

## VIETNAM FRESHWATER ENVIRONMENT

Tran Quoc VINH<sup>1</sup>, Nguyen Khac THOI<sup>1</sup>, Nguyen Thi BICH LOC<sup>2</sup>

<sup>1</sup>Faculty of Land Resource and Environment Hanoi Agricultural University,

<sup>2</sup>University of Zielona Góra

Vietnam is a tropical country, amount of rainfall is quite much, the network of rivers and lakes is high density. They make Vietnam become one of the countries that have large freshwater resources in Asian. However, freshwater quality in Vietnam is becoming worse, the pollution make the rivers and lakes become the problem that need to take care. It is because domestic wastewater and industries wastewater flow into rivers and lakes without treatment; the chemicals using for agricultures effect to groundwater make amount of heavy metals and chemicals be found high in fishes and vegetables raised, moreover, wastewater and its heavy metals and chemicals also pollute underground water; the rain take none- fresh air that from vehicles to water resources. The pollution is the serious problem of Vietnam. Researching the methods to decrease the water pollution and save water resources is belong to not only scientists but also everyone. We always make Vietnam become the country that have water potentials not only quantity but also quality.

Keywords: Vietnam, freshwater quality, environment

### 1. INTRODUCTION

Vietnam covers an area of some 330,000 square kilometers (km<sup>2</sup>) with total population of about 80 million people. Being a developing country with a high speed of industrialization and urbanization, natural resources, therefore, are under strong pressure. Freshwater is not an excluded case.

About two thirds of Vietnam's freshwater resources originate from catchments in riparian countries. Vietnam is the lower riparian country in the Mekong and Red Rivers—the biggest rivers which provide most of water in Vietnam—and is thus susceptible to water resource decisions made in upstream countries.



Moreover, Vietnam is one of the most disaster-prone countries in the world; about 70 percent of the population is exposed to the effects of typhoons and torrential rains in combination with strong winds, floods, landslides and mud flows. In contrast, droughts have been localized and seasonal, but they have become a more serious problem for the country in recent years (World Bank, 2003).

Another problem happened to freshwater in Vietnam is the improper use of water and its network, then it makes the quality of fresh-water in certain areas became worse. The report, therefore, focuses on quality of freshwater in the whole Vietnam.

## **2. CURRENT SITUATION OF VIETNAM'S FRESHWATER**

### **2.1. Surface Water**

#### **2.1.1. Rivers**

Vietnam has a dense river network of which 2,360 rivers have a length of more than 10 km. Eight out of these are large basins with a catchment area of 10,000 km<sup>2</sup> or more (Table 1). The rivers flowing through Vietnam include many trans-boundary or international rivers. The total area in- and outside Vietnam of all international catchments is close to 1.2 million km<sup>2</sup>, which is approximately 3 times the size of Vietnam itself.

The total annual runoff is 835 billion cubic meters (m<sup>3</sup>), but the shortage of water is aggravated in the 6-7 month dry season, when the runoff is only 15 to 30% of this total.

Of the international rivers, the Mekong and the Red rivers are the most important. The Mekong –the longest river in Southeast Asia–drains from China and enters the lower basin at the common Myanmar-Laos-Thailand border point. The 'lower basin' covers some 600,000 km<sup>2</sup> and includes parts of four countries Laos, Cambodia, Thailand and Vietnam. The Red River basin is the largest in Vietnam. The river rises in Yunnan Province in China and flows through the northern part of the country into the Tonkin Gulf, forming an extensive delta.

#### **2.1.2. Reservoirs**

Most dams and reservoirs in Vietnam have been constructed for multiple purposes, including flood control, irrigation, hydropower, water supply and other flow management. Most are more than 20-30 years old. There are about 3,600 reservoirs of various sizes, of which less than 15 percent are large or medium (capacity of over 1 mill. m<sup>3</sup> or a height of more than 10 m). Siltation/sediment from degradation of watersheds is causing a decline in reservoir capacity – some with only 30% of the original capacity remaining.

Table 1. Vietnam freshwater resources in major rivers

	River Basin	Catchment area		Total volume		
		Total area in VN (km <sup>2</sup> )	% in VN	Total (bill.m <sup>3</sup> )	Total generated in VN (bill.m <sup>3</sup> )	% generated in VN
1.	Ky Cung – Bang Giang	11,220	94	8.9	7.3	82
2.	Red River – Thai Binh	155,000	55	137	80.3	59
3.	Ma – Chu	28,400	62	20.2	16.5	82
4.	Ca	27,200	65	27.5	24.5	89
5.	Thu Bon	10,350	100	17.9	17.9	100
6.	Ba	13,900	100	13.8	13.8	100
7.	Dong Nai	44,100	85	36.6	32.6	89
8.	Mekong	795,000	8	508	55	11

Source: Program KC-12, cited in World Bank, 2003.

Table 2. Major reservoirs in Vietnam

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

Source: National Water Sector Profile, 2002 in World Bank, 2003.

### 2.1.3. Lakes

There are several major natural lakes in Vietnam, one of those is Ba Be lake with a surface area of 4.5 km<sup>2</sup> and a volume of 90 million m<sup>3</sup>. In addition, there are numerous other smaller lakes - including urban lakes in Hanoi (West Lake, Hoan Kiem Lake, and so on).

## 2.2. Groundwater

The groundwater resources in Vietnam are also abundant – with the total potential exploitable reserves of the country's aquifers estimated at nearly 60 billion m<sup>3</sup> per year. The availability varies from abundant resources in the Mekong River Delta to somewhat limited resources in the North Central Region.

However, despite the abundance of groundwater reserves, only less than 5% of the total reserves are exploited, for the country as a whole. The abstrac-

tion of groundwater also varies. For example, groundwater exploitation is difficult in the Northeast because the reserves are scattered and diverse. In the Central Highlands, on the other hand, groundwater is exploited heavily for irrigation of cash crops resulting in shortages of water in parts of this region. In the Red River and Mekong River Deltas groundwater is exploited beyond the recharge capacity around Hanoi and Ho Chi Minh City. This over-exploitation is resulting in falling water tables, further causing land subsidence and salinity intrusion, especially in the Mekong River Delta.

*Mineral and thermal water resources* are abundant in Vietnam as well. Good in quality and varied in types bring about a great value for different purposes such as baln-eological treatment, bottled mineral water, geothermal energy, extraction of CO<sub>2</sub> gas etc. According to investigation there are about 400 mineral and thermal water sources in the country, of which 287 sources have been exploited and reliable data exist (Table 3).

Table 3. List of mineral and thermal water sources

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

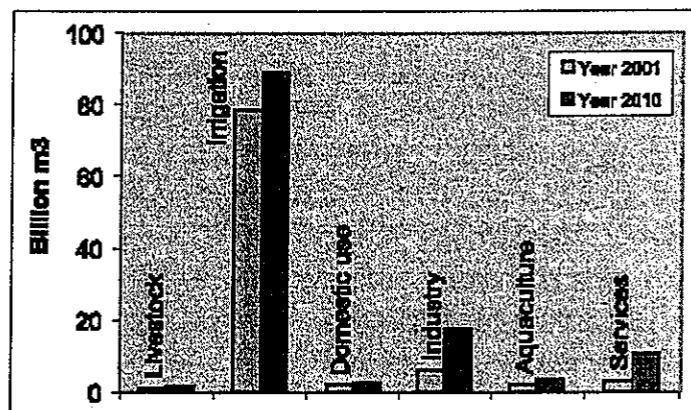
Source: Ministry of Industry, 1999 in World Bank, 2003.

### 3. WATER UTILIZATION

In Vietnam, irrigation makes the largest demand on water resources (Figure 2). For year 2001 the water consumption for agriculture is about three times higher than the other water uses. Supply of clean drinking water to households is now provided to 60% of Vietnam's population. In addition, sectors such as fisheries (including aquaculture), industries, hydropower, services and transport also make demands on the country's water resources.

#### 3.1. Irrigation

Agriculture is by far the largest water-consuming sector. Total irrigation demand in 2000 was 76.6 bill. m<sup>3</sup>, representing 84% of total demand. Since 1998,



Source: Program KC-12 and National Water Sector Profile, 2002 in World Bank, 2003.

Fig. 2. Annual water demand

total irrigated area has increased annually 3.4% in average, but the irrigation systems can serve only 7.4 mill. ha (or 80% of total cropped land). The Government of Vietnam (GoV) expects irrigation demand to increase to 88.8 bill. m<sup>3</sup> by 2010, (representing an irrigated area of 12 mill. ha). Of the direct water abstraction from groundwater and rivers nearly 84% are for agricultural purposes. However, the river minimum environment flow has to be secured (30% of mean annual flow).

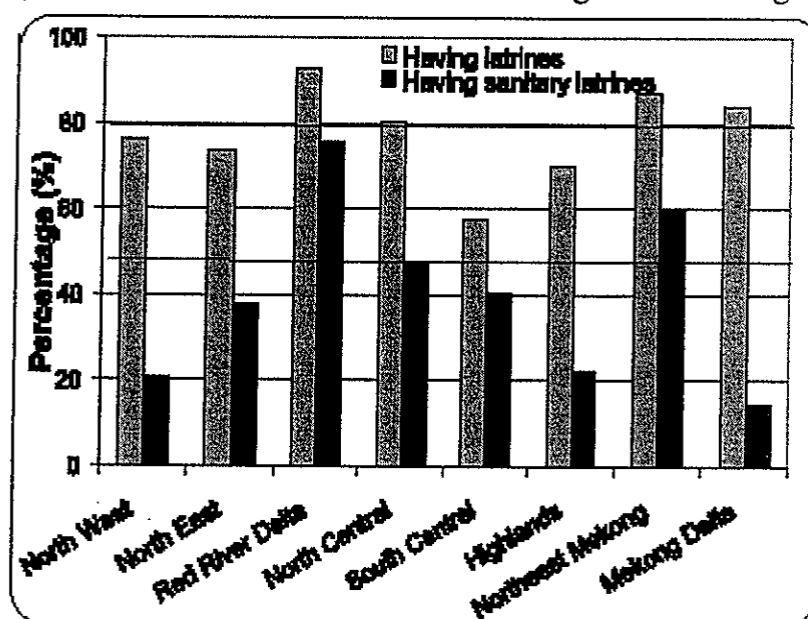
### 3.2. Domestic Use

Domestic use of water by comparison is very small, accounting only for 2% of total demand. The consumption was only 1.341 bill. m<sup>3</sup> in 1990 but is expected to increase to 3.088 bill. m<sup>3</sup> in 2010 with population growth. At present nearly 60% of the population have access to clean water in Vietnam. The GoV's strategy is to increase this to 80% by 2005 and the urban coverage to 95% by 2010. This strategy will bring Vietnam up to the level of its neighboring countries. To achieve the ambitious target for water supply the GoV has put a lot of effort in providing safe water for domestic use. Although there is an overall increase in the percentage of the population that has access to safe water over the last decade, the supply of piped water is far from the demand, given the rapid growth of urban population. Most of rural and remote areas have not yet benefited much from a GoV Clean Water Supply and Sanitation Program.

The percentage of households that have sanitary latrines is only 44% in average for the whole country (Figure 3), and that has imposed a threat on the quality of water supply, provided that 60% and 20% of population are still using water from wells and surface sources respectively. Household living standard surveys 1992 and 1998 indicate that the improvement in supplying safe water has been mainly made to the three highest quartile income groups.

During the period 1992-1998, access to piped water for the lowest income group has increased from 0.34% to 1.97% while this figure for the highest income

group is 22.94% to 73.98%. During the same period percentage of population with access to well water has increased from 2.06% to 11.28% for the lowest income group and from 7.49% to 27.47% for the highest income group.



Source: MISC11-2000 in the World Bank, 2003.

Fig. 3. Percentage of households with access to sanitation, 2000

## 4. WATER QUALITY

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

### 4.1. Surface Water Quality

In Vietnam, data on surface water quality is poor. However, limited testing reveals rising pollution levels in downstream sections of the major rivers. The upstream water quality of most rivers remains good, while downstream pollution mainly from urban areas and industries affects the water quality. The National Monitoring Network (NMN) covers 4 rivers running through the main urban areas of Vietnam, Red River (Hanoi), Cam River (Hai Phong), Huong River (Hue) and Saigon River (HCM City). However, other rivers are monitored as well in the various regions (Table 5).

Table 5. Water quality in some Vietnam's rivers

Region	River	Exceedance of Class A
Red River Delta	Red River, Lao Cai	1.5-2 / NH <sub>4</sub>
	Red River, Dien and Hanoi	3.8 / BOD <sub>5</sub>
	Hong to Viet Tri	2 / NH <sub>4</sub>
	Cau River	2 / NH <sub>4</sub>
North Central Coast	Thuong River	2.7 / BPD <sub>5</sub>
	Hieu River	2-3 / BOD <sub>5</sub> 1.5-1.8 / NH <sub>4</sub>
South Central	Huong River	2.5 / BOD <sub>5</sub>
	Han River	1-2 / BOD <sub>5</sub> 1.4-2.6 / NH <sub>4</sub>
Coast Northeast	Sai Gon River	2-4 / BOD <sub>5</sub>

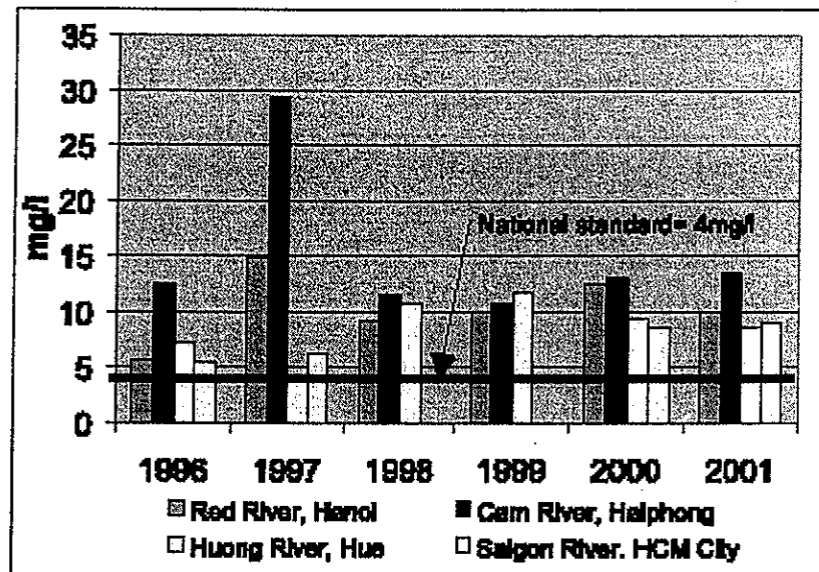
*Source: The World Bank, 2003.*

Trends indicate that the levels of two primary pollution indicators, Ammonia-nitrogen (NH<sub>4</sub>-N) and Biochemical Oxygen Demand (BOD<sub>5</sub>) vary considerably and exceed national water quality class A standard by several folds (Figures 4 and 5). The problems are worst during the dry season, when the flows in the rivers are reduced. Industrial and other pollution adds to the human waste from the population. Around 70 industrial parks have been developed, and with more than 1,000 hospitals nationwide some million m<sup>3</sup> of untreated wastewater is discharged from these sources alone per day. According to Ministry of Natural Resources and Environment (MONRE), there are about 4,000 enterprises discharging wastewater, of which 439 enterprises are the most serious, and are required reallocated, closed or will have to adapt cleaner technologies and treatment of their wastewater.

Rivers in Vietnam's urban areas, especially major cities, are seriously polluted by untreated industrial wastewater. Surveys conducted by the Institute of Tropical Techniques and Environmental Protection show that the content of contaminants in rivers in Hanoi, Ho Chi Minh City, Hai Phong, Hai Duong, Bac Giang, Hue, Da Nang, Quang Nam and Dong Nai, are much higher than permissible levels.

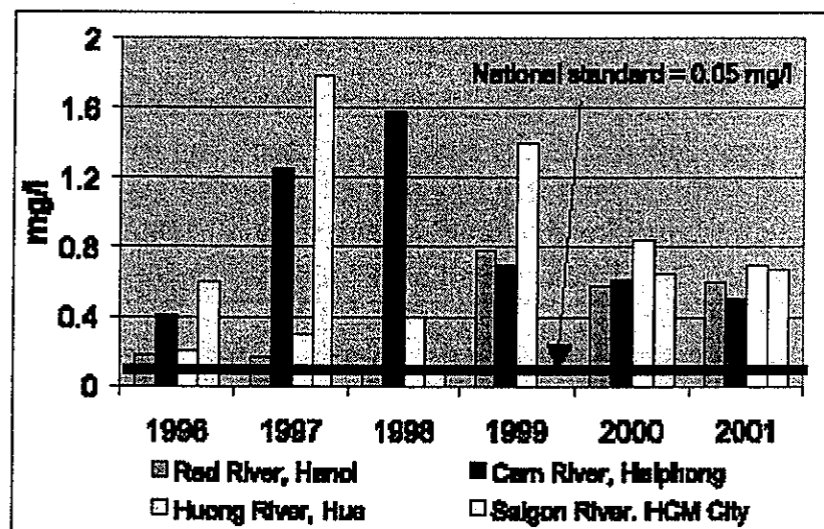
Untreated industrial wastewater discharging into rivers is the main source of the pollution. According to the institute, industrial parks (IPs) and export processing zones (EPZs) in the Southern Key Economic Zone discharge over 137,000 m<sup>3</sup> of wastewater containing nearly 93 tons of waste into the Dong Nai, Thi Vai and Saigon Rivers each day. Meanwhile, two out of 12 IPs and EPZs in Ho Chi Minh City, three out of 17 in Dong Nai, two out of 13 in Binh Duong, and none of the IPs and EPZs in Ba Ria-Vung Tau have wastewater treatment facilities. According to environmentalists the Southern Key Economic Zone





Source: NEA, SOE Report, 1997-2002, in the World Bank, 2003.

Fig. 4. BOD Levels in Vietnam's major rivers



Source: NEA, SOE Report, 1997-2002, in the World Bank, 2003.

Fig. 5. NH<sub>4</sub> levels in Vietnam's major rivers

needs investment of 5.7 trillion VND (380 million USD) in 2005 and 13 trillion VND (867 million USD) in 2010 to deal with environmental pollution.

Within cities, lakes, streams, and canals increasingly serve as sinks for domestic sewage, municipal, and industrial wastes. Most of the lakes in Hanoi are seriously polluted with high BOD levels. Similarly, 4 small rivers in Hanoi and 5 canals in Ho Chi Minh City have levels of DO as low as 0-2 mg/l, and BOD levels as high as 50-200 mg/l (Table 6).

Table 6. Water quality in urban rivers, lakes, and canals

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

*Source: Ministry of Science, Technology and Environment (MOSTE) – Documentation on Red River Delta (1997-1998), in the World Bank, 2003.*

## 4.2. Groundwater Quality

Groundwater is emerging as an important source of water for domestic, industrial, and agricultural uses. While the quality of ground water remains good, there are some pockets of contamination. There is evidence of pollution – from poorly maintained septic tanks, garbage dumping, and industrial effluents and overexploitation in parts of Hanoi, HCMC and the Mekong River Delta.

New investigations have shown potential problems related to the presence of arsenic in alluvial deposits in the Red River region and in tubewells pumping water from lower aquifer. This requires further study and careful assessment. In addition nitrogen and iron levels above the admissible standards are found both in the Red River (see Box 1 below) and Mekong River Deltas.

### BOX 1

#### GROUND WATER POLLUTION IN HANOI

A research project in Hanoi has shown an alarming sign of ground water contamination by ammonia in the South of Hanoi. The level of ammonia (NH<sub>4</sub>) in the treated water at the three treatment plants is higher than the national standard by 2-8 times. All samples taken from the upper aquifer exceed ammonia standard many times. Scientists estimate that with the current abstraction rate of 700,000 m<sup>3</sup>/day, there will be a high risk of lowering the water table down to 114 m and the groundwater pollution would spread over the Hanoi city.

Sources: VEPA website <http://www.nea.gov.vn>  
(Jun 11, 2003), p. 2621, cited in the World Bank, 2003.

**Salinity intrusion.** A pressing issue is the salinity intrusion taking place both in the Red River Delta, the Central Coastal Regions and in the Mekong River Delta. Salinity intrusion is a natural phenomenon in coastal areas. However, due to increased groundwater exploitation salinity intrusion increases and poses a threat to safe water supply e.g. in the Red River and Mekong River Deltas. In the Red River Delta, salinities higher than 3‰ stretches more than 60 km inland to

Hai Duong in the north and Nam Dinh in the south of the delta. In the Mekong River Delta, saltwater is registered in half of the delta area.

Besides, water quality in river mouth area/estuaries (able to be considered coastal and sea area) also has some problems owing to the pollution of fresh water in rivers:

*Land-based pollution.* The dominating land based sources of pollution to the coastal environment is the discharge from the river and sewage systems. The fluxes of some important pollutants have been estimated as presented in Table 7.

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

Table 7. Gross flux of pollutants in six river mouths (unit: tons/year)

River system	Region	Cu	Pb	Zn	As	Phosphate	Nitrate
1-Red and 2-Thai Binh	North	6,790	885	5,367	790	24,748	35,068
3-Han and 4-Thu Bon	Central	293	75	676	44	1,253.1	4,012
5-Sai Gon and 6-Dong Nai or Mekong	South	11,00 0	1,10 2	15,69 6	1,60 0	28,220	191,57 0

Source: Pham Van Minh, 1998 in the World Bank, 2003.

## 5. OVERALL CONCLUSIONS

In Vietnam, irrigation places the largest burden on water resources. However, there is increasing evidence of pollution of Vietnam's surface, ground and coastal waters. Although the quality of upstream river waters is generally good, downstream sections of major rivers (like in Red River Delta or Hanoi) reveal poor water quality and most of the lakes and canals in urban areas are fast becoming sewage sinks. Groundwater shows pockets of contamination and some salinity intrusion. Rapid urbanization and industrialization in coastal areas, port and marine transport development contribute to the deterioration of coastal water quality.

## REFERENCES

1. *Ground Water Exploitation Company*, Hanoi, Vietnam, 2003.
2. Hanoi Department of Science, *Technology and Environment 2001, 2002, 2003*.

3. *Le Thi Thuy and collaborators. Content of heavy metal in sewage and mud from some factories and drainage rivers in Hanoi.* Soil Science Magazine No. 17. p.138-141. Vietnam, 2003.
4. *Le Van Khoa and collaborators. Rural environment of Vietnam.* Agricultural Publishing House, p. 24-25, p.26-33, p.57. Vietnam, 2002.
5. *Pham Tran Khanh and collaborators. Commenting Some Epidemiology Characteristics of Food Poisoning through Reports of Agency of Food's Quality, Hygienic and Safety Management of Provinces and Cities from 1999-2001.* Science Report for I Workshop on Quality, Hygiene and Safe of Foods, Ho Chi Minh City, Nov 2001. Proceeding, p.139-150, Vietnam, 2001.
6. SEARUSYN. *City Report - Hanoi and Its Related Issues.* Project of Southeast Asia Rural Urban Synergy, Center for Agricultural Research and Ecological Studies (CARES), Hanoi Agricultural University (HAU), Hanoi, Vietnam, 2003.
7. *Tran Cong Khanh. Estimating research on underground water's quality in some areas in Hanoi.* Soil Science Magazine No 17/2003. p.142-151. Vietnam, 2003.
8. Vietnam News. *Wastewater Pollution Blights Hanoi's Famous River System.* May 29, 2002.
9. World Bank. *Vietnam Environment Water Monitor 2003,* Hanoi, Vietnam, 2003.

## PROBLEMY JAKOŚCI WODY DO PICIA W WIETNAMIE

### Streszczenie

Wietnam to tropikalny kraj, posiada dużo rzek i jezior, a opady atmosferyczne są obfite. Wszystko to czyni Wietnam krajem posiadającym wiele źródeł czystej wody. Jakość czystych wód niestety została pogorszona. Jest to poważny problem, trzeba go brać pod uwagę i mieć pod ścisłą kontrolą. Przyczyną skażenia wód był brak kontrolowanych dopływów ścieków bytowych, ścieków przemysłowych do rzek i jezior. Stosowane środki chemiczne w rolnictwie powodują obecność metali ciężkich i składników chemicznych w rybach oraz w warzywach. Ponadto ścieki oraz spływy retencyjne z terenów uprawianych rolniczo powodują skażenie wody gruntowej. Zanieczyszczone wody stają się problemem w Wietnamie. Badania nad sposobami ograniczenia stopnia zanieczyszczenia wód i ratującymi źródła wody, to zadanie nie tylko dla naukowców, lecz też dla wszystkich ludzi, aby Wietnam pozostał krajem, który posiada potencjał ilościowy, a także jakościowy. Nie bez znaczenia są również wody opadowe na terenach uprzemysłowionych oraz na terenach wzmożonego ruchu pojazdów, które wnoszą do wód powierzchniowych znaczne ładunki zanieczyszczeń.