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Authors

Duc, Hiep Nguyen
Truong, Truong Phuoc

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Water resources and environment in and around Ho Chi Minh City, Vietnam

Hiep Nguyen Duc

Environment Protection Authority, NSW, Australia

Truong Phuoc Truong

University of New South Wales, Australia

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The increase in population, and rapid economic growth in recent years, after Doi Moi (Renovation) Policy, have put a large and increasing stress on the water resources and environment in Ho Chi Minh City, Vietnam. The demand from industries, businesses, and households surpassed the current supply distribution capacities. The water quality in river courses and underground sources is also highly degraded due to many sources of pollution. The authorities have initiated some joint venture works with foreign water companies to invest in the commercial development of water supply infrastructure. In this paper, the status of water environment and water resources in and around the city is described. Various environment organizations have responded to the problems of water pollution. Of interest are the emerging roles of non-government organizations (NGO) and of public participation in environment issues, especially in a traditionally government-controlled society. Some suggestions for improvement of water management are also proposed.

Ho Chi Minh City is the largest city in Vietnam with a current (1995) population of about 5 million and which is increasing rapidly due to internal migration and natural growth. The city covers an area of 2,056 sq km, which is about 0.61% of the total country area and a population density of 2,338 persons/sq km (see Figure 1).^{1,2} With rapid economic growth following the opening of the Vietnamese economy after "Doi Moi" or "Renovation Policy" in 1987 and the end of the U.S. trade embargo in 1994, water demand in the City has been increasing rapidly. This has caused considerable stress on the environment.

The Ho Chi Minh City Service of Communication and Public Works (SCPW) admitted in September 1998 that the city's decades-old water supply system is incapable of meeting the growing demand. According to the SCPW, the water consumption is estimated to be 800,000 cubic meters per day, but the combined daily capacity of its two water treatment plants at Thu Duc and Hoc Mon, and of underground wells in the city, stops short at 750,000 cubic

meters. In addition, if water loss in delivery is taken into account (the proportion of water loss can be as high as 32% in some areas), then only about 500,000 cubic meters are available for use each day. In 2000, in fact, the daily water demand jumped up to 1,250,000 cubic meters /day while the supply capacity of Water Supply Company could only reach 850,000 cubic meters/day.³ This is despite the fact that the City is situated in an area where water resources are plentiful and potential supply should be able to meet the increased demand even with sustained urban growth if the water resources are properly developed and managed. Ho Chi Minh City is situated next to the Saigon River, which joins the Dong Nai River to make northern and eastern boundaries of the city. These waterways can act both as potential water supply resources and as a medium to carry away the wastewater.

The Dong Nai River has a minimum flow of approximately 100 cubic meters/sec. It originates from the central highlands of Vietnam and flows through Dong Nai and Ho Chi Minh City with tributaries from other provinces. The total catchment area is 42,665 sq km and total flow volume is 30.6 cu km/year.⁴ Forests cover approximately 30% of the basin. The upstream area in the lowland part of the river is the present Cat Tien National Park. The Tri An reservoir and hydropower plant is located downstream nearby. Further downstream of the river it is joined at Nha Be area of Ho Chi Minh City by the Saigon River. Inside the city a hydrological network of five canals acts as the natural water drainage⁵: Nhieu Loc - Thi Nghe (9 km), Tau Hu - Kinh Doi - Kinh Te (19.5 km), Ben Nghe (5.9 km), Tan Hoa - Ong Buong - Lo Gom (7.2 km), and Tham Luong - Ben Cat - Vam Thuat (14 km).

Before finally reaching the sea, the Dong Nai River passes through a coastal mangrove forested delta area with many interconnecting riverlets. This Can Gio area is the "green lungs" of Ho Chi Minh City. This 75,740 ha area is rich in biodiversity and was designated in 2000 as a Man and Biosphere (MAB) Mangrove Reserve area by UNESCO.



Figure 1.

Ho Chi Minh City and surrounding areas (Source: ESRI World map)

Water Environment and Pollution

One of the important aspects of water resource usage management is the prevention and mitigation of sources of pollution into the watercourses. A brief description of the current water environment and pollution is presented below.

Sources of Pollution

The majority of industries are located in industrial zones around Ho Chi Minh City. In addition to old industrial zones such as Bien Hoa zone 1, built in 1963, a large number of new industrial zones were set up recently in the neighboring provinces of Dong Nai, Song Be, and Ba Ria-Vung Tau. They were established to attract foreign investment to set up factories to produce goods for domestic and export markets.

The industrial zone in Bien Hoa (Dong Nai) is upstream from the Ho Chi Minh City. The foremost concern is that the wastewater discharge from this zone to the Dong Nai River is near the Hoa An pumping station which supplies water to the residents of Ho Chi Minh City.⁶ Altogether, it was estimated that about 200,000 cubic meters/day of wastewater is discharged into the Dong Nai-Saigon River from the industrial zones.⁷ In early April 2000, more than 50 tonnes of fish were killed in an upstream feeder of the Tri An Reservoir in the upper reach of the Dong Nai River. The Dong Nai River provides drinking water for most of the residents of Ho Chi Minh City and the surrounding provinces. The main suspects for the pollution were two agro-industrial plants, the La Nga Sugar Cane Company and the Mauri La Nga Food Fermentation Joint Venture Company.⁸ Another source of pollution in the

Dong Nai-Saigon catchment and watershed is agricultural run-off from the high usage of chemical and organic fertilizers and widespread use of pesticides.²

In Truong Tho, Thu Duc district, residents near the industrial zone have suffered from the problem of severe creek and groundwater pollution, which results from the discharge from a number of sources. Their farms suffered from vegetable and animal losses. There are reports of fish dying off in ponds. Odors emanating from polluted water have also made living condition worse.⁹ Each day, about *7,000 cubic meters* of untreated wastewater from 10 factories are discharged into the receiving creek, which flow on to waterways in the residential area before eventually reaching the Saigon River. In 2001 it was reported that companies such as Phuoc Long Textile company, the seafood processing company Cofidec, and the Mai Tan Paper Company discharged about 1500 cubic meters, 90 cubic meters, and 200 cubic meters of untreated wastewater respectively into the water environment daily.

While the sources of the industrial discharges are located mostly in the Thu Duc and Bien Hoa areas, their discharges are eventually found scattered along the many canals in and around Ho Chi Minh City. There are five main canal systems that receive direct wastes from various sources: Nhieu Loc-Thi Nghe, Tau Hu-Ben Nghe, Doi-Te, Tan Hoa-Lo Gom, and Tham Luong-Vam Thuat. The total length of these canal systems is about 56 km with about 100 km from smaller tributaries. According to the data provided by the Water Supply Company, there are about 461,000 cubic meters of wastewater discharged into the canal systems daily⁶ coming from 680 factories and 22,562 small manufacturing enterprises operating in the city in 1997. Nearly all of these wastewater sources are not equipped with any wastewater treatment facilities. Wastewater samples collected from some of the food-processing plants (numbering about 100) situated in and around the city area were analyzed by the Geographic and Geological Society of Ho Chi Minh City, and the results showed that the BOD (biological oxygen demand) levels ranged from 300 to 2800 mg/l which is 3 to 28 times above the Vietnamese standard (TCVN 5945). This is the standard for class C wastewater which would be allowed to be discharged into the environment.⁶

According to a report by the Department of Science, Technology and Environment (DOSTE) to the HCM City People's Committee, most of the 57 factories of various types existing in the city discharge wastewater with high pollutant concentrations to the Tham Luong canal without any proper treatment.¹⁰ This canal, flowing through districts 12, Tan Binh, and Go Vap, has been one of the most polluted canals in the city and the problem has been in existence for over 10 years. The health of the residents around the

canal is thus severely affected with frequent outbreaks of dermatitis and gastroenteritis. The district most affected, District 12, has begun taken action to reduce the wastewater discharge problem. Most enterprises in district 12 now have wastewater treatment. Recently (June 2001) the local government in the Go Vap District has also demanded that industrial sites in the district should treat wastewater before discharging to the Tham Luong canal. Other local governments in the districts surrounding the canal have also asked the HCM city DOSTE to inspect and take action against companies that fail to treat wastewater properly.¹¹

Illegal liquid waste discharge from solid waste site at Dong Thanh landfill in Hoc Mon District to Saigon River has been detected and reported to the city authority.¹² This unlined landfill site was expanded in 2000 to cope with the increasing volume of city waste. Because the site was not lined, seepage has been leached to surrounding areas. To prevent further leakage, retention ponds were used to capture liquid escaping from the exposed waste on the ground. The operator of the site, however, has constructed an illegal channel to drain the liquid waste in the ponds directly to the Rach Tra, confluent of the Saigon River.¹² Even without this direct discharge significant wastewater still escapes to the river during the rainy season.

Illegally built semi-permanent boathouses on Tau Hu, Te, and Ben Nghe canals have also contributed to the total waste discharge on these waterways going to the Saigon River.¹ Water pollution is more visible during the rainy season when the inadequate drainage system cannot cope with the water flow. In many areas of the city traffic cannot move due to extensive flooding after the rain.

It is of no surprise that the canals in the city are severely degraded and polluted. Contamination by PCB's, DDT's, and heavy metals in sediments of Ho Chi Minh City's canals are detected at very high levels of concentration.¹³ Contaminated groundwater areas are also detected in some areas around the city.^{2,14} Nearly all of the water samples were reported with high coliform and E. Coli bacteria concentration.^{1,2}

Pollution Management

Wastewater treatment facilities are required for new and established industrial zones. In Binh Duong province a wastewater treatment plant was built in 1998 for the Vietnam-Singapore Industrial Park and adjacent areas. The system includes an 8 km canal to drain rainwater and treated wastewater from the zone into Saigon River. In Bien Hoa II Industrial Park a plant for treating wastewater from factories was put into operation in 1999.¹⁵ The plant has an initial daily capacity of treating 4,000 cubic meters,

and 20 of the 76 factories had been connected to the plant since it started operation. The 2-hectare plant has four reservoirs for biological, chemical, and physical treatment of liquid waste before it is conveyed to another reservoir for final treatment.

In June 2001 the city DOSTE conducted some inspection and took action against the polluting factories on Tham Luong canal in Go Vap, Tan Binh, and District 2.¹⁶ A number of plants have since installed treatment facilities. DOSTE reported to the city People's Committee that 13 enterprises had agreed to have their wastewater treated and many were in the process of installing wastewater treatment facilities.¹⁷ These actions were long overdue, considering the state of water pollution in the Tham Luong canal.

Another issue regarding the management of water pollution is the storm water system. In 2001 the municipal Communication and Public Works Department spent 101 billions VND (Vietnamese Dong) to upgrade and improve the storm water drainage system. This was part of a five-year plan to reduce flooding during the rainy season.¹⁸ To partly finance the maintenance and upgrading of the drainage system, the city authority decided in early 2001 to allow the Water Supply Company to collect water drainage levy on water users, beginning in July 2001. The rest of the finance was to come from loans from foreign governments or from international bodies such as the World Bank. However, there were complaints from customers of the Water Supply Company who did not believe the levy would be used entirely for the maintenance and upgrade of the system or thought that it might be diverted to some other uses. Non-customers of the Water Supply Company also protested that it was unfair for them to pay the drainage levy when the company currently did not provide any connection service to their residences.

Financial loans from Japan to clean up the canal systems of Tau Hu-Ben Nghe, Do, and Te include the renovation of the storm water drainage and construction of a wastewater treatment facility with an initial capacity of 141,000 cubic meters/day. The first phase of the project is from 2001-2006. This catchment area covers 3,793 hectares with a population of 1.47 million. Most people in this area are from poor economic backgrounds.

Another on-going work is the improvement of the Nhieu Loc-Thi Nghe canal catchment area. This area suffered from frequent flooding and highly polluted water in the canals. Since the relocation of the residents in squalid housing along the canals to a different area, and with the creation of parklands along the canals, water pollution in the canals has been mitigated. However, there is still much more work to be done. A comprehensive project to build a new drainage system for the Nhieu Loc-Thi Nghe canal

system is being carried out. This project has a budget of US\$200 million over the 2001-2007 period, which includes funding of US\$166 million from the World Bank.¹⁹

Various solutions for implementing this project had been sought from different organizations and research institutions and considered by the municipal Communication and Public Works. One such solution is the building of an underground sewer tunnel underneath the canals with mechanical screens to remove solids and sludges at a pumping station, which will discharge the wastewater at a peak capacity of 64,000 cubic meters/hour in a 0.8 km outfall to the Saigon River. A sewer system to connect wastewater from 30% of the houses in this basin will be built to connect them to the main underground tunnel.²⁰

It was estimated in 1997 that about 3,500 tonnes of wastes were produced daily in Ho Chi Minh City.⁶ To alleviate the household dumping of waste at the over-capacity dump site at Dong Thanh (Hoc Mon District), another landfill site in the east of the city (Binh Chanh District) at Go Cat was being upgraded and built with drainage pipes to a wastewater treatment facility. Wells for trapping gases and pipes to connect to a gas factory were also constructed. The landfill site was lined with polyethylene to prevent groundwater contamination. In contrast to the Hoc Mon site, the Binh Chanh area is downstream the Saigon River from the Ho Chi Minh City. More than half of this project's cost of VND 261 billions was being funded by a grant from the Dutch government.

The Dong Thanh waste site will also have its capacity increased with 130 hectare expansion. On this new area, a lined landfill will be established with waste liquid retention and treatment facility as well as gas utilities. This ADB-funded expansion site will be designed to comply with approved environment standards.

Environment Organizations and Activities

Besides the Department of Science, Technology and Environment (DOSTE) in the Ho Chi Minh City, there is also a Department of Science Technology and Environment in each of the provinces surrounding the City. The coordination between these organizations in relation to environmental regulation, however, is not strong. Companies can thus simply move their operations from one province to another when the regulation and enforcement imposed on them in one particular province is not to their liking.

In Ho Chi Minh City, the DOSTE requires the environment unit of each local

district government to report and submit to it an annual environment plan aiming at reducing pollution within the district. Such a plan often includes many public participation campaigns to raise the level of environmental awareness but does not include any real plan for the enforcement of the law against environmental violations. As a result, the People's Committee, in 2001, sent letters to many local government districts reminding them of this lack of implementation plans and criticized those districts which behaved irresponsibly in not following the city guidelines on environment policy.²¹

The most significant plan for improving water quality and environment is the Urban Drainage and Sewer Master Plan. This plan was prepared and developed in 1999 with assistance from the Japanese Government. The Nhieu Loc-Thi Nghe canal basin has been identified and given the highest priority to improve the water environment and associated infrastructure.¹⁹ The shoreline improvement, via house clearance, relocation, and parkland development as well as canal dredging, has been done since 1996 but there has not been any capital investment on the drainage and sewer infrastructure. As a result, street flooding and traffic jams during the rainy season are frequent phenomena. In early 2001, the Nhieu Loc-Thi Nghe Project was started with part of the finance coming from a World Bank loan. The Project is being managed and implemented by the Urban Drainage Company. The city Urban Drainage and Sewer Master Plan conforms to the national Urban Wastewater Collection and Sanitation Strategy Study and the Government Decision No. 35/1999/QD-TTg promulgated on March 5, 1999.¹⁹

Roles of Nongovernmental Organizations and Public Participation

Nongovernment organizations (NGO) are traditionally attached to the Patriotic Front (Mat Tran To Quoc), which is part of the elaborate structure of government and the communist party in Vietnam. Some of the important NGOs are The Woman Union and the Scientific and Technology Union, which are part of the Patriotic Front and also of the recently established community-based Education for Nature-Vietnam (ENV).

Public participation in the environmental issues is via public campaigns organized by such groups as the Youth Union with support from the local government. So far, there has been no independent assessment of the effectiveness of these campaigns, such as the Green Day and Clean-Up Day campaigns, in raising the level of environment awareness through public education. The press media is the main venue for the local population to voice their concerns and complaints. Public demonstrations are very rare although there are exceptional cases, such as the demonstration outside the Saigon paper plant in Go Vap District in November 2001 to protest the water discharges that were causing severe pollution in the district canal. However,

the situation is changing with increasing environmental awareness and public demands for more transparency and accountability.

As various nongovernmental environment organizations in the city have responded to the problems of water pollution, their special roles in the current framework of local governance is rapidly evolving, especially in relation to the interaction process between government agencies, business enterprises, and the public. This is similar to the formation of environmental NGOs in China and their evolving roles in that society.²² The case, in 2001, of a controversy on the tender and the technical feasibility of a World Bank-sponsored project to clean up and manage the severely polluted Nhieu Loc canal is an example. The technical solution provided by the successful foreign tenderer has been analyzed and criticized by a group of scientists from the Union of Science and Technology Societies, and there was a call in the press for the city government to reject and rescind the award of the tender. However, another group of scientists supported the work of the project and the city government's decision. In response, the city administration organized a conference to discuss and review the tenderer's work plan with a view to taking into account the broader community opinions and to try to reach a more consensual view on the project.

Strengths and Weaknesses in Environmental Regulation

The nature and process of environment management and the rising expectation from the local population on issues that directly affect their lives have led to some outcomes which exposed the strengths and weaknesses of the current structure of government in Ho Chi Minh, in particular, and in Vietnam, in general, in relation to the issue of environmental regulation. On the issue of "strength," for example, some flexible and innovative measures have been taken up by both the local government and the local population in response to some pressing problems arising out of the joint implementation of environmental programs by both the government and the public. An example is the overseeing by a local neighborhood group of water pipes construction work. In the process, the detection by the local neighborhood group of the shoddy work led to a series of notes and diaries, which were then presented to the press and the central government. This then led to the government promptly ordering the company to redo the work, and the government was forced to follow its own policy rather than merely talking about it. Such strength, however, is in contrast with the weakness in the area of enforcement of the environment law by the various responsible agencies and with the lack of coordination between agencies established at different levels of governments or in different regions. Such institutional weakness can be ameliorated, for example, with the formation of a joint task force for the emerging issues appearing across agencies and/or across

provinces.

To mitigate the wastewater pollution from upstream industrial zones on the Saigon River, besides strong regulation and enforcement, it may be necessary to encourage companies to follow the ISO 14001--Environmental management systems standard. This may bring economic benefits to some companies, especially those involved in the export markets, as many of them are in the industrial zones in Ho Chi Minh City and Dong Nai province.

Public participation in the environmental review processes should be addressed and enhanced. Besides the traditional means of the press, which the public uses to complain about pressing environmental issues that affect their living conditions, it is also beneficial to bring about earlier public consultation well before the outcomes of any environment decisions or development plans. This is the emerging trend in the environment management and policy in many countries.

Secondary and tertiary sewage treatment of wastewater from domestic sources and storm water should be considered. This requires a significant investment to build a comprehensive sewage network connecting the households to the treatment facility. The current Nhieu Loc-Thi Nghe Canal Project is the first step. The sewage network with treatment facility will improve the quality of underground water and the Saigon River. Both of these water resources are under severe stress of pollution, especially the groundwater in Thu Duc, Hoc Mon, and Binh Thanh areas.

A more integrated approach on sustainable development involving economics and social issues or policies (such as poverty reduction and population growth) should be considered. Bolay, Cartoux, Cunha, Thai Thi Ngoc Du, and Bassan²³ have studied and suggested such an approach in their study of water management in Ho Chi Minh City.

Water Supply and Distribution

Government and City Organizations

In 1977 the city People's Committee established the Environmental Protection Council to oversee the environment. In 1992 the Environment Committee was formed. In 1994 the Department of Science, Technology and Environment (DOSTE) was established as part of national body run by the Ministry of Science, Technology and Environment (MOSTE) when the Environment Law was passed by the National Assembly.

The Department of Transport Communication and Public Works is the city

government body in charge of planning of the water supply network and other infrastructures. HCM Water Supply Company is the city operating enterprise in charge of supplying water to the city. The Urban Water Drainage Company is another city authority enterprise, which oversees the operation of the water waste and storm water network. The Waste Treatment Company of Ho Chi Minh City is concerned with the disposal of solid wastes, including household and hospital wastes, produced in the city. It owns several landfill waste sites in and around the city. These three public service enterprises report to the city's Director of Transport Communication and Public Works.

As all these companies are city government enterprises, the Department of Science, Technology and Environment (DOSTE) does not strictly enforce the environmental control regulation. In fact, in contrast to private companies, it is not known if any of these enterprises were prosecuted or blacklisted in the so-called "Black Book," even though there were serious violations such as the illegal discharge of liquid waste from waste site by the Waste Water Treatment Company.¹²

Commercial and Business Organization

The HCM Water Supply Company initiated the Dong Nai River Water Supply Project to increase the water supply volume to meet the increasing water demand. From the past and up to the present, water shortage is a fact of life for many residents in the city,²⁴ this project is a major undertaking by the major city water company to alleviate the water shortage problem.

The first private water treatment plant in Vietnam was built in 1999 on a Build-Operate-Transfer (BOT) basis under a 20-year contract with the city People's Committee and the Water Supply Company of Ho Chi Minh City. The plant was built and run by Binh An Water Corporation, a consortium of Malaysian companies with a loan from the International Finance Corporation (IFC).²⁵ The Binh An treatment plant, when completed in 1999, provided 100,000 cubic meters/day (about 10% of current demand) to the Ho Chi Minh City and Bien Hoa industrial zone.²⁶

Due to water demand in the outer suburbs and outlying areas of Ho Chi Minh City, many families have resorted to using wells to access underground water. Private companies were also encouraged to set up and provide services of supplying underground water to resident homes via pumping facilities. In 2000 one such company, Phuc Doan Company in Tan Thoi Hiep ward of District 12, was set up to supply 1000 cubic meters/day to 3,000 homes in this district.

Water Demand and Supply Network

The recommended international minimum water consumption is 150 liters/day per person in urban areas. This consumption per person is based on the standard of industrialized countries. As only a fraction of that consumption is used for drinking and cooking, a widely accepted sustainable WHO standard is 50 liters/day per person for urban and non-urban areas.²⁷ However, as renewable water resources in Ho Chi Minh City and most regions of Vietnam are relatively abundant, the potential is strong for the water supply in Vietnam to reach a minimum target of 150 liters/day per person.

At a seminar on urban development in Ho Chi Minh City in August 2000, the Construction Ministry of Vietnam provided details about a new plan. According to this plan, by the end of the year 2000, people in major cities such as Hanoi, Ho Chi Minh City, and Hai Phong would be supplied with an average of 120 liters to 150 liters/person/day, and the target for the end of the year 2020 was 180 liters to 200 liters/person/day. This was also the aim of the Vietnam Water Supply and Discharge Association. Another aim related to the problem of water leakage. In Vietnam, water losses due to leakage in an old network can be between 40% to 50%. The water authorities aimed to reduce this loss to between 30% and 40% by 2005 and between 20% and 25% by 2020.²⁸

Despite these plans, the majority of people living in the outer suburbs of Ho Chi Minh City, such as districts 4, 8, and Can Gio, do not have access to tap water as supplied by the Water Supply Company, the main water supplier in the city. The main water supply plant for Ho Chi Minh City is the Thu Duc Water Station. It currently supplies 650,000 cubic meters/day to the city using the water from Dong Nai River. The Dong Nai Water Supply Project, when completed in 2004, will increase the plant capacity to 750,000 cubic meters/day.²⁹ Part of the project cost is funded from loan from the Asian Development Bank (ADB). Lyonnaise des Eaux is building another water plant at the existing Thu Duc Water station to supply 300,000 cubic meters each day to districts 2, 7, 9, Thu Duc, and Nha Be. This is a 25-year joint BOT venture with the Water Supply Company.

In 1991 there was a planned project to build a new water supply plant using water from Saigon River with funding aid from the Italian government. The planned supply plant, with a capacity of 300,000 cubic meters/day, will provide water to districts 12, 6, Tan Binh, and Binh Chanh. But as the project was underway in 1995, the aid was stopped by the Italian government due to faults in timing management. Since then the HCM People Committee has tried to use various schemes to get the project restarted,

first as a joint venture with foreign companies, then as a BOT project, and finally in April 2000 as a total sale package including equipment and project works to private investors. But so far none of these attempts have been successful. Of particular interest is the outcome of the last scheme. Some foreign companies showed an interest and a tentative agreement was signed with one of these companies. However, after the press and the public raised concerns and strong protests about the low price paid for the project, the agreement was terminated.

For the surrounding areas of the city the water supply problem was alleviated with some new projects. In 1997 the Hoc Mon Underground Water plant was upgraded to a capacity of 50,000 cubic meters/day with loan from the Asian Development Bank (ADB). In Dong Nai province a construction of a new water supply plant is being carried out at Thien Tan. The US\$25 million Thien Tan water project is funded by aid from the government of the Republic of Korea to provide clean water to more residents of the province. The plant, when completed, will have a capacity of 100,000 cubic meters/day.³⁰

Water Economics and Management

To pay for the upgrade and construction of the water supply network infrastructure, water authorities in the Vietnam Water Supply and Discharge Association called for the dropping of remaining subsidies on water usage.²⁸ They also suggested the establishment of a national strategy on the sustainable usage of water. Adoption of a cost-recovery scheme is recommended. One of the major advantages of the cost-recovery program is the reduction in the water wastage. Cost-recovery programs have been adopted widely in many cities in the world. However, this issue was not resolved, as water subsidy was part of the national and local government policy on social issues. Recently, however, due to pressure from foreign companies and international bodies, the government started looking into the overall issue of subsidies on state-owned enterprises generally, but also including state-owned water supply companies.

Water loss in the current supply network is too high. It is mainly due to the inefficient and antiquated pipe network connecting households. The economic loss is significant and it is a priority area to be fixed.

The city population is increasing rapidly. Urban sprawl has expanded to outer rural districts such as Binh Chanh, Can Gio, and Hoc Mon. In these areas the Water Supply Company currently cannot provide water to most of the local population. Recognizing its limited capacity, the city government allows and encourages private companies to invest and extract underground

water on a commercial basis to supply people with water.

The use of groundwater in the outlying districts of the city is a solution to the water demand there. But an integrated impact study of the groundwater withdrawal on ground subsidence should be conducted and managed properly. Excessive withdrawal of groundwater has caused severe subsidence problems in Bangkok and Manila, in particular, where severe salt-water intrusion has also occurred. Recent investigation of the underground water level at a number of monitoring sites in Ho Chi Minh City and Thu Duc, including sites that are near the water plants such as Tan Son Nhat and Linh Trung and near plants used by industries such as Tan Chanh Hiep (District 12) adjacent to the Saigon Beer and IBC soft drink manufacturing plants, showed a drop of water levels at all sites from 1.7 m to 4.5 m.

A current major problem in managing the surface and underground water resources and environment is the lack of cooperation and clear management roles between the Department of Agriculture and Rural Development (DARD) and the Department of Science, Technology and Environment (DOSTE). The Law of Water Resources and Environment as passed by the National Assembly in 1998 allocates the responsibility of managing the water resources to the DARD while the DOSTE is responsible for its environment. However, in reality, many cases of water environment degradation and violation of water environment law have to be dealt with by DOSTE without any collaboration and feedback from DARD. Currently DOSTE has no concrete rules on the protection of the water resources. Recently DOSTE have raised this issue publicly to correct the imbalance in the water management role.³¹ A whole approach to the river basin management of the entire watershed and catchment across Ho Chi Minh City and surrounding provinces is more appropriate for managing water resources. This integrated ecosystem strategy and approach will benefit the people in these areas in the long run rather separate plans and actions at different areas in the catchment. An example of this approach is a water resources planning and management model, which was studied and illustrated by Van Duc and Gupta.³²

Conclusion

The increase in population and rapid economic growth rate in the years following the "Doi Moi" policy from 1987 onwards have put an increasingly large stress on the water resources and environment in the city. The demands for water from industries, businesses, and households have surpassed the current supply and distribution capacities. The water supply quality in river courses and underground sources is also degraded due to the

many sources of pollution. To cope with the situation, the city administration and government have made some efforts to solve these problems. The Ho Chi Minh City and the nearby Dong Nai Province administration have stipulated and controlled the amount of waste discharges of some industries into the main canal and river courses. Due to pressures and vocal complaints from the local populations living around these water sources, many enforcement campaigns have been conducted and measures have been taken (such as requiring waste treatment facilities) to mitigate the water pollution problem.

The water environment issues in Ho Chi Minh City are not unique to the City, as many other cities in the world are also facing and dealing with similar situations. However, what is perhaps unique in Vietnam is the way the different levels of government and local population react to the impact and pressure of environmental degradation and the way the management of the water resources is carried out.

It is now acknowledged that an important requirement for a successful outcome of an environmental management plan is early public participation. It is important therefore that the issue of public participation in the management of the environment in Vietnam be addressed and the process of participation enhanced. Besides the benefit of having a traditional channel for public "participation" via complaints by the population in the public press about pressing environment issues, there are also benefits to be gained from having an early public consultation process. This will forestall many of the complaints and also ensure that any environment policy devised by the government will be carried out successfully.

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Hiep Nguyen Duc <duch@epa.nsw.gov.au> Environment Protection Authority
NSW, Australia, PO Box 29 Lidcombe, NSW 2141, Australia.

Truong Phuoc Truong <t.truong@unsw.edu.au> School of Economics,
University of New South Wales, Sydney NSW 2052, Australia.