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Vietnam

ENVIRONMENT

Monitor 2006

WATER QUALITY IN VIET NAM
with a focus on the Cau, Nhue-Day and Dong Nai River Basins

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The Ministry of Environment and Natural Resources (MoNRE), the World Bank, and DANIDA contributed to the preparation of this report, the fift in the Vietnam Environment Monitor series. A team of consultants consolidated much of the data up to 2005 from a variety of sources, including published reports of government agencies, universities, nongovernmental organizations, individuals, and documents of the World Bank and international partners.

The World Bank task team consisted of Messrs./Mmes. Tran Thi Thanh Phuong (Team Leader), John Morton, and Phil Brylski. MONRE was represented by VEPA staff Messrs./Mmes. Tran Hong Ha, Phung Van Vui, Hoang Duong Tung, Nguyen Van Thuy, Le Hoang Anh, Nguyen Thi Nguyet Anh, Pham Quang Hieu, Nguyen Thi Khanh Binh, Luong Hoang Tung, Mac Thi Minh Tra. Consultants who assisted the task team included Des Cleary, Jorgen Carle, Lenart Emborg. National consultants were Nguyen Chi Cong, Nguyen Van Cu, Pham Ngoc Dang, Tran Duc Ha, Nguyen Thao Huong, Nguyen Thanh Hung, Tran Hieu Nhue, Nguyen Ngoc Sinh, Phung Chi Sy, Trinh Thi Thanh, Lam Minh Triet, Ngo Dinh Tuan. The document was peer-reviewed by Messrs. Rafik Hirji and William Kingdom. Other comments were received from Yoshiharu Kobayashi, Tony Whitten, and Keiko Sato. Ms. Le Thanh Huong Giang provided logistic support.

Comments on the report were received from the ministries of Industry, Agriculture and Rural Development, Health, Construction, Finance, Planning and Investment, General Statistics Office, Departments or Natural Resources and Environment of the provinces within the three river basins, and many researchers.

Special appreciation and thanks are due for the support and encouragement given by Mr. Mai Ai Truc, Minister, and Mr. Pham Khoi Nguyen, Vice Minister of MoNRE; Mr. Klaus Rohland, Country Director of the World Bank in Vietnam; Ms. Teresa Serra, Sector Director of the Environment and Social Development Sector Unit of the World Bank East Asia and Pacific Region; and Mr. Peter Lysholt Hansen, Ambassador Extraordinary and Plenipotentiary of DANIDA to Vietnam.

FOREWORD

Vietnam has a dense river system with many large river basins. Over recent years, rapid socio-economic development has strongly and adversely affected the environment of river basins. Today the quality of the water is being increasing polluted as a result of economic development, many river reaches to severe levels. Environmental concerns and economic development are not aligned towards sustainable growth.

Under the *Law on Environmental Protection*, the Ministry of Natural Resources and Environment is required to prepare annual thematic reports on the state of the environment. In 2006, the Ministry compiled the thematic report *Water Quality of Three River Basins – the Cau, Nhue-Day and Dong Nai River Systems*.

These three river basins are recognised as containing the most severely polluted rivers and lakes throughout the country. All are within focal economic regions and all three are also amongst the most densely populated areas. The Northern Economic Region, encompassing a part of the Cau and Nhue-Day river sub-basins, and the Southern Economic Region, located in the Dong Nai river basin, are two regions with the most intense and rapid economic development and play a critical role in the development of the country.

The Vietnam Environmental Monitors (VEM) are annual reports on the trends, challenges and priorities that the country faces in environmental management. This year's report is the fifth in the series and builds on the state of the environment report prepared by the Ministry of Natural Resources and Environment. As in previous issues, which focused on environmental conditions generally (2002), water (2003), solid waste (2004), and biodiversity (2005), this VEN provides a frank assessment of water quality status and trends, highlights key issues, and identifies experiences and lessons which can guide decision makers in setting priorities for future action to improve the management of Vietnam's river basins.

In order to provide adequate information on the current state of water quality in Vietnam, the VEM provides a focus on the water environment of the three river basins. In doing this the VEM reports on three main issues:

- The current state of the surface water of each of the three river basins, their pollution levels and pollution features;
- Identification of the main sources of pollutants, which are mostly attributed to wastewater from industrial production activities, human living activities and craft villages; and
- The current management of water quality in river basins and proposed priority solutions.

While the water quality of other river basins might not be at the same level of concern overall as in these three focus basins, localised areas across Vietnam are experiencing serious pollution. The finding of this VEM should assist in understanding and dealing with these pollution problems.

Contributing to this Monitor, are scientists from research institutes, universities, environmental management officers, international experts, and staff of the World Bank. The report also benefited from the interest and comments by agencies of the line ministries, sectors, and the local authorities in the three river basins. During the preparation of the report, a number of workshops were held to get comments on the concept note, outline, and draft reports. Data and information used in the report were updated as of the end of December 2005, and data for some emerging issues were updated up to September 2006.

The Monitor has been prepared as collective effort of the Ministry of Natural Resources and Environment, the World Bank, and the Danish International Development Agency (DANIDA) – targeted to the wider readers who care about the problems of environmental protection for sustainable development.

Hopefully, this Monitor will be used to help the decision-making on water quality management and environmental protection across Vietnam, but particularly in the focus three river basins, and also be used as a reference document in the development of economic development plans and planning of related provinces. The Report should also be used to encourage the approach of integrated management of river basins for all other localities in Vietnam.

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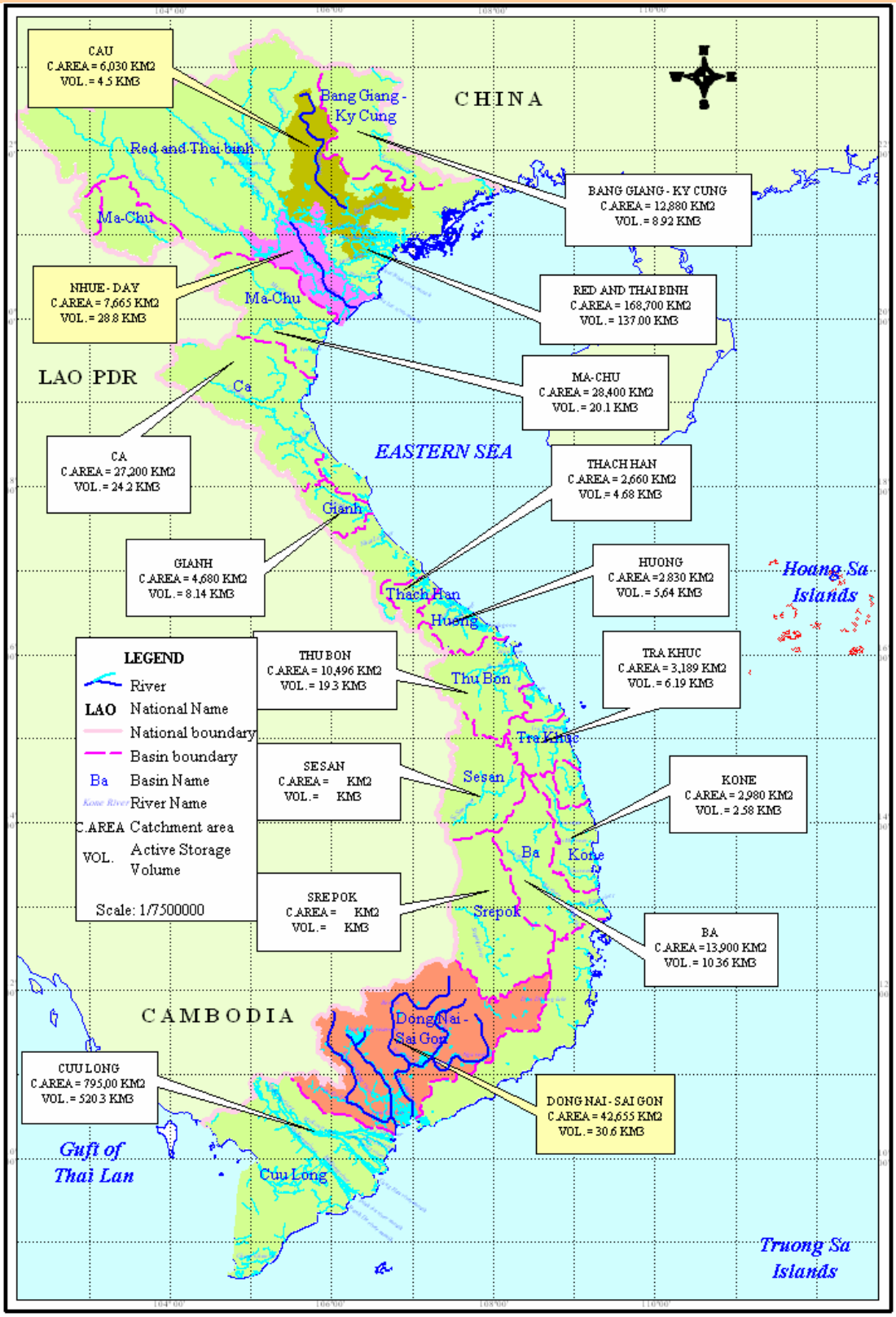
ABBREVIATIONS AND ACRONYMS

ADB	Asian Development Bank
DOE	Department of Environment
Danida	Danish International Development Agency
DoNRE	Department of Natural Resources and Environment
DWT	Deadweight of boat
EFR	Economic Focal Region
EPZ	Export Processing Zone
EIA	Environment Impact Assessment
GDP	Gross Domestic Product
GoV	Government of Vietnam
GSO	General Statistical Office
HCMC	Ho Chi Minh City
IWRM	Integrated Water Resource Management
IRBM	Integrated River Basin Management
JICA	Japanese International Cooperation Agency
LEP	Law on Environment Protection
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
MPI	Ministry of Planning and Investment
MRC	Mekong River Commission
NEA	National Environment Agency
NPK	Nitrogen, Phosphorus and Potassium
NWRC	National Water Resource Council
RAMSAR	The Convention on Wetlands, signed in Ramsar, Iran, in 1971
SEDP	Socio Economic Development Plan 2006-2010
SOE	State of Environment
SOEs	State-Owned Enterprises
TCVN	Surface Water Quality Standard TCVN 5942-1995

TCVN(A)	Standard for surface water used for domestic water supply
TCVN(B)	Standard for surface water used for other purposes
UNDP	United Nations Development Programme
UNESCO	United Nations Education, Scientific and Cultural Organisation
VEPA	Vietnam Environment Protection Agency
VND	Vietnamese Dong
WB	World Bank

OVERVIEW OF RIVER BASINS IN VIETNAM



MAJOR POLLUTANTS AND THEIR EFFECTS

Indicator	TCVN 5937:1995 Limit (B)	Comparable limit in developed country	Pollution effect
pH	5.5 to 9	6.5 – 9 for freshwater	The pH of a water source is important in maintaining a proper ecological balance. The pH directly affects the physiological functions and nutrient use by plant and animal life. Extremes in pH can kill all life in a water source.
Temperature	From 2^{o} to 4^{o}C of the receiving water	Varies per location	Wastewater temperature is important as biological processes are temperature dependent, and chemical reactions and reaction rates and aquatic life are all temperature sensitive.
Suspended Solids (SS)	≤ 100 mg/l	Can be as low as 10 mg/l	Turbidity adds costs to the treatment of surface water supplies used for drinking water. Particulates also provide attachment sites for heavy metals such as cadmium, mercury and lead, and many toxic organic contaminants and many pesticides. High concentrations of particulate matter can modify light penetration, cause shallow lakes and bays to fill in faster, and smother benthic habitats.
Dissolved Oxygen (DO)	> 0.2 mg/l	Varies but can be as high as 7.5mg/l	Oxygen is essential for the survival of nearly every living thing — even those living in water. Fish growth and activity usually require 5-6 mg/l of dissolved oxygen. Dissolved oxygen levels below 3 mg/l are stressful to most aquatic organisms. Levels below 2 mg/l will not support fish at all.
Biological Oxygen Demand BOD_5	≤ 25 mg/l	Varies but can be as low as 3mg/l	BOD and COD determine the amount of organic pollutants found in surface water. Waters low in dissolved oxygen can lead to increased release of phosphorus from sediments that can fuel algal blooms when mixed into the upper euphotic (sunlit) zone. It also leads to a build-up of chemically reduced compounds such as ammonium and hydrogen sulphide which can be toxic to bottom dwelling organisms. In extreme cases, sudden mixing of H_2S into the upper water column can cause fish kills.
Chemical Oxygen Demand COD	≤ 35 mg/l	varies but can be as low as 5mg/l	
Total nitrogen			Large inputs of nitrogen and phosphorous to water bodies can lead to eutrophication causing ecological changes that result in loss of plant and animal species, and affect the use of water for human consumption and other purposes. The nitrate level in drinking water is extremely important for infants. Nitrates in infants are converted to nitrites that oxidize blood cells so that they can no longer carry oxygen, which can result in brain damage or suffocation. Water with nitrite levels exceeding 1.0 mg/l should not be used for feeding babies. Studies also show a correlation between high nitrate levels and gastric and stomach cancers.
Total phosphorus			

Amonia (NH_3)	0.05	0.025	Ammonium is toxic to aquatic life at certain concentrations It is toxic to freshwater organisms in concentrations in the range 0.53 to 22.8 mg/L. Toxic levels are both pH and temperature dependent. Toxicity increases with decreasing pH (as the water becomes more acidic and less basic) and as the water temperature decreases. It also exerts a demand on oxygen in water as it is transformed to oxidised forms of nitrogen.
Oil (lipid)	≤ 3 mg/l	Can be as low as 0 mg/l	All types of freshwater organisms are susceptible to the effects of excessive oil in water, including mammals, aquatic birds, fish, insects, micro-organisms, and vegetation. In addition, the effects of oil on freshwater micro-organisms, invertebrates, and algae tend to move up the food chain and affect other species.
Coliform	≤ 10,000 mg/l	Primary contact waters: faecal coliform counts below 200 mg/l. Secondary contact waters: faecal coliform counts below 2,000 mg/l	The presence of faecal coliform bacteria indicates that the water has been contaminated with the faecal material of humans or other animals. At the time this occurred, the source water may be contaminated by pathogens or disease producing bacteria or viruses which can also exist in faecal material. Some waterborne pathogenic diseases include typhoid fever, viral and bacterial gastroenteritis and hepatitis A. The presence of contamination is an indicator that a potential health risk exists for individuals exposed to this water.
Metals **Lead (Pb)** **Mercury (Hg)** **Arsenic (As)** **Cadnium (Cd)**	 0.05 mg/l 0.001 mg/l 0.05 mg/l 0.01 mg/l	 0.01 mg/l 0.0005 mg/l 0.01 mg/l 0.01 mg/l	The heavy metals linked most often to human poisoning are lead, mercury, arsenic and cadmium. Other heavy metals, including copper, zinc, and chromium, are actually required by the body in small amounts, but can also be toxic in larger doses. Severe effects include reduced growth and development, cancer, organ damage, nervous system damage, and in extreme cases, death. Exposure to some metals, such as mercury and lead, may also cause development of autoimmunity, in which a person's immune system attacks its own cells. This can lead to joint diseases such as rheumatoid arthritis, and diseases of the kidneys, circulatory system, and nervous system. The young are more prone to the toxic effects of heavy metals, as the rapidly developing body systems are far more sensitive. Childhood exposure to some metals can result in learning difficulties, memory impairment, damage to the nervous system, and behavioural problems such as aggression and hyperactivity. At higher doses, heavy metals can cause irreversible brain damage.
Others: **Pesticides**			LD_{50} is an expression of the toxic level of pesticide. The smaller the LD_{50} value, the more toxic the pesticide. The LD_{50} is the dose of a pesticide that will kill half of a group of test animals from a single exposure. The larger an animal, the greater the lethal dose required to kill it. The LD_{50} is expressed in milligrams per kilogram of body weight of the test animal. A pesticide with a lower LD_{50} is more toxic than a pesticide with a higher number because it takes less of the pesticide to kill half of the test animals.

SUMMARY

Background

Water resources are a primary input for a huge array of human needs and economic activities. These include domestic and industrial water use, irrigation, agriculture, recreation, bathing and transport. Water resources also help sustain the integrity of the ecosystems and natural processes that serve important ecological and hydrological functions upon which communities and globally important biodiversity depend.

The 2003 Vietnam Environment Monitor (VEM) and the 2005 State of the Environment Report identified the degradation of Vietnam's water resources as a result of declining water quality as a growing problem in urban and economic development areas, where households and industrial enterprises are using rivers, lakes, wetlands and canals as waste sinks. This is especially acute in the population and economic centres of the North and South.

The Government of Vietnam (GoV) has recognised water pollution as a development priority. Through its Five-year Socio-economic Development Plan (SEDP) (2006-2010) the GoV has identified the preservation and improvement of the ecological environment as a key task and has set specific targets for pollution control. The Natural Resources and Environment Sector Strategy further describes actions to be undertaken to meet these targets including measures to improve the environmental quality of river basins. As part of this strategy and in response to growing public pressure, the Ministry of Natural Resources and Environment (MoNRE) has identified three river basins as priorities for water pollution control in the country. In support of this GoV priority, the draft 2006 World Bank Country Assistance Strategy identifies "*Managing Natural Resources and the Environment*" as one of its key pillars. The draft strategy highlights the impact of Vietnam's rapid growth on pollution and environmental degradation and identifies the need to improve the management of water resources and to reduce environmental degradation through better waste management.

The purpose of the VEM series is to raise public awareness and provide concise information and analysis on the current state of knowledge of environmental issues in Vietnam for use by decision-makers. The specific objectives of this VEM are to:

- Highlight the importance of water quality in river basins to ecology, economy, livelihoods, food supply, and health in Vietnam;
- Assess the status of water quality and resulting impacts within three focus river basins - the Cau, Nhue – Day, and Sai Gon – Dong Nai;
- Assess the current and future pressures on water quality in these basins; and,
- Identify the challenges for improving water quality, particularly for these river basins, and how this can apply to river basins nationally.

Characteristics of the focus river basins

The Dong Nai River basin is a large river catchment area located in southern Vietnam. About 15% of the basin area lies outside of the country. The Cau River and the Nhue-Day River are sub-basins of the much larger Red River basin in northern Vietnam - comprising 8% and 10% of the basin respectively.

The three basins are critically important to the national and regional economies and are located in key economic development zones. All three are experiencing rapid and sustained population growth and corresponding urbanisation processes, coupled with rapid and concentrated industrial development. This includes both large scale developments in industrial and export processing zones and smaller but intense developments in craft villages. They have rates of population densities and growth well above the national average.

Undoubtedly the key factor that will affect pollution of the three river basins is the current and planned level of socio-economic development. The overall planning targets for Vietnam are set out in the Socio Economic Development Plan 2006-2010 (SEDP) and they concern the drive to consolidate the industrialisation of the country as a means of increasing GDP per capita and reducing poverty.

With respect to the Cau River and the Nhue-Day River sub-basins, the Northern Economic Focal Region (EFR) aims to achieve an average annual economic growth rate of 11%. Within the industrial sector, priority is given to knowledge intensive products (such as software), products of electric and electronic engineering, equipment and machinery, steel and ship building, coal, cement, high quality construction materials, food processing, textile and garment, and leather industries. The rate of urbanisation is expected to increase from the existing 31% to 52% in 2010, and 65% in 2020.

With respect to the Dong Nai River basin, The Southern EFR is the industrial powerhouse of the country with more than 8,500 firms employing 1.5 million people. The EFR aims to achieve an average annual GDP growth rate of 14%, and to increase the share of the 'industry and construction' sector to 53%. Priority is given to the development of high value added and knowledge–based products (such as software, industrial and civil electronics), oil, gas and petrochemical products. The leather tanning and dressing, wearing apparel, and food and beverage sectors represent 56% of all industrial employment in the Southern EFR. These last two sectors include more than 2,200 enterprises, or 26% of all firms in the region.

In the face of such sustained economic expansion, water availability – river flows per person – is low in the three basins compared to national average and international standards. All three basins are below the level of having "inadequate water" and the Cau River is currently below the much lower "water stress" level. By 2025 the Dong Nai River will also be below this level. This accentuates water shortages and conflicts over access to water over the long dry periods, and exacerbates the effects of poor water quality. Water quality in all three river systems is greatly influenced by river flows and their management.

Agricultural development remains a strong sector for all three basins both now and into the future, even though it is declining in relative economic importance.

The natural resource and environmental values of the three basins in the mid and lower reaches are under increasing threat. Conservation areas are few and not isolated from the effects of development. Throughout the basins, forest cover is declining in area and quality, reducing water retention for the dry periods and the ability to mitigate floods.

Pollution levels

In this Monitor, Surface Water Quality Standard TCVN 5942-1995 (TCVN) is used to evaluate water quality in the three rivers basins – see Appendix A.

Pollution levels of rivers in the lower reaches of the Dong Nai River Basin are the worst in the country. The Thi Vai River is the most polluted in the basin with a "dead" section of 10 km, and drainage canals in inner Ho Chi Minh City suffer similar levels of pollution - extremely low DO levels, and high levels of $N\text{-}NH_4$, mercury and zinc. While these are the worst examples, there are many other pollution "hot spots" in the basin.

The Nhue-Day River sub-basin is also severely polluted in places. The Nhue River is the worst and is seriously polluted in its upper reaches as it receives most of the urban drainage and domestic wastewater from Hanoi. . Even in the flood season, BOD_5, DO, NH_4+, and coliform all fail to meet TCVN (B). Within Hanoi, surface water in rivers, lakes and drains is also seriously polluted. Levels of DO are low, COD exceeds the standard by 7 to 8 times, BOD_5 by 7 times and coliform by 2 times. While these are the worst examples, there are many other pollution "hot spots" in the sub-basin.

The Cau River section flowing through Thai Nguyen is seriously polluted. SS, BOD_5 and COD exceeding TCVN (A) by 2 to 3 times, and the waters contain oil residues. There are other badly polluted areas in the sub-basin, mostly from organic pollution.

These findings are consistent with those from the technical report *Analysis of Pollution from Manufacturing Sectors in Vietnam*, (ICEM for The World Bank, January 2007). In terms of water pollution, this study ranked all provinces in the country. Of the top 10 that are experiencing the worst pollution, 7 are provinces/cities in the three focus river basins. Of the top 5 provinces/cities, 4 are in the Dong Nai River Basin.

For the top ten provinces, the analysis was extended down to commune and enterprise level. This showed that Cam Gia commune in Thai Nguyen province was ranked first overall – suffering the most pollution generally – and first in terms of metals and SS discharged to surface water. It also ranked in the top ten nationally for chemical pollution and BOD. Di An commune in Binh Duong ranked second nationally and also ranked in the top ten nationally for all pollutant types.

The pollution in the three river basins is generated from a number of sources – although point sources are by far the most significant. For the Cau River sub-basin the major pollution is caused by industrial production, craft villages and urban runoff. Wastewater from mining and mineral processing makes up 55% of the total industrial wastewater, metal production (29%) is the second largest, then paper production (7%), and food processing (4%).

In the Nhue-Day River sub-basin, domestic wastewater accounts for the biggest proportion of wastewater (56%), making this sub-basin different to many other basins. Industry contributes 24% of the wastewater and craft villages 4%. In the industrial sector, mechanical engineering makes up 33% of production activities, food processing 15%, weaving and dying 13%, construction materials 13% and chemicals and paper manufacturing 8%.

Major pollution in the Dong Nai River basin is dominated by domestic and industrial wastewater. Key industries that cause pollution dominate – for example, the wearing apparel, fabricated metal products, rubber and plastics products, and food and beverage industrial sectors in Ho Chi Minh City together represent 47% of all industrial facilities. In Binh Duong the leather tanning and dressing sector employs 27% of all industrial labour in the region. A similar situation is found in Dong Nai where the leather tanning and dressing sector has 34.3% of all industrial employment.

The technical report *Analysis of Pollution from Manufacturing Sectors in Vietnam*, (ICEM for The World Bank, January 2007) found that, although BOD and TSS loads represent the largest in terms of their relative share to overall water pollution, of most concern are chemicals and metals. Their persistence in the environment and potential health linkages makes them a higher priority in the short-term. Chemicals and metals that are highly toxic and represent high load shares to water in Vietnam include: ammonia, chlorine, chromium and formaldehyde. In addition, the analysis found that sub-sectors associated with highly toxic materials for water pollution are fertiliser, pesticide, paper and paperboard, plastics and leather sectors.

Most of these industrial sectors are prominent in the three river basins and these should form the basis for a focused approach to water quality management.

Non-point source pollution is caused by land clearing and development (leading to high levels of SS in many rivers) and runoff containing agricultural chemicals. Agricultural chemical are used by a high proportion of the population and on large land areas. Most of pesticides used are of high toxicity level and some chemicals classified as prohibited or of restricted use are available. The application of chemicals is usually far greater than recommended, levels of exposure are unnecessarily high, costs of chemical use is high but efficiency is low. Most farmers have little awareness of the negative impacts of pesticide use and do not have proper protective measures and storage facilities, and wash their equipment in river or lakes.

Future projections

In terms of the future, the environmental pollution level of the basins has been analysed based on three scenarios:

- Scenario 1: The wastewater volume in the basin increases according to the planning targets, but is not treated;
- Scenario 2: The wastewater volume in the basin increases according to the planning targets, but with 30% of all wastewater treated (existing and additional);
- Scenario 3: The wastewater volume in the basin increases according to the planning targets and all of the wastewater (existing and additional) is treated to meet environmental standards.

Scenario 1 projections indicated that, compared to 2005, the 2010 wastewater volume discharging into the three river basins/sub-basins will have increased by up to 1.8 times. Projections under Scenario 2 show some significant improvements over Scenario 1. However, the water quality would not meet TCVN (A).

Under Scenario 3, as expected, there are further improvements. In the Cau River sub-basin the water quality would nearly meet TCVN (A) meaning that the surface water could generally be supplied for domestic use purposes after appropriate treatment.

However, in the Nhue-Day and the Dong Nai River systems, although pollution levels would be within the standard for the relatively less polluted areas, at some locations predicted levels would still exceed TCVN (A). This indicates an enormous amount of residual pollution in the system and means that extensive and costly treatment would be required for the water at these locations to be suitable for drinking water. Even to get to this stage, significant investment in treating current wastewater loads would be required as well as ensuring all new developments are treated to proper environmental standards.

Impacts of pollution levels

Many people of the three river basins do not have access to clean water. In the Cau River sub-basin the average percentage of people having clean water is 61%; for the Nhue - Day this figure is 70%; and for the Dong Nai - Sai Gon it is 67%. As the investment costs for a household domestic water treatment system is often much higher than rural people's average income, many rural people must take their water supply directly from rivers or from lakes and ponds around the home. When the surface water source is degraded, people are quickly and significantly affected.

Although it is it difficult to accurately assess the contributions of poor water quality to human health, there is a clear link between the regular use of polluted water and human illness. In the three river basins/sub-basins the rate of sicknesses related to surface water quality has been high – provinces and communes located near polluted rivers generally have higher rates of dysentery and diarrhoea than those located away from such rivers. However, this recent trends show declining levels of sickness. There are also a high proportion of cases of children infected with diseases related to contaminated water, as children are more vulnerable and easily affected by their environment.

In the three focus basins, rivers are a common source of supply for towns. However, as most raw water quality generally does not meet the standards, the raw water needs to be treated before it can be provided to communities. This is imposing substantial costs on the river communities. In some cases where the water is badly polluted, water production facilities at times cannot cope and have to be stopped completely.

The use of agricultural chemical is causing ill-health in the farming community. A study has found that around 25% of farmers were suffering from health problems, and that over 12% of people suffer problems at least once, over 4% twice, and 0.5% three times during their working lives.

Polluted water also has a major impact on irrigation. On the one hand, because of the high levels of nitrogen, phosphorus and potassium in wastewater, the additional application of chemical fertilisers became unnecessary, or could be considerably reduced. But on the other hand, and much more

seriously, the rice yield in the pollution-affected locations is lower, especially for the summer paddy rice.

The need for satisfactory water quality to maintain viable aquaculture operations is an increasing problem in the three basins/sub-basins. Poor water quality has a significant influence on the quality and quantity of aquaculture product, and can result in loss of production of culture species.

In all three river systems, there are currently water shortages in the dry months, which are quite serious in some locations. The continual flow of wastewater to the rivers and the extraction of water from the river for agriculture and other purposes have lead to serious deteriorations in water quality. Water quality does not meet requirements for domestic use or aquaculture, limiting opportunities for development and imposing real costs on river communities by making the scarce water resources less productive and useful.

Current management of water quality

Recent changes have now provided a legal and institutional basis that will allow water quality and environmental management to be effectively dealt with. There is clear Government commitment, there are strong laws and the institutional framework is sound.

However, the reforms are recent and much of this is still new to Vietnam. The application of approaches and the use of management tools are mostly in their initial stages.

Institutionally, the major weakness is the establishment of coordinating arrangements at the river basin scale. The current principle of the administrative system is to combine state management of the sectors with management at central, provincial, district and village administrative levels. However, river basin management must provide leadership and coordination at the regional levels. As a result, it is impossible to use normal administrative boundaries and a coordinating mechanism is needed. To date attempts to make this happen have not been effective. However, as a result of Government Decision 43/2007/TB-VPCP, clearly establishing MoNRE as the lead agency for river basin management, a Government Decree on management of river basins is being prepares and this should provided a firmer base for the coordinating arrangements.

A start has been made on the application of various tools for water quality management – planning, the application of environmental impact procedures, licensing, pollution discharge fees, and investigation and inspection. However, there are problems with the application of all of these – there are no river basin plans; environmental protection plans are not effective; environmental impact reports are not always done, are not effective, are not being complied with and are not checked; licensing has only just started; pollution discharge fees are not being applied uniformly and fairly across all sectors and in all areas; and investigation and inspection is limited and not consistent.

As well, staff and financial resources are not adequate to make real in-roads in the backlog of work required to achieve sustainable natural resource management, including pollution and water quality management. Data and information is also limited and not properly shared, providing an inadequate basis for management decisions.

Priority solutions for water quality management in river basins

The three focus river basins must be the priority for the immediate future – they suffer the worst pollution in the country, pollution levels are severe and the situation is declining rapidly.

For these river basins, it will be essential to firstly set priorities for better management of wastewater discharge. This will allow the appropriate controls, regulations and management actions to be developed and implemented in a strategic and focussed way, making the best use of scarce resources.

Under the ADB Second Red River Basin Sector Project (TA 3892 – VIE), consultants ICEM are currently undertaking this work for the Day River sub-basin, as a basis for setting priorities for management action and building a pollution inventory. A comprehensive approach is underway to

assess all activities in the river basins that are impacting on the quality of water, including an assessment of their current and future risk to communities.

Using the skills and experience gained in the analysis for the Day River, it is hoped that MoNRE can undertake a similar analysis for the Dong Nai River basin, and also for the Cau River sub-basin, at least in some form. MoNRE should urgently seek international support for this work, given its importance.

The result of the pollution assessment will be the identification of priority industries or sectors that are causing the most significant impacts within the focus river basins. For these industries or sectors, a suite of focused point source pollution prevention measures can then be developed and applied, including:

- Setting levels of water quality to be achieved in well defined stages, each subsequent target closer to the required water quality objective. .
- Accelerating licensing of wastewater discharges for the priority industries/sectors in the high risk provinces, districts and communes. MoNRE should lead a focused approach with the Provinces to deal with the highest risk industry types and develop industry specific licensing provisions for these priority industries/sectors and apply them to the specific establishments.
- Concentrating regular environmental inspections and investigations on these priority industries/sectors and priority locations.
- Strengthening the application of Decree No. 67/2003 and its operation for the priority industries/sectors, and progressively linking these charges to wastewater licensing provision to make closer links between rights and responsibilities.
- Creating favourable conditions for enterprises in the priority industries/sectors to access loan sources from Vietnam's Environmental Protection Fund as well as other financial sources.

Other short -term actions for the Done Nai River basin should also be taken:

- Concentrate pollution activities on the 87 units in the basin which are listed under Decision No. 64/2003;
- Temporarily ban investment permits for 5 industrial types and limit the number of investment permits for another 5.
- Obtain approval of the submitted plan for the environment protection of Dong Nai River basin.
- Carry out a comprehensive study of the river flow regimes of the Thi Vai Rivers and propose solutions for better managing flows, supplementing water resource and making the most of the assimilative capacity of the river.

Other short -term actions for the Day River sub-basin should also be taken:

- Concentrate pollution activities on the 52 units in the sub-basin which are listed under Decision No. 64/2003;
- Limit the number of investment permits for 5 industrial types.
- Accelerated the development of the plan for environmental protection of the Nhue–Day River system and submit to the Government for approval.
- Coordinate the regulation of flows from the Red River to the Day and Nhue Rivers in the dry and wet seasons to improve the ability of the river system to provide a source of fresh water for domestic use and agricultural production, and to enhance the assimilative capacities of the rivers in the sub-basin. The analysis for this will take place under the ADB Second Red River Basin Sector Project (TA 3892 – VIE).

Other short -term actions for the Cau River sub-basin should also be taken:

- Concentrate pollution activities on the 45 units in the sub-basin which are listed under Decision No. 64/2003;
- Limit the number of investment permits for 2 types of industrial activities.
- Strictly control sand exploitation on the Cau River to sustainable levels of extraction.

Other common short -term actions for the three basins should also be taken:

- Zone some areas for safe vegetable production, and warn people of the high risks of using polluted water source for food production;
- In waters whose quality is better than the level specified in water quality objectives, establish measures to prevent contamination from all sources. It is just as important to protect these areas as it is to restore the degraded areas.
- Stop further deforestation and encourage re-forestation with the view to achieving the national targets for forest cover, particularly in the upper areas of the basins.

As well, MoNRE's current river basin planning initiatives for the northern economic zone, which includes the Day/Nhue and Cau River sub-basins, and for the Dong Nai River basin, should be strengthened and supported.

To facilitate this short -term work for the three focus basins, additional resources should be allocated to local authorities in the areas required to deal with the priority industries/sectors, from the 1% of the annual State budget committed to fund environment protection. As well, all investment opportunities in pollution control and management for the three focus basins should be based on the priority setting work outlined above.

Although at the national level the concentration should be on the three focus river basins, there are many other water quality issues in the country that Provinces must deal with. The short -term actions in relation to these are to:

- Set priorities for water quality management based on risk analysis to allow the appropriate controls, regulations and management actions to be developed and implemented in a strategic and focussed way.
- Concentrate pollution activities on these priorities and on the units causing serious environment pollution as listed under Decision No. 64/2003.
- Develop zoning plans for water resource exploitation and wastewater discharge for priority areas. These will be a foundation for the issue of wastewater discharge permits based on the assessment of the assimilative capacity of each river section and the national standards.
- Accelerate licensing of wastewater discharges in the high risk provinces, districts and communes. Focus on the highest risk industry types and develop industry specific licensing provisions for these priority sectors.
- In badly polluted waters set intermediate levels of water quality to be achieved in well defined stages, each subsequent target closer to the required water quality objective, until it is finally met. Continual improvement should be a fundamental principle guiding water quality management.

Other short -term actions are also proposed. These include

- Revisions to the Law on Water Resource to incorporate integrated water resources management concepts. MoNRE is planning to review the Law during 2008.
- Promulgating a Decree on the management of river basins, which will detail how integrated water resources management and environmental protection will be implemented at the river basin scale. MoNRE is finalising such a decree and will submit it to the Government in mid 2007. Support the implementation of this decree with comprehensive community awareness, guidelines and capacity development.

- Improve public knowledge of the importance of water to life. MoNRE should lead and implement awareness campaigns on the importance and values of the environment to the lives of the community, with the contents and delivery appropriate to each group in society.
- Strengthen the plans for dealing with safety measures for handling and using agricultural chemicals by furthering a national program for the training/education for farmers, strengthen the pesticide registration scheme, and expand the inspection and control of pesticide importation, distribution and use.
- Urgently strengthen the EIA system and its operation, particularly in relation to developments that affect water quality in the three river basins. This system must become the means through which the impacts of developments are thoroughly and transparently appraised and potentially affected communities can put their views forward. This report shows how critical it will be to ensure that new developments all meet environmental standards.

Arising from this report is a range of other general measures that should be used to address water pollution in river basins. Some of these have short -term application, some are on-going; others are more longer term in nature. These cover the application of scientific, technological and economic tools, capacity strengthening, public participation and responsibility, and international cooperation.

CHAPTER 1
RIVER BASINS IN VIETNAM

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A 'river basin' is the area of land from which all surface run-off flows through a sequence of drainage lines, creeks and rivers into the sea at a single river mouth, estuary or delta.

Source: European Environment Agency

This Chapter discusses river basins and their occurrence in Vietnam, and describer some of the basic features of the three river basins under study. Every river basin has unique features and characteristics. This means that their management must reflect the nature and resources of each basin. Therefore, the management of each basin will be potentially different to reflect the administrative, socio-economic, land use and natural resource character and values of each basin, and the opportunities and constraints for their management.

1.1 RIVER BASIN PROCESSES AND VALUES

In many countries, including Vietnam, river basins have been adopted by Law as the basis for water related planning and management.

Land and water are ecologically linked in a river basin. From the smallest raindrop to the largest river, water shapes the land, taking with it sediment and dissolved materials that drain to rivers and, in most cases, eventually to the sea – see Figure 1.1. Conversely, the river is affected by the land. The type of rocks and soils, the shape of the land, the amount of rainfall and type of vegetation are some of the factors that determine the river's shape, size and flow.

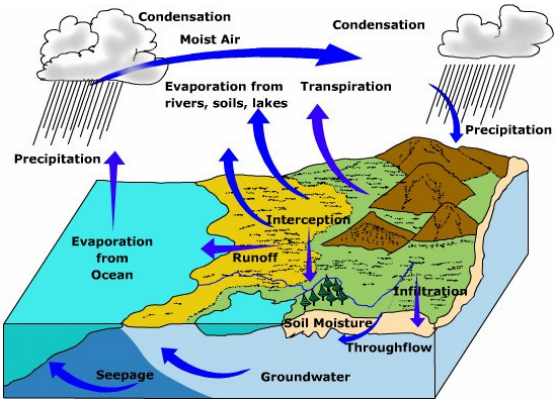


Figure 1.1: Water cycle in a river basin

A river basin includes everything that lives in it and all the things humans have added to it such as buildings and roads. All people belong to a river basin. Everything people do affects their river basin – from washing clothes and growing food to larger–scale activities such as mining, commercial farming, and building roads or dams. The reverse is also true: river basins affects everything people do by determining what kinds of plants to grow, the number and kinds of animals that can live there, and how many people and livestock can be sustainably supported by the land.

River basins provide a wide range of values to the community who live in the basin. These include the following.

Multi-functional values:

- Providing a pool of natural resources with high economic value: water, land, forest, minerals and aquatic products.
- Protecting human lives and eco-systems.
- Receiving, moving and assimilating waste.

Values of water resources in river basins:

- Direct values - providing water for:
  - domestic and industrial uses,
  - irrigation,
  - hydro power,
  - aquaculture and fishery,
  - preventing salt intrusion,
  - agricultural development.
- Indirect values:
  - water transport,
  - sand exploitation,
  - receiving and assimilating waste,
  - unique and beautiful landscapes,
  - sport and recreation.
- Conservation values:
  - preserving the natural water circle,
  - maintaining fresh water eco-systems,
  - conserving aquatic biodiversity,
  - conserving wetlands.

1.2 OVERVIEW OF RIVER BASINS IN VIETNAM

Vietnam is located in the tropical monsoon region, with a total annual rainfall of about 1,940 mm. It has a dense river network with about 2,372 rivers over 10 km long. 13 of these are large river basins each with an area of 10,000 km^2 or more, and 10 of these are trans-boundary rivers.

There are 9 major rivers – the Bang Giang-Ky Cung River, Thai Binh, River Red River, Ma River, Ca River, Thu Bon River, Ba River, Dong Nai River and the Mekong (Cuu Long) River. These major rivers account for 90% of the total area of river basins in Vietnam and their within-border area is around 80% of the total area of the country.

Some large rivers, such as the Cuu Long, Red and Ca Rivers, originate within other countries and have significant areas of the basin in those countries. Branches of the Mekong River, including Se San and Srepok, start in Vietnam and flow through Lao and Cambodia, before joining the Mekong. The Bang Giang - Ky Cung is a large river system which originates from the Chau Giang river in China. Almost all of the other rivers lie within the country, generally originating in the highlands in the west and flowing to the sea in the east.

Table 1.1 shows some key characteristics of the major river systems. For example, this indicates that 53% of the Red River basin lies outside of Vietnam but only 36% to the total water comes from this external area. For the Mekong River, these figures are 91% and 89% respectively.

Water availability per basin area (thousand m^3/km^2) is lowest for the Bang Giang - Ky Cung, Ba and Dong Nai River basins. Based on the population, the Dong Nai has far less water than the other rivers.

The total annual flow of the Mekong River accounts for 60% of the country's total annual water flow – see Figure 1.2. The Red River has about 15% of the total flow and the Dong Nai River 4%. The total river flow of Vietnam is about 2% of total water flow of all rivers in the world.

Table 1.1. Key Information on Major River Basins in Vietnam

		Basin Area (km^2)			Average Annual Water Discharge (billion m^3)			Water availability (total)	
		External	Internal	Total	External	Internal	Total	Thousand m^3/km^2	m^3/ person
1	Bang Giang – Ky Cung	1,980	11,280	13,260	1.7	7.3	9.0	798	9,070
2	Thai Binh		15,180	15,180		9.7	9.7	1,550	5,160
3	Red	82,300	72,700	155,000	45.2	81.3	126.5		
4	Ma	10,800	17,600	28,400	5.60	14.0	19.6	1,110	5,500
5	Ca	9,470	17,730	27,200	4.4	17.8	22.2	1,250	8,290
6	Thu Bon		10,350	10,350		20.1	20.1	1,940	16,500
7	Ba		13,900	13,900		9.5	9.5	683	9,140
8	Dong Nai	6,700	37,400	44,100	3.5	32.8	36.3	877	2,980
9	Mekong	726,180	68,820	795,000	447.0	53.0	500.0	7,265	28,380
10	Others		66,030	66,030		94.5	94.5	1,430	8,900
Vietnam		837,430	330,990	1,167,000	507.4	340	847.4	2,560	10,240

Source: National Water Resources Profile

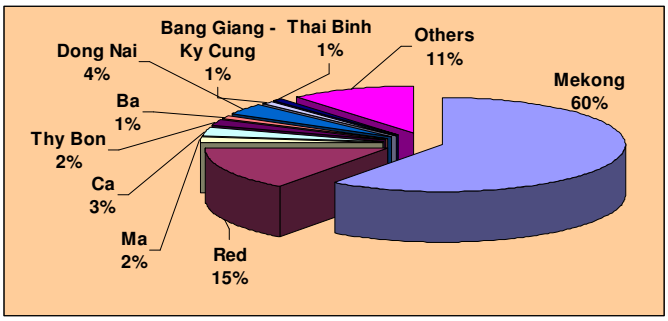


Figure 1.2: River basin flow volumes

Source: National Water Resources Profile

Rainfall is distributed differently from one area to another and varies over time. The annual rainfall varies considerably, from highs of 4,000 to 5,000 mm - but up to 8,000 mm at Bach Ma Mountain - to lows of only 600 to 800 mm in Nha Ho and Binh Thuan. The average rainfall is about 1,400 to 2,400 mm per year. The variation of rainfall during the year and its impact on river flow causes severe dry periods in the low-flow season, and flooding in the high-flow season.

Rainfall varies from season to season in a year, and neither the wet seasons nor the dry seasons occur simultaneously from one part of the country to another. The wet season is generally between April to October, but it is from July to December in the centre of the country. The rainfall in the wet season accounts for 75 - 85% of the total annual rainfall. The dry season starts from July to August and in some areas there is no, or very little, rain for 3 to 4 months.

Corresponding to the wet and dry seasons, there are high-flow and low-flow seasons for the rivers. The interval between the wet season and the high-flow season is about one month. The starting and ending of the seasons differ from place to place, and are later towards the south.

Internationally it is agreed that areas with water availability of 4,000 m^3 per person per year or less are areas with inadequate water resources. At the national level, Vietnam appears endowed with abundant water resources – with around 10,240 m^3 per person per year. However, flows of the Mekong River dominate this statistic. If these are excluded, then the rest of Vietnam will be at the inadequate water level by 2025. If all external water sources are excluded then Vietnam will be well below the inadequate water level by 2025. Those calculations show the importance to Vietnam of international agreements on fair sharing of water resources as it is located in the lower sections of large internationally shared river systems.

Box 1.1: Vietnam's water resources are unsustainable

Global climate changes will lead to a decline in water resources. Recent research has forecast that the total volume of surface water in 2025, 2070 and 2100 will be around 96%; 91% and 86% respectively of today's quantity.

The current average per capita surface water availability from the total volume of water in rivers within Vietnam is about 3,840 m^3 per year. If water inflows from outside the country are included, the average per capita river water availability is 10,240 m^3 per year. Taking population growth into consideration, by 2025 the average per capita surface water availability will be 2,830 (internal) and 7,660 (internal and external) m^3 per year. According to standards of the International Water Resources Association (IWRA), nations with average per capita water availability lower than 4,000 m^3 per year are considered nations with inadequate water supply.

Water resources are not evenly distributed over different regions. About 60% of river water is concentrated on the Cuu Long River delta (Mekong River). The remaining 40% is spread over nearly 80% of the nation's population and over 90% of production, trade and other service activities.

The average volume of water in four or five months in the wet reason makes up 75 - 85% of the total volume, while the 8 or 9 months of the dry season receives 15 - 25% of the year's water quantity.

Source: National Resources Water Strategy, 2006

Water availability is also markedly different from area to area. For the Dong Nai River basin, the current water availability is 2,230 m^3 per person per year and with projected population growth, this will decrease to around 1,600 m^3 per person per year by 2025. This is an alarming figure by international standards which define an area with water availability of 1,700 m^3 per person per year or less as one of "water stress". The problem is even worse in the Cau River sub-basin where water availability is currently only 656 m^3 per person

per year. For the Nhue-Day River sub-basin, water availability is currently 3,760 m^3 per person per year.

Some areas in Vietnam are currently experiencing water shortages and competition for access to water. The strong growth in population is accentuating this.

1.3 CHARACTERISTICS OF THE CAU RIVER SUB-BASIN

Area: 7,900 km^2 (accounting for 2% of the total country area, and 8% of the total Red River basin area within Vietnam)

Annual river flow: about 4.5 billion m^3

Current available water: 656 m^3 per person

Wet season: June to October

Dry season: November to May

Main rivers: Cho Chu, Nghinh Tuong, Du, Cong, Ca Loà, Ngu Huyen Kheâ.

Provinces: all of Thai Nguyen, parts of Bac Kan, Bac Ninh, Bac Giang, Vinh Phuc, Ha Noi and Hai Duong

Population: 4,800,000 (approx, based on 2005 census).

Population density: 870 persons per km^2 (3.5 times the national average).

Industrial establishments: 2000

Craft villages: 200

Medical establishments: 74 with 15,400 beds.

Note that Hai Duong is not formally part of the Cau River sub-basin. However, because of the strong impact of the river system on that province, it has been included in this analysis.

1.3.1 Natural features

The Cau River is a main tributary of the Thai Binh River and is a part of Red River - Thai Binh River basin. The total river length in the basin is 1,600 km, with the Cau River 288 km long. The river originates at Phia Deng (1,527m high) in the south east of the Pia-Bi-Oc range in Bac Kan.

The sub-basin has a complex geography with 3-typical ecological zones: the plains, midlands and highlands. Its topography generally slopes from the North-west to the Southeast.

The basin is a long river system which is relatively developed. The main river has many branches, with the larger ones mostly located on the east of the Cau River - such as Cho Chu, Du, Cong, and Ca Lo rivers.

The sub-basin has 68 rivers over 10 km long. Of the total river flow in the sub-basin (about 4.5 billion m^3/year), the Cong and Ca Lo Rivers each contribute about 0.9 billion m^3/year.

There are two distinct seasons with the wet season lasting from June to October. During this period, flows are around 75% of the yearly total. The dry season lasts 7 or 8 months, providing up to about 18-20% of the annual water volume. The driest months of January, February and March provide only 5.6 to 7.8% of the annual river flows.

1.3.2 Natural resources and environmental features

The Cau River sub-basin is rich in natural resources including forests, water and minerals. There are several iron, zinc, coal, gold and tin mines in the basin. The average forest cover in the sub-basin is about 45%.

The natural landscape of the sub-basin has been changed considerably to the extent that there is no more natural forests along rivers. The forest quality has significantly degraded and is now incapable of storing water to keep moisture for land in the dry season and prevent floods in the wet season. As a results, land has been degraded, severe floods occur and long lasting water shortages persist.

The sub-basin contains protected areas such as Tam Dao National Park, Kim Hy Natural Conservation Area and other cultural and environmental conservation areas with high eco-system values. Fauna and plants are plentiful, including many rare forestry species and wild animals.

However, deforestation, accompanied by socio-economic development activities such as industry, mining, craft villages and agriculture, have created increasing pressure on the natural environment of the basin, threatening these community values.

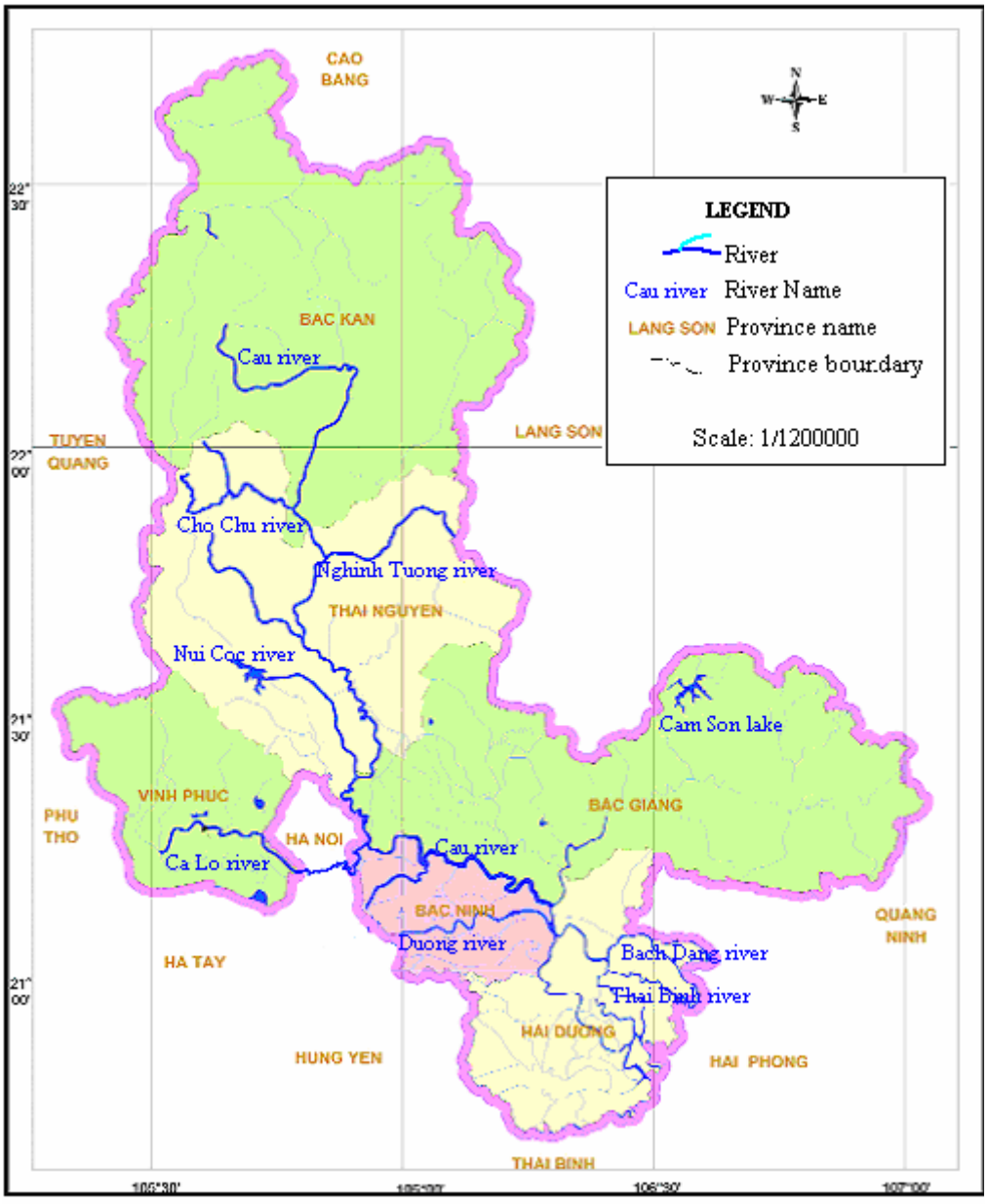


Figure 1.3: Cau River sub-Basin

Source: Vietnam Environment Protection Agency

1.3.3 Socio-economic features

The sub-basin covers about 47% of the area of the six provinces. It has a population of about 5 million people, of which about 80% live in rural areas. The average population density is high at about 870 people per km^2 (3.5 times the national average of 252 persons/km^2).

The lowest population density is in Cho Don and Bach Thong district, Bac Can province (around 55 people per km^2) and the highest, of around 2,000 people per km^2, is in Gia Lam district in Ha Noi city and Tu Son district in Bac Ninh province.

The economy of the 6 provinces is mostly based on agriculture, forestry and industry, with some aquaculture. GDP is growing

strongly in all provinces, doubling over the last five years - see Figure 1.4.

The production from agriculture, forestry and aquaculture is about 26% of GDP but this proportion is declining. The industry sector growth rate is higher than the national average. Thai Nguyen, Bac Ninh and Vinh Phuc provinces are developing rapidly in industry, construction and services.

Mining and ore screening industries are concentrated in the two up-river provinces of Bac Kan and Thai Nguyen.

There are about 200 craft villages located in Bac Ninh and Bac Giang provinces. These villages specialise in iron and steel producing, copper adn lead casting, paper production, weaving and dying. Typical examples are Phong Khe and Duong O paper recycling villages, Dai Bai copper casting village, Da Hoi metal refinery village.

Sand and gravel exploitation are large-scale activities along the rivers and this has caused river bank erosion and in places has changed flow direction.

Chemicals and pesticides are increasingly used in agriculture, especially in Thai Nguyen and Bac Ninh.

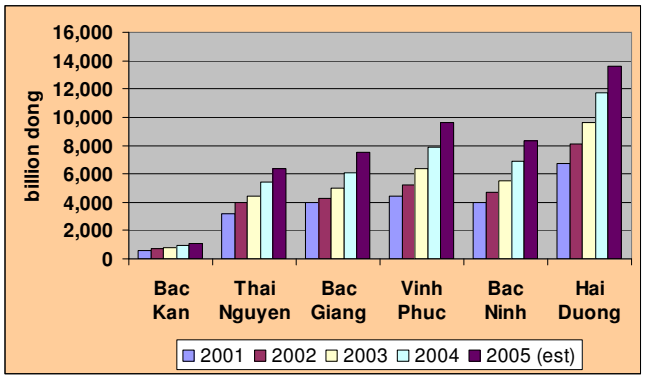


Figure 1.4: GDP of provinces in the Cau River sub-basin

Source: Statistical Year Book, 2005

1.4 CHARACTERISTICS OF THE NHUE-DAY RIVER SUB-BASIN

Basin area: 7,665 km^2 (accounting for 2% of the total country area, and 10% of the Red River Basin area within Vietnam)

Annual flow: about 28.8 billion m^3

Current available water: 3757 m^3 per person

Wet season: June to October

Dry season: November to May

Main tributaries: Nhue, Thanh Ha, Tich, Hoang Long, Chau Giang, Dao, Ninh Co and To Lich (a main branch of the Nhue River receiving water from Lu, Kim Nguu and Set rivers)

Provinces: All of Ha Tay, Ha Nam, Ninh Binh and Nam Dinh; and parts of Hanoi, Hoa Binh

Population: 7,665,000 (2005)

Population density: 990 persons per km^2 (nearly 4 times the national average)

Industrial entities: 4,100

Craft villages: 458

Medical establishments: 1,400 with 26,000 beds.

1.4.1 Natural features

The Nhue-Day River is a distributary river system of the Red River and forms a sub-basin of this much larger River basin. The sub-basin area is large, rich in resources and plays an important role in Vietnam's economy in general and the Red River floodplain in particular.

The sub-basin has 2 main rivers that flow from the Red River - the Day and Nhue - and also many large tributaries including the Tich, Thanh Ha, Hoang Long, Vac, Nhue, Chau, Sat and Dao Rivers. Some of these (the Chau Giang River and the Dao River) are, or were, also distributaries of the Red River. Others drain local catchments in the sub-basin. The river system is also connected with the Ninh Co River by the Quan Lieu channel.

The Day River is 237 km long. Since the construction of Day Dam in 1937, significantly less Red River water has flowed into the Day River. The River has become more of a drain to carry floods in the wet season and convey water supplies in the dry season.

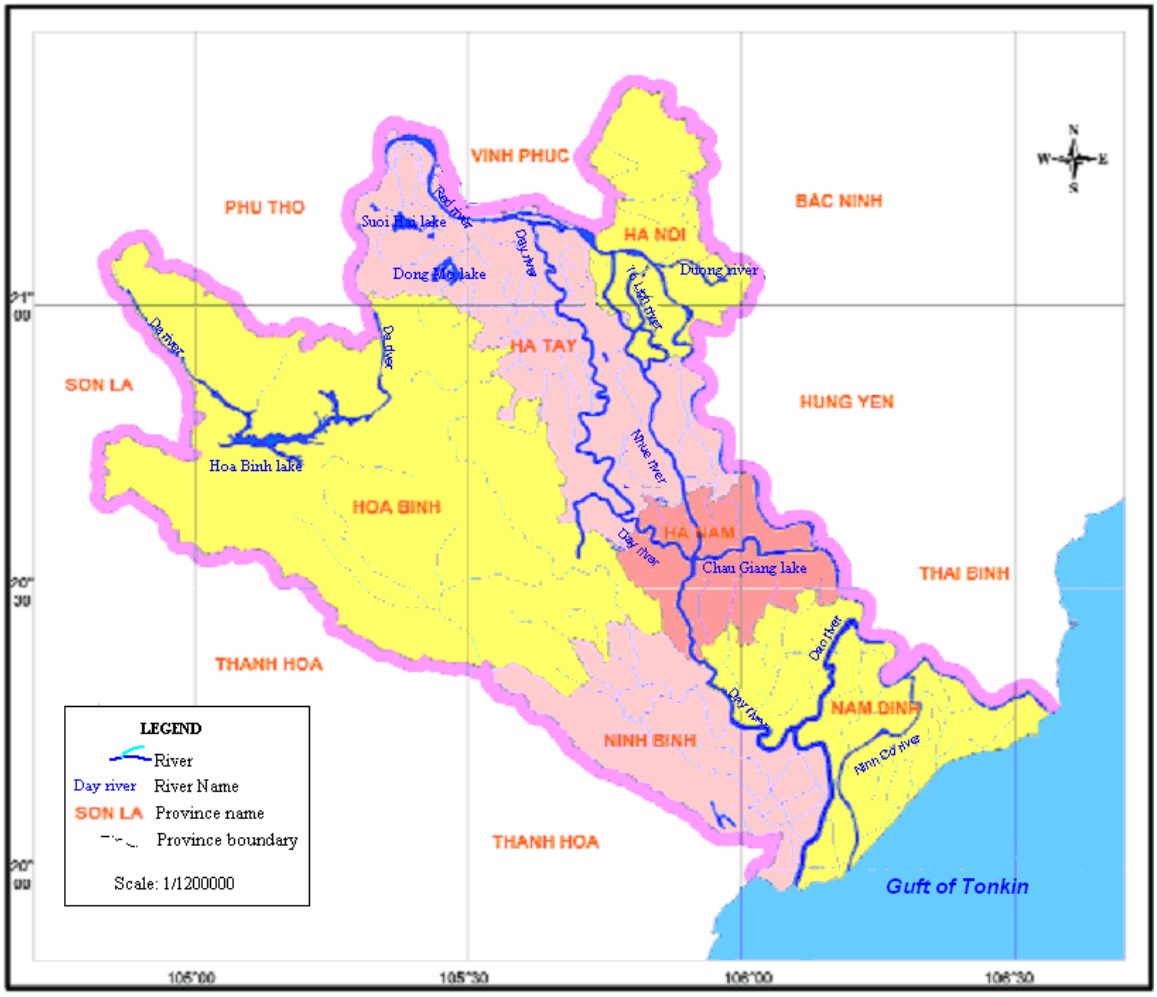


Figure 1.5: Nhue – Day River sub-Basin

Source: Vietnam Environment Protection Agency

The Nhue River is 74 km long and receives water from the Red River through Lien Mac channel. The River also serves as drainage system for Hanoi city and Ha Dong town. It joins the Day River at Phu Ly town. The Nhue river has a catchment area of 1,070 km^2.

The Red River provides about 85 to 90% of the total yearly flow in the Nhue-Day River sub-basin - 25.7 billion m^3 out of the total of 28.8 billion m^3 a year. The Hoang Long River provides 0.68 billion m^3 (2.4%); and the Tich River and Day River 1.35 billion m^3 (4.7%).

The wet season (from June to October) provides about 70% to 80% of the total annual flow. The dry season is from November to May. Water in the dry season is provided mainly from the Nhue River which takes water from the Red River through Lien Mac sluice, and the Dao River, which transfers large volumes of water from the Red River (at an average of 200 to 300 m^3/s).

River flows of the sub-basin reflect both the Red River flow regime and the mountainous (Hoa Binh) flow characteristics, as well as the tidal influences from the Gulf of Tonkin. Therefore, the hydrology of the river system is complex and there are specific differences between river sections. The river's flows are very much influenced by the closing or opening of the Red River diversion schemes at Lien Mac (Red River) and Thanh Liet (To Lich River), and other channels on the main river such as Ha Dong, Dong Quan, Nhat Tuu and Luong Co-Diep Son.

In the lower river, the flood-tide and ebb-tide generally only affects drainage of the rivers

near the sea. However, if there are storms with heavy rain and wind, the sea water level will rise and the low-lying land areas will be flooded severely for a long period.

1.4.2 Natural resources and environmental features

Due to a diverse terrain of mountains, hills and plains, the sub-basin includes a wide range of eco-systems such as hill-slopes, limestone mountains, fresh water bodies and wetlands. Although major parts of the sub-basin have been long exploited, the ecological features of the basin generally remain diverse and abundant. Parts of the sub-basin are set aside as special use forests, Cuc Phuong and Ba Vi National Parks, Huong Son and Hoa Lu protected areas, and Van Long and Xuan Thuy wetland conservation areas.

The diverse topography, with the majority of the land area being flat, means that the sub-basin has strong advantages for economic development. However, there are problems with flooding of low-lying lands. Many dyke sections are lower than the standard height by up to 1.2 meters so that low areas and swamps, particularly the flood-carrying areas of the Day River, are often inundated during the wet season. Many areas are often inundated by water of up to 4 meter deep affecting the living and production activities of local people.

1.4.3 Socio-economic features

The Nhue-Day sub-basin has a population of around 7.7 million people (2005). From 1996 to 2002, the population of the sub-basin increased by 1.27% per year, especially in urban areas. There is a strong urban base in the sub-basin, with Hanoi as the national capital, Nam Dinh as a category-2 city and many other provincial towns and industrial zones. The population is increasing strongly - from 1996 to 2003 the yearly average urban population growth rate was 5% (5.58% for Hanoi).

The average population density is about 990 persons per km^2 (nearly 4 times the national average). All provinces except Hoa Binh have population densities greater than the national average, while Hanoi has a density over 13 times the average (Figure 1.6).

Both the Day and Nhue Rivers run through Ha Tay and Ha Nam, both of which have high population densities. Therefore the condition of the river is vitally linked to a large and growing population base.

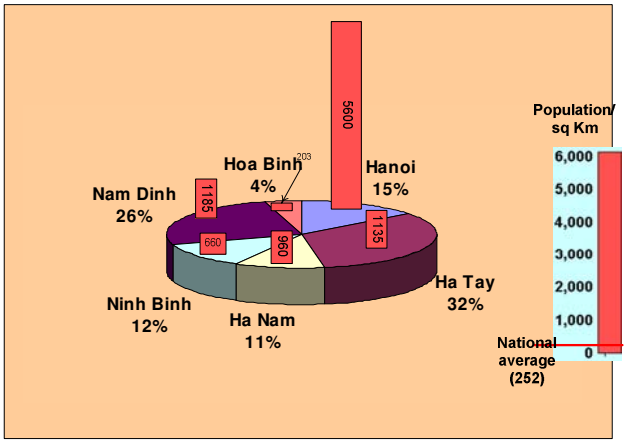


Figure 1.6: Population density and population distribution per provinces

Source: Statistical Year Book 2005

The Nhue-Day sub-basin is under great pressure from socio-economic development activities, especially the establishment and operation of industrial zones and residential areas, craft villages, small factories, mining and processing, and agricultural activities. These have caused significant changes to the environment in general and to water-related environmental features.

The economic structure is based on industry, agriculture and craft villages. Agriculture and craft villages contribute significantly to the economy; between 60 - 70% of the total population work in agriculture, contributing 21% of economic production. For the past few years, the GDP of the provinces has been increasing dramatically.

There are more than 458 craft villages covering activities such as silk production, dyeing, food and foodstuff processing, steel works, handicrafts, forest product processing, etc. 149 of these villages are in Ha Tay Province.

1.5 CHARACTERISTICS OF THE DONG NAI RIVER BASIN

Natural area: 37,400 km^2 (accounting for 11% of the total country area)

Annual river flow: about 36.6 billion

Current available water: 2,227 m^3 per person

Wet season: May to October

Dry season: November to April

Main tributaries: Dong Nai, Be, Sai Gon, Thi Vai, Vam Co

Provinces: Dac Nong, Lam Dong, Binh Phuoc, Dong Nai, Binh Thuan, Ninh Thuan, Tay Ninh, Binh Duong, HCM city, Ba Ria - Vung Tau, Long An

Population: 16,431,000 (2005)

Population density: 440 people per km^2 (1.75 times the national average)

Industrial entities: more than 9,100

Craft villages: 491

Medical establishments: 1,633 with 35,000 beds.

1.5.1 Natural features

The Dong Nai River Basin within Vietnam is about 37,400 km^2 (or 84.8% of the total river basin area). The basin has 266 rivers with a length of at least 10 km. The major rivers are as follows:

River	Length (km)	Catchment area (km^2)
Dong Nai	470	14,800
Sai Gon	256	4,710
Be	344	7,170
La Nga	290	4,100

The basin flows to the sea at two main estuaries - Ganh Rai Bay and Soai Rap. In the lower reaches of the rivers, tidal influences can create salt water conditions. The tidal effects in the lower river are significant - they can affect Dau Tieng Dam which is 148 km from the river mouth.

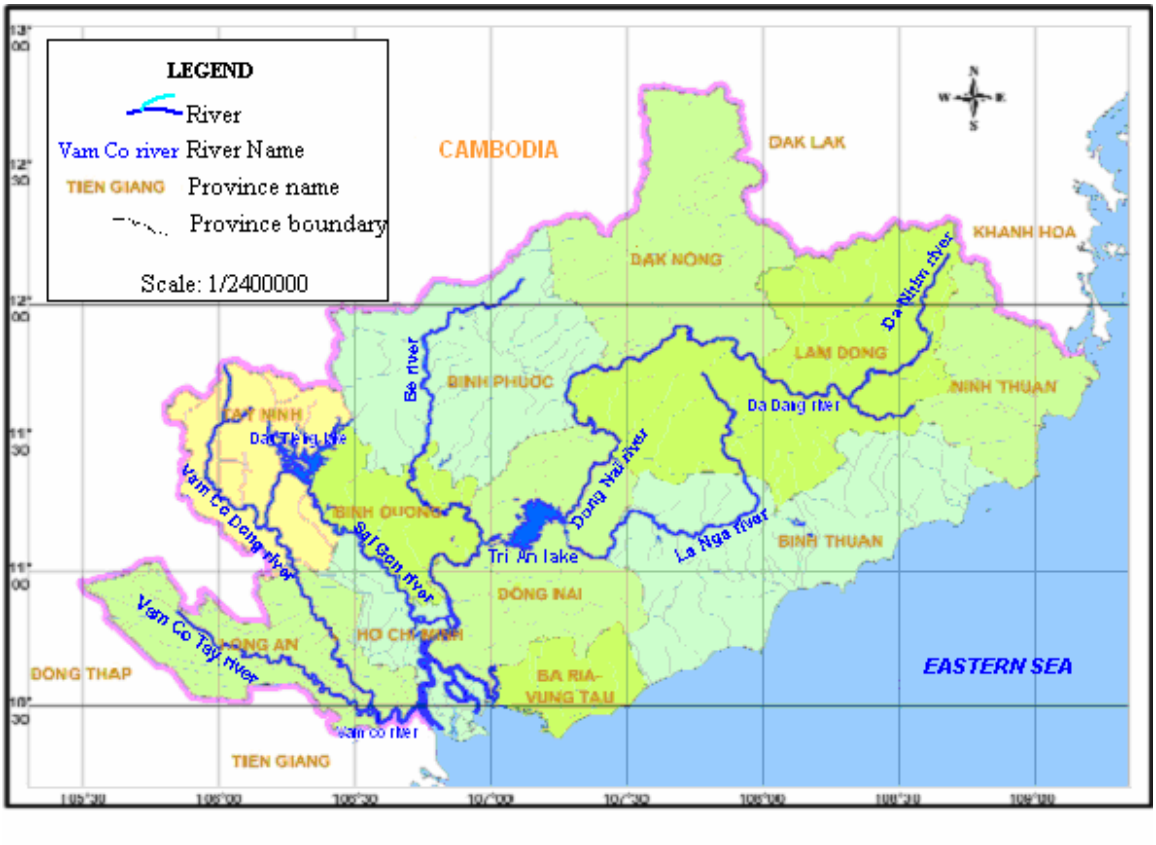


Figure 1.7: Dong Nai River Basin

Source: Vietnam Environment Protection Agency

The annual flow of the basin is approximately 36.6 billion m^3. Of this, about 32 billion m^3 (or 89%) originates within Vietnam. The average flow in the Be River is about 8 billion m^3; the Sai Gon River is about 3 billion m^3; and the Vam Co and La Nga Rivers is about 5 billion m^3.

The area has tropical and monsoon climate conditions with typical wet and dry seasons. The wet season (May to October) provides about 85% the total rainfall per year.

The Dong Nai River basin has good geographical advantages for the development of hydroelectricity and other works - changing height and high slopes. The basin has many dams and control works, with the major two being the Tri An reservoir (Dong Nai River, principally hydropower) and the Dau Tieng reservoir (irrigation). Other major hydropower dams are Da Nhim and Dai Ninh on the Dong Nai River, Thac Mo and Ca Don on the Be River, and Ham Thuan and Da Mi on the La Nga River.

Following the construction of the Tri An and Dau Tieng dams, the average river flow per month in the driest months (February, March, April, May) increased by 4 or 5 times. Flows in the wetter months (August, September, October) decreased by about 50%.

The construction of major dams significantly changes the flow patterns of the River which can also affect the stability of the river channel. Many parts of the riverbank from Bien Hoa to Dong Nai have seriously slipped because of sand exploitation and through changes in the water flow from Tri An Lake.

1.5.2 Natural resources and environmental features

The Dong Nai River basin is rich in mineral resources, including gold, iron, tin, zinc, which are increasingly being exploited.

The up-river forest system has a very important role in the basin. There are approximately 950,000 ha of forests, accounting for 19% of the total land area of the provinces. Of this approximately 280,000 ha is special-use forest. This is an important area for rare and valuable gene protection and biodiversity conservation of the tropical ecological system. These forests also help to maintain water sources for the Dong Nai River in the dry season and prevent flash flooding in the wet season.

Over the last century, large areas of the basin's forests have been lost to agriculture and plantations - rice cultivation, rubber plantations, coffee and pepper. Between 1990 to 2002 the forest area decreased by 107,300 hectares, amounting to an annual average reduction of 8,942 hectares/year (Institute of Natural Resources and Environment, 2003).

The pressures from the loss of large amounts of forest area has led to a decrease in water retention in the upper catchment and increased erosion. It is now estimated that nearly 90% of the flora mass is not able to retain water. The new land activity is generally agriculture and rain takes many contaminants from agricultural land (mud, alum, fertiliser, pesticide, etc.) to water sources.

In the urban and industrial provinces of Binh Duong and Ba Ria-Vung Tau and in HCMC, there are no or very little forest areas. In the remaining provinces, the forested area represents only about 20% of the land area.

There are many natural protected areas with high economic and ecological values in the Basin. The Can Gio Wetland Biosphere Conservation Area covers a network of river estuaries and intervening mangroves with a total area of 73,360 ha, of which 54% is forest. This is a biosphere nature reserve, the first such reserve in Vietnam recognised by UNESCO and one of only two designated RAMSAR sites in Vietnam. Can Gio occupies approximately one third of the Ho Chi Minh City administrative area.

The Cat Tien National Park is also within the basin, with an area of 73,878 ha. There are many other watershed forests providing natural landscapes and ecological values and which also play an important role in climate change and water protection in the basin.

The estuarine areas of the Dong Nai basin are known to be a major breeding ground for marine fisheries which constitute an important part of the local economy and support significant fishing communities.

1.5.3 Socio-economic features

The population of the 11 provinces in the basin in 2005 was about 16.4 million people (accounting for nearly 20% of the country's total population) of which 8.3 million live in rural areas. Figure 1.8 shows how the population distribution differs from area to area and from urban to rural areas.

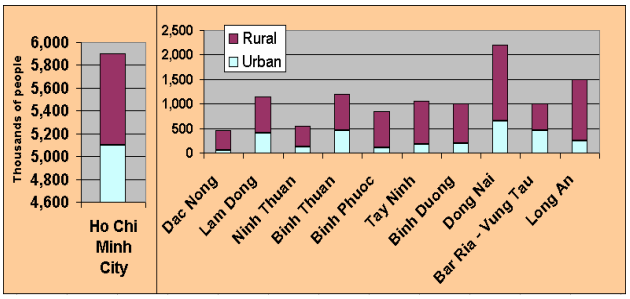


Figure 1.8: Population of provinces in the Dong Nai river basin

Source: Statistical Year Book 2005

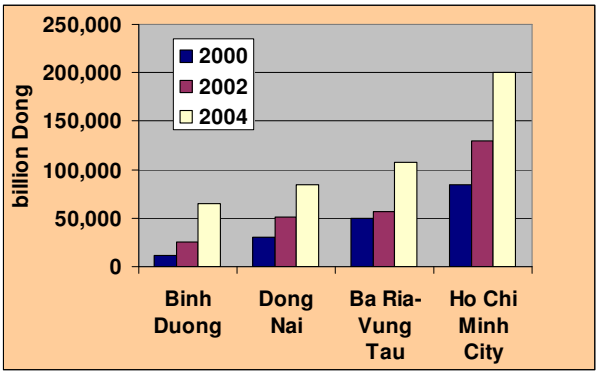
The average population density in the basin is 440 persons per $km^{2.}$ In HCM city the density is 2,811 persons per km^2, which is 11 times higher than the national average.

The basin is experiencing high urban growth rates in Ho Chi Minh City, Dong Nai, Binh Duong, and Ba Ria - Vung Tau, and high population densities in urban areas. The yearly average urban population growth rate in the basin is averaging 5.5% (15.6% for Binh Duong Province), compared to the national average rate of 2.5 to 3%.

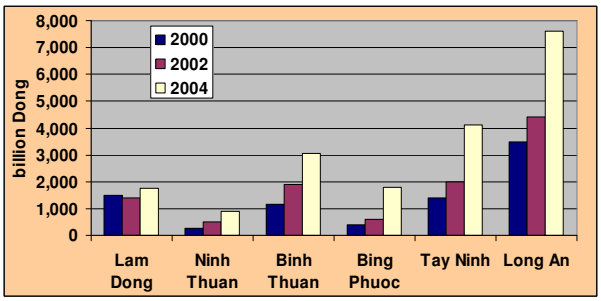
The Dong Nai River basin is the most active economic development area nation-wide. Tay Ninh, Long An, Binh Duong, Dong Nai, Ba Ria – Vung Tau, Ho Chi Minh City lie in the economic centre of the South, contributing up to 40% of the national GDP.

This is one of the key economic development regions, with high and sustained growth rates, and is providing core momentum for the economic growth of the country.

There are about 60 industrial and processing zones in the basin, mainly located in the 6 key economic provinces and cities, and in the lower river sections of the basin. In other localities, new industrial zones are also developing. The industrial development rate comprises 58% of GDP and the average growth rate is above 15% per year (nearly twice the national economic growth rate) – see Figure 1.9.



(a) Provinces with high GDP



(b) Provinces with lower GDP

Figure 1.9 Industrial production growths of provinces in Dong Nai River basin

Source: Statistical Year Book 2005

Box 1.2: Industrial development in the Basin

Ho Chi Minh City is the most important geographical area with 53.7% of total industrial employment (more than 840,000 employees) and 64.4% of all industrial facilities (approximately 5,500). Binh Duong and Dong Nai are the next most important industrial provinces. Together those three provinces have 92% of all industrial employment and 91% of all industrial facilities in the Region. In fact, they hold 50% of *all* industrial employment in the country, and 38% of *all* industrial facilities.

Source: *Analysis of Pollution from Manufacturing Sectors in Vietnam*, Technical Report prepared by ICEM (International Centre for Environmental Management) for The World Bank, January 2007

Total agricultural land is approximately 1,448,667 ha (about 24% of the total area). Agriculture comprises perennial plants such as rubber trees, coffee, tea, cashew nut, peanut, pepper and sugarcane, and annual crops such as rice, maize and vegetables.

Animal husbandry is also developing quickly in the basin. The number of cattle has increased from 2.7 million in 2001 to 4.4 million in 2005.

Aquaculture is a strong growth sector in the basin for species such as shrimp, goby, and wagtail fish. The total water surface area for aquaculture is approximately 71,800 ha, with fisheries output of 449,000 tonnes.

River transportation is well developed in the basin. There are 37 ports in the basin with the capacity to ship 1,000 to 30,000 DWT (Source: National Report on Inland source of Marine Pollution, 2004).

1.6 CONCLUSION

This chapter has presented a physical and socio-economic profile of the three river basins as a basis for considering water pollution level in Chapter 2.

All three basins are important to the national and regional economies and are located in key economic development zones. All are experiencing rapid and sustained population growth and corresponding urbanisation processes, having rates of population densities and growth well above the national average. They are all are experiencing rapid and concentrated industrial development, both large scale developments in industrial and export processing zones, and smaller but intense developments in craft villages. Although termed "villages", most of these centres are in effect light industrial areas.

Box 1.3: Importance of the 3 Economic Focal Regions

In 2004, the three Economic Focal Regions (EFRs) – Northern, Central and Southern - accounted for 71.4% of all firms in the industrial sector. The Southern EFR is significantly more important, with 68.4% of the total EFR employment and 58.5% of the firms located within the 3 EFRs. The Southern EFR alone has approximately 55% of the total industrial labour force in the country.

Source: *Analysis of Pollution from Manufacturing Sectors in Vietnam*, ICEM for The World Bank, January 2007

Undoubtedly the key factor that will affect pollution of the three river basins is the current and planned level of socio-economic development. Most economic activity in Vietnam is concentrated in the Red River Delta and the Southeast Region. The Southeast Region and the Mekong River Delta account for 55.6% of the total value of Vietnam's industrial production in 2004. With the Red River Delta, these 3 regions account for 75.6% of all industrial production value in the country.

The overall planning targets for Vietnam are set out in the Socio Economic Development Plan 2006-2010 (SEDP). Appendix B lists the major targets related to water quality and pollution in river systems. These targets concern the drive to consolidate the industrialisation of the country as a means of increasing GDP per capita and reducing poverty, specifying expanded targets for the various industrial sectors, agricultural targets and environmental targets.

With respect to the Cau River and the Nhue-Day River sub-basins:

- The Northern Economic Focal Region (EFR) aims to achieve an average annual economic growth rate of 11% and in doing so to contribute 20% to national GDP by 2010 (from the existing 18%) with a rapid restructuring of its economy towards industrialisation. Industry should grow at an annual rate of 16% over the period 2006-2010. By 2010, industry should represent 45 % of the total economy of the region (from 41% in 2004), and services 50% (from 45% in 2004).
- Within the industrial sector, a priority is given to knowledge intensive products (such as software), products of electric and electronic engineering, equipment and machinery, steel and ship building, coal, cement, high quality construction materials, food processing, textile and garment, and leather industries. Hanoi supports 43.1% of all industrial employment and 53.3% of all industrial facilities in the Northern EFR. With Hai Phong, these two provinces represent 66.6% of all industrial firms and 65.1% of all industrial employment.
- In Hanoi, the fabricated metal products sector, publishing and printing, and the food and beverage sector represent 38% (or 1,046) of all firms. Industrial activity in Hanoi spans many sectors.

- The rate of urbanisation is expected to increase from the existing 31% to 52% in 2010, and 65% in 2020.

With respect to the Dong Nai River basin:

- The Southern EFR is the industrial powerhouse of the country with more than 8,500 firms employing 1.5 million people. The EFR aims to achieve an average annual GDP growth rate of 14%, and to increase the share of the 'industry and construction' sector to 53%.
- Priority is given to the development of high value added and knowledge–based products (such as software, industrial and civil electronics), oil, gas and petrochemical products. As industrial activity is increasingly concentrated in the EFR, a priority is also given to the relocation of labour intensive industries (such as the food processing industry) to the provinces of Long An, Binh Phuoc, and Tay Ninh), and to complete the construction of 47 industrial zones and enhance the operational proficiency of existing industrial parks and areas.
- The leather tanning and dressing, wearing apparel, and food and beverage sectors represent 56% of all industrial employment in the Southern EFR. These last two sectors include more than 2,200 enterprises, or 26% of all firms in the region. Once again, firms in the leather tanning and dressing sector are on average much larger than in other sectors.

  (**Source**: *Analysis of Pollution from Manufacturing Sectors in Vietnam*, Technical Report prepared by ICEM for The World Bank, January 2007)

Water availability – river flows per person – is low in the three basins compared to national averages and international standards. All three basins are below the level of having "inadequate water" and the Cau River is currently below the much lower "water stress" level. By 2025 the Dong Nai River will also be below this level. This accentuates water shortages and conflicts over access to water over the long dry periods, and exacerbates the effects of poor water quality. Water quality in all three river systems is greatly influenced by river flows and their management.

Agricultural development remains a strong sector for all three basins both now and into the future, even though it is declining in relative economic importance.

The natural resource and environmental values of the three basins in the mid and lower reaches are under increasing threat. Conservation areas are few and not isolated from the effects of development. Throughout the basins, forest cover is declining in area and quality, reducing water retention for the dry periods and the ability to mitigate floods.

CHAPTER 2
WATER POLLUTION IN THE FOCUS RIVER BASINS

CHAPTER 2: WATER POLLUTION IN THE FOCUS RIVER BASINS

This Chapter describer the current pollution levels in the three focus river basins and the main causes of current pollution. It also provides indications of the future projections of pollution loads.

The levels of water pollution described in this chapter are based on ambient water quality assessments of the rivers in the basin. Ideally this information would be assessed from trends in water quality assessed over a reasonable time period and covering a good representative sample of parameters and water sources. However, for this report this is not possible as regular and routine water quality monitoring programmes are only now being established in Vietnam. The analysis here is based on monitored data and reports of local and central agencies using whatever good information is available, mostly monitoring undertaken by VEPA in late 2005.

2.1 INTRODUCTION

2.1.1 Water Quality Standards

Water quality standards are generally concentration limits for physical, chemical, biological and aesthetic (appearance and odour) parameters recommended to support and maintain a designated water use, such as drinking water.

In this report, Surface Water Quality Standard TCVN 5942-1995 is used to evaluate water quality in the three rivers basins. This is set out in Appendix A. These standards define the limits and permitted concentrations of pollutants for surface waters, and are used for assessing the ambient quality of a water source. There are two standards:

- TCVN (A): is applicable for surface water used for domestic water supply, assuming appropriate treatment.
- TCVN (B): is applicable for surface water used for other purposes. Water for agriculture and aquaculture is specifically regulated under other standards.

2.1.2 Pollution sources

Changes in water quality can be caused by natural factors – for example as rainfall and runoff moves over different rock and land types it can pick up naturally occurring chemicals before entering a river or aquifer. However, pollution from both point sources (such as industrial and sewage discharges) and diffuse sources (such as stormwater runoff from agricultural and urban areas) can have dramatic effects on water quality. Changes to river flows can compound pollution effects.

There is also a growing understanding that water quality is closely related to overall river health. This is affected by changes in catchment condition, channel form, riverbank vegetation, floodplain condition, flow variability and in-river habitat.

All of these factors are important to the three river systems under focus. However, in terms of the major pollutants, although BOD and SS provides the largest overall pollution, of most concern are chemicals and metals. Their persistence in the environment and potential health linkages makes them a higher priority in the short-term. This Chapter therefore, where possible, provides a greater focus on these aspects.

2.2 CAU RIVER SUB-BASIN

Note that in the Cau River sub-basin, the wet season generally occurs from June to October, and the dry season from November to May. This is important when considering the monitoring results presented here.

2.2.1 Current pollution levels

In the upper reaches of the sub-basin, the Cau River flowing through Bac Kan province is generally of good quality, although there is local pollution. For example, at Pha and Thac Rieng bridges, the levels of BOD_5 and SS have exceeded TCVN (A) by 2 to 4 times.

Before entering Thai Nguyen city, the Cau River section shows the first signs of serious pollution. This comes from industrial, mining

and agricultural activities along the river and two tributaries – the Nghinh Tuong River is affected by gold mining activities and the end section of the Du River receives wastewater from Phan Me coal mine.

The Cau River section flowing through Thai Nguyen city is seriously polluted, containing many organic compounds and oil residues. In the technical report *Analysis of Pollution from Manufacturing Sectors in Vietnam* (ICEM for The World Bank) all provinces in the country were analysed in terms of their pollution levels. This found that Thai Nguyen had the seventh highest ranking for water pollution of all the provinces. However, Cam Gia Commune in the Province came out on top of the commune pollution rankings nationally. It also ranked highest in terms of pollution from metals and from suspended matter. The report noted that only 5 factories were contributing the majority of this total pollution load.

At Tan Long ward, the water is very turbid, black in colour and with bad odours. The section of the Cau River flowing past the Thai Nguyen Steel Cast Industrial Zone has SS, BOD_5 and COD exceeding TCVN (A) by 2-3 times (Figure 2.1). These waters also contain oil residues and odours (Figure 2.2).

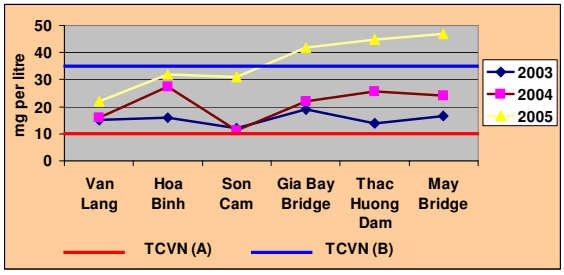


Figure 2.1: COD through Thai Nguyen

Source: Thai Nguyen Provincial Department of Natural Resources and Environment, 2006.

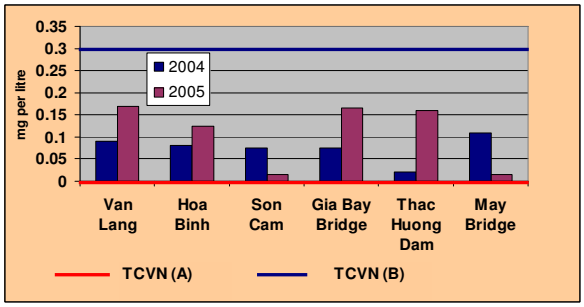


Figure 2.2: Oil levels in the section of Cau River through Thai Nguyen

Source: Thai Nguyen Provincial Department of Natural Resources and Environment, 2006

The Phuong Hoang River is a small tributary flowing through Tan Long in Thai Nguyen City. The river is polluted with organic matter directly from the Paper Production Company. Pollutants are BOD_5, COD, phenol and nitrates. COD and BOD_5 concentrations have exceeded TCVN (B) – see Figure 2.3.

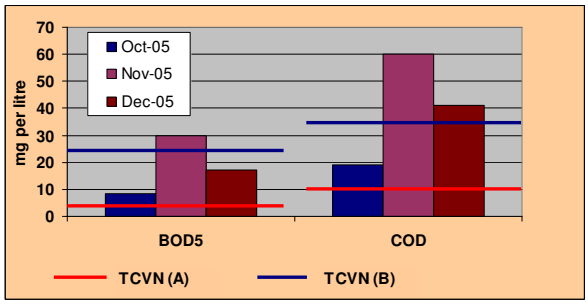


Figure 2.3: BOD_5 and COD levels in Phuong Hoang River, Thai Nguyen

Source: Vietnam's Environmental Protection Agency, 2005.

The Cong River is the second largest in the sub-basin and flows through Thai Nguyen province and into the Cau River at Da Phuc. The river water has shown signs of organic and oil pollution, and agricultural chemical residues have been found at some points. Figure 2.4 shows the average level of BOD_5 in the river through Thai Nguyen from monitoring in 2004 and 2005. This river section is impacted by tourism activities on Nui Coc Lake, sand exploitation activities on the river, and wastewater from mining activities and from the Cong River Industrial Zone.

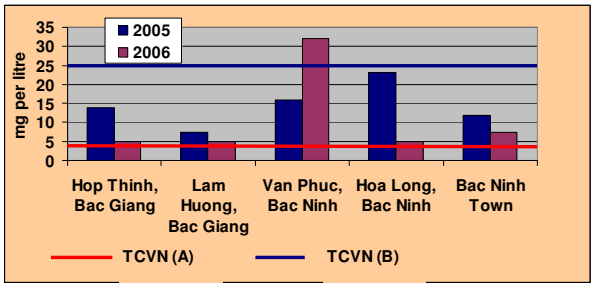


Figure 2.4: BOD_5 levels in the Cong River

Source: Thai Nguyen Provincial Department of Natural Resources and Environment, 2006

Water quality in the lower Cau River (through Bac Giang and Bac Ninh) is polluted by organic substances. Water at the end of the Cau River in Pha Lai has a high density of water traffic and oil levels are consequently high, generally exceeding TCVN (A). The lower river receives water

from Ca Lo River in Bac Giang and Ngu Huyen Khe River in Bac Ninh, which is seriously polluted. Oil scum is evident on the river water surface.

The Ca Lo River flows through industrial zones and towns in Vinh Phuc and some sections of Hanoi (Soc Son and Dong Anh Districts). Its water is polluted by organic substances from domestic wastewater, urbanisation and tourism, and by oil from industrial waste. The level of organic substances and nutrients is above TCVN (A). Oil pollution is clearly evident at Lo Cang Bridge, Binh Xuyen.

The Ngu Huyen Khe River is one of the most severely polluted rivers in the Cau River sub-basin. The River flows through Bac Ninh town and Tu Son and Yen Phong districts in Bac Ninh province. Wastewater discharge pours from production activities, especially from craft villages lying along the river from Dong Anh, Ha Noi to Van An. Sewage from Bac Ninh town and Tu Son and the Yen Phong districts add to the problem. River water is polluted by organic substances and levels of nutrients about ten times higher than TCVN (A) have been recorded – see Figure 2.5.

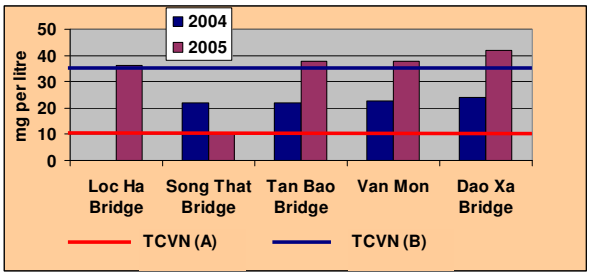


Figure 2.5: COD in Ngu Huyen Khe River in 2004 and 2005

Source: Thai Nguyen Provincial Department of Natural Resources and Environment, 2005

2.2.2 Sources of pollution

Socio-economic development and economic structures in the Cau River sub-basin are having a significant influence on water quality. There are differences between the mountainous provinces, and the midlands and plains. Pollution in Bac Kan, Bac Giang, and the agricultural areas in the sub-basin, is generally caused by waste from domestic areas and agricultural production – mostly non-point sources. However, for areas near the Cau River in Bac Ninh, Thai Nguyen, Vinh Phuc (Me Linh District) and Hanoi (Dong Anh District), pollution arises from point sources - industrial production, craft villages and urban wastewater.

Industrial wastewater

In 2004 there were 2,000 industrial enterprises, of which Bac Giang has the highest proportion (28%), Hai Duong (23%), and Bac Ninh (22%) (Figure 2.6).

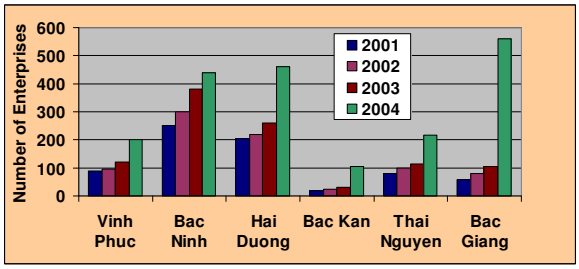


Figure 2.6: Industrial production enterprises in provinces

Source: Statistical Year Book, 2005

Industrial production in the sub-basin includes metallurgy, food processing, forestry processing, construction material, production of vehicles, and many others. Industrial zones and factories are concentrated mainly in Thai Nguyen, Hai Duong, Bac Ninh and Bac Giang. Thai Nguyen has 27 industrial zones - the most of the 6 provinces in the sub-basin - with 12 of these in operation. Thai Nguyen has 12 iron-casting and steel production sites, over 30 ore exploitation sites and over 100 gold exploitation sites.

Figure 2.7 shows that wastewater from mining and mineral processing makes up 55% of the total. Metal production (29%) is the second largest, then paper production (7%), and food processing (4%). All wastewater is discharged to surface waters at point sources.

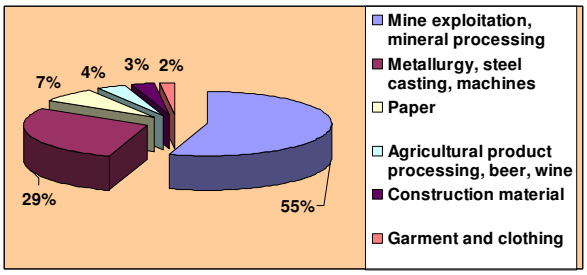


Figure 2.7: Wastewater proportion of major production sectors

Source: Vietnam Environment Protection Agency, 2005

Table 2.1. Volume of wastewater from selected mines in Thai Nguyen

Mines	Design capacity (tonne/year)	Wastewater (thousand m^3/year)			
		2001	2002	2003	2004
Phan Me Coal Mine	80,000	335	453	580	937
Trai Cau Metal Mine	35,000	8,120	13,460	19,852	15,971
Dai Tu Zinc Mine	200	696	629	636	629
Cuc Duong Clay Mine	15,000	4	71	138	79
Lang Hich Lead Zinc Mine	15,000	710	939	1,093	796

Source: Thai Nguyen State of Environment Report, 2005

Mining and ore exploitation: There are many mining activities in the up-river provinces of Bac Kan and Thai Nguyen, including gold, metal, zinc, lead, coal and clay. Most of these mines do not have wastewater treatment systems and wastewater is discharged to surface waters.

Table 2.1 shows the volume of wastewater produced by a number of mines in Thai Nguyen over a 4 year period. This shows that the wastewater generated has generally been steadily increasing over the period. However, the wastewater from the Phan Me Caol Mine has tripled in the period and that from the Trai Cau Metal Mine has doubled. Dai Tu Zinc Mine is of particular concern as the wastewater generated per tonne of production capacity is up to hundreds of time greater than the other mines.

Metallurgy, steel casting and machinery manufacturing: is concentrated mainly in Thai Nguyen, which has 12 iron-casting and steel production sites, and the total wastewater quantity is 16,000 m^3/day discharged. Wastewater from The Thai Nguyen Cast-iron Industrial Zone in Thai Nguyen City has considerable influence on water quality. Wastewater runs into 2 drains and then to the Cau River at an estimated quantity of 1.3 million m^3/year. It contains many contaminants such as oil, phenol and cyanide. However, the industrial zone has now built a wastewater treatment system to limit pollution.

The second largest industrial zone is the Song Cong Industrial Zone in Song Cong Town. This zone has mechanical engineering and vehicle machinery plants. The Zone has been in operation since 2001, but to date no wastewater treatment facilities have been built. Most factories in the Zone do not have wastewater treatment systems, or only have a simple treatment system such as primary sludge treatment. The wastewater, containing oil and heavy metals, runs directly into the Cong River.

Paper production: This provides wastewater volumes of 3,500 m^3/day. Wastewater from the Hoang Van Thu Paper Factory (Thai Nguyen) has the most significant influence on water quality. Wastewater from the factory is discharged into the Cau River and contains inorganic substances and suspended fibres. The water is black in colour with high concentrations of alkaline, and has bad odours.

In 2005, this factory stopped using the old production line and in 2006 it invested in a wastewater treatment system to reduce pollution. However, next to this mill is another paper mill producing paper for export. This also directly discharges its wastewater to the Phuong Hoang River.

Food processing: Food production and food processing plants discharge about 2,000 m^3/day of untreated wastewater into ditches, drains and the river. This wastewater contains organic substances, glucose, lipids, bacteria, coliform etc, which produce serious odours in surface water and many other problems.

Other factories and production sites also discharge untreated wastewater to rivers of the sub-basin. These include pharmaceutical production factories, garment factories, construction material

production plants, packing material plants and automobile assembly factories.

Wastewater from industrial zones and production factories of Bac Giang (Dinh Tram Industrial Zone, Song Khe-Noi Hoang, Ha Bac Nitrogen and Chemical Company, etc) receives basic treatment and is then discharged directly into water sources. Some large-scale factories, such as Dap Cau Glasses Factories, Bac Son Cigarettes Factory (Bac Ninh), discharge their wastewater direct to the Ngu Huyen Khe River.

Many establishments in Vinh Phuc industrial zones discharge their wastewater to the Ca Lo River without treatment or with only primary treatment. Wastewater from industrial clusters and factories of Bac Giang province (such as Dinh Tran Industrial Zone, Song Khe – Noi Hoang Industrial Cluster, Ha Bac fertiliser and chemical factory, etc.) is discharged to surrounding water bodies after basic primary treatment (mechanical settlement). Large-scale factories such as Dap Cau Glass Factory, Bac Son Tobacco Factory (Bac Ninh province) discharge their untreated wastewater to the Ngu Huyen Khe River.

Wastewater from craft villages

Craft villages are in effect industrial production areas, characterised by high volumes of wastewater, high levels of pollution, none or at best insufficient wastewater treatment, and wastewater directly discharged to surface water sources.

There are more than 200 craft villages in the Cau River sub-basin including paper production, alcohol production, iron plating, waste recycling and pottery. A large quantity of untreated wastewater from craft villages runs directly into ponds, lakes and the River. Some villages, have concentration points for wastewater treatment but these are not effective.

Craft villages are concentrated mainly in Bac Ninh, but some are dispersed in Thai Nguyen, Vinh Phuc and Bac Giang. Bac Ninh has 60 craft villages about 30% of the total – see Figure 2.6. These villages concentrate along the river banks and therefore badly affect surface water in the sub-basin.

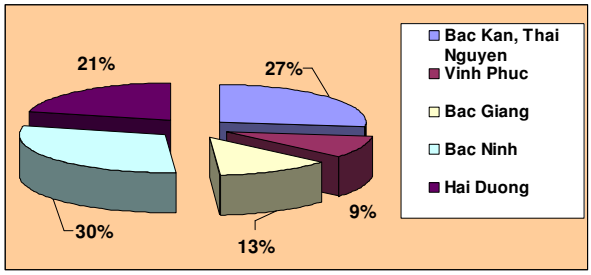


Figure 2.8: Proportion of craft villages in provinces/cities

Source: Vietnam Environment Protection Agency, 2006

Traditional craft villages in Bac Ninh have diversified production but suffer from old equipment, small scale and space, and limited ability to invest in wastewater treatment systems. This combination produces a badly polluted environment. Most of the wastewater is high in BOD and other pollutants, and runs directly into the Ngu Huyen Khe River without treatment.

Bac Giang has 25 craft villages of many types. Van Ha village uses 40 to 50 tonnes of dry cassava to produce wine, with the by-products used for raising pigs. Solid and liquid waste discharged to the environment is about 5,000 m^3 /day. Phuc Lam is a livestock slaughter village killing 300 to 400 animals every day. Each household releases about 3 to 4 m^3 of wastewater a day and 80 to 100kg of sewage a day. As well, significant amounts of salt used in pickling animal skin are discharged. Wastewater from these two villages runs into ponds or lakes in the village, then to the Cau River, adding considerable quantities of organic substance pollution.

Thai Nguyen has craft villages such as bamboo, weaving and brick production. In addition, there are 12 iron casting and steel refining establishments, more than 30 small lead and zinc ore establishments and more than 100 gold production establishments. None of these have wastewater treatment systems and the wastewater, containing many heavy metals and harmful chemicals, is directly discharged to sewage systems and then to the Cau River.

Vinh Phuc has 16 craft villages including machinery, carpentry, pottery, bamboo weaving and food processing. Most of the wastewater is not treated and runs directly into ponds, lakes and drains and then discharges into the main rivers.

Table 2.2. Typical craft villages in Bac Ninh

Craft village	No. of units/ house-holds	Waterwater quantity m^3/day	BOD amount kg/day
Phong Khe paper production	64	3,500	1,000-1,500
Phu Lam paper production		2,000-2,500	260-330
Da Hoi Iron Production	450	15,000	600-675
Van Mon aluminium and lead casting	80 - 120	500-1,000	5-25
Dong Ky wood processing	1,000	800-1,200	40-60

Source: Bac Ninh DONRE, 2006

Box 2.1. Wastewater from craft villages in Bac Ninh Province

Phong Khe and Phu Lam recycled paper production craft village produces 18 – 20 thousand tonnes/year of paper and discharge about 5,500 m^3 of wastewater/day. Wastewater from paper factories contains many toxic chemicals such as alkali, detergents, alum, resin and artificial colouring agents. The level of BOD_5 is 130 mg/l exceeding TCVN (B) by 4.3 times and COD is 617 mg/l exceeding TCVN (B) by 6 times.

Da Hoi steel processing craft village has a total output of 500 – 700 tonnes/day of product and discharges 15,000 m^3 of wastewater/day. Wastewater is high in acid or alkali, oil, rust, etc. which are released to the environment and greatly exceeds the allowed standard: colour by 3.1 times, iron by 3.3 times, Cr by 8.6 times and CN- by 2 times.

Households processing food in Tam Da Commune, Yen Phong District, produce 1.2 - 1.3 billion litres of alcohol/year. Wastewater from the production contains many organic substances which are discharged without treatment directly to the Ngu Huyen Khe River.

Source: National report on results of science and technology: Environment in Cau River sub-Basin, 2003

Domestic wastewater

The population density for the Cau River sub-basin is already many times the national average and the growth rate is high (3.5% a year). However, the support facilities, particularly in urban areas, is developing much more slowly, which increases domestic water pollution.

Urban areas tend to be located along rivers and most domestic water is untreated, running directly to rivers and ponds. Domestic wastewater contains nutrients, high levels of BOD and organic substances such as azotes, coliform, bacteria and potential disease causing germs. The amount of various pollutants from domestic sources is shown in Table 2.3.

Based on the population in the provinces, it is estimated that Hai Duong produces the most wastewater (about 25%). The town is located at the lower end of the river system so that its influence on the whole sub-basin is not as great as other provinces – such as Bac Giang (23%), Vinh Phuc (17%) (Figure 2.9).

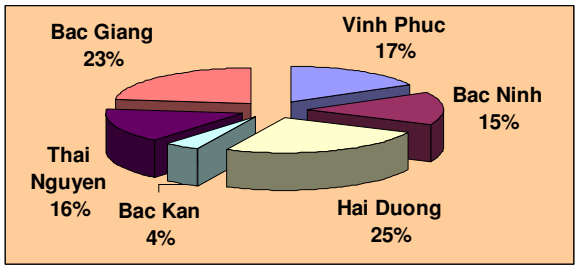


Figure 2.9: Estimated proportion of domestic wastewater from provinces

Source: Calculation based on population of provinces – Statistical Year Book, 2005

Table 2.3. Estimated pollutants from domestic wastewater, 2005

	Vinh Phuc	Bac Ninh	Hai Duong	Bac Kan	Thai Nguyen	Bac Giang	Basin
COD (tonne/day)	83 – 119	71 - 101	122 - 174	21 - 30	79 - 112	112 - 161	488 - 697
BOD (tonne/day)	52 - 62	44 - 53	76 - 92	13 - 16	49 - 59	70 - 85	304 - 367
Total nitrogen (tonne/day)	7 - 14	6 - 12	10 - 20	2 - 4	7 - 13	9 - 19	41 - 82
Total phosphor (tonne/day)	0.5 – 4.6	0.4 - 4	0.7 - 7	0.2 – 1.2	0.4 - 4	0.6 - 6	2.8 – 26.8
Coliform (10^9 tonne/day)	1,155 – 1,155,000	987 – 987,000	1,698 – 1,698,000	295 – 295,000	1,095 – 1,095,000	1,564 – 1,564,000	6,794 – 6,794,000
Oil (tonne/day)	11	10	17	3	11	14	66
SS (tonne/day)	196 - 254	168 - 217	289 - 374	50 - 65	186 - 240	266 - 344	1,155 - 1494

(Based on pollutant calculation of WHO, 1993; and populations 2005, Statistical Year Book, 2005

Hospital wastewater

In 2005, provinces in the Cau River sub-basin had 74 hospitals with 15,400 sick beds. These hospitals discharge about 5,400 m^3/day via point sources. The proportion of this wastewater from the provinces is shown in Figure 2.10.

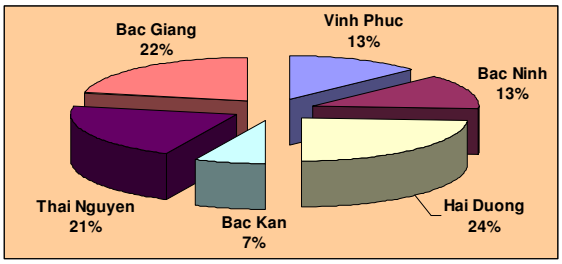


Figure 2.10: Proportion of medical wastewater from provinces

Source: Statistical Year Book, 2005

Currently only Thai Nguyen General Hospital has a central wastewater treatment system. Some other hospitals have wastewater treatment facilities installed, but these do not operate or are not effective. Untreated wastewater from these hospitals runs directly into the surface water environment. Hospital wastewater is a serious concern for local communities as it contains many toxic chemicals, organic substances and potentially lethal bacteria.

Animal husbandry activities

The number of farm animals in the sub-basin had been steadily increasing, particularly in Bac Giang where that now over 1.1 million head (Figure 2.11).

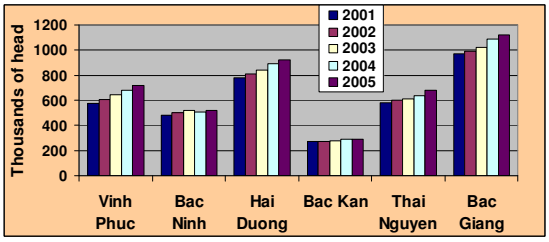


Figure 2.11: Number of farming livestock

Source: Statistical Yearly Book, 2005

Facilities for the treatment and the disposal of solid matter and wastewater from these farms are generally not built and the waste finds its way to water sources as point source discharges.

Agricultural activities

Agriculture is an important sector in the sub-basin with each province tending to specialise in agriculture production. In Bac Giang, soybeans and lycees are common. Farmers plant tea in Thai Nguyen and vegetables in Bac Ninh.

To increase plant productivity, pesticides and chemical fertilisers are increasingly used, especially in Thai Nguyen and Bac Ninh. This results in elevated levels of NO_2 and NO_3 in soils and in farm produce from Bac Ninh province, Me Linh district (Vinh Phuc) and some areas in the lower parts of the sub-basin. This finds its way to surface water via runoff and drainage, as non-point sources of pollution.

Box 2.2 Use of plant protection chemicals in Thai Nguyen

The average amount of plant protection chemicals used in a rice or maize crop is from 3 to 3.5 kg/hectare of farmland. For each tea crop, farmers apply pesticides 3 to 5 times. Therefore, the amount of plant protection chemicals used in a rice crop is about 175 tonnes, in maize crop 32 tonnes, and in a tea crop 56 tonnes.

Source: Thai Nguyen State of Environment Report, 2005

Chemical fertilisers and pesticides are now used widely in all of the agriculture production areas. The average amount of pesticides used in the sub-basin is 3kg/hectares/year, of which insecticides make up 68.3% (Figure 2.12). Chemical fertiliser use is about 500,000 tonnes/year and pesticide use is about 4,000 tonnes/year. About 33% of this is estimated to be in excess of requirements.

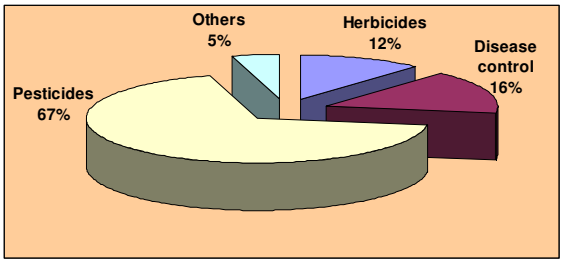


Figure 2.12: Amount of chemical use in agriculture

Source: Vietnam State of Environment Report, 2005

In Bac Ninh, to protect vegetable, jutes, sugar canes, ground nuts, bean, etc. 1,200 tonnes of pest eradication chemicals and 200,000 to 300,000 tonnes of NPK fertiliser (Nitrogen, Phosphorous, Potassium) are used. Vegetable areas have pest eradication chemicals applied at rates of 3 to 5 times more than rice areas. At present, the province is encouraging farmers to use biological pest control measures and farming and protection methods.

In Bac Giang farmers are increasingly developing fruit trees, especially longan and litchi. This also requires chemical sprays to protect the crop and about 145 tonnes per year of chemicals are used. (Bac Giang Provincial State of the Environment Report, 2005)

Solid waste

The amount of solid waste is estimated at about 1,500 tonnes/day, and is mainly domestic waste. Thai Nguyen generates nearly 350 tonnes a day – more than twice the amount of any other province.

The proportion of solid waste collected is low, about 40-45% in the whole basin. In urban areas, the proportion is higher, about 60-70%. In most of the provinces there are no sanitary landfill sites or solid waste treatment systems. Most of the waste from cities and towns is collected and dumped in a specific location without treatment. In rural areas, waste is mostly dumped on river banks, or in lakes or ponds surrounding residential areas. This is a source of pollutants to both surface water and underground water.

Toxic industrial and hospital solid waste is less in quantity than household solid waste – see Table 2.4 - but needs greater attention because they have far greater influence on the environment and human health if not effectively disposed. However, at present most of this waste is not classified and treated according to the regulations.

Table 2.4: Hospital solid waste in 2004

Province	Kg/day
Thai Nguyen	350
Vinh Phuc	141
Bac Ninh	438
Hai Duong	613

Source: State of Environment Report in provinces, 2005

2.2.3. Pollution forecasts

Based on the approved socio-economic development plans of the provinces, it is estimated that by 2010 the wastewater discharged to rivers in the Cau River sub-basin will have doubled compared to the current volume.

The environmental pollution level of the sub-basin has been analysed based on three scenarios:

- Scenario 1: The wastewater volume in the sub-basin increases according to the planning targets, but is not treated;

- Scenario 2: The wastewater volume in the sub-basin increases according to the planning targets, but with 30% of all wastewater treated (existing and additional);
- Scenario 3: The wastewater volume in the sub-basin increases according to the planning targets and all of the wastewater (existing and additional) is treated to meet environmental standards.

Some of the results are shown in Figures 2.13, 2.14 and 2.15. Under Scenario 1, the planned economic development would be accompanied by severe depletion of surface water quality: the average BOD concentration would increase by 1.5 times, and by 1.8 times at some locations such as like Quan Trieu ward in Thai Nguyen city; the average total nitrogen would increase by 1.3 times; the average total phosphorous would increase by 1.2 times, and by 1.5 times in some locations such as Van Yen (Yen Phong – Bac Ninh); and the average coliform concentration would increase by 1.3 times.

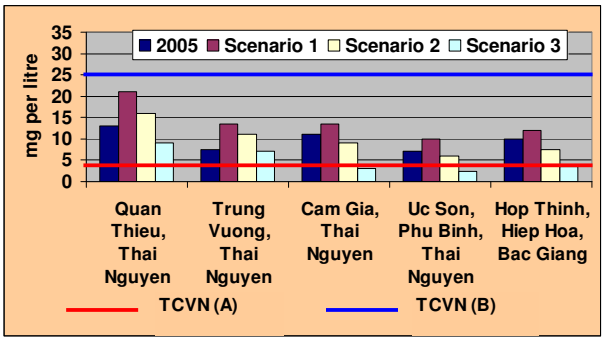


Figure 2.13: BOD_5 concentration (2005 and projected for 2010)

Source: The Institute of Hydro-meteorological and environmental studies, 2006

For Scenario 2 there is a significant improvement, although pollution levels would still be above the standards.

Under Scenario 3 the analysis shows that if all of the wastewater is properly treated, water quality in the Cau River sub-basin would be considerably improved - the quality indicators of the water would nearly meet the TCVN (A). This means that the surface water could generally be supplied for domestic use purposes after appropriate treatment.

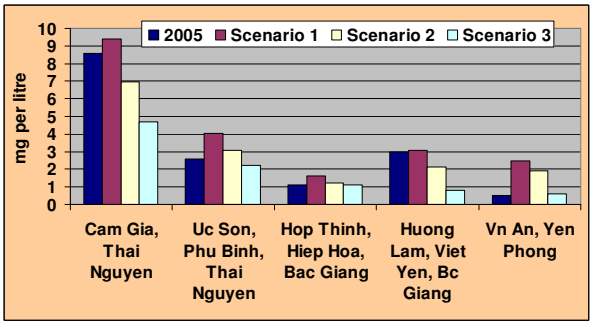


Figure 2.14: Total nitrogen (2005 and projected for 2010)

Source: The Institute of Hydro-meteorological and environmental studies, 2006

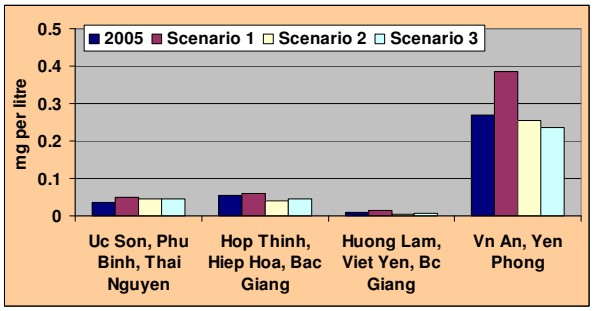


Figure 2.15: Total phosphorous (2005 and projected for 2010)

Source: The Institute of Hydro-meteorological and environmental studies, 2006

2.3. NHUE-DAY RIVER BASIN

Note that in the Nhue-Day River sub-basin, the wet season generally occurs from June to October, and the dry season from November to May. This is important when considering the monitoring results presented in this section.

2.3.1 Current pollution levels

River water quality in this sub-basin depends on river flows, wastewater discharge in the upper river and on pollution from agriculture and aquaculture in the lower parts of the river system. In general, the water of the Day River is less polluted than the Nhue River. Pollutants are mainly organic substances and coliform, often at relatively high levels, especially in the dry season. Pollution tends to be increasing.

Within Hanoi, surface water in rivers, lakes and drains is seriously polluted. Parameters measured exceed TCVN (B) and even exceed TCVN 6772-2000, level IV (for domestic wastewater). The monitoring

results conducted in late 2005 show that levels of DO are low. COD exceeds TCVN (B) by 7-8 times; BOD_5 by 7 times (Figure 2.16). The level of coliform is nearly twice TCCP (B). Pollution levels increase markedly in the dry season when the Lien Mac channel closes (between each November and May).

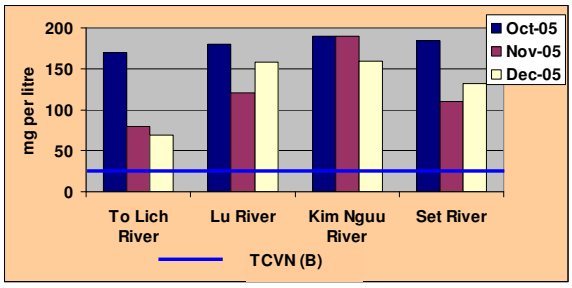


Figure 2.16: BOD_5 within Hanoi

Source: Vietnam Environment Protection Agency, 2005

In a technical report *Analysis of Pollution from Manufacturing Sectors in Vietnam* (ICEM for The World Bank), all provinces in the country were analysed in terms of their pollution levels. This found that Hanoi had the second highest ranking for water pollution of all the provinces nationally. For all provinces in the top 10 of the rankings, the analysis was extended to commune and enterprise level. This found that the Phuong Liet commune in Hanoi ranked tenth nationally for water pollution.

Most of the stormwater, plus domestic and industrial wastewater from Hanoi city and surrounding areas, finds its way to the rivers in the city. Wastewater then runs into the Nhue River through Thanh Liet Dam. The river system is heavily polluted as until recently no domestic, industrial or agriculture wastewater was treated. The Yen So reservoir now receives most of Hanoi's wastewater. This is pumped into the Red River and reduces the amount of wastewater from the To Lich River. However, this operation is limited mainly to the dry season, and in the wet seasons a large amount of wastewater still runs directly to the Nhue River.

In the upper reaches, before receiving runoff from Hanoi, water quality of the Nhue River is generally good, although SS levels are very high.

The sections of the Nhue River through Ha Dong Town (Phuc La) before receiving water from the To Lich River, are seriously polluted: COD and BOD_5 exceed TCVN (B) by between 3 and 4 times. DO remains very low and does not meet TCVN (A). The water has poor physical appearance, being black and scummy, and there are strong fish odours.

Down river from the To Lich River junction, the river water is extremely polluted, especially in the dry season when there are minimal diluting flows from the Red River. Even in the wet season, BOD_5, DO, NH_4+, and coliform all fail to meet TCVN (B).

From the To Lich River junction to the confluence with the Day River, the pollution level gradually decreases as the pollutants are assimilated and dispersed. However, pollution overall generally remains at levels exceeding TCVN (B) (Figure 2.17).

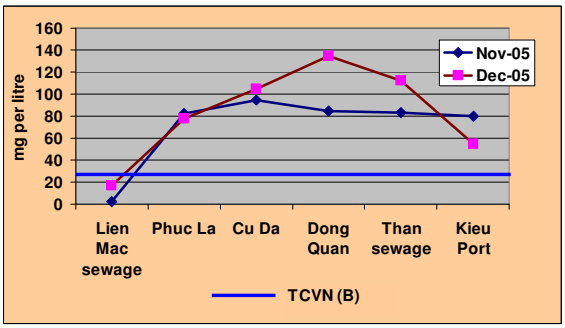


Figure 2.17: BOD_5 trends in the Nhue River

Source: Vietnam's Environmental Protection Agency, 2005

Although wastewater discharge to the To Lich River is now treated in Yen So Pond and pumped to the Red River in the dry season, the Nhue River still shows a trend of increasing pollution. Figure 2.18 indicates increasing COD levels over time.

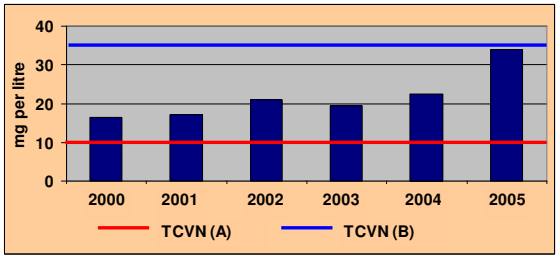


Figure 2.18: COD in the Nhue River at Nhat Tuu (Ha Nam)

Source: Ha Nam provincial Department of Natural Resources and Environment, 2006

The Day River is locally polluted with the pollution level tending to increase, especially as the river is affected by the polluted inflows from the Nhue River.

From Ha Dong Town (Ha Tay) to Phu Ly Town (Ha Nam), water in the Day River is mainly polluted by organic substances. Typical parameters of organic pollution in the river sections flowing through Ung Hoa and My Duc in Ha Tay, and Kim Bang and Phu Ly in Ha Nam have all exceeded TCVN (A). At Hong Phu bridge (Phu Ly, Ha Nam – the confluence of the Nhue, Day and Chau Giang Rivers) - the water is polluted with relatively high level of organic pollutants, especially in the dry season when Lien Mac Drain closes – see Figures 2.19 and 2.20 which show BOD_5 and COD trends at Te Tieu and Hong Phu bridgse.

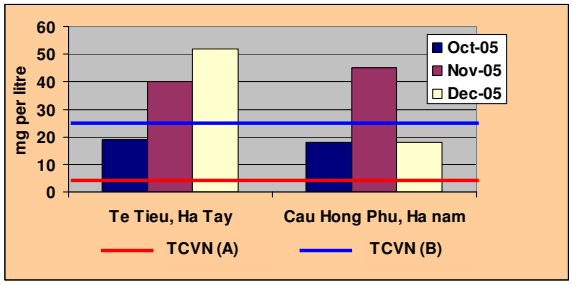


Figure 2.19: BOD_5 trends at Te Tieu and Hong Phu bridge

Source: Vietnam's Environmental Protection Agency, 2005

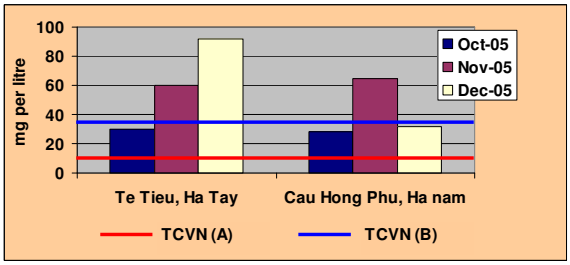


Figure 2.20: COD trends at Te Tieu and Hong Phu bridge

Source: Vietnam's Environmental Protection Agency, 2005

Figure 2.33 shows how BOD_5 has varied along this section of the River.

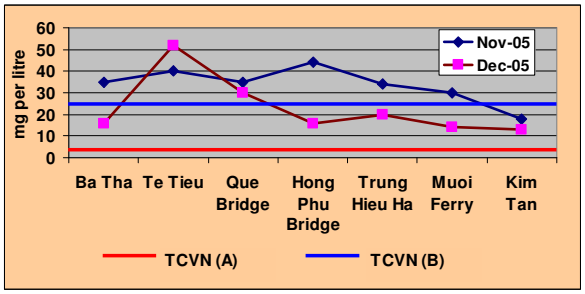


Figure 2.21: BOD_5 on the Day River section from Ba Tha to Kim Tan

Source: Vietnam's Environmental Protection Agency, 2005

From Phu Ly to the junction of the Hoang Long and the Day Rivers (Gian Khau – Gia Vien – Ninh Binh), river water is quite seriously polluted not only by inflows from the Nhue River, but also by wastewater from domestic activities and industrial production in Phu Ly Town. BOD_5 is 2 to 3 times higher than TCVN (A). As well, the River receives water from the Hoang Long River, which is polluted after flowing through Hoa Binh and Ninh Binh (Gia Vien District).

In the Day River sections from Gia Vien to Kim Son (Ninh Binh), water is polluted by organic substances and parameters do not meet TCVN (A) (for example BOD_5 is 2-3 times higher than the standard). The quality in some sections fails to meet TCVN (B), especially at the Ninh Binh Thermoelectric Factory, where the water is black and muddy.

The lower reaches of the Day River (from Kim Son to the estuary) is also polluted. Although wastewater from the upper and mid river is diluted and the pollutants dispersed and assimilated, water quality of the River is affected by waste from agricultural production and domestic activities. Many parameters still do not meet TCVN (A).

In general, water quality of the Day River changes along its length and over time. However, water quality of the River has deteriorated over recent years – see Figure 2.22, which shows the changes in COD (average value/year) over time in Ha Nam (mid-river) and in Nam Dinh (lower-river).

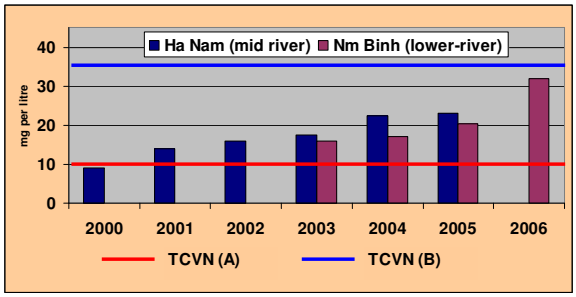


Figure 2.22: COD trends of the Day River in Ha Nam (mid) and Nam Dinh (lower)

Source: Ha Nam and Nam Dinh provincial Department of Natural Resources and Environment, 2006

Other rivers in the basin have also shown signs of water quality deterioration.

The Tich River is polluted by organic substances at levels exceeding TCVN (A). This is due to the river receiving polluted wastewater from the Hoa Lac and Son Tay areas, which are developing rapidly, and the Bui River. Water quality of the Bui River is being polluted from production and domestic wastewater from Luong Son and Hoa Binh.

The Chau Giang River is polluted and the pollution is increasing. This river joins the Day River and Nhue River at Phu Ly. However, its off-take from the Red River has now been closed, and its water quality is increasingly affected by agricultural waste and water from the Nhue and Day Rivers. Monitoring results show a steady increase in some pollutants, such as COD, over recent years (Figure 2.23).

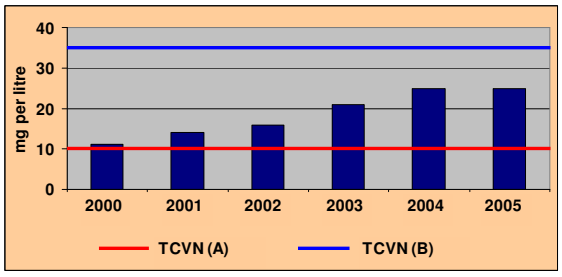


Figure 2.23: COD trends in Chau Giang river

Source: Ha Nam provincial Department of Natural Resources and Environment, 2006

The Hoang Long river is polluted by organic substances at a relatively high level at the confluence with the Day River (Figure 2.24), after flowing through Hoa Binh, Nam Dinh and Ninh Binh. BOD and COD are at, or exceed, TCVN (B).

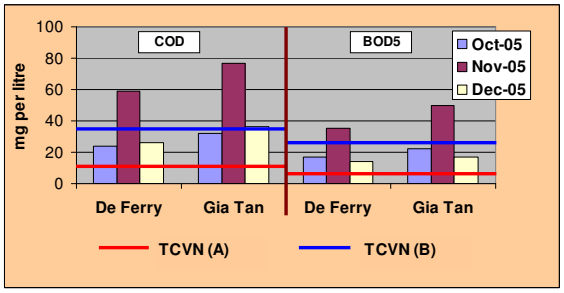


Figure 2.24: COD and BOD_5 levels for Hoang Long River at De Ferry (mid river) and Gia Tan (lower river)

Source: Vietnam's Environmental Protection Agency, 2005

The quality of the Dao River (which runs to the Day River) in some parts is slightly polluted by organic substances. Parameters exceed TCVN (A), but are within TCVN (B). However, water quality of this River is tending to degrade.

2.3.2. Sources of pollution

There are many wastewater sources that pollute the Nhue-Day River sub-basin. Of these, domestic wastewater contributes the largest part (56%). This is a unique feature of this sub-basin compared to others (Figure 2.25).

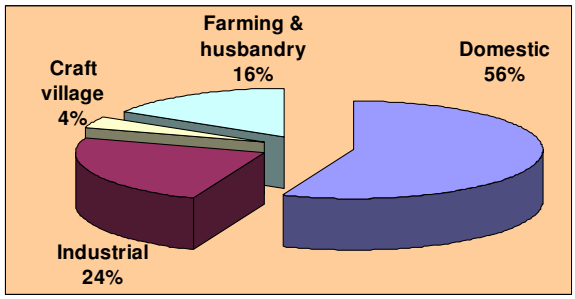


Figure 2.25: Proportion of wastewater discharged to Nhue-Day River

Source: Vietnam Environment Protection Agency, 2006

Industrial wastewater

In 2004, there were 4,113 industrial enterprises (of which 67% were in Hanoi) with an industrial production value of VND 83,382 billion (*General Department of statistics, 2005*) – see Figure 2.26. These enterprises are producing considerable amounts of waste (solid, liquid and air) polluting and affecting the environment of the sub-basin. This is a major source of point source discharge to water sources, causing serious surface water pollution.

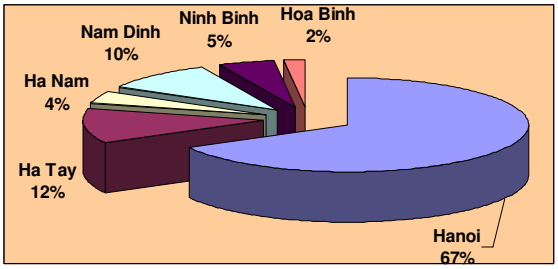


Figure 2.26: Proportion of industrial production enterprises in province/cities

Source: General Dept of Statistics, 2005

Box 2.3: The output of wastewater from industrial sectors in Hanoi

Textile and Dyeing: 14,500 - 17,210 m^3 per day
Foodstuff Companies: 3,870 - 16,010 m^3 per day
Chemical Factories: 24,500 - 26,540 m^3 per day
Mechanics Factories: 3,730 - 4,500 m^3 per day

Source: Report on state of environment, 2005

Industrial activities in Hanoi produce the most industrial wastewater in comparison to other provinces in the sub-basin (approximately 100,000 m^3/day, or about 30% of the total). Ha Tay produces approximately 80,000 m^3/day (around 25% of the total).

There are 218 industrial enterprises that are the major wastewater producers in the sub-sasin – see Table 2.5. Wastewater from different industries has different characteristics and different impacts on water quality. The mechanical industry produces the largest amount (33%) - see Figure 2.27 - and its wastewater has significant amounts of oil and suspended solids. Wastewater from food processing factories contains considerable amino acid and organic compounds. Wastewater from textile industry contains such chemicals as alkali, detergent, pine resin and artificial colouring agents.

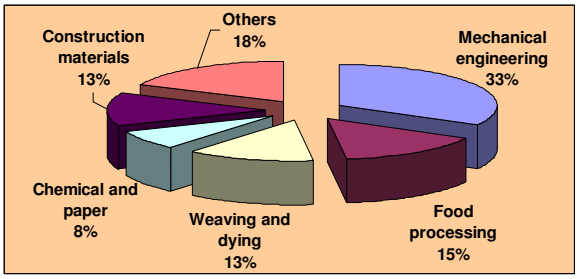


Figure 2.27: Waste generating industries

Source: Institute of Geography, 2005

Table 2.5: Sectors discharging industrial waste to rivers

Province	Mechanical industry		Food processing industry		Textile industry		Paper and chemical industry		Construction materials		Other industries	
	No units	%	No units	%	No units	%	No units	%	No units	%	No units	%
Hanoi	45	64	10	30	17	56.5	5	28	9	32		
Ha Tay	11	16	9	28	6	20	5	28	5	18		
Nam Dinh	9	13	2	6	6	20	3	16.5	0	0		
Ninh Binh	3	4	4	12	0	0	1	5.5	4	14.5		
Ha Nam	1	1.5	5	15	1	3.5	3	16.5	4	14.5		
Hao Binh	1	1.5	3	9	0	0	1	5.5	6	21		
Total	70	100	33	100	30	100	18	100	28	100	40	100

Source: Institute of Geography, 2005

Wastewater from craft villages

Craft villages have provided significant economic benefits, but also contribute to major environmental pollution in the sub-basin. Craft villages provide about 45,000 to 60,000 m^3 of wastewater/day via point sources.

Most of the small production establishments within craft villages have developed spontaneously to meet market demands. They are characterised by simple equipment, old technologies and small workplaces, and limited investment potential for wastewater treatment facilities. Some investments have been made in central wastewater treatment facilities for some villages; however the effectiveness of these has been low. Therefore, wastewater is usually discharged to receiving sources without prior treatment.

Currently there are 458 craft villages in the sub-basin with the vast majority in Ha Tay at the top of the river system - nearly 50% of this total (Figure 2.28). Here, the amount of wastewater from only 11 villages in Ha Dong and Hoai Duc is 15,000 to 18,000 m^3/day. This flows directly to the Nhue River without treatment.

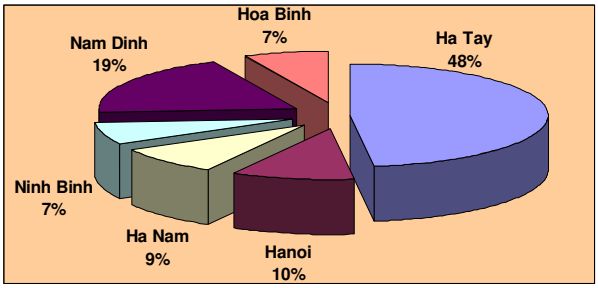


Figure 2.28: Craft villages in provinces/cities

Source: Departments of Natural Resources and Environment of provinces/cities, 2006

The surface water pollution caused by production activities of these villages has become increasingly severe, with different characteristics from different type of activities – see Table 2.6. Agricultural food processing villages are among the biggest wastewater generators, causing major impacts to the surface water environment. Some typical examples are:

- Cat Que village, Hoai Duc (producing malt, vermicelli, sugar, dry rice pancake): discharging 3,500 m^3/day.
- Duong Lieu village, Hoai Duc (producing vermicelli, starch): discharging 6,800 m^3/day.
- Minh Khai village, Hoai Duc (producing vermicelli, starch): discharging 5,500 m^3/day.

*(**Source**: Ha Tay provincial Department of Natural Resources and Environment, 2005)*

Table 2.6: Number of craft villages per main production sectors

Province/ City	Total Number	Silk sowing/ weaving/ dying	Food processing	Mechanical	Handicraft, timber processing	Construction material	Others
Hoa Binh	34	29	-	5	-	-	-
Ha Tay	219	29	33	10	96	-	51
Ha Noi	48	5	14	3	10	1	15
Ha Nam	40	5	8	1	26	-	-
Ninh Binh	30	4	-	-	26	-	-
Nam Dinh	87	14	4	9	21	3	36
Total	458	86	59	28	179	4	102

Source: Departments of Natural Resources and Environment of provinces/cities, 2006

Box 2.4: Environment pollution due to production groups of craft villages

The extent of polluted water from food and agriculture products processing factories is very high. The major pollutants are organic substance - 380 to 400 kg BOD_5/tonne of product, 600 to 650 kg COD/ tonne of product

Textile factories use lots of water and chemicals. Wastewater contains high levels of pigment and excess chemicals - 81 kg COD/tonne of product, 300 kg SS/ tonne of product.

Wastewater from mechanical factories contain waste exceeding TCVN (A) by many times: Cr(VI) by 420 times; Cr (III) by 18 to 100 times; Pb by 6 to 24 times; Zn by 6 to 32 times

Wastewater from construction material factories contain a high level of SS which exceeds TCVN (A) from 1.3 to 7.3 times; SO_4^{2-} exceeds the standard by 300 to 400 times.

Source: Study on "Application of technological solution and management in some small scale industries to improve the environment of Nhue - Day River", 2003

In most of the craft villages, water quality parameters have exceeded the permitted standards by many times. However, the pollution by wastewater from craft villages is often local, and in total comprises 4% of the total wastewater volume discharged.

Domestic wastewater

Domestic wastewater, with high loads of organic compounds, has seriously polluted the Nhue River and some parts of the Day River. Hanoi contributes 54% of wastewater to the sub-basin, and Ha Tay ranks second with 17% (Figure 2.29). Both of these sources are in the upper parts of the river so that their effects are felt by communities further down the system.

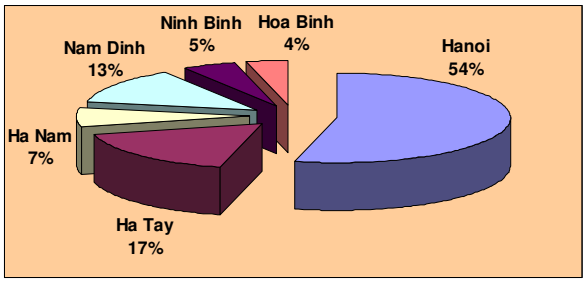


Figure 2.29: Domestic wastewater of provinces and cities

Source: The Institute of Geography, 2005

The average population density in the basin is nearly 4 times higher than the national average. The population is increasing, especially in and around Hanoi, leading to a steady increase in the quantity of domestic wastewater. Although the urbanisation process in parts of the sub-basin is rapid, urban infrastructure development cannot keep pace with the growth causing an increase in domestic wastewater discharge. Most domestic wastewater has not been treated and runs to lakes and rivers.

Table 2.7 shows the estimated amounts of contaminants generated from domestic wastewater.

Table 2.7: Estimated pollutants from domestic wastewater, 2005

	Hanoi	Ha Tay	Ha Nam	Nam Dinh	Ninh Binh	Hoa Binh	Total
COD (tonne/day)	226 - 323	182 - 259	59 - 84	141 - 201	66 - 94	59 - 84	733 – 1,045
BOD (tonne/day)	142 - 170	114 - 136	37 - 44	88 - 106	41 - 50	37 - 44	459 - 500
Total nitrogen (tonne/day)	19 - 38	15 - 30	5 - 10	12 - 24	6 - 11	5 - 10	62 - 123
Total phosphorous (tonne/day)	1 - 13	1 - 10	0.3 - 3	0.8 - 7	0.4 - 3	0.3 - 3	4 - 39
Coliform (10^9 con/ngµy)	3,145 – 3,145,000	2,526 – 2,526,000	823 – 823,000	1,961 – 1,961,000	919 – 919,000	813 – 813,000	10,187- 10,187,000
Oil (tonne/day)	31	25	8	19	9	8	100
SS (tonne/day)	535 - 692	429 - 556	140 - 181	334 - 431	156 - 202	138 - 179	1,732 – 2,241

Source: Polluted tonnage calculations of WHO, 1993; and populations in 2005, Statistical Year Book, 2005

Hospital wastewater

Hospital wastewater is extremely dangerous and should be treated before discharge to the environment. However, currently there are few wastewater treatment systems at most medical centres and hospitals. Wastewater runs directly to the drainage system of the sub-basin via point sources.

Box 2.5: Hospital wastewater treatment in Ha Nam

There are 147 medical units/hospital in Ha Nam. However, most do not have wastewater treatment facilities, except for the provincial General Hospital with treatment capacity of 400 m^3/day using bio-technology, and Binh Luc District General Hospital with treatment capacity of 200 m^3/day.

Source: Ha Nam provincial Department of Natural Resources and Environment, 2006

At present, there are about 26,300 sick beds in the sub-basin (out of which Hanoi has 47%) in more than 1,400 medical bases – see Figure 2.30. The wastewater discharge is estimated at nearly 10,000 m^3/day.

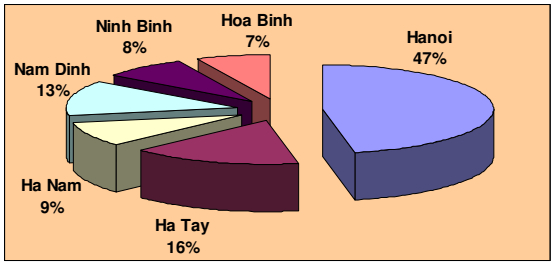


Figure 2.30: Proportion of hospital wastewater from provinces

Source: Statistical Year Book, 2005

Animal husbandry activities

Livestock farms are increasing in number and in size, generating large volumes of concentrated wastewater (Figure 2.31). In Hay Tay, there are nearly 1.5 million animals.

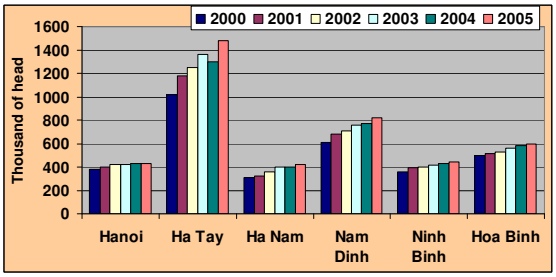


Figure 2.31: Number of farming livestock

Source: Statistical Yearly Book, 2005

Box 2.6: Wastewater from animal husbandry

With livestock of 10,000 head, each 1,000 tonnes of meat produces 10,000-20,000 tonnes of dung and 20,000-30,000 m^3 of urine, and requires 50,000- 200,000 m^3 water for washing sheds and facilities.

Source: Institute of Environmental sciences and technologies, 2004

Investments in environmental treatment are generally not made, even in large livestock husbandry facilities. Therefore, wastewater is discharged directly to rivers.

Agricultural activities

The Nhue - Day River sub-basin remains an important agricultural area with 60-70% of the population taking part in agriculture activities. The total crop area is around 740,000 ha, about 10% of the sub-basin area, of which rice counts for 70%.

Fertilisers and pesticides are a common feature of cultivation activities, providing a non-point pollution source throughout the sub-basin. The farmers in Phu Xuyen district (Ha Nam province) use an average of 425 kg of fertiliser/ha/yr in comparison with a use of around 30 to 60 kg in regional countries. This means that about 40 – 60% of the fertiliser used is wasted. Pesticide use is also relative high at 0.3 – 0.4 kg/ha (Reference: Dung and Chung).

The inappropriate use of pesticides, particularly those of high toxicity has caused many harmful impacts on the health of the community and the environment, and could affect the sustainability of agricultural production and rural development.

Solid waste

Solid waste is a major polluting source for surface water in the sub-basin. Increasing economic development, urbanisation and the strong increase in population are all adding to the total amount of solid waste. Of the waste generated, 80 percent is from domestic sources and the remainder is from industrial production. The amount of solid waste has been growing steadily over recent years as the population grows.

Collection of solid waste is low in general, especially in rural areas where an average of 20% is collected. In major cities, the rate of domestic solid waste collection is higher – see Figures 2.32 and 2.33. In rural areas,

solid waste becomes piled up on the banks of rivers and lakes, polluting surface waters.

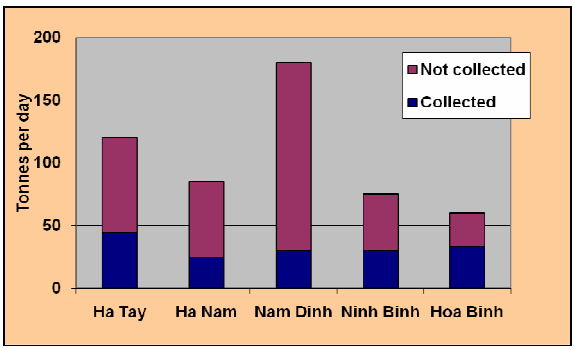


Figure 2.32: Solid waste collection, 2003

Source: Vietnam's Environmental Protection Agency, 2004

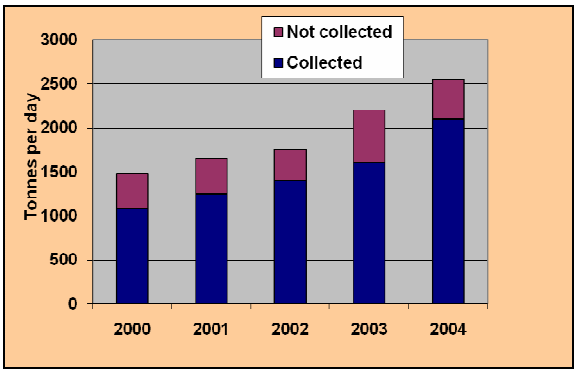


Figure 2.33: Growth in waste and its collection in Hanoi

Source: Hanoi Urban Environment Company, 2005

At present the collection and transportation of urban and industrial solid waste is low. Except for the Nam Son Landfill site at Hanoi, other landfill sites in the sub-basin are using antiquated burial technologies. Most fill quickly and are not properly sealed - after closure they still badly affect the surrounding environment, providing a long-term, non-point sources of pollution for surface and groundwater pollution.

Harmful industrial and hospital solid waste is relatively small in volume, but is a growing proportion of the waste generated – see figure 2.34. This has a high risk of harm to human health and to the environment under current procedures for disposal.

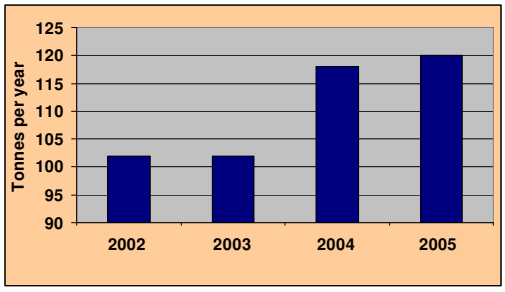


Figure 2.34: Growth in hospital solid waste of Ha Nam Province

Source: Ha Nam Department of Natural Resources and Environment, 2006

River Flow Impacts

The Nhue - Day River system is an inter-province irrigation system, supplying water from the Red River principally for agriculture. The operation of the water supply system has a significant effect on the river flows. Opening or closing these flow control works markedly affects water quality of the sub-basin, especially for the Nhue River.

A study by Nguyen Quang Trung [2001] showed that the quality of the Nhue River can be improved significantly by using dilution flows from the Red River. His study showed that with a dilution rate of an additional 20% of the basic river flow, the values of BOD_5 were reduced to 24% at a distance 10 kilometres down river of the To Lich River junction. At a dilution flow of 32%, the values of BOD_5 were reduced to 59%, 20 kilometres down river.

2.3.3. Pollution forecast

Based on an analysis of the socio-economic development planning of provinces in the Nhue-Day River sub-basin to 2010, the volume of wastewater is forecast to continue to strongly increase, especially that of Hanoi city and Ha Tay province in the upper parts of the river system. The analysis indicates that that by 2010 the wastewater volume of Hanoi will have increased by 1.2 times and Ha Tay by 1.9 times compared to that of 2005.

The environmental pollution level of Nhue-Day River sub-basin has been analysed based on three scenarios:

- Scenario 1: The wastewater volume in the sub-basin increases according to the planning targets, but it is not treated;

- Scenario 2: The wastewater volume in the sub-basin increases according to the planning targets, but with 30% of all wastewater treated (existing and additional);
- Scenario 3: The wastewater volume in the sub-basin increases according to the planning targets and all of the wastewater (existing and additional) is treated to meet environmental standards.

Some of the results are shown in Figures 2.35, 2.36 and 2.37.

Under Scenario 1, by the year 2010 the water quality of Nhue – Day River would be significantly worse. The BOD concentration will have increased by 1.2 – 1.5 times; total nitrogen by 1.2 to 1.85 times; total phosphorous by more than twice; and total coliform by 1.3 times to more than twice.

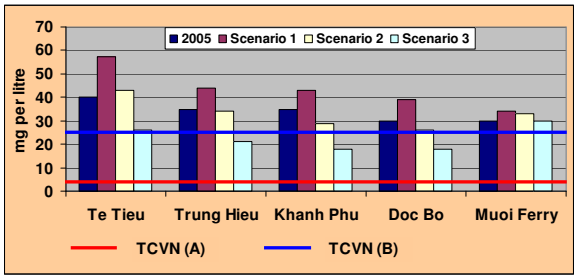


Figure 2.35: BOD_5 in 2005 and estimation for 2010

Source: The Institute of Hydro-Meteorology and Environment, 2006

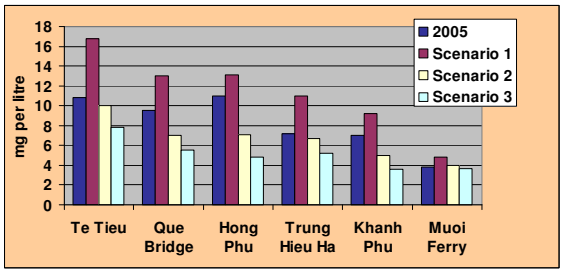


Figure 2.36: Total nitrogen in 2005 and estimation for 2010

Source: The Institute of Hydro-Meteorology and Environment, 2006

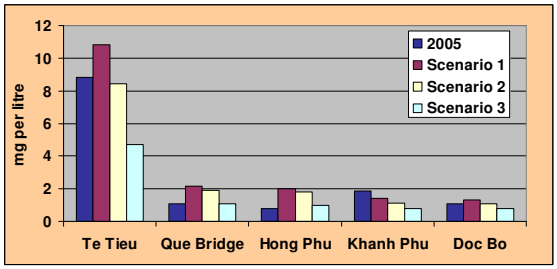


Figure 2.37: Total phosphorous in 2005 and estimation for 2010

Source: The Institute of Hydro-Meteorology and Environment, 2006

Projections under Scenario 2 show some significant improvements over Scenario 1 at some locations, particularly for total nitrogen. However BOD_5 would not meet TCVN (B).

Under Scenario 3 there are further improvements, particularly for BOD_5. However, this would still not meet TCVN (A). This indicates the amount of residual pollution in the system and means that extensive and costly treatment would be required for the water to be suitable for drinking water. Even to get to this stage, significant investment in treating current wastewater loads would be required as well as ensuring all new developments are treated to proper environmental standards.

2.4. DONG NAI RIVER BASIN

Note that in the Dong Nai River basin, the wet season generally occurs from May to October, and the dry season from November to April. This is important when considering the monitoring results presented in this section.

2.4.1 Current pollution levels

The Dong Nai River basin covers many provinces and is affected strongly by many sectors. The lower-river parts of some Rivers in the basin have been seriously polluted, with some sections becoming "dead" rivers.

The technical report *Analysis of Pollution from Manufacturing Sectors in Vietnam* (ICEM for The World Bank), found that Ho Chi Minh City had the highest water pollution ranking of all the provinces/cities nationally; Bing Duong was third; and Dong Nai was fifth. For all provinces in the top 10 of the rankings, the analysis was extended to commune and enterprise level. This found

that the Thuan An commune in Binh Duong ranked second nationally for water pollution; Bien Hoa commune in Dong Nai ranked fourth; commune 1 in Nguyen Thai Binh District in Ho Chi Minh City ranked fifth; and an unspecified commune in Phu My District in Ba Ria Vung Tau ranked eighth.

The water of the mid-river sections of the Dong Nai River (especially the part from Thien Tan Water Plant to Long Dai - Dong Nai) has high levels of SS and organic pollution. SS exceeds TCVN (A) by between 3 and 9 times, DO is lower than the standard and COD exceeds it from 1.8 to 2.8 times. At the Dong Nai Bridge the lead concentration has exceeded TCVN (A).

The water quality of the River from Hoa An Water Pumping Station to Cat Lai Station, through the Ho Chi Minh City area, has remained relatively stable since 2001. BOD_5 varies by about 2mg/l which is within the permitted standards for domestic use. Oil concentration is around 0.025 – 0.029 mg/l, while the Standards set a zero limit for domestic water sources. High micro-organic pollution occurs in areas of Hoa An and Cat Lai, but this is showing a reducing trend in recent years (Figure 2.38).

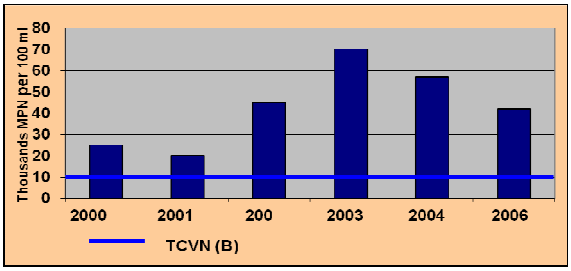


Figure 2.38: Trends in coliform levels at Hoa An, Dong Nai River

Source: Ho Chi Minh's Department of Natural Resources and Environment, 2005

The lower River quality is polluted and affected by saline conditions. The level of DO is decreasing while SS is over 2 to 2.5 times TCVN (A) levels. This area also suffers saline intrusion so water in this area cannot be used for domestic water or irrigation.

The Sai Gon River is seriously polluted with organic substance and micro-organism; in some areas there are signs of heavy metal pollution.

The water quality in the middle parts of the river system, such as at Ben Suc bridge and Thi Tinh River mouth, is locally polluted by organic substances. The monitoring results show that DO is low and $N\text{-}NH_4$ is above TCVN (A). At the Thi Tinh River mouth, $N\text{-}NH_4$ levels are over 30 times the allowable limit under TCVN (A).

Around Ho Chi Minh City (from Thi Tinh river mouth to Binh Phuoc Bridge) there are clear signs of serious and increasing water pollution. Monitoring result show that pH is alkaline and DO is very low, especially in the areas close to An Léc Bridge and the An Ha area. DO does not meet TCVN (B) and is decreasing over time. Around Phu Cuong Bridge, Coliform levels are over 16 times TCVN (B).

The water quality monitoring results from 2000 at Phu Cuong, Binh Phuoc and Phu An monitoring stations (Sai Gon River in Ho Chi Minh City) show that the river water of these areas has been polluted by organic substances, especially by oil and coliform. The DO value varies from 0.7 to 2.7 mg/l, which does not meet TCVN (A). The BOD_5 value varies from around 2 to over 14 mg/l and also frequently does not meet that standard, especially at Phu An (Figure. 2.39).

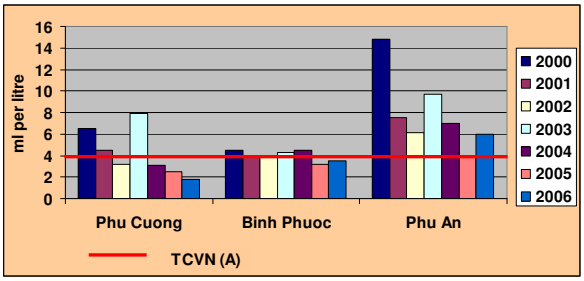


Figure 2.39: BOD_5 trends in the Sai Gon River at Ho Chi Minh City

Source: Ho Chi Minh City's Department of Natural Resources and Environment , 2006

Oil levels are well in excess of TCVN (A), although they do show a decreasing trend in recent years (Figure 2.40).

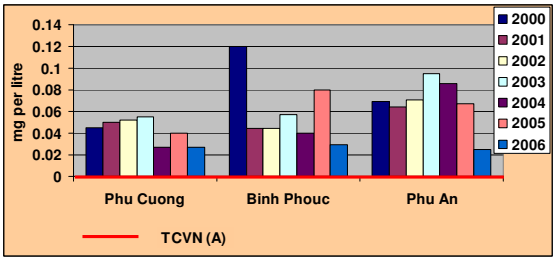


Figure 2.40: Oil levels along the Sai Gon River

Source: Ho Chi Minh City's Department of Natural Resources and Environment, 2006

This area has also been polluted by high concentration of coliform, which is from 3 to 168 times higher than TCVN (A). Concentration levels increase from up-river areas, around Phu Cuong, to down-river areas in Binh Phuoc and Cat Lat stations (Figure 2.41).

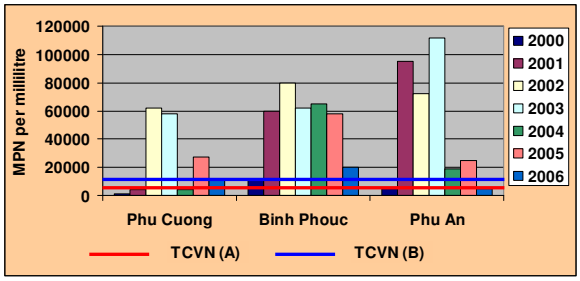


Figure 2.41: Coliform along Sai Gon River

Source: Ho Chi Minh City's Department of Natural Resources and Environment , 2006

Around Nha Be – Can Gio (the confluence of Sai Gon and Dong Nai Rivers), Nha Be and Ly Nhon (Nha Be River), Tam Thon Hiep (Dong Tranh River) and Vam Co (at the Vam Co River mouth), DO and BOD_5 values meet TCVN (B). The oil pollution levels have tended to decrease over recent years. Coliform pollution is still high and has been increasing.

Other Rivers in the basin also show deteriorating water quality.

The water quality of tributaries in the upper River Basin is declining - such as for the Be River and the Da Nhim - Da Dung River. Iron levels are high, over TCVN (A) by 10 to 12.5 times, causing difficulties in providing domestic water supply. In the wet season, the suspended solid levels in the river are high because of drainage from agricultural farmland.

The Vam Co River is polluted by organic substances, with levels well over TCVN (A). This river also has signs of heavy metal pollution. The area around Kenh Xang bridge (Tay Ninh, Vam Co Dong River) is heavily polluted during the last months of the year. DO values are much lower than TCVN (A), while $N\text{-}NH_4$+ value is several times higher that the standard. River water quality does not meet the standards for domestic water use.

A 10 kilometre long section of the Thi Vai River is the most polluted area in the basin, and is called a "dead" river. This river section is located behind the confluence of the Suoi Ca and Thi Vai Rivers, about 2 km from the My Xuan industrial zone. The water is seriously polluted by organic substances and is a blackish brown colour with fetid odours, in both high and low tidal periods.

The DO value is often lower than 0.5 mg/l (Figure 2.42) - the lowest value registered is at Ve Dan port (0.04 mg/l). When the DO value is at or nearly at zero, biological species are unable to live.

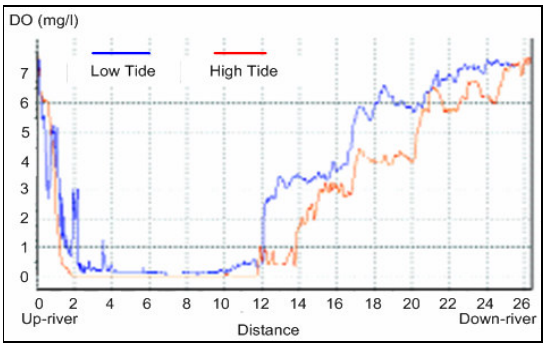


Figure 2.42: DO levels in areas along Thi Vai River (May, 2006)

Source: VEPA, 2006

$N\text{-}NH_4$ exceeds TCVN (B) from 3 to 15 times(Figure 2.43); and coliform exceeds the standard from dozens to hundreds of times. Mercury levels at My Xuan Port exceeds TCVN (B) by 1.5 to 4 times and zinc by 3 to 5 times. The high mercury level is of most concern as it accumulates in sedimants and in fauna.

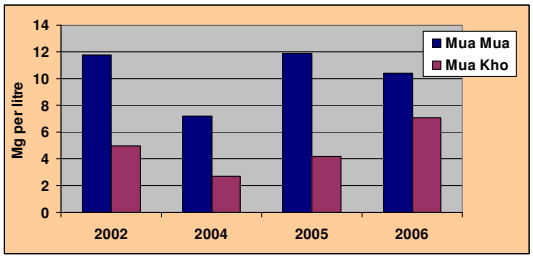


Figure 2.43: NH_4 levels along the Thi Vai River (near the Vedan glutamate plant)

Source: DONRE Ba Ria – Vung Tau, 2005

The system of lakes, ponds, and canals in urban areas in the Dong Nai River basin are seriously polluted

Surface water pollution in drainage canals in inner Ho Chi Minh City has become one of the major problems of the basin. There are 5 main drainage systems, with most of the canals highly polluted from organic and micro-organic compounds. Coliform levels are very high, exceeding TCVN (B) from

hundreds to tens of hundreds of times (Figure 2.44). In the dry season, the pollution becomes even worse.

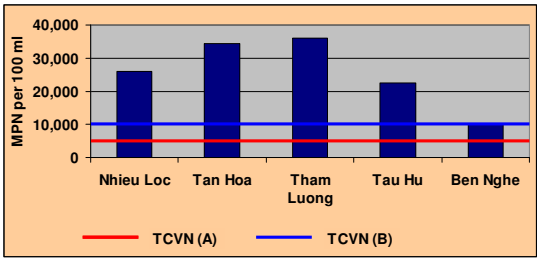


Figure 2.44: Coliform levels in canals in Ho Chi Minh City, 2005

Source: Vietnam's Environment Protection Agency

Many canals in the cities have become wastewater canals where BOD_5 values are many times higher than TCVN (B) (Figure 2.45).

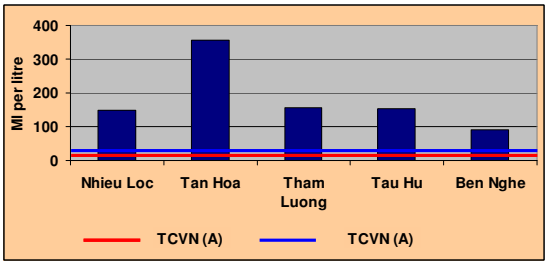


Figure 2.45: BOD_5 value in canals in Ho Chi Minh City, 2005

Source: Institute of Natural Resources and Environment

Box 2.7: Pollution of drainage lines in urban areas.

Van Mau drainage line (in the centre of Bien Hoa City, Dong An) is polluted from wastewater from the City. Water is seriously polluted by organic substance and coliform - DO content was monitored at only 1.6 mg/l and coliform at over 240 times TCVN (B).

Ba Bo drainage line (Thu Duc, Ho Chi Minh City) is polluted by organic substance from wastewater from the industrial zones at Dong Nai and Song Than (Binh Duong Province), and residential areas. The level of BOD_5 is over 3.5 times higher, and DO over 5 times lower, than TCVN (B).

Source: State of the environmental report and the situation of water management and protection in Dong Nai river system basin, 2004

Monitoring results show that the Tan Hoa – Lo Gom drainage system is the most seriously polluted, with DO value of almost zero. This situation has existed for nearly ten years, making the river a dead river. The environment along the canal's banks is seriously polluted, the fetish odours spread from the canal and some canal parts are obstructed by waste matter.

2.4.2. Sources of pollution

At present, the Dong Nai River basin is experiencing strong population growth, urbanisation and economic development - industrial zones are rapidly developing throughout the basin. This intense development has resulted in the discharge of large quantities of industrial and domestic waste. The use of chemicals and pesticides in agriculture, contaminants from mining and from water transport are additional causes of pollution. The rivers are also experiencing pressure from increasing water extractions for off-river productive use and the strong development of hydropower and other dams.

Domestic (urban) and industrial wastewater make up the largest proportion of wastewater generated and are the major point sources of discharge to surface waters.

Industrial wastewater

At 2004 there were 9,147 industrial enterprises, 61% of which were in Ho Chi Minh City (Figure 2.46). As many of these are interspersed in residential areas, it is difficult to monitor and control these wastes. This is a waste source with a high risk of seriously affecting people and communities.

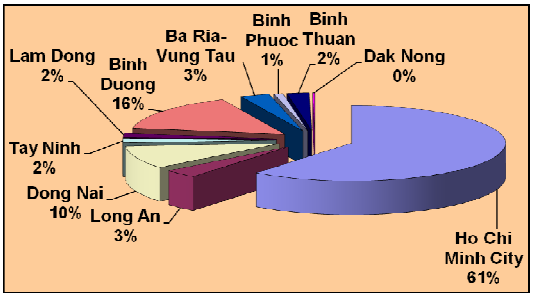


Figure 2.46: Number of industrial enterprises in provinces/cities

Source: Statistical Yearbook 2005

Currently, there are 56 operating industrial and export processing zones, with most of them located in the Southern Focal Economic Region. Only 21 of these zones have central wastewater treatment systems. The others discharge wastewater directly to water sources. For example, the industrial zones and export processing zones in Ho Chi Minh City discharge over 27,200 m^3 of

wastewater a day. Of this, only about 6,000 m^3 a day is treated.

The total industrial wastewater discharge in the basin is about 480,000 m^3 per day. Industrial zones (IZs) and export processing zones (EPZs) contribute about 118,000 m^3 a day of this, with the largest volume from Dong Nai province (57%), and then Ho Chi Minh City (23%), and Binh Duong province (9%) (Figure 2.47).

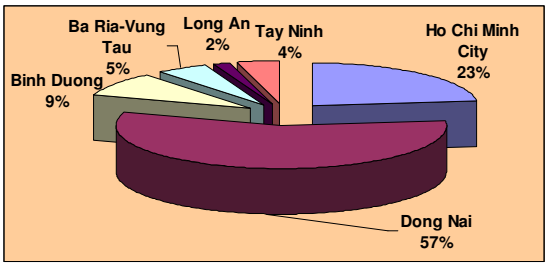


Figure 2.47: Proportion of wastewater from industrial zones

Source: Institute of Environment and Natural Resources, 2005

Table 2.8 provides, for cities and provinces, details of the industrial zones and the estimated pollution load discharged. Ho Chi Minh City and Dong Nai and Binh Duong provinces provide the vast bulk of the wastewater, and therefore the pollutants.

The receiving waters for the waste from these point sources are the middle and down-river areas of the Dong Nai River (receiving wastewater from the Dong Nai and Binh Duong industrial zones), the Sai Gon River (from industrial zones of Ho Chi Minh City and Binh Duong), and the Thi Vai River (from industrial zones and the deep water port of Dong Nai and Ba Ria – Vung Tau). Together with domestic wastewater, this has caused serious pollution to the downstream areas of the Dong Nai and Sai Gon Rivers. The Thi Vai River has been particularly severely polluted.

Recently, mining activities have developed strongly in the basin. Groups of metal mines are located in the upper river areas (Lam Dong, Dong Nai, Binh Thuan, etc); and groups of non-metal mines, mainly for construction materials (sand, stone, clay, etc) are located in the lower sections (Binh Duong, Ho Chi Minh City, Dong Nai and Long An provinces). Exploitation activities are a major factor affecting surface water quality, including heavy metal pollution.

Bauxite ore exploitation occurs in Lam Dong in the upper parts of the basin. There are about 50 mineral and gold mines in the northern part of Dong Nai province, Lam Dong and one in the southern part of Dak Nong province. The exploitation method is simple open cut, with little or no protection for the water environment. Mining requires thousands of cubic metres of water and generates thousands of tonnes of sediment washed to the Dong Nai River.

Sand exploitation occurs from the alluvium sand in the lower sections of the Dong Nai, Sai Gon, Vam Co Dong, Nha Be and Soai Rap rivers. Extraction activities in the lower sections, especially in the Dong Nai River, cause serious erosion to the river banks.

Table 2.8 Estimated wastewater and pollutants from industrial zones

province	No. of IZ & EPZ	No. of plants	No. with water treatment facilities	Waste water volume (m^3 /day)	Load of pollutants (kg/day)				
					TSS	BOD_5	COD	Total N	Total P
HCM city	15	982	7	27,205	5,924	12,826	28,390	508	256
Dong Nai	17	608	6	67,680	8,317	6,264	46,828	920	261
Binh Duong	12	613	7	10,620	410	224	651	132	17
BR-VT	6	89	1	6,100	298	366	1057	42	8
Long An	5	47	0	1,717					
Tay Ninh	1	68	0	5,000 (estimate)					
Total	56	2,407	21	118,322					

Source: Institute of Environment and Natural Resources, 2005

Wastewater from craft villages

In 2002, in the south and mid-south, there were 491 craft villages with 291 production units. They are involved with food processing, sedge mat production, lacquer, rattan and bamboo, pottery, embroidery, weaving, wood processing, metal processing and others. Nearly 28% of craft villages specialise in rattan and bamboo processing, followed by sedge mat production villages (around 19%), wood processing villages (11%) and pottery production villages (7%).

Most of the craft villages develop in an ad hoc way to meet the demand of markets; their equipment and technology are old and simple; production scales are small; and wastewater treatment system are either not there or not effective.

Details of some craft villages are shown in Table 2.9 (their characteristics) and 2.10 (their pollution loads).

Domestic wastewater

There are 77 urban areas in the basin with a total population of about 9 million people. These areas are distributed unevenly - most are located in the Sai Gon River sub-basin.

There are 27 urban areas from the centre of Ho Chi Minh City to Thu Dau Mot Town with a population of about 6 million people. The more rapidly the urbanisation process develops, the greater is the demand for water and the amount of waste generated. The construction of urban infrastructure cannot keep up with the pace of development, adding to water pollution

The amount of wastewater from urban areas discharged to rivers of the basin is about 992,000 m^3 per year. However, few urban areas have a wastewater treatment system meaning that large volumes of domestic waste are discharged directly to rivers causing organic pollution (high levels of BOD_5, COD), nutrient pollution (nitrogen and phosphorous), oil pollution, etc – see Table 2.11.

Table 2.9: Some typical craft villages in the basin

Craft village	Location	No. of prod. Households	Wastewater volume (m^3/year)	Domestic wastewater volume (m^3/year)
Tra Co cassava processing village	Tra Co, Binh Minh commune, Thong Nhat district, Dong Nai	65	105,480	83,424
Thuan An pottery village	Hung Dinh commune, Thuan An, Binh Duong	800	-	211,846
Tan Binh Hiep Lacquer art village	Tuong Binh Hiep, Thu Dau Mot, Binh Duong	200	-	406,698
Bao Loc silk village	Bao Loc town, Lam Dong	5,000	180,000	4,701,200

Source: Report of the Environmental Technology Centre (ENTEC), 2002

Table 2.10 Pollutant load from some craft villages

Craft village	Load of pollutants (Kg/day)						
	BOD_5	COD	SS	Total N	Total P	CN	NH_4^+
Tra Co cassava processing village	218	544	282	43	7	1	-
Bao Loc silk village	145	379	310	984	132	-	742

Source: Report of the Environmental Technology Centre (ENTEC), 2002

Table 2.11: Pollution from domestic wastewater, 2004

Province	Pollutants (kg per day)					
	TSS	BOD_5	COD	$N\text{-}NH_4^+$	P total	oil
Lam Dong	22,824	14,658	27,138	951	517	2,603
Binh Thuan	1,000	594	1,074	43	24	90
Dac Nong	2,972	1,765	3,193	128	72	269
Binh Phuoc	7,448	4,494	8,170	317	177	707
Binh Duong	21,209	12,596	22,789	911	511	1,916
Tay Ninh	14,366	8,695	15,821	613	340	1,377
Long An	14,994	9,134	16,655	639	354	1,467
Dong Nai	34,620	22,512	41,820	1435	776	4,082
HCM	255,787	175,126	329,857	10,380	5,467	34,461
Total	375,220	249,574	466,517	15,417	8,238	46,972

Source: Institute of environment and natural resources, 2005.

Ho Chi Minh City contributes the largest amount of domestic wastewater (77.5%). The lower sections of the Sai Gon River, which flows through the centre of Ho Chi Minh City, has been seriously polluted as it receives such large volumes of wastewater.

Dong Nai provides the second largest amount of domestic wastewater. Most of this runs into the lower sections of the Dong Nai River leading to a seriously polluted water environment, particularly by organic substances. The section flowing through Bien Hoa City, which receives 87% of the province's wastewater, is particularly bad.

Hospital wastewater

Few hospitals/healthcare centres have waste treatment systems. Most hospital wastewater flows directly to the sewage system and to surface water sources.

Hospital wastewater is a potential source for transmitting infectious diseases through the water environment. Figure 2.48 shows the proportion of this wastewater from the provinces.

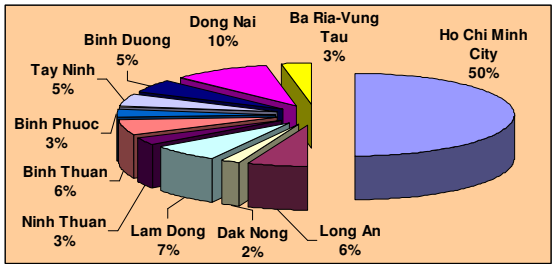


Figure 2.48: Proportion of hospital wastewater, 2004

Source: Statistical Year Book, 2005

Box 2.8: Hospital wastewater in Ho Chi Minh City

In Ho Chi Minh City there are 109 hospitals and medical centres with a total wastewater volume of 17,000 m^3/day. Of this about 13,000 m^3/day is treated (78% of the total). However, the rate of hospital wastewater being treated to meet Vietnam Standards TCVN 6772-2000 is only 26% of the total volume.

Source: Ho Chi Minh City's Department of Natural Resources and Environment, 2006

Animal husbandry

Animal husbandry is strongly developed in Lam Dong, Binh Thuan and Dong Nai provinces (Figure 2.49). In Dong Nai provinces there are currently over 1.2 million head of livestock.

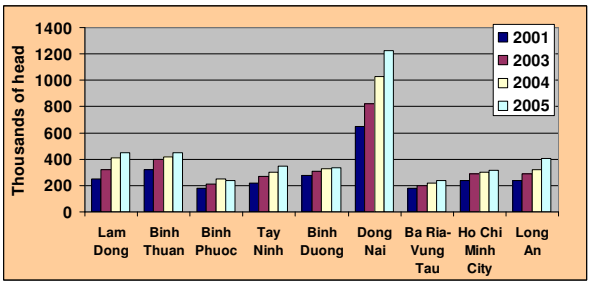


Figure 2.49: Number of livestock of provinces and cities

Source: Statistical Yearly Book, 2005

Wastewater from these activities is about 147,300 m^3/day. At present, wastewater treatment even in large farms is limited and wastewater runs direct to surface water sources.

Agriculture and aquaculture

The Dong Nai River Basin has an agricultural land area of 1.8 million hectares nearly 50% of the basin area). Farming activities have been increasingly dependant on the use of fertiliser and pesticides. Based on an assumed chemical use of 1 kilogram of active ingredient/ha/year, this equates to about 180 tonnes of chemical applied each year in agricultural activities, and is the major source of non-point pollution in the basin. About half of this amount would stay in the soil. (Vietnam Country Report to the 7th GINC Conference in Tokyo, 2001).

The improper use of these chemicals, particularly those of high toxicity, causes many harmful impacts on community health and the environment, and could affect the sustainability of agriculture production and rural development.

In the lower sections of the Dong Nai River, there are about 351,478 hectares of alkaline land. The exploitation and transformation of these soil in areas such as Long An, Cu Chi, Binh Chanh (Ho Chi Minh City), together with the use of alkaline fertilisers, have led to the increased acidification in the Sai Gon and Vam Co Dong Rivers.

Aquaculture, including breeding ponds and cages, has developed strongly across the basin. Breeding technology is changing from extensive to semi-intensive and intensive breeding with advanced technology. The total area of surface water for aquaculture is 71,800 hectares, and the output is 500,000 tonnes a year.

Wastewater from these activities is not controlled and treated, and runs directly to the environment. Moreover, the occasional large scale death of aquatic animal stock contributes to pollution of surface water.

Solid waste

There has been a steady increase in the solid waste matter generated as the population has risen. Ho Chi Minh City contributes the largest amount of waste – nearly 6,500 tonnes a day. Dong Nai contributes about 800 tonnes a day and the other provinces about 50 to 250 tonnes a day.

Most of this waste in not collected nor treated. Figure 2.50 shows the amount of solid waste from urban areas in provinces and cities and the proportion of this which is collected.

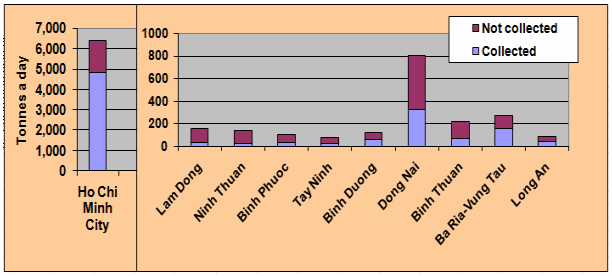


Figure 2.50: Solid waste in urban areas

Source: VEPA, 2004

In the basin, there are 73 waste dump sites of which few meet the sanitary requirements of hygienic landfill, such as Go Cat, Phuoc Hiep (Ho Chi Minh City) and Nam Binh Duong Solid Waste Treatment Complex. The others do not.

Box 2.9: Problems with the Dong Thach Dump Site in Ho Chi Minh City

Dong Thach is the second biggest dump site in Ho Chi Minh City and Vietnam, with an area of about 40 hectares. The site is not sealed so wastewater percolates into the soil, causing underground water pollution. Many nearby residents use wells and, in a 20 km circle, are now not able to use this water because of its poor quality and bad odours.

Additionally, leakage from the landfill (mainly from the wastewater storage lakes) into the underground water strata of surrounding areas has caused damages to the production and living activities of the local people, i.e. fish, pigs, chickens and ducks have died and agricultural productivity is reduced. Wastewater from the waste storage lakes (about 200,000 m^3 with average COD concentration of about 40,000 – 50,000 mg/l) is not treated to environmental requirements.

In June 2000, persistent heavy rain caused a 6 meter high dumpsite wall to collapse. A great deal of waste and wastewater spilt causing environment pollution and harming production and people's lives nearby.

Source: Institute of Environment and Natural Resources, 2004

Dangerous industrial wastes and hospital wastes are relatively small in quantity but are seriously contributing to the increase in pollution. Figure 2.51 shows the growth in hazardous industrial waste in the basin.

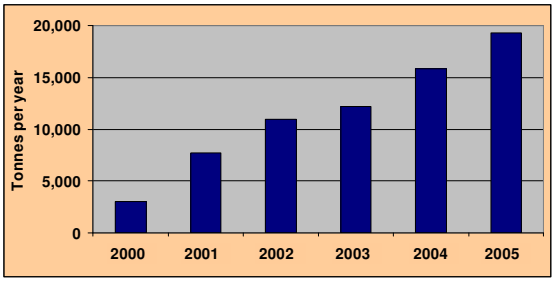


Figure 2.51: Hazardous industrial waste generated in the Dong Nai river system

Source: VEPA, 2004

Water transportation activities

Many of the rivers in the basin are large, stable and deep, making them suitable for river transport, especially in the down-river areas of Dong Nai, Sai Gon, Nha Be, Soai Rap, Vam Co and Thi Vai Rivers. A significant water transport and deep-water port system has developed.

There are a total of 37 ports in the Southern Focal Economic region with a capacity of from 1,000 to 30,000 DWT. The rapid development of the port system and increasing number of boats and ships has led to pollution from waste oils and domestic waste. Cleaning out oil carriers also produces considerable oil residue. The quantity of waste oil from cleaning a tanker is about 0.6% of the total quantity of oil contained in the tanker. Wastewater from cleaning the boats runs directly to rivers.

Environmental problems, especially oil spills, are increasing due to water accidents and shipwrecks. In coastal area like Ba Ria – Vung Tau, oil spills also occur.

Box 2.10: Oil spills in Ho Chi Minh City from 2003 to 2005

Collision between the ship *Fortune* and an oil tanker in An Giang on January 12, 2003: spill of 388 m^3 of oil.

A tanker crashed against Kasco Quay on January 21, 2003: spill of 300 m^3 of oil.

Shipwreck of Hong Anh Tanker (due to storm) on March 20, 2003: spill of 600 tonne of oil.

Collision between 2 ship on April 6, 2005: spill of 540 m^3 of oil.

Source: State of the environment Report, Ho Chi Minh City, 2005.

Environmental problems due to broken oil pipes and oil containers in stores and ports along the rivers are also sources of pollution.

River flow impacts

Many dams for water supply for hydro-electric, agriculture and urban purposes have been developed. However, these activities also reduce flows that mitigate against saline intrusion, and change the dilution and assimilative ability of rivers.

After the completion of Phuoc Hoa dam, the change in the flow of the Be River to the Sai Gon River will contribute to improvements in the quality of the Sai Gon River (which has acidified strongly) as well as providing greater dilution flows. However, the amount of water flowing to the lower sections of the Dong Nai River is going to decrease, meaning that pollution levels and salt encroachment will increase.

Table 2.12: Correlation between river flows and BOD_5 load

	Average river flow (m^3/s)	BOD_5 content (kg/day)			BOD_5 load in each m^3 of river water (g/m^3) (R coefficient)	Indication of assimilative and dilution ability
		from urban areas	From industry areas	Total		
La Nga rive	171.5	7,920	0	7,920	0.53	Good
Be river	255.2	5,824	0	5,824	0.26	Very good
Sai Gon river	93.5	162,399	12,549	174,948	21.66	Very bad
Vam Co river	169.7	17,153	280	17,443	1.19	Not bad
Dong Nai river	871.8	51,327	5,145	56,472	0.75	Good

Note: Dilution ability of river: *R <= 0.5, "very good"; 0.5 < R <= 1, "good"; 1 < R <= 20, "not bad"; R > 20, "very bad"*

Source: Institute of Environment and Natural Resources, 2005

The current average annual flow of the Sai Gon River is much lower than that of other rivers in the basin. This means that the assimilative and dilution capacity of the Sai Gon River is lower than that of the other rivers and the pollution level is much higher. This compounds the pollution issues for the Sai Gion River.

Table 2.12 shows the correlation between river flows and BOD_5 loads in the main rivers in the Dong Nai river basin.

2.4.3. Pollution forecast

Based on an analysis of the socio-economic development planning of provinces in the River basin, 3 scenarios have been established for calculating the threat and level of environment pollution in Dong Nai river basin.

- Scenario 1: The wastewater volume in the sub-basin increases according to the planning targets, but it is not treated;
- Scenario 2: The wastewater volume in the sub-basin increases according to the planning targets, but with 30% of all wastewater treated (existing and additional);
- Scenario 3: The wastewater volume in the sub-basin increases according to the planning targets and all of the wastewater (existing and additional) is treated to meet environmental standards.

Some of the results are shown in Figures 2.52, 2.53 and 2.54.

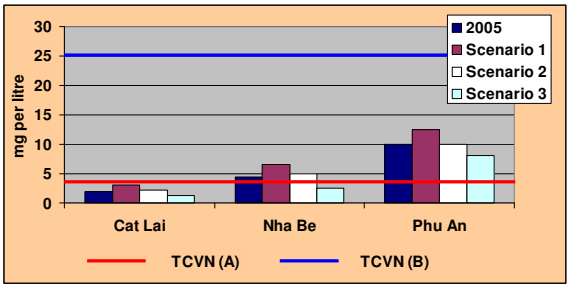


Figure 2.52: BOD_5 concentration in 2005 and estimation for 2010

Source: The Institute of Hydro-Meteorology and Environment, 2006

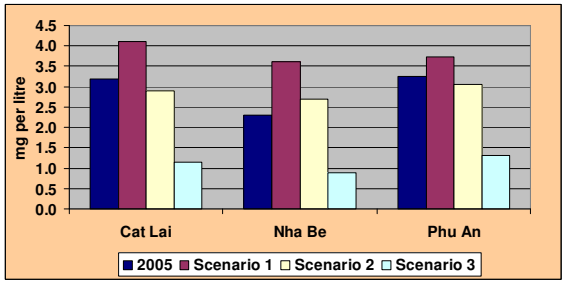


Figure 2.53: Total nitrogen in 2005 and estimation for 2010

Source: Institute of Hydro-Meteorology and Environment, 2006

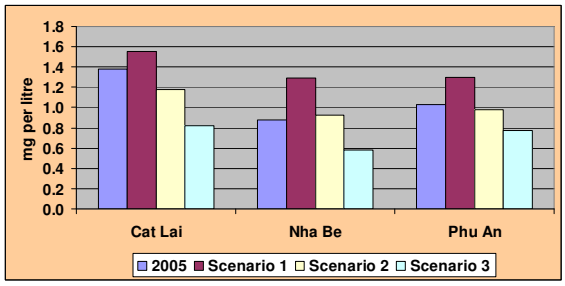


Figure 2.54: Total phosphorus in 2005 and estimation for 2010

Source: Institute of Hydro- Meteorology and Environment, 2006

Under Scenario 1, it is predicted that by 2010 the wastewater volume discharging into the Dong Nai River basin would have increased by about 1.5 to 1.7 times that of 2005. In Ho Chi Minh City and in Dong Nai province, the wastewater volume would be much greater than current volumes, causing further serious reductions in water quality: BOD_5 concentration would be increased by up to 1.4 times, total nitrogen by 1.3 times, total phosphor by up to 1.5 times in some locations, such as in the Nha Be area.

Projections under Scenario 2 show some significant improvements over Scenario 1. However, BOD_5 would not meet TCVN (A).

Under Scenario 3 there are further improvements, particularly for nitrogen. However, although BOD_5 levels would be within the standard for the relatively less polluted areas, at Nha Be predicted levels would still exceed TCVN (A). This indicates an enormous amount of residual pollution in the system and means that extensive and costly treatment would be required for the water at these locations to be suitable for drinking water. Even to get to this stage, significant investment in treating current wastewater loads would be required as well

as ensuring all new developments are treated to proper environmental standards.

2.5 OTHER STUDIES

Findings from the recently completed technical report *Analysis of Pollution from Manufacturing Sectors in Vietnam*, (ICEM for The World Bank) confirm many of the findings presented in the preceding sections.

In terms of water pollution, all provinces in the country were compared and the following were the rankings for provinces in the 3 river basins that made up the top 10 most polluting provinces.

Province/City	National Ranking for water pollution
Ho Chi Minh City	1
Hanoi	2
Binh Duong	3
Hai Phong	4
Dong Nai	5
Thai Nguyen	7
Ba Ria Vung Tau	10

Of the top 10, 7 are provinces/cities in the three focus river basins. Of the top 5 provinces/cities, 4 are in the Dong Nai River Basin.

For the top ten provinces, the analysis was extended down to commune and enterprise level – see Table 2.13.

The table shows that in Thai Nguyen, Cam Gia commune was ranked first overall – suffering the most pollution generally – and first in terms of metals and SS discharged to surface water. It also ranked in the top ten nationally for chemical pollution and BOD. Five firms are causing the pollution, employing 10,000 people. Di An commune in Binh Duong ranked second nationally, but this pollution was generated from 160 firms. The commune also ranked in the top ten nationally for all pollutant types.

In Binh Duong the leather tanning and dressing sector employs 27% of all industrial labour in the region. A similar situation is found in Dong Nai where the leather tanning and dressing sector has 34.3% of all industrial employment.

The ICEM report found that, nationally, three industry groups contribute most to overall water pollution. These are:

1. Paper and wood products, including corrugated paper and paperboard, particle board and plywood, and pulp processing.
2. Chemicals, including agro-chemical products and medical chemicals, and soap, detergents, cleaning and polishing preparations, perfumes and toiletries.

Table 2.13: Top ranked communes for water pollution

Province	District/ Commune	No. firms	Employ-ment	Metals	Chemicals	BOD	TSS	Water ranking
Thai Nguyen	Thai Nguyen/ Cam Gia	5	10,777	1	8	9	1	1
Binh Duong	Thuan An/ Di An	160	62,455	3	6	4	2	2
Dong Nai	Bien Hoa/ An Binh	74	24,720	7	3	1	4	4
Ho Chi Minh city	1/Nguyen Thai Binh	29	8,568	9	7	2	5	5
Ba Ria Vung Tau	Unspecified/ Phu My	8	2,727	6	4	8	8	8
Ha Noi	Thanh Xuan/ Phuong Liet	37	4,926	4	2	7	10	10

Top 5 ranking

3. Metal processing, including processing, treatment and fabrication of iron and steel and non-ferrous products, in addition to general mechanical engineering.

As well, a broader group of food processing industries appear in the top 30 of the industry sectors most contributing to water pollution, including 48 sugar refineries and factories, processing and preserving of fruit and vegetables and the "other food products" category (which covers production of coffee products, packing of tea, manufacture of soups and broths, spices, sauces and condiments, and frozen meat and poultry dishes). In this list, fish processing is significant in terms of its impacts.

In terms of the major pollutants, the technical report found that although BOD and TSS loads represent the largest in terms of their relative share to overall water pollution, of most concern are chemicals and metals. Their persistence in the environment and potential health linkages makes them a higher priority in the short-term. Chemicals and metals that are highly toxic and represent high load shares to water in Vietnam include: ammonia, chlorine, chromium and formaldehyde.

In addition, the analysis for the report found that sub-sectors associated with highly toxic materials are fertiliser, pesticide, paper and paperboard, plastics and leather sectors for water pollution.

Most of these industrial sectors are prominent in the three focus river basins and these should form the basis for a focused approach to water quality management.

2.6 CONCLUSIONS

This chapter has provided an overview of the current pollution levels of the focus river basins and an indication of the major sources of pollution.

Pollution levels of rivers in the lower reaches of the Dong Nai River Basin are the worst in the country. The Thi Vai River is the most polluted in basin with a "dead" section of 10 km, and drainage canals in inner HCMC suffer similar levels of pollution - extremely low DO levels, and high levels of N-NH_4, mercury and zinc. While these are the worst examples, there are many other pollution "hot spots" in the basin.

Box 11: Key baseline findings from the report *Analysis of Pollution from Manufacturing Sectors in Vietnam*

Industry is growing: industry has been growing very rapidly over the past decade and is likely to continue to do so over the next ten years. Overall production in some fields, such as iron and steel, cement, textiles and ceramics are growing at between 16 and 32 per cent.

Industry is concentrated: most industry is highly concentrated in a few areas of the country which creates environmental problems and opportunities in terms of management. That concentration is intensifying and will consolidate over the next ten years. The growth of industrial zones and craft villages is creating new and significant small decentralised nodes of production and pollution.

Populations are growing and concentrating: population density and numbers around those industrial centres will continue to increase dramatically over the next decade. That trend is certain even though the Government's rural development and industrial decentralisation policies are having an impact.

Industrial pollution will continue to increase as industry grows: while technological innovation is happening in new industry, the greater proportion of plants operating now will continue to do so over the next five years with little or no innovation. Also, given current levels of uptake, only a relatively small part of the 15 per cent annual growth in industry over the next five years is likely to be consistently clean. Therefore continued increases in the total pollution load can be expected.

The toxicity and complexity of pollution will increase as industry grows: the number and quantity of toxic chemicals and metals in pollution is expected to increase rapidly as manufacturing processes diversify and grow in volume. This anticipated trend presents major management problems for industry and government. Preventative measures will be essential because of the high cost of monitoring and clean up.

Source: *Analysis of Pollution from Manufacturing Sectors in Vietnam*, Technical Report prepared by ICEM (International Centre for Environmental Management) for The World Bank, January 2007

The Nhue-Day River sub-basin is also severely polluted in places. The Nhue River is the worst and is seriously polluted in its upper reaches. Even in the flood season, BOD_5, DO, NH_4+, and coliform all fail to meet TCVN (B). Within Hanoi, surface water in rivers, lakes and drains is also seriously polluted. Levels of DO are low, COD exceeds the standard by 7 to 8 times, BOD_5 by 7 times and coliform by 2 times. While these are the worst examples, there are many other pollution "hot spots" in the sub-basin.

The Cau River section flowing through Thai Nguyen is seriously polluted. SS, BOD_5 and COD exceeding TCVN (A) by 2 to 3 times, and the waters contain oil residues. There are other badly polluted areas in the sub-basin, mostly from organic pollution.

The pollution in the three river basins is generated from a number of sources – although point sources are by far the most significant. For the Cau River sub-basin the major pollution is caused by industrial production, craft villages and urban runoff. Wastewater from mining and mineral processing makes up 55% of the total industrial wastewater, metal production (29%) is the second largest, then paper production (7%), and food processing (4%).

In the Nhue-Day River sub-basin, domestic wastewater accounts for the biggest proportion of wastewater (56%), making this sub-basin different to many other basins. Industry contributes 24% of the wastewater and craft villages 4%. In the industrial sector, mechanical engineering makes up 33% of production activities, food processing 15%, weaving and dying 13%, construction materials 13% and chemicals and paper manufacturing 8%.

Major pollution in the Dong Nai River basin is dominated by domestic and industrial wastewater. Key industries that cause pollution dominate – for example, the wearing apparel, fabricated metal products, rubber and plastics products, and food and beverage industrial sectors in Ho Chi Minh City together represent 47% of all industrial facilities.

In terms of the future, Scenario 1 projections were that, compared to 2005, the 2010 wastewater volume discharging to the three river basins/sub-basin will have increased by up to 1.8 times. Projections under Scenario 2 (with 30% of all wastewater treated) show some significant improvements over Scenario 1. However, the water quality would not meet TCVN (A).

Under Scenario 3 (100% of all wastewater treated) as expected there are further improvements. In the Cau River sub-basin the water quality would nearly meet TCVN (A) meaning that the surface water could generally be supplied for domestic use purposes after appropriate treatment.

However, in the Nhue-Day and the Dong Nai River systems, although pollution levels would be within the standard for the relatively less polluted areas, at some locations predicted levels would still exceed TCVN (A). This indicates an enormous amount of residual pollution in the system and means that extensive and costly treatment would be required for the water at these locations to be suitable for drinking water. Even to get to this stage, significant investment in treating current wastewater loads would be required as well as ensuring all new developments are treated to proper environmental standards.

CHAPTER 3
IMPACTS OF WATER POLLUTION IN THE FOCUS RIVER BASINS

CHAPTER 3: IMPACTS OF WATER POLLUTION IN THE FOCUS RIVER BASINS

This chapter discusses the impacts of poor river water quality on the people who live in the three river basins and on the environment; and the economic costs imposed on the communities of the basins.

3.1 IMPACTS ON HUMAN HEALTH

Waterborne diseases continue to be a major cause of sickness and death in the developing world, especially for children. Since most people drink water every day, a contaminated public drinking water source has the potential to quickly expose nearly all members of a community to harmful chemicals or micro-organisms.

This section firstly discusses the current situation regarding the provision of clean water and sanitation. Then it considers the impacts of the poor quality of water sources described in Chapter 2 on human health.

3.1.1 Clean water supply and sanitation – an overview

In developing countries such as Viet Nam, many people have little option but to use polluted river water for their basic everyday requirements – drinking, cooking, bathing, washing, recreation, household-scale crop and animal production, etc. Regular use of polluted water can result in intestinal (inflammation, digestion, parasitic worms, etc.), dermatological and gynaecological diseases, amongst others. Polluted water with high levels of organic matter, oil, toxic substances, etc will directly affect people's health when it is used for washing and eating.

Pollutants can be natural (such as salts or other chemicals picked up by runoff over rocks and through soils) or from economic production and human processes as described in Chapter 2 (chemicals, sediments, heavy metals, oil, polluting organic substances).

The microbiological quality of water is of particular concern since the most common and widespread health risk associated with drinking water is contamination by micro-organisms contained in faeces. Micro-organisms that can cause disease are called pathogens. The pathogens of concern in water sources are mainly those that are found in the excrement (faeces) of humans or animals. If these micro-organisms are present in water, and are not removed by water treatment or disinfection, then people are very likely to suffer infections. High levels of coliform are a good indicator of potential problems. Chapter 2 showed that there is little treatment of sewage effluent before it is discharged to rivers and that significant coliform levels are a common feature of rivers in the three focus river systems.

When water environments contain excessive heavy metals and pesticide, they accumulate in aquatic creature and plants. When used as foods, these transfer poisons to humans. In sufficient quantities, these chemicals can cause many physical disorders as well as diseases such as genetic mutation, cancer, anaemia, cardiovascular diseases (high blood pressure, blood circulation disorder, blood blockage), skin diseases (pigment changes, tanning, skin cancer), diabetes, liver complaint and related matters to the digestive system, and mental disorders. These can result in death.

Over recent decades, the Government has invested heavily in the provision of clean water supplies and sanitation services. Under Vietnam's development target, by the year 2010, 95% of the rural population will be provided with safe water. This is essential for ensuring their basic well-being and reducing poverty. By 2010, 75% of rural households will have toilets that meet basic sanitation standards. However, the current programme cannot meet the needs and is being accelerated with significant international assistance.

People in many areas such as mountainous, coastal and dry areas do not have access to clean water. Nationally, in rural areas the average percentage of people having clean water is 66% (2005). In the Cau River sub-

basin the average percentage is 61%; for the Nhue - Day this figure is 70%; and for the Dong Nai it is 67% (Source: Centre of Clean Water and Rural Environmental Sanitation, MARD, 2006).

Different income groups have clean water provisions at different levels. For example, in the Red River Delta, only about 50% of the poor have a clean water supply, whereas, the percentage is 90% of the high-income people (Source: *The State of Clean water supply, Environmental sanitation and Rural people's health in Viet Nam* - Donor Review, 2005). This means that about half of the poorest people must rely on raw water from a river or on groundwater for their basic needs. Figure 3.1 shows the sources of water supply for people in some provinces/cities.

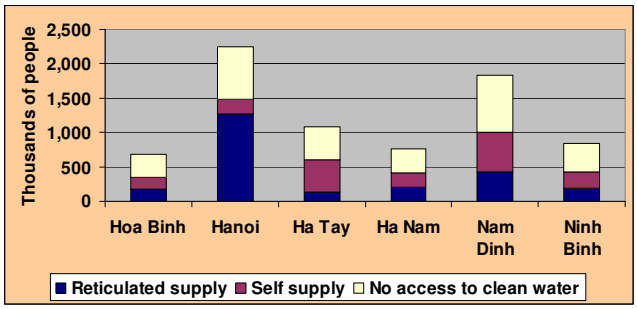


Figure 3.1: Water supply in the Nhue-Day river basin

Source: Office of the National Target Programme on Clean Water and Rural Environmental Sanitation, 2004

As the investment costs for a household domestic water treatment system is often much higher than rural people's average income, many rural people must take their water supply directly from rivers or from lakes and ponds around the home. When the surface water source is degraded, people are quickly and significantly affected.

In urban areas and major cities of the basin/sub-basins the rate of providing clean water for living is generally high. However, the poor usually live in wards in which clean water and sanitary conditions are limited.

3.1.2 Domestic water supply human health impacts

In the Cau and Nhue – Day River sub-basins and the Dong Nai – Sai Gon River basin the rate of sicknesses related to surface water quality has been high. Although it is it difficult to accurately assess the contributions of poor water quality to this, there is a clear link between the regular use of polluted water and human health effects. Therefore, the results presented in this section should be seen as an indicator of the impact of poor river water quality.

In Bac Kan province (where the Cau River and its tributaries are less polluted) and in Thai Nguyen province (where good quality water is supplied from Nui Coc reservoir), the number of digestive infections is generally lower than that of the provinces in the lower river sections, such as Vinh Phuc, Bac Ninh, Bac Giang and Hai Duong, were people tend to rely more on raw water from the river (Figure 3.2).

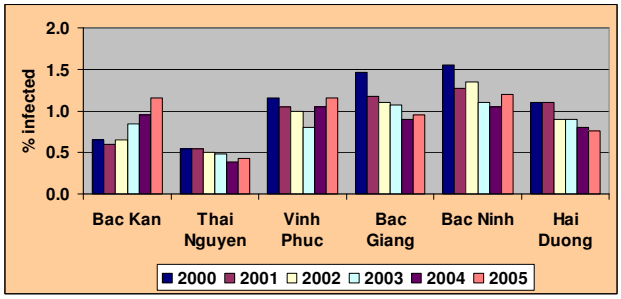


Figure 3.2: Percentage of the population infected with diarrhoea

Source: Ministry of Health, 2005

Similarly in the Nhue – Day River sub-basin, provinces directly using polluted water from the Nhue River (particularly Ha Nam) generally have higher levels of digestive complaints compared to other provinces with less reliance on this water (Ninh Binh and Nam Dinh) and especially compared to those that do not use the water at all (Hoa Binh) (Figure 3.3).

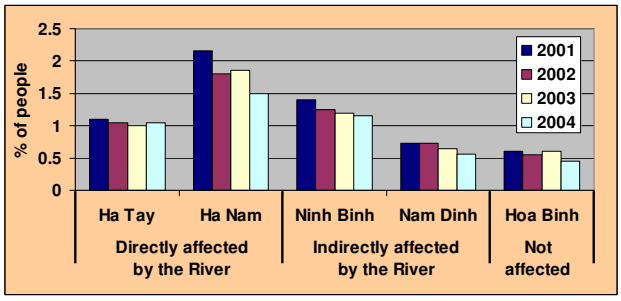


Figure 3.3: Percentage of people with digestion complaints

Sources: Ministry of Health, 2005

Note that Figures 3.2 and 3.3 generally show a trend of declining incidences of sickness over recent years.

In Ha Tay and Ha Nam Provinces, districts and communes through which the Nhue River flows have much higher rates of people infected by amoeba and diarrhoea than other districts not by river (Figures 3.4 and 4.5).

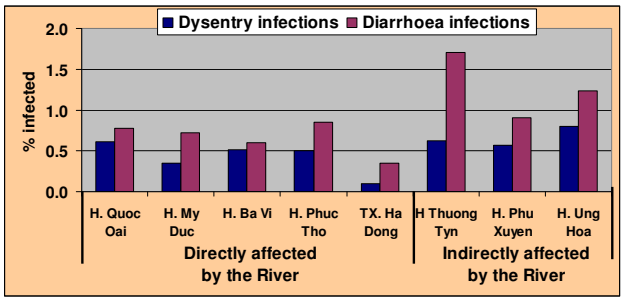


Figure 3.4: Percentage of population infected by amoeba and diarrhoea in districts in Ha Tay (2005)

Source: Ministry of Health, 2005

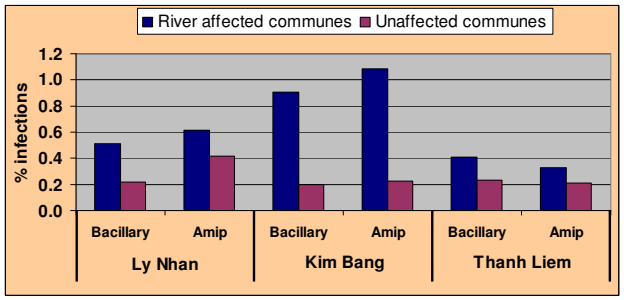


Figure 3.5: Percentage of people infected by dysentery (bacillary and amip) in Ha Nam communes

Source: Institute of Geography, 2005

In Binh Duong Province in the Dong Nai River Basin, Phu Giao, Di An and Thu Dau town districts are not affected by polluted water and the rate of diarrhoea and amoeba is much lower than districts near the Sai Gon River - such as Ben Cat, Dau Tieng, and Thuan An (Figure 3.6).

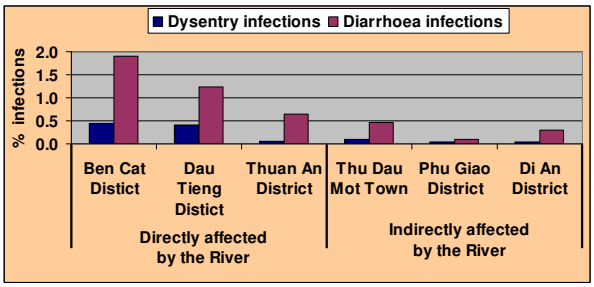


Figure 3.6: Percentage of people infected by amoeba and diarrhoea in Binh Duong

Source: Ministry of Heath, 2005

There are a high proportion of cases of children infected with diseases related to contaminated water, as children are more vulnerable and easily affected by their environment (Figure 3.7).

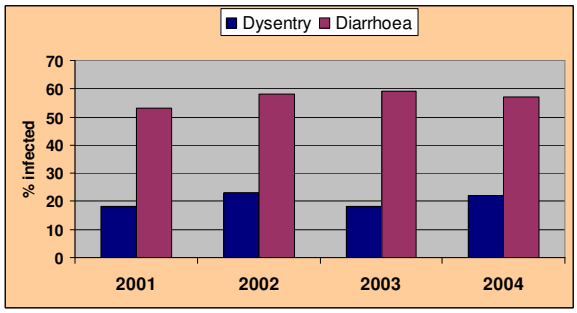


Figure 3.7: Percentage of children infected in Thai Nguyen

Source: Thai Nguyen Provincial Department of Natural Resources and Environment, 2006.

Box 3.1: Infections from the Nhue River in Ha Nam

In Ha Nam province, 21% of children under 5 years old in Hoang Tay Commune have been infected with diarrhoea. In two communes of Hoang Tay and Nhat Tan (Kim Bang District), about 86% children were infected with ascarid, 76% infected with hairworm and 9% infected with hookworm. The rate of eye and skin diseases and gynaecological problems is high.

Source: Institute of Geography, 2005

In addition, people in parts of the three river basins are being infected by heavy metals and pesticides in surface waters. Ingestion of food containing those contaminants (in vegetables, fish) over long periods accumulates in human bodies.

In the Nhue-Day River sub-basin, a study was undertaken over two years in order to better understand the impacts of people using

contaminated water for irrigation, including human health impacts (Reference: *Nguyen Trung Dung and Vu Quang Chung*). In 2004, irrigation in 6 communes along the river system (from the top of the river to the end) was studied. The study had a sample size of about 750 farm households and in 2005, it was expanded to 11 communes.

The study found that 40% to 60% of households had eye infections, 20% to 40% suffer intestinal problems and 20% to 40% had skin disorders. 80% of households located in the polluted river sections thought that the costs they have to pay for the treatment of illness related to the use of polluted river water are increasing each year.

3.1.3 Human health impacts from agricultural chemicals

Agricultural chemical are used by a high proportion of the population and on large land areas. The Vietnam Country Report to the 7th Global Information Network on Chemicals Conference in Tokyo in 2001 provided the results of a study of 2,500 farmer households in 4 areas of Viet Nam showing the close link between the use of pesticides and the health of farmers. The analysis showed the following problems:

- Most of pesticides used were of high toxicity level (Classes I and II) with oral LD_{50} < 50 and 50-500 mg/kg. It was found that some organophosphates classified as prohibited or of restricted use, such as methamidiphos, monotocrophos and parathion methyl, were available.
- The number of sprays per crop season and the dosage applied was usually 2 to 4 times greater than the recommended levels and, most spraying equipment was of low quality. Therefore, levels of exposure were unnecessarily high, costs of chemical use was high but the efficiency low.
- Most farmers had little awareness of the negative impacts of pesticide use. The majority did not have appropriate protective measures and storage facilities.

The awareness of farmers on pesticides and their safety use is reflected in Table 3.1 (percentage of farmers interviewed).

Table 3.1: Pesticide Use in survey areas

Items	Survey area			
	Rice	Vege-tables	Tea	Grape
Householders surveyed (No)	367	500	540	693
Householders using pesticides (%)	100	100	100	100
Pesticide users				
Male	5.9	69	62	92.7
Female	94.1	31	37.1	7.3
Awareness of pesticides and their use	20	19.3	49.7	52
Protective means				
Sufficient	0	0	7	0
Partial	65	82.6	64.9	100
Absence	35	17.4	28.1	0
Cleaning the spraying equipments				
Special cleaning area	0	0	0	20
Lake, pond, rivers	86	29	51.4	77
Well, or other water sources	14	8	49.6	31
Chemical storage and use				
Special storage facility	20	01	66	80
Disinfecting measures after spraying	100	100	100	100
First aid availability	0	0	0	0
Collect wastes after spraying	40	0	48	70

The study interviewed 898 farmers and found that 218 of them were suffering from health problems associated with pesticide poisoning, such as:

Hypertension and hypotonic diseases (7% and 13.5% respectively)
Nerve disorders (39%)
Digestive problems (29%)
Stomach and pancreatic intestinal problems (5.5%)
Skin diseases (53.5%)

Dysfunctions of excretory system (24%)

The study showed that over 12% of people interviewed suffer various pesticide related problems at least once, over 4% twice, and 0.5% three times during their working lives.

There is no reason to assume that results of this study would not also apply from the use of agricultural chemicals in the river systems under study. Farmers generally have poor awareness of safe and effective use of chemicals in agriculture. Also disturbing is that equipment used for chemical application is generally cleaned in public water sources, causing broader scale impacts on local communities.

The consequence of these results is that community health, agricultural product quality and the rural environment are seriously affected due to the toxicity of pesticides.

3.2. IMPACTS ON THE ENVIRONMENT

Water (and sediment) quality is an important aspect of maintaining environmental values. Rivers act as conduits for pollutants by collecting and carrying run-off from surrounding lands, and by receiving point source discharge of wastewater. Therefore, surface water quality is closely linked to the environment and land use in a river basin. Chapter 2 has shown how changes in land use for socio-economic development have seriously degraded water quality.

However, water quality is only one aspect of a healthy environment - in many cases other factors are also important, e.g. flow, habitat condition, soil type, groundwater hydrology and barriers to movement of aquatic wildlife. Changes in river flow structure, riverbank vegetation, floodplain condition, flow variability and in-river habitat also affect environmental health.

Wastewater with high levels of organic substances creates favourable conditions for plants to grow, which, in excess, can decrease oxygen in water, killing living creatures.

Toxic substances such as oil, heavy metal and chemicals in the water have serious effects on the ecology of the river system, killing fish and destroying the natural food chain.

There is little direct information or data on the environmental health of the river and its ecology in the focus river systems. Therefore some related factors are described here as broad indicators of environmental conditions.

In the Cau River sub-basin, mining and related activities are a significant feature of the economy. Because the size, scope and production techniques of mining activities are different, their individual impacts on the environment also vary. However, it is evident that the environment is increasingly polluted and damaged. In mining areas the local ecological environment has been degraded through the destruction of forests and the impacts of such a major land disturbance. At some mines nearby areas of protection forests have become degraded and littered with waste piles.

Waste piles are often placed in unsuitable places, resulting in severe erosion of the pile. Virtually all mines have waste piles outside the mine area, causing environmental pollution and local flooding.

Wastewater from mining coal contains clay and coal dust. This pollutes the surface water and cause problems for aquatic wildlife. In addition, mining coal requires open-cut exploitation to levels lower than the underground water, causing water levels to be lowered and decreasing the quantity of underground water around the mines.

Sand mining is a major activity in Bac Ninh, Bac Giang and Thai Nguyen, which affects river flows and river banks. Construction material sites and brick fields beside dams in Bac Giang, Bac Ninh and Vinh Phuc (especially around Dap Cau in the lower river section) block and modify river flows, damage bamboo areas and threaten the surrounding environment. These typically increase the sediment load of rivers to levels far above those naturally occurring, causing problems for the survival of aquatic wildlife.

Before wastewater treatment began in 2005, in some of the Cau River tributaries, particularly the Ngu Huyen Khe River, organic substances and dangerous chemicals were routinely discharged to the river. This meant that its water could not be used for drinking, eating or washing, and aquatic creatures were not able to live. Traditional uses of the river were lost. However, since 2005, some

factories have changed their production technology (Hoang Van Thu Paper company, Thai Nguyen cast iron factory) which reduces environmental pollution. Despite this, in many other parts of the Cau River, the quality of river water remains degraded, which affects the environment, the river and people's lives.

In the Nhue - Day River sub-basin aquaculture is a significant industry. Increasingly most of the surface water quality indicators do not meet the Vietnam standard. Therefore, the output and the quality of aquaculture product is changing. Sudden changes in water quality dramatically impact on aquaculture farming.

In the dry seasons, water diversions from the Red River to the Nhue River are limited and a large amount of water from Hanoi's drainage system flows down the Nhue River. This causes sudden increases in poisonous substances (CO_2, H_2S, CH_4) and decreasing oxygen levels. Cases of mass death of aquaculture fish occurred in 1994, 2002, and 2003. Where aquaculture fish are significantly affected, it can be assumed that native river fish and other aquatic species are similarly affected.

The level of pollutants in the Dong Nai- Sai Gon River basin is so high in parts of the basin that that there is no capacity for them to disperse and there is little dilution effect. This leads to some river sections being classified as "dead" sections. Heavily polluted surface water runs into brackish and lower estuarine areas, which also seriously influences this environment and its aquatic wildlife, and reduces the level of aquaculture production.

The Thi Vai River is an examples of how the environmental pollution can directly affect the aquatic ecological system of the river. Along this river, wastewater from ports and industrial zones is not treated or poorly treated before discharge to the river. Pollutants remain in the river for a long time and its flows are affected by tides. A section of about 12 km (from Ca River to Thi Vai River about 2 km to Phu My Port behind the My Xuan industrial zone) is seriously polluted and is regarded as "dead". Shrimps, fish and other species hardly exist and cannot develop. Seaweed can live in nutrient rich and dirty waters and their excessive growth contaminates the water environment.

3.3 ECONOMIC IMPACTS

3.3.1 Domestic water supply

In the three focus river systems, rivers are a common source of supply for towns. For example the Day River and some its tributaries are water sources for water supply facilities in Phu Ly Commune (Ha Nam), Ninh Binh Commune (Ninh Binh), Y Yen District, Nghia Hung (Nam Dinh) and some riverside communes.

Currently in Nam Dinh, there are total of 42 water supply works with an output capacity of 90,000 m^3/day. Their water source is the Day and Dao Rives where quality is now tending to reduce to below the standard. Other areas (Ha Dong and the urban areas in the south of Hanoi) have used underground water as an urban supply source. However, the groundwater is directly or indirectly related to the Nhue-Day river flows and their quality.

Box 3.2: Water shortage is worrying 60,000 people in Ha Nam

Underground water is affected by high salt levels and Phu Ly Town is using water from the Nhue and Day Rivers for its supply. However, in the dry season the two rivers are badly polluted and the two supply works for the town have had to stop production.

The Ha Nam Water Supply Company said that the town has been short of water since 2001. In October and between 9th November and 14th December 2005, water in the Nhue and Day Rivers was black and smelly. Both water supply works had to stop their production.

Source: Vnexpress, 22 March 2006

As most raw water quality (surface water and underground water) for urban areas generally does not meet the standards, the raw water needs to be treated before it can be provided to communities. Water treatment costs 1,500 to 2,000 VND/m^3, for normal raw water. These costs increase to 2,500 VND/m^3 or more if raw water is polluted by organic substances. (*Source: Urbanisation Environmental Technology Centre and CEETIA Industrial Zones*), and even higher for more serious pollutants.

Box.3.3: Water treatment costs in Ha Nam

Mr. Lai Thanh Tuyen, Vice Director of Ha Nam Water Supply Company said that in the dry season between November and March, the cost for water treatment is 3 or 4 times higher than normal. In seriously polluted days, the suppliers had to stop production.

To solve the problem, it is necessary to move the water supply facilities 2 km upstream, and this will cost about VND 7 billion.

Source: Enterprise Forum, dated 2/12/2003

Box 3.4: Water treatment costs in Dong Nai

The Dong Nai River at Hoa An Pumping station (supplying water to HCMC and Bien Hoa City) is now polluted with BOD_5 concentrations at twice the standard. The price for each m^3 of water after treatment increases by 4,658 VND (which is more expensive than the present price per m^3 of water supply). The result will be that the price for each m^3 of water after treatment is 9,077 VND/m^3. Therefore, on average per day, the Thu Duc water station has additional costs about 5.9 billion VND.

Source: Environment Protection Project in Dong Nai River Basin , 2003

3.3.2 Aquaculture

The Government is promoting aquaculture as a means of enhancing incomes and reducing poverty. Aquaculture and processing fish products are an important means of increasing export earnings – the sector already is the third highest export earner. However, most producers are poor and inefficient with no understanding or capacity to introduce environmental management.

The need for satisfactory water quality to maintain viable aquaculture operations is an increasing problem. Poor water quality has a significant influence on the quality and quantity of aquaculture product, results in loss of production of culture species, and can also lower the quality of the end product.

In the Nhue - Day River sub-basin in 2005, the surface water area of aquaculture was 42,900 ha with an output of 121,360 tonne/year. As most of the surface water quality indicators increasingly do not meet the Vietnam standard, the output and the quality of aquaculture product is deteriorating. Sudden changes in water quality dramatically impacts on aquaculture farming, especially cage-fish farming.

Box 3.5: Loss of caged-fish farming in Ha Nam Province

Over the period 2000-2003, from November to March, polluted water from the Nhue River to the Day River killed many fish and shrimp. Water from Thanh Liet Dam (Hanoi) during November 22 to November 26, 2003 caused heavy losses in Chau Thuy, Chau Giang, Phu Ly Commune, Ha Nam Province. Nguyen Van Nam, investing 70 million dong to raise caged fish, lost 3 tons of breed fish and 10 tons of valuable fish; Bui Quoc Ky lost 400 million dong along 2.5 km of river used to raise caged fish.

Source: The Business Forum, 2003

In 2005, the area of surface water for aquaculture in 11 provinces of the Dong Nai River basin was 71,800 hectares with a production output of 488,921 tonnes a year. This production has been growing strongly, particularly in the brackish waters at the lower end of the river system. Much of this is now threatened by pollution.

3.3.3 Agriculture

Agricultural practice in Vietnam is dependent on irrigation. Because of climatic constraints, it often has with a heavy reliance on surface water and groundwater for irrigation of crops.

An important national goal is to maintain or improve the productivity of irrigated agricultural land. The quality of water used in irrigation can have a major effect on the soil, plant and water factors at the crop level. Key issues concerning the effects of irrigation water quality include:

- **Soils**: root zone salinity, soil structural stability, build-up of contaminants in soil, effects on soil biota, and the release of contaminants from soil to crops and pastures.
- **Crops**: yield, product quality, salt tolerance, specific ion tolerance, foliar injury, and the uptake of toxicants in produce for human consumption, contamination by pathogens.

- **Water resources**: deep drainage and leaching below the root zone, and movement of salts, nutrients and contaminants to groundwater and surface waters.
- **Other important factors**: quantity and seasonality of available water, soil properties, crop species and management options, land type, and groundwater depth and quality.

For example, yield reductions occur if the salts accumulate in the root zone to such an extent that the crop is no longer able to extract sufficient water from the salty soil solution, resulting in a water stress for a significant period of time. If water uptake is significantly reduced, the plant slows its rate of growth. The plant symptoms are similar to those caused by drought.

In the Nhue-Day River sub-basin, a study was undertaken over two years in order to better understand the impacts of using contaminated water for irrigation (Reference: Dung and Chung**)**. In 2004, irrigation in 6 communes along the river system was studied (Tu Liem, Thanh Tri, Thuong Tin, Dong Van, Ung Hoa and Kim Son). The study had a sample size of about 750 farm households and in 2005, it was expanded to 11 communes.

The study found that because of the high levels of nitrogen, phosphorus and potassium (NPK)in wastewater, the additional application of chemical fertilisers became unnecessary, or could be considerably reduced. The chemical fertiliser amount needed for rice production in communes with high pollution level is generally lower than in the other communes – the amounts of nitrogen and potassium used in Than Tri and Thuong Tin is significantly less that that of the other communes (Figure 3.8).

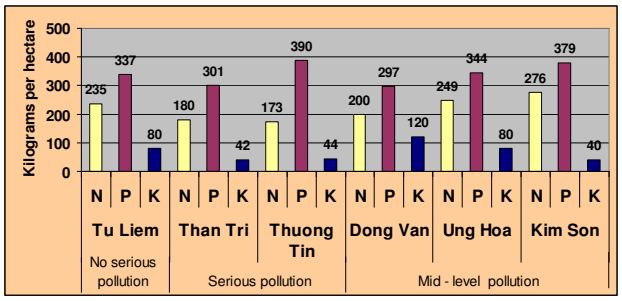


Figure 3.8: Use of chemicals for rice growing

Source: Nguyen Trung Dung and Vu Quang Chung

However, the rice yield in the pollution-affected locations (Than Tri and Thuong Tin) is lower, especially the summer paddy rice which is 20% lower - Figure 3.9.

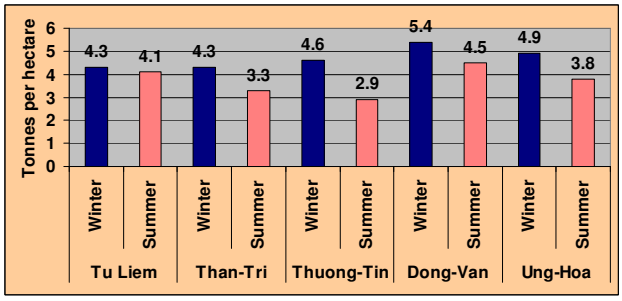


Figure 3.9: Rice yields

Source: Nguyen Trung Dung and Vu Quang Chung

In the pollution-affected communes, the vegetables which are grown on the riverbanks sell for half price in the local market. Since 2000, aquaculture production has not been possible. The study concluded that using heavily polluted water can save some fertiliser costs, but reduces the income from rice production (Table 3.2).

Table 3.2: Fertiliser costs and income from rice production

	Fertiliser cost	Income
	(000' VND/ ha)	
Tu Liem	**1,324**	**2,380**
Than Tri	**1,258**	**2,150**
Thuong Tin	**1,375**	**2,370**
Ung Hoa	**1,653**	**3,740**
Dong Van	**1,796**	**2,490**
Kim Son	**1,788**	**3,390**

Source: Dung and Chung

This study can be extrapolated to the other rivers and indicates that the communities in the these focus river basins are suffering real costs because of the high levels of pollution. These communities have little option but to continue using the river water.

Good-quality drinking water is also essential for successful livestock production. Poor-quality drinking water may reduce animal production or impair fertility; in extreme cases, stock may die. Water quality requirements for livestock may differ between animal species, stages of growth and animal condition. Contaminants in drinking water can produce residues in animal products (e.g. meat, milk and eggs), adversely affecting their saleability and/or creating human health risks.

3.3.4 Pollution and river flows

In all three river systems, there are currently water shortages in the dry months, which are quite serious in some locations. Poor water quality exacerbates these problems as it makes the water far less useful for productive purposes.

As discussed in Chapter 1, the available yearly water in the Cau River sub-basin is exceptionally low – around 656 m^3 per person. This water flow is unevenly distributed over the year and in some locations there is a real shortage of water, especially in February to March. At these times there is competition over access to water and the water that is available is diverted from the river mostly for irrigation use - over 85% of the water use in the sub-basin is for irrigation. As the pollution discharges continue, the contaminants in the water are increasingly concentrated and the quality of water quickly declines.

The Nhue-Day river basin is used for many different, even conflicting purposes - such as domestic use, agricultural irrigation, animal husbandry, aquaculture, industrial production, and craft production. These different water uses lead to conflicts between the sub-basin provinces over how they need to use the river system. Ha Noi and Ha Tay use the Nhue River as a receiving and draining medium for wastewater, whereas Ha Nam, Nam Dinh and Ninh Binh use the rivers as water sources for agriculture, aquaculture and domestic use.

Currently the water in the Nhue-Day River sub-basin is being over-exploited, particularly when diversions from the Red River are not being made. The continual flow of wastewater to the river, and the extraction of water from the river for agriculture, has lead to the deterioration in water quality discussed in Chapter 2. Water quality does not meet requirements for domestic use or aquaculture, limiting opportunities for development and imposing real costs on river communities by making the scarce water resources less productive and useful.

In the Dong Nai River basin the water is used for three main purposes: domestic water supply, agriculture and industry. The major part of the water is currently used for agriculture and domestic use, but this will reduce in the future as the water for industry and domestic purposes will increase. This will naturally lead to competing interest among sectors and related provinces in the basin.

From a basin perspective, the socio-economic development of one province/city always has potential impacts on the use of water in another or many other provinces/cities. If upstream provinces increase their water use and extract more water from rivers, or pollute the water source making the water less useful for community needs, the threat of water conflicts in the down-river areas will be increased.

3.4 CONCLUSIONS

The lack of a safe water supply and human waste disposal system causes waterborne disease to spread easily in poorer areas. Many people in the focus river basins/sub-basins do not have access to clean water. In the Cau River sub-basin the average percentage of people having clean water is 61%; for the Nhue - Day this figure is 70%; and for the Dong Nai - Sai Gon it is 67%. As the investment costs for a household domestic water treatment system is often much higher than rural people's average income, many rural people must take their water supply directly from rivers or from lakes and ponds around the home. When the surface water source is degraded, people are quickly and significantly affected.

Although it is it difficult to accurately assess the contributions of poor water quality to human health, there is a clear link between

the regular use of polluted water and human illness. In the focus river basins the rate of sicknesses related to surface water quality has been high – provinces and communes located near polluted rivers generally have higher rates of dysentery and diarrhoea than those located away from such rivers. However, the level of sickness has showed a declining trend recently.

There are also a high proportion of cases of children infected with diseases related to contaminated water, as children are more vulnerable and easily affected by their environment.

In the three river systems, rivers are a common source of supply for towns. However, as most raw water quality generally does not meet the standards, the raw water needs to be treated before it can be provided to communities. This is imposing substantial costs on the river communities. In some cases water production has to be stopped completely as the water is so badly polluted.

Agricultural chemical are used by a high proportion of the population and on large land areas. Most of pesticides used are of high toxicity level and some chemicals classified as prohibited or of restricted use were available. The application of chemicals is usually far greater than recommended, levels of exposure are unnecessarily high, and the costs of chemical use is high but efficiency is low. Most farmers have little awareness of the negative impacts of pesticide use and do not have proper protective measures and storage facilities, and wash their equipment in river or lakes. A study has found that around 25% of farmers were suffering from health problems, and that over 12% of people suffer problems at least once, over 4% twice, and 0.5% three times during their working lives.

Polluted water also has a major impact on irrigation. On the one hand, because of the high levels of nitrogen, phosphorus and potassium in wastewater, the additional application of chemical fertilisers became unnecessary, or could be considerably reduced. But on the other hand, and much more seriously, the rice yield in the pollution-affected locations is lower, especially the summer paddy rice.

The need for satisfactory water quality to maintain viable aquaculture operations is an increasing problem in all three basins/sub-basins. Poor water quality has a significant influence on the quality and quantity of aquaculture product and can result in loss of production of culture species.

There is little direct information or data on the environmental health of the river and its ecology, as a result of poor water quality, in the three river systems. Therefore other factors are described as broad indicators of increasingly degrading environmental conditions.

In all three river systems, there are currently water shortages in the dry months, which are quite serious in some locations. The continual flow of wastewater to the rivers and the extraction of water from the river for agriculture and other purposes has lead to the deterioration in water quality discussed in Chapter 2. Water quality does not meet requirements for domestic use or aquaculture, limiting opportunities for development and imposing real costs on river communities by making the scarce water resources less productive and useful.

CHAPTER 4
CURRENT WATER QUALITY MANAGEMENT

CHAPTER 4: CURRENT WATER QUALITY MANAGEMENT

Water quality protection is central to the planning, exploitation and protection of water resource in river basins. However, management of water quality in river basins faces many difficulties: it crosses many laws and sub-laws and comes under the scope of many industries and agencies; the mandates and duties amongst ministries and departments are only recently clarified; river basins are still managed according to administrative lines; and mechanisms to mobilise participation of private organisations, non-government organisations, international organisations and the community in water resource development and protection are not yet effective. This chapter provides an overview of the framework for water quality management in Vietnam, within which the three focus sub basins operate.

4.1 LEGAL AND POLICY FRAMEWORK

There are many documents that give legal status to water quality management in river basins. The principal laws are the Law on Environment Protection, 2005 (LEP), the Law on Water Resources, 1998 (LWR), the Land Law (2003), the Vietnam Standard – Standards of river and pond water quality (revised in 2005), and various resolutions and sub-laws to give effect to the primary laws.

Box 4.1: Provisions of the LEP on water protection 2005:

Item 2, Chapter II, includes Article 59, 60, 61 and 62 on river water protection:

Article 59: providing principles for water protection:

1. River water environment protection must be one of the crucial contents of the planning, exploitation and use of water resources in river basins.

2. Localities neighbouring the river basins are jointly obliged to protect the environment of the river water; proactively share the benefit brought about by river water resources and ensuring the interests of the river-dependent communities.

Article 60 on monitoring and treating water pollution and water degradation in river basins.

Article 61 on the responsibility of Committees at provincial level for water protection in river basins.

Article 62: organisational arrangements for water protection.

The LEP prohibits the discharge of wastes to water sources which are not at the environmental standards; and the discharge of toxic, radioactive and other hazardous substances to water sources. The LEP provides regulations on water quality management and river water protection.

The LEP provides the basis for environmental standards, including those for waste discharge, and provides the requirements for strategic environmental assessment reports. Organisations and individuals must comply with environmental protection requirements not only during inventory, exploration and the exploitation and use of natural resources, but also upon completion of the exploitation activities.

The LEP has specific provisions for the environment protection requirements for:

- concentrated production and service areas (Article 39);
- production and services establishments (Article 40);
- craft villages (Article 41);
- medical establishments (Article 42);
- construction activities (Article 43);
- transportation and traffic activities (Article 44);
- mineral resources activities (Article 47);
- tourism (Article 48);
- agriculture and fisheries (Article 49);
- concentrated farming areas (Article 50);
- dealing with polluting production and service establishments (Article 52); and
- urban and residential areas (Articles 53 and 54).

The LEP provides a comprehensive basis for managing environmental quality in Vietnam. However, it is a relatively new Law and its implementation is not well advanced. Many of its provisions are new and guidelines on their application are being developed. As well, the Law in not well known or understood in the community.

The Vietnam standards relating to the environment protection of rivers, pond and lake water for the purpose of water use were firstly issued in 1995, and were revised in 2001 and 2005. However, there are no standards developed yet covering sediments and solid residue.

The LWR covers surface water, rain, groundwater and sea water. Under the Law it is strictly prohibited to introduce into water sources, without a permit, any noxious waste, unprocessed discharge water or water that has been processed but not up to the permissible standards as provided under the legislation on the protection of the environment. Permits to discharge wastewater must be based on the receiving capacity of the water source. Wastewater must be processed in order to reach the permissible standards before discharge.

The LWR provides that organisations and individuals have rights to take water from a water source. Generally a licence is required to take and use water, but there are some exceptions to this for family scale purposes.

The Land Law requires the reasonable exploitation of natural resources and the protection of the environment in all land use zoning and planning activities as a basis for land allocation.

Although these laws provide a sound basis for water quality management, the application and enforcement of the Laws in pollution control is still limited and under development. Currently, very few enterprises comply with the legal requirements.

4.2 ENVIRONMENT AND NATURAL RESOURCE MANAGEMENT IN RIVER BASINS

4.2.1 National Level

The creation of MoNRE was an important part of the Governments Public Administration Reform programme in terms of role separation in the natural resource and environment sector. MoNRE has responsibility for the state management of natural resources and the environment (bringing together the state management functions for land, water, minerals, environment and related functions such as hydrometeorology, surveying and mapping). The establishment of the State water resource management functions within MoNRE separated this from operational water service delivery functions of other Ministries. Table 4.2 shows the key water related responsibilities of Ministries.

Since the creation of MoNRE, there has been some confusion on the respective roles of MoNRE and the Ministry of Agriculture and Rural Development for river basins. Recently, Government Decision 43/2007/TB-VPCP of 15th March 2007 clarified the assignment to MoNRE of the overall responsibilities for river basin management in Vietnam. The Government decision required MoNRE to prepare a decree on river basin management by mid-2007.

Based on the LWR, The National Water Resources Council was established in 2000. The Council is chaired by the Deputy Prime Minister, with Deputy Minister level participating members from MoNRE, MARD, and Ministries representing fisheries, science and technology, planning and investment, finance, industry, construction, transport, health and National Defence. The Council advises the Government on policy, strategy and approval of river basins plans; major projects on water sources development; disputes over water; and international aspect of water resources management and development.

Table 4.1: Water related responsibility of Ministries

Ministry of Natural Resources and Environment (MoNRE)	Management of water resources, water quality, planing for the use, management and protection of water resources in river basins, licensing of water use and wastewater discharge.
Ministry of Agriculture and Rural Development (MARD)	Irrigation, flood prevention, water supply for rural living, management of irrigation schemes and dykes
Ministry of Planning and Investment (MPI)	Establishment and implementation of all socio-economic development strategy
Ministry of Industry (MOI)	Hydropower development through EVN
Ministry of Science and Technology (MOST)	Appraisal of draft and announcement of water quality standard by MONRE
Ministry of Construction (MOC)	Design and construction of urban water supply and drainage schemes
Ministry of Transportation (MOT)	Water transport and port system
Ministry of Fishery (MOF)	Aquaculture and aqua-product processing
Ministry of Health (MOH)	Drinking water quality: establish and monitor water quality standards
Ministry of Finance (MOF)	Policies on taxes and fees for water resources

During 2006, the Government requested MoNRE to prepare plans for the integrated exploitation, use and protection of water resources in major river basins and for key economic zones (Prime Minister's decisions 113/2005, 123/2006 and 191/2006). In response to this, MoNRE is currently preparing three river basin plans – for the Dong Nai River basin, the Ba River basin and for the rivers within the Northern Economic Zone (broadly covering the Red River Delta). Design proposals for these plans have been approved by the Government and additional State funding has been assigned to MoNRE to undertake this work.

4.2.2 Provincial and river basin level

Since 2003, 64 DoNRE's have been established in provinces and cities, including Departments of Environment Management. Some provinces have also established Centres for Monitoring or Environment Monitoring Agencies.

At the river basin level, a number of river basin organisations/boards have been established. Decisions on the establishment of planning management boards for the Cuu Long River Basin, Dong Nai River Basin, and Hong-Thai Binh River Basin were issued by MARD in 2001. However, these organisations are no longer active.

More recently, under the ADB's TA 3892: Second Red River Basin Sector Project, which started in 2001, MARD established organisations for the Cau River sub-basin and Nhue-Day River sub-basin. Following the Government's Decision 43/2007/TB-VPCP, the future of these boards is not clear.

On 7 August 2003 the leaders of 6 People's Committees of provinces/cities in the Nhue-Day River sub-basin committed to protect the environment in the basin. The Prime Minister assigned the Hanoi People's Committee to preside over and cooperate with other provinces/ cities to prepare an Environment Protection Plan for the basin. However, the Plan has not been finalised as the Hanoi People's Committee was unable to act as the coordination unit.

In the Dong Nai River basin an Environment Protection Committee was established in November 2001, including representatives from the 11 People's Committees of provinces and cities. On 28th December 2001, a meeting of the Chair people of the People's Committees of provinces/cities discussed cooperation among localities for water source management in the basin. On 21 March 2002, a Government decision was made on the preparation of a master plan for water protection in the basin (Official Letter No. 291/CP-KG). The Ho Chi Minh City

People's Committee led the preparation of the Environment Protection Plan, which has been completed and is with the Government for Review.

In May 2004, MONRE cooperated with localities in the basin and scientific agencies to develop an Environment Protection Programs for the Dong Nai River basin.

In the Cau River sub-basin, the Chair-people of the People's Committees of the 6 provinces have agreed a shared commitment to the protection and sustainable exploitation of water in the Cau River sub-basin. A provisional steering committee was founded to coordinate activities and an Environment Protection Plan has been prepared - "*A general project on protection and sustainable development for ecological environment and landscape in sub River Basin*" – and has been approved by the Prime Minister (Decision No. 174/2006/QD – TTg). On the 8th November 2006, a number of priority measures were agreed for early implementation of the Plan.

Although many initiatives have been taken, management of river basins faces many difficulties: There are problems with cooperation between ministries and departments, and amongst localities. A further problem is the poor level of awareness of pollution and environmental protection at all organisational levels. The responsibility of localities and industries for the environment is not clear and many localities misunderstand the purpose of environment protection and their roles and responsibilities.

4.3. RIVER BASIN PLANNING

4.3.1 Water resource planning in river basins

Water resource planning in river basins is one of the most important activities in river basin management. On 13th February 2006, MoNRE approved a project plan and general budget for water resource planning in the Dong Nai River basin, the Ba River basin and for the focal economic zones in the North.

These river basin planning projects have common objectives as follows:

- To establish common principles and a framework for water resources protection, exploitation, development and use; prevent and mitigate damages caused by water; protect the environment of the within-border basin area; identify objectives; and set priorities and general solutions for planning.
- To identify measures and activities to use and manage water resources in a sustainable manner, including measures for:
  - sharing, exploiting, using and developing water resources;
  - protecting water resources and water ecosystems;
  - preventing and mitigating damage caused by water.

Irrigation and hydro-power are the two sectors most strongly and directly affecting the quantity and distribution of river flows in the three river basins under study. Rivers are controlled by reservoirs, dykes, and other structures changing flows and flow patterns. Sector planning has taken place as follows: irrigation planning in the Dong Nai River basin, the Cau River sub-basin and the Day River basin; and hydro-power planning in Dong Nai River basin. The planning for hydro-power development in particular proposes the construction of a large number of reservoirs.

In the past these sector plans have been undertaken to serve one particular purpose, with little or no consideration of combined or integrated uses. Preparation of river basin plans provides the opportunity to consider the benefits of multi purpose works serving a number of purposes, and also taking into account other water needs – such as water for living within the basin, water quality management and environmental requirements.

4.3.2 Zoning natural resources exploitation and wastewater discharge

Although there are no effective zoning plans on water resources, there are rules for zoning areas of water resource exploitation, use and waste discharge in some localities, such as in the Dong Nai

and Ba Ria – Vung Tau Provinces. This provides the basis for licensing wastewater discharge to water resource.

It is important to define and zone areas of water resource exploitation and use, and wastewater discharge. If river sections are not zoned, there could be situations where waste is discharged to upper sections of the river, making water use for living impossible in lower sections. However, to avoid conflicts among localities, zoning of areas must be applied to the whole river basin.

4.4. ENVIRONMENTAL IMPACT ASSESSMENT AND WASTEWATER DISCHARGE

4.4.1 Environmental impact assessment

Environmental impact assessment (EIA) is carried out systematically for individual projects from central to local levels in all sectors. Project assessment reports are approved by MoNRE which has issued delegations to the Provinces and cities. Registration forms are issued to establishments that achieve environment standards. The total number of EIA reports and the registration forms of achieving environment standards which have been approved and appraised over the last 10 years has been steadily increasing.

However, the number of approved reports which meet environmental standards and their registration is low compared to the total number of projects, and varies between provinces and cities. Checking of activities after the environmental impact reports are approved is weak - many projects are approved but are not operated according to the approved designs.

4.4.2 Granting licenses for wastewater discharge

Applications for and issuing licenses for wastewater discharge are regulated under Article 18 of the Law on Water Resources. Decree 149/2004/ND-CP dated 27th July 2004 provides details about water licensing – for exploiting and using water sources, and for discharging wastewater into water sources. MoNRE has issued Circular No. 02/2005/TT-BTNMT (24th June 2005) guiding the implementation of this Decree.

Box 4.2: Assessment of EIA reports in some provinces

In Bac Ninh: over the past 10 years, the province's Board of Assessment of EIA reports have granted approval for 132 units to operate and invest in projects in which 434 organisations and individuals are granted land both inside and outside of industrial zones.

In Vinh Phuc: there are 48 enterprises which have prepared EIA reports and 143 enterprises meeting environmental standards (about 56.8%).

In Binh Duong: up to October 2004, 1,785 enterprises in the province prepared EIA reports or registered their achievement of environment standards (including 71 EIA reports appraised by MoNRE). All of the industrial zone have prepared EIA reports and they were appraised and approved.

In Dong Nai: up to 2004 the province had appraised 373 EIA reports and 770 registrations of achieving environment standards.

Source: Proceeding summarising 10 years of environment assessment in Vietnam in December 2004

Many localities have identified establishments where wastewater discharge licences are required. However, for the 3 focus river systems, the number of licenses currently issued can be measured in tens, out of the many thousands of enterprises which will require licenses. This indicates that this work is now in its infancy and needs considerable development in the coming years.

4.5 SETTING PRIORITIES FOR POLLUTION MANAGEMENT

This Report has shown that there are a vast range of pollutants, generated by thousands of different types of enterprises, affecting water quality in the 3 river basins at various locations.

The comprehensive management of water quality is extremely complex, costly and takes considerable time. Vietnam lacks the financial and human resources required to

fully develop and implement the "ideal" water quality management approach. This is why it is critical that management actions are prioritised and directed towards the areas of greatest risk to communities and their environments within river basins.

A risk assessment approach was used to establish the priority enterprises stipulated in the Prime Minister's Decision No. 64/2003/QD-TTG of 22nd April 2003, approving the plan for thoroughly handling establishments which cause serious environmental pollution.

Vietnam can now build on this important initial work to establish a priority setting process based on risk analysis. This will allow the appropriate controls, regulations and management actions to be developed and implemented in a strategic way.

Box 4.3: Decision No 64/2003

Identifications of 4,295 polluting establishments, 439 in Stage 1.

Stage I (2003 – 2007):

Immediately handle the 51 highest priority polluting establishments (29 production businesses, 3 toxic chemical storage zones, 1 wartime bomb warehouse, 15 plant protection chemical warehouses and 3 rubbish dumps).

Prepare plans to handle the remaining 388 establishments including:

- upgrade technologies at 55 establishments;
- build waste treatment works at 200 establishments;
- control pollution, upgrade, renovate and build a pollution treatment systems at 49 former and existing rubbish dumps; and
- treat environmental pollution at 84 hospitals.

Stage II (2008 - 2012)

Continue handling the remaining 3,856 establishments causing serious environmental pollution.

4.6 APPLICATION OF ECONOMIC MEASURES

Economic tools can play an important role in the development and use of river basin resources. Economic measures include pricing of water services, financial self-sufficiency of enterprises, taxes on water resources and other taxes, policies of mobilising investment capital for development, fee for environment protection, etc. These economic tools use market forces so that organisations and individuals choose effective responses as they exploit, use and preserve natural resources - particularly by consumptive uses of water such as irrigation, urban water supply and drainage and water pollution reduction.

The government has acknowledged the role and importance of economic measures in environment protection. Decree No. 67/2003/ND-CP seeks to use pollutions charges to limit the environmental pollution caused by wastewater, to use clean water economically and to create a funding source for the Environmental Protection Fund, used to protect the environment and address the environmental pollution.

Box 4.4: Features of Decree No. 67/2003

The People's Councils decides on the specific rates of the environmental protection charges for domestic wastewater, but the rate must not exceed 10% of the non-VAT clean water selling price.

The Finance Ministry coordinates with MoNRE in prescribing the charge rate for each pollutant in industrial wastewater.

The Central budget receives 50% of the income which is added to the operation capital of the Vietnam Environmental Protection Fund under Prime Minister's Decision No. 82/2002.

The local authorities receive the other 50% to be used for environmental protection, new investment projects, sewerage, dredging, and repair and maintenance of local water drainage systems.

Under the decree, fees are levied for the discharge of wastewater from domestic sources, essentially based on the cost of

clean water supply, and from industrial sources, based on the amount of each pollutant found in the wastewater. The decree provides a range of charges for industrial discharge, with kez.

The Environment Protection Fund provides finance for environmental protection nationwide (but not for profit). Since 2004, 13 projects have borrowed funds under preferential interest rates. Among these projects, 3 have funded wastewater treatment systems in the 3 focus river basins: at the Vinh Phuc Garment Company, the Thai Nguyen Paper Export Joint Stock Company and the Dong Xuan Knitted Company (Hanoi). Although projects which borrow funds in provinces and cities are generally small, this creates favourable conditions for the development and application of other economic measures in water quality management in river basins.

In 2005 provinces/cities in the focus River basins collected over VND 132 billion; from which the industrial wastewater fee was around VND 13.4 billion (10.2%) and the domestic wastewater fee around VND 118.7 billion (89.8%). However, the amount of fees collected is much lower than estimated.

Most provinces/cities in the focus basins are collecting the fee - the exceptions are Hai Duong, Bac Kan, Ha Tay and Ninh Binh. Twelve provinces/cities are collecting both the industrial and domestic wastewater fee.

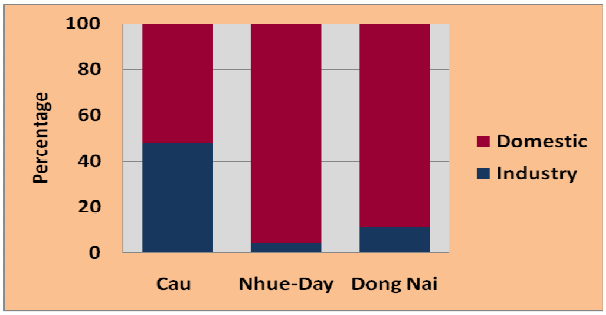


Figure 4.1: Industrial and domestic wastewater discharge fee collection, 2005

Source: MoNRE, 2006

4.7 POLLUTION INVESTIGATION AND INSPECTION

Implementing and checking (periodically and without warning) business agencies and industrial zones on their discharge of wastewater and the impacts on water quality is necessary to protect the environment in river basins.

In accordance with the instructions of the Prime Minister on treating environmental pollution in the Thi Vai River, MoNRE is cooperating with the People Committees of Ba Ria – Vung Tau and Dong Nai to check production sites and business sites that discharge to the River. Based on the results and analysis from 77 production sites and industrial zones, it is evident that most production sites do not implement, or incorrectly implement, the approved procedures. 49 out of the 77 production sites have wastewater treatment systems but only 12 production sites meet the national standards (15.6%). 28 of the production sites and industrial zones violate regulations on wastewater discharge. 8 of the 12 industrial zones have not built wastewater treatment systems sufficient to meet the demands of wastewater generated in the projects within the industrial zones. Wastewater exceeds the national standards for many parameters.

During 2006, MoNRE and the DoNREs in the Nhue – Day River sub-basin undertook inspections of industrial zones, business establishments and craft villages. The inspection aimed at identifying waste sources causing environment pollution, establishments that were causing serious pollution, as well as the establishments having environmentally friendly operations. 141 establishments, industrial zones and industrial complexes with a high risk of pollution were checked, with a total wastewater discharge of 28,500 m^3/day. 119 establishments (84.4%) discharged wastewater directly into the Nhue-Day Rivers, 75 (48%) establishments treat the wastewater (13,700 m^3/day), but only 11 establishments (3,185 m^3/day) have wastewater treatment meeting the Standards.

The inspection found that 40 establishments seriously violated the Law on Environment Protection and were fined nearly 250 million VND. These establishments were also classified and listed as stipulated under Decree No. 81/2006/ND-CP (on sanctioning of administrative violations in the area of

environmental protection) and Article 49 of the Law on Environment Protection.

4.8 RESOURCES AND CAPACITY

4.8.1 Staff

Staff working on environment protection in river basins includes management staff (environmental manager, pollution controller, surface water resource manager, environmental inspector) and monitoring staff (surface water and coastal water).

It is estimated that there are only 150 officers working on environment management in river basins out of 1,200 officers working on environment management in Vietnam. Most of the environmental protection staff have not received advanced training on river basin issues or on the concepts of integrated water resource management. They also have to undertake a number of other tasks, therefore their knowledge of river basin environmental protection is limited.

Traditional skills and current knowledge of staff does not align with new requirements, especially in a complex and multi-sector areas such as water quality management and environmental protection in river basins

4.8.2 Financial investment

Expenditure from the state budget for environmental protection in river basins is not a specific line item. Functions related to water quality management and environmental protection are carried out by many different ministries and departments. Budget items are also allocated according to ministry functions. However, most of the budget and expenditure is with MoNRE and MARD (at national level) and the DoNRE's and DARD's (at local level).

The total investment budget for environmental protection is increasing as a result of the Resolution No. 41-NQ/TW by the Politburo. Under the resolution, MoNRE co-ordinates with MOF and MPI to budget 1% of annual expenditure on the environment sector. However, investment in river basin environment protection has been limited. The capital investment in the 3 focus river basins from 2000 to 2005 was not evenly distributed and was highest in the Nhue- Day River sub-basin and lowest in Cau River sub-basin (Figure 4.2).

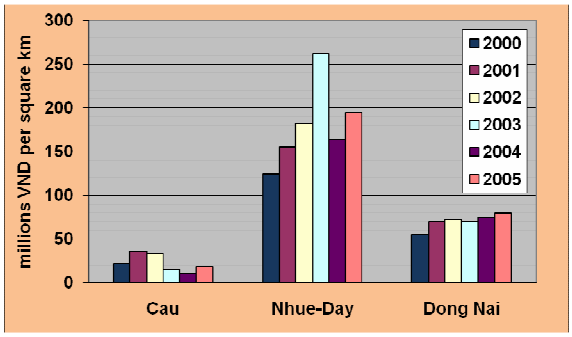


Figure 4.2: Estimated total investment rate for environment protection

Source: Institution of strategy and policy, Ministry of Planning and Investment

Sources of capital for water quality management in river basins vary: state budget, international aid, investment from the community and private enterprises. However, capital resources come mostly from the state budget.

Major issues for financial investments are that effectiveness and efficiency is low, priorities have not been sufficiently identified and investments are often not focused.

4.8.3 Environment monitoring and information system

Over recent years programs for monitoring water quality have been increasing and surface water quality monitoring systems are being progressively organised more systematically. Provinces and cities have limited budgets for monitoring as well as limited experience. However, many of them have equipped and built laboratories for water quality testing and analysis. Despite these activities, water information generally is not readily available providing serious limitations for more effective planning and management.

a. Monitoring networks

Water environment monitoring in rivers at the national level is now undertaken by departments of MoNRE and other ministries/departments. A national environmental monitoring network is managed by VEPA.

In 2005, VEPA approved 3 general water environment monitoring programs in the 3 focus river basins. Under these programs, national level water environment monitoring was to be conducted 6 times per year and expenditure was 1.2 to 2.5 billion VND per year per basin. However, due to limited budgets, monitoring activities have not covered all of the stations and the intensity designed in the program has not been met.

Within MoNRE, there is also a meteorological monitoring network and water environmental monitoring system under the National Hydrometeorology Centre; and a water environmental monitoring system (including surface water and underground water) under the Department of Water Resources Management.

Other ministries and departments also monitor surface water in river basins for requirements under their specific mandates. For example, MOFI monitors the quality of water for aquaculture, MOH monitors water quality and ensures sanitation standards, and MARD monitors river flow for its operational activities.

Many provinces and cities in river basins also establish local monitoring centres in order to monitor for local environmental protection (Ho Chi Minh City, Dong Nai and Binh Duong in the Dong Nai River basin; Thai Nguyen, Bac Ninh and Vinh Phuc in the Cau River Sub-basin; Ha Noi, Nam Dinh in the Nhue – Day River Basin).

Surface water quality monitoring in the focus river basins has the following limitations:

- Available funding and human resources for environment monitoring are limited, and therefore monitoring is infrequent and the parameters monitored and the number of stations are insufficient.
- Continuous monitoring systems have not been established which can be used to provide timely warnings to communities of pollution events.
- The purchase of monitoring equipment and analysis of environmental conditions often takes place in an ad hoc way without a strategic focus on long term outcomes and human resource training.
- Quality assurance and quality control in environmental protection is weak, which affects the quality and utility of the data.

b. Information system and database

There are no environment information systems at the national level or at river basin level. There are also no adopted standards for environment information systems and information update mechanisms in river basins. Localities in river basins have established some environment database to suit their own specific needs.

During 2006, VEPA co-ordinated with provinces in river basins to establish and update a website-based information system.

Decree No. 162/2003/ND-CP promulgating the regulation on the collection, management, exploitation and use of data and information on water resources, and on the development of a data management model, sought to establish a water information, collection and sharing framework. The Decree also clarifies roles and authorities of concerned agencies in data management. However, the regulation has not been applied effectively so that the exchange and sharing of environmental data and information among the provinces in river basins remains very poor.

4.8.4. Research activities

Studies and research on river basins in Vietnam have been conducted over many years, especially on aspects such as hydrometeorology, topography and water assessment. Many studies have been supported by international aid. The studies have been used as a basis for socio-economic development in river basins.

Studies and research have provided practical solutions for environmental protection in river basins. However, many studies are not properly planned and often overlap with other studies. Most of the studies are either general or sector based, and have not focussed specifically on water quality, methodologies for planning, economic measures, information measures and conflict resolution at the river basin scale.

4.9 PARTICIPATION OF COMMUNITIES

In reality, achievements in environment protection and water quality management depend very much on the participation of communities.

Box 4.5: Resolution No. 41/NQ-TW by the Politburo on environmental protection in the time of industrialisation and modernisation

"Environment protection is the right and obligation of organisations, households and all citizens; it is an expression of cultural life, an important criteria of a civilised society. It is also the continuation of our ancestors' tradition of living in harmony with nature."

Participation of communities in river basins has many limitations.

- Community potential has not been sufficiently understood or mobilised. Participation of communities in making decisions, planning policy and environmental management is still not effective.
- Community and enterprise awareness of river basin protection, as well as legal provisions, are low.
- The community does not properly value their environmental assets and often views them as resources to be taken for production or as areas for the deposit of rubbish.

4.10 CONCLUSION

Recent changes have now provided a legal and institutional basis that will allow water quality and environmental management to be effectively dealt with. There is clear Government commitment, there are strong laws and the institutional framework is sound.

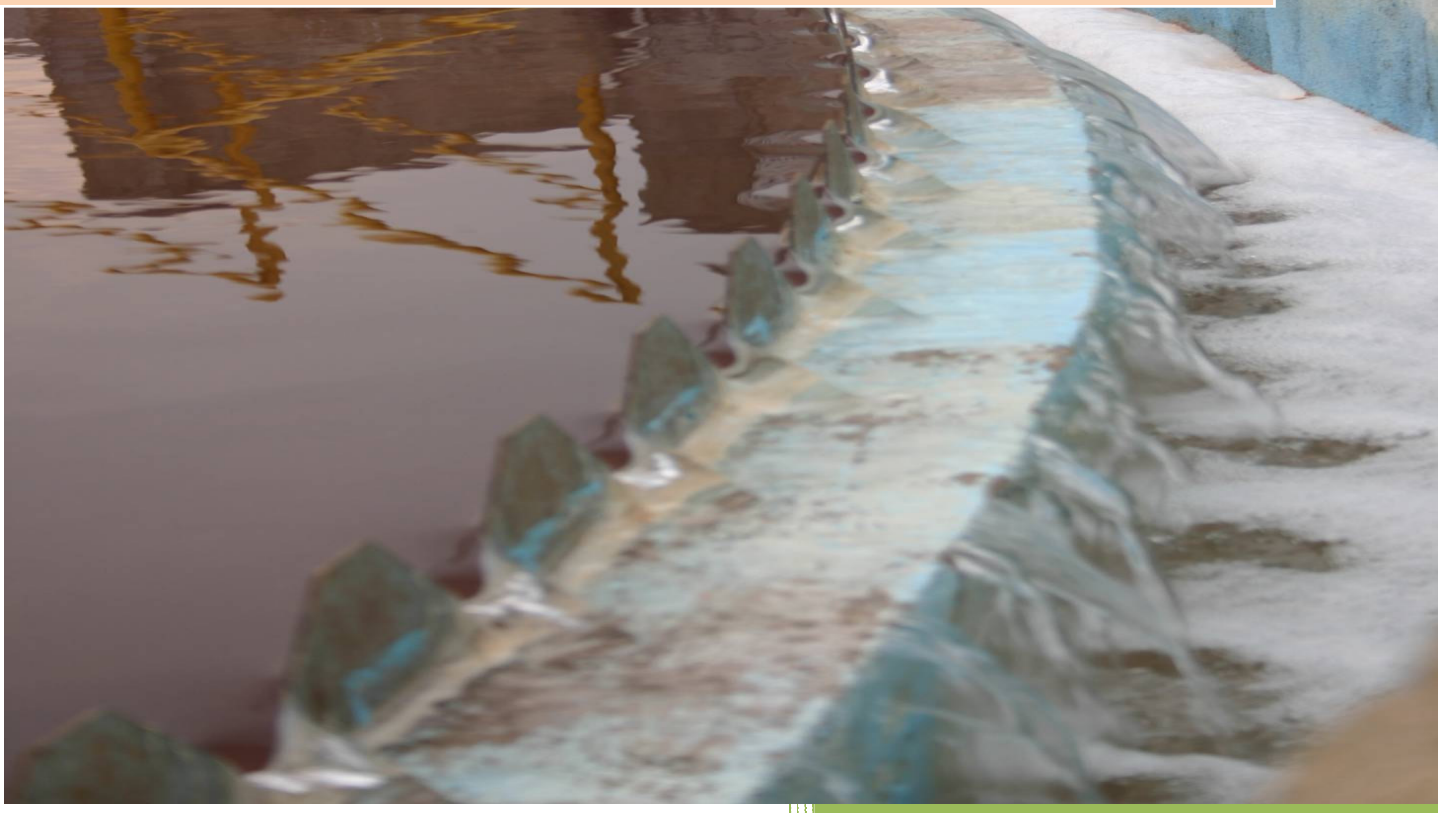
However, the reforms are recent and much of this is still new to Vietnam. The application of approaches and the use of management tools are mostly in their initial stages.

Institutionally, the major weakness is the establishment of coordinating arrangements at the river basin scale. The current principle of the administrative system is to combine state management of the sectors with management at central, provincial, district and village administrative levels. However, river basin management must provide leadership and coordination at regional levels. As a result, it is impossible to use normal administrative boundaries and a coordinating mechanism is needed. To date attempts to make this happen have not been effective. However, as a result of Government Decision 43/2007/TB-VPCP, clearly establishing MoNRE as the lead agency for river basin management, MoNRE is preparing a Government Decree on integrated river basin management and this should provided a firmer base for the coordinating arrangements.

A start has been made on the application of various tools for water quality management - planning, the application of environmental impact procedures, licensing, pollution discharge fees, and investigation and inspection. However, there are problems with the application of all of these – there are no river basin plans; environmental protection plans are not effective; environmental impact reports are not always done, are not effective, are not being complied with and are not checked; licensing has only just started; pollution discharge fees are not being applied uniformly and fairly across all sectors and in all areas; and investigation and inspection is limited and not consistent.

As well, staff and financial resources are not adequate to make real in-roads in the backlog of work required to achieve sustainable natural resource management, including pollution and water quality management. Data and information is also limited and not properly shared, providing an inadequate basis for management decisions.

CHAPTER 5
PRIORITY SOLUTIONS FOR WATER QUALITY MANAGEMENT IN RIVER BASINS



CHAPTER 5: PRIORITY SOLUTIONS FOR WATER QUALITY MANAGEMENT IN RIVER BASINS

Previous chapters have demonstrated the urgent need to prevent increased pollution in the three focus river basins and recover polluted rivers. The extent of current levels of pollution and the inadequate resources and systems to tackle the issues makes this a daunting challenge.

This chapter describes some short term actions (over 1-3 years) that could be taken to deal with the water quality and pollution issues in the three focus river basins. Other common solutions for water quality management and environmental protection are also presented.

5.1 SHORT-TERM ACTIONS

5.1.1 Dealing with the focus river basins as a priority

The three focus river basins must be the priority for the immediate future – they suffer the worst pollution in the country, the pollution levels in some arts are extremely severe, and the situation is declining rapidly.

For these river basins, it will be essential to firstly set priorities for better management of wastewater discharge. The importance of this was identified in the technical report *Analysis of Pollution from Manufacturing Sectors in Vietnam* (ICEM for The World Bank). This will allow the appropriate controls, regulations and management actions to be developed and implemented in a strategic and focussed way, making the best use of scarce resources.

Under the ADB Second Red River Basin Sector Project (TA 3892 – VIE), consultants ICEM are currently undertaking work for the Day River sub-basin to set priorities for management action and build a pollution inventory. The approach is to assess all activities in the river basins that are impacting on the quality of water, including an assessment of their current and future risk to communities. The consultant's work is divided into four linked components:

A Estimating domestic, industrial, agricultural, mining and craft-village water pollution releases.

B Modelling the dispersion of domestic, industrial, agricultural, mining and craft-village pollutants and estimating ambient water quality.

C Assessing environmental health risks associated with domestic, industrial and agricultural pollutants dispersed.

D Partnership and capacity building of officials from the Department of Water Management in MoNRE in model development, data gathering and analysis.

This work for the Day River is expected to provide a focus on the seriously polluted areas in the sub-basin:

- To Lich River and lakes and rivers in the inner part of Hanoi; and
- The section of the Nhue River from Ha Dong town to Phu Ly, Ha Nam province.

Using the skills and experience gained in the analysis for the Day River, it is hoped that MoNRE can undertake a similar analysis for the Dong Nai River basin, and also for the Cau River sub-basin, at least in some form. MoNRE should urgently seek international support for this work, given its importance.

For the Dong Nai River basin this prioritisation work is urgently required. It should concentrate on the industrial wastewater from provinces in the Southern Focal Economical Region and the treatment of domestic wastewater in Ho Chi Minh City and other large cities, and in particular on the seriously polluted areas of the basin:

- Dong Nai River: area at La Nga bridge; and the area from Hoa An bridge to Dong Nai bridge, as there are 3 large water supply facilities operating in this area;
- Sai Gon River: from Phu Cuong bridge to the Tan Thuan area;

- Thi Vai River;
- Tay Ninh channel in Tay Ninh town; and
- Rivers and canals in Ho Chi Minh city.

For the Cau River sub-basin, the prioritisation should focus on wastewater from industrial and mining activities in Bac Kan and Thai Nguyen, wastewater from craft villages in Bac Giang and Bac Ninh and domestic waste water from cities and towns in the sub-basin, and in particular on the seriously polluted areas in the sub-basin:

- Two sections on the Cau River: one that flows through Thai Nguyen city (from the rear of Hoang Van Thu Paper Factory to Tra Vuon bridge) and another from Van Phuc bridge to Dap Cau bridge;
- The river section located downstream of Phuong Hoang River in Thai Nguyen city;
- The end section of Ca Lo River; and
- Ngu Huyen Khe River.

The result of the pollution assessment will be the identification of priority industries or sectors that are causing the most significant impacts within the focus river basins. For these industries or sectors, a suite of focused point source pollution prevention measures can then be developed and applied, including:

- Setting levels of water quality to be achieved in well defined stages, each subsequent target closer to the required water quality objective. In the worst polluted waters, such as parts of the Dong Nai, managers may need to set several intermediate levels of water quality until the required water quality objective is achieved.
- Accelerating licensing of wastewater discharges for the priority industries/sectors in the high risk provinces, districts and communes. MoNRE should lead a focused approach with the Provinces to deal with the highest risk industry types and develop industry specific licensing provisions for these priority industries/sectors and apply them to the specific establishments.
- Concentrating regular environmental inspections and investigations on these priority industries/sectors and priority locations.
- Strengthening the application of Decree No. 67/2003 and its operation for the priority industries/sectors, and progressively linking these charges to wastewater licensing provision to make closer links between rights and responsibilities.
- Creating favourable conditions for enterprises in the priority industries/sectors to access loan sources from Vietnam's Environmental Protection Fund as well as other financial sources.

Other short-term actions for the Done Nai River basin should also be taken as follows:

- Concentrate pollution activities on the 87 units in the basin which are listed under Decision No. 64/2003;
- Temporarily ban investment permits for 5 industrial types that generate major pollution: cassava starch processing, rubber latex processing, basic chemicals production, dying, and leather tanning, as directed by the Prime Minister.
- Limit the number of investment permits for another 5 industrial types: the plating industry, fishery processing, agricultural chemicals production and fertiliser production, and paper pulp production in the Thi Vai river system.
- Obtain approval of the submitted plan for the environment protection of Dong Nai River basin.
- Carry out a comprehensive study of the hydraulic regimes of the Thi Vai Rivers and propose technical solutions for better managing flows, supplementing water resource and making the most of the assimilative capacity of the river.

Other short-term actions for the Day River sub-basin should also be taken as follows:

- Concentrate pollution activities on the 52 units in the sub-basin which are listed under Decision No. 64/2003;
- Limit the number of investment permits for 5 industrial types that generate major pollution to the environment including: cassava starch processing, basic chemicals production, dying, leather tanning and paper pulp production.

- Accelerated the development of the plan for environmental protection of the Nhue–Day River system and submit to the Government for approval.
- Coordinate the regulation of flows from the Red River to the Day and Nhue Rivers in the dry and wet seasons to improve the ability of the river system to provide a source of fresh water for domestic use and agricultural production, and to enhance the assimilative capacities of the rivers in the sub-basin. The analysis for this will take place under the ADB Second Red River Basin Sector Project (TA 3892 – VIE).

Other short-term actions for the Cau River sub-basin should also be taken as follows:

- Concentrate pollution activities on the 45 units in the sub-basin which are listed under Decision No. 64/2003;
- Limit the number of investment permits for 2 types of industrial activities that generate serious environmental pollution, namely mineral exploitation and paper pulp production.
- Strictly control sand exploitation on the Cau River to sustainable levels of extraction.

Other short-term actions for the three basins should also be taken as follows:

- Zone some areas for safe vegetable production, and warn people of the high risks of using polluted water sources for food production;
- In waters whose quality is better than the level specified in water quality objectives, establish measures to prevent contamination from all sources. It is just as important to protect these areas as it is to restore the degraded areas.
- Stop further deforestation and encourage re-forestation with the view to achieving the national targets for forest cover, particularly in the upper areas of the basins.

As well, MoNRE's current river basin planning initiatives for the northern economic zone, which includes the Day/Nhue and Cau River sub-basins, and for the Dong Nai River basin should be strengthened and supported.

To facilitate this immediate work, additional resources should be allocated to local authorities in the areas required to deal with the priority industries/sectors, from the 1% of the annual State budget committed to fund environment protection. As well, all investment opportunities in pollution control and management for the three focus basins should be based on the priority setting work outlined above.

5.1.2 Actions for other river basins

At the national level the concentration should be on the three focus river basins, as they have the worst pollution levels in the country. However, there are many other water quality issues in the country that Provinces must deal with. The short-term actions in relation to these are to:

- Set priorities for water quality management based on risk analysis to allow the appropriate controls, regulations and management actions to be developed and implemented in a strategic and focussed way.
- Concentrate pollution activities on these priorities and on the units causing serious environment pollution as listed under Decision No. 64/2003.
- Develop zoning plans for water resource exploitation and wastewater discharge for priority areas. These will be a foundation for the issue of wastewater discharge permits based on the assessment of the assimilative capacity of each river section in the basin and the national standards.
- Accelerate licensing of wastewater discharges in the high risk provinces, districts and communes. Focus on the highest risk industry types and develop industry specific licensing provisions for these priority sectors.
- In badly polluted waters set intermediate levels of water quality to be achieved in well defined stages, each subsequent target closer to the required water quality objective. Continual improvement should be a fundamental principle guiding water quality management.

5.1.3 Actions to strengthen the legal and institutional framework

Revise the Law on Water Resource to incorporate integrated water resources management concepts, with clearer definition of responsibilities and coordination mechanisms between central and local authorities, amongst ministries, and amongst provinces in river basins. MoNRE is planning to review the Law during 2008.

Promulgate a Decree on the management of river basins, which will detail how integrated water resources management and environmental protection will be implemented at the river basin scale. MoNRE is finalising such a decree and will submit it to the Government in mid 2007. Support the implementation of this decree with comprehensive community awareness, guidelines and capacity development.

5.1.4 Other short-term actions

Improve public knowledge of the importance of water to life. MoNRE should lead and implement awareness campaigns on the importance and values of the environment to the lives of the community, with the contents and delivery appropriate to each group in society.

Strengthen the plans for dealing with safety measures for handling and using agricultural chemicals by furthering a national program for the training/education of farmers to improve their knowledge on the best use of pesticide, strengthen the pesticide registration scheme, and expand the inspection and control of pesticide importation, distribution and use.

Urgently strengthen the EIA system and its operation, particularly in relation to developments that affect water quality in the three river basins. This system must become the means through which the impacts of developments are thoroughly and transparently appraised and potentially affected communities can put their views forward. The previous chapters have show how critical it will be to ensure that new developments all meet environmental standards.

5.2 OTHER GENERAL MEASURES FOR WATER QUALITY MANAGMENT

Arising from this report is a range of other general measures that should be used to address water pollution in river basins. Some of these have immediate application, some are on-going; others are more longer term in nature. These are set out as follows.

5.2.1 Application of scientific, technological and economic tools

Carry out regular environmental inspections and investigations. Prescribe measures to enforce enterprises to implement self-monitoring programmes and other regulations according to the Law on Environmental Protection, 2005.

Strengthen monitoring of water source health in river basins, including the development of simple and cost-effective biotic indexes for assessing water quality which can be executed not just by government scientists but citizen groups, students and even school children. Develop databases for river basins to provide and share with all relevant stakeholders at central and local levels.

Enhance the efficiency, effectiveness and equity in the application of Decree No. 67/2003 across the country. Strengthen its operation and ensure that all provinces apply it fairly and uniformly across all sectors and in all places. Prepare guidelines to assist this based on the “polluters pay” principle. Progressively link these charges to wastewater licensing provision to establish the relationship between rights and responsibilities.

Provide codes of conduct for concerned organisations, including management agencies, businesses and local communities.

Where the water quality is better than the level specified in water quality objectives, establish measures to prevent contamination, particularly for highly modified water resources. Wherever possible, managers should aim to improve the quality of natural and semi-natural water resources rather than allow them to degrade.

Prioritise limited investment opportunities in pollution control and management based on

work to identify high risk water sources and enterprises, including an assessment of their current threats and vulnerability.

Provide incentives for industries to develop and adopt best management practises for the treatment of wastewater from urban and industrial areas, craft villages (eg. end-of-pipe and common treatment facilities, urban sewer and drainage systems). Ensure that commercial businesses of Ministries are at the forefront of this work (the Government should lead by example).

Allocate resources to local authorities for the protection of river basins from the 1% of the annual State budget committed to fund environment protection. The resources must be spent for appropriate purposes and in an effective manner.

5.2.2 Capacity strengthening

Clarify and strengthen the roles of agencies and units in charge of water quality management and protection of the environment in river basins, at both central and local levels.

Increase the number of officers working on water quality management and environmental protection in river basins; strengthen their skills in water quality management, environment management and protection, and integrated water resources management at the river basin scale.

5.2.3 Public participation and responsibility

Develop mechanisms to ensure the participation of all relevant stakeholders, including local communities, in the development of river basin plans, and in the implementation of measures to protect water quality in river basins.

Promote the role of the mass media in improving public awareness of the policies and laws affecting the quality of water resources.

Develop and implement major communication campaigns for the business and industrial sectors highlighting the importance of environmental protection and their responsibilities to local communities.

5.2.4 International cooperation

Establish cooperative mechanism in preventing and addressing water environmental pollution in shared international rivers.

Expand international cooperation for regional river basin protection in forms of bilateral and multilateral programmes and projects. Further strengthen the cooperation with international, governmental and non-governmental organisations in order to take advantage of international assistance in all forms as well as experiences and techniques.

APPENDICIES

Appendix A
SURFACE WATER QUALITY STANDARD TCVN 5942

1. Scope

1.1 This standard specifies parameter limits and maximum allowable concentrations of pollutants in surface water.

1.2 This standard is applicable to control of quality of a surface water source.

2. Limitation Value

2.1 Parameter limits and maximum allowable concentration of pollutants in surface water are specified in the Table 1.

2.2 Standard methods of analysis of parameters and pollutant concentrations of surface water are specified in available current TCVNs.

Table 1

Parameter Limits and Maximum Allowable Concentration of Pollutants in Surface Water

№	Parameter and Substance	Unit	Limitation Value	
			A	B
1	pH value	--	6 - 8.5	5.5 - 9
2	BOD_5 (20ºC)	mg/l	<4	<25
3	COD	mg/l	<10	<35
4	Dissolved oxygen	mg/l	³0 6	³0 2
5	Suspended solids	mg/l	20	80
6	Arsenic	mg/l	0.05	0.1
7	Barium	mg/l	1	4
8	Cadmium	mg/l	0.01	0.02
9	Lead	mg/l	0.05	0,1
10	Chromium. Hexavalent	mg/l	0.05	0,05
11	Chromium. Trivalent	mg/l	0.1	1
12	Copper	mg/l	0.1	1
13	Zinc	mg/l	1	2
14	Manganese	mg/l	0.1	0,8
15	Nickel	mg/l	0.1	1
16	Iron	mg/l	1	2
17	Mercury	mg/l	0.001	0.002
18	Tin	mg/l	1	2
19	Ammonia (as N)	mg/l	0.05	1
20	Fluoride	mg/l	1	1.5
21	Nitrate (as N)	mg/l	10	15
22	Nitrite (as N)	mg/l	0.01	0.05
23	Cyanide	mg/l	0.01	0.05
24	Phenol compounds	mg/l	0.001	0.02

25	Oil and grease	mg/l	not detectable	0.3
26	Detergent	mg/l	0.5	0.5
27	Coliform	MPN/100 ml	5,000	10,000
28	Total pesticides (except DDT)	mg/l	0.15	0.15
29	DDT	mg/l	0.01	0.01
30	Gross alpha activity	Bq/l	0.1	0.1
31	Gross beta activity	Bq/l	1.0	1.0

Note

- Values in the column A are applied to the surface water using for source of domestic water supply with appropriate treatments.
- Values in the column B are applied to the surface water using for the purposes other than domestic water supply. Quality criteria of water for aquatic life are specified in a separate standard.

Appendix B

Planning Targets from the Socio Economic Development Plan 2006-2010

The overall planning targets for Vietnam are set out in the Socio Economic Development Plan 2006-2010 (SEDP). One of the key objectives of this is to consolidate the industrialisation of the country as a means of increasing GDP per capita and reducing poverty. Specific industrial sector production targets include:

- *Steel*: Steel demand in 2010 is forecasted to reach 12 million tons, with an average annual rate of increase of 7.5 to 8%.
- *Cement*: Annual cement production should increase 15% annually to reach 50 million tons by 2010, from the existing 32 million tons.
- *Paper*: Investment in numerous paper and pulp projects is expected to substitute for pulp import. 1.2 million tons of cardboard and wrapping paper of all kinds will be produced in 2010.
- *Fertilisers and chemicals*: The objective is to ensure self-sufficiency of fertilisers for agricultural production. It is estimated that 70 to 75% of the domestic demand for urea as well as 100% of phosphate, and fertilizers will be satisfied through domestic production by 2010.
- *Textile and garments*: The objective is to produce 1,100 million m^2 of silk of all types, 1,500 million garment items, and reach an export turnover of 10 billion USD in 2010.
- *Footwear*: The focus is on modernising footwear and leather production, developing leather sources of all types and increasingly using local materials to improve the value added of export products.
- *Plastics*: The aim is to satisfy the domestic demand for plastic packages and accessories and to link material input production for the plastics industry with petrochemical industry.
- *Beer, liquor and beverages*: Priority will be given to increasing the production capacity of beverages from fruits and mineral water and to expand existing beer breweries to increase capacity to 2.5 billion litres in 2010.
- *Machinery*: The overall objective is an annual growth rate of 18 to 20% achieved by: (1) concentrating on products with market competitiveness, particularly those serving agriculture and rural areas such as small motors, water pumps, tractors, farming machines, processing equipment, etc; (2) developing machinery for construction equipment, shipbuilding, automobiles and motorbikes; (3) undertaking research, design and the manufacture of equipment and gradually substituting imports; and (4) satisfying 35% of the country's demand for heavy machinery.

(**Source**: *Analysis of Pollution from Manufacturing Sectors in Vietnam*, ICEM for The World Bank, 2007)

Agriculture will continue to be an important sector under the SEDP. In order to achieve the agricultural goals, the targets are as follows:

- *Food*: Increase production at reasonable rate to ensure national food security, food reserve, animal feeds and export of 3 to 4 million tonnes per annum. Increase high-quality rice for export without increasing rice-cultivating areas; low-productivity areas are to shift to other crop cultivation or livestock raising; increase intensive farming and productivity, strongly develop maize cultivation. Diversify fruits and vegetables; intensify food and foodstuff hygiene and safety, and increase organic products.
- *Industrial Crops*: improve their productivity and quality; process high-value products and develop product trademarks. Develop large-scale specialisation areas closely linked with processing industry, gradually industrialise and modernise agriculture and rural areas.

- *Meat*: Ensure sufficient meat for domestic markets by developing livestock in the orientation of centralised farm in association with processing industry and disease prevention and treatment. Quickly develop milk production on the basis of ensured conditional competition.
- *Fisheries*: Synchronously develop fishery products, including all stages of exploitation, aquaculture, processing and export. Intensify processing high value added aquatic products. Ensure fast and sustainable growth of fishery. Implement the strategy for domestic and export market establishment within the context of international economic integration.
- *Forestry*: Create significant change in increased forestry products and primarily wooden products. Fundamentally reform the forestry sector with stronger linkages between protective and economic functions; reduce forest areas directly managed by State agencies; increase forest coverage. Plant forests to establish raw material supply areas for paper mills and artificial wood factories, etc.

In terms of the environment, the SEDP has the following targets:

- By 2010, increase forest coverage to 43%.
- Strive for 100% newly built production establishments to apply clean technology or equipped with pollution minimisation facilities, ensure waste treatment and 50% of production and business establishment satisfy environmental standards.
- By 2010, 40% of urban areas and 70% of industrial zones, export processing zones are equipped with centralised wastewater treatment systems, 80 to 90 % of solid waste collected, over 60% of hazardous waste and 100% of medical waste treated.
- Strive to reach 95% of the urban population and 75% of the rural population to have access to clean water.

Appendix C

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