box 15. IPs and Clinics Told to Build sewage treatment facilities

The Ministry of Construction has asked all industrial parks (IP) and hospitals with more than 500 beds to build wastewater treatment facilities between now and 2005 if they want to gain approval from local governments to continue their operations. The deadline for small and medium hospitals to acquire such facilities is 2010.

This is part of a program for urban sewage development that the ministry mapped out following instructions from the government for implementation until 2020.

Source: *Saigon Times Daily Mar 25, 2003.*

Conserving Biodiversity

To protect its rich coastal and marine biodiversity, the GoV has established marine protected areas. In addition, it has undertaken programs such as planting mangroves (Box 16), and establishing wetland protected areas, aimed at protecting both inland and coastal aquatic ecosystems.

Marine Protected Areas Currently, an institutional and legislative framework for marine protected areas in Vietnam is under development. A new Government decision has designated MOFish be responsible for the establishment and management of protected areas for fishery resources, including a national MPA system of 15 sites (Table 24). Of these, a pilot marine protected area at Hon Mun in Khanh Hoa Province has been functioning since 2001 and two others – Cu Lao Cham and Con Dao – are under preparation for the next phase of establishing MPAs.

Wetlands More wetlands sites are being proposed for inclusion in a list of protected areas. Also, to fulfill the GoV commitments to the Ramsar convention, MONRE has submitted a GoV Decree on wetland conservation and sustainable utilization to the Prime Minister. A National Strategy on Wetland management and conservation is also scheduled to be submitted for MONRE approval by the end of 2003.

Box 16. Mangrove planting saves lives and money in Vietnam

Since 1994 the Red Cross has planted 12,000 hectares of mangrove forests in northern Vietnam. The mangroves act as buffers against the sea, reducing potentially devastating 1.5 metre waves into harmless, centimetre-high ripples.

The mangroves protect 110 kilometres of the 3,000 km sea dyke system. The benefits are staggering. The planting of mangroves has cost 1.1 mill. USD, but has helped reduce maintenance costs by 7.3 mill. USD per year.

The typhoon Wukong in October 2000 hit three northern provinces, but the dykes behind the regenerated mangroves were not harmed, and no deaths found behind the protected dykes. In the past, waves would breach the coastal dykes and flood the land of poor coastal families.

Source: *World Disasters Report 2002*

Making Fisheries Sustainable

Numerous regulations on fishing methods and technologies have been imposed by the government to improve the sustainability of its fisheries. Some of these include:

- Efforts to stop destructive fishing methods have been made by issuing two government directives, and allocating 2 bill. VND during the last four years to implement the proposed measures. However, the progress has been limited due to weak enforcement.
- Off-shore fishing has been promoted to lessen the fishing pressure in the nearshore. Government Decision 393/TTg was issued on June 9, 1997 to provide procedures on management of subsidies from GoV through soft loans for building off-shore fishing boats. An amount of 1,300 bill. VND was available for loans during the period 1997-1999.
- Land-use planning in the coastal provinces and other policies are aiming to promote sustainable aquaculture practice. MOFish has been given the mandate to guide and supervise the planning and development of investment proposals to convert unfertile agriculture land to aquaculture areas.

Table 24. Existing and Proposed Marine Protected Areas in Vietnam

Region	Existing site	Proposed site	Area (km^2)
Northeast		2	42.7
Red River Delta	1	1	152.5
North Central Coast		3	27,482
South Central Coast	2	2	124.66
Northeast of Mekong	1	2	35.5
Mekong River Delta	1		31,422
Total	5	10	59216.66

Source: *NEA, 2001.*

Addressing Vulnerability

Both physical solutions and institutional strategies have been formulated and implemented in Vietnam to mitigate water-related disasters and subsequent damage.

The major physical means used to mitigate water disasters in Vietnam has been to build river and sea dykes, salt-water barriers and other intrusive technologies. Recognizing this, the GoV is allocating more of its annual budget towards building and stabilizing dykes.

After the damages caused by the 1999 flood, the GoV adopted a policy on *Optimizing Non-structural and Structural Disaster Mitigation Interventions in Central Vietnam* to provide guidance for the use of multiple types of interventions. In addition, the GoV has recently promulgated statutes on dyke management, flood and typhoon mitigation –which set out the responsibilities and power of the authorities for controlling developments in flood-prone lands, and for preparing for floods and typhoons. Furthermore, a new partnership between the GoV, donors and stakeholders supports the GoV strategy for disaster mitigation (Box 17).

Strengthening River Basin Management / ICZM

River basin plans have recently been accorded a high priority by the GoV. In June this year, the National Water Resources Council (NWRC) prioritized the development of annual work plans for 2003-2005, for all major river basins. Plans are currently being prepared for the Saigon – Dong Nai, Cau, Nhue, Day, and Thu Bon river basins.

To protect its fragile coastal areas, integrated coastal zone management (ICZM) is recognized to be a high priority. With the establishment of MONRE, an Integrated Coastal Zone Management Division has been created within VEPA. This new division will work in collaboration with other relevant departments, to develop ICZM schemes for coastal areas. The ICZM Division plans to implement ICZM practices in 40% of the coastal provinces by 2008 and in all 29 coastal provinces by 2013.

Box 17. Natural Disaster Mitigation Partnership

The Natural Disaster Mitigation Partnership (NDM-P) is an association made up of Government, Donors and NGOs was set up in June 2001 by the Consultant Group (CG) of donors to the Government of Vietnam. This partnership is working for Central Vietnam to support the GOV strategy for disaster mitigation. A Secretariat of the NDM-Partnership was setup in May 2002 in Hanoi.

The principles for the NDM-P include regular and transparent information sharing, policy dialogue, identification, prioritization and recommendation for the allocation of resources, and effective utilization of Government, Donor, and NGOs resources.

Box 18. Donor Support for ICZM

Several donors (IMO, ADB, Dutch) are actively supporting integrated coastal zone management (ICZM) in Central Vietnam. During 2002 –2003, an ICZM Strategy and Action Plan has been adopted for Da Nang and Thua Thien - Hue. Monitoring activities have commenced and training of 100 staff have carried out. Activities continue in 2003.

Source: *VNICZM Project (NEDECO/VEPA)*

CHALLENGES

Over the past decade, the Government of Vietnam has enacted laws, created institutions, expanded investments and decentralized authority to manage the country's vast water resources. However, rapid economic expansion, high population growth, worsening environmental conditions and frequent natural disasters are overwhelming the capacity and capability of the existing policy and institutional regime, which in turn undermines the effectiveness of numerous government-led interventions. Based on the foregoing analysis and feedback received from consultations, the following emerge as key challenges for the country.

1. Strengthening policy and institutional framework for integrated water resources management

The Government has established ambitious targets to be achieved by 2010 for expanding water supply for irrigation, aquaculture, industry and domestic consumption and controlling water pollution. Their success will largely depend on adopting an integrated approach to managing water resources that addresses equity, efficiency and environmental sustainability on one hand and institutions and participation on the other.

a. Framing an appropriate Government policy. The challenge for Vietnam is to establish a practical strategy for integrated water resources development and management at the national level and provide a clear mechanism for coordinated sectoral development and management decisions across ministries and tiers of administration

b. Adapting a basin approach. The GOV has established RBOs for three of the eight largest river basins, though none of them are fully operational. Inadequate mandate, authority and capacity are the main reasons for the slow progress. The immediate priority would be to resolve the outstanding issues and to provide clear guidance for implementation and sufficient resources to the three RBOs so that they can begin to function as model units for future replication in the country.

c. Improving riparian cooperation. Because about two thirds of the country's water comes from neighboring countries, water resource development and watershed degradation in upstream nations can have an adverse effect Vietnam's water resources. Regional cooperation with Cambodia, Laos, Thailand and China needs to be strengthened for an optimal utilization and management (including flood management) of these shared water resources. Vietnam's proactive engagement in the Mekong River Commission should be a very high priority. The riparian cooperation should result in the development of rules, protocols and procedures for shared water allocation and utilization, and further strengthening of institutional regulatory capacity.

d. Making institutions effective. The establishment of MONRE provides a unique opportunity to separate the water management function from the water service function. There is a clear need to better define policy, regulation and operational functions of MONRE, MARD and MoFish, and their respective roles. Further, there is an urgent need to train technical staff of MONRE so that they can carry out the recently assigned responsibilities. The coordination arrangements among the key ministries and agencies that have responsibility for water management need to be improved through NWRC.

Along with the national institutions, capacity at the provincial and district levels needs to be strengthened. The administrative reforms at the central level need to reach the provincial level, where the priority is a move toward integrated water resources management. There is an urgent need to agree on the appropriate extent of delegation of authority to the provincial and district level entities, following which the relevant staff should be relocated and their capacity enhanced.

2. Expanding and diversifying investments in infrastructure

Expanding investment in infrastructure for the water sector should be of the highest priority to address the country's vulnerability to climate variability and natural disasters, as well as the susceptibility to actions and decisions made by the upstream riparian nations. This could create a buffering capacity to protect the country from regular and extreme climatic cycles, and the significant downstream consequences of consumptive and non-consumptive water uses. Increased investment in infrastructure will also help Vietnam meet national water quality and environmental flow requirements.

CHALLENGES

a. Irrigation modernization is necessary as the agricultural sector diversifies and water resources become more scarce. New infrastructure will improve the distribution and help irrigation companies provide more equitable, reliable and flexible irrigation and drainage services.

b. Urban water supply and sanitation. Inadequate infrastructure for urban water supply and sanitation is also a critical issue. To meet the 2020 targets for urban water supply with 100% coverage, Vietnam needs to spend at least 1.3 billion USD for the period 2003-2020. This figure could be up to 2.2 billion USD if the efficiency of water supply remains at the current level. Financing will need to be from a combination of government revenue budget, external borrowing, private sector participation and user fees.

c. Increase of both coverage and efficiency of water suply is the main challenge. In addition, there is a huge need for further investment to deal with water shortages during the dry season, to increase storage capacity during high flows and floods, and to improve physical methods for disaster management.

d. Greater funding for water resources management and introducing management changes will promote new types of financing to improve investment efficiency and benchmarking of scheme performance to improve accountability.

e. Further decentralization. The government's policy of decentralizing financial autonomy and responsibilities for the provision of irrigation management companies, municipal water supply, sewerage collection and treatment services need to be continued and accelerated.

3. Improving compliance and enforcement

The political will and organizational capacity for enforcing the existing laws remains weak, and this is very evident in the major rivers that traverse urban and industrial areas with high pollution levels. Reversing the declining trend in water quality and aquatic biodiversity, remains a key challenge to health improvement. To achieve this, the Government has recently begun to shift its strategy to introducing economic instruments and performance disclosure, while at the same time effecting changes to its command-and-control approach.

a. Improving command-and-control approach. While the assimilative capacity of Vietnam's major rivers is large, and on average the ambient water quality is reasonable, moderate to severe pollution is increasingly occurring in specific areas ("hot spots"). Together with the set of standards regarding the discharging of wastes into water bodies, the shift from concentration-based to load-based pollution standards should provide sufficient flexibility for polluters to better comply with the laws.

b. Broadening the use of charges and disclosure. The pilot programs that the Government has successfully undertaken (reported elsewhere in the report) should now be mainstreamed as part of its compliance toolkit.

Box 19. Investment needs for water supply

The Ministry of Planning and Investment estimates that at the current water consumption levels and projections for population growth, about 147 million USD (2.2 trillion VND) in investment capital will be required annually until 2020 for the provision of water supply. This excludes the estimated 143 million USD (2 trillion VND) to drill 1.2 million wells needed for rural areas.
Source: *http://www.tradeport.org/ts/countries/vietnam/isa.*

c. Strengthening EIA for water projects. In water projects it is required that environmental issues are addressed in cooperation with the construction, and that greater attention should be given to physical, biological, and social impacts in both downstream and upstream areas. The challenge is to increase the capacity of implementing agencies to undertake EIA studies and to sufficiently implement environmental management plans so that EA can be a tool for integrating environment into project planning and decision-making.

d. Conserving biodiversity. Although there has been a high demand to create more protected areas both marine and inland, it is more important to manage the already established systems and ensure the conservation functions of them. The linkage between development activities and their impact on aquatic ecosystems, especially wetlands, will need

to be addressed with careful consideration. Integrating operational measures should be better enforced, including land-use planning for fishery and aquaculture, for safeguarding appropriate levels of protection of endemic species and habitats, and for preventing the introduction of exotic species.

4. Deepening public participation and involvement

a. Participatory planning processes. Although there has been some coordination among relevant authorities, the role of local communities for managing water resources has yet to be highlighted in Government policies. An example could be the people's right to participate in the national programs on clean water and sanitation by contributing ideas to the Communal People Councils. A high priority could be to include all stakeholders in planning, decision-making, implementation, and operation of water infrastructure.

b. Expanding water use companies and associations. At present, water users have limited say in the overall system management and the management companies have little incentives to improve service delivery. Recent efforts have aimed at setting up pilot water cooperatives and associations, and upholding the role of local water user communities. An effective water sector could use these associations as its agents with greater involvement from the private sector, community-based organizations and WUGs in management, operation and maintenance of water facilities. At the central level, the Vietnam Water Partnership is a network that liaises with agencies, institutions, social entities, professional associations, scientists and water users active in the fields of integrated utilization, protection, development and management of water resources. Expanding these arrangements and activities to include more enterprises and NGOs and to reach the local level remains a challenge to Vietnam.

Part II

REGIONAL WATER RESOURCES PROFILE

REGIONAL WATER RESOURCES PROFILE : Northwest Region

The Northwest region has an area of 35,637 km^2 and a population of 2.3 mill. people, of whom only 303.4 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.

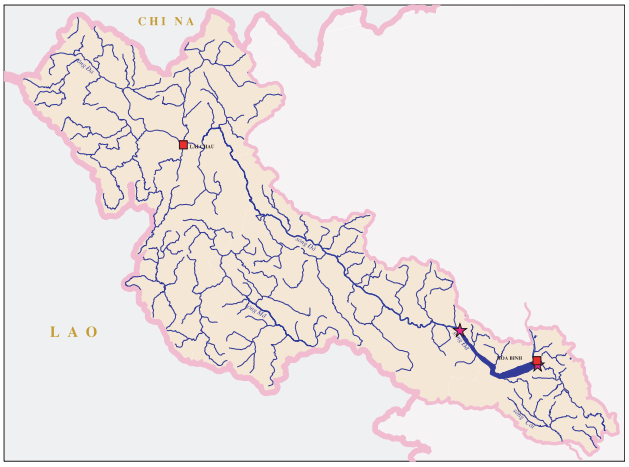
Water Resources Profile

The average annual rainfall varies widely from 3200 mm in the northwest mountains to 1200 mm in the central region. The average is from 1400 to 2000 mm/year over the rest of the region[17]. The Da River is the main river with a total length of 1010 km and joins the Red River at Trung Ha. The Da basin is mountainous and covers 26,600 km^2. It is bordered by Laos in the west and the Red River Basin in the east. Other smaller rivers are the Nam Po, Nam Na and Nam Muc. Water resources in the area are abundant and the population relatively small and dispersed. The estimated annual water demand of 5.06 bill. m^3/year (Table 2 in Annex 2) is equivalent to only 9% of the available resources (Fig 14). The Da Basin has high hydropower potential with three more hydropower plants according to the National Hydropower Plan Study. The largest reservoir in the country, Hoa Binh, is located on the Da River.

There is a large gap in domestic water supply between the urban and rural areas. In general the supply is well below the country average level (Fig 15).

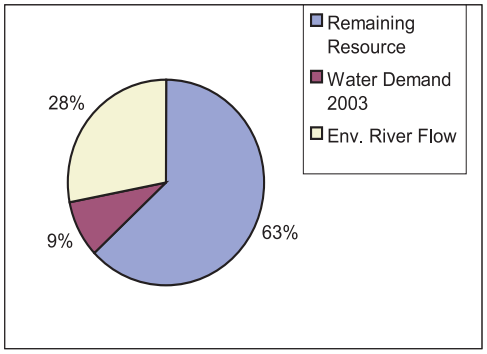
Groundwater

Groundwater resources are large but dispersed and not easily extracted. The Hoa Binh town water supply is the largest groundwater exploitation, but elsewhere it is limited. There is a total of 87 springs and boreholes containing mineral and thermal water in the region (Table 3).



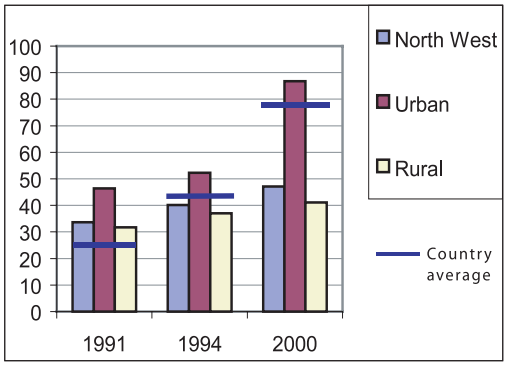
★ Monitoring station.

Fig 14. Water Resource Use in Northwest Region
Total Resources: 56 bill. m3/year



Source: *KC12 and National Water Sector Profile (2002).*

Fig 15. Percentage of household with access to safe water sources



Note: *Data for 1991 and 1994 is combined for the Northwest and Northeast regions (known in the past as Northern Uplands)*

Source: *GSO, 1990-1995, MICS II 2000.*

Note 17: *Vietnam Water Resources Atlas 2003.*

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.

Biodiversity and Natural Resources

More than 48 aquatic species are harvested in the Da River Basin including many species of fish, crabs, soft-shell turtles, snails and clams. Fish are the main catch. Freshwater resources both up- and down-stream of the Hoa Binh Dam have declined very seriously since its construction.

The perceived causes of the decline are hindrance of fish migration, use of destructive fishing methods, over-harvesting, and fishing during the breeding season even at breeding grounds. There has been some compensation due to increased fisheries yields in the reservoir itself.

Fish species formerly of commercial value that are no longer caught include: *Tenualosa reevesii, Nematalosa nasus, Onychostoma ovale, Parabramis pekinensis, Spinibarbus hollandi, Ochetobius elongatus, Acrossocheilus iridescens, Onychostoma gerlachi, Garra bourreti, Microphysogobio vietnamica and Channa maculata*[18].

Aquaculture is increasing in the region and has somewhat compensated for the loss in fisheries (Fig 16).

Table 25a. Da River Water Quality, Lao Cai Province

	Class A	Class B	Out-of-range
COD (mg/l)	X		
BOD5 (mg/l)	X		
NH4-N (mg/l)	X		
DO (mg/l)		X	
Coli (MPN/100 ml)	X		
Overall		X	

Table 25b. Da River Water Quality, Hoa Binh province

	Class A	Class B	Out-of-range
COD (mg/l)	X		
BOD5 (mg/l)	X		
NH4-N (mg/l)	X		
DO (mg/l)		X	
Coli (MPN/100 ml)	X		
Overall		X	

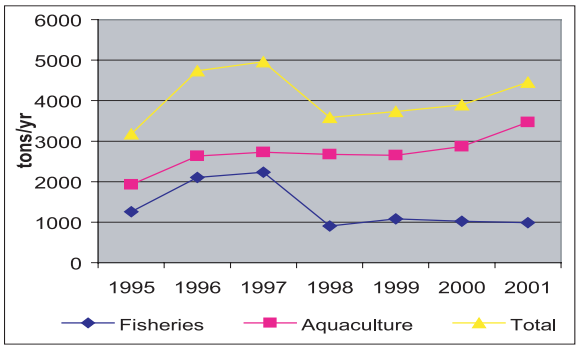
Box 20. Flood Control in Da River Basin

Flood control is one of the main reasons for implementing dams on the Da River. According to a government statement, 10 bill. m3 of flood storage volume should be provided in Da River to protect Hanoi and the Red River Delta.

Although it is feasible to install this flood retention capacity, long-term sustainability is a problem. The flood storage capacity will be considerably reduced within 50 to 75 years due to sedimentation, even when special countermeasures, such as flushing, are taken. However, sediments would have to be passed down the Da River Basin. In the long term sedimentation in the Delta may lead to raised flood water levels in the range of 1 to 1.5 meters every 100 years.

Source: *National Hydropower Plan Study, Vietnam. Dec. 2001.*

Fig 16. Northwest Region Fish Production



Source: *GSO 1996-2002.*

Note 18: *WB | Kottelat M., 2001, Freshwater Fishes of Northern Vietnam*

REGIONAL WATER RESOURCES PROFILE : Northeast Region

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 Resources Profile

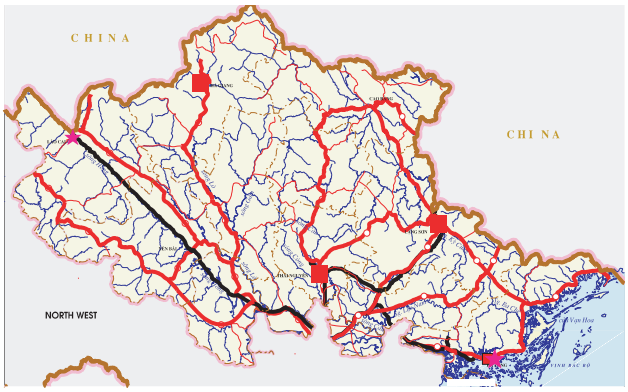
The region has some of the highest average annual rainfall in the country with averages of 4000 mm in the northwest and 1200 mm in the northeast area. The average for the remaining region is 1400 to 1600 mm/year[19]. The river basins in the Northeast Region rise in the mountainous northern part of Vietnam at the Chinese boarder. The Ky Cung Bang Giang river system is the farthest north-east and flows into Ta Giang, China. The Lo (GamChay) to the north enters the Red River at Viet Tri. The Red River is the main river running through the western part of the region. The Cau, Thuong and Luc Nam rivers to the east are tributaries to the Thai Binh that runs downstream through the Red River Delta Region.

The estimated annual water demand of 3.95 bill. m^3/year (Table 2 in Annex 2) is equivalent to 14% of the available resource (Fig 17). Although water resources are abundant in the region, the flow distribution is uneven. There is a scarcity of water in the coastal areas of Quang Ninh province. Droughts and flashfloods occur frequently in the region.

Domestic water supply contains a relatively big gap between the urban and rural areas, and in general is below the country average level (Fig 18).

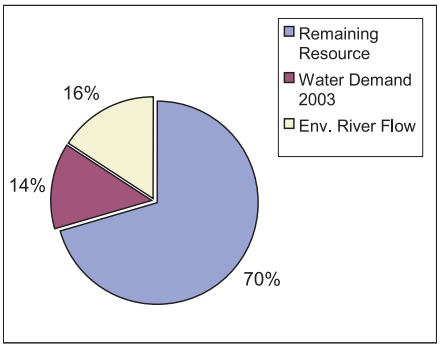
Groundwater

Groundwater resources in this region are limited, fairly dispersed, and marginally exploited for smaller supply schemes such as in the towns of Thai Nguyen and Quang Ninh. A total of 14 springs and boreholes containing mineral and thermal water are found in the region (Table 3).



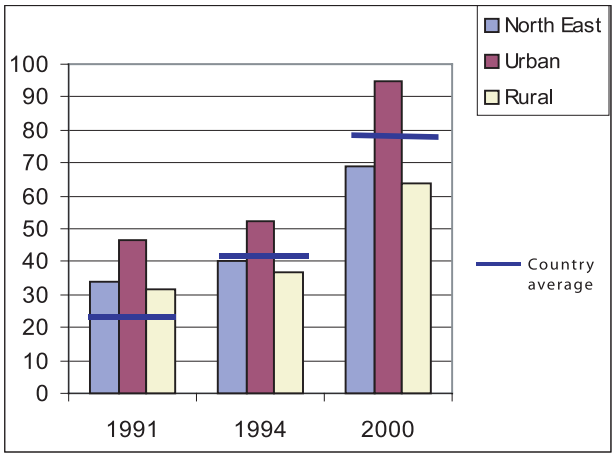
★ Monitoring station.

Fig 17. Water Resources use Northeast Region
Total Resources: 22 bill. m^3/year



Source: *KC12 and National Water Sector Profile (2002).*

Fig 18. Percentage of household with access to safe water sources



Note: *Data for 1991 and 1994 is combined for the Northwest and Northeast regions (known in the past as Northern Uplands)*

Source: *GSO, 1990-1995, MICS II 2000.*

Note 19: *Vietnam Water Resources Atlas 2003.*

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 NO_2, NH4 and BOD5 that exceed the standards by 10, 2 and 5 times respectively. TSS and H_2S 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.

Biodiversity and Natural Resources

The coastal region in the Northeast faces a dilemma between development and conservation. The Ha Long Bay is a UNESCO World Heritage Site. In addition, there are a number of existing national parks and proposed marine protected areas. However, pollution discharges from Ha Long City and Hon Gai, and rapid tourism development at Ha Long Bay, Cat Ba and Ba Mun National Parks is thre atening the biodiversity resources.

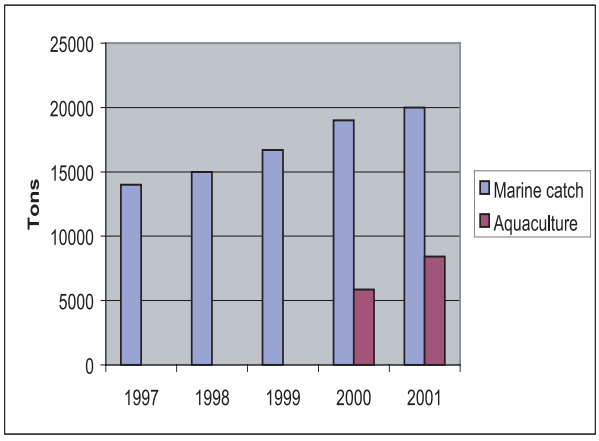
Table 26a. Red River Water Quality, Lao Cai Province

	Class A	Class B	Out-of-range
COD (mg/l)	X		
BOD5 (mg/l)	X		
NH4-N (mg/l)	X		
DO (mg/l)	X		
Coli (MPN/100 ml)	X		
Overall	X		

Table 26b. Cau River Water Quality, Bac Ninh province

	Class A	Class B	Out-of-range
COD (mg/l)		X	
BOD5 (mg/l)		X	
NH4-N (mg/l)		X	
DO (mg/l)		X	
Coli (MPN/100 ml)		X	
Overall		X	

Fig 19. Fish Production Northeast Region



Note: *data for 1997-1999 is not available.*
Source: *GSO 1998-2002.*

REGIONAL WATER RESOURCES PROFILE : Red River Delta

The Red River Delta covers an area of 14,788 km^2 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 Resources Profile

The average annual rainfall varies from 1400 mm to 2400 mm in the hilly areas north of Hanoi and in the south-east part of the region. The mean rainfall is 1600 to 1800 mm / year for the remaining areas[20]. The region covers the lower reaches of the Red River–Thai Binh River, where there are many other interlacing tributaries and effluent streams. The center of the delta is flat at 2m-17m above mean sea level. Almost all lands are protected behind the 3000 km–long dikes along the river and behind the 1500 km sea dikes. 14 irrigation schemes are constructed on the Red River and 16 on the Thai Binh.

The Red River Delta is one of the most industrialized areas in Vietnam with a dense population. In the coastal region rice cultivation is being replaced by brackish aquaculture. The annual water demand of 17.4 bill. m^3 / year (Table 2 in Annex 2) is mainly from irrigation and represents 12% of the available water resources (Fig 20). However, demands from industry and services are expected to increase considerably in the future.

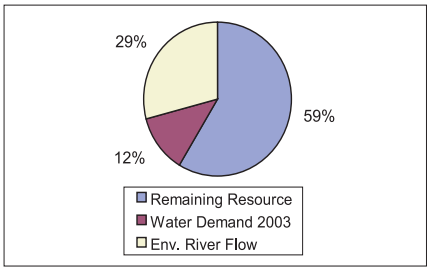
Domestic water supply covers the urban and rural areas almost evenly, and in general is higher than the country's average level (Fig 21). Calculated on the adjusting coefficient from the data on safe water sources in year 2000, clean water access is as low as 74%, 93%, and 69% for the region's average, urban and rural areas respectively, which shows the poor quality of water supply in rural areas.

Groundwater

Groundwater resources are abundant but exploitation is intensive in and around Hanoi. As a consequence the groundwater table is constantly declining and land subsidence is a problem (Fig 1a and Map 3 in Annex 2). In the Hanoi area near Tuong Mai and Thuong Dinh wellfields, the land subsidence rate is 30-40 mm / year. A further consequence of groundwater exploitation is the salt water intrusion that affects the coastal parts of the delta (Map 1 in Annex 2).

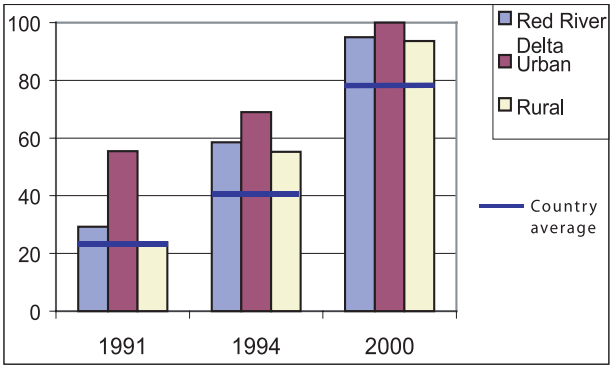
★ Monitoring station.

Fig 20. Water Resources Use - Total Mean Annual Resources 141 bill.m3/year



Source: *KC12 and National Water Sector Profile (2002).*

Fig 21. Percentage of households with access to safe water sources



Source: *GSO, 1990-1995, MICS II 2000.*

Note 20 : *Vietnam Water Resources Atlas 2003.*

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 NH_4 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 BOD_5 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).

Biodiversity and Natural Resources

The coastal zone of the Red River Delta supports a great diversity of wildlife, especially water birds. However, the delta also sustains one of the highest human population densities in the world and accounts for a major part of the Vietnam's rice production. As a consequence of these conditions and intensified aquaculture production, the delta is most at risk of losing the natural and seminatural wetland habitats they support and the essential functions they provide.

Patches of natural mangroves remain at the only Ramsar site of Vietnam - Xuan Thuy National Park in the Nam Dinh province. Replanting of mangroves has taken place along other coastal parts.

The coastal zone of the Red River Delta supports a large inshore fishery (Fig 22) that depends on the ecological integrity of mangrove forests, intertidal areas and other associated habitats. The most important wetlands that need protection are in the Xuan Thuy National Park, coastal area of Nghia Hung district, Thai Binh Estuary, Van Uc Estuary, Tien Hai Nature Reserve and the coast of Thuy Nguyen district.

Table 27a. Red River Water Quality

	Class A	Class B	Out-of-range
COD (mg/l)		X	
BOD5 (mg/l)		X	
NH4-N (mg/l)		X	
DO (mg/l)	X		
Coli (MPN/100 ml)	X		
Overall		X	

Table 27b. Thai Binh River Water Quality

	Class A	Class B	Out-of-range
COD (mg/l)	X		
BOD5 (mg/l)		X	
NH4-N (mg/l)		X	
DO (mg/l)	X		
Coli (MPN/100 ml)	X		
Overall		X	

Box 21. Species Diversity Hai Phong

In 1975 ground animals in the tidal wetlands were surveyed for species composition and biological quantity. The statistics comparison shows a dramatic change in the number of species and density between the 1975 and 2000. This was primarily caused by the evolution of the mangrove marshes. Another factor that decreased the number of worms and crustacean species relates to human activities. Apart from catching lobsters and crabs, the breeding of several tens of thousands of ducks that eat crustaceans is regarded as a cause of worm and crustacean resource decrease.

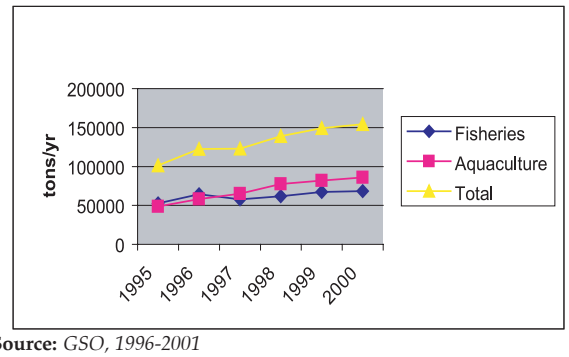
Source: *Man-made threats to biodiversity of tidal wetlands in Tien Lang coastal area, Hai Phong City, Vietnam, 2001.*

Table 28. 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 ?g /l	50 ? g/l	30-40 mg/l	10-20 mg/l	0.05 mg/l	1000 (MPN)

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

Fig 22. Fish Production in Red River Delta



Source: *GSO, 1996-2001*

REGIONAL WATER RESOURCES PROFILE : North Central Coastal Region

The North Central Coastal region has an area of 51,501 km^2 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 Resources Profile

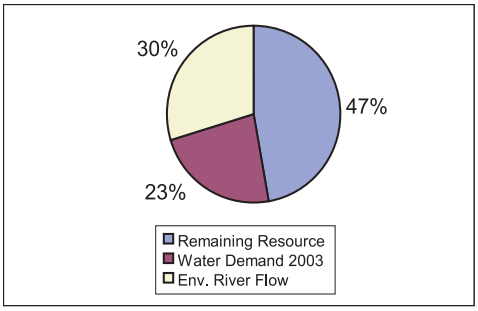
The average annual rainfall varies from 1600 mm in the north to 3200 mm in the south. The mean rainfall for the middle section of the region ranges from 2400 to 2600mm / year[21]. The rivers in the North Central Region are generally short and experience a two-season regime with low flows during the dry season and high flows during the monsoon. The main rivers are the Ma which is 500 km long, the Ca with a length of 432 km and the smaller Chu, Gianh, Nhat Le, Quang Tri, Thach Han and Huong further south. The region is prone to floods during heavy monsoon rains and saline intrusion during the dry season.

The estimated annual water demand of 10.72 bill. m^3 / year (Table 2 in Annex 2) is equivalent to 23% of the available resource (Fig 23). A relatively high percentage of the mean annual water resources are already exploited mainly for irrigation. During dry periods the demand surpasses the water resources available and droughts are frequent[22].

Domestic water supply covers almost evenly the urban and rural areas, and in general is higher than the country's average level (Fig 24). Calculated on the adjusting coefficient from the data on safe water sources in year 2000, clean water access is as low as 50%, 60%, and 48% for the region's average, urban and rural areas respectively, which shows the poor quality of water supply in the whole region .

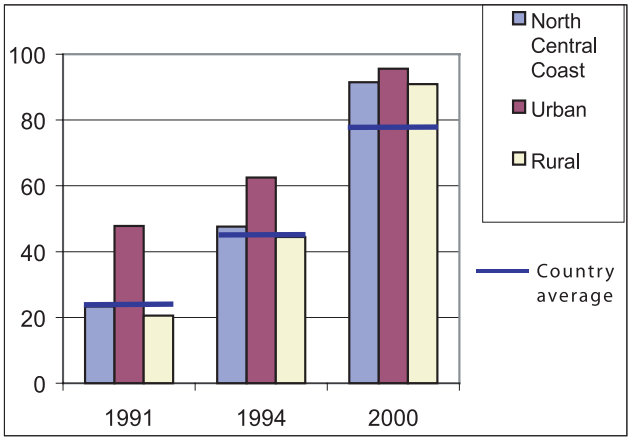
★ Monitoring station.

Fig 23. Water Resource Use in North Central Coast Region. Total Mean Annual Resources: 46.1 bill. m3/year



Source: *KC12 and National Water Sector Profile (2002).*

Fig 24. Percentage of household with access to safe water sources



Source: *GSO, 1990-1995, MICS II 2000.*

Note 21: *Vietnam Water Resources Atlas 2003.*

Note 22. *Water Resources Investment Strategy for the Central Region, ADB 2001.*

Groundwater

Ground water resources are not abundant in the North Central Coastal Region, and the abstraction ranges from small to medium. The main groundwater abstraction for water supply is for Dong Ha. There is a total of 22 mineral and thermal springs and bore-holes in the region (Table 3) that mainly consists of natrium carbonate or calcium with low mineralization.

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 BOD_5 and COD concentrations exceeding class A standards by 2-3 times, NH_4 and PO_4 by 1.5-1.8 times. In the Huong river section running through Hue city the BOD_5 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.

Biodiversity and Natural Resources

The lagoon system in Thua Thien Hue province is one of the typical ecosystems in this region. Ecologically, the lagoons serve as productive systems along with the mangroves and coral reefs. Seagrass beds are also abundant in this region. Rapidly expanding tourism in this region is a potential threat to these biodiversity resources.

Table 29a. Ca River Water Quality

	Class A	Class B	Out-of-range
COD (mg/l)		X	
BOD5 (mg/l)		X	
NH4-N (mg/l)	X		
DO (mg/l)	X		
Coli (MPN/100 ml)	X		
Overall		X	

Table 29b. Huong River Water Quality

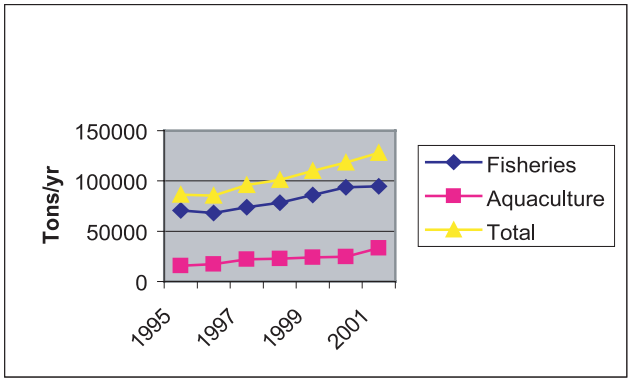
	Class A	Class B	Out-of-range
COD (mg/l)		X	
BOD5 (mg/l)		X	
NH4-N (mg/l)	X		
DO (mg/l)	X		
Coli (MPN/100 ml)	X		
Overall		X	

Box 22. Huong River Protected Watershed

A total of 44% of the Thua Thien Hue Province's area is covered by protected forests out of which 16% is Special Use Forest, Nature Parks and Nature Reserves. The remaining 28% is designed Watershed Protection Forest. Effectively the protected forests cover the portions of the mountainous areas that drain to the sea. The forests have multiple functions related to water resources, preventing land erosion, land slides and deterioration of water quality. The forests and nature reserves protect the water quality in the Huong River that supplies water to a population of 220,000 people.

Source: *Economic Contribution of Protected Areas to the Province of Thua Thien Hue. Lower Mekong Protected Areas Review April 2002.*

Fig 25. Fish Production in North Central Coastal Region



Source: *GSO 1996-2002.*

REGIONAL WATER RESOURCES PROFILE : South Central Coastal Region

The South Central Coastal region has an area of 33,100 km^2 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.

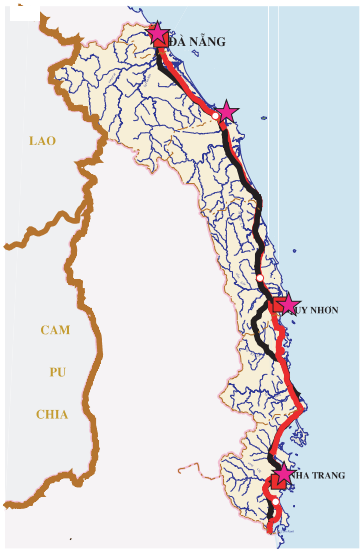
The region is characterized by high temperatures, heavy rainfall during the wet season, and a prolonged dry season. Yellow-red soils are dominant in the uplands and white sandy beaches are all along the coastline.

Water Resources Profile

The region has an average annual rainfall as high as 4000 mm in the north and as low as 1400 mm in the south. In the middle region, the mean rainfall is generally from 1600 to 2000 mm / year[23]. The coastal rivers in the South Central Region are generally short and experience a two-season regime with low flows during the dry season and high flows during the monsoon. The main river systems are the Thu Bon and the Ba. Smaller rivers include Tra Khuc, Kon and Ky Lo. The region is prone to floods during heavy monsoon rains and saline intrusion during the dry season.

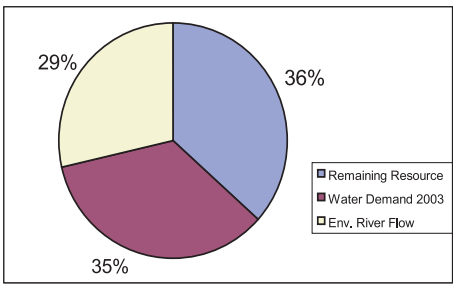
The estimated annual water demand of 11.47 billion m^3 / year (Table 2 in Annex 2) is equivalent to 23% of the av ailable resources (Fig 26). A relatively high percentage of the mean annual water resources are already exploited, pred ominantly for irrigation. During dry periods the demand nearly exhausts, and in parts of the region surpasses the avail-able resources. The region is often hit by severe droughts[24].

Domestic water supply covers almost evenly the urban and rural areas, and in general is higher than the country average level (Fig 27). Calculated on the adjusting coefficient from the data on safe water sources in year 2000, clean water access is as low as 46%, 62%, and 40% for the region's average, urban and rural areas respectively, which shows the poor quality of water supply in the whole region.



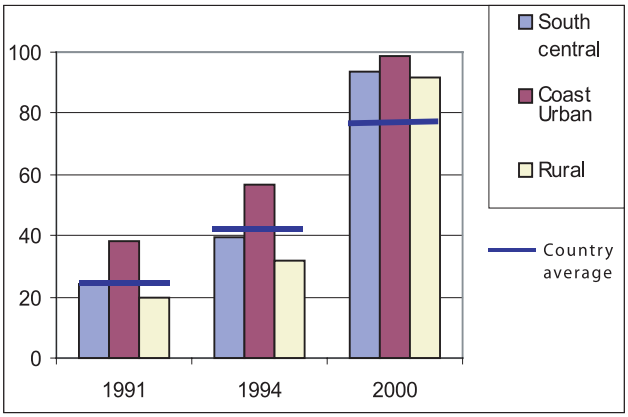
★ Monitoring station.

Fig 26. Water Resource Use in South Central Coast Region. Total Mean Annual Resources: 33.1 bill. m3/year



Source: *KC12 and National Water Sector Profile(2002).*

Fig 27. Percentage of household with access to safe water sources



Source: *GSO, 1990-1995, MICS II 2000.*

Note 23: *Vietnam Water Resources Atlas 2003.*

Note 24: *Water Resources Investment Strategy for the Central Region, ADB 2001.*

Groundwater

Ground water resources are not abundant in the South Central Coastal Region. Abstraction of groundwater resources is small to medium. The main groundwater abstractions for water supply are at Quang Ngai, Quy Nhon and Xuan Phong. There is a total of 56 mineral and thermal springs and boreholes in the region (Table 3) that mainly consists of natrium bicarbonate or natrium chloride with high mineralization.

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. How-ever, BOD_5 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).

Biodiversity and Natural Resources

This region has a wealth of natural resources including a variety of ecosystems like coral reefs, seagrass beds and coastal lagoons. Many rare animals are found living in these ecosystems. There are a number of proposed marine protected areas, of which Cu Lao Cham and Hon Mun have been accorded the highest priority.

Table 30a. Han River Water Quality

	Class A	Class B	Out-of-range
COD (mg/l)		X	
BOD5 (mg/l)		X	
NH4-N (mg/l)		X	
DO (mg/l)	X		
Coli (MPN/100 ml)		X	
Overall		X	

Table 30b. Thu Bon River Water Quality

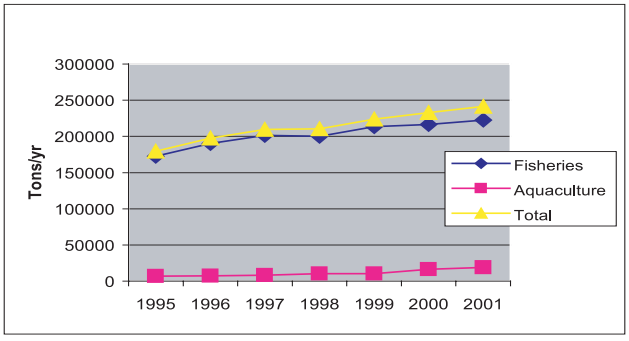
	Class A	Class B	Out-of-range
COD (mg/l)	X		
BOD5 (mg/l)	X		
NH4-N (mg/l)	X		
DO (mg/l)	X		
Coli (MPN/100 ml)	X		
Overall	X		

Table 31. Quality of Coastal Water

	Phosphate	Nitrate	COD	BOD5	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 (MPN)

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

Fig 28. Fish Production in South Central Coastal Region



GSO: *1996-2002.*

REGIONAL WATER RESOURCES PROFILE : Central Highlands Region

The Central Highlands Region covers an area 54,476 km^2 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 km^2 this constitutes the least densely populated region in Vietnam. 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 Resources Profile

The average annual rainfall ranges from 2000 mm in the north to 1600 mm/year in the south[25]. The major river basins in the Central Highlands are the Se San and Srepok river basins that form tributaries to the Mekong River through Cambodia. Smaller rivers include the Dak Psi, Dab Bla and Sa Thay. Water is scarce in the region and droughts have occurred frequently in recent years.

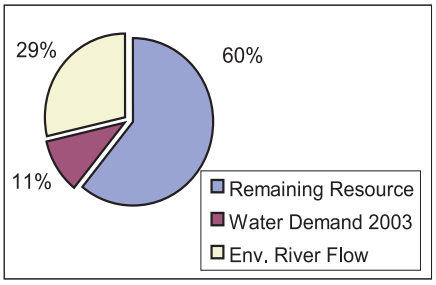
The Se San River has a high potential for development of hydropower. Under the National Hydropower Plan a total of five schemes were studied. In this study, the implementation of Se San 3, a dam with a full supply level of 305 meters with a planned installed capacity of 273 MW was given the highest priority.

The annual water demand is estimated to 4.81 bill. m^3/year (Table 2 in Annex 2). This is equivalent to 11% of the mean annual water resources available (Fig 29). However, during dry periods the available resources are less, and the demand nearly exhausts and in parts of the region surpasses the availability. As a consequence the region is often hit by droughts[26].

There is a large gap between domestic water supply in the urban and rural areas, and in general the supply is below the country average level (Fig 30). Calculated on the adjusting coefficient from the data on safe water sources in year 2000, clean water access is as low as 34%, 51%, and 29% for the region's average, urban and rural areas respectively, which shows the poor quality of water supply in the entire region.

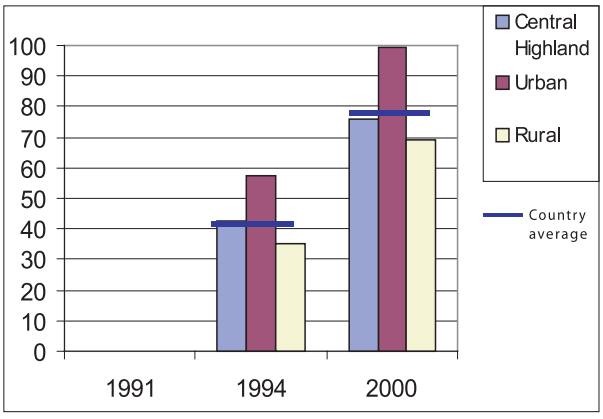
★ Monitoring station.

Fig 29. Water Resource Use in Central Highland Region. Total Mean Annual Resources: 45.7 bill. m3/year



Source: *KC12 and National Water Sector Profile (2002).*

Fig 30. Percentage of household with access to safe water sources



Note: *data for 1991 is not available*

Source: *GSO, 1990-1995, MICS II 2000.*

Note 25: *Vietnam Water Resources Atlas 2003.*

Note 26: *Water Resources Investment Strategy for the Central Region, ADB 2001.*

Groundwater

Groundwater abstraction for irrigation of cash crops is widespread in the Central Highlands. Groundwater monitoring shows that in some areas, the exploitation rate exceeds the natural recharge (Fig 1b in Annex 2). The declining water table increases pumping costs, and is not sustainable. There is a total of 24 springs and boreholes providing mineral and thermal water in the Central Highlands (Table 3).

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 NH_4-N. No available measurements were identified for BOD_5, as this parameter is not part of the MRC program.

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

Biodiversity and Natural Resources

Research has shown that more than 160 fish species are found in rivers and streams in the region. Of these 12 species are recorded in the Vietnam Red Book at different levels. Of these the Cyclocheilichthys enoplos, Probarbus jullieni, Labeo chrysophekadion, Clarius batrachus and Channa striata[27] are threatened.

The Central Highland Region has a low capture of fish compared to other regions in Vietnam. However, with no opportunity for marine catch, the region has high potential for developing fresh water fish aquaculture, especially in larger surface water bodies. This potential is under exploitation and the total fish production is increasing (Fig 31).

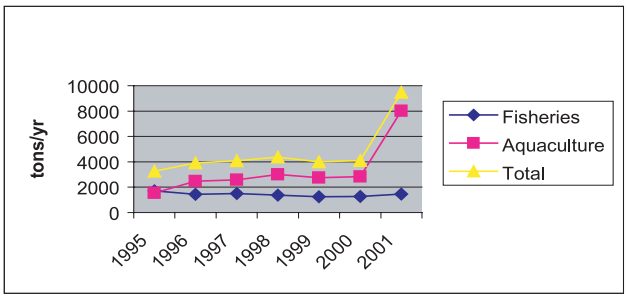
Table 32a. Se San River Water Quality

	Class A	Class B	Out-of-range
COD (mg/l)	X		
BOD5 (mg/l)			
NH4-N (mg/l)	X		
DO (mg/l)	X		
Coli (MPN/100 ml)	X		
Overall	X		

Table 32b. Sre Pok River Water Quality

	Class A	Class B	Out-of-range
COD (mg/l)	X		
BOD5 (mg/l)			
NH4-N (mg/l)	X		
DO (mg/l)	X		
Coli (MPN/100 ml)	X		
Overall	X		

Fig 31. Fish Production in Central Highland Region



Source: *GSO 1996-2002.*

Note 27: *WB / Kottelat M., 2001, Freshwater Fishes of Northern Vietnam*

REGIONAL WATER RESOURCES PROFILE : Northeast of Mekong

Northeast of Mekong has a total area of 34,733 km^2 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 Resources Profile

The average annual rainfall varies from 1400 mm at the coast to 2800 mm / year in the central Dong Nai River basin[28] that covers the main river system in the Northeast of Mekong (Dong Nam Bo) region. The Dong Nai stretches over a length of 500 km and is formed by the Da Dung and Da Nhim rivers. One of the biggest reservoirs in Vietnam, the Tri An, regu-lates the flow of Dong Nai. An important right side tributary is the La Nga, and from the left is the Be River. Further downstream the Vam Co Dong and Vam Co Tay enters from the Mekong Delta Region. Drought is a recurring problem especially in the provinces of Ninh Thuan and Binh Thuan.

The estimated annual water demand of 7.42 bill. m^3 / year (Table 2 in Annex 2) is equivalent to 17% of the available resource (Fig 32). The water demand in the region is atypical from the rest of Vietnam. The demand from irrigation is relatively low (only 37% of available resources) while in other regions is higher than 80% (Table 2 in Annex 2). Industrial and service sectors have a larger demand. During dry periods, demand outstrips the available resources, and the region is relatively frequently hit by droughts[29].

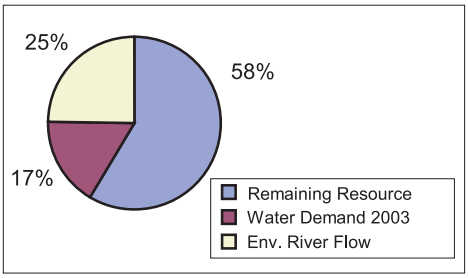
There is a gap in domestic water supply between the urban and rural areas, and in general the supply is higher the country average level (Fig 33).

Groundwater

Groundwater resources are abundant. Water abstraction is relatively high in the region, especially in Ho Chi Minh City. The abstraction in HCMC is far higher than the recharge, and the groundwater table is declining rapidly (Fig 1c in Annex 2). There is a total of 54 boreholes with mineral water in the region (Table 3).

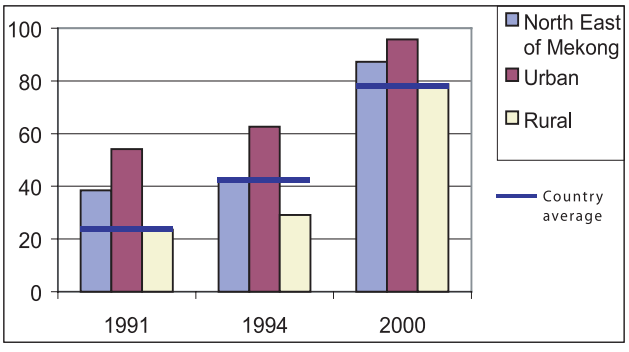
★ Monitoring station.

Fig 32. Water Resource Use Northeast of Mekong
Total Mean Annual Resources:44.4 bill. m3/year



Source: *KC12 and National Water Sector Profile (2002).*

Fig 33. Percentage of household with access to safe water sources



Source: *GSO, 1990-1995, MICS II 2000.*

Note 28 : *Vietnam Water Resources Atlas 2003.*

Note 29 : *Water Resources Investment Strategy for the Central Region, ADB 2001.*

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 BOD_5 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.

Biodiversity and Natural Resources

Harvesting of fish in the Dong Nai river basin is focused on 5 to 15 species, depending on the catch site. Reports indicate that after the construction of the Tri An Reservoir, catches have been reduced to 20-30% of their former levels[30].

The fish production in the region is dominated by marine catches. Aquaculture is still relatively less important, but increasing (Fig 34).

Note 30: *WWF Social report for Freshwater Biodiversity Overlay Project, WB Hanoi, June 2000.*

Table 33a. Sai Gon River Water Quality

	Class A	Class B	Out-of-range
COD (mg/l)		X	
BOD5 (mg/l)		X	
NH4-N (mg/l)			X
DO (mg/l)		X	
Coli (MPN/100 ml)			X
Overall			X

Table 33b. Dong Nai River Water Quality

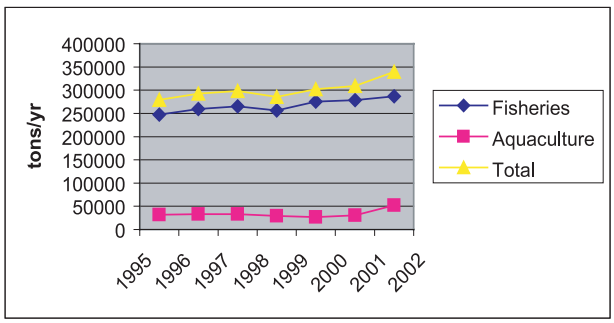
	Class A	Class B	Out-of-range
COD (mg/l)	X		
BOD5 (mg/l)	X		
NH4-N (mg/l)		X	
DO (mg/l)	X		
Coli (MPN/100 ml)		X	
Overall		X	

Box 23. 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*

Fig 34. Fish Production in Northeast of Mekong Region



Source: *GSO 1996-2002*.

REGIONAL WATER RESOURCES PROFILE : Mekong River Delta Region

The Mekong River Delta region covers an area of 39,713 km^2 and has a population of 16.5 mill. people, of which 3 mill. live in urban areas. With a population density of 416 persons/km^2 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 phenomena in the delta. Soils are mostly alluvial, but there are extensive areas of acid sulfate and saline soils.

Water Resources Profile

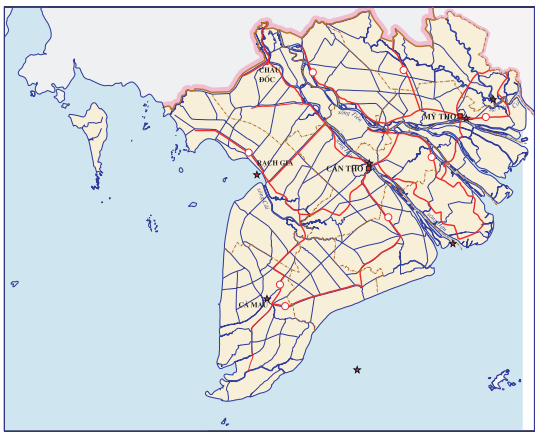
The average annual rainfall varies from 1400 mm in the northwest central part to 2400 m in the southern most part of the Mekong River Delta. The mean rainfall ranges from 1600 to 1800 mm/year for the major remaining part of the region[31]. The Mekong River is 4,800 km in length and originates from the Tibetan Plateau. Its total catchment area is 795,000 km^2 and includes parts of China and Myanmar, one third of Thailand, most of Lao PDR and Cambodia, and one fifth of Vietnam's territory. The Mekong River Delta is the lowest reach of the Mekong River Basin. The flow in this part of the basin depends not only on the flow in the upper reaches of the river, but also on the tide in the South China Sea and the rainfall in the interior fields. With the effect of the tide the Mekong River is diverted into nine branches toward the sea.

The estimated annual water demand is as high as 30.44 bill. m^3/year (Table 2 in Annex 2) but this is equivalent to only 6% of the available resource (Fig 35).

There is a very big gap in domestic water supply between the urban and rural areas, and in general the supply is below the country average level (Fig 36).

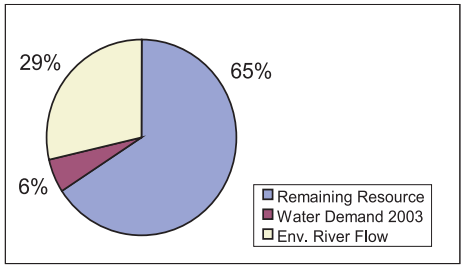
Groundwater

Groundwater resources in the Mekong River Delta are abundant. In large parts of the region exploitation is leading to a decline in the groundwater table (Fig 1d in Annex 2) and causing groundwater pollution. There are no springs in the delta, but there are 54 boreholes (Table 3) with thermal and mineral water of mixed composition and various mineralization



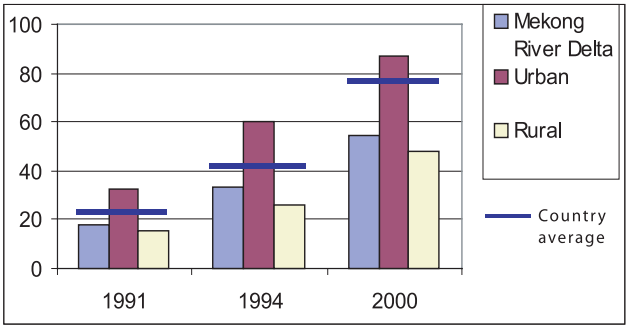
★ Monitoring station.

Fig 35. Water Resource Use
Total Mean Annual Resources: 533 bill. m3/year



Source: *KC12 and National Water Sector Profile (2002).*

Fig 36. Percentage of household with access to safe water sources



Source: *GSO, 1990-1995, MICS II 2000.*

Note 31: *Vietnam Water Resources Atlas 2003.*

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 stan-dards is BOD5, and occasionally NH4. However, in the smaller tributaries, especially in the urban and in-dustrialized 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 com-pounds 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).

Biodiversity and Natural Resources

The Mekong River Delta is a large wetland area, covering 3.9 mill. hectares, and fulfils an important role in regional and global biodiversity conservation. More than 200 bird species and 260 species of fish are found in the delta, together with numerous species of shellfish, amphibians and reptiles. It is an important breeding area and migratory route for waterfowl birds, including globally threatened and near-threatened species. High animal and plant diversity is reflective of the diverse habitats in the Mekong River Delta. However, there are indications that this diversity is at risk.

Ten key wetland sites in the Mekong River Delta are the seasonally inundated grasslands of the Ha Tien plain, Tram Chim National Park, U Minh Thuong Nature Reserve, Dat Mui Nature Reserve, Vo Doi Nature Reserve, Bai Boi, Tinh Doi, Tra Su, Lang Sen and Lung Ngoc Hoang.

The fisheries and aquaculture production in the region is substantial (Fig 37). Valuable ecosystems that include seagrass and coral reefs are plentiful off-shore of the Mekong Region. These ecosystems provide habitats for marine species such as Dugon dugong and sea turtles.

Table 34a. Mekong River Water Quality

	Class A	Class B	Out-of-range
COD (mg/l)	X		
BOD5 (mg/l)		X	
NH4-N (mg/l)	X		
DO (mg/l)	X		
Coli (MPN/100 ml)		X	
Overall		X	

Table 34b. Vam Co River Water Quality

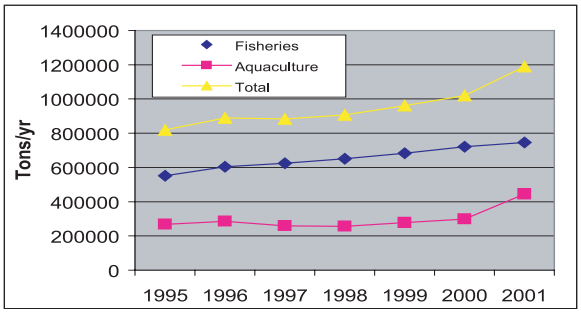
	Class A	Class B	Out-of-range
COD (mg/l)	X		
BOD5 (mg/l)	X		
NH4-N (mg/l)		X	
DO (mg/l)	X		
Coli (MPN/100 ml)		X	
Overall		X	

Table 35. Quality of Coastal Water

	Phosphate	Nitrate	COD	BOD	Oil	Coliform
1996	9.8	251	19.3	1.63	1.29	3796
1997	10	360	20.5	1.5	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 (MPN)

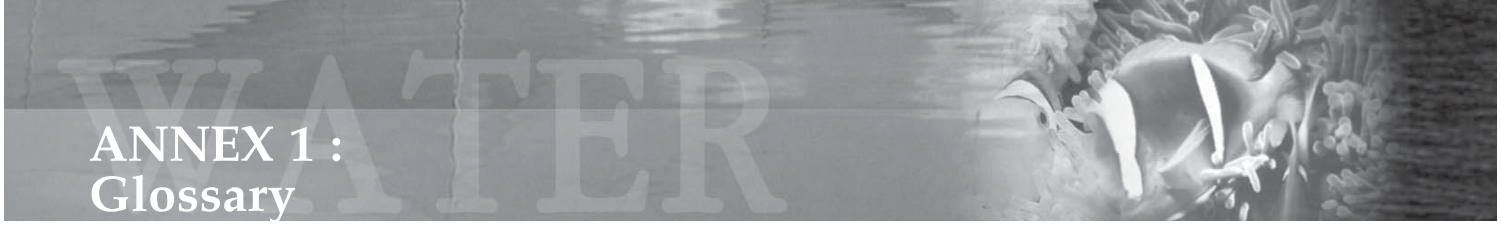
Source: *NEA (1997-2002) and HIO (1999).*

Fig 37. Fish Production in Mekong River Delta Region



Source: *GSO 1996-2002.*

ANNEXES



ANNEX 1 : Glossary

Glossary of Environmental Terms

Ambient Measurement: A measurement of the concentration of a substance or pollutant within the immediate environs of an organism; taken to relate it to the amount of possible exposure.

Aquifer: An underground geological formation, or group of formations, which are sources of groundwater.

Biochemical Oxygen Demand (BOD): The amount of oxygen consumed in the biological processes that break down organic matter in water. The greater the BOD, the greater the degree of organic pollution.

Dissolved Oxygen (DO): The oxygen freely available in water, vital to fish and other aquatic life and for the prevention of odors. DO levels are considered a most important indicator of a water body's ability to support desirable aquatic life. Secondary and advanced waste treatments are generally designed to ensure adequate DO in waste-receiving waters. Effluent: Wastewater - treated or untreated - that flows out of a treatment plant, sewer, or industrial outfall. Generally refers to wastes discharged into surface waters.

Environmental Flow: When estimating the water availability compared to water demands environmental sustainability requires that a certain level of flow be maintained. The percent of mean annual flow is assumed to roughly describe aquatic habitat conditions. For example, 10% of the mean annual flow offers 'poor' habitat conditions, 30% is 'fair' and 40% or more is 'good'.

Heavy Metals: Metallic elements with high atomic weights (e.g., mercury, chromium, cadmium, arsenic, and lead); can damage living things at low concentrations and tend to accumulate in the food chain.

Most Probable Number (MPN): An estimate of microbial density per unit volume of water sample, based on probability theory.

Organic Pollution: Carbonaceous waste contained in plant or animal matter and originating from domestic or industrial sources.

Pesticide: Substances or mixture thereof intended for preventing, destroying, repelling, or mitigating any pest. Also, any substance or mixture intended for use as a plant regulator, defoliant, or desiccant.

Point Source: A stationary location or fixed facility from which pollutants are discharged; any single identifiable source of pollution; e.g., a pipe, ditch, ship, ore pit, factory smokestack.

Pollutant: Generally, any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals, or ecosystems.

Run-Off: That part of precipitation, snowmelt, or irrigation water that runs off the land into streams or other surface-water. It can carry pollutants from the air and land into receiving waters.

Salinization/ Saline Intrusion: The invasion of fresh surface or ground water by salt water.

Sewage: The waste and wastewater produced by residential and commercial sources and discharged into sewers.

Standards: Norms that impose limits on the amount of pollutants or emissions produced.

Subsidence: Downward movement of the land surface associated with groundwater pumping, especially where such pumping exceeds safe yield and the water table has dropped.

Suspended Solids: Small particles of solid pollutants that float on the surface of, or are suspended in, sewage or other liquids. They resist removal by conventional means.

Total Coliform Bacteria (TCB): A collection of relatively harmless microorganisms that live in large numbers in the intestines of man and warm- and cold-blooded animals. A specific subgroup of this collection is the fecal coliform bacteria - whose presence in aquatic environments indicates that the water has been contaminated with the fecal material of man or other animals.

Total Suspended Solids (TSS): A measure of the suspended solids in wastewater, effluent, or water bodies, determined by tests for "total suspended non-filterable solids." (See: suspended solids.)

Water Quality Standards: The standards prescribe the use of the water body and establish the water quality criteria that must be met to protect designated uses.

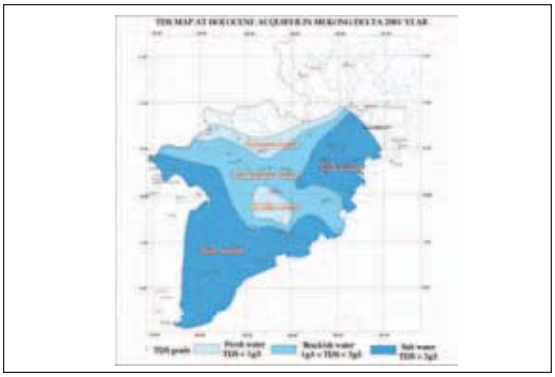
Watershed: The land area that drains into a stream; the watershed for a major river may encompass a number of smaller watersheds that ultimately combine at a common point.

Source: *This glossary is based on United States Environmental Protection AgencySs ‰Terms of the Environment‹, revised May 1998.*

Map 1. Saltwater intrusion at Holocene aquifer in Red River Delta (1998-2001)

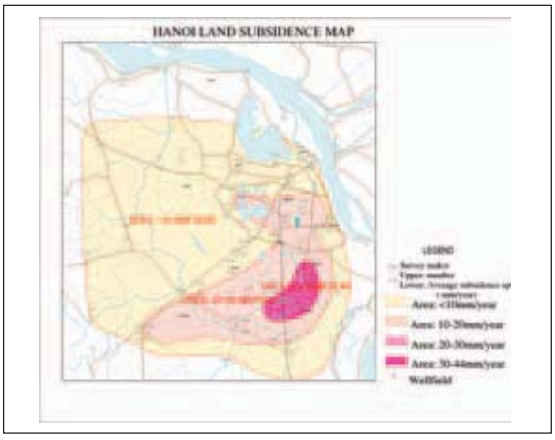
Source: *MOI, Dept. Geology and Minerals, data from Yearbook on dynamics of groundwaters.*

Map 2. Extent of Salinity intrusion in the Mekong River Delta - 2001



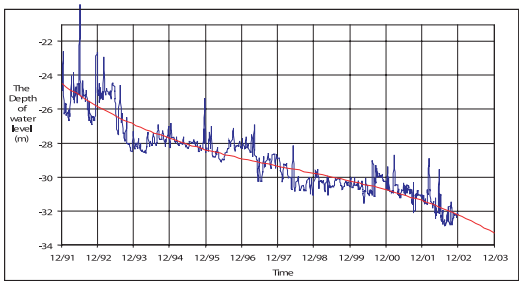
Source: *MOI, Dept. Geology and Minerals 2002, Data from Yearbooks on Dynamics of Groundwater.*

Map 3. Land subsidence in Hanoi



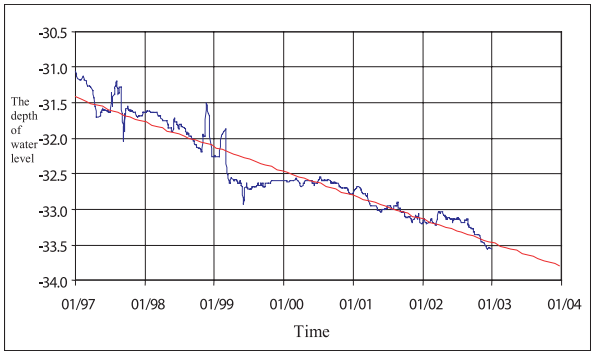
Source: *Data from The North Hydrogeological Division.*

Fig 1a. Groundwater Level Decline in Hanoi Area



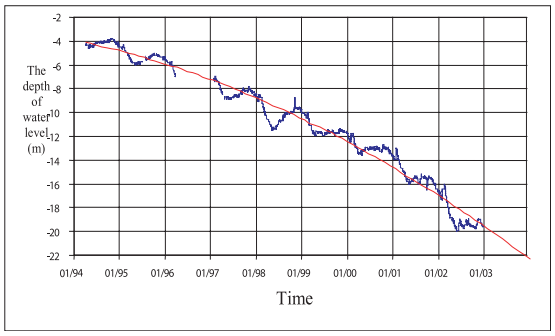
Source: *Data from National Monitoring for Dynamic Groundwater.*

Fig 1b. Groundwater level decline Buon Ma Thuot area



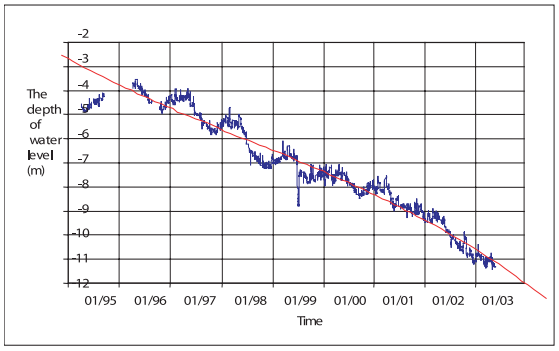
Source: *Data from National Monitoring for Dynamic Groundwater.*

Fig 1c. Groundwater Level Decline in HCM City



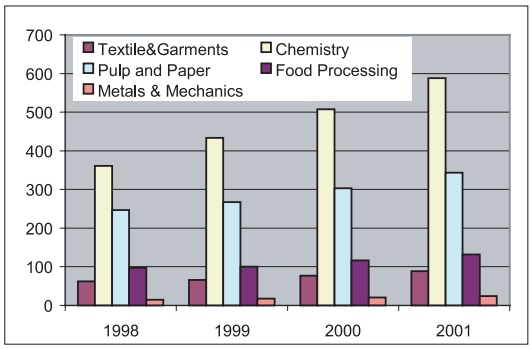
Source: *Data from National Monitoring for Dynamic Groundwater.*

Fig 1d. Groundwater level decline in Ca Mau area



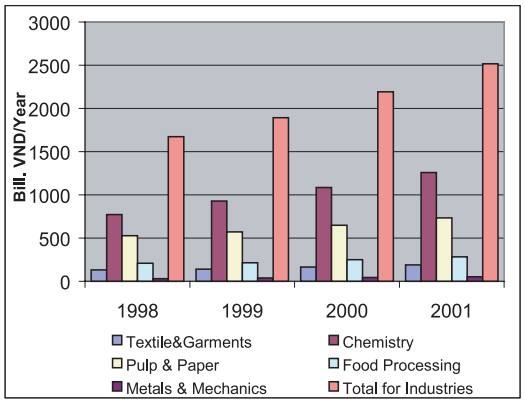
Source: *Data from National Monitoring for Dynamic Groundwater.*

Fig 2. Water Consumption by Selected Industrial Sectors



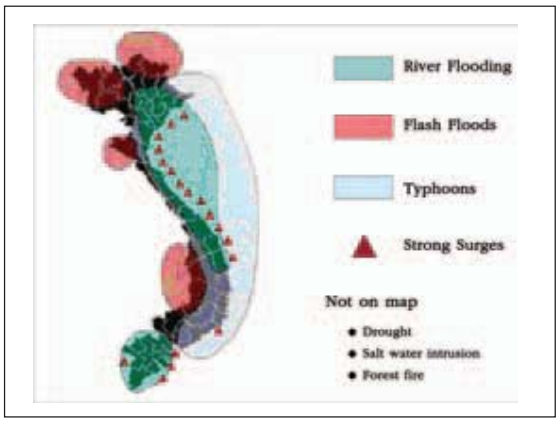
Source: *Extrapolation of water consumption figures from: "Final Report - Summary on the Master plan Study for Industrial Pollution prevention in Vietnam, 2000.*

Fig 3. Water Fees by Selected Industries



Source: *Progression of data from Survey of Industrial Pollution in, JICA 2000.*

Map 4. Natural Disasters in Vietnam



Source: *UNDP/Disaster Management Unit website http://www.undp.org.vn/dmu.*

ANNEX 2 :
Maps, Figures and Tables

Table 1. Water Quality Up- and Downstream Industries

Province	Positions	pH	COD	BOD	NO3-	NH4+
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			
	Dien Hong Pumping Station	7	4.5	2.7	0.01	0.01
Thai Nguyen	Upstream of Thai Nguyen Industrial Area	6.9	3.5	2.0	0.03	0.02
	Sluice-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
	Sluice-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
	Sluice-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).*

Table 2. Water demand per regions

Region	Livestock (% of total demand)	Irrigation (% of total demand)	Domestic use (% of total demand)	Industry (% of total demand)	Aquaculture (% of total demand)	Services (% of total demand)	Total (% of total (bil.m3/y)
Northwest	2.0	88.9	1.1	4.0	0.8	3.3	5.06
Northeast	2.5	88.7	5.6	1.3	0.5	1.4	3.95
Red River Delta	0.6	84.7	2.1	6.2	1.4	5.1	17.42
North Central Coast	3.1	89.2	2.3	2.6	0.7	2.1	10.72
South Central Coast	1.2	90.5	1.4	4.4	0.9	1.6	11.47
Central Highlands	0.8	85.4	1.7	1.0	10.4	0.7	4.81
Northeast of Mekong	1.5	37.2	4.4	41.6	0.8	14.5	7.42
Mekong River Delta	0.9	89.4	1.3	2.5	4.0	1.9	30.44

Source: *KC12 and National Water Sector Profile (2002).*

Table 3. Assessment of Disaster Severity in Regions

Region	Storm	Flood	Flash flood	Drought	Deserti fication	Saline Intrusion	Inundation	Land slide	Storm Surge	Reservoir problem
Northwest	+++	-	+++	+++	-	-	-	++	-	+++
Northeast	+++	++	+++	+++	-	-	-	++	-	+++
Red River Delta	++++	++++	-	+	-	+	+++	++	++	++
North Central Coast	++++	++++	+++	+++	++	++	++	++	++	+
South Central Coast	++++	++++	+++	++++	++	++	++	++	++	+
Central Highlands	++	++	+++	+++	+	-	-	+	++	++
Northeast of Mekong	+++	+++	+++	++	++	++	++	++	++	++
Mekong Delta	++	+++++	+	++	+	+++	+++	++	+++	+

Source: *National Water Sector Profile, Draft May 2002 (revised).*

Key Legislation on Water Resources

National Law on Environmental Protection (December 27, 1993 and Decree No 175/CP of the Government dated October 18, 1994 on guidance implementation Law on Environmental Protection;

Law of Land (July 14, 1993; amended 2001);

Law on Water Resources (May 20, 1998) and Decree 179/1999/ ND-CP of July10, 1999 on implementing the Law on Water Resources;

Law on Fishery resources (expected to be approved at the coming National Assembly Session in October 2003)

Ordinance on Development and Protection Aquatic resources (1989)

Ordinance on prevention, combat against floods and typhoons (1993) and Ordinance on Supplement and amendment ordinance on prevention, combat against floods and typhoons (2000);

Decree No 26/Cp of the Government dated April 26, 1996 on administrative fines for violation of environmental protection;

Decree No 49/ND-CP/1998 dated July 13, 1998 on issuing Regulation of fishery activities of foreigners and foreign boats in Vietnam's areas

Decree No 91/2002 dated November 11, 2002 on the Mandate, Organization and Functions of MONRE;

Decree No 43/ND-CP/2003 dated May 2, 2003 on Mandate, Organization and Functions of MOFish;

Decree No 67/2003 dated June 13, 2003 on Fees for wastewater;

Decree No 70 -CP of the Government dated June 17, 2003 on administrative fines for violation in the fishery sector;

Directive No 200/TTg of Prime Minister dated April 29, 1994 on guarantee clean water and rural environmental sanitation

Directive No 487/ TTg of the Prime Minister dated July 30, 1996 on Enhancement of State management on Water Resources;

Decision 327 CT of September 15, 1992 on Policies for the use of bare land, denuded hills, forests, alluvial flats and water bodies;

Decision No 860-TTg of Prime Minister dated December 30, 1995 on functions, responsibilities, powers and organization's machinery of Vietnam Mekong Committee;

Decision No 299/TTg of Prime Minister dated May 13, 1996 of Prime Minister on establishment the Central Guidance Board of prevention, combat against floods and typhoons;

Decision 63/1998/QD-TTg of Prime Minister dated March 18, 1998 on National Orientation on water supply development in urban areas by 2020;

Decision No 35/1999/QD-TTg dated March 5,1999 on National Orientation on drainage development in urban areas by 2020;

Decision No 155/1999/QD-TTg of Prime Minister dated July 16,1999 on issuing Regulation of hazardous waste management (including hazardous wastewater);

Decision No 67/2000/QD-TTg of Prime Minister dated June 15, 2000 on establishment National Water Resources Council;

Decision No 104/2000/QD-TTG dated August 25, 2000 on National Strategy on Clean water and environmental Sanitation in rural areas;

Decision No 99/2001/QD-TTG of Prime Minister on issuing Regulation on organization and operation of National Water resources Council;

Decision 82/2002/QD-TTg dated June 26, 2002 on Establishment, Mandate and Operations of the Vietnam Environment Protection Fund;

Decision No 45/QD-TTg dated on April 2, 2003 on establishment of provincial Department of Natural Resources and Environment.

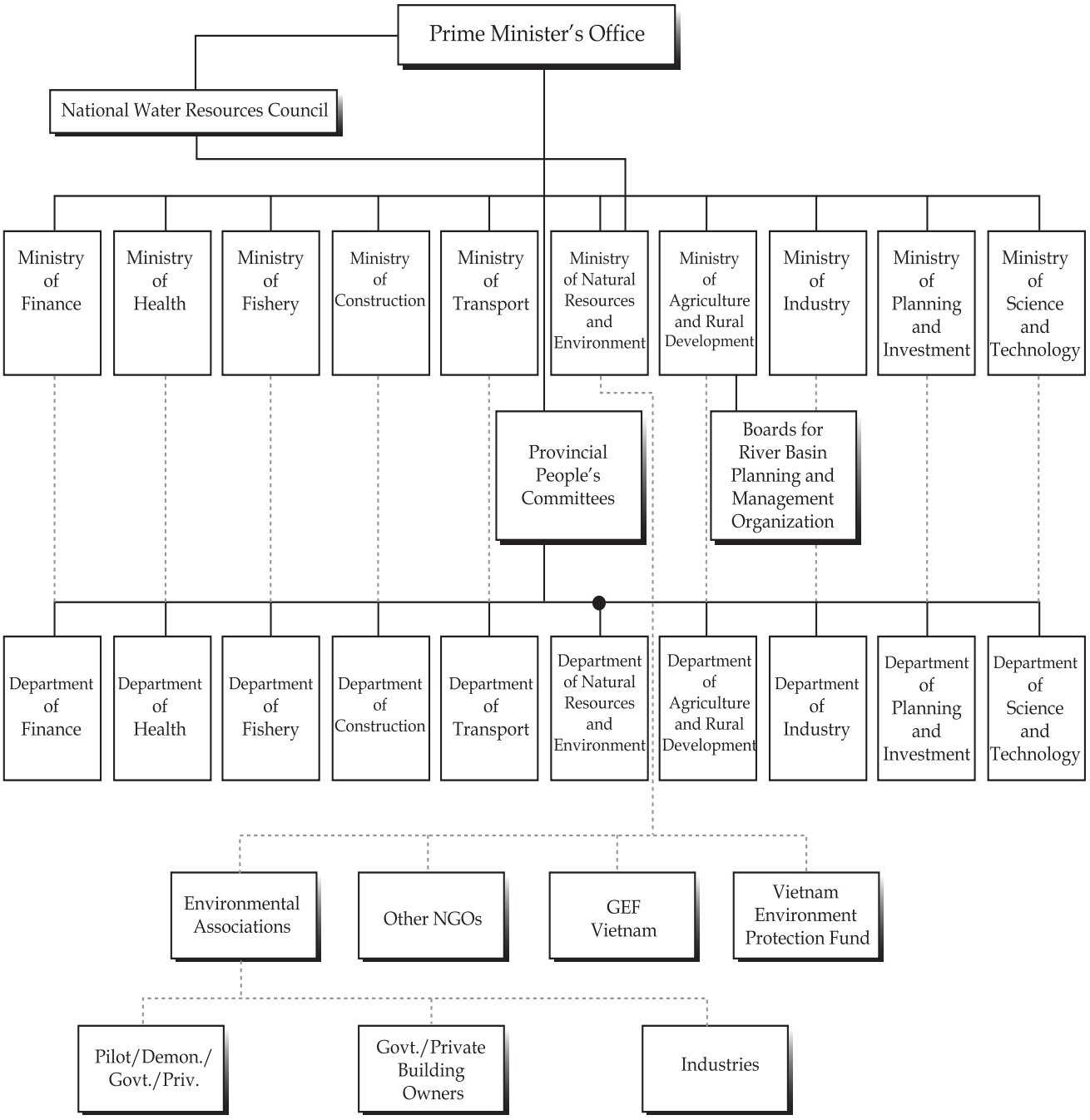
Decision No 357 of MARD dated March 13, 1997 on issuing Temporary Regulation of implementation of regimes of license and permit for searching, exploring, exploiting and drilling ground water and registration of ground water exploitation works;

Decision No 395/1998/QD-BKHCNMT of MOSTE dated April 10, 1998 on issuing Regulation of environmental protection in searching, exploring, developing, exploiting, storing, transporting and processing oil, gas and other related services.

Decision No 37, 38, 39/2001/QD/BNN-TCCB of MARD dated April 09, 2001 on establishment Boards for River basin planning and management of Mekong, Dong Nai, Thai Binh and Red Rivers;

ANNEX 4 :
Organization Chart of Water-related Institution

Organizational chart of water-related institutions



ANNEX 5 : Water Classification & Standards

Vietnam has an extensive set of Water Quality Classifications and Standards: Class A is water resource for domestic use (subject to appropriate treatment), Class B – for other users. There are separate standards for agriculture and aquaculture purposes.

Ambient standards. The standards prescribe three types of water quality standards. For a) Surface Water Quality, b) Coastal Water Quality, and c) Groundwater Quality.
The standards below are shown only for parameters used in this report

TCVN 5942 : 1995: Surface water quality Standard

Parameter	Unit	Class A	Class B
pH		6 - 8.5	5.5 - 9
COD	mg/l	<10	<35
BOD5	mg/l	<4	<25
NO3	mg/l	10	15
NH4-N	mg/l	0.05	1.0
Dissolved Oxygen	mg/l	>6	>2
SS	mg/l	20	80
Coliform	MPN/100 ml	5000	10,000

TCVN 5943: 1995: Coastal Water Quality Standard

Parameter	Unit	Beach	Aquaculture	Other places
BOD	mg/l	< 20	< 10	< 20
Oil	mg/l	Nil	Nil	0.3
Coliform	MPN/100 ml	1000	1000	1000
Standards suggested at National Conference on Coastal Environment Monitoring in 1998 within framework of a National Research Program.				
Phosphate	10 µ g /l			
Nitrate	50 µ g/l			
COD	30-40 mg/l			

TCVN 5944: 1995: Water Quality V Ground water quality standard.

Parameter	Unit	Limits
Arsenic	mg/l	0.05
Chloride	mg/l	200 - 600
Nitrate	mg/l	45
Fe	mg/l	1 - 5
Coliform	MPN/100 ml	3\

Effluent Standards: Standards are prescribed for Industrial Wastewater and for Domestic Wastewater. The standards are adapted to consider the type and use of the receiving aquatic system.

TCVN 5945: 1995: Industrial Waste Water -Discharge Standards

TCVN 6772: 2000: Water Quality - Domestic wastewater standards.

TCVN 6773: 2000: Water Quality - Water quality guidelines for irrigation

TCVN 6774: 2000: Water Quality - Freshwater quality guidelines for protection of aquatic sites

TCVN 6980: 2001: Water Quality - Standards for industrial effluents discharged into rivers used for domestic water supply.

TCVN 6981: 2001: Water Quality - Standards for industrial effluents discharged into lakes used for domestic water supply.

TCVN 6982: 2001: Water Quality - Standards for industrial effluents discharged into rivers used for water sports and recreation.

TCVN 6983: 2001: Water Quality Standards for industrial effluents discharged into lakes used for water sports and recreation.

TCVN 6984: 2001: Water Quality - Standards for industrial effluents discharged into rivers used for protection of aquatic life.

TCVN 6985: 2001: Water Quality - Standards for industrial effluents discharged into lakes used for protection of aquatic life.

TCVN 6986: 2001: Water Quality - Standards for industrial effluents discharged into coastal waters used for protection of aquatic life.

TCVN 6987: 2001: Water Quality Standards for industrial effluents discharged into coastal waters used for water sports and

ANNEX 6 :
Donor Assistance in Water Sector

List of Donor - funded projects

Donor	Project Title	Time Frame
ACIAR	Mixed Shrimp Farming: Mangrove Forestry Models in the Mekong Delta	1998-2000
ADB	HCMC Water Supply and Sanitation	1995-2003
ADB	Provincial Towns Water Supply and Sanitation	1995-2003
ADB	2nd Provincial Towns Water Supply and Sanitation	1997-2004
ADB	Forestry Sector and Watershed Management Project	1997-2003
ADB	Red River Basin Water Balance and Management	1998-2001
ADB/ AFD/ GovNED	2nd Red River Basin Water Resources Sector Project	2002-2008
ADB/AFD	3rd Provincial Towns Water Supply and Sanitation	2002-2008
ADB/GovNED	Central Region Water Sector Project	2002-2003
AusAID	Water Resources Management Assistance	2001-2004
AusAID	Model of Water/Sanitation Services for Mekong Delta	2000-2004
AusAID	North Vam Nao Flood Control Project	2001-6/2007
BMZ	Support for Wastewater and Solid Waste Management	Hard Pipeline
BMZ	Waste Water Disposal, South	Hard Pipeline
BMZ/KfW/GTZ	Provincial Cities Sanitation Programme North (Bac Ninh, Hai Duong)	2003-2007
BMZ/KfW/GTZ	Provincial Cities Sanitation Programme South (Can Tho, Soc Trang)	2003-2007
BMZ/KfW/GTZ	Provincial Cities Sanitation Programme Central (Nghe An, Ha Tinh)	2003-2007
Danida	Water Resources Management Assistance	2001-12/2005
Danida	Forest Protection and Watershed Management in Nghe An Province	2002-5/2005
Danida	Support to the Marine Protected Area Network in Vietnam: Cu Lao Cham, Quang Nam Province	2003-8/2006
DGDC	Elimination of Metals in Wastewater	2002-2006
DGDC	Drinkable Water Contamination by Arsenic in Hanoi	2002-2003
DGDC	Protection of Coastal Environment Binh Thuan	2001-2003
DGDC	Social Forestry: Mangrove in Can Gio District, HCMC	1995-2002
DGDC	Participatory Watershed Management in the Hoanh Bo District (Quang Ninh Province). Phase II Project	2000-2003
DGDC	Sanitation and Urban Upgrading of the Tan Hoa - Lo Gom Canals in HCMC - Feasibility Study	2001-2002
DGDC	Sanitation and Urban Upgrading of the Tan Hoa - Lo Gom Canals in HCMC - Extension and Aerated lagoon	2002-2004
EC	Environmental Management of Refuse & the Waste Disposal/Drainage System in District 5-HCMC	2001-2003
EC	Public Health, Hygiene & Environmental Problems in Urban & Peri-urban Areas	2001-2003
EC	Sustainable Socio-economic Urban & Rural Development for Hanoi: Renewal of the Water and Waste Water System for the West Lake Network	2001-2002
EC	Sustainable Community-based Extension Models - solidifying and replicating the gains of ongoing EC and AFAP projects through capacity building in the Upper Na Ri River Watershed.	Hard Pipeline
EC	Environmental Sustainability of Brackishwater Aquaculture in the Mekong Delta	2000-2003
EC/MAE/GRET	Red River Programme - DIALOGS	2000-2004

ANNEX 6 : Donor Assistance in Water Sector

Donor	Project Title	Time Frame
GovNED	Conservation of Key Wetlands Sites in the Mekong Delta	1998-1999
GovNED	Vietnam Integrated Coastal Zone Management - Bridging Phase	2003-2004
GovNED	Upgrading of the Training Capacity in Coastal Engineering at HWRU	2000-2004
GovNED	Vietnam Integrated Coastal Zone Management	2000-2003
GovNED	Rehabilitation of Mangrove Forests Mekong Delta	1996-2000
GovNED	Wetlands Conservation Programme - Implementation	2004-2006 (HP)
GovNED	Integrated Water Resources Management: A Technical Assistance Cluster	2001-2004
GovNED	Mekong River Commission - Flood Management Programme	2003-2009
IAEA	Ground Water and Nutrient Management	1999-2002
IAEA	Isotope and Nuclear Techniques for Better Management of Groundwater	2001-2002
IUCN	Huong River Basin Integrated Management	2004-2008
JBIC	Hanoi Drainage Project for Environment Improvement	1995-2005
JBIC	HCMC Water Environment Improvement Project	2001-2008
JBIC	Ta Trach Reservoir Project	5 years
JEC	Red River Delta Environmental Cleanup and Insecticide Elimination	2003-6/2004
NORAD	Vietnam Fisheries Law – Phase 1	1999-2001
NORAD	Vietnam Fisheries Law – Phase 2	2004-2009
NORAD	Rural Development in the Coastal Area of Trieu Phong District, Quang Tri Province – Phase 1 Quang Tri Province – Phase 1	2000-2004
NORAD/Sida	National Hydropower Masterplan Study – Stage 2	2003-2005
NORAD/Sida	National Hydropower Masterplan Study – Stage 1	1998-2001
SDC	Shrimp Hatcheries Improvement Programme in Veit Nam	2003-2006(HP)
UNDP (GEF)/ Danida	Sustainable Use of Coastal and Marine Resource in the Con Dao Islands Region	2003-2006
USAID	Certification & Training Support for Vietnam Water and Sewerage Associations	2003-2006
USAID	Marine Conservation Initiatives for Con Dao NP	2000-2002
USAID	Building Capacity for Integrated Coastal Management in Tonkin Gulf	2002-2004
USAID	The East Asia-Pacific Coral Reef Conservation Initiative Phase I	2002-2003
USAID	East Asia-Pacific Coral Reef Conservation Initiative Phase II	2003-2004
WB	Assistance to Water Resource Management (WB3-TA)	2001-2/2004
WB	HCMC Environmental Sanitation Project (Nhieu Loc - Thi Nghe Basin)	3/2001-12/2007
WB (GEF)	Integrating Watershed Management and Biodiversity at Chu Yang Sin NP	2003-2007
WB (GEF)/ Danida	Hon Mun Marine Protected Area Pilot Project	6/2001-6/2005
WB (GEF)/ others	Mekong River Basin Wetland Biodiversity Conservation and Sustainable Use Programme	2002-12/2006
WB/Danida	Coastal Wetlands Protection and Development Project	2/2000-2006
WB/MFAF/Danida /AusAID	3 Cities Sanitation Project	2000-2005
WWF Netherlands	Marine and Coastal Conservation	1997-2002
ZSCSP	Conservation in Cat ba National Park Porject	2000-11/2004

Source: *VEPA/UNDP 2003*

ANNEX 7 :
Stakeholder workshop on 12 June 2003

List of participating agencies

Government agencies

Ministry of Natural Resources and Environment: Department of Environment, Department of Science and Technology, Vietnam Environment Protection Agency, Institute of Meteorology and Environment, Agency of Geology and Mineral Resources, Agency of Water Resources Management, National Council of Water Resources, National Steering Committee for Safe Water Supply and Environmental Sanitation.
Ministry of Agriculture and Rural Development: Agency of Flood Protection and Dyke Management, Department of Forest Protection.
Ministry of Fisheries: Department of Science and Technology, Agency of Fisheries Protection.
Office of the National Assembly: Department of Science, Technology and Environment.
General Statistics Office: Department of Social and Environmental Affairs

Academia

Institute of Water Resources Planning.
Institute of Water Resources: Centre of Water Resources and Environment.
Polytechnic University: Institute of Science, Technology and Environment.
Institute of Geology: Centre of Remote Sensing and Geomatics.
Institute of Economics and Fisheries Planning.
National Centre of Natural Science and Technology: Institute of Ecology and Biological Resources.
Research Centre of Ecology and Environment.
Institute of Agricultural Planning and Design.
Institute of Mechanics: Centre of Marine Environment Survey, Research and Consultation.
National Committee of Clean Water and Environmental Sanitation: Consultation Centre of Training and Technology Transfer.
University of Civil Engineering: Center for Environment Engineering of Towns and Industrial Areas.
Research Centre of Resources and Environment.
National University of Natural Resources.
Institute of Fisheries Research and Aquaculture.
University of Water Resources.
North Corporation of Hydrogeology and Engineering Geology.

NGOs, international organizations and others

Centre for Resources Development and Vietnam Association of Nature and Environment Protection.

Association of Water Resources.
Institute of Environment and Sustainable Development.
United Nations Development Program in Vietnam.
Danish International Development Agency.
Research Institute of Environment Issues, Germany.
Japan Bank for International Cooperation (JBIC).
World Wildlife Fund for Nature (WWF) Vietnam.
Japan International Cooperation Agency.
The World Conservation Union (IUCN) Vietnam.
Vietnam - Netherlands Integrated Coastal Zone Management Project.

ANNEX 7 : Stakeholder workshop on 12 June 2003

List of specialists giving comments on VEM report 2003

No	Name	Organisation
1.	Prof. Le Quy An	President, Vietnam Association of Nature and Environment Protection
2.	Dr. Dang Kim Chi	Deputy Director, Institute of Environmental Science and Technology, Hanoi University of Technology
3.	Nguyen Van Chiem	Department of Science and Technology, MoFish
4.	Dang Thi Dap	Institute of Biological Resources and Ecology
5.	Mr. Le Hong Hanh	Vice Rector, Hanoi University of Laws
6.	Dr. Hoang Minh Hien	Dyke Management and Flood Control Department, MARD
7.	Dr. Le Van Hoc	Institute of Water Resource Planning.
8.	Dr. Phan Nguyen Hong	Mangrove Research Division, CRES
9.	Mr. Le Minh Hong	Department of Science, Technology and Environment, Office of the National Assembly.
10.	Mrs. Pham Thi Hong	DANIDA Water Sector Program Support
11.	Mrs. Vu Thanh Huong	Institute of Water Resources
12.	Mrs. Phan Thu Huong	Department of Science, Education and Environment, MPI
13.	Le Van Hung	WWF Indochina Programme
14.	Dr. Nguyen Dac Hy	Director, Centre for Ecology and Environment Research
15.	Mr. Vu Duc Khanh	General Statistics Office
16.	Dr. Nguyen Thai Lai	Deputy Director, Water Resources Management Agency, MoNRE.
17.	Dr. Nguyen Viet Nam	Department of Science and Technology, MoFish
18.	Dr. Tran Hieu Nhue	Hanoi Civil University
19.	Dr. Nguyen Xuan Nguyen	National Council of Water Resources, Centre of Consultancy Training and Technology Transfer.
20.	Dr. Pham Van Ninh	Director, Centre of Marine Environment Survey, Research and Consultation, Institute of Mechanics
21.	Mrs. Do Hong Phan	Center of Resources Development and Environment
22.	Mr. Lam Hung Son	Institute of Water Resources Planning
23.	Dr. Nguyen Trong Sinh	Water Resources Association
24.	Mr. Do Trong Su	Department of Science and Technology, MoNRE
25.	Mr. Vu Trung Tang	Hanoi National University
26.	Dr. Trinh Thi Thanh	Hanoi National University
27.	Mr. Tong Ngoc Thanh	Director, Northern Geological and Hydraulic Division
28.	Dr. Tran Thuc	Director, Institute of Meteorology, MoNRE
29.	Dr. Nguyen Van Thang	Hanoi Water Resources University
30.	Dr. Truong Manh Tien	Director, Department of Environment, MoNRE
31.	Dr. Le Trung Tuan	VNWP
32.	Hans Pos	VNICZM Project

Government Review Committee (August 10, 2003)		
1.	Prof. Le Quy An	President, Vietnam Association of Nature and Environment Protection.
2.	Prof. Tran Hieu Nhue	Center for Environment Engineering of Towns and Industrial Areas.
3.	Dr. Nguyen Hong Thao	Government Borders Committee.
4.	Dr. Tran Duc Hai	Director, Department of International Cooperation, MONRE.
5.	Dr. Le Bac Huynh	Water Resources Management Agency, MONRE.
6.	Dr. Truong Manh Tien	Director, Department of Environment, MoNRE
7.	Mr. Le Minh Tam	Measurement and Cartography Agency
8.	Mr. Le Thanh Khuyen	Legislation Department, MONRE.
9.	Eng. Duong Thi To	Vietnam Environment Protection Agency, MONRE.

VIETNAM AT A GLANCE

Economy/ Society	Geography
GDP: $32.9 billion (2002) **GDP** growth rate: 6.0 percent (2002) **GDP-composition by sector (2002):** *Agriculture: 23.0 percent* *Industry: 38.5 percent* *Services: 38.5 percent* **Consumer price index:** 4.0 percent (CPI of December 2002 compared with December 2001) **Unemployment rate of labour force of working age in urban area:** 6.01 percent (2002) **Gross Domestic Investment/GDP:** 27.3 (2002) **Industrial sector production growth rate:** 9.44 percent (2002 at 1994 price) **Agricultural sector production growth rate:** 4.06 percent (2002 at 1994 price) **Agriculture-products:** rice, rubber, corn, sugarcane, coconuts, soybeans. **Exports:** *total value:* $15.027 billion (fob, 2001) **Imports:** *total value:* $14.401 billion (fob, 2001)	**Area:** *land: 331,114 km2* **Land boundaries:** *total:* 4,510 km *border countries:* China 1,306 km; Cambodia 1,137 km; Laos 2,067 km **Coastline:** 3,260 km **Maritime claims:** *Continental shelf:* 200 nm or edge of continental shelf exclusive economic zone: 200 nm *territorial sea:* 12 nm **Climate:** Tropical in south; monsoonal in north with hot, rainy season (mid-May to mid-September) and warm dry season (mid-October to mid-March) **Terrain:** Mekong River Delta in the south (area approx. 59,000 km2) and the Red River Delta in the north (area approx. 17,000 km2); mountains in the central and west. **Elevation extremes:** *lowest point:* 0 m at the sea level *highest point:* Phan xi pang 3,000 m **Mineral resources:** Oil, natural gas, coal, iron, zinc, bauxite. **Land use (2000):** Agricultural land: 28.4% Forestry land: 35.2% Special use land: 4.7% Scrub and grass land: 23% **Environment-international agreements:** *party to:* Biodiversity, Climate Change, CITES, RAMSAR, Basel, Ozone Layer Protection, MARPOL, Law of the Sea. *signed, but not ratified:* Desertification, POPs conventions, Kyoto Protocol
Population, mid-year: 79.7 million (2002) **Population growth rate:** 1.4 percent (1996-02) **Poverty (% below poverty line):** 32 (1996-02) **Urban population (% of total population):** 25 (1996-02) **Crude birth rate:** 19.0 births / 1,000 population (2002) **Death rate:** 5.8 / 1,000 population (2002) **Infant mortality:** 26 deaths / 1,000 live births (1996-02) **Child malnutrition (% of children under 5):** 34 **Access to safe water (% of population):** 56 (2002) **Access to sanitary latrines (% of population):** 44 (2000) **Life expectancy at birth:** 69 years (2002) **Literacy (% of population of age 15 +) :** 94 **National capital:** Hanoi **Administrative divisions:** 61 provinces **Independence:** 1945	

Sources: *General Department of Statistic 2002, Government of Vietnam; World Development Indicators 2001, World Bank.*

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