FORMULATION OF AN INTEGRATED APPROACH TO SUSTAINABLE WATER MANAGEMENT IN HO CHI MINH CITY, VIETNAM

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ABSTRACT

In 1986, Vietnam opened up the country's economy by launching the Doi Moi (renovation) policy, which made the process of economic liberalisation possible. Accordingly, Ho Chi Minh City, the country's biggest city, has undergone rapid growth of population, urbanisation and industrialisation. While achieving remarkable economic growth, the city faces considerable urban environmental challenges. The rapid growth of urbanisation and industry has placed increasing pressure on available freshwater resources, through excessive water use and increasing volumes of untreated wastewater. Firstly, the urban water sector has had to meet growing demand for water use for domestic purposes during the dry season. Secondly, groundwater levels have experienced a substantial drawdown in outlying urban districts as a result of over-abstraction. Thirdly, rapidly expanding industrial activities are causing severe demand on water resources. The city's major supply sources have developed an alarming level of pollutants discharged by industry.

The aim of this thesis is to formulate an integrated approach to the sustainable management of water resources in Ho Chi Minh City. In order to achieve this, the research was designed to examine institutional frameworks and arrangements and to explore the perception of water value by water users and stakeholders. The underlying reasons for ineffective management are anchored in fragmented management practices which result from inadequate institutional frameworks and arrangements, inadequate regulations and inappropriate water governance. Weak enforcement of law and insufficient cooperation between government agencies and departments in Ho Chi Minh City and their counterparts in neighbouring provinces also limit management efficacy.

The research results show that stakeholders have different perceptions of water resources. Overall, water value has been considered as a social and economic good by both the urban respondents and government officials. However, most urban residents view water as a social good rather than an economic one. Public involvement in the water sector is limited. Most urban dwellers have little understanding and knowledge about the city's water issues or the available channels to access information on water resources.

Many government officials are inadequately trained, poorly qualified, inexperienced and have irrelevant or outdated background knowledge about their field of management. Government respondents did not provide consistent data and information on the water profile because there is no shared common information on water issues in place. Findings from the fieldwork show that decentralisation, privatisation and using rainwater as a potential alternative water source are preferred.

Finally, the study proposes a schematic revision of existing management structures and mechanisms between local government agencies. This thesis proposes a model for a water conservation strategy for which the management and use of water resources is aligned with adequate institutional arrangements and effective regulations. Water governance and management of water resources need to work with economic and urbanisation growth.

DECLARATION

This thesis contains no material which has been accepted for the award of any other degree of diploma in any university and that, to the best of my knowledge and belief, it contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

I give consent for this copy of my thesis, being available for loan and photocopying when deposited in the University Library.

Phu Le Vo

February 2008.

I dedicate this work to my beloved and ailing parents who have been encouraging and awaiting to see the success of my studies.

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ABBREVIATIONS

ADB	Asian Development Bank
ASEAN	Association of Southeast Asian Nations
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
DARD	Department of Agricultural and Rural Development
DI	Department of Industry
DO	Dissolved Oxygen
DONRE	Department of Natural Resources and Environment
DOSTE	Department of Science, Technology and Environment
DTPWs	Department of Transportation and Public Works
EMD	Environmental Management Division
EPZs	Export Processing Zones
GDP	Gross Domestic Product
GoV	Government of Vietnam
GWP	Global Water Partnership
HCMC	Ho Chi Minh City
HCMC DoNRE	Ho Chi Minh City's Department of Natural Resources and Environment
HEPA	Ho Chi Minh City Environmental Protection Agency
ICWE	International Conference on Water and the Environment
IPs	Industrial Parks
IPZs	Industrial Processing Zones
IWRM	Integrated Water Resources Management
JBIC	Japanese Bank for International Cooperation
LEP	Law on Environmental Protection
LWR	Law on Water Resources
MARD	Ministry of Agricultural and Rural Development
MDGs	Millennium Development Goals
MI	Ministry of Industry
MONRE	Ministry of Natural Resources and Environment
MPI	Ministry of Planning and Investment
NEA	National Environment Agency
NWRC	National Water Resources Council

OMWRM	Office of Mineral and Water Resources Management
PC HCMC	People's Committee of Ho Chi Minh City
PPP	Public Private Partnership
PSP	Private Sector Participation
RBO	River Basin Organisation
SAWACO	Sai Gon Water Supply Company
SFEZ	Southern Focal Economic Zone
SMEs	Small and Medium Enterprises
SOE	State-Owned Enterprises
SOER	State of Environment Report
SPWPs	Small Private Water Providers
SSWPs	Small Scale Water Providers
TAI	The Access Initiative
TCVN	Tieu Chuan Vietnam – Vietnamese Standards
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNIDO	United Nations Industrial Development Organisation
VEM	Vietnam Environment Monitor
VIWASE	Vietnam Water Supply and Environment Company
WB	World Bank
WWC	World Water Council
WSSD	World Summit on Sustainable Development

Vietnamese Phrases

Doi Moi	Renovation policy, which is referred to as Vietnam's political and economic reform programme, which began in. 1986.
Phuong	Ward level- the lowest administrative level in urban settings. Neighbourhoods are divided into wards (Phuong) which have their own People's Committee.

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CHAPTER 1

INTRODUCTION

At the United Nations Conference on Environment and Development held at Rio de Janeiro in June 1992, Agenda 21 -a blueprint for the global action of sustainable development - was adopted. Article 18.2 of this Agenda stated that:

> Water is needed in all aspects of life. The general objective is to make certain that adequate supplies of water of good quality are maintained for the entire population of this planet, while preserving the hydrological, biological and chemical functions of ecosystems, adapting human activities within the capacity limits of nature and combating vectors of water-related diseases (United Nations 1992, p. 166).

Nevertheless, the world's population has faced growing water stress and the misuse of fresh water which poses a serious threat to sustained socio-economic development in both developed and developing countries. The second World Water Forum 2000 in The Hague, Netherlands, noted that global water resources are irregularly distributed in both time and place:

> There is plenty of water, only not at the time and place when we need it most. Or sometimes there's too much when we do not need it. Which all goes to show that human society is very dependent on water (Van Deursen 2000).

The geographical and temporal variability of water resources is the driving force for many problems regarding water use and management. Water is an indispensable resource for the existence and development of human society, and the bloodstream in biosphere processes (Falkenmark 2005; Ripl 2003). Humans are still coping with a water crisis as evidenced by increases of water scarcities in many parts of the world (Biswas 2004; Jackson et al. 2001; Postel 2000). This crisis complicates the sustainable development of global water resources to meet basic human needs as identified by the World Water Assessment Programme:

> We are in the midst of a water crisis that has many faces. Whether concerning issues of health or sanitation, environment or cities, food, industry or energy production, the twenty first century is the century in which the overriding problem is one of water quality and management. Water management has evolved, but in 2003 some 25,000 people are still dying every day from malnutrition and 6,000 diseases (UN World Water Development Report 2003, p. 4).

Major global water challenges include water availability, scarcity and stress. These challenges hamper sustainability in human social development not only because of its geographically uneven distribution, but also as a result of inadvertent mismanagement in both developed and developing countries. Furthermore, the management of the world's water resources is influenced by dramatic changes to the world, notably the rapid growth of population and urbanisation (Biswas 2001b), changes in social and institutional components of water resources management systems (Loucks 2000).

Apart from natural conditions and variability in the distribution, there are other major forces placing pressure on water resources. These forces include changes of population growth and demography in urban areas, increases in water demand for food and domestic use, increase in competing water use, and pollution from industrial, domestic and agricultural sources (UN World Water Development Report 2006; UNEP 2006). These changes have substantial implications for all aspects of natural resource use, including water. These changes also affect how water resources are effectively managed and used.

1.1 Water and Sustainable Development

The 1987 UN World Commission on Environment and Development announced the fundamental concept of "sustainable development", in which the world's population should change its view on the relationship between economic growth and development and the use of natural resources to sustain such development. More importantly, the concept of sustainable development was thrust into the mainstream of global concern, as the world was already threatened by serious issues of managing natural resources and environmental problems (Haman and Brown 1994). The Brundtland Commission report has stimulated debate on the twin problems of environmental degradation and the necessity of economic development. Accordingly, the 1992 Rio Earth Summit on Sustainable Development, the largest international meeting and the highest level on development and environment cooperation, produced Chapter 18 on freshwater, which is a comprehensive blueprint for global action into the management of water resources in the new millennium.

1.2 Evolving Water Resource Management, Stress and Scarcity

Since the dawn of human civilisation, anthropogenic activities have interfered with the Earth's hydrological cycle, and have unintentionally caused deterioration, pollution and depletion of water resources. One of the global challenges is how to manage our finite water supply wisely and efficiently to meet growing demand for it.

Water is a scarce resource because of its limited quantity in the global hydrological cycle and the accessibility is often impossible due to uneven geographical distribution associated with distance and cost. Consequently, the world's population has faced plagues of water stresses, including water shortages, pollution, floods and droughts. The international community and developing nations have failed to meet basic human needs of access to safe and clean water (Gleick 1999, 2000b). An increasing number of people worldwide lack access to adequate water for basic needs shows the failure of existing world management practices.

Global water resources are experiencing stress owing to the imbalance of the growing world's population and the availability of water. The world's population tripled during the twentieth century, but its water demands increased six-fold (UNEP 2006). More than one billion people lack access to safe drinking water; about 2.4 billion people live without access to adequate sanitation services; and more than 5 million die every year from water-related diseases (Cain and Gleick 2005; Cosgrove and Rjisberman 2000; Gleick 1999; Gleick 2003a; Niemczynowicz 2000). These figures imply that the world now requires further concerted attention of the international community to redress the situation. Box 1.1 summarises the evolution of international dialogues about water resources. However, water-related issues have become more diversified (Hashimoto 2002; Kataoka 2005).

Water is essential for world sustainability (Abu-Zeid 1998). Not surprisingly, many international agendas and fora, from Mar del Plata in 1977 to the Rio Summit in 1992, have discussed water. The World Water Council (WWC), an international water policy think tank, was formed in 1996 to tackle world water issues and challenges. The WWC has identified world water challenges and addressed the vision ahead for world water, life and the environment in the 21st century. This vision includes guiding principles, targets and mechanisms (see Table 1.1).

Box 1.1 Evolution of International Dialogues in Water Resources

1970-the early 1980s: Human health issues ignited international discussion over water

- The Mar del Plata Action Plan in 1979 calls on countries to develop national plans and programmes regarding the provision of water supply and sanitation at the community level;
- United Nations International Drinking Water Supply and Sanitation Decade in the 1980s.

1980s-the early 1990s: Growing recognition of water as an element of sustainable development

- The Brundtland Commission (WCED 1987) introduced the concept of sustainable development in "Our Commission Future" report. It also identified water as a key global issue;
- Negative social and economic impact of water issues became highlighted. Such negative impacts include water pollution, water disputes, destruction of natural ecosystems;
- Dublin Principles in 1992 refer to the economic value of water, and the importance of "integrated water resources management";
- Chapter 18 of Agenda 21 at the Rio Earth Summit (UNCED) in 1992 presents various agendas related to water issues.

1992-2000: Priorities of Water Resources

- World Water Vision presented at the 2nd World Water Forum promoted awareness of the critical conditions of water to international community;
- A goal for safe water supply was emphasised in the Millennium Development Goals, to halve the proportion of the world's population without safe drinking water by 2015;
- The Earth Summit at Johannesburg reaffirmed the water supply goal of the Millennium Development Goal and also set a sanitation goal. It also required countries to formulate integrated water resources management and water efficiency plans at national and local levels by 2005;
- The 3rd World Water Forum in Tokyo, Japan was the first major international conference on water in Asia;
- The UN Commission of Sustainable Development (CSD) reviews the progress of the implementation on water and sanitation sectors during 2004-05 as biennial thematic review.

Source: Kataoka (2005); Hashimoto (2002).

Table 1.1 World Water Challenges and Vision

NOTE: This table is included on page 5 of the print copy of the thesis held in the University of Adelaide Library.

Source: Abu-Zeid (1998).

Faced with such challenges, the global community has made enormous efforts to diminish the number of people lacking access to water. This effort has been targeted in the Millennium Development Goals (MDGs), which pledged to halve the proportion of people without such water access by 2015. Furthermore, the United Nations MDGs provide guidelines linking water issues, sustainable development and poverty alleviation, in particular in developing nations. The International Conference on Water and the Environment (ICWE, held in January 1992, Dublin) was the earliest international call for fundamental approaches to the assessment, development and management of global water resources. The Conference formulated four guiding principles of water and sustainable development (Box 1.2).

Box 1.2 The Four Dublin Principles of Water and Sustainable Development

1. Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment.
2. Water development and management should be based on a participatory approach involving users, planners and policy-makers at all levels.
3. Women play a central part in the provision, management and safeguarding of water.
4. Water has an economic value in all its competing uses and should be recognised as an economic good.

Source: Young et al. (1994, pp. 161-162)

The four Dublin principles, also known as the Dublin Statement, reiterated that water is a finite resource and should be considered to be an economic good. This Statement eventually led to international efforts that emphasised integrating water use and sustainable development, and the need to manage this resource in an integrated manner.

In 1992, the nations of the world urged more actions to focus on the sustainable use of freshwater resources, and drew up an action plan for the new millennium, called Agenda 21, at the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in June 1992. Chapter 18 is one of the most important components of Agenda 21, and put strong emphasis on the management of freshwater resources:

> The holistic management of freshwater as a finite and vulnerable resource, and the integration of Sectoral water plans and programmes within the framework of national economic and social policy, are paramount importance for actions in the 1990s and beyond (UN World Water Development Report 2003, p. 18).

Both the Dublin principles and Chapter 18 of Agenda 21 forged an international paradigm of water resources development and management. Later, the Global Water Partnership (2003) proposed the concept of Integrated Water Resources Management (IWRM), which was drawn from the Dublin principles:

> IWRM is a process which promotes the coordinated development and management of water, land, and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems (Global Water Partnership - GWP 2000, p. 24).

This concept has shaped a new paradigm for water management towards integrative solutions: multi-institutional, multi-sectoral, multi-dimensional, and multi-stakeholder coordination. As water and its management practices cannot be viewed in isolation, IWRM has become a conceptually attractive approach and has been examined around the world (Biswas et al. 2005; Varis 2005).

Universal theories and approaches to water resources development and management are undergoing fundamental changes around the world. Gleick (2003b) maintains that there is a need for an integrated approach to global freshwater resources management, including a wide range of solutions, such as: centralised physical infrastructure; low-cost scale systems; decentralised and opened decision-making; water pricing mechanism; and water saving technologies termed the “soft path” approach (Gleick 2002, 2003a).

Rapid growth in urban expansion and population has put profound pressures on water use, development and management. The world’s urban population and water use has increased manifold in the past century (Folke 2003). During 1950-2000, the world’s population increased nearly 150%, from 2.5 billion in 1950 to over 6 billion by 2000. The number of megacities (with a population of more than 10 million) has increased from 1 in 1950 to 16 in 2000 (Biswas 2006). Global urban population increased to 47%, and it is estimated that more than 50% of the world population will live in urban areas (UN World Water Development Report 2003).

For the developing world, the rapid rates of urban expansion, economic and population growth have placed severe constraints on water resource management. The gap between water availability and water demand has widened in many developing countries. This leads to problems in the provision of water supply and sanitation for many developing cities and urban centres (Biswas 2006). Future water management trends are more complex and more difficult than in the past, particularly in large cities, due to the interrelation of water problems with development issues comprising industry, agriculture and energy (Biswas 2004, 2006; Uitto and Biswas 2000). Future solutions to water management also depend upon socio-economic and environmental conditions, institutional capacity, legal frameworks and political factors at both the local and national levels (Biswas 2004).

1.3 Urbanisation, Water Development and Management

1.3.1 Global Urbanisation Trend

Urbanisation is the process of “the spatial concentration of people and economic activity” (Roberts and Kanaley 2006). On a global scale, urbanisation usually refers to an expansion of urban areas. Vlahov et al. (2002) stated, “Urbanisation refers to change in size, density and heterogeneity of cities”. Knox and Marston (2007) maintain that towns and cities are central to social transformation and political changes. There is no internationally agreed definition of urban area and city. In virtually all nations, the urban area can be defined based on one or more features, including population size, population density, social and economic factors, and administrative and political status (Biswas 2006; Brockerhoff 2000; Hardoy et al. 2001). Therefore, the terms “urban area” and “city” are used interchangeably throughout this thesis.

The development of urban areas or cities is usually defined as the expansion of the built-up areas. This expansion is concomitant with the rapid growth of economy and population. Urbanisation means the rapid expansion of urban areas, and these urban areas are among the most life-threatening environments (UN World Water Development Report 2003). The United Nations Population Division (2002) estimated that the global urban population will increase from 2.9 billion in 2000 to 5 billion in 2030, and the number of megacities will reach 21 by 2015. The majority of these megacities will be in the developing world {UN World Water Development Report, 2003 #8}. Given such rapid urbanisation, water is one of the key resources needed to underpin sustainable urban development. The management of water resources will pose major challenges to governments at all levels (Biswas 2006; Varis et al. 2006).

1.3.2 Urbanisation and Water Management

United Nations Environment Programme (2006) indicated that rapid urbanisation is one of the four root causes of the world's freshwater scarcity. The existence and availability of adequate and safe water resources have been important influences on urban development. Since civilization began, agricultural practices and the expansion of urban areas have eventually hampered water development and management (Biswas 1997; Gleick 2003b). Most developing cities initially expanded with weak and vulnerable management systems. These shortcomings include careless management and governance structures, inadequate government attention given to ensuring sustainable water availability and wastewater management (UN World Water Development Report 2003).

Water resource development and management in urban areas are affected both directly and indirectly by local and international factors, as described in Table 1.2. Water challenges in the developing world's urban centers are more serious and complicated than their counterparts in Western countries, which have more efficient construction of urban infrastructure and capacities, appropriate institutional frameworks and effective management practices (Biswas 2006; Biswas et al. 2005).

Table 1.2 Factors Contributing to Water Resource Management

NOTE: This table is included on page 6 of the print copy of the thesis held in the University of Adelaide Library.

Source: UN World Water Development Report (2003).

1.4 The Challenges to Water Resource Management in Vietnam and Ho Chi Minh City

1.4.1 Vietnam: The Country's Economic Development and Water Resources

Since the launch of the "Doi Moi" (renovation) policy in 1986, Vietnam has progressively stepped up the process of "industrialisation and modernisation". This momentum promoted an impressive economic growth for Vietnam during the past two decades. National GDP and industry rose 8% and 13%/year respectively during the 1990s and GDP growth was steady at 7.5% in 2004 (Nguyen To Lang 2006; O'Rourke 2004). More importantly, the Doi Moi policy and the advanced program of modernisation and industrialisation have triggered social, economic and environmental changes in Vietnam (O'Rourke 2004, p. 37).

Water pollution, occupational and environmental health problems have become increasingly important issues (Claudio 2006; Tenenbaum 1996). Parallel with rapidly expanding industrialisation, urban expansion is occurring concomitantly with population growth (O'Rourke 2004). By 2005, there were more than 22 million people living in urban areas, accounting for 27% of the country's total urban population (Nguyen To Lang 2006). Rapid growth of population and urbanisation has accelerated in large urban centres, and approximately half of the urban population lives in Hanoi and Ho Chi Minh City (O'Rourke 2004). Urbanisation in tandem with industrialisation has posed numerous environmental challenges to urban authorities, planners and managers in terms of using natural resources and matching available resources to growing demand more wisely and appropriately. Of all natural resources, the management of water has been a pressing aspect for all government levels to meet sustainable development goals in most urban centres.

Vietnam has an abundance of water resources including surface water and groundwater. However, its water resources are under stress despite relatively high annual rainfall (ADB 2000, p. 28). Parallel with the growth of its national economy, Vietnam's water resources are deteriorating in both quality and quantity as a consequence of the discharge of municipal and industrial wastewater directly into receiving water bodies without any proper treatment (UN ESCAP 1997, p. 7). Its water availability per capita (4,170m^3/person) is low for the Southeast Asian region (average 4,900 m^3/person) (World Bank et al. 2003, p. 14). The country's total surface water capacity of over 2,360 rivers is estimated at 835 GL/year (ibid). About 60% of this annual runoff flows from nations upstream, mainly from the Red River in the north, which flows from China down to Vietnam, and the Mekong River in the south, which is shared by Thailand, Laos and Cambodia. An estimated 40% is from Vietnamese territory (Cao Van Sung 1995; Tran Thanh Xuan 2003; Vo 2000a). Vietnam's rivers have great potential but they are not equally distributed by area and they vary in flow from year to year and from region to region. The Red River and the Mekong River are the largest rivers in Vietnam and account for more than 75% of total annual runoff. Table 1.3 presents the annual discharge of major river systems in Vietnam.

Table 1.3 Water Resources in Vietnam's Major River Systems

NOTE: This table is included on page 11 of the print copy of the thesis held in the University of Adelaide Library.

Source: World Bank et al. (2003).

Topography and climate are the two main factors that influence Vietnam's water resources. Annual rainfall in Vietnam averages 2,000 mm but it is unequally distributed over the seasons and regions. In the wet season, there are frequent floods whereas drought is a common phenomenon in dry weather (UNEP Regional Resource Centre for Asia and the Pacific 2001; Vo 2000a). Figure 1.1 shows the key features of Vietnam's water resources.

NOTE: This figure is included on page 12 of the print copy of the thesis held in the University of Adelaide Library.

Key features

78 million people
330,000 km^2
- 8 M ha agricultural land
- 3 M ha irrigated land
- Crop intensity 2.3

Rainfall:
- Average : 2000 mm/yr
- Min : 500 mm/yr
- 80 percent within 3 mths

10 Large River Basins:
- 4 downstream
- 3 upstream

Water Resources:
- 873 billion m^3/yr
- 2/3 generated outside Vietnam

Figure 1.1 Vietnam's Water Resources

Source: Vietnam Water Resource Sector Review, World Bank Report No. 15041-VN, 1996.

Despite having abundant water resources, Vietnam has been faced with water stress in recent years. Most surface, ground and coastal waters are being seriously polluted by urban runoff and untreated wastewater from domestic and industrial centres (Hansen and Do Hong Phan 2005; O'Rourke 2004; Thanh Nien News 2006). It was estimated that 90% of the country's industrial factories have no waste treatment facilities and use out-dated technologies (Hansen and Do Hong Phan 2005; O'Rourke 2004; Tenenbaum 1996).

Secondly, water has become a competing commodity between users, including households, industry, agriculture and hydropower. Thirdly, rainfall and basin runoff vary greatly in time and space. These factors have led to water shortages around the country, even areas with abundant water resources (Hansen and Do Hong Phan 2005). With the rapid economic development, water demand by sectors will increase significantly until 2010 (World Bank et al. 2003). Although agriculture is the largest water consumption sector, representing 84% of total demands, other water demands are also accelerating. Figure 1.2

presents water demand by selected sectors in Vietnam.

The rate of access to safe and clean water is still very low in Vietnam and particularly in rural areas. About 75% of the country's population presently lives in the countryside. In the year 2000, only 52.5% of Vietnam's population had access to safe water. In 1999, only 24% of households had piped water facilities (World Bank et al. 2002). In 2003, 60% of the country's population is provided with clean drinking water (World Bank et al. 2003). The Vietnam government (GoV) aims to increase this number to 80% in 2005 and plans to provide 95% of the urban population with access to 150 litres/day of water per capita by 2010 (World Bank et al. 2003). However, inadequate water supply infrastructure and overlapping jurisdictional responsibilities have been identified as major difficulties which contribute to an inadequate water resources management system (World Bank et al. 2002).

NOTE: This figure is included on page 13 of the print copy of the thesis held in the University of Adelaide Library.

Figure 1.2 Water Demand by Selected Sectors in Vietnam
Source: World Bank et al. (2003)

1.4.2 Ho Chi Minh City: Population, Urbanisation Trend and Water Challenges

Ho Chi Minh City (HCMC) is the biggest municipality in Vietnam. It has experienced the fastest urbanisation, industrialisation and rapid population growth in the country. After the "Doi Moi" policy was introduced, HCMC became one of the fastest growing metropolitan centres in Southeast Asia (Ha and Wong 1999), and the largest agglomeration in Vietnam (Gubry and Le 2002). Its population has doubled over the past 25 years, from 2.5 million people in 1975 to 5.1 million in 2000 (People's Committee of Ho Chi Minh City 2002). By mid 2004, the City's population reached 6.1 million people, accounting for 7% of the country's total population and is estimated to reach 10 million in 2010 (Ho Chi Minh City Statistical Office 2005; People's Committee of Ho Chi Minh City 2006c).

HCMC lies at the downstream cross section of the Dong Nai and the Sai Gon rivers, and characterised by a dense canal network. The Dong Nai-Sai Gon river system is the main source for water supply in HCMC and its neighbouring provinces. As a corollary to rapid urbanisation and population growth, HCMC is facing water challenges to sustainable urban development, including groundwater depletion, surface water pollution and inadequate clean water provision for urban dwellers (Asia Times 2000). The city's total water demand is projected to triple by 2020. However, water quality has been diminished by industrial and domestic wastewater. The rate of extraction of all groundwater sources is excessive (Nguyen Phuoc Dan et al. 2006; People's Committee of Ho Chi Minh City 2002).

Intensive industrialisation has created serious challenges for meeting agricultural, industrial and domestic water needs. For sustainable development in Ho Chi Minh City to work, the challenge is not only how to match available resources to growing demand among water users, but also to manage and use it efficiently. It is necessary to take into account social, environmental, technological and economic dimensions in water resources management in the course of socio-economic development. Therefore, water management requires a holistic approach. The aim of this thesis is to formulate an integrated, efficient and sustainable approach to urban water resources management in Ho Chi Minh City.

1.5 Significance of the Research

Article 18.6 of Agenda 21 states that "the holistic management of freshwater as a finite and vulnerable resource, and the integration of sectoral water plans and programmes within the framework of national economic and social policy, are of paramount importance for action in the 1990s and beyond" (United Nations 1992, p. 167).

The programme of economic liberalisation created new threats of urban and industrial pollution in which the degradation of water resources accelerated (Forsyth 1997, p. 255). The formulation of an approach to the sustainable management and use of water resources is therefore needed both at a national level and at the local scale of HCMC.

There is a paucity of literature and related research on HCMC as one of the dynamic metropolitan centres in the developing world. Most commonly, there is an unshakeable belief of most urban planners and policy-making authorities that urban expansion means filling urban areas with as many impermeable surfaces as possible (Vo 2000b). Consequently, urban expansion is inevitably associated with dramatic changes in the urban hydrology cycle, watercourses and water receiving bodies.

As a national economic hub, HCMC should be better served and managed than rural areas in terms of water provision and wastewater management. Additionally, there are not only more people but also an increasing number of enterprises accruing to this densely populated metropolis. This leads to concentrated and accumulated wastes and environmental contaminants placing burdens on management of water resources when urban infrastructure, resources and capacities are lacking.

Ho Chi Minh City typifies the paradox of water availability and water stress and the need for comprehensive approaches to water resource management. Firstly, HCMC does not apparently lack adequate water for its social and economic development, as it is located in a water-rich region. Ironically, the city is flooded in the wet weather with water that is scarce during the dry season. Water has been considered as one of nature's 'free gifts' but it has recently become a scarce commodity between competing users. There is a lack of horizontal coordination between agencies and high levels of centralisation of environmental management systems, which traditionally relied on command and control solutions (Vo and Williams 2006).

The accelerating urbanisation of HCMC is currently exceeding the limited management capacities and resources of the government at all levels. The limited capacities and resources include lack of proper planning and water infrastructure, poor management and practices, incomplete institutional mandates, poor governance and inadequate water tariffs, inadequate public awareness and an insufficient water pricing mechanism.

The City's authority has recently launched a framework Environmental Management Strategy up to 2010 where two major objectives for water resources conservation are defined. As a natural resource, the management of water requires a long-term and integrated strategy as the water sector is an integral part of social development. However, the proposed strategy for water management and conservation is unlikely to turn the situation around as it still follows a piecemeal approach and lacks integration.

This research will focus on five key issues, as follows:

- Securing sustainable and alternative water sources for social and economic activities;
- Strengthening local water policy and institutional frameworks for integrated urban water resources management;
- Enhancing performance, compliance and enforcement of water regulations;
- Expanding water governance and improving water pricing mechanisms;
- Improving and deepening public participation and involvement in all water issues.

This thesis will explore possible solutions to these current water issues in HCMC. The hope is that communication of the research results might help awaken local government in HCMC to the need for rethinking fundamentally the way water resources are distributed, managed and used more sustainably, efficiently and equitably.

1.6 Research Aims and Objectives

There is no universal handbook on how to manage water resources wisely in different contexts and different countries. Developing countries can face similar problems, but the solutions will differ from country to country. This is because of site-specific features of water management practices. Creating an efficient and sustainable policy, plan or program to manage water resources in HCMC is something that needs to be made a top priority and to be given high attention by the City's government at all levels. To address the five key issues of water management, HCMC authorities need to rethink and reshape their own strategy and approach.

The overall aim of the research is to formulate an integrated approach to the sustainable management of urban water resources management in HCMC. The research will investigate the perceptions of water users, past and present water issues as well as existing government management practices that have posed potential water scarcity and stress as a result of rapid population growth and urbanisation. The researcher will propose affordable and feasible approaches to urban water resources management in HCMC. These approaches will be drawn from insights gained from a literature review covering institutional, environmental, social, technological and economic dimensions.

In order to achieve this overall aim, the thesis has the following more specific objectives:

- To explore existing water resources issues in Ho Chi Minh City;
- To ascertain water users' and stakeholders' valuation of water resources;
- To evaluate the impacts of urbanisation on water resources and its management practices in Ho Chi Minh City;
- To examine existing water governance in Ho Chi Minh City, including institutional framework, legislative documents, regulations and ordinances in terms of water management and development;
- To assess and analyse horizontal coordination between the sectors responsible for water governance and management;
- To undertake a SWOT (Strength – Weakness – Opportunity – Threat) analysis on the dimensions of water management practices based on institutional capacities, resources and mechanisms;
- To propose a schematic revision of existing institutions and mechanisms for the management of water resources;
- To develop an integrated model for more effective and sustainable water resources management.

1.7 Thesis Structure

Chapter 1 reviews the context and scope of the research. Chapter 2 reviews research methodology and relevant research frameworks, methodological techniques deployed to conduct the research as well as unavoidable hurdles and research limitations. Chapter 3 provides a comprehensive literature review of water resource development and management, ascertains past and present water management practices, and cutting-edge integrated approaches to the management of water. The background to Ho Chi Minh City, urbanisation trends and its water resource management practices are detailed in Chapter 4. A conceptual framework for sustainable development and an integrated approach to urban water resource management is outlined in Chapter 5. Chapter 6 discusses challenges of water governance in the sustainable management of water resources. Chapter 7 describes fieldwork results and outcomes of water management and practices in Ho Chi Minh City. Chapter 8 proposes a future sustainable strategy for the management and use of water resources in Ho Chi Minh City. Conclusions and further research are also outlined in Chapter 8.

CHAPTER 2

RESEARCH METHODOLOGY

2.1 Introduction

Chapter One addressed the irreplaceable role of water for the continued existence of Earth's ecosystems and human civilisation. From the development of basin-based societies to the burgeoning of large mega-cities, water has been a subject of many international water fora and agenda in which water was emphasised as follows: Water is life. Thus, the management and development of water resources is closely linked to social development factors. Water problems cannot be separated from other issues that are social, economic, technical, and legislative in character. Research worldwide on water issues has evolved from a single disciplinary approach to a more integrated multi-disciplinary approach. Not surprisingly, it is important to develop interdisciplinary, integrative and participatory research approaches and methodologies in the area of water management (Giupponi et al. 2006).

Worldwide, the management practices of water resources need to shift towards a new paradigm due to a number of indisputable facts that can be encapsulated as follows:

- Water is an indispensable component for human social development. However, the world's population faces the harsh reality that provision of clean water and adequate sanitation for billions of people worldwide is still unmet.

- Human civilisation is dependent on water but for centuries, people have interfered with the hydrological cycle in many different ways. Human society has increasingly experienced unrelenting challenges in balancing socio-economic development and water conservation.

- The essential role of water and the failure of the international community in water resource management were reiterated at many major water agenda and fora, in which water valuation and key management actions were addressed and identified.

- The world's water supply is in crisis and experiencing scarcity as a result of variable precipitation, spatial distribution and an increase in water demands in the industrial, agricultural and household sectors. Water scarcity has also resulted from accelerated deterioration of water quality, overexploitation, inadvertent use and mismanagement practices.

- The rapid growth of urban expansion and population is one of the root causes of water stress and scarcity worldwide. Developing countries will experience rapid urbanisation and population associated with growing consumption and demands.

- The developing world is likely to face severe water stress because it is subject to rapid urbanisation and a burgeoning urban population within the next few decades. However, developing nations will find it harder to deal with water problems than their counterparts in wealthy nations in terms of economic resilience and management capacity.

- The underlying reasons for water shortage in developing countries not only come from insufficient infrastructure investment but also largely from fragmented management practices that result in institutional weakness, ineffective mechanisms, inappropriate legal arrangements and inadequate regulations.

- Water shortage in the developing world is exacerbated due to the decline of allocating finances and poor strategic planning, which does not consider the participation of stakeholders in the private sector and the general public.

The above research problems and questions were the catalyst for this research. The rationale, significance and objectives were outlined and justified in the Introduction.

2.2 Research Framework

2.2.1 Theoretical Framework

The theoretical framework of the management practices of water resources in this study is anchored in Chapter 18 of Agenda 21 which emphasised the integration of water management is "based on the perception of water as an integral part of the ecosystem, a natural resource, and a social and economic good…" (United Nation 1992).

Furthermore, water and its management has been widely characterised as either a social good or a common property good. The declaration of the United Nations Committee on Economic, Social and Cultural Rights, stating: access to clean and safe freshwater is fundamental to human survival and now regarded as a universal human right (CESCR - Committee on Economic Social and Cultural Rights 2002). Recently, the Millennium Development Goals also include the extended access to safe drinking water and sanitation (UNDP 2006).

These international normative frameworks are the mainstays of this study. Therefore, the term "social good" is explicitly considered as a common property resource throughout this thesis when it refers to a social good.

2.2.2 Research Question

Despite the fact that Ho Chi Minh City's location is endowed with abundant water supplies, this city has experienced water crises during the period of economic development. Issues in HCMC include acute water shortages during drought periods, increasing depletion of groundwater sources and growing deterioration of surface water. Why does HCMC face a water shortage though it is located in a water-rich region? How has the local government recognised water issues in the course of socio-economic development? How has the local authority responded to increasing water challenges? In a developing city like HCMC, it is a Herculean task to seek comprehensive approaches to the management of water resources.

The management of water resources in any context is not an easy practice. Many countries still face issues of water availability and scarcity. It is not simply how to match available supplies to the demand, but how to use it more efficiently.

In the course of sustainable socio-economic development, the long term water management approach in HCMC should be based on the following conceptual model:

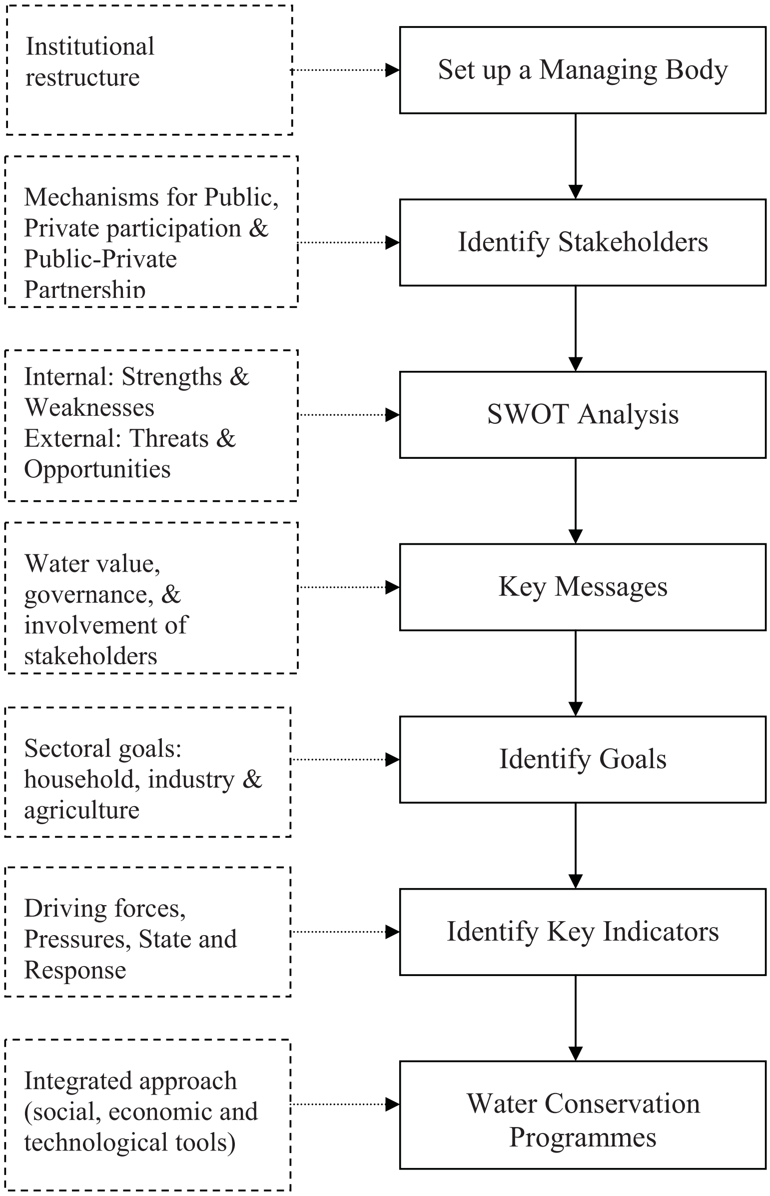


Figure 2.1 Conceptual Model for Water Conservation Plan

Source: The author

Most water problems in HCMC are recognised by institutional causes (regulation and mechanism). To formulate an integrated approach to the sustainable management of water in HCMC, such issues of the water conservation plan will be addressed and discussed in the following chapters of this thesis.

Neuman (2000, p. 18) reveals that there are several reasons why people conduct social research: (i) some researchers pursue it to answer practical questions; (ii) some want to ascertain the effectiveness of existing decision systems; (iii) other researchers want to describe something in real life and explain the changes; and (iv) some scholars want to explore new knowledge about things in the real world.

In developing a theoretical research framework, it is useful to formulate the research questions. Research questions entail research objectives as Blaikie (2003) identified in Table 2.1 below. The theoretical research methodology is the set of investigative techniques employed to attain answers to imposed issues put forward for the research.

Table 2.1 Research Questions and Objectives

Research Objectives	**Research Questions**		
	What	**Why**	**How**
Exploration	✓		
Description	✓		
Explanation		✓	
Understanding		✓	
Prediction	✓		
Intervention			✓
Evaluation	✓	✓	
Assess impacts	✓	✓	

Source: Blaikie (2003, p. 14)

With reference to water resources management in HCMC, this thesis will attempt to investigate the following research questions:

- What are the existing water issues in HCMC in the course of socio-economic development?
- What are the forces driving water shortage and what are the challenges in regard to rapid economic development and urbanisation?
- How have the city's water issues been identified in the context of the process of 'industrialisation and modernisation' launched by the central government two decades ago?

- What are the root causes of water problems that need to be addressed in a comprehensive manner?
- Are there any effective management practices put forward for using and managing water resources sustainably?
- What are the challenges and perspectives of the synergistic approach to the management of water resources in terms of strength, weakness, opportunity and threat?
- What needs to be addressed in terms of rethinking or reshaping urban environmental policy in which managing water is an integral part?
- What approaches, improvements and modifications can be suggested and formulated into a sustainable water strategy?

These questions cover the overall research objectives presented in Chapter One. The framework of the research will comprise the following components. Global concerns about the world's water resources and the driving forces of growing water demands provide the impetus for research on the role of water resources in underpinning socio-economic development and sustaining the growth of industrial production and urbanisation. I then consider global changes in water use patterns and water management practices that impinge on the shift of water management paradigms to more integrative approaches. The driving force for water resources management in growing cities in the developing world associated with rapid urbanisation will be examined. An overview of the case study, Ho Chi Minh City, is followed by an examination of the current trend of urban agglomeration, water issues and existing water management practices. Fieldwork data are analysed and finally, the results of this research are evaluated.

2.3 Research Design and Methods

Prior to conducting any research, it is necessary to design a theoretical research framework. This framework provides a set of perspectives and views on how the world is viewed and how human society works. Once the theoretical framework is defined, the selection of appropriate research methods is the next step. The methods used for the research will depend upon the scope, magnitude, purpose and focus of the research topic in accordance with the specific context in which such research is conducted. Strauss and

Corbin (1998, p.3) define *methods* as “a set of procedures and techniques for gathering and analyzing data”. In other words, the selection of methodological techniques derives from the researcher’s perception about the real world and the way in which knowledge is constructed or the so-called ‘epistemology’ (Winchester 2000, p. 3).

Once the framework of knowledge is constructed, it is important to identify what methods will be used. Strauss and Corbin (1998, p. 3) define *methodology* as “a way of thinking about and studying social reality”. Taylor and Bogdan (1998, p. 3) note that “the term *methodology* refers to the way we approach problems and seek answers… to how research is conducted”. Methodology is viewed as a bridge between theory and method, and is a procedure in which “theory and methods come together in order to create a guide to, and through, research design, from question formulation through analysis and presentation” (Hesse-Biber and Leavy 2006, p. 21).

Two main approaches are used in social science research regarding methods and techniques (Table 2.2).

Table 2.2 Quantitative Style versus Qualitative Style

NOTE: This table is included on page 25 of the print copy of the thesis held in the University of Adelaide Library.

Source: Neuman (2000, p. 16).

Denzin and Lincoln (1998,p.2) describe qualitative research as “a complex, interconnected groups of terms, concepts and assumptions”. Taylor and Bogdan (1998) maintain that, in the field of anthropology and sociology, the phrase *qualitative research* includes fieldwork, participant observation and ethnography. These authors note further that a qualitative approach is “research that produces descriptive data-people’s own written or spoken words and observable behavior" (Taylor and Bogdan 1998, p. 7). Miller and Dingwall (1997) maintain that qualitative approaches are strategies which researchers employ to observe aspects of social life. Accordingly, qualitative research has been considered to be a broad approach to the study of social phenomena. Rossman and Rallis (2003, cited in Marshall and Rossman 2006) identify five characteristics of qualitative research and four types of qualitative researchers who practice it. These are summarised in Table 2.3.

Table 2.3 Characteristics of Qualitative Research and Researchers

Qualitative Research	The Qualitative Researcher
▪ Take place in the natural world	▪ Views social phenomenon holistically
▪ Uses multiple methods that are interactive and humanistic	▪ Systematically reflects on who he/she is in the inquiry
▪ Focuses on context	▪ Is sensitive to his/her personal biography and how it shapes the study
▪ Is emergent rather than tightly prefigured	▪ Uses complex reasoning that is multifaceted and iterative
▪ Is fundamentally interpretive	

Source: Marshall and Rossman (2006, p. 3)

Denzin and Lincoln (2005) suggest the following definition for the qualitative methodology:

> Qualitative research is a situated activity that locates the observer in the world. It consists of a set of interpretive, material practices that make the world visible. These practices transform the world. They turn the world into a series of representations, including field notes, interviews, conversations, photographs, recordings, and memos to the self. At this level, qualitative research involves an interpretive, naturalistic approach to the world. This means that qualitative researchers study things in their natural settings, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them (Denzin and Lincoln 2005, p. 3).

The methodology applied in this research is best described as an interpretive approach in which values, beliefs and perspectives are formed through experiences and explorations. The accumulation of knowledge in a specific research area is not only acquired from observation, but also through experiencing and interpreting to obtain a deeper understanding of the issue.

The main method for data collection and analysis in this study is a mixed methodology consisting of qualitative and quantitative approaches. This is due to the nature of the subject matter where studies of the management practices of water resources have complex linkages with social factors and human behavior, including people’s beliefs, habits and perceptions of water use and management.

2.3.1 Case Study

A case study is a selection of the entity to be studied (Stake 1998). It is a methodological approach combining a variety of data sources to obtain sufficient information on a particular setting. Thus, the term ‘case study’ is labeled interchangeably with fieldwork (Stake 1998; Yin 2003). This is a useful strategy to examine the interaction of multiple variables and empirical data that may be implicated in a given phenomenon (Yin 2003, pp. 1-3). The case study approach also enables researchers to focus on contextual aspects of real world entities such as organisation, community or individuals in their natural settings over a period of time (Berg 2001; Yin 2003).

The case study in this research is an example of current urban water stress and shortage and the government’s policy response to issues of urban water resources in HCMC. In conducting the case study, the research uses a wide range of data sources from different collection methods to gather relevant information and meaningful evidence. The state of water resources, key water stress issues, causal factors, relationship between water issues and management practices will be described, analysised and synthesized to answer the research questions. The case study approach allows us to employ both qualitative and quantitative research. This involves interviews, questionnaires, observation, analysis of documents and a literature review.

2.3.2 Mixed Methods

Classically, qualitative and quantitative methods, such as interviews combined with questionnaires, are seen as providing both an individual and a general perspective on an issue. This triangulation of methods and use of multiple methods is sometimes deemed to offer cross-checking of results by approaching a problem from a different angle and using different techniques (Winchester 2000, p. 14).

According to Hesse-Biber (2006) the multi-method approach is considered as a way of combining qualitative and quantitative themes. Creswell (2003) claims that a mixed methods study is one of three approaches which help the researcher to examine multiple approaches to data collection in a study. It also involves activities of data collection either "simultaneously or sequentially to best understand research problems. The data collection also involves gathering both numeric information as well as text information" (Creswell 2003, pp. 18-21). He identifies further possibilities of data collection in a study between qualitative, quantitative and mixed methods, as presented in Table 2.4.

Table 2.4 Quantitative, Qualitative and Mixed Methods Procedures

Quantitative Research Methods	Qualitative Research Methods	Mixed Methods
Predetermined	Emerging methods	Both predetermined and emerging methods
Instrument based questions	Open-ended questions	Both open-and closed-ended questions
Performance data, attitude data, observational data, and census data	Interview data, observation data, document data, and audiovisual data	Multiple forms of data drawing on all possibilities
Statistical analysis	Text and image analysis	Statistical and text analysis

Source: Creswell (2003, p. 17)

The main reason for applying the mixed methods principle in this research is that "mixed methods research provides stronger inferences and the opportunity for presenting a greater diversity of divergent views" (Tashakkori and Teddlie 2003, pp. 14-15). In any given study, some research questions are exploratory while others are confirmatory. They often involve theory verification and generation. An advantage of the mixed methods approach is that it enables the researcher to answer both the confirmatory and exploratory questions in the same study (Tashakkori and Teddlie 2003). A research study utilizing mixed methods has been recognised as a separate research design that provides guidance to the researcher in combining qualitative and quantitative data collection in a single study (Creswell et al. 2003). In social science research, most qualitative and quantitative data are available to be used. However, social phenomena are complex and methods of data collection have certain limitations. The potential insights of the subject matter cannot always be gathered from quantitative surveys. Using different types of methods can mitigate shortcomings and strengthen a study (Creswell et al. 2003). Creswell and his colleagues come ultimately to a definition of the mixed methods as follows:

> A mixed methods study involves the collection or analysis of both quantitative and/or qualitative data in a single study in which the data are collected concurrently or sequentially, are given a priority, and involve the integration of the data at one or more stages in the process of research (Creswell et al. 2003, p. 212).

This research uses mixed methods to investigate many aspects of water resources management in HCMC. Multiple sources, moreover, were collected and consulted to improve the research results since data sources in Vietnam and particularly in HCMC are highly unreliable and inconsistent.

2.4 Data Collection

This research uses various data collection techniques, including primary and secondary sources such as perceptions of stakeholders regarding water valuation, formal discussions with government officers in the management process of water resources, observed events and actions concerning management practices, legal documents and government reports on the state of water issues in HCMC, the scale and proportion of water use, demands between different sectors, evaluation of the quality of water resources (groundwater, surface waters as well as urban waterways), media coverage and other relevant literature. Burgess (1989b, pp. 163-167) notes that a "multiple methods of investigation" approach can be used to collect various data. He calls this approach 'multiple strategies' (Burgess 1989b, p. 163) and it is also known as 'combined operations' (Stacey 1969). The methodological techniques outlined above are discussed in more detail below.

2.4.1 Interviews, Questionnaires and Surveys

Interviews, questionnaires and surveys were used to obtain individuals' views, perceptions of people and participatory practices of government servants in the use and management of water resources in HCMC. According to Neuman (2000, pp. 246-248) questionnaires and interviews known as the *social survey* are incorporated into both quantitative survey and qualitative field research. The early social surveys, both quantitative and qualitative, were largely used for social and political-oriented purposes (Neuman 2000).

A survey is needed when the required data and information do not already exist (Gorard 2003). Gorard also noted that surveys are useful for gathering facts, attitudes or explanations. The incorporation of interviewing into questionnaires and surveys is therefore appropriate for obtaining perceptions and opinions of HCMC's residents and governmental officers about the issues and management practices of water resources as well as their valuation on water as a natural resource. In order to create quantitative and qualitative data, this study will employ unstructured interview and questionnaire surveys.

Questionnaires are known as instrument administration (Sproull 1995, p. 162) as they apply tools to facilitate information collection. Marshall and Rossman (2006) maintain that the advantages of questionnaire surveys include convenience, accuracy and generalisability in getting information from respondents as well as validity of information (Sproull 1995). In addition, the strength of this method is that the surveys and statistical analysis are not difficult to manage and record. However, there are also some disadvantages in different administering techniques (Neuman 2000) and limited value for investigating complex social relationships (Marshall and Rossman 2006). The respondents sometimes ignore "what people really mean", implying that the research topic could be simplified or distorted (Wadsworth 1997). Despite these weaknesses, questionnaires and surveys are useful in collecting supplementary data (Marshall and Rossman 1989), such weaknesses will be expected to be reduced via the multi-methods approach such as observation and document analysis.

Unstructured interview has been deemed to be informant focused (Dunn 2000, p. 61). It is "flexible but it is also controlled" (Burgess 1989c, p. 107). This technique is a form of interview, more flexible in terms of questions, organisations, language and procedure. Palmer (1928, cited in Burgess 1989c) stated that unstructured interviews provide the researcher with the opportunity to explore new aspects of a problem and to ascertain the accuracy of information related to personal experience.

The unstructured interview is deployed to make respondents feel that they are having a conversation with the researcher rather than being questioned. In this respect, the researcher shares the culture, perceptions and opinions with respondents. Additionally, the researcher also allows respondents to express their own terms regardless of what questions are posed (Burgess 1989c). Therefore, it is not necessary to consider order or sequence of the questions being asked for each respondent. The method also reveals unexpected aspects or new clues of a particular problem that might occur during the field work.

Elite interview is a special form of interview that focuses on a specific type of individual (Marshall and Rossman 2006). Elite respondents are considered to be well informed in an organisation or society and having expertise in appropriate areas of the research project (Marshall and Rossman 2006, p. 105). This technique enables the researcher to gain valuable and relevant information about particular aspects due to elites' role in social, political or administrative matters. However, Marshall and Rossman (2006) also maintain that there are some disadvantages when conducting an elite-oriented interview. One of those hurdles is that it is not easy to make appointments with elite individuals due to their busy schedule or political reasons. Therefore, the researcher had to rely on assistance via a reference letter before making initial contacts with elite people. The researcher obtained such an introduction from Department of Natural Resource and Environment of HCMC (DONRE) prior to contacting a number of government officials relating to the management practices, the design and conduct of the policy-making and planning processes.

2.4.2 Questionnaire Design

Questionnaire design is one of the important steps in the data collection strategy. Neuman (2000) claims that the effectiveness and quality of collected data greatly depend on the way a questionnaire is designed. Those factors include the length, order or sequence of questionnaire. The main principles of a good question are clarity, validity and reliability. The type of questions and wording also have significant impacts on the effectiveness of the tool, and the questions need to avoid any confusion or bias (Neuman 2000, p. 251). He also identifies some frequent errors that may occur with designing questions (see Box 2.1). In order to achieve meaningful and relevant data, the survey in this study used open-ended and close-ended questions.

Box 2.1 Guidelines for Questionnaire Design

NOTE: This box is included on page 32 of the print copy of the thesis held in the University of Adelaide Library.

Source: Neuman (2000, p. 251-255).

This research uses two types of questionnaire for two groups of respondents. The first group surveyed is randomly selected urban dwellers throughout 24 districts of HCMC. This type of questionnaire aimed to investigate people's perceptions and valuation on water resources, their opinions over encountered urban water issues, their possible participation in any existing water protection programmes, events or campaigns. The second group consists of government civil servants from key state agencies, who take responsibility for managing the City's water resources. The purpose of these questionnaire surveys was to ascertain to what extent the government departments value and view water resources for the City's economic and social development in the long run and to explore the local government policy responses in terms of management and governance. Further explorations of this survey were done via unstructured interviews (conversations) including current sectoral coordination between key government agencies and departments, future actions and opportunities or any evident improvement of the local strategy and policy in management practices.

2.4.3 Sampling

The primary purpose of sampling is to collect specific cases, events or actions in qualitative research. This enables the researcher to clarify and gain a deeper understanding, but not necessarily generalisation and accuracy of results (Hesse-Biber and Leavy 2006; Neuman 2000). Gorard (2003, p. 91) mentions that the most important preliminary step involves selecting a sample. However, Gorard claims that a high quality sample alone does not ensure that the work is perfect, but sampling is nonetheless the basis of all research (Gorard 2003, p. 56).

Due to the large population size, a random sampling of the public was conducted. Moreover, the principle of sampling is to use a relatively small group of people for generalizing or applying to a much larger population (Gorard 2003). The simple random sampling in this study was designed for that purpose, and also helps to minimise bias (Bryman and Cramer 1994). Sproull (1995, p. 111) states that a representative sample is more important than size of sample with reference to the same probability.

HCMC has a natural area covering 24 districts and the list of its districts is constructed as a sampling frame. Thus, the selection of population sample in this research consists of:

i) 5 outlying suburban districts: the Hoc Mon, the Cu Chi, the Binh Chanh, the Nha Be and the Can Gio (the two latter are coastal districts);

ii) 5 outlying urban districts: The Thu Duc district, the Go Vap district, District 2, District 9, and District 12;

iii) 14 inner urban districts: the Binh Thanh, the Phu Nhuan, the Binh Tan, the Tan Binh, the Tan Phu, District 1, District 3, District 4, District 5, District 6, District 7, District 8, District 10 and District 11.

Sample size is described in Table 2.5, where urban residents are randomly selected urban dwellers across 24 districts of HCMC; government officials are staff/servants who work for government agencies responsible for management and governance practices of water resource; elite people are managers, experts, researchers and lecturers from government bodies, departments, institutions and universities in HCMC.

Table 2.5 Sample Size of the Study

Type of respondents	**Number of expected respondents for data collection methods**		
	Questionnaire and survey	Questionnaire & unstructured interview	Unstructured interview
Urban residents	200		
Government servants/officers		60	
Elite individuals			30

2.4.4 Observation

Marshall and Rossman (2006, pp. 98-99) categorise observation as a primary method to obtain data in the social setting and claim that “observation is a fundamental and highly important method in all qualitative inquiry”. This technique usually applies to the exploration of interactions, events, behaviours and objects in natural social settings. In addition, the observation method requires a holistic description of events and behaviour. Observation could be a passive observer or active participant (Wadsworth 1997) and could range from complete observation to full participation (Marshall and Rossman 2006). To facilitate the observation process, the use of field notes, observational checklists, event recordings, and photographs taking in a particular issue are useful. Neuman (2006) suggests watching, listening and taking notes during the process of observation. Most data during the observation process are rendered in the form of field notes, such as maps, diagrams, photographs, memos and objects from the setting (Neuman 2006, p. 399). This author also recommends several types of field notes taking as shown in Box 2.2. However, field notes of observation could be fruitful results if the researcher organises a good note-management strategy by adding more observer’s comments (Marshall and Rossman 2006). This study used a participant observation approach which is quite flexible and will lead to additional data being generated apart from the questionnaire surveys and interviews.

2.4.5 Document Analysis and Record Interpretation

Document analysis was used to fill gaps in data collection. This approach is employed in various types of research including quantitative, qualitative and case studies. It is a non-reactive, unobtrusive measure and does not involve respondents. It frequently produces more valid data and information in comparison with interview or survey questionnaires (Sproull 1995). This technique also enables the researcher to trace back past events (Marshall and Rossman 2006), policy analysis as well as supporting data cross-checking. However, particularly in the Vietnamese context, there are some disadvantages of this method including non-updated, inconsistent and inaccurate data as well as bias (Neuman 2000).

Once documents and records are gathered, the analysis of those contents is crucial in presenting what has been done and what remains to be researched. This will enable the researcher to answer questions and address the objectives. The technique of content analysis is used in social research for gathering and analyzing the content of texts. Neuman (2000, p. 292) identifies that the *text* is a type of written, visual or spoken form serving as media for communication, while the *content* varies from words, meanings, pictures, themes or messages. Hesse-Biber and Leavy (2006) suggest this technique can be employed both quantitatively and qualitatively. With the content analysis method, the researcher can explore aspects of the text's content in a source of written communication that is difficult to see. This technique also helps to make comparisons across texts with quantitative techniques in the form of charts, figures or tables (Neuman 2000). This research employs content analysis in the form of text analysis where written work presents the primary type of data (Hesse-Biber and Leavy 2006) and merely focuses on ideas, facts and figures. For this reason, many of HCMC's government documents were read, including mandatory guidelines, internal reports, project feasible studies, annual environmental reports, legal documents, legislation, newsletters, corporate regulations, plans and policies, minutes of meetings and media notices.

2.4.6 Literature Review and Media Coverage

The perusal of literature on a given topic enables the researcher to identify research problems and to find answers to the following questions as addressed in Box 2.2 by Hesse-Biber (2006, p. 56):

Box 2.2 Purposes of Literature Review

- How have other researchers approached the topic?
- What has been the history of research on this topic?
- What are the research controversies in the literature?
- What kind of specific questions have been posed?
- What has been found out and what remains to be done?
- Where are the gaps via a review of in the literature?

In addition, Neuman (2000, p. 445) notes that the literature review approach is based on accumulated knowledge that was generated by scientific and other researchers. To answer a broad research question, a researcher might take a long time to review the sheer diversity of literature on a given topic. Neuman (2000, p. 446) addresses four distinct purposes of the literature review: "i) To demonstrate a familiarity with a body of knowledge and establish credibility; ii) To show the path of prior research and how a current project is linked to it; iii) To integrate and summarise what is known in an area; iv) To learn from others and stimulate new ideas." Early on in this study an extensive review of the literature was conducted to identify water issues that the developing world has faced, and to identify gaps in developing countries' management practices of water resources.

2.5 Data Processing and Presentation

Blaikie (2003) notes that the purpose of data analysis in social science is to find answers to the research questions or to examine posed hypotheses. According to Jorgensen (1989, p. 107) data analysis is the process of "breaking up, separating or disassembling of research materials into pieces, parts, elements or units" in a comprehensible manner. Nonetheless, the approaches to data analysis have been extensively discussed in the literature review.

Several types of data analysis are categorised, including descriptive (univariate and bivariate), explanatory and inferential (Blaikie 2003, p. 29). Both quantitative and qualitative have similar and different forms of data analysis (Neuman 2000).

Data processing and analysis is the process of bringing all raw collected data and manipulating them in manageable ways to categorise, interpret and understand (Marshall and Rossman 2006). This is an essential step because facts and raw data do not automatically produce a conclusion (Jorgensen 1989, p. 108). The stage of data analysis involves several procedures such as collecting, organising, categorising, coding, interpreting, validating, presenting and concluding (Becker and Geer 1989; Jorgensen 1989; Marshall and Rossman 2006; Neuman 2000).

The results of this study generated both numerical and textual data. For each questionnaire, the frequency of response was calculated manually and recorded as a word document. Several descriptive statistical techniques (graphs, tables, charts) were used to present the numerical data in visual fashion. The textual data which is mainly obtained from unstructured interviews are presented as block or indented quotes in order to emphasise or highlight different themes and also to support interpretations made in this research. The research will apply coding methods to guarantee the anonymity of respondents/elite people. For this purpose, there are three types of coding presenting stakeholders' discussions in the study. Firstly, a respondent code with HEPO1 means he/she is government officer in the local government agencies through a survey in a numerical order 1. Secondly, a respondent code with HCMUR2 means that he/she is a researcher or lecturer from a government institution or university in a numerical order 2. Thirdly, a respondent code with HEPM1 rendering he/she is a manager or chief of a government department/agency.

2.6 Research Participants

This study was conducted with the support of various stakeholders and a wide range of government organisations and agencies in HCMC. Through the kind assistance of the Chief Manager of Environmental Management Division (Ho Chi Minh City Department of Natural Resources and Environment), the researcher acquired a strong reference letter for forwarding to government departments. Such a referral clarified the purpose, scale and significance of the research project in the context of HCMC. Hence, the researcher could access relevant information (internal reports, annual reports, legal documents) and make contacts with key persons and government bodies in HCMC, including:

- Department of Natural Resources and Environment (DONRE) of HCMC;
- HCMC Environment Protection Agency (HEPA);
- Office of Mineral and Water Resources Management (OMWRM);
- Natural Resources and Environment Divisions from 24 districts in HCMC;
- Institute for Resources and Environment (IRE) of HCMC National University;
- HCMC University of Technology, HCMC National University;
- Private University of Technology of HCMC;
- Urban Water Supply Company of HCMC (WASACO);
- Urban Drainage Company of HCMC;
- Tan Tao Industrial Park;
- Staff, officers and managers of government bodies;
- Private consultants and experts.

2.7 Research Limitations

The process of data collection and acquisition has faced some hurdles that are typical of questionnaire surveys and unstructured interviews, including non-response, vague interpretations of questions and contact/appointment failure. The researcher was asked to take notes only instead of tape recording when making appointments with elite people for unstructured interviews. Some appointments were delayed or cancelled due to time constraints and some senior managers were unwilling to be interviewed. In addition, questionnaires distributed to key government persons and stakeholders, who are most directly or indirectly involved in the management practices of water resources, regulative and composing legal frameworks, were not returned. Similarly, suspiciousness from local residents also constrained the research. Many urban dwellers are not willing to engage in questionnaire response and formal interviews for various reasons. Ambivalent responses and attitudes are another limitation. The respondents may say what they think the researcher wants to hear rather than to state what they actually know (Taylor and Bogdan 1998; Wadsworth 1997). Sample size and survey questions (Question 22 for local residents and Question 24 for government officers) may be a weakness in the research strategy. Furthermore, the researcher also encountered other limitations, including a paucity of Vietnamese literature, the vagary of data and high cost of secondary data. The researcher's effort to acquire data on urban water supply (from the local government company) was restricted because of suspicion and a lack of political will. Razavi (1992) notes that participants in Third World countries may be extremely suspicious of officials or researchers because of their previous experience.

These problems are due to a pervasive local culture. Most Vietnamese government staff/officials are afraid of formal interviews being recorded because this could expose their responsibilities and degree of involvement. This is also one of the common issues for conducting research in developing countries (Devereux and Hoddinott 1992) because the planning phase and mechanisms that put plans into practice are generally highly political. Those limitations and hurdles may affect or diminish the quality of the research. However, this research employs a mixed methods approach that enhances different research methods to supplement each other. The weaknesses can be overcome by combining multiple methods: observation, theories and data sources.

CHAPTER 3

CHANGING APPROACHES TO WATER MANAGEMENT

3.1 Introduction

Water, an indispensable component of the earth, is a subject of international attention and considerable debate. The world is facing a water crisis which is unprecedented in human history (Biswas 1999). Recent international discussions among water managers have increased, largely because an enormous number of people around the world lack access to safe water, adequate sanitation, and die each year from water-related diseases (Cain and Gleick 2005; Cosgrove and Rjisberman 2000; Gleick 1999; Gleick 2003a).

Global changes have affected the distribution and use of water resources. These changes include rapid population growth and urbanisation, political change, changes in energy, agricultural and industrial demands, lifestyle and living standards, globalisation and technological changes (UN World Water Development Report 2003). As a result, the management and use of water resources are intricately linked with social development factors. Given these changes, the management practices of water resources cannot be divorced from the four key pillars of water management issues, namely: institution, technology, environment, and society. Therefore, it is necessary to evaluate a wide range of studies on water.

The first principle of the Dublin International Freshwater Conference in 1992 highlighted the fact that *"fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment"*. Even today, this principle expressing the restricted nature of water as a resource together with its necessity for human beings' survival and social and economic development is still attracting worldwide attention. For both the developed and developing world, the management practices of water resources to satisfy the food, drinking, sanitation and health needs of people is of vital importance.

Earlier studies of water concentrated on the worldwide constraints on available water. Ensuring access to clean and adequate water services is a human right and basic need

(Gleick 1999, 2000b). The important role of water in social and economic development has been highlighted and discussed as the basis for life and development (Biswas 1984; Falkenmark and Lindh 1993). A possible integrated approach to technology, economy, legislation and society into the management practices and uses of water resources in developing cities of the developing world has not yet been widely explored. There remains a gap in information and knowledge of urban water use and management in developing countries. Closing this gap is a desirable task for many water professionals, economists, hydrologists, urban planners and managers in the developing world. Since 1986, with the introduction of renovation policy, Vietnam has experienced rapid economic development and population growth with the annual growth of GDP and industry were 8% and 13% respectively during the period 1990s (O'Rourke 2004). This has placed a great deal of strain on the use and management of water resources in many major urban centres.

The following discussion provides an overview of global freshwater resources; water availability, scarcity and development; urbanisation and water demand; evolution of paradigms of water development and management; and the need for urban water management in developing countries.

3.2 The State of the World's Water Resources

Lomborg (2001) controversially stated in his book, *The Skeptical Environmentalist,* that the world is not running out of water, and indeed has enough water. He also argues that the problems of water shortage in the Third World result from a lack of sufficient investment in water-engineered facilities and the solution to this is actually to increase consumption (Lomborg 2001). Are these rhetorical words? In order to debate Lomborg's argument, this section will discuss the availability of global freshwater for human use. A key question addressed by international water professionals is how much freshwater is available, and is there enough water for the world's growing demand?

Water is an integral part of and a driving force for every aspect of human life and Earth's ecosystems (Biswas 2004; Falkenmark 2005; Gleick 1993a; Shiklomanov 2000). For centuries, humans have developed many ways of exploiting, storing, treating and using water. However, water availability and accessibility for human consumption is limited. Even though 70% of the planet's surface is covered with water, a vast majority of it is salt water and located in polar ice, snow, or far from human habitats. The total freshwater resource on earth is approximately 35 million km^3, accounting for only 2.5% of the earth's water volume of 1.4 billion km^3 (Gleick 2000b; Shiklomanov 1993). However, less than 1% of the earth's freshwater (or merely 0.01% of all water on the planet) is accessible for human consumption uses (Crabb 1996; Gleick 2000b; Postel 2000; Shiklomanov 1993; Sundaresan 1984). This minute portion of the world's accessible water resources implies that water, circulating in the hydrologic cycle, is a finite resource.

Nevertheless, the distribution of fresh water on the globe is variable, over both space and time (Gleick 2000b; Shiklomanov 1993). Water availability differs greatly also in different regions and according to seasonal variations in them (Gleick 2000b). Gleick (2000b) further claimed that this variability is the main reason for the many problems facing the management of the world's water resources. Additionally, the use of water is dramatically increasing and changing with accelerated global population growth and increasing demands in agriculture, industry, transport and energy (UN World Water Development Report 2003, 2006). An estimate made by Rosegrant and Ringler in 1998 indicated water demand in domestic and industrial activities will increase by 590 x 10^9 m^3 from 1995 to 2020 (Postel 2000). The world's population and water use have increased in the last century by a factor of four and nine respectively (Folke 2003). In addition, water use is accelerating, evident in the construction of 45,000 dams since 1950, providing water and electricity for agricultural production (Postel 2003). Along with this, the quality of water resources has been deteriorated by domestic and industrial wastewater. The deterioration of water sources was indicated by important paramters for aquatic life, such as the concentration of dissolved oxygen, biological oxygen demand, faecal coliforms, and organic matters (Nash 1993; Postel 2003; UN World Water Development Report 2003).

Moreover, climate change will influence the availability of water resources around the world (Van Deursen 2000). As a result of climate impacts, there are concerns over water quantity and quality in satisfying the world's food production and security as rapid global population growth occurs (Rosegrant et al. 2002; Rosegrant et al. 2003). In other words, global water resources are shrinking and degrading in terms of quantity and quality. Therefore, it can be argued that global water problems result not only from the nature of uneven distribution, but also from the growing demands of the world's population for food security.

3.3 Water, Socio-Economic Development and Scarcity

A number of early human settlements in the Middle East, Asia and America developed along major rivers such as the Nile, Euphrates, Tigris, Indus and Colorado (Biswas 1997; Gleick 1993a). The Red River and the Mekong Delta River in Vietnam represented the cradles of ancient Vietnamese civilisation. Historically, human beings have developed many engineering facilities to exploit, augment and use water resources for various activities, including drinking, farming, manufacturing, energy and navigation (Gleick 1993a). The use of water for agriculture is one of humankind's earliest activities. Those early civilisations relied on major river basins and streams to provide water for irrigation and for people's livelihoods (Clarke 1991; Gleick 1993a; Gleick 2003b).

Although accounting for a tiny fraction of the global water pool, fresh water resources play an essential role in the sustainability of socio-economic development and ensuring the integrity of ecosystems (UN World Water Development Report 2003; Young et al. 1994). Furthermore, the critical role of water for socio-economic development and ecological maintenance was emphasised in Chapter 18, Agenda 21 (Earth Summit in Rio de Janeiro, 1992):

> Water is needed in all aspects of life. The general objective is to make certain that the adequate supplies of water of good quality are maintained for the entire population of this planet, while preserving the hydrological, biological and chemical functions of ecosystems, adapting human activities within the capacity limits of nature and combating vectors of water-related diseases (United Nations 1992, p. 166).

Humans depend on water (Van Deursen 2000; Young et al. 1994), but water is also a scarce resource and has become a limiting factor in economic and social development (Falkenmark and Lindh 1993; Shiklomanov 1993). About 40% of the world's population already faces water shortage (Falkenmark and Lindh 1993). A number of past water development projects, including huge dams, hydropower stations, massive water constructions of reservoirs and pipelines have brought enormous welfares and benefits to humans. These benefits include flood mitigation, food production, power generation associated with greenhouse gas reduction, and economic growth (Gleick 2000a).

Furthermore, the links between water and human health are well identified. The use of contaminated water causes water–related diseases for the human population, including diarrhoea, cholera, schistosomiasis and dengue fever (Gleick 1993a; Nash 1993). A severe outbreak of cholera in London in 1854 is an early example of such a disease linked to poor water quality (Gleick 1993a). Inadequate provision of water supply and sanitation has been responsible for the millions of deaths of children every year (Nash 1993). About 250 million cases of water-borne disease and roughly 10 million deaths all over the world are reported every year. Additionally, 75% of these deaths occur in developing tropical countries and reflects climatic conditions and inadequate water supply and sanitation infrastructure (Nash 1993). Gleick et al. (2001) noted that about 250 million cases of water-related diseases every year and about 3.3 million people have died every year from diarrhoeal diseases. The United Nations estimated that 2.8 billion people are currently at risk of infection from dengue fever and there are over 1 million deaths each year due to malaria (Gleick et al. 2001).

The importance of water for ecosystems, humanity and social welfare has been increasingly recognised as a limiting factor in social and economic development (Falkenmark 2001; Falkenmark et al. 1987). Water is an important amenity to maintain human health, and ensuring the provision of sanitation facilities and access to safe water has a profound impact on people's lives. It is estimated today that there are approximately 2.4 billion people worldwide who lack access to adequate sanitation services (Cosgrove and Rjisberman 2000; Gleick 1999, 2000b; Gleick 2003a; UN World Water Development Report 2003).

Contrary to many of the prevailing arguments, Lomborg (2001, pp. 149-155) claimed that there is enough water on the globe and believed that the world's water issue has not worsened. This statement runs counter to all the evidence discussed above.

The main water stress driver is world population which has increased dramatically over the past hundred years, from 1.6 billion in 1900 to 6 billion in 2000 (Gleick 2000a). By 2025, global population is projected to reach around 8 billion and this will make water a vulnerable resource (Kulshreshtha 1998). More land will be irrigated in order to satisfy food production and demand. The world's irrigated area has increased nearly five-fold since the beginning of the 20th century, from 50 million to more than 250 million hectares.

(Gleick 1993a; Gleick 2000a; Postel 1993; Rosegrant et al. 2002; Rosegrant et al. 2003). Accordingly, agriculture was the largest water user - about 90% of total global water use in 1900 (Rast 2003) - for the production of food for the world's rising population.

Apart from a dependable water supply for agriculture, water is also a key input to energy and industrial production (Crabb 1996; Gleick 1993a). The demand for water in industry, urban centres, and for ecological purposes is also expected to increase (Rosegrant et al. 2002). Because there has been an increase in urbanisation and in the incomes of urban dwellers, domestic water demand has grown rapidly, particularly in developing countries. Rosegrant et al. (2002) estimated that the world water withdrawal will increase by 50% for all human uses by 2025. These well documented trends coupled with rapid population growth have posed threats to global food security and led to an increase in water demand to produce more food.

The third factor regarding increased water demand is rapid urbanisation in the developing world. In many large cities and major urban centres, water has become a fundamental factor for socio-economic development in terms of availability (Biswas 1984; Falkenmark and Lindh 1993; Uitto and Biswas 2000). Urbanisation and industrialisation coupled with rapid population growth add severe strains on water consumption and cause conflicts between users. As a result of these developments, the withdrawals of global freshwater resources increased roughly sevenfold between 1900 and 2000 (Gleick 2000a). These factors and other driving forces have aggravated global water demands, placed tremendous stress on the world's water resources and changed the world's water use pattern.

Water scarcity has been highlighted as a contributor to local and regional political tensions throughout the world (Gleick 1993a). McCaffrey (1993) and Gleick (1998) claimed there is a close relationship between water and security, and an increase in international controversies over shared water resources. Gleick (1998) listed a number of matters of international security in which water has been the sole source of violent conflict or war. In fact, there are many resolutions of disputes over water between nations around the world such as the agreement between Israel and Jordan, the Indus River Commission between India and Pakistan and the Mekong River Committee between Vietnam, Thailand, Laos and Cambodia (Lomborg, 2001).

3.4 Urbanisation and Water Management

It can be argued that demand and availability is the pendulum of the water management process. Water demand often exceeds availability. Water demand is expanding for both domestic and industrial uses in many cities, while the availability of water resources is diminishing in many parts all over the world. Urban expansion is exacerbating the problem. In the early stages of social development, water consumption was mainly for irrigation and livestock purposes. In contrast, intensive agricultural practices and activities such as industry, power generation, and domestic urban use, became the dominant water-using sectors in the 20th century. A number of global estimates indicate that about 75% of water resources are used for agriculture, 22% for industrial sectors and 4% for household use (Moore 1989; Ryding 1992).

Urbanisation has been depicted as one of the triggers for many urban environmental issues. Uitto and Biswas (2000) noted that urbanisation has grown rapidly during the last century. In 1930, about 30% of the world's population lived in urban areas, and the proportion of the world urban population was 45% by 1995 (Uitto and Biswas 2000). From 1995 to 2000, the number of inhabitants in urban centres increased by 2 billion, and is estimated to add more than 2 billion between 2000 and 2025 (Meinzen-Dick and Appasamy 2002). It is further anticipated that by 2025 the urban population worldwide will rise 60% with some 5 billion people living in large urban centres (UN World Water Development Report 2003; Young et al. 1994). This rapid urban population growth associated with industrialisation is undoubtedly placing stress on water demand management in both the developed and developing world.

The growth of urban centres to unprecedented sizes is one of the most significant issues facing the world's water resources. During 1950-1990, the number of cities with 1 million or more inhabitants increased from 78 to 290 (Uitto and Biswas 2000). By 2000, there were 338 such cities (UN World Water Development Report 2003), and it is projected to reach more than 600 by 2025 (Uitto and Biswas 2000). The number of megacities, consisting of more than 10 million people, increased from 1 in 1950 to 16 in 2000, and is projected to grow to 21 by 2015. Of these megacities, 18 will be in the developing world (United Nations Population Division 2002). Given such rapid growth of megacities, the worldwide challenges of water management for urban demands that megacities currently face are enormous (Biswas 2006; Varis et al. 2006). It is clear that meeting the water needs of rapidly growing urban centres will be one of the great challenges in cities of the developing world.

Not surprisingly, rapid urbanisation is a main factor in the escalation of water demand in urban areas for domestic purposes in developing countries (Lee 1994). Urban water demand will result from two main drivers: the concentrated number of inhabitants who need water for daily basic needs, and the growth of urban economic activities (Meinzen-Dick and Appasamy 2002). Lee (1994) also claimed that economic activities in expanding urban areas have led to increased water demands and conflict in water use between major sectors as well as within each sector. Furthermore, the high rate of water consumption by urban consumers continues to rise in the developing world. Urban dwellers consume two to three times more than rural users (Uitto and Biswas 2000; UN World Water Development Report 2003).

All of these trends are intensifying water demand and conflicts within the urban water sector. However, the international community still fails to meet human basic needs for many people, and to satisfy unrelenting increase in demand. The picture of water resource management is critically exacerbated in many densely populated cities of the Third World. The reasons vary from country to country, but the most common shortcomings and obstructions can be attributed to three major factors. Firstly, urban infrastructure in developing countries has not kept pace with the rapid growth of population and urbanisation. Secondly, institutions and legal frameworks in developing nations have not yet accomplished dramatic changes in social and economic development. Thirdly, the management practices of water resources have changed around the world due to the link between water resources and development of civil society. Along with foreseeable environmental consequences, the world's paradigms of water management have shifted to more integrated approaches, but they suit wealthy countries with resilient economies. Developing nations have yet to confront this challenge to their existing economic development. Globalisation trends have impinged significantly on the development of the world's market-based policies. The formulation of water policy is not an exception to this, especially developing countries (Takahashi 2001). In the developing world, the connection between the management of water resources and globalisation derives from investment, technology transfer, information technology and development policies (Takahashi 2001).

As a result, these countries lag behind emerging advocatory paradigms of water resource management.

3.5 The Evolution of a Paradigm in Water Resource Management

The path to sustainable water resource management began with the international fora and events in the early 1970s. Some of those major global efforts to tackle water problems are encapsulated in Table 3.1. Gleick (2003a) recently reviewed earlier approaches to water development and planning, including huge dams and massive infrastructures of reservoirs and pipelines. He argued that these traditional water projects are likely to be insufficient and ineffective in coping successfully with current water problems in terms of quality and quantity. Gleick named these ways the “hard path” and also asserted that this path has not solved current problems and will not resolve future water demand due to adverse social, economic and environmental costs (Gleick 2000a, 2002, 2003a).

However, it is difficult to claim that the negative effects of past water facilities were foreseeable. Many previous engineered water projects were driven by three main factors: population growth, rising living standards and increasing irrigated area (Gleick 2000a). Moreover, most previous water–related projects relied on huge constructions and water management activities that were carried out by governments aiming for one or two objectives with perhaps a few related goals (White 2000). Thus, it can be argued that some of these hard path strategies will still provide solutions for current problems in developing nations.

These projects are still considered to be locally appropriate in the context of the developing world. In developing countries, this continuing trend of promoting physical infrastructure has been the subject of intense debate. Many dam projects, for example, have been examined in relation to people’s livelihoods, ecosystem status and their cost-benefit balance (Bird 2003). Some countries still choose this path to boost their economic growth by providing affordable electricity for industrialisation and modernisation. The most recent Asian large dam is the Three Georges Dam in China, which is one example of traditional investment in water development projects. This dam was built to protect millions of people from disastrous floods and to provide about 18,000 MW of electricity for China’s industrial centres. It will also save the burning of 100 million tons of coal, which is equivalent to the reduction of 2 million tons of sulphur dioxide emission into the atmosphere (Steele 2006).

Gleick noted the damage caused by the hard path in the past, including biodiversity and habitat loss, reduction in river flow and huge cost for relocation of many people (Gleick 2000a, 2003a). These disadvantages have been increasingly questioned in regard to the efficiency and sustainability of traditional approaches. Ultimately, they have posed the biggest challenge for the international community of how to meet basic human needs and growing demands for water without ecological disruption, and how to supply water without compromising the ability of future generations to meet their own needs. These have become one of the driving forces of the discussion to change the paradigm of the world's water management.

The growing threats of water scarcity and the increasing number of deaths worldwide have been identified as serious issues (Gleick et al. 2001). A wide range of solutions for the future has been addressed, including better water regulation and enforcement, water price reform and institutional arrangements (Crabb 1996; Gleick 2000a; Newman 2001). Many technical aspects of water management such as wastewater reuse and recycling technologies, stormwater utilisation and integration of the water cycle, have also been discussed by international water professionals (Asano 2000; Mitchell 2000; Mitchell et al. 2001; Niemczynowicz 1999, 2000; Speers and Mitchell 2000).

Table 3.1 Major International Fora and Events on the World's Water Resources

NOTE: This table is included on page 50 of the print copy of the thesis held in the University of Adelaide Library.

Source: UN World Water Development Report (2003)

The fourth Dublin principle emphasised that water should be viewed as an economic good; "water has an economic value in all its competing uses and should be recognised as an economic good" (Young et al. 1994). This has drawn international attention to the economic value of water and further water pricing reforms to cut down inefficient water use. Consequently, this guiding principle entailed a variety of discussions concerning the economic aspect of water resource management, including the municipal and agricultural sector (De Azeverdo and Baltar 2005; García 2005; Kulrshreshtha 2002; Rogers et al. 2002; Savenije and Van der Zaag 2002; Whittington 2003). Perry et al. (1997) argued the need for a distinct recognition when pursuing water as an economic good. Perry and his colleagues emphasised that the true 'economic' value of water will differ from its 'financial' value. Some key guiding principles in valuing water are summarised in Table 3.2 and Figure 3.1

Table 3.2 Key-guiding Principles for an Integrated Approach to Freshwater Resource Management

NOTE: This table is included on page 52 of the print copy of the thesis held in the University of Adelaide Library.

Source: UN World Water Development Report (2003)

NOTE: This figure is included on page 53 of the print copy of the thesis held in the University of Adelaide Library.

Figure 3.1 Economic Value of Water

Source: UN World Water Development Report (2003)

Notwithstanding global efforts to improve water management practices, the large number of people in developing countries who do not have clean and safe water and adequate sanitation services is still the biggest challenge for the international community. Regardless of past and recent management practices, they are approaches that are sector-driven, i.e. according to water users in agriculture, industry, municipality or ecology (Sehring 2005). These approaches are characterised by fragmented frameworks, inadequate strategy, weak governance and a lack of cooperation between sectors. Furthermore, some past and current practices of water resource management still lack adequate links with urbanisation and globalisation trends, energy demand and water quality (Biswas 2001b). This challenge has added to the impetus to change the paradigm of the world's water management systems.

The change in management practices and approaches to water resources was driven by four different paradigms of civil society, namely industrial, ecological, economic and political institutional paradigms (Sehring 2005). Together, the past failures of sectoral approaches have shaped a new way of water management. A new paradigm of water resource management emerged towards the end of the 20th century. The change from the traditional approach to the new approach was also driven by economic, environmental and ecological factors (Gleick 2000a).

This new paradigm of water management is the so-called “soft solution” or “soft path”. In fact, the so-called new approach to water development and management has long been adopted in Europe and Australia. For example, there is a wide range of integrated approaches adopted in Sweden such as rainwater harvesting, stormwater management, wastewater reuse and recycling technologies (Niemczynowicz 2000). Total water cycle management and water sensitive design have been developed and adopted in Australia (Newman 2001). Urban stormwater reclamation has been implemented in Adelaide to augment water supplies by replenishing surface water or groundwater resources (Argue 1997). This approach also provides an alternative water source while preserving higher quality water resources. Elsewhere, the United Nations Industrial Development Organisation (UNIDO) has been advocating and implementing the cleaner production approach throughout the world. The impetus for the cleaner production approach is to minimise wasteful use of natural resources in which the reduction of water consumption in industrial production is one of the highest priorities (UN World Water Development Report 2003).

However, many changes have affected the management practices of water resources around the world. These changes comprise geopolitical change, demographic patterns, urbanisation and globalisation trends, agricultural and industrial demand, technological and lifestyle changes as well as climate change (UN World Water Development Report 2003). Biswas (2001) claims that the existing policies or strategies of water management in the developing world are either traditional, conservative, engineering-driven or too inadequately connected with health, industrial policies and future trends and development (Biswas 2001a). He further states that future water problems could have more complex and intricate links with emerging development factors. A shift to a new paradigm of water management is needed. Future strategies and policies of water management in the new millennium should be considered with respect to ongoing changes (Biswas 2001a). Figure 3.2 illustrates the shift to a new paradigm of water resource management.

Traditional approach (hard path)

- Massive structure systems;
- Centralised infrastructure for capture, store, and distribution;
- Centralised water treatment facilities;

Soft path/solutions

- Centralised physical infrastructure;
- Low-cost/small scale systems/projects;
- Decentralised and open decision-making
- Water tariff and pricing improvement;
- Water saving technologies (reuse, recycle and reclaimed)

Figure 3.2 Shift to New Paradigm of Water Resource Management

Source: Compiled by the author from Gleick (2000a) and Biswas (2001a)

Gleick (2003) advocated the "soft path"-a new transitional path in which many approaches are integrated together. This means that investment in water projects is not only based on centralised, large-scale infrastructure, but also based on decentralised and small-scale community projects. However, this is not easy in the developing world. Special attention needs to be given to a shift in direction, but this is a challenge due to the need to move smoothly without compromising economic growth and social stability. I believe that developing countries cannot immediately adopt all the new technologies on the soft path for several reasons.

Firstly, for developing countries, most water project investments have been subsidised or fully funded by governments and international financial organisations. Government budgets in developing countries are under serious pressure and constrain investment in major water development projects. At the same time, in return for assistance, some countries have reluctantly made some political commitments to administrative reform, democracy and religious freedom. The question is whether this is a suitable compromise for the developing world. Secondly, in order to adopt advanced technologies for efficient water consumption, developing countries have to buy from developed countries. This usually requires high capacity building in staff and often results in corruption. Thirdly, water institutions and policy formulation in developing countries are incomplete and inconsistent with economic resilience, appropriate infrastructure and management practices compared to their counterparts in developed countries.

Therefore, a transitional path is needed and would become an integral part of the aim to shift to the soft path. On the one hand, developing countries partly pursue traditional water projects to satisfy their economic growth. On the other hand, non-structural approaches should be in place, such as institutional arrangements, mechanism improvement and water pricing reform. This means developing countries or countries in transition should integrate and focus on an 'integrated transitional path' that would be a necessary step to the developing world reducing tensions concerning economic growth and social development.

The Global Water Partnership (2000) adopted an integrated approach termed Integrated Water Resource Management (IWRM). The IWRM stems from the four Dublin principles and aims to provide policy makers, planners and water professionals shaping management systems of water resources more efficiency, equity and environmental sustainability (Global Water Partnership - GWP 2000). Increasingly, IWRM emerges as a new paradigm for water management. However, Biswas (2004) maintains that this paradigm is merely the rediscovery of a concept that was successfully implemented six decades ago. The IWRM approach is under question due to its vague definition that is less practical than present management practices (Biswas 2004). While Dukhovny (2004) argues that IWRM should be considered as a management system rather than a process. Nonetheless, IWRM is being applied in developed and developing countries as listed by GWP, including water-rich and water-stressed countries (Global Water Partnership - GWP 2003, pp. 147-155).

3.6 Water Resource Management in the Developing World

3.6.1 Water Resource Management in Developing Nations: Driving forces and Challenges

We have discussed the indispensable role of water in socio-economic development. The growth of population and economies is also accelerating and hampering urban water use. According to Young et al. (1994), in the developing world, agricultural activities account for about 85% of water resources, 10% is used for industrial purposes and 5% for domestic urban use.

Biswas (2000) noted that the provision of adequate water and sanitation has become a serious problem to many developing cities. In 1990, about 33% of the urban population had no access to adequate sanitation services and this increased to 37% in 1994. Most large urban centres in the developing world are experiencing a critical water shortage and facing challenges of access to safe drinking water and adequate sanitation services (Biswas 2000).

The United Nations (2002) indicates that the number of megacities in 2015 will be 21, and of these, the 18 largest cities will be in developing countries. These cities will face acute water provision as economic growth in developing nations is not strong and resilient like their counterparts in the developing world (Biswas 2006). The dramatic changes in demographic size and pattern are considered crucial in formulating water strategies and policies (Drangert et al. 2002). Most cities in the developing world have undergone significant transformation of social and economic development. Their demographic change is an inevitable process, and should be taken into account in policy formulation.

The management of water resources is also imperative to developing nations since they contain most of the world's population. A large number of citizens in these countries greatly depend on water for food production (Chaturvedi 2000). The World Health Report 1999 indicated that the third cause of deaths in developing countries is diarrheal disease which is closely related to contaminated water use (WHO 1999).

Urbanisation and expanding industrial production have led to greater demand for water consumption and water pollution problems in the Southeast Asia region (Marcotullio 2007; UN ESCAP 2005; Wong et al. 2006). In spite of having abundant rainfall and water resources, developing countries in Southeast Asia are facing major challenges in water resource and development (Boehmer et al. 2000; UNEP 2002). Given rapid urbanisation, the growth of water demand in Southeast Asian countries is projected to increase by approximately one-third by 2025 (ASEAN 2005). Water challenges in this region comprise widespread water pollution, increasing demands between competing users of industry, agriculture and household as well as conflicts between stakeholder interest groups. Goh (2003) maintains that many Southeast Asian cities have faced acute water shortage owing to rapid regional economic development. McInstosh (2003) analysed the roots of water shortage in developing Asian countries as being linked to poor performance of institutional frameworks, regulations, governance and tariffs.

3.6.2 Water Resource Management in Major Urban Centres in Vietnam

Vietnam is located in an abundant water resource region of Southeast Asia. Although Vietnam's average annual precipitation is around 2,000mm, this rainfall is highly uneven distribution over regions (Vo 2000a). Additionally, seasonal fluctuation of yearly rainfall results in variation of water quantity. This affects management capability to satisfy growing water demands in agriculture, industry and household, particularly in the dry season. More importantly, water availability and its management practices in Vietnam are substantially influenced by the country's topography and tropical climate (Malano et al. 1999).

In terms of water availability per capita, the United Nations (ESCAP) (1997) categorised Vietnam in a group of countries in Asia and the Pacific with potential water stress. A research by the ADB team indicates that Vietnam's water resources are likely to come under stress despite the country's high annual rainfall (ADB 2000). The 2003 Vietnam Environment Monitor report by the World Bank states that Vietnam's water availability is low ranking in comparison with average levels in the Southeast Asian region (World Bank et al. 2003). In addition, the third State of the Environment Report of Southeast Asia (ASEAN 2006) states that Vietnam's available internal water resources account for only 7.4% of the region's total water resources. Along with this, the proportions of national population with access to clean water supply and improved sanitation is 74% and 41%, ranking 6th and 7th respectively in the ASEAN region (ASEAN 2006).

Ho Chi Minh City, the Vietnam's biggest city, has grown rapidly economically since the 'Doi Moi' policy was launched in 1986. This city experienced social changes in the so-called 'industrialisation and modernisation' process (O'Rourke 2004). The rapid economic growth has resulted in striking pressure on water resource use and management. Water demand, accelerated by intensified expansion of industrial activities, has caused many incidences of water pollution (Asia Times 2000; Hiep Nguyen Duc and Truong Phuoc Truong 2003; O'Rourke 2004). The fall in groundwater level is observed in outlying districts in HCMC where water tables have fallen up to 5m during the last five years (Nguyen Phuoc Dan et al. 2006). Hiep Nguyen Duc (2003) claimed that water quality in many receiving bodies is also exacerbated by fragmented legal frameworks and inadequate regulations.

The management of economic, environmental and social development, for both the present and the future of Ho Chi Minh City, is imperative. Ho Chi Minh City lacks a strategic management plan for water resources. An increase in water demand, pollution control and conservation coupled with industrial growth, population and urbanisation are stalemates facing Ho Chi Minh City's government at all levels. Therefore, the formulation of an overriding institutional framework for water planning, management and development is important.

3.7 Concluding Remarks

Water is a fundamental requirement for human survival and social development. It is also essential to all forms of life on the earth. However, the amount of water on the planet is constant and limited, and water is becoming a vulnerable and scarce natural resource. The scarcity of water is placing enormous pressures on social and economic development. The availability of and access to freshwater have been described as the world's most challenging problem. For the developing economies, the availability of water resources in urban areas is a serious one if urban development is to be sustainable. A basic human need -safe and clean water- is still unmet.

Water is essential for environmental sustainability and economic development. As urbanisation and growth of megacities proceeds, the sustainability of urban centres is dependent on the inputs and outputs of natural water flows. During the process of development, as human populations have inexorably grown, water resources have been treated poorly due to the poor regulation of activities. Water and sustainability are two sides of the same coin, which have led to many concerns and controversies over the global implications of water problems.

The salient progress of technology has become a main driver in changing the paradigm of water management. This has produced a proliferation of applications in water planning and management, including decentralised physical water facilities, institutional arrangements, water pricing and water reuse and reclamation. However, this new approach is not easy for developing countries to adopt because they are facing technical and financial constraints. A change to soft paths of water management is necessary, but for the developing world, an integrated path of traditional and new approaches would be most useful, at least initially. The shortage of access to water in the developing world is not only due to lack of adequate investment in water infrastructure but also to a lack of a proper and comprehensive water management policy. It will be useful to investigate the extent to which the soft path can be developed and applied in developing countries and to explore an affordable approach to large urban centres in developing nations. For the developing world, a possible way could be an integrated transitional path comprising technology, society and economy.

CHAPTER 4

WATER RESOURCE MANAGEMENT IN HO CHI MINH CITY, VIETNAM

4.1 Background to Ho Chi Minh City

Ho Chi Minh City, formerly known as Sai Gon, was founded in 1698. After reunification in 1975, Sai Gon was renamed Ho Chi Minh City (HCMC). HCMC was originally a small fishing village known as Prey Nokor (means "forest city" or "forest land") (Vuong Hong Sen 1968). The area that the city now occupies was originally marsh and swamp land, and was inhabited by Khmer people for centuries before the arrival of the first Vietnamese settlers in 1698. After a long and turbulent history, HCMC celebrated its 300th anniversary of establishment and development in 1998 (People's Committee of Ho Chi Minh City 2006d).

Situated in the south of Vietnam, HCMC is the largest and most dynamic city in Vietnam. Since the "Doi Moi" reforms of 1986, HCMC has experienced rapid industrial and urban growth over the past two decades. Increasingly, it has become an important hub for political, economic and cultural activities (Ha and Wong 1999). HCMC has attracted an increasing number of migrants from rural areas (Gubry and Le 2002). Consequently, it is the most densely populated city in Vietnam and is the heart of the Mekong Delta region.

4.1.1 Geographical Location

Ho Chi Minh City is located at $10^{0}10'$ to $10^{0}38'$ North and $106^{0}2'$ to $106^{0}54'$ East. Its total land area is approximately 2,095 km^2. The distance from north to south is 120 km, and from the eastern point to the western point is about 50 km. Its neighbouring provinces include Binh Duong in the north, Tay Ninh in the northwest, Dong Nai and Ba Ria- Vung Tau in the Southeast, and Long An in the west and southwest (Nguyen Phuoc Dan et al. 2006; People's Committee of Ho Chi Minh City 2006a). Figure 4.1 illustrates the geographical location of Ho Chi Minh.

NOTE: This figure is included on page 62 of the print copy of the thesis held in the University of Adelaide Library.

Figure 4.1 Location of Ho Chi Minh City

Source: Nguyen Phuoc Dan et al.(2007)

4.1.2 Natural and Climatic Conditions

HCMC features a diverse terrain that is part of a transitional region with different characteristics between the southeastern and the Mekong Delta region. The terrain is lower from north to south and from east to west (Nguyen Phuoc Dan et al. 2005; People's Committee of Ho Chi Minh City 2002, 2006a). HCMC's topography can be divided into three areas, as follows:

- *Area 1*: the elevation of this area is below 2 m. This is a low-lying plain in the south-west of the city. This area includes the downstream basin of the Dong Nai-Sai Gon River (consisting of Nha Be and Can Gio districts) and is strongly affected by tidal movements.

- *Area 2*: Altitude of this area ranges from 2 to 5 m. This area includes urban centres, population-concentrated areas comprising Hoc Mon, Binh Chanh and south of Cu Chi districts. They are dense residential areas and tenured land with cultivated vegetables and crops, fruit-trees and industrial crops.

- *Area 3*: the altitude of this area varies from 5 to 25m, and is mainly occupied by the remainder of Cu Chi district, the north of Thu Duc district and Go Vap district. This area features a large proportion of the urban population and industrial crops.

Ho Chi Minh City is situated in the sub-equatorial and tropical zone. Thus, its climate is monsoonal with a high level of solar radiation, a relatively stable temperature, and with clearly divided rainy and dry seasons. The dry season is from November to April while the wet season lasts from May to October. The city's climate is as follows:

- *Temperature*: daily average temperature is 27^0C. The highest daily temperature is 35–36^0C and the lowest is 24–25^0C. Urban areas have average temperature higher than the surrounding suburbans by 1– 1.5^0C.

- *Humidity*: The annual average humidity is 70–80%. During the rainy season, humidity reaches 85–90% and falls in the dry season to 60–75%.

- *Rainfall*: Yearly average rainfall is about 1,950 mm. The rainy season accounts for 80–85% of yearly rainfall. High rainfalls occur in June and September, averaging 250–330 mm/month, and maximum rainfall is up to 640 mm. The highest annual rainfall was recorded in 1908 at 2,718 mm and in 1958 at 1,392 mm. The rainfall is not distributed evenly and tends to increase from the southwest to northeast. Most central districts and northern districts usually have higher rainfall than districts in the south and southwest (People's Committee of Ho Chi Minh City 2002, 2006a). The Can Gio suburban district has the lowest rainfall, 1,300 mm–1,700 mm. Cu

Chi and Thu Duc districts have the highest rainfall, 1,900 mm–2,100 mm (Tran Kim Thach 1998).

- *Evaporation*: Average evaporation is 3–5 mm/day; the highest evaporation is in the dry season, about 80–180 mm/month.

Seasonal fluctuations in annual precipitation result in variation of water quantity and quality in Vietnam's major urban centres, particularly in HCMC. Generally, Vietnam's rainfall is highly distributed in a short period of the year and causing water shortages and floods (Malano et al. 1999). During the rainy season, some areas of HCMC, particularly in riparian districts, experience stark inundation following intense rainfall associated with high tides. In contrast, the city's dwellers recently encountered water shortages during the dry season in recent severe drought years. This situation has become critical owing to the rapid growth of population and urban expansion; the expansion of urbanised areas is haphazard in nature. This has led to significant changes in urban hydrology in terms of reduction in aquifer replenishment, diminution of urban drainage capacity, and changes in areas and borders of urban water receiving bodies. This situation confronts the City's government policy at all levels, including severe inundation in the wet season and shortage of water supplies during the dry season. The causes are rooted in ineffective management practices, such as unbridled urban expansion, inadequate planning of new urban development areas, and ineffective administrative/institutional arrangements.

4.1.3 Demographic conditions

After reunification in 1975, the demography and the population pattern of HCMC dramatically changed. Its population has doubled over 25 years from 2.5 million in 1975 to 5.17 million people in 2000. By 2004, the mid-term census indicated the population figure has accelerated to 6.1 million people, accounting for 7% of the country's population in which 5.2 million inhabitants live in urban districts and 0.9 million people in outlying districts (Ho Chi Minh City Statistical Office 2005; People's Committee of Ho Chi Minh City 2006c). Due to the rapid population growth, population density steadily increased up to 2,987 inhabitants per km^2 in mid-2005 (Demaine 2005). By 2005, the urban population increased to 6.2 million (Ho Chi Minh City Statistical Office 2007). By 2010, it is estimated to reach around 8-10 million people or a megacity size taking into account the unofficial population (Gubry and Le 2002; People's Committee of Ho Chi Minh City 2006c; Water and Sanitary Engineering Company 2 -WASE 2001). The urban population growth is depicted in Figure 4.2 below.

HCMC consists of 19 urban districts (Quan) and 5 outlying suburban districts (Huyen). The five outer suburban districts are named Can Gio, Nha Be, Hoc Mon, Cu Chi and Binh Chanh, accounting for 79% of the City's total area (1,601 km^2) and 16% of the total urban population. Of five suburban districts, Can Gio and Nha Be are the two coastal districts. Eighty-four percent of the City's population is located in urban districts (Gubry and Le 2002; People's Committee of Ho Chi Minh City 2006c; UN ESCAP 2003).

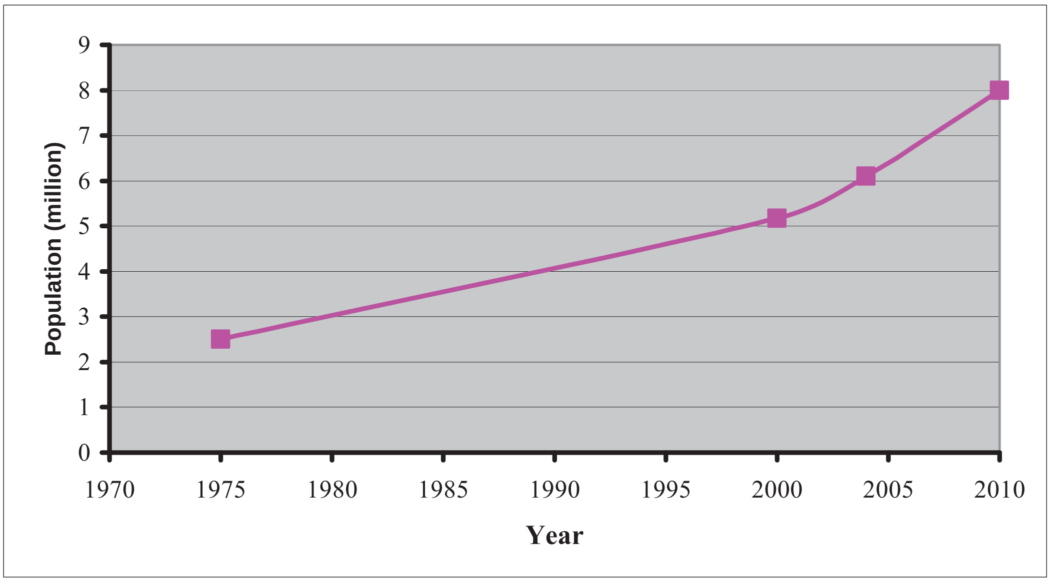


Figure 4.2 Evolution of Urban Population Growth in Ho Chi Minh City, 1975-2010

Source: Compiled by the author from different cited sources

In the Population Report (2001 revision) of the United Nations seven years ago, the urban population of Ho Chi Minh City was projected to reach 6.2 million people by 2015 with a rate of urban growth of 2.02% (United Nations Population Division 2002). However, the urban population exceeded 6 million by 2004 (People's Committee of Ho Chi Minh City 2006c), 10 years earlier than the United Nations prediction and the city will become a mega-city. This will result in pressure on urban services and the environment. Most commonly, securing adequate water sources, ensuring basic human needs and managing water resources will pose challenges to urban planners, managers and water professionals as well as burdens on urban water infrastructure.

4.1.4 Socio-Economic Growth

The renovation policy in 1986 triggered the so-called 'industrialisation and modernisation' process which created momentum and impetus for social transformation and radical economic development in Vietnam (O'Rourke 2004). Not surprisingly, HCMC has witnessed a remarkable economic growth, evidenced by GDP growth rate in 2004 reaching 11.6% of the whole country's 18.4% (People's Committee of Ho Chi Minh City 2006b). Despite accounting for only 0.6% of Vietnam's total area and 6.6% of the country's total population, Ho Chi Minh City made an important contribution to Vietnam's GDP in 2000. During the period 1995–2000, the City's GDP steadily accelerated. Its contribution to total GDP was 16.7%, 18.9% and 19.3% in 1995, 1999 and 2000 respectively (People's Committee of Ho Chi Minh City 2006b). In 2004, the city's GDP continued to rise and accounted for one-third of Vietnam's total GDP value, more than 130 trillion Vietnam dong (People's Committee of Ho Chi Minh City 2006b). Importantly, the value of its industrial output in 2000 was VND 76.66 million, which was many times higher than its counterpart provinces (Ba Ria – Vung Tau and Dong Nai provinces) in the Southern Focal Economic Zone (SFEZ) (People's Committee of Ho Chi Minh City 2002, 2006b). HCMC is the heart of the southern region as it makes up 66% of SFEZ's GDP and 30% of southern GDP growth (People's Committee of Ho Chi Minh City 2006b). Thus, HCMC has been a leading contributor to Vietnam's economic and industrial development for the past 20 years. Annual GDP growth of HCMC between 2001 and 2005 is summarised in Table 4.1.

Table 4.1 Economic Growth of Ho Chi Minh City, 2001-2005

NOTE: This table is included on page 67 of the print copy of the thesis held in the University of Adelaide Library.

(Source: People's Committee of Ho Chi Minh City (2006b)

4.2 Urban Agglomeration and Environmental Challenges

4.2.1 Urban Agglomeration

Since the renovation policy's launch, HCMC has experienced rapid economic growth evidenced by annual GDP growth of 10.2%, 11.2% and 11.6% in 2002, 2003 and 2004 respectively (see Table 4.1). The population growth was 3.1% per year between 1985 and 1990 and 4.5% per year from 1990 to 1995 (Bennie Black & Veatch 2002). As a result, Drakakis-Smith (2000, p. 18) maintained that HCMC is one of the most concentrated urban populations in the world. It is one of the most dynamic urbanised areas in the Southeast Asian region with rapid recent economic growth (Bolay et al. 1997). Not surprisingly, HCMC is predicted to become the largest urban agglomeration in Vietnam (Gubry and Le 2002).

For the past two decades, the so-called process of "industrialisation and modernisation" is the driving force of rapid economic and urban growth in HCMC. Its rapid development brings both opportunities and challenges. HCMC has become the heart of the southern region and the country's economic hub. However, the City's rapid annual economic development has burdened urban services, infrastructure and facilities, such as traffic, water supply and drainage systems (People's Committee of Ho Chi Minh City 2002). Urban environmental agglomerations in HCMC have made urban infrastructures obsolete (Hiep Nguyen Duc and Truong Phuoc Truong 2003). Furthermore, there have been inadequate government responses to pressing environmental problems. The vulnerability of urban ecology systems in and around HCMC reflect such inadequate management capacity (Bolay et al. 1997; Wust et al. 2002).

HCMC, together with three neighbouring provinces (Dong Nai, Binh Duong and Ba Ria-Vung Tau) forms the Southern Focus Economic Zone (SFEZ) of Vietnam, which has been the most dynamic economic development area for the past two decades (People's Committee of Ho Chi Minh City 2002). This SFEZ has received priority and political support, both national and local, to become the country's leading economic zone. Many industrial factories, industrial parks (IPs) and export processing zones (EPZs) have been established and expanded. There are almost 30,000 small and medium-scale enterprises (SMEs) and 800 large-scale manufacturers spread over urban districts in Ho Chi Minh City (O'Rourke 2004; People's Committee of Ho Chi Minh City 2002).

These industrial factories daily discharge more than 10^5 m^3 of effluent with high pollutant concentrations into receiving bodies, including major rivers (the Dong Nai and Sai Gon river), and urban canal systems, without any proper treatment (Asia Times 2000; O'Rourke 2004; People's Committee of Ho Chi Minh City 2002). Similarly, a huge amount of industrial solid wastes is generated and disposed of illegally to the open canals and drainage systems, and even to uncontrolled landfills or dump sites (People's Committee of Ho Chi Minh City 2002). The Environmental State Report for HCMC 2000 estimated that total municipal solid waste amount to about 5,200 tons/day, including 4,900 tons/day of domestic waste, 260 tons/day of industrial solid wastes and 11 tons of hospital waste (People's Committee of Ho Chi Minh City 2000b).

The Institute for Tropical Technology and Environmental Protection survey of total solid waste generated by industrial and hospital activities in HCMC arrived at a figure of 600,000 tons/year. This is an underestimate since there are no separate collection and disposal systems in place for hazardous and industrial solid wastes (People's Committee of Ho Chi Minh City 2002). Tables 4.2 and 4.3 give estimates of wastewater from industrial and domestic activities up to 2020, and total loads of industrial solid waste in 2000.

Table 4.2 Summary of industrial and domestic wastewater in HCMC

NOTE: This table is included on page 69 of the print copy of the thesis held in the University of Adelaide Library.

Notes: 1) n.a: not available;
2) Domestic and industrial wastewater is calculated separately from main receiving bodies: the Sai Gon and the Dong Nai rivers;
3) Industrial wastewater is only estimated for effluent from industrial parks

Source: People's Committee of Ho Chi Minh City (2002)

Table 4.3 Summary of Industrial Waste Loads in 2000

NOTE: This table is included on page 69 of the print copy of the thesis held in the University of Adelaide Library.

Source: People's Committee of Ho Chi Minh City (2002)

4.2.2 Urban Environmental Issues

HCMC's remarkable economic development over the past two decades, albeit creating many positive impacts and opportunities, has had an adverse impact on the use of natural resources and environmental quality. The process of rapid urbanisation, population and industrial growth has resulted in large-scale changes on environmental and resource conditions in both urban and rural areas. These impacts include land use changes, resource depletion, and air, water and soil degradation (O'Rourke 2004).

4.2.2.1 Urban Inundation and Water Shortage

HCMC is situated at the downstream section of the Dong Nai and the Sai Gon rivers. This river system has a large network of rivers and tributaries, and provides water to the City. However, HCMC typifies a paradox regarding water issues. On the one hand, there is too much water during the wet season resulting in inundation in many districts. Many areas are subject to flooding in the rainy season from May to October. Moreover, HCMC is considered to “stand with its feet in the water” (Bolay et al. 1997). The inundation is seriously exacerbated when associated with seasonal tidal surges in low-lying districts, as in November 2006 (VNexpress 2006a, 2006b). Consequently, many districts face serious waterlogging and inundation after heavy storms combined with tidal surges (People's Committee of Ho Chi Minh City 2002).

On the other hand, water stress and shortages face many urban districts and outlying suburbs during the dry season (Vo and Williams 2006). In contrast to inundation in inner districts, suburban dwellers lack access to clean water or have inadequate provision of clean water. The reasons for water shortages in HCMC include insufficient water sources and inadequate supply networks. District 7 and Nha Be District suffered a water shortage in the 2006 dry season. These Districts’ residents paid approximately $ USD 2 per cubic metre of clean water (Thanh Nien Online 2006). The situation is severely aggravated for the two coastal districts of Can Gio and Nha Be where it is hard for clean drinking water to reach residential areas (UN ESCAP 2003). In addition, the proportion of residents with access to clean drinking water in outlying Districts is low. Of the five outlying suburban Districts, in Binh Chanh and Nha Be, only 10.65% and 22.15% of people have access to clean water respectively. There is no water supply network in place in three suburban districts for Can Gio, Cu Chi and Hoc Mon (Ministry of Natural Resources & Environment -MONRE 2006d).

4.2.2.2 Urban Drainage System

HCMC is naturally located in a dense river and canal network which is very important for the City’s navigation and drainage (People's Committee of Ho Chi Minh City 2000a). The network of waterways accounts for 17.5% of HCMC’s total area, conveying all kind of discharges from domestic and industrial activities. Figure 4.3 shows the waterway system in Ho Chi Minh City. The HCMC's urban drainage system was originally constructed in the 19^{th} century (People's Committee of Ho Chi Minh City 2002) and was improved during the American war in the 1970s (Vo 2000a). However, this sewerage system has been designed for a small population size of about 1.5 million inhabitants. Consequently, current population growth has burdened the facility and caused severe floods in existing urban districts during the monsoon season (People's Committee of Ho Chi Minh City 2002). Vo (2000a), indicating that most urban drainage systems in Vietnam's major cities are combined systems of stormwater and wastewater. This causes floods and inundation after heavy storm events with rainfall exceeding 30 mm. During the last three decades, HCMC's urban drainage system has continued to expand as a result of rapid social and economic development. Unfortunately, the expansion of its urban drainage system was poorly planned and uncontrolled due to the rapid expansion of urbanised areas. It can be argued that the inadequate planning and incompatible drainage system construction is one of the root causes for urban inundation and environmental hygiene issues.

The existing urban drainage system includes the underground inlet sluice system and the open canal drainage system. The under ground system functions as a combined system that conveys rainwater and domestic wastewater into the canal system. HCMC's drainage system is heavily influenced by the daily tidal regime, leading to highly concentrated wastewater at discharge sluices (People's Committee of Ho Chi Minh City 2002). The underground drainage system is about 800,000 km in length with 415 discharging gates spreading over urban districts.

The canal drainage system is constituted by seven waterways and basins as follows (People's Committee of Ho Chi Minh City 2000a, 2002):

- **Tan Hoa – Lo Gom canal:** This canal system covers an area of 3,110 ha, the main waterway is 7,240 m in length. The tributaries are 4,920 m long. The upstream waterway is 3–5m wide. The down stream mouth of the waterway is 73 m in width and 2–3 m in depth.

- **Tau Hu-Ben Nghe canal:** This system receives wastewater from Tan Hoa-Lo Gom and wastewater from districts: 1, 4, 5, 6, and 8. The total length of the main canal is

12,200m, and total tributaries are 3,950m long. The width of the canal is 50–100m and the average depth is 3–5m.

- **Kenh Doi-Kenh Te:** The main canal is 13,200 m in length and all tributaries are 7,300 m long. The average width is 100m, and the average depth is 5-10m.

NOTE: This figure is included on page 72 of the print copy of the thesis held in the University of Adelaide Library.

Figure 4.3 Waterway Systems in Ho Chi Minh City

Source: Department of Science Technology & Environment (DOSTE) (2001)

- **Nhieu Loc-Thi Nghe canal:** The area of the valley is approximately 3,000 ha. This canal drains water from districts: 1, 3, 10 and Tan Binh, Go Vap, Phu Nhuan and Binh Thanh districts. The main canal is 9,470m in length. The total length of tributaries is 8,716m. The upstream head of the canal is 3–5m wide but the downstream mouth is 60–80m wide and 4–5m deep.

- **Tham Luong canal – Ben Cat – Vam Thuat waterway:** The area of the valley is quite large, up to 9,000 ha. The main waterway is 14,080 m long. The tributaries are 5,360 m long, 16-100m wide and 2-5.5m deep. This system drains water from Tan Binh, Go Vap, and Binh Thanh districts.

- **Can Giuoc – Muong Chuoi waterway:** This is a waterway system belonging to Nha Be and Binh Chanh districts. It receives wastewater from Tan Hoa – Lo Gom, Tau Hu – Ben Nghe canals and Kenh Doi – Kenh Te, and then drains water into the Nha Be river and discharges into the East Sea. The average width is approximately 100m. The average depth is 6 – 10m.

- **Sai Gon-Nha Be-Nga Bay river:** This is a large river system receiving all domestic wastewater from urban and suburban areas and discharging into the sea through two main waterways: Soai Rap estuary into Dong Tranh bay and Nga Bay river into Ganh Rai bay. This river system comprises 15 direct discharge gates.

NOTE: This figure is included on page 74 of the print copy of the thesis held in the University of Adelaide Library.

Figure 4.4 Main canal systems in the inner city

Source: Nguyen Phuoc Dan et al.(2007)

4.2.2.3 Groundwater Depletion

Groundwater is one of three main sources of water supply for social development in HCMC. This aquifer source will continue to play a crucial role in the city's water supply in the future (Water and Sanitary Engineering Company 2 -WASE 2001). However, the alarming diminution of groundwater is becoming apparent to water managers. The results of a five year monitoring project between 2001 and June 2006 indicate that the annual average drawdown of the water table in HCMC is 2–3 m (Ministry of Natural Resources & Environment-MONRE 2006a). Table 4.4 shows the annual drawdown of the water table in high bores density.

Table 4.4 Drawdown of water table at monitoring stations in high well density areas

NOTE: This table is included on page 75 of the print copy of the thesis held in the University of Adelaide Library.

Source: Nguyen Phuoc Dan et al.(2007)

A report (Vietnam Environment Monitor 2003) by the World Bank and its partner agencies also stated that the decline of the groundwater table in HCMC is accelerating because of the overdraft of extraction volume (World Bank et al. 2003). Thus, this city is facing the risk of depletion and environmental damage, including salt intrusion, aquifer pollution and land subsidence (Ministry of Natural Resources & Environment-MONRE 2006a). In addition, the Union of Hydrology and Geology No. 8 states that the current total abstraction volume-520,000 m^3/day-has exceeded the limiting volume (People's Committee of Ho Chi Minh City 2002). Figure 4.5 shows that the extraction volume of groundwater has increased in HCMC.

The total recharge volume is only one-third of the extraction rate due to accelerated growth of impermeable urban surfaces and hydrological changes associated with rapid urbanisation (Ministry of Natural Resources & Environment-MONRE 2006a). The over-abstraction from aquifer sources has resulted in further lowering of the water table in suburban districts. The water table in Thu Duc and Go Vap, outlying Districts, has dropped 4–5 m during the last five years (Nguyen Phuoc Dan et al. 2006). The root causes of this incidence are complex, and include inadequate water supply services and poor infrastructure (Water and Sanitary Engineering Company 2 -WASE 2001).

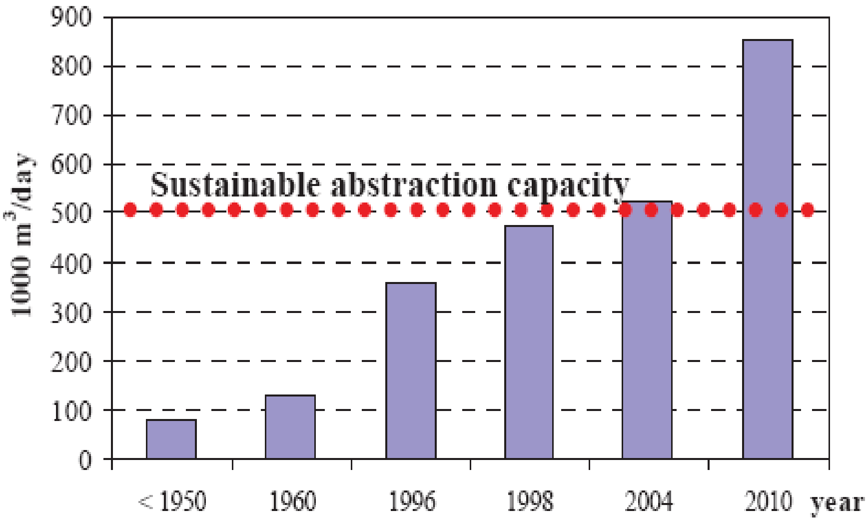


Figure 4.5 Groundwater Exploitation with Time

Source: Nguyen Phuoc Dan et al.(2006)

A recent statistic of the Department of Natural Resources and Environment (DONRE) in HCMC claims that the urban water supply service can only satisfy 77% of urban residents with 50-100 litres/person/day and 21% of suburban dwellers with 20-40 litres/person/day (People's Committee of Ho Chi Minh City 2002). This insufficient supply has resulted in an enormous number of private wells being bored in urban districts to satisfy many domestic uses (Ministry of Natural Resources & Environment-MONRE 2006b).

4.2.2.4 Pollution of Water Resource

HCMC occupies 2,095 km^2, and is characterised by a dense waterway network. While it is an economic hub of the southern region, it is ironically a hotspot of environmental issues, water pollution and unsustainable urban habitats among them (Bolay et al. 1997; O'Rourke 2004). HCMC is the home of about 30,000 small and medium-scale enterprises and more than 800 large-scale factories from EPZs and IPs (People's Committee of Ho Chi Minh City 2002). However, most of them are not equipped with any wastewater treatment facilities (Hiep Nguyen Duc and Truong Phuoc Truong 2003; O'Rourke 2004). This huge number of industries has generated 260 tons of solid waste daily including 25 tons/day of hazardous waste (People's Committee of Ho Chi Minh City 2002). In addition, it is estimated that industrial wastewater effluent in HCMC accounts for 20-30% of the total flows in Vietnam's river systems. The major industrial contributions to water pollution are oil refining, chemical and food processing industries (ADB 2000), and have caused serious water pollution (O'Rourke 2004; Tenenbaum 1996). The growing exhaustion of water resources and pollution has been observed in both groundwater and surface water sources in rivers and canal systems.

4.2.2.4.1 Pollution of Groundwater Sources

Groundwater not only suffers from the over-withdrawal but its quality is also being worsened from both point and non-point sources. Tran Van Xuan (2001) stressed that the management and protection of aquifers is a pressing task for HCMC. He also claimed that the quality of groundwater is threatened by major contaminant sources, including industrial wastewater impoundment, septic tank systems and landfill leachate. More importantly, shallow wells near to the Dong Thanh open dumpsite (Hoc Mon- a northern district of HCMC) were heavily contaminated by organic matter and nitrogen from leachate from this unsanitary landfill (Dan et al. 2006). In addition, the presence of several contaminants was identified in shallow aquifers (Huynh Ngoc Sang and Vo Thi Kim Loan 2001)

Huynh Ngoc Sang and Vo Thi Kim Loan undertook a study in the northern part of HCMC which comprises Hoc Mon, Go Vap District and District 12. This area is occupied by many factories, stock farms, agricultural activities and landfills. This study found that water at a depth from -5 to -10 m is unusable for domestic purposes because of bad odour, with the concentration of bacteria, nitrate (NO_3^-), nitrite (NO_2^-) and ammonia (NH_4^+) exceeding Vietnamese standard levels (TCVN 5944-1995- Code of Groundwater Quality Standard). At depths between -30 and -40 m, it was contaminated by organic and inorganic substances such as nitrate, nitrite phosphate (PO_4^{3-}) and iron (Fe). Salt intrusion was also recorded in groundwater samples along the Sai Gon River, the Vam Thuat River and the Ben Cat canal (Huynh Ngoc Sang and Vo Thi Kim Loan 2001).

The HCMC Environment State Report (2005) indicated that the water quality of shallow aquifers of all monitoring wells was polluted with organic matter, microorganisms and iron. Salt intrusion and the fall in the water table are observed in some areas. In 2002, 2,359 wells were not used due to salt intrusion (Nguyen Phuoc Dan et al. 2007). Figure 4.6 shows salinity intrusion of groundwater sources in 2000 and 2004.

NOTE: This figure is included on page 78 of the print copy of the thesis held in the University of Adelaide Library.

Figure 4.6 Maps of Salinity Intrusion in Aquifers in HCMC, 2000 and 2004

A: Lower Pliocene aquifer B: Pleistocene aquifer

Source: Nguyen Van Nga (2006)

The Environmental State Report also concluded that with the rapid expansion of urban areas, industrial zones associated with the over-abstraction are the causes of groundwater depletion and quality degradation (Department of Natural Resources & Environment - DONRE 2005, p. 35).

4.2.2.4.2 Pollution of Rivers

Pollution of water resources is also increasing in many rivers in and around HCMC by untreated wastewater from municipal and industrial activities (Hiep Nguyen Duc and Truong Phuoc Truong 2003; Tenenbaum 1996). The deterioration of water quality in the Dong Nai–Sai Gon river system is at an alarming level. It was estimated that about 200,000m^3 of industrial wastewater and 17,000m^3 of hospital effluent was discharged into the Dong Nai-Sai Gon river daily (Asia Times 2000; Ho Chi Minh City Environmental Protection Agency-HEPA 2006a). This wastewater comes only from industrial activities located along this river system. However, the Environmental Management Division of DONRE identified that only 40% of this wastewater is treated (Ho Chi Minh City Environmental Protection Agency-HEPA 2006a). The statistic for pollution was aggravated starkly as over 50 tonnes of dead fish were found in the upstream reach of the Dong Nai River in April 2000 (Hiep Nguyen Duc and Truong Phuoc Truong 2003).

The Dong Nai-Sai Gon river system not only supplies HCMC with water, but is also a conveyor of wastewater (Hiep Nguyen Duc and Truong Phuoc Truong 2003). An increase in pollution resulted in a recent urgent response of the HCMC government to protect the water quality of the Sai Gon from pollution (Ministry of Natural Resources & Environment -MONRE 2006f). The 2004 monitoring results showed that the deterioration of water quality of the Dong Nai-Sai Gon River has been exacerbated by organic oil, grease and bacteria (Department of Natural Resources & Environment-DONRE 2005).

4.2.2.4.3 Pollution of Canal Systems

Many urban canals and creeks have been heavily polluted and increasingly served as sinks for untreated domestic sewage and industrial wastewater (Hansen and Do Hong Phan 2005; Hiep Nguyen Duc and Truong Phuoc Truong 2003; Ministry of Natural Resources & Environment-MONRE 2006c). The first four of seven canal systems in HCMC are high density population and industrial polluting areas. Unfortunately, industrial wastewater is directly released into watercourses and canal systems without treatment or with inadequate treatment (Hiep Nguyen Duc and Truong Phuoc Truong 2003; O'Rourke 2004). The Tan Hoa-Lo Gom, Nhieu Loc-Thi Nghe, Tau Hu-Ben Nghe and Kenh Doi-Kenh Te canals receive daily about 700,000m^3 of municipal and industrial effluent with high levels of biological oxygen demand (BOD), chemical oxygen demand (COD) and heavy metals

(O'Rourke 2004; People's Committee of Ho Chi Minh City 2002), well above Vietnamese standard levels (Hiep Nguyen Duc and Truong Phuoc Truong 2003).

A study of the Urban Upgrading Project indicated that the Nhieu Loc-Thi Nghe and Tan Hoa-Lo Gom canal systems are the two most polluted watercourses in HCMC. This poses health threats to the inhabitants settled along this canal system (World Bank et al. 2003). The Department of Natural Resources and Environment (DoNRE) noted that all HCMC's rivers and canals are heavily polluted by organic waste and coliform, particularly in the dry season. The situation is likely to accelerate because of rapid industrial growth and inadequate control mechanisms (Department of Natural Resources & Environment - DONRE 2005). Nevertheless, the state of the canal systems is aggravated during the wet season as the canals receive additional contaminated flows from urban and agricultural runoff. Not surprisingly, high concentrations of PCBs, DDT and heavy metals were found in canal sediments in HCMC (Phuong et al. 1998; Tenenbaum 1996).

4.3 Water Use and Demand

HCMC is situated in a well-watered region with abundant swamps and marshes. It has been maintained by abundant surface and subsurface water. Three major water sources are used to supply HCMC: surface water (from the Dong Nai-Sai Gon river system); groundwater; and rainwater (Nguyen Phuoc Dan et al. 2007; People's Committee of Ho Chi Minh City 2002; Water and Sanitary Engineering Company 2 -WASE 2001).

Total water demand for domestic and industrial purposes in 2006 was 1.75 million m^3, and is estimated to reach 3.6 million m^3 in 2020 (Nguyen Van Nga 2006). The major water sectors are industries, households and services. Water consumption for agriculture is taken from surface sources of the Dong Nai - Sai Gon river system and rainwater (Nguyen Phuoc Dan et al. 2007). Groundwater sources have not been used for the HCMC's agricultural practices because of (i) availability of water from irrigation canals and (ii) inadequate quality of groundwater due to high iron content and low pH (Nguyen Phuoc Dan et al. 2007).

The Sai Gon Water Supply Company (SAWACO), a state enterprise, takes responsibility for exploitation, purification and distribution of water in HCMC. The 2006 capacity of the piped water was 1,236,000 m^3/day, and will be upgraded to 2,000,000 m^3/day in 2010 to meet the growing urban population and water demand (Saigon Water Supply Company-SAWACO 2007).

4.3.1 Surface Water Sources

The Dong Nai and the Sai Gon rivers are important basins providing massive water supplies for HCMC and its neighbouring provinces. The Dong Nai River is 628 km in length. It originates in the central highlands of Vietnam (Lam Dong province) and enters the East Sea through Soai Rap estuary. It covers a total catchment area of more than 40 000 km^2 (Hiep Nguyen Duc and Truong Phuoc Truong 2003; Water and Sanitary Engineering Company 2 (WASE) 2001). The Sai Gon River rises in Tay Ninh and Binh Duong provinces, and merges into the Dong Nai river at a confluence 40 km from the East Sea. The Sai Gon river is 280 km in length and its total area is nearly 5,000 km^2 (Water and Sanitary Engineering Company 2 (WASE) 2001).

The Sai Gon-Dong Nai river system is the largest river basin originating in Vietnam's territory. Before reaching the sea, the Dong Nai-Sai Gon river flows through the Can Gio coastal mangrove forested delta area. This mangrove area comprises many inter-connecting river lets and functions as the 'green lung' of HCMC. Since 2000, the Can Gio mangrove forest was designated as a Man and Biosphere Mangrove Reserve area by UNESCO (Hiep Nguyen Duc and Truong Phuoc Truong 2003). Figure 4.7 illustrates the Sai Gon-Dong Nai river system and its water projects.

The largest component of HCMC's water supply sources comes from upstream sources of the Sai Gon-Dong Nai River. The proportion of supply from this river system has increased significantly since 2003. The ratio of river and groundwater source in HCMC's water supply before 2003 is Dong Nai river: Sai Gon river: Groundwater ≈ 700,000 (m^3/day): 10,000 (m^3/day): 520,000 (m^3/day) = 57% : 1% : 42%. It is estimated that the ratio of river supply will be increased after 2003 as soon as the Sai Gon Water Works starts operation, that is Dong Nai river: Sai Gon river: Groundwater ≈ 800,000 (m^3/day): 310,000 (m^3/day) : 520,000 (m^3/day) = 49% : 19%: 32% (People's Committee of Ho Chi Minh City 2002). Figure 4.8 shows the ratio of water resources use in HCMC.

NOTE: This figure is included on page 82 of the print copy of the thesis held in the University of Adelaide Library.

Figure 4.7 The Dong Nai- Sai Gon River System

Source: Lam Minh Triet et al. (2003)

NOTE: This figure is included on page 83 of the print copy of the thesis held in the University of Adelaide Library.

Figure 4.8 Proportion of Water Supply Sources in Ho Chi Minh City

Source: People's Committee of Ho Chi Minh City (2002)

4.3.2 Groundwater Sources

Apart from surface supplies, aquifer sources have been increasingly exploited for domestic and industrial uses, accounting for 30–40% of water demand in HCMC. Aquifers in Ho Chi Minh City are categorized into five layers, namely: Holocene, Pleistocene, Upper-Pliocene, Lower-Pliocene and Mezozoic. Of the five aquifers in Ho Chi Minh City, three major aquifer layers are important sources for water supply, including Pleistocene (20–50m), Upper Pliocene (50–100) and Lower Pliocene (100–140m) (Nguyen Phuoc Dan et al. 2006).

As urbanisation and industrialisation grew, the exploitation rate of groundwater accelerated. There were more than 95,828 wells in 1999 and about 150,000 bores in 2003, equivalent to 530,000 m^3/day, of which 100,000 m3/day is withdrawn for domestic use (Ngo Duc Chan 2004; Nguyen Phuoc Dan et al. 2006; Nguyen Van Nga 2004). However, the aquifer source has been haphazardly exploited at an alarming level - evidenced by the abstraction volume, 520,000 m^3/day, which surpassed the sustainable limits (People's Committee of Ho Chi Minh City 2002). The over-pumping of groundwater has jeopardised the available quantity of aquifer sources. The groundwater decline is evidenced by salt intrusion being observed in monitoring wells (Department of Natural Resources & Environment -DONRE 2005; People's Committee of Ho Chi Minh City 2002).

- ***Holocene aquifer*:** There were over 60 wells (drawing about 120 m^3/day) located mostly in the Can Gio district (coastal suburban district). This aquifer is a small water reserve and has only been exploited for household uses (Nguyen Phuoc Dan et al. 2006).

- ***Pleistocene aquifer*** (20–50 m deep): There were over 120,000 wells (drawing over 277,000m^3/day), which included about 20,000 wells in the Upper Pliocene aquifer and five wells in the Lower Pliocene aquifer. The groundwater is fresh, with low pH and higher iron and ammonia (Nguyen Phuoc Dan et al. 2006).

- ***Pliocene aquifer*** (40–80 m deep for the Upper Pliocene and 50–100 m for the Lower Pliocene): Many large industrial wells are located in this aquifer with a capacity of over 245,000 m^3/day (Nguyen Phuoc Dan et al. 2006).

Most of the wells in Ho Chi Minh City are in the Pleistocene and Pliocene aquifers (99.9% total number of surveyed wells). These wells are mainly located in the inner districts and some suburban districts (Nguyen Phuoc Dan et al. 2006).

4.3.3 Rainwater

Currently, rainwater is harvested by residents in coastal districts: Can Gio, Nha Ba and District 7 (see Table 4.5). It can be argued that rainwater is abundant and an alternative source for HCMC as the rainy season accounts for 80-85% of the annual rainfall. However, it is not easy to harvest and store in the context of HCMC in terms of cost and area (Nguyen Phuoc Dan et al. 2007). The utilisation of rainwater is only small in most of the households in Can Gio district because there are no freshwater sources or a distribution network. During the dry period, the district is provided with clean water by vessels of 5,000 m^3/month. A piped water network is planned by SAWACO in coming years (Nguyen Phuoc Dan et al. 2007).

Table 4.5 Water Supply Source for Domestic Purposes in some Districts in HCMC

NOTE: This table is included on page 85 of the print copy of the thesis held in the University of Adelaide Library.

(*) Surface supplies include river and canal water

Source: Institute for Tropical Technology and Environmental Protection (2001).

4.3.4 Water Demand and Use

The water supply coverage in HCMC has increased from 52% in 1997 (McIntosh and Yñiguez 1997) to 84% in 2004 (Andrews and Yñiguez 2004). However, the proportion of unaccounted flow is relatively high in comparison with other Asian cities (Andrews and Yñiguez 2004). The total capacity of supplied water for all purposes in 2005 was 1.2 million m^3/day (Nguyen Phuoc Dan et al. 2005) and increased to 1.75 million m^3/day in 2006 (Nguyen Van Nga 2006). However, only 76% of urban dwellers are provided with clean water by Sai Gon Water Supply Company (SAWACO) and 10.5% of suburban residents have access to clean water from the UNICEF programme. It is said that this is only statistical data. The real figure remains unmeasured because a large number of citizens in outlying Districts still lack access to clean and safe drinking water (Ministry of Natural Resources & Environment -MONRE 2006d).

It is estimated that total water demand for municipal and industrial purposes will be 2.4 million m^3/day in 2010 (Water and Sanitary Engineering Company 2 -WASE 2001) and

3.6 million m^3/day in 2020 (Nguyen Van Nga 2006). According to the projected population growth, municipal water consumption will be 1.1 million and 1.6 million cubic metres in 2010 and 2020 respectively (Nguyen Phuoc Dan et al. 2006). This growing demand will lead to more extraction of water from the Sai Gon- Dong Nai river system. In the meantime, the City's government at all levels will face major challenges and management constraints on conserving aquifers at sustainable levels and protecting the main river system from pollution and degradation.

4.3.5 Water Loss

In terms of water supply, water loss usually refers to unaccounted for water (UfW) or non-revenue water (NRW). The statistic for water loss in HCMC is not consistent in documented reports. Whilst it varies from 35% to 40% between 1999 and 2006 (McIntosh 2003; Nguyen Phuoc Dan et al. 2007; Pham Sy Liem 2001), Andrews et al. (2004) observed that unaccounted for water was 38% in HCMC. If average water loss is 36%, then 440,000m^3 was lost daily. This volume is equivalent to the first stage capacity of the Thu Duc Water Supply Plant (Quang Khai 2007). However, it is reported that the proportion of water loss was 33% in 2005 and is to be reduced to 26% in 2010 (Saigon Water Company-SAWACO 2005). The Water Supply Company also noted that poor infrastructure and incompatible network pipelines are one of the reasons for water loss.

4.4 The Management Practices of Water Resources in Ho Chi Minh City

4.4.1 National Institutional and Legal Frameworks

HCMC has the same administrative structure as other Vietnamese provinces: Thanh Pho (City), the Huyen/Quan (district), the Xa (Commune) and the Phuong (Ward). Therefore, its legislation, institutions and regulations on water resources comply with national institutional frameworks.

4.4.1.1 Water resources institutions and policy pre-1998

Following the adoption of the Doi Moi policy, the government of Vietnam reorganised and reformed the national institutional frameworks on water resources management in the early

1990s. An overarching Law on Environment Protection (LEP) introduced in 1993 and was revised in 2005, which protects the status of key natural resources including water (see Appendix 2). Additionally, there are a set of standards on air and water quality, decrees on environmental fines and enforcement, and on the implementation of environmental impact assessment, as well as directives on environmental protection (Cheesman and Bennett 2005; O'Rourke 2004).

Accordingly, a National Environment Agency (NEA) and water-related management agencies were established. NEA is a sub-body within the Ministry of Science, Technology and Environment (MOSTE). Each province and central city has a corresponding Department of Science, Technology and Environment (DOSTE) which closely works with NEA. In 1995, three ministries responsible for natural resources management (Agriculture and Food Industry, Water Resources and Forestry) were amalgamated into one department - the Ministry of Agriculture and Rural Development (MARD) (Bennett and Nguyen 1996). Similarly, the Department of Agriculture and Rural Development (DARD) was established in each province and city. The state management of water resources remains DARD's major responsibility. Table 4.6 describes the functions and responsibilities of water resources management across government agencies.

Table 4.6 Functions and Responsibilities of Government Agencies on Water Resources Management

NOTE: This table is included on page 88 of the print copy of the thesis held in the University of Adelaide Library.

Source: Bennett (1996)

4.4.1.2 Water resources legislation, institutions and policy post-1998

For the management of water resources, the most important institutional framework is the Law on Water Resources (LWR - full wording of the Law is attached in Appendix 2), which was enacted in May 1998, and became effective in 1999 (ADB 2000; Hansen and Do Hong Phan 2005). The LWR addressed the key legal aspects of water resources management, including a concept of river basin organisation, water rights and an integrated approach involving all stakeholders at a national level. Most importantly, it confirms that the ownership of water resources is vested in the Vietnamese people, which is addressed in the first article "water resources come under the ownership of the entire people and under the unified management of the State" (Bennie Black & Veatch 2004; Hansen and Do Hong Phan 2005; Truong Thi Quynh Trang 2005).

Following the advent of the LWR, the National Water Resources Council (NWRC) and the three largest river basin organisations (the Red-Thai Binh River; the Dong Nai-Sai Gon River and the Cuu Long River) were formed in 2000 and 2001 respectively. These river basin organisations are managed by MARD.

The LWR was expected to establish effective institutions and instruments for the comprehensive management practices of water resources, including (ADB 2000; Hansen and Do Hong Phan 2005):

- National Water Resources Council (NWRC), a high-level advisory body, which comprises high level decision-makers and officers with many duties and responsibilities. An initial key task of this Council is to commission and supervise a National Water Resource Strategy and Action Plan. It also plays an important role in conflict resolution;
- River Basin Organisations (RBO) for water resources planning on the basis of major river basins such as the Red-Thai Binh River Basin in the North, the Dong Nai-Sai Gon river basin in the South;
- A system of water allocation through licenses and water rights;
- A system of wastewater discharge permits for key water users; and
- An inspection system for the safety of dams and other hydraulic works.

The key objective of the LWR is to provide for the management, protection, exploitation and use of water resources and to protect, combat and overcome the harmful effects of water. Specifically, water conservation and management through economic and rational use is defined in Articles 14-16 and specific obligations for different sectors are stated in Articles 25-31. Under the LWR, water resources are defined as surface water, rainwater, underground water and seawater within the territory of Vietnam. Specific exclusions from the scope of the LWR are: (i) sea water and underground water within Vietnam's exclusive economic zone and the continental shelf which are to be provided for in "other documents", and (ii) mineral water and thermal water which are to be provided for in the Law on Minerals (Bennie Black & Veatch 2004).

Article 58 of the LWR describes the responsibility of government for managing water resources. This Article also states that the Ministry of Agricultural and Rural Development

(MARD) is responsible for managing water resources (Hansen and Do Hong Phan 2005). After 2002, this function was taken over by the new Ministry of Natural Resources and Environment (MONRE) in accordance with Government Decree 91/2002/ND-CP. Within MONRE, the Agency of Water Resource Management (AWRM) has been formed to carry out this duty. Following this, several other water-related departments were established (see Appendix 4). However, the function of irrigation and rural water supply still remains with MARD (Hansen and Do Hong Phan 2005; World Bank et al. 2003). In accordance with the new Ministry, provincial and municipal Departments of Natural Resources and Environment were set up in 2002.

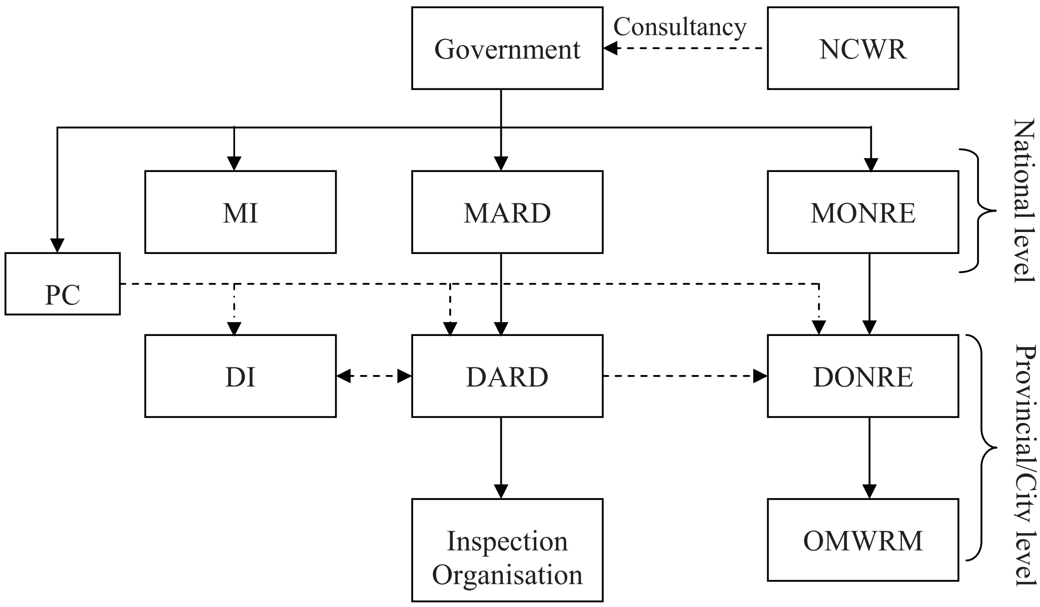
To achieve successful implementation of the LWR, a number of subordinate decrees, regulations, ordinances and directives were established, most importantly Decree 179/1999/ND-CP in 1999. This laid an important change in the management of water resources from the mechanisms of water supply to integrated water resources management at the national level (Cheesman and Bennett 2005). It provides more detailed provisions on: (i) the management, protection, exploitation and use of water resources, the discharge of wastewater into water sources; (ii) the granting of permits related to water resources, and (iii) the prevention of, and protection from harmful effects caused by water. Tables 4.7 and 4.8 summarise key legislation in Vietnam and Ho Chi Minh City.

4.4.2 Structure of the Management of Water Resources in HCMC

Within the Department of Natural Resources and Environment (DONRE), Environmental Management Division (EMD) is principally responsible for managing the environment and natural resources, in which water is an integral part. DORNE is a new organisation established to take over the responsibility for water resources management from the Department of Agricultural and Rural Development (DARD). However, the responsibility for water resource management in HCMC is undertaken by many government departments. The traditional responsibilities were well established between sectors and government agencies. HCMC's DONRE takes responsibility for inspection of certification/license of trade, well boring and groundwater exploitation. The Department of Industry is responsible for management of groundwater use for industries. DARD is the main manager for management of water use for agricultural and rural development in the City's rural areas

(Nguyen Phuoc Dan et al. 2006). The Office of Mineral and Water Resources Management, which is a subordinate division of DONRE, was designated to manage all groundwater resources in HCMC. This Office is responsible for coordinating with the Department of Transportation and Public Works (DTPW) and SAWACO to undertake project appraisal regarding groundwater survey and exploitation before submission to the HCMC People's Committee for approval (Nguyen Phuoc Dan et al. 2006). The organisational structure of water resources management is described in Figure 4.9 and the responsibilities between departments are depicted in Table 4.9.

Recently, a new subordinate division was formed within DONRE, the Environment Protection Agency (HEPA). HEPA is responsible for monitoring environmental quality (air and water), collecting the wastewater discharge levy, and raising public awareness about environmental topics. The functions and duties of HEPA are likely to overlap with EMD's responsibilities when both of them conduct inspection of environmental compliance in industrial enterprises.



Notes:

PC: People's Committee (Provincial or City level)

MI: Ministry of Industry

DI: Department of Industry

MARD: Ministry of Agricultural & Rural Development

MONRE: Ministry of Natural Resources & Environment

DARD: Department of Agricultural & Rural Development

DONRE: Department of Natural Resources & Environment

NCWR: National Council for Water Resources

OMWRM: Office of Mineral & Water Resources Management

Figure 4.9 The Organisational Structure of Water Resource Management in HCMC

Source: Nguyen Phuoc Dan et al.(2006)

Table 4.7 Key Legislation on Water Resources in Vietnam

Date Issued	Name of Legal Documents
27 Dec 1993	National Law on Environment Protection
14 July 1993	Law of Land (amended 2001)
21 Dec 1994	Decision 773/TTg - To exploit and using uncultivated land, riverside warp land, coastal zone and surface water in delta areas
29 April 1994	Directive 200/TTg of Prime Minister on guarantee clean water and environmental sanitation
30 July 1996	Directive 487/TTg of Prime Minister on Enhancement of State Management on Water Resources
20 May 1998	The Laws on Water Resources (LWR)
13 Mar 1997	Decision 63/1998/QD-TTg of Prime Minister on National Orientation on water supply development in urban areas by 2020
1999	Decree 179/1999/ND-CP on implementing the LWR
30 Dec 1999	Decree 171/1999/ND-CP – Regulation on implementation of the laws on water resources
15 June 2000	Decision 67/2000/QD-TTg on establishment of national Water Resource Council (NWRC)
25 Aug 2000	Decision 104/2000/QD-TTg on National Strategy on Clean Water and Environmental Sanitation in rural areas
31 Aug 2000	Circular 329/2000/TT-BGTVT – guidelines on implementation of acts of decree 179/1999/ND-CP
28 Jun 2001	Decision 99/2001/QD-TTg on issuing Regulation on organization and operation of National Water Resource Council
11 Nov 2002	Decree 91/2002 on the Mandate, Organisation and Functions of MONRE
2 April 2003	Decision 45/QD-TTg on establishment of provincial Department of Natural Resources and Environment
13 June 2003	Decree 67/2003 on Fees for wastewater
26 Nov 1998	Guidelines on implementation of Direction 68/1998/ND-CP

Source: Compiled by the author from World Bank et al. (2003); Nguyen Phuoc Dan et al. (2005).

Table 4.8 Legal Frameworks of Water Resource Management in HCMC

	Regulations	Status
1	Guidelines on strengthening management of groundwater exploitation and trade of well drilling	Under consideration by HCM PC
2	Regulations on water resources management in Ho Chi Minh City	Issued as Decision No.17/2006
3	Regulations on limitation or prohibition of groundwater exploitation in Ho Chi Minh City	Being compiled by DORNE
4	Draft guidelines on collection of resources tax in Ho Chi Minh City based on the Ordinance of Resources Taxes of Ministry of Finance	Under consideration by HCM PC
5	Draft regulation on charges of groundwater exploitation fee in Ho Chi Minh City	Under compilation by DORNE
6	Decision on Stipulation for Water Resource Management in Ho Chi Minh City (Decision 17/2006/QD-UBND, see Appendix 2)	Issued by HCMC PC

Source: Compiled by the author from Nguyen Phuoc Dan et al. (2006); People's Committee of Ho Chi Minh City (2006d).

Table 4.9 Roles and Responsibilities of HCMC Government Departments

Organization	Responsibility
Department of Natural Resources and Environment (DONRE)	**DONRE** is responsible to the HCMC People's Committee for: (i) Compliance inspection of certificate, permit or license holders of all water development projects in HCMC (ii) Water resources investigation, assessment in accordance with MONRE guideline (iii) Project monitoring and appraisal for water exploitation facilities
Environmental Management Division (EMD)	**EMD** is responsible to the director of DONRE for: (i) Certificate inspection of environmental standard compliance of industries (ii) Pollution control and environmental disaster response
Office of Mineral and Water Resources Management (OMWRM)	**OMWRM** is responsible to the director of DONRE for: (i) Licensing and revoking permits for exploitation and harness of water resource projects (ii) Licensing and withdrawing permits for discharging wastewater into classified receiving bodies (iii) Proving guidelines and regulations on compliance of water resource projects (iv) Managing and administrating water resources monitoring networks
HCMC Environmental Protection Agency (HEPA)	**HEPA** is responsible to the director of DONRE for: (i) Monitoring, inspecting, preventing and improving environmental quality (air and water) (ii) Collecting wastewater levy from industries (iii) Raising public awareness in the management and protection of the environment and natural resources.
Department of Agricultural and Rural Development (DARD)	**DARD** is responsible for provision and management of water resources in rural areas
Department of Industry (DI)	**DI** takes responsibility for the management of groundwater resource use for industrial activities

Source: Compiled by the author from Nguyen Phuoc Dan et al. (2006); Department of Natural Resources & Environment (DONRE) (2006); Ho Chi Minh City Environmental Protection Agency-HEPA (2007)

4.4.3 Response Policy to Key Water Issues in HCMC

It is clear that HCMC faces three major water resource issues. Firstly, the rate of groundwater extraction is not sustainable. The deterioration of water quality in shallow aquifers is evident in organic-related contaminants, coliform levels and salt intrusion. Secondly, water quality of the main water supply river system, the Dong Nai-Sai Gon River, receiving water at all urban canal systems, has been degraded by organic and inorganic matter from agricultural runoff, municipal and industrial wastewater. Thirdly, the city's inner districts are inundated in the monsoon season during high tidal surges. However, the environmental strategy for HCMC up to 2010 only identified and prioritised the protection of surface water quality and conservation of groundwater. Table 4.10 shows the key water issues facing HCMC's administration.

In an attempt to deal with the increasing deterioration of water quality, the government implemented the environmental improvement project of Nhieu Loc-Thi Nghe canal in 1995. It was the first effort made by the City's government to improve the quality of the environment, to improve public health, to relocate urban habitats and to strengthen the ability of the local government to manage wastewater services (Nguyen To Lang 2006; Wust et al. 2002). Furthermore, during the 1990s HCMC set up 11 monitoring groundwater wells and 10 monitoring stations for surface water resources. Since 2001, 10 water monitoring stations have been installed at urban canal systems, including Nhieu Loc-Thi Nghe, Ben Nghe-Tau Hu, Kenh Doi-Kenh Te, Tan Hoa-Lo Gom, Tham Luong-Ben Cat. The number of stations for water resources monitoring is proposed to increase in 2007 (Department of Natural Resources & Environment-DONRE 2005; Division of Environmental Quality Monitoring and Assessment 2006). The network of water quality monitoring systems in HCMC is presented in Figures 4.10, 4.11 and 4.12.

Table 4.10 Summary of key issues on water resource management in HCMC

NOTE: This table is included on page 97 of the print copy of the thesis held in the University of Adelaide Library.

Source: People's Committee of Ho Chi Minh City (2002).

NOTE: This figure is included on page 97 of the print copy of the thesis held in the University of Adelaide Library.

Figure 4.10 Network of Groundwater Monitoring System

Source: Division of Environmental Quality Monitoring and Assessment (2006)

NOTE: This figure is included on page 98 of the print copy of the thesis held in the University of Adelaide Library.

Figure 4.11 Network of Surface Water Monitoring System

(Lower Reach of the Dong Nai - Sai Gon River)

NOTE: This figure is included on page 98 of the print copy of the thesis held in the University of Adelaide Library.

Figure 4.12 Network of Urban Canal Water Quality Monitoring System

Source: Division of Environmental Quality Monitoring and Assessment (2006)

4.5 The Underlying Causes of Water Issues in Ho Chi Minh City

4.5.1 Institutional Capacity

Biswas (2006) emphasised that rapid urban expansion in the developing world has exceeded governments' ability to manage water resources in terms of efficiency, equity and sustainability. He further stated that the future major challenge in developing nations is the shrinkage of water resources, arising from increased water quality deterioration due to improper planning, inadequate management practices and the lack of political involvement. Drakakis-Smith (1996) noted that urban managers in developing countries often neglect their responsibilities to the environment. In HCMC, the causes of the city's water resource problems are rooted in inadequate institutional frameworks and arrangements and insufficient implementation of laws and regulations.

The root causes of any environmental concerns should be analysed in accordance with the existing social development and management practices of local governments at all levels. Firstly, over-abstraction of groundwater has two major causes. The insufficient water supply network has resulted in an increasing number of wells dug in urban districts. The local government at all levels failed to control wells which have been bored haphazardly. There are more than 200,000 tube wells throughout the City supplying domestic and industrial activities (Union for Geology and Hydrology in the South 2001). Districts with highest density wells are Binh Chanh district (about 22,000 wells), Go Vap district (15,000 wells) and Tan Binh district (approximately 50,000 bores). In fact the real number of private wells in HCMC could be triple the reported figure (Ministry of Natural Resources & Environment-MONRE 2006b). These wells have caused a fall in the groundwater table now evident in the outlying districts, Thu Duc and Go Vap (Nguyen Phuoc Dan et al. 2006). In addition, the degradation of water quality and depletion of groundwater can be attributed to rapid urbanisation coupled with the increase in urban cement surfaces. This causes a reduction in recharge and natural replenishment (Huynh Ngoc Sang and Vo Thi Kim Loan 2001). The underlying reason is that the rapid urban expansion has overwhelmed the limited management capacities and existing resources of the City's government.

Secondly, the deterioration of water quality in surface water resources stems from institutional problems. Weak enforcement of law against industries that are flouting laws that protect the environment is one example (Hiep Nguyen Duc and Truong Phuoc Truong 2003; O'Rourke 2004). Water pollution upstream of the Dong Nai-Sai Gon river can be attributed to the lack of coordination between DONRE of HCMC and its counterparts in neighbouring provinces evident in the lack of horizontal cooperation or overlapping responsibility across agencies and government departments in HCMC (Hiep Nguyen Duc and Truong Phuoc Truong 2003). For example, HEPA is responsible for inspections in industries for the wastewater levy, whilst EMD inspects industrial enterprises for their environmental compliance. However, both these government authorities are likely to pose the same compliance requirement in terms of wastewater concentration. This causes confusion to many industries and leads to conflict and avoidance rather than fear or compliance. In addition, poorly trained staff and inconsistent implementation of regulations are additional factors (O'Rourke 2004).

Thirdly, the inundation of the city in the wet season stems not only from topographical conditions but also from the unbridled expansion of many urban areas in the last two decades. The rapid expansion of urban boundaries has led to the level of canals, waterways and receiving waters which act as regulators and retention facilities during the high peak of rainfalls. The number of canals filling up has accelerated throughout the city, particularly in outlying Districts (Ministry of Natural Resources & Environment -MONRE 2006e). In June 2006, the total area of filled canals was 2,157 ha, and the city still has 105 inundated sites (VietnamNet 2006). One scientist stated:

> The incidence of inundation directly involves an ongoing process of urbanisation. If the solutions are separated from issues of urban planning and management, it cannot be solved thoroughly[1] (VietnamNet 2006).

[1] These words were translated from the Vietnamese into English by the author, based on a newspaper article titled "No more inundation in Ho Chi Minh City within next 14 years", issued on 5th August 2006, available at URL http://www.vietnamnet.vn/khoahoc/moitruong/2006/08/598747/.

Most urban planners view urbanisation as ‘cementisation’ of urban area surfaces. It is argued that the replacement of natural drainage canals by concrete drainage pipes should be considered deliberately within the context of urban drainage and hydrology (Ministry of Natural Resources & Environment -MONRE 2006e). Thus, it is hard to disagree with the view that inadequate knowledge on environmental matters is a common characteristic of many developing nations (Pernia 1992). Not surprisingly, this will result in policy failures. Government practices in urban planning lag behind the rapid degree of urban expansion (Ministry of Natural Resources & Environment -MONRE 2006e). Therefore, a number of consequences are inevitable, including changes in urban surface, hydrology and flow patterns and erosion associated with heavy rains.

Additionally, HCMC’s environmental regulatory system is the traditional ‘command-and-control’-based system. Like other cities in Southeast Asia, a state-driven and top-down approach has long been applied to urban environmental challenges (Storey 2005). However, this traditional approach seems to be unsuccessful in dealing with the issues in HCMC. More importantly, the combination of laws and subordinate decrees and regulations itself creates the traditional environmental regulatory system, i.e. ‘command-and-control’. This system fails in developing countries because standards can be set but are hard to enforce; fines and punishments can be stipulated, but they are not easy to implement in the face of political involvement or interference (O'Rourke 2004).

Furthermore, it is common for Asian nations to set up a short-term horizon for water resource plans. A long-term design plan of 50 or 100 years would be better in securing water for human needs rather than a 10-year vision (McIntosh 2003, p. 15). This is one of the stark challenges in water policy development and planning - to keep up with rapid changes occurring in the economy. In addition, O’Rourke (2004) claims that the lack of political will and the technical resources of environmental authorities in the developing world results in weak enforcement of compliance with environmental regulations. Consequently, the policy and planning is not resilient enough to respond to emerging trends (O'Rourke 2004, pp. 45-50).

4.5.2 SWOT Analysis

To formulate appropriate strategies and policy for the management of water resources in HCMC, it is necessary to analyse existing practices in terms of strengths, weaknesses, opportunities and threats from a wide range factors upon which future formulation and directions of water policy and strategy depend: institutional capacity, legal arrangements, inter-sectoral cooperation, human resource and financial capacity. The comprehensive analysis of the management of water resources in HCMC is summarised in Table 4.11.

Table 4.11 Analysis of Water Management Practices in Ho Chi Minh City

STRENGTH	• There are sufficient institutional and legal frameworks in place including Law on Environment Protection (LEP) and Law on Water Resource (LWR); • The management of water resources is one of the high priorities of the local government agenda in urban environmental management; • The authorities of water resource management and river basins within Ho Chi Minh City and its neighbouring provinces have been established; • Water concerns have drawn attention from various stakeholders and interest groups.
WEAKNESS	• Planning, development and management of water resources have been fragmented among number of agencies or departments. This sometimes leads to conflicting missions or goals; • Poor water governance and absence of well-defined responsibilities for water resources management and water service delivery among the agencies concerned; • Lack of horizontal coordination between government departments in line that leads to an overlapping responsibilities and missions; • Lack of technical capacity or political power to enforce compliance with the full range of regulations and rules as assigned to monitor; • Under-trained and unqualified staff who are unable to implement regulations to keep pace with industrial practices, social changes and responses; • Lack of economic instruments for controlling groundwater exploitation such as exploitation fees, regulations on limitation and prohibition areas of groundwater withdrawal; • Ineffective water price structure and tariff.
OPPORTUNITY	• Water problems were addressed by the City's Environmental Strategy in 2002; • Some relations and legislative framework are under complied and enacted; • There are existing water related projects in urban environmental management: Nhieu Loc-Thi Nghe Environmental Improvement; Tan Hoa- Lo Gom Canal Urban Hygiene Upgrading; • Rainwater can be a significant potential to secure additional supply as annual rainfall is relatively high;
THREAT	• The incidences of water shortage, pollution, degradation and depletion is increasing as increased water demand has occurred in line with economic and population growth; • The current practice of groundwater withdrawal is unsustainable; • Water demand is increasingly growing as the growth of new urban development and population is continuing to grow; • Many urban areas are experiencing uncontrolled population growth and urbanisation, associated with increased water needs; • Community involvement is not fully engaged and given inadequate attention.

Source: Compiled by the author from Nguyen Van Nga (2006); Nguyen Phuoc Dan et al.(2006); Hiep Nguyen Duc and Truong Phuoc Truong (2003); People's Committee of Ho Chi Minh City (2002); Vo and Williams (2006)

It can be argued that inadequate institutional arrangement and fragmentation of management practices are the critical underlying causes of water problems in HCMC. Therefore, future water resources management in HCMC must be more comprehensive. This will be further discussed in more detail in the following chapters.

4.6 Conclusion

Implementing a dual approach in terms of promoting economic and social development while protecting the environment and natural resources upon which the development depends, faces striking challenges in many developing countries (O'Rourke 2004). The management of balancing economic, environmental and social considerations for both the present and the future of HCMC is crucial. Once this balance is accomplished, the City is on track for sustainable development.

The management of water resources in HCMC raises more questions than answers. Such questions include: to what extent the existing water policy is sustaining the balance of water resource protection during the process of industrialisation and modernisation? To what extent is the City intensively polluting and depleting water resources when it industrialises and urbanises? How can the City deal with increased stresses and burdens on water resource management in the pursuit of social and economic development coupled with the rapid trend of urban expansion in a sustainable way?

Water is undoubtedly one of the key natural resources underpinning the sustainable development of HCMC. Sustainable urban development has been deployed as a fashionable slogan of many government authorities. However, HCMC’s authorities lack a strategic plan for water resources management. An increase in water demand, pollution control and conservation coupled with industrial growth, population and urbanisation are problems facing HCMC’s governments at all levels. An effective future strategy should take into account rethinking and reshaping government policies, regulations and institutional frameworks. The future management approach also needs to involve public and private partnership, market-based mechanisms, community participation and civil society. Therefore, the formulation of an overriding institutional framework for water planning, management and development in HCMC is a vital and daunting task.

CHAPTER 5

SUSTAINABLE URBAN DEVELOPMENT AND WATER RESOURCE MANAGEMENT

5.1 Overview

The theme '*water and sustainable urban development*' was clearly identified as one of the seven major programme areas in Chapter 18 of Agenda 21 (United Nations 1992). Urbanisation, which consists of the spatial concentration of people and economic activity, is considered to be the most important social transformation in the history of human civilisation (Roberts and Kanaley 2006). However, urbanisation around the world has come at a price of environmental degradation of regions and ecosystems. On a global scale, all cities cannot be sustained without extracting their resources, and will not be wealthy unless their economy's activities and inhabitants' consumption of natural resources are maintained at sustainable rates (Rees 1992). Therefore, the sustainable development of urban centres is closely linked to the sustainable management of natural resources in which water resources is an integral part.

Worldwide, urbanisation has accelerated at an unprecedented scale. The world's urban population rose 13-fold during the last century (Marcotullio and McGranahan 2007). In 1900, less than 15% of the world's population was urban. This figure expanded from 30% in 1930 (Uitto and Biswas 2000) to almost 50% by 2000 (Brockerhoff 2000; United Nations 2004). By 2005, about 50% of the world's population lived in urban centres (Roberts and Kanaley 2006; UN World Water Development Report 2006; United Nations 2004) and will increase according to some estimates to 60% by 2030 (Postel and Vickers 2004; Roberts and Kanaley 2006). By 2000, Asia was already the home of nearly half the world's urban population and had the highest growth in urban population at a scale unprecedented in history (Roberts and Kanaley 2006; UN World Water Development Report 2006). This rapid rate of urbanisation is provoking profound socio-economic changes and posing serious environmental challenges (Meinzen-Dick and Appasamy 2002). Within the urban sector, meeting urban water needs is emerging as the most pressing challenge to the world community as water shortages in many cities around the world are rising (Meinzen-Dick and Appasamy 2002; Postel and Vickers 2004). At a global level, the growing number of people living in urban areas is likely to continue and this will have crucial implications for water resource use and management (UN World Water Development Report 2006, pp. 87-91).

This chapter will outline urbanisation trends in connection with growing water demand in the Asia-Pacific region, Southeast Asia and Vietnam. As stated previously, urbanisation is one of the driving forces of urban environmental problems in both the developed and developing world. At a regional level, the speed of Asia's urbanisation is generating unprecedented social, economic, political and environmental changes (Roberts and Kanaley 2006). Though rapid urbanisation has created huge economic and social advances, it is at the same time also undermining the sustainability of Asian economic development (Roberts and Kanaley 2006). The sustainability of urban environmental management is part of the sustainable development framework. Accordingly, the concept of sustainable development is discussed with reference to the urban context. The integrated water resources management (IWRM) approach is also discussed as an emerging paradigm. From a managerial point of view, a wide range of existing water management practices in Ho Chi Minh City is analysed in terms of their institutional, economic and social contexts.

5.2 Urbanisation, Sustainable Development and Cities

> Cities usually have serious environmental impacts far beyond their boundaries through the ecological impacts of the demand they concentrate for natural resources and the wastes that they generate and dispose of outside their boundaries (United Nations Centre for Human Settlements (HABITAT) 1996, p. xxx).

This quotation illustrates the fact that urbanisation is responsible for many environmental problems. Within the urban boundary, there is a growing proportion of the world's population and a much higher proportion of resource use and waste generation is concentrated. Rees (1992) developed the concept of cities having an ecological footprint, which is a sophisticated ecological understanding of how cities draw on natural resources (water, energy and land) and rely on ecosystem functions to absorb their wastes.

5.2.1 Urbanisation and Environmental Issues

Urbanisation is an ongoing process and has been the most important social transformation in human history (Lundqvist et al. 2003; Roberts and Kanaley 2006). The urbanisation trend created enormous economic and social benefits and cities, in turn, are the engine of economic growth. However, the escalation of urbanisation is widely recognised as one of the leading factors of many urban environmental issues (Roberts and Kanaley 2006; White and Whitney 1992). There has been considerable discussion over the rapid growth of population in urban centres coupled with rising demand for water (Meinzen-Dick and Appasamy 2002; Uitto and Biswas 2000; UN World Water Development Report 2003; Young et al. 1994). Over the past 50 years, urbanisation has become the most pervasive population trend worldwide (Ichimura 2003), and this is reflected in the development of Asian cities (Jones 1993; Jones 1997).

In Asia, urbanisation brings both opportunities and challenges. Roberts and Kanaley (2006) claim that most Asian countries have benefited from urbanisation in terms of employment, lifestyles, welfare, social structures and institutions. Additionally, Biswas (2000) noted that the large urban centres of the developing world contribute to 60% of total national economic growth. Urbanisation, on the other hand, is responsible for a wide range of environmental consequences, including water resource deterioration, inadequate drinking water and sanitation, coupled with health problems from water-related diseases, air pollution and solid waste management (Marcotullio 2003; Roberts and Kanaley 2006).

Varis et al. (2006) argue that urbanisation and the increase in major urban centres are not new trends; in fact this process was evident in the 19th century in Europe and North America. However, these scholars identify two crucial differences between urbanisation in the developed and the developing world. The first major difference is the rate of urbanisation. The formulation of urban areas in developed countries was a gradual process, and their population growth was spread over a century. In contrast, the expansion of large urban centres in developing countries has exploded since the 1950s. The second difference is that when the expansion of large cities proceeded in developed countries, this coincided with their economic development. The economies of cities in the developing world in contrast have progressed poorly during the period of rapid urbanisation (Biswas 2006; Varis et al. 2006).

These two factors mean that cities in the developed world are advanced in the necessary infrastructure, capacities and financial resources to manage their urban water supply and sanitation services. Governments of urban centres, in the developing world, have failed to cope with the high rate of urbanisation and concomitant urban water issues. They are unable to develop a good governance system, management capacity and efficient financial resources to provide their urban dwellers with basic water-related services (Biswas 2006; Varis et al. 2006).

In the developing world, urban expansion associated with environmental degradation is one of the major issues faced by cities and urban centres in the Asia-Pacific region (Ichimura 2003; Imura et al. 2005). Drakakis-Smith (2000) elaborated on the general environmental pressures concerning economic and population growth in Third World cities (Figure 5.1). Furthermore, Asian countries are experiencing urban population growth at a rate unprecedented in the last 55 years, from 17% in 1950 to 40% in 2005 (Roberts and Kanaley 2006). It is estimated that by 2030, about 55% of the Asian population will be in urban areas and account for 66% of the world's urban population (Roberts and Kanaley 2006). The combination of urbanisation and economic growth have resulted in many urban environmental challenges, so that provision of water supply, sanitation, drainage and waste management is unable to meet the rapid pace of urbanisation. As a result, these cities will face various environmental problems, including safe water and adequate sanitation associated with health consequences from water-related diseases and accelerated water pollution from agricultural, industrial and domestic discharges (Roberts and Kanaley 2006).

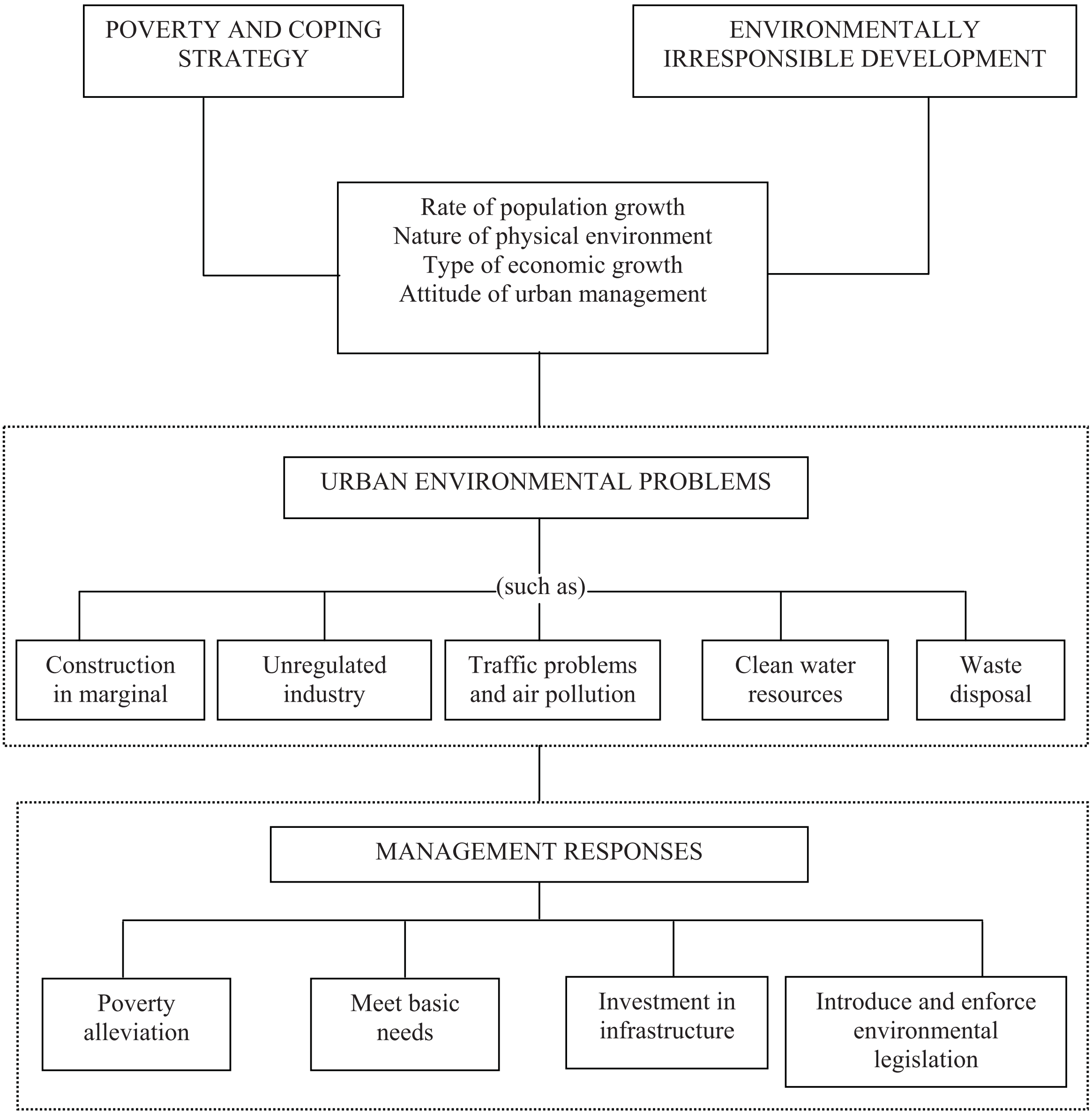


Figure 5.1 Environmental Pressures in Third World Cities

Source: Drakakis-Smith (2000, p. 87)

In the Southeast Asian perspective, dense population and massive urbanisation are the main contributors to growing managerial problems regarding natural resources (Varis 2005). This author states that these factors have overwhelmed the capacities of water policy.

Urban population growth in Vietnam accelerated 1.5 times from 2000 to 2005. The country's urban population growth was 6.4% in 2005 with 22.3 million people (27% of the country's total population). Nguyen To Lang (2006) estimated that 26.2 million (29.4%) and 35.8 million people (36%) are expected to live in urban areas in 2015 and 2030 respectively. This trend is high in comparison to other Southeast Asian countries (Table 5.1).

Table 5.1 Urbanisation Trends in Selected Southeast Asian Countries

NOTE: This table is included on page 110 of the print copy of the thesis held in the University of Adelaide Library.

Source: Roberts and Kanaley (2006, p. 14)

By 2005, the urban population of HCMC reached 6.2 million, accounting for 27% of the country's urban population (Ho Chi Minh City Statistical Office 2007). This figure is 10 years sooner than the United Nations predicted.

Following the 'Doi Moi' policy launch in 1986, rapid economic and population growth in HCMC have posed a formidable challenge. This challenge embodies achieving continued economic development without compromising social and environmental sustainability. In addition, with the rapid economic progress associated with accelerated urban expansion, the population is likely to put more pressure on the use of natural resources. The sustainable management of water resources will be one such stress.

5.2.2 Conceptual Framework of Sustainable Development and Cities

The Brundtland Commission defined sustainable development as ‘development that meets the needs of the present without compromising the ability of future generations to meet their own needs’ (World Commission on Environment and Development [WCED] 1987, p. 8). The core theme of this report is sustainable development which marks a fundamental change in how the world community views the relationship between economic growth and development and the use of natural resources to sustain development. It is also stated that ‘sustainable development is not a fixed state of harmony, but rather a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are made consistent with future as well as present needs’ (World Commission on Environment and Development [WCED] 1987, p. 9).

Five years later, sustainable development became the core theme at the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992 (Jakeman et al. 2006). The concept of sustainable development emerged as a dominant paradigm of development, balancing economic growth, social development and environmental protection. More importantly, the UN Conference produced Agenda 21, which identified the interdependence of development and environment, and embodied an ambitious global action plan for achieving sustainable development. However, the world’s efforts are unlikely to achieve the expectations of Agenda 21 as environmental degradation continues to worsen (Jakeman et al. 2006). The Earth Summit on Sustainable Development (WSSD) in South Africa in 2002 voiced more urgency and was strengthened by more widespread participation by the heads of member governments. The World Summit stated that implementation efforts should take place at both the local and national levels for achieving sustainable development goals (Jakeman et al. 2006). WSSD put integrated water resources management (IWRM) at the top of the international agenda, in which IWRM is considered to be an effective mechanism in achieving sustainability in water management (Rahaman and Varis 2005).

Nevertheless, there is not much discussion on the role of cities in meeting sustainable development goals in most national and global reports (McGranahan and Satterthwaite 2003; Stren 1992). Environmental problems have become particularly serious where ‘there is a rapid expansion in urban population and production’ (Hardoy et al. 2001, p. 4). Sustainable urban development has drawn attention of scholars because urban centres are concentrations of natural resource use and waste generation (Hardoy et al. 2001). These authors proposed many goals of sustainability that cities must consider (Box 5.1).

According to the Asia-Pacific Forum for Environment and Development (APFED), most environmental challenges confronting regional governments can only be solved if all stakeholders make a discernible effort in accordance with sustainable frameworks (Asia-Pacific Forum for Environment and Development -APFED 2005). In this context, regional governments should identify principles for a sustainable framework to: i) address critical environment and development issues; ii) propose a new development framework that will be effective and sustain growth; and iii) determine action to be undertaken by relevant stakeholders (Asia-Pacific Forum for Environment and Development -APFED 2005).

Box 5.1 Multiple Goals of Sustainability as Applied in Cities

NOTE: This box is included on page 113 of the print copy of the thesis held in the University of Adelaide Library.

Source: Hardoy et al. (2001, p. 354)

5.3 Sustainability of Water Resources

Water is essential for environmental sustainability and economic development. However, sustainability of human society is facing constraints over the availability of and the accessibility to water resources. The 1987 Brundtland report titled “Our Common Future” called for a new era of growth based on the sustainable use of natural resources as part of the strategy for sustainable development. Sustainability of water resources is further embodied in Chapter 18 of Agenda 21 at the Rio Summit 1992 and the Dublin Principles in 1992 (Rast 2003). Chapter 18 of Agenda 21 is directed to the goal of sustainable freshwater resources. The essential role of water for sustainability was emphasised as follows: “water is needed in all aspects of life” (United Nations 1992, p. 166), and its general objectives are to: (i) ensure that adequate supplies of clean, safe water are maintained for the world’s entire population; (ii) preserve the hydrological, biological and chemical functions of ecosystems; (iii) adapt human activities within the capacity limits of nature; (iv) to combat vectors of water-related diseases (United Nations 1992, p. 166).

Furthermore, the vital role of water resources in sustainable development was clearly stated in the United Nations Development Declaration in 2000 (United Nations 2000). Table 5.2 summarises the role of water in the list of Millennium Development Goals.

Table 5.2 Water, Poverty and the Millennium Development Goals

NOTE: This table is included on page 115 of the print copy of the thesis held in the University of Adelaide Library.

Table 5.2 Water, Poverty and the Millennium Development Goals (Cont)

NOTE: This table is included on page 116 of the print copy of the thesis held in the University of Adelaide Library.

Source: UN World Water Development Report (2003, p. 9)

5.4 The Impacts of Urbanisation on Water Resources

Urbanisation has produced physical impacts, changes and modifications to both the quantity and quality of water resources. The repercussions of urban development can vary from localised impacts on water courses such as sewage and waste disposal to landscape-level impacts due to the construction of engineered water facilities (Perry and Vanderklein 1996). Many developing cities rely on groundwater as an important supply source in the course of socio-economic development. However, urbanisation and industrialisation have substantial impacts on this resource (Foster 2001). Typical impacts of urbanisation on urban groundwater resources are presented in Table 5.3.

Rapid urbanisation has created pressing water problems in urban areas for several reasons. Firstly, excessive water demands in cities and metropolitan regions resulted from a growing number of people. Secondly, urban areas and cities usually concentrate many and large-scale economic activities and industrial production. As a result, water demand for domestic purposes, industry, energy generation, etc. increase exponentially (Meinzen-Dick and Appasamy 2002; Perry and Vanderklein 1996; Postel and Vickers 2004). Thirdly, urbanisation usually outstrips the development of urban infrastructure. The unprecedented levels of urbanisation in the developing world have imposed serious health and water quality problems (Perry and Vanderklein 1996) because existing urban infrastructure, water supply and sewerage systems are already overloaded and overtaxed.

Table 5.3 Typical Impacts of Urbanisation Processes on Groundwater

Process	Effect on filtration			Quality implications	
	Rates	Area	Time base	Impact	Contaminant groups
a) Modifications to natural system					
Surface impermeability and drainage					
Stormwater soak ways	Increase	Extensive	Intermittent	Marginally negative	Chloride and salinity, hydrocarbons, dissolved organic carbon
Mains drainage	Reduction	Extensive	Continuous	None	None
Surface water canalisation	Reduction	Linear	Variable	None	None
Irrigation of amenity areas	Increase	Restricted	Seasonal	Variable	Nitrogen compounds, chloride, dissolved organic carbon
b) Introduction of water service network					
Mains water supply leakage	Increases	Extensive	Continuous	Positive	None
Sanitation system installation					
In situ sanitation	Major increases	Extensive	Continuous	Negative	Nitrogen compounds, fecal pathogens
Mains sewerage	Some increases	Extensive	Continuous	Negative	Nitrogen compounds, fecal pathogens, dissolved organic carbon
c) Uncontrolled aquifer exploitation					
Falling water table	Some increases	Extensive	Continuous	Potentially positive	
Induced downward leakage	Minor increase	Extensive	Continuous	Negative, causes pollution of deep aquifers with persistent contamination	

Source: Foster (2001)

5.4.1 Quantity

On the quantity side, it is widely recognised that urbanisation is outpacing available water supplies (Meinzen-Dick and Appasamy 2002; Postel and Vickers 2004), especially in the megacities. This may result in conflicts and competition in water consumption between different parts of urbanised areas and its surrounding regions (Lindh 1992). In addition, the rapid growth of megacities has overwhelmed the capacity of all levels of government in providing clean drinking water, adequate sanitation and managing water resources, particularly in developing countries (Biswas 2006; Varis 2006; Varis et al. 2006). Despite receiving abundant rainfall and having abundant water resources, the Southeast Asian region is experiencing important issues regarding water supply and water quality protection (UNEP 2002). Surface water pollution and groundwater depletion associated with land subsidence in Southeast Asia is attributable to urbanisation (Marcotullio 2007; UN ESCAP 2000).

Water stress in terms of quantity in Southeast Asia continues to rise as a result of changes in urban lifestyles and industries (UN ESCAP 2005). The status of ample water resources in the region is rapidly changing. For example, water demand for industrial uses rose twenty-fold in both Thailand and Vietnam between 1995 and 2000 (UN ESCAP 2005). With the rapid pace of urbanisation in Southeast Asia, the escalation of water demands will be one of the biggest challenges. Moreover, the increasing number of urban centres will lead to seasonal water scarcity in most cities of Southeast Asia (ASEAN 2005). The overall demand for water in the ASEAN region is estimated to increase by one-third in 2025 (ASEAN 2005). Furthermore, the region has undergone rapid economic development, coupled with rapid urbanisation, which has led to an increase in the imbalance of water consumption between urban and rural users (Goh 2005). In terms of geographical scale, urban water-related challenges in Southeast Asian cities are classified into three categories depending on the scope of impacts on cities or region as presented in Table 5.4.

Table 5.4 Different Scales of Urban Water-related Challenges in Southeast Asia

Water-related Challenge	Scale of Impact
Brown issues	
Access to water supply	Household
Access to sanitation	Household
Adequate drainage	Neighbourhood
Gray issues	
River pollution	Metropolitan region to regional
Over-extract groundwater supplies	Neighbourhood to metropolitan region
Ground subsidence	Neighbourhood to metropolitan region
Coastal area degradation	Metropolitan region to regional
Flooding	Neighbourhood to metropolitan region
Green issues	
Increasing water consumption per capita	Metropolitan region to regional
Water scarcity	Metropolitan region to regional
Increased vulnerability because of climate change/variability	Regional

Source: Marcotullio (2007)

5.4.2 Quality

One of the foremost challenges of urbanisation for water is the degradation in its quality (Perry and Vanderklein 1996). Quality, of course, bears on the availability of water for use. The quality of urban water resources around the world has already been aggravated by the degradation of urban infrastructure. Rapid urban expansion surpassed sewerage and drainage systems leading to a vast majority of wastewater discharge into receiving waters without proper treatment (Perry and Vanderklein 1996). In the developing world, water quality is increasingly recognised as an impediment to water availability and economic development (Ongley 1999, 2001). As urbanisation and population grow, there is an increase in modification and utilisation of water resources, which results in more waste and different types of impacts on water quality (Perry and Vanderklein 1996). Millions of people die each year from water-related diseases and this is linked to the use of contaminated water sources. Using contaminated water caused 250 millions cases of water-related disease and many more deaths from diarrhoeal disease every year throughout the world (Gleick 1993a; Gleick 2001; Nash 1993).

Increasing pollution of surface water and groundwater resources has major public health implications and led to high levels of eutrophication in many developing countries (Ongley and Booty 1999). Serious deterioration of water quality in surface and ground water resources is prevalent in many urban areas of Southeast Asia as a result of expanding economies, population and urban centres (Douglas 2005). It is a widely held view that many Asian cities depend on groundwater supplies in the course of socio-economic development. Unfortunately, this resource has worsened in quality and quantity (Institute for Global Environmental Strategies (IGES) 2006). The quality of groundwater is threatened by various pollutants and sources as described in Table 5.5.

Table 5.5 Some Major Threats to Groundwater

NOTE: This table is included on page 121 of the print copy of the thesis held in the University of Adelaide Library.

Source: Sampat (2001, p. 27)

In addition, the quality of urban surface water bodies is affected by waste disposal from many sources with a wide range of pollutants, including urban runoff, industrial, commercial wastewater and household waste streams. Typical pollutants in urban wastewater streams include suspended solids, biodegradable chemicals (BOD, COD), nutrients (nitrogen, phosphorus), pathogens (*E.coli*, faecal coliform) and organic and inorganic chemicals (Perry and Vanderklein 1996; Viessman and Hammer 1998). Tables 5.6 and 5.7 summarise the concentrations of various components in urban wastewater and the effects of pollutants in urban stormwater.

Table 5.6 Average Concentrations of Urban Runoff and Raw Sewage

Parameter (mg/L)	**Urban Runoff**			**Raw Sewage**	
	General Urban Areas	Developing Urban Areas	Commercial Areas	Industrial	Commercial
BOD_5	74	25-50	100	500-700	150-300
Suspended solids	200-4800	27 500	50-830	450-1 700	100-250
Total phosphorus	0.3-4.8	23	0.1-0.9	0.9-4.1	1-3
Total nitrogen	0.2-18	63	1.9-11	1.9-14	2-10
Chloride	130-750	N/A	10-150	75-160	25-100
Lead	0.14-0.5	3	0.7-1.1	2.2-7	0.1-1
Copper	0.02-0.21	N/A	0.07-0.13	0.29-1.3	0.05-0.75
Zinc	0.3-0.1	N/A	0.25-0.43	3.5-12	0.5-2.5

Notes:

N/A: Not available

BOD_5: Biochemical Oxygen Demand in 5 days

Source: Perry and Vanderklein (1996, p. 404)

Table 5.7 Effects of Pollutants in Urban Stormwater

Contaminants	Environmental Effects
▪ Oxygen demanding substances (BOD, COD, ammonia)	▪ Dissolved oxygen depletion, biomass accumulation
▪ Nutrients (nitrogen and phosphorus total)	▪ Enrichment/ Eutrophication
▪ Toxicants (metals, organic micro-pollutants)	▪ Toxicity
▪ Hygiene (pathogens)	▪ Public health and biomass
▪ Physical factors (temperature, suspended solids)	▪ Temperature rise and long term change, habitat change-toxic "hotspot"
▪ Flow regimes	▪ Organism removal, habitat changes

Source: Herricks (1995, p. 26)

5.4.3 The Impacts of Urbanisation on Water Resources in Ho Chi Minh City, Vietnam

Rapid urbanisation has caused a wide range of serious environmental issues in coastal cities of the Asia-Pacific region, including water and air pollution and land degradation (Kataoka 2005; Wong et al. 2006). Marcotullio (2003) elaborated on how the ongoing trend of globalisation, urban transformation and rapid development has accompanied the worrisome issues of environmental problems in Asia-Pacific cities. Both low-income and high-income cities in the region have faced water-related challenges (Marcotullio 2003).

Since 1986, the experience of industrialisation and urbanisation in Vietnam has generated undesirable environmental and social effects and concerns about the livability of urban habitats (Douglass et al. 2002). Vietnam, the second most populous country in Southeast Asia, with about 20% of its population living in urban areas, experiences water supply, sanitation and pollution problems (Douglas 2005). Ho Chi Minh City, a coastal city, was categorised as being in group 1 (low-income cities) which is already afflicted with brown issues (Webster 1995) or a mix of brown and gray issues - water shortage, pollution and sanitation (Wong et al. 2006).

Expanding economic activities, industrial production and rapid urbanisation over the last two decades in HCMC have had an adverse effect on urban water resources. The concentration of BOD and coliforms in the Sai Gon River exceeded Vietnamese standards by a factor of four and fifty respectively (UNEP Regional Resource Centre for Asia and the Pacific 2001). Existing urban infrastructure is being burdened by the rapid growth of population (People's Committee of Ho Chi Minh City 2002). Consequently, most canals in HCMC now serve as drainage systems (Hansen and Do Hong Phan 2005; Marcotullio 2007). The 2004-2005 monitoring results indicated that the quality of water surface of the Dong Nai-Sai Gon river system at both the upstream and downstream stations has been polluted by organic matter, oil and microorganisms (Department of Natural Resources & Environment-DONRE 2005). The following tables show the poor quality of inner-water sources and adjacent regions of HCMC.

Table 5.8 Water Quality of the Dong Nai-Sai Gon River System, 2004-2005

NOTE: This table is included on page 124 of the print copy of the thesis held in the University of Adelaide Library.

DO	: Dissolved Oxygen
BOD_5	: Biochemical Oxygen Demand in 5 days
TCVN 5942-1995 (see Appendix 4)	Class A: permitted concentration of sources which can be applied for water supply
	Class B: permitted level of sources which are used for other purposes
n.a	: Not available

Source: Department of Natural Resources & Environment-DONRE (2005)

Table 5.9 Quality of Groundwater in HCMC, 2005

NOTE: This table is included on page 125 of the print copy of the thesis held in the University of Adelaide Library.

Notes:

TDS	: Total Solid Suspended
n.a	: Not available
TCVN 5944-1995	: limited values, Vietnam standard of groundwater quality (see Appendix 4)

Source: Department of Natural Resources & Environment-DONRE (2005).

Table 5.10 Quality of Major Urban Canal Systems, 2005

NOTE: This table is included on page 125 of the print copy of the thesis held in the University of Adelaide Library.

Notes:

DO	: Dissolved Oxygen
BOD_5	: Biochemical Oxygen Demand in 5 days
TCVN 5942-1995 (see Appendix 4)	Class A: permitted concentration of sources which can be applied for water supply Class B: permitted level of sources which are used for other purposes

Source: Department of Natural Resources & Environment-DONRE (2005).

Table 5.11 Quality of Urban Runoff in inner-district of Ho Chi Minh City

NOTE: This table is included on page 126 of the print copy of the thesis held in the University of Adelaide Library.

Notes:

COD	: Chemical Oxygen Demand
TCVN 5942-1995 (see Appendix 4)	: Class B- limited values of sources which are used for other purposes

Source: Nguyen Minh Hoi (2002).

The concentration of pollutants has increased year after year (Department of Natural Resources & Environment-DONRE 2005). As stated in Chapter 4, water resource problems in HCMC include water shortages, pollution, over-abstraction and anarchical exploitation of groundwater resulting from the aftermath of urban expansion and intensive industrial production. The major cause of increased pollution levels can be attributed to industrial, domestic, aqua-cultural and navigation activities (Department of Natural Resources & Environment-DONRE 2005). This situation is due to insufficient investment in water infrastructure and the weakness of implementing agencies' institutional arrangements (Douglas 2005).

5.5 Urban Water Resource Management

It is widely accepted that water is a driver of social development (Braga 2005), and underpins the growth of urbanisation. The Global International Waters Assessment report claims that population growth and urbanisation throughout the world is one of the underlying causes of greater water use and shortage of freshwater resources (UNEP 2006). Therefore, the management of water resources in urban areas is a key element in achieving sustainable urban development. In the urban sector in HCMC, it is importantly to emphasise that management practices require an integrated approach, an understanding of the characteristics of urban water management systems and models integrated with social and economic development.

5.5.1 Integrated Urban Water Management

Global water issues were discussed at many important international meetings from Mar del Plata in 1977 to the Rio Earth Summit in 1992. The importance of securing water resources and urban development were thoroughly identified in Chapter 18 of Agenda 21. However, continued growth of urban population and expansion, coupled with water shortage, pollution and health problems led to a global realisation that water issues would require a holistic approach in which concerted participation from all stakeholders. In 1996, the Global Water Partnership produced such an approach for water management, known as integrated water resources management (IWRM). Increasingly, IWRM is the most important concept for sound water management and became the water management mantra (European Commission 2006) because the integration of management practices is required to take account of social and economic goals, including sustainable development.

The 2001 UNESCO Symposium on Frontiers in Urban Water Management in Marseille addressed issues that need to be taken into account in the management of water resources in urban areas:

- Current urban water management practices are piecemeal solutions and unsustainable in both the developed and developing world;
- Rapid growth of urban population has posed striking stresses on water supply sources, groundwater, receiving water bodies, aquatic ecosystems and water-related health issues;
- An increase in competition between water users, including agriculture, industry, domestic and the ecosystem, which requires a new institutional framework for better management;

- Inadvertent use of water resources results in diminishing supply and increasing inequitable water access;
- The impact of poverty, demographic change and globalisation has placed stark strains on supply, disposal and sanitation.

Source: The Marseille Statement (2001, pp. 129-130)

Lundqvist et al. (2003) identify three interrelated links between urbanisation and water management. Firstly, the growing urban population and water demand require management capacity to secure supply sources. Secondly, water distribution and use between users in urban areas pose challenges to meeting basic human needs and environmental sustainability. Thirdly, there is an increase in alarming levels of water pollution and degradation resulting from growing urban agglomerations.

The management practices of water resources need to view them in a holistic way in which social, economic and environmental aspect are integrated (Giupponi et al. 2006). The management and use of water resources inevitably impinge on the social and economic conditions and natural environments (Braga 2001). Past water development projects were often based on a single-purpose such as irrigation, hydropower, navigation or water supply (Braga 2001; White 2000). Further, past and existing water strategies or plans are dominantly either uni-sectoral, engineering-oriented or top-down approaches (Biswas 2001a). However, ample evidence in many parts of the world indicates that the existing forms of use and management of water resources are unsustainable (Rast and Holland 2003). Rast and Holland (2003) emphasise that the unsustainable management of water resources is due to a lack of integration. The present environmental consciousness and global change have increasingly shaken the dominance of such single approaches. Thus, the old water management approaches have been replaced by multi-objectives, multiple participation and multiple decision-makers at all levels, both nationally and internationally (Biswas 2001a; Braga 2001). Accordingly, many water professionals and government managers have attempted to establish a theoretical framework of integration or an integrated approach within a social, economic, development and environmental context. To this end, the Global Water Partnership proposes such a framework of water management integration: Integrated Water Resources Management (IWRM):

> Integrated Water Resources Management (IWRM) is a process, which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems (Global Water Partnership - GWP 2000, p. 22).

The IWRM approach originally stemmed from the Dublin principles of water and development. It is noted that this approach is tied up with sustainable development (Giupponi et al. 2006) which requires wider integration (Jakeman et al. 2006). This integration includes: issues (land, water, river basins); major drivers (urbanisation, population, industry, agriculture and household); scientific and engineering areas (economics, hydrology, sociology and ecology); stakeholders (public or groups of people) interested in a management problem; and integrating methods, tools and models such as multi criteria analysis, monitoring networks, software, physical models (Jakeman et al. 2006). IWRM is developed to change the view of decision-makers to adapt a new paradigm of water governance and management (Global Water Partnership - GWP 2003). IWRM can be interpreted as a scenario where different uses of water resources are considered and all stakeholders (water users, civil society, governments and the private sectors) should be included in consultations and the decision-making process.

5.5.2 Characteristics of Urban Water Management System

Niemczynowicz (1999) argued that urban hydrology plays a crucial role in sustainable urban development as human societies are faced with rapidly growing urban areas and how to meet growing water demands. Within the urban water sector, there is now recognition that all processes of urban hydrology should be considered as a total urban water cycle (Mitchell 2000). Accordingly, the urban water cycle is characterised by all water pathways in the urban environment, including surface and groundwater sources, stormwater, and wastewater from industries and households. Figure 5.2 illustrates urban water cycle pathways and processes.

In a broader context, the management of urban water systems involves the incorporation of water supply, wastewater and stormwater (Speers and Mitchell 2000). As water scarcity has also to be viewed in relation to growing population and water demand pressure on the water resource, a water sensitive urban design concept has emerged as a part of the wider integrated water management framework (Mouritz 2000, quoted in (Mitchell 2000).

As specified in the IWRM framework, the sustainability of an urban water management system can be achieved by using an integrated approach rather than a single one. Within the urban water sector, therefore, a sustainable water system should take into account environmental, social, technological and community issues on which the following actions need to be taken:

- Establishing strategic partnerships in urban water management (national, provincial and city agencies/departments, private sector, non-governmental organisations or NGOs);

- Developing alternative water sources to secure water supplies to match socio-economic development (reclaimed/treated water, water reuse/recycle, rainwater harvesting);

- Implementing technological measures (water metering, auditing systems, leak detection, water saving devices) and financial tools (user charges, environmental funds, municipal bonds);

- Encouraging public participation and community involvement in local and regional water planning process.

Source: Global Development Research Centre (2006)

5.5.3 Sustainable Urban Water Management

It has been said that 'current water management practices and policies have resulted in stark and terrible failure. But the problems we witness today are only an indication of what may lie ahead' (Serageldin 1995, quoted in (Rast and Holland 2003). This implies that water-related problems already extend beyond management practices. Many water issues reflect existing practical regulations and mechanisms. In the urban context, water issues have raised concerns on how to match available supplies with rising demand or redressing inequitable distribution (Hashimoto 2002).

Not surprisingly, “Water and Cities” is one of the 17 major themes selected and discussed at the Third World Water Forum, Tokyo 2003. This is because there is an increase in people living in urban areas and escalation of water-related disease due to inadequate water for drinking and sanitation (Hashimoto 2002). Moreover, urban water problems are intricately linked with development issues and the management practices of urban water resources particularly in megacities have not been received adequate attention from water professionals (Biswas 2001b; Hashimoto 2002).

It is now noted that although urban centres consume huge amounts of national resources, they also contribute the lion’s share of national production, particularly cities in developing nations (Biswas 2000; Biswas 2006). However, the development and expansion of urban economies may not last without adequate regard for the environmentally sound management and use of natural resources (Rast and Holland 2003). Accordingly, urban growth and development should embrace the concept of sustainable development forged in 1987. The reality is that if anthropogenic activities continue uncontrolled exploitation, nature’s capacity will be overwhelmed and economic growth will be imbalanced (Rast and Holland 2003). As developing countries are rapidly undergoing urban expansion, the management of water resources will be more complex (Biswas 1999, 2001a; Uitto and Biswas 2000). Thus, the sustainable management of water resources in urban areas has become a central concern of urban environmental issues.

Figure 5.2 Urban Water Cycle Pathways and Processes

NOTE: This figure is included on page 132 of the print copy of the thesis held in the University of Adelaide Library.

Source: Lawrence (2001)

Sustainable management of urban water resources is therefore the integrated management of urban watershed comprising water processes in the urban environment, including water supply, stormwater and wastewater. With the constraints on the quantity and quality available, there are three emerging strategies that need to be adopted to regulate growing urban demands, including: (i) increasing supplies through new sources (inter-basin transfers, surface storage, non-conventional sources, rainwater harvesting and reuse and recycling); (ii) reallocating water use between sectors and (iii) managing urban water demand or demand management (Meinzen-Dick and Appasamy 2002).

It is interesting to note that the sustainability of cities reflects how they manage water systems and the old fashioned paradigm of urban water management (separate single objective) is no longer adequate in coping with rapid urbanisation and industrialisation (Newman 2001). Box 5.2 presents an integrated solution of sustainable water goals and shows how new urban water technologies and urban water management processes are needed for a more socially sensitive, economically efficient and environmentally responsible urban water management system (Newman 2001).

In urban areas, domestic wastewater is considered as a resource and its utilisation through reclamation and reuse has become one of the fashionable options in integrated water resources management (Asano 2000, 2005; Kazmi and Furumai 2005). It is also noted that securing water for urban expansion and growing demand provides an impetus that encourages urban re-use of wastewater to alleviate water stress (Biswas 2006).

Box 5.2 Water and Sustainable Cities

Water-oriented goals for a sustainable city

- Recycling of water for various urban and peri-urban uses;
- Recycling of nutrients and organics;
- Creeks and wetlands are an integral part of the city but are managed for their ecological integrity;
- Increased soft surfaces (and reduce urban sprawl) for stormwater retention;
- Reduce requirement for large pipes.

New urban water technologies

- Small scale high quality sewage treatment;
- Localised stormwater treatment and recycling;
- Water harvesting for localised supply purposes;
- Water efficient appliances, fitting and technologies.

New urban water management processes

- Water sensitive design processes;
- Total water cycle planning;
- Urban integrated catchment management;
- Localised community processes in water management.

Source: Newman (2001)

Foreseeable opportunities for new sources lie ahead in future urban water management such as reusing stormwater for urban purposes, recycling wastewater for agricultural activities, urban landscaping or for non-potable purposes (Asano 2000; Niemczynowicz 1999, 2000). These strategies hold an enormous promise for developing cities, particularly in developing countries in Southeast Asia (Kazmi and Furumai 2005; Niemczynowicz 2000). The driving forces and benefits for wastewater reclamation and reuse were identified in the literature, particularly: (i) increasing water supplies by reducing demand for higher-quality water; (ii) protecting aquatic ecosystems by reducing wastewater discharge, decreasing the quantity of nutrients and pollutants entering water bodies; (iii) augmenting alternative water sources to meet both present and future water needs (Asano 2005; Kazmi and Furumai 2005). Boxes 5.3 and 5.4 present the benefits and potential of wastewater reuse.

Box 5.3 Benefits of Water Reclamation and Reuse

Water recycling conserves water supplies: water recycling increases the total available water supply. High-quality water supplies can be conserved by substituting reclaimed water where appropriate.

Water recycling is environmentally responsible: water recycling can preserve the health of waterways, wetlands, flora and fauna. It can reduce the level of nutrients and other pollutants entering waterways and sensitive marine environments by reducing effluent and storm water discharge.

Water recycling makes economic sense: reclaimed water is at the doorstep of the urban development where water supply reliability is most crucial and water is priced highest.

Water recycling can save resources: recycled water originating from treated effluent contains nutrients; if this water is used to irrigate agricultural land, less fertilizer needs to be applied to the crops. By reducing pollution and nutrient flows into waterways, tourism and finishing industries are also helped.

Source: Asano (2005); Kazmi and Furumai (2005); UNEP (2005)

Box 5.4 Driving Forces for Wastewater Reuse

Increasing pressure on existing water resources due to population growth and agricultural demand.

Growing recognition among water and wastewater managers and the public of the economic and environmental benefits of using recycled water

Recognition that reclaimed water can be a reliable source of water supply even in drought years.

Increasing awareness of the environmental impacts associated with over-use or overdraft of water supplies.

Greater recognition of the environmental and economic costs of water storage facilities such as dams and reservoirs.

Preference for recycling over effluent disposal, coupled with tighter controls on the quality of any effluent discharge to the environment.

Community enthusiasm for reusing water and water conservation.

The growing number of successful water reuse projects worldwide.

The introduction of new water charging arrangements that better reflect the full cost of delivering water to the consumers, and the widespread use of these charging arrangements.

Increased costs associated with upgrading wastewater treatment facilities to meet higher water quality standards.

Source: Asano (2005)

The utilisation of wastewater for agricultural production has been viewed as an opportunity to increase food security in rapidly growing urban areas around the world (Tropp et al. 2006; Van der Hoek 2001) and has for a long time been used in China, India, Thailand and Vietnam (European Commission 2006; Kazmi and Furumai 2005). The reuse of untreated urban wastewater is commonly applied for aquaculture production in peri-urban areas of

Vietnam. In the peri-urban region of Hanoi, most domestic wastewater was reused for wastewater-fed aquaculture systems (Edwards 1996; European Commission 2006; Nguyen Ngoc Thu 2001; Vo Quy Hoan 2001).

Rainwater, a part of the hydrological cycle, is a valuable source for many activities (Kataoka 2005; Meinzen-Dick and Appasamy 2002; Niemczynowicz 1999). It is naturally pure and drinkable but can be contaminated by air pollution. There are several ways in which rainwater can be collected on rooftops, land surface or rock catchment and stored in tanks. Rainwater harvesting can also be practiced on a small scale (household rooftop) or sub-watershed scale (Meinzen-Dick and Appasamy 2002). Historically, rainwater harvesting has long been used in rural areas dating from ancient times in China and Thailand (Kataoka 2005; Tropp et al. 2006). Increasingly, rainwater harvesting has been done in many developed countries to augment water supplies by replenishing surface water or to recharge the groundwater (Government of South Australia undated; Meinzen-Dick and Appasamy 2002; Niemczynowicz 1999). In the face of limited water availability, it is noteworthy that urban rainwater harvesting is a promising option for urban areas (Kataoka 2005; Tropp et al. 2006). In seasonal monsoon regions, using rainwater is considered to be affordable to increase water availability in urban areas because rainwater and urban runoff can be either captured or used directly for non-potable water purposes or to recharge the aquifers. Moreover, its utilisation in urban areas as an alternative water source can benefit urban stormwater management, including: (i) increasing water availability; (ii) reducing stormwater runoff in both peak flow rates and volume; (iii) minimizing pollution load discharges to downstream and receiving water bodies; and (iv) collecting and using stormwater runoff to alter water consumption in non-potable water applications (Argue 1997).

From the point of view of sustainable urban water management, the integrated management practices of water supply, wastewater and urban stormwater runoff are all part of urban water resources management. Therefore, to achieve sustainable urban water management, future challenges, current opportunities and different aspects of water processes in the urban environment should be incorporated into integrated water resources management.

5.6 Urban Water Management and Comprehensive Analysis of Water Resource Issues in Ho Chi Minh City

5.6.1 Urban Water Sector

Many coastal cities of Asia and the Pacific region have become hotspots of environmental degradation as a result of population growth and urbanisation (Wong et al. 2006). In the Southeast Asian region, the environmental issues of most cities are classified as "brown" (water supply, sanitation) and "gray" (air and water pollution, other negative aspects of industrial processes) (Webster 1995; Wong et al. 2006). Furthermore, economic growth and urbanisation have been accompanied by acute water shortages in the developing cities of Southeast Asia (Douglas 2005; Goh 2003). Thus, the development of these countries will not be sustainable if a comprehensive approach to water resources management is not formulated and adopted (Goh 2005). The situation of Vietnam's water resource use is no exception.

Ho Chi Minh City is a city in which water resources are coming under stress, an anomaly given that on an annual basis it has abundant water supplies. HCMC has too much water in the wet season, and too little during the dry season, associated with escalating demand and needs (Vo and Williams 2006). In the urban water sector, the proportion of water supply in HCMC increased from 52% in 1997 (McIntosh and Yñiguez 1997) to 84% in 2004 (Andrews and Yñiguez 2004). However, the proportion of urban households connected to the main water supply system is still low.

It is estimated that 47% of the City's dwellers have access to reticulated water supply systems from the public utility, 34% of households have access to wells and 19% have to purchase water from small private water providers (Dardenne 2006). A survey by McIntosh (2003) shows that within a number of households using water from small scale water providers (SSWPs), 61% of these SSWPs are resellers (who have connections from the Sai Gon Water Supply Company-SAWACO, and provide a service to an average of 3-5 households in the neighbourhood), 19% of SSWPs are tanker operators (who access water from SAWACO), 11% of SSMPs provide water via piped systems, and 9% provide bottled water. Urban water coverage, availability and consumption in HCMC in comparison with other Southeast Asian cities are presented in Table 5.12.

Table 5.12 Water coverage, availability, consumption and non-revenue water in selected Southeast Asian cities

Cities	Water coverage (%)	Water availability (hours/day)	Consumption/capita (litre/capita/ day)	Non-Revenue Water (NRW, %)
Bangkok*	82	24	265	38
Ho Chi Minh City	84	18	167	38
Jakarta	51	22	77	51
Kuala Lumpur	100	24	132	43
Manila	58	21	127	62
Phnom Penh	84	24	104	26
Singapore*	100	24	183	6
Vientiane	63	12	110	28

Source: Andrews and Yñiguez (2004) and (*): McIntosh and Yñiguez (1997).

Water shortage in HCMC is partly a result of insufficient supplies and service infrastructure. The majority of urban residents cannot have enough water, particularly in the drought periods. About 77% of urban dwellers have access to 50-100 litres/person/day and 21% of suburban residents to 20-40 litres/person/day (People's Committee of Ho Chi Minh City 2002). The underlying causes of water shortage in urban areas include a high proportion of water loss and inefficient and antiquated pipe networks connecting households (Hiep Nguyen Duc and Truong Phuoc Truong 2003). In the urban water sector, water shortages associated with rapid urban expansion and population growth entail a wide array of economic, environmental and social aspects (see Table 5.13).

Table 5.14 Stakeholders' Issues regarding Water Supply

NOTE: This table is included on page 139 of the print copy of the thesis held in the University of Adelaide Library.

Source: Jayasuriya and Ho (2006).

5.6.2 Perceptions of Community and Local Authorities

Chapter 4 identified three dimensions of water resource problems: seasonal water shortage, groundwater depletion and pollution of receiving water bodies. The growing stress upon and deteriorating quality of the City's water resources have already raised serious concerns among local water professionals and government leaders at all levels. The trend of rapid urban population growth along with growing water demand due to intensification of the domestic and industrial sectors has added to this concern (Nguyen Van Nga 2006). Consequently, water resource management in urban areas is becoming a critical issue in HCMC, and requires appropriate strategies and policies.

During July-September 2001, the HCMC authority conducted a consultation survey of both the community and the authority at ward level. Although this survey covered a small geographical proportion of the city (Districts 2, 3 and 6), the results showed that existing water issues in HCMC are complex and intricately linked with urban development issues (planning, public services) and the accountability and responsibility of government authorities at all levels. The survey outcomes are summarised in Tables 5.14 and 5.15.

Table 5.14 Community's Comments on Urban Water Issues

NOTE: This table is included on page 141 of the print copy of the thesis held in the University of Adelaide Library.

Source: People's Committee of Ho Chi Minh City (2002)

Table 5.15 Local Authorities' Opinions on the Causes and Solutions

NOTE: This table is included on page 142 of the print copy of the thesis held in the University of Adelaide Library.

Source: People's Committee of Ho Chi Minh City (2002)

Serious urban floods in recent years are caused by irregular high rainfall combined with seasonal tidal surges. However, the situation in inner districts was aggravated due to inadequate planning and illegal filling and encroachment of natural regulating ponds and lakes. In recent years, the Urban Water Drainage Company was responsible for flooding eradication over urban and suburban districts. Unfortunately, the number of flooding sites in urban districts remains the same year after year (VietnamNet 2006). This can be considered a "pick to fit" approach rather than a holistic solution of urban water system planning. The Department of Transport and Public Works is the city's governing body in charge of planning and managing the water supply network. Sai Gon Water Supply Company (SAWACO) is the city enterprise in charge of water supply to the city. The Urban Water Drainage Company is also a city authority, responsible for overseeing the operation of the urban wastewater drainage system and stormwater network. These government agencies lack cooperation and a comprehensive plan for urban water supply and flood management.

5.6.3 Analysis of Water Pollution Control in Ho Chi Minh City

The need for addressing concerns over water resources management and planning has increasingly emerged in developed and developing countries (Malano et al. 1999). Pollution is an unwanted by-product of society's legitimate activities, and thus the key role of governments is to set a regulatory policy that lessens adverse impacts that individuals or organisations impose on others or the public good (Weale 1992). As noted in Chapter 4, water pollution caused by industrial and domestic wastewater is one of the critical water problems in HCMC. The city is the home of an enormous number of industries. However, most enterprises, industrial parks and processing zones lack wastewater treatment plants. Six out of 13 industrial parks surveyed in 2006 have equipped or partly installed wastewater treatment facilities (Ho Chi Minh City Environmental Protection Agency-HEPA 2006, 2006b). Industrial wastewater discharges directly into receiving water and rivers without treatment have caused serious pollution with the concentration of pollutants well above Vietnamese standards (Ho Chi Minh City Environmental Protection Agency-HEPA 2006b).

5.6.3.1 Capacity of State Local Authority

Water issues resulting from uncontrolled urban expansion and unbridled exploitation of groundwater resource have only drawn local political attention in HCMC. In early 2002, the Environmental Management Strategy up to 2010 in HCMC was tabled by authorities where the management of urban water resources was addressed as one of the urban environmental priorities. At the national level, the fragmentation and failures of water resources management practices resulted from the lack of a comprehensive legal framework. Most importantly, the newly formed MONRE has not yet achieved its goals as expected. There is still controversy as to which functions of state management of national water resources will be handed over from MARD to MONRE. Unsurprisingly, MARD currently manages the three largest river basins (Truong Thi Quynh Trang 2005). Table 5.16 shows the function of water resources management before and after the formulation of MONRE in 2002.

In the local context, the weakness of water resources management in HCMC still outweighs the strong points. The unsound management of water resources comprises institutional weakness and inadequate mechanisms of collaboration. UNDP identified institutional weakness as one of the barriers in developing world governments:

> Even if policy, legislation and regulations are in place, the administrative machinery in many developing countries can implement policy only with difficulty … environmental agencies usually have poor powers of sanction, few staff relative to the scale of responsibilities, and few staff with good skills. And because of the dearth of data on environmental matters and the lack of training facilities, enforcement is haphazard (UNDP 1992, p. 52).

Table 5.16 Responsibility for Water Resources Management before and after Establishment of MONRE

Activities	Before Establishment of MONRE	After Establishment of MONRE
State management of water resources	MARD	MONRE
Watershed management, irrigation, drainage, rural water supply and flood prevention	MARD	MARD
Urban water supply	MOC	MOC
Water quality monitoring	NEA/MOSTE, MARD, MOH	MONRE, MARD, MOH
Hydropower, reservoir operation	MOI, MARD	MOI, MARD
Hydro meteorological data collection	GDHM, MARD, MOSTE	MONRE
River Basin Management and International Coordination of Water Resources Management	MARD	MARD

Notes:

MARD : Ministry of Agriculture & Rural Development

MONRE : Ministry of Natural Resources & Environment

MOSTE : Ministry of Science, Technology & Environment

MOH : Ministry of Health

MOI : Ministry of Industry

GDHM : General Department of Hydro-Meteorology

Source: Bennett and Nguyen (1996); Truong Thi Quynh Trang (2005).

Furthermore, O'Rourke (2004) claims that:

> Environmental agencies in developing countries seldom have technical capability or the political power to enforce compliance with the full range of environmental laws they are assigned to monitor. Low pay and a lack of resources can lead to corruption in the public sector in which fines become a means to supplement incomes rather than reduce pollution. Pervasive corruption not only impedes environmental protection, but also leads the public to lose confidence in the legal system and in the credibility of regulatory agencies, further undermining the rule of law (O'Rourke 2004).

At the local level, the water sector suffers from poor coordination and cooperation across several government agencies (Hansen and Do Hong Phan 2005; Hiep Nguyen Duc and Truong Phuoc Truong 2003). Many local agencies do not even realise the existence of the LWR and its implications. Consequently, provincial and city authorities, who have a high degree of administrative and legislative autonomy, have been lax with local interpretation and enforcement of the LWR (Hansen and Do Hong Phan 2005).

Furthermore, the traditional command and control regulatory system exposes the ingrained weakness of anti-pollution enforcement. This is due to complex industrial practices and changes in which the state's actors usually lag behind industrial activities to regulate effectively (O'Rourke 2004; Storey 2005). Hardoy et al. (2001) claim that most urban water problems in the developing world resulting from the lack of supply sources are due to the lack of political involvement:

> In most cities, poorer groups' lack of piped water supplies is not the result of a shortage of fresh water resources but the result of governments' refusal to give a higher priority to water supply … A failure of governance underlies most environmental problems (Hardoy et al. 2001, p. 382).

The management of water tariff, poor public participation and insufficient decentralisation of ownership and autonomy in the water sector are also adding to the constraints of water management and governance:

> It is commonly experienced that many local stakeholders such as local communities, farmers and urban residents are not sufficiently connected to the decision-making processes and therefore not involved in the real dialogue with decision makers in connection with water-related investments (Hansen and Do Hong Phan 2005, p. 238).

5.6.3.2 Potential Opportunity

However, there are opportunities to synergise existing water projects which have been funded by various international sponsors. In the urban water sector, HCMC has received a number of urban water-related projects such as the World Bank (the Nhieu Loc-Thi Nghe Basin Improvement), Asian Development Bank (ADB, Hang Bang, Tau Hu- Ben Nghe-Kenh Doi-Kenh Te Canal System), Belgian government (Tan Hoa-Lo Gom Hygiene Upgrading), Japan International Bank for Cooperation - JBIC (HCMC central wastewater treatment plant), Japan International Cooperation Agency-JICA (HCMC waste Management), and NORAD project (Hazardous Waste Management); SIDA/UNIDO project (Industrial Polluting Relocation Programme) (People's Committee of Ho Chi Minh City 2002). However, the implementation of some of these projects is merely a pilot project for local experts and staff. For example, the underlying significance of the Nhieu Loc-Thi Nghe Canal was to emphasise the benefits of capacity building (Nguyen To Lang 2006). Similarly, the Tan Hoa-Lo Gom Canal Upgrading project was intended to build the capacity of local government experts and agencies in strengthening urban planning skills. According to my observations, it was also to provide practice for local wastewater treatment experts to design wastewater disposal after the treatment process. Not surprisingly, investment in these projects has not paid off because the primary results of these projects were not well incorporated or scaled up to a higher level. The fragmented implementation of these projects can be redressed if the city’s authority recognises the need for a peak body responsible for organising all available resources and coordinating across government agencies.

Rainwater is likely to receive stakeholder attention as a potential resource when the demand for water increases in coming years. The rainy season accounts for 85% of rainfall in HCMC, and will be worth using for coastal suburban districts (Can Gio, Nha Be and District 7).

5.6.4 Potential Alternative Water Sources

It is interesting to note that the preference of alternative water sources, from more to less preferred, are: (i) surface water, (ii) groundwater, (iii) rainwater, (iv) brackish and (v) reclaimed water (Nguyen Phuoc Dan et al. 2007). The use of surface water sources to spearhead supply both for short and long term development is due to its abundant quantity, simple treatment and distribution, strong public acceptance, available monitoring systems and management institutions. Reclaimed water was less prioritised due to the lack of treatment technologies and concerns over health risks. Tables 5.17, 5.18, 5.19 and 5.20 summarise the analysis of potential water resources based on quality, quantity, technology, economic and management factors.

Table 5.17 Quality-based Factors

NOTE: This table is included on page 148 of the print copy of the thesis held in the University of Adelaide Library.

Source: Nguyen Phuoc Dan et al. (2007)

Table 5.18 Technological and Economic-based Factors

NOTE: This table is included on page 149 of the print copy of the thesis held in the University of Adelaide Library.

Source: Nguyen Phuoc Dan et al. (2007)

Table 5.19 Quantity-based Factor

Source: Nguyen Phuoc Dan et al. (2007)

Table 5.20 Management and Social-based Factors

NOTE: This table is included on page 151 of the print copy of the thesis held in the University of Adelaide Library.

Source: Nguyen Phuoc Dan et al. (2007)

5.7 Conclusion

It is obvious that the Asia-Pacific and Southeast Asia region have faced increasing water stress as a result of rapid urbanisation and population growth. Securing water for agriculture, industry, households, etc. has been a challenge for many countries in the region. With reference to the urban development of HCMC, water stress is an impending issue in the course of industrialisation and modernisation and inevitably linked to sustainable urban development. Water resource problems, like other urban environmental issues, can be dealt with in the framework of sustainable development. The sustainable management of water resources underpins sustainability in urban development. The issues of urban water resource management in Ho Chi Minh City can be tackled, but only if the local government reshapes and rethinks an institutional and mechanism framework of water policy upon which an appropriate approach depends. IWRM is such a holistic management approach. However, a proper IWRM approach to HCMC can be developed by examining water governance aspects, which will be discussed in Chapter 6 and fieldwork findings in Chapter 7.

CHAPTER 6

CHALLENGE OF WATER GOVERNANCE IN THE SUSTAINABLE MANAGEMENT OF WATER RESOURCES

6.1 Overview

The availability of and accessibility to freshwater is a decisive factor in socio-economic development. In releasing the 1997 *Comprehensive Assessment of Freshwater Resources of the World*, the UN Secretary-General stated that 'Water shortages and pollution are causing widespread public health problems, limiting economic and agricultural development, and harming a wide range of ecosystems' (United Nations 1997). The international water community has identified increasing demand for water as one of four major factors that will threaten human health and ecological integrity in the coming decades (UN World Water Development Report 2003). On the global scale, there is plenty of water for terrestrial ecosystems and human survival. However, there are also a number of challenges in attaining sufficient water with adequate quality at the right place and the right time (UN World Water Development Report 2006). Apart from the natural driving forces of climate change and hydrological variability in water's distribution, growing population and urbanisation pressures mean that the sustainable management of water resources remains a considerable challenge(UN World Water Development Report 2006).

In recognising the indispensable component of water in socio-economic development and poverty alleviation, the United Nations addressed the crucial role of water in setting its eight Millennium Development Goals (MDGs). The MDGs were adopted in September 2000 by the largest-ever gathering of world leaders and enunciated a bold global commitment to a vision for a better world. The achievement of these MDGs closely relates to the improvement of access to sufficient water for basic human needs (Tropp et al. 2006; UN World Water Development Report 2006). Accordingly, the seventh Millennium Development Goal-MDG7 (ensure environmental sustainability), comprising three targets and eight indicators, is critical to the sustainable achievement of the other goals (see Table 6.1). More importantly, the MDG7 emphasises two bold targets: (i) to integrate the principles of sustainable development into national policies and programmes and prevent the loss of environmental resources; (ii) to halve the number of people without sustainable access to safe drinking water and sanitation by 2015 (UN World Water Development Report 2006). It is implicit that healthy ecosystems are essential for maintaining people's well-being while they depend on them for drinking water, food security and a wide range of environmental goods and services.

However, as discussed in Chapter 3, there are billions of people without adequate drinking water and basic sanitation services around the world (Cain and Gleick 2005; Cosgrove and Rjisberman 2000; Gleick 2002, 2003a; UN World Water Development Report 2003). The depressing figures fuel intensive debate on water resources management practices. It is claimed that the world has enough water for all because water is infinitely renewable (The Economist 2003) and the problem of the world's water deficit is primarily due to the mismanagement of this resource and a crisis of water governance (Bate 2006; UN World Water Development Report 2003; UNDP 2006).

The management of water resources is essentially an issue of governance and the ways in which the social, economic and political aspects relating to water resources can be effectively and efficiently governed (UN World Water Development Report 2003). Globally, mismanagement of water is attributed to the shortcomings of governance. It is argued that poor water governance in many countries is caused by malfunctioning institutional and legislative systems (Somlyódy and Varis 2006). Furthermore, ineffective water governance also underlies the failure of decentralisation of water control and decision-making and the failure to match water demand and supply (UN World Water Development Report 2003, 2006). Sustainable management of water resources is influenced by a complex process of governance, decentralisation and demand management.

Table 6.1 Implications of the Millennium Development Goal 7

Millennium Development Goals	Dependence on Environmental Sustainability
1. Eradicate extreme poverty and hunger	The majority of the region's population still lives in rural areas and is directly dependent on ecosystem goods and services as the primary basis of their livelihood and food security. Ensuring environmental sustainability reduces economic vulnerability and reduces the impacts of natural disaster and so contributes to poverty reduction.
2. Achieve universal primary education	Children of poor rural families who live in degraded environments spend increasing amounts of time gathering firewood and collecting water as these commodities become more and more scarce or polluted. This takes them away from studying or attending school, but also increasing pressure on environmental resources such as forests. Providing alternative fuels, protecting water quality and promoting sustainable water use therefore also contribute to the achievement of MDG2.
3. Promote gender equality and empower women	Poor rural women and girls often spend a much higher proportion of their time gathering food and fuel and collecting water than male family members. Added to the socio-cultural tendency in some societies, this reduces opportunities for education and income-generating activities and acts as a barrier to the achievement of MDG3.
4. Reduce child mortality	Unsafe water and inadequate sanitation are the primary sources of waterborne diseases (such as diarrhea and typhoid fever) which are the leading killers of children under five. Indoor air pollution caused by burning solid fuels is also increasing the incidence of bronchial diseases and death among children. Meaningful progress on achieving MDG4 requires greater progress on protecting environmental resources.
5. Improve maternal health	Indoor air pollution and the burden of gathering solid fuel and water exact a heavy toll on pregnant women, particular in early pregnancy, increasing the risk of miscarriage and complications during childbirth. Inadequate sanitation and lack of water services increase risks to the health of pregnant women.
6. Combat HIV/AIDS, malaria and other diseases	One in five major diseases (including malaria and parasitic infection) in developing countries is associated with environmental risk factors. Tuberculosis is exacerbated by indoor air pollution or deteriorating ambient air quality, especially in urban areas. From a preventive viewpoint, new and promising medicines derived from fast-disappearing biodiversity resources have the potential to fight debilitating diseases.
7. Develop a global partnership for development	Global environmental issues such as climate change, biodiversity loss and the depletion of forest resources are related to unsustainable consumption and production patterns. These issues can be addressed through a genuine and equal partnership between developed and developing countries.

Source: Adapted from UNDP (2003)

6.2 Governance of Water Resources

The advent of integrated approaches to water resources management has led to a strong emphasis on water governance in the international water agenda. The governance of water will continue to be an international priority to 2015 in the United Nations Decade on Water for Life (United Nations 2004). Water governance refers to "relationships that can be manifested in various types of partnerships and networks". However, there is no agreed conventional definition of water governance, and its meanings are still evolving and being discussed (UN World Water Development Report 2003). The governance of water involves many participants with different objectives, including governments, institutions, civil society groups and the private sector. The notion of water governance has changed with the task of water management no longer an exclusive area of governments, but one involving civil groups. Government authorities around the world face common problems in struggling to manage water resources in ways that are effective, equitable and environmentally sound (Jansky et al. 2005). Box 6.1 presents some issues of water governance which need to be reflected in water policy, institutions and management practices.

6.2.1 Why Is Governance needed in the Water Sector

The world's water scarcity is a result of mismanaging access to and use of water resources (Tropp et al. 2006; UNDP 2006). The achievement of good water policies depends upon effective governance (The Economist 2003). Governments worldwide already face common issues of water governance, as they struggle to manage water resources efficiently and equitably (Jansky et al. 2005). Therefore, redressing water governance will be a central issue in solving water crises and underpinning sustainable development. The Access Initiative (TAI) notes, "Transparent, participatory, and accountable governance is an essential foundation for sustainable development" (The Access Initiative - TAI 2007). The reason for the critical role of governance in water management is illustrated by the following questions: How are decisions regarding water policy made? What kind of stakeholders are involved in the process of water management? What principles and regulations can be applied in the water sector?

Box 6.1 Issues of Water Governance

NOTE: This box is included on page 157 of the print copy of the thesis held in the University of Adelaide Library.

Source: UN World Water Development Report (2003)

Since Agenda 21 was endorsed in 1992, it has become a flagship of the international community to address several challenges regarding sustainable development. Accordingly, the governance of water was presented in many programme areas in Chapter 18 of Agenda 21 as follows (United Nations 1992):

- National or local comprehensive policies for water resources management that need to be holistic, integrated and environmentally sound;
- Institutional strengthening and reform in alignment with reform of water laws;

- Integrated water resources management (IWRM) based on dynamic, interactive, iterative, and multi-sectoral approaches. The evolution of IWRM should integrate all water users, and should be an integral part of socio-economic planning.

As developed by the Global Water Partnership, the IWRM approach marks an important turning point in the international community for how water should be governed equitably and efficiently. In spite of the incomplete implementation of IWRM in developed and developing nations, its positive progress has been observed as follows (UN World Water Development Report 2003):

- Water governance and required reforms of policies and institutions in the water sector are increasingly recognised as the key to sustainable water development;
- Water institutions and policies are being reformed in many countries to identify fragmented institutional arrangements, inadequate policies and mechanisms, lack of significant incentives of partnerships and to encourage participation of various stakeholders;
- Integrated approaches to water resources management are widely accepted as the driving-force to manage water resources in a more effective manner and to increase community awareness of water resources and their management.

Governance refers to partnerships and networks of civil society, and a sustainable city should have a good governance system for urban services. According to Dubois-Taine (2003) urban services can be well managed with good environmental governance and there are no quality urban services without multi-stakeholders governance. McIntosh (2003) argues that poor governance is the core problem of water management in Asian urban centres (see Figure 6.1).

The United Nations World Water Development Programme has stated that good water governance is needed to improve water management and reduce ecological degradation (UN World Water Development Report 2003). Accordingly, a good water governance system comprises both sufficient frameworks to ensure provision and effective regulations to enforce compliance and to protect water sources. Such a good governance system involves more effective government institutions as well as a more efficient relationship between government authority and civil groups (McCarney 1996). Good water governance also means that all stakeholders' water needs are impartially considered and institutions responsible for water and wastewater management are accountable to them (UN World Water Development Report 2003). Box 6.2 describes some attributes of an effective water governance system.

NOTE: This figure is included on page 159 of the print copy of the thesis held in the University of Adelaide Library.

Figure 6.1 Consequences of Poor Water Governance in Asian Cities

Source: McIntosh (2003, p.6)

Box 6.2 Criteria for Effective Water Governance

NOTE: This box is included on page 160 of the print copy of the thesis held in the University of Adelaide Library.

Source: UN World Water Development Report (2006).

6.2.2 Governance of Water Resources Management

As noted above, governance addresses the relationship between government, organisations and civil groups involved in the process of water decision-making in local and international contexts (UN World Water Development Report 2006). Water governance, therefore, is not an exclusive government responsibility but involves the private sector and civil groups. In this respect, water governance refers to the existence of a water policy which is influenced by political empowerment (UN World Water Development Report 2006).

With worrying signs of water shortages clearly evident, the Global Water Partnership introduced an IWRM approach in which water governance can be strengthened through 13 identified key change areas (see Box 6.3). IWRM has been widely accepted as an appropriate tool for the sustainable management and use of water resources and for improving provision and water services. Within the context of IWRM, water governance can be observed in four dimensions: (i) the social dimension of water depicts the use of this resource equitably; (ii) the economic dimension promotes the efficient use of water resources and the role of water in economic growth and poverty alleviation; (iii) the political empowerment involves ensuring various stakeholders and water users have opportunities to monitor political processes and outcomes of water policies; (iv) the environmental sustainability dimension means that improving water governance enables sustainable use of water resources and enhancement of ecosystem capacity (UN World Water Development Report 2006).

Rising pressures of urbanisation and population on the management of water resources are the driving forces for reforming water governance. Current reforms in the developing world are focusing on infrastructure and technological issues (measures for demand management) and governance-management issues (private participation, public-private partnership and decentralisation) (UN World Water Development Report 2006).

NOTE: This figure is included on page 161 of the print copy of the thesis held in the University of Adelaide Library.

Figure 6.2 Four Dimensions of Water Governance

Source: UN World Water Development Report (2006, p. 46).

Box 6.3 Thirteen Key IWRM Change Areas

NOTE: This box is included on page 162 of the print copy of the thesis held in the University of Adelaide Library.

Source: Global Water Partnership - GWP (2004)

However, there is no agreed universal model for good water governance because it varies from country to country depending on specific contexts and local capacities (UN World Water Development Report 2003, 2006). In order to improve water governance, the following issues have to be considered (UN World Water Development Report 2006):

- Water is an infinitely renewable resource, as it replenishes itself through the hydrological cycle;
- The nature of water resources is multi-purpose and hydrologically interconnected;
- Water is considered both a social good and an economic good;
- Water has social, economic and environmental values requiring the full participation of multi-stakeholders;

- For water supply and sanitation, the provision of water services is often influenced by monopoly situations;
- Water-related infrastructure is often combined with low-cost recovery and heavy subsidization.

6.3 Decentralisation of Water Management

6.3.1 The Need for Decentralisation

Principle 10 of Agenda 21 of the Rio Declaration stressed the importance of decentralization:

> Environmental issues are best handled with the participation of all concerned citizens, at the relevant level. At the national level, each individual shall have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in decision-making processes. States shall facilitate and encourage public awareness and participation by making information widely available. Effective access to judicial and administrative proceedings, including redress and remedy, shall be provided (United Nations 1992, p. 10).

Principles 20, 21 and 22 emphasised the important roles of women, youth and indigenous people in environmental management and planning. These principles also stressed that the full participation of these civil groups needs to be strengthened (United Nations 1992). Together, these principles mean that countries are encouraged to involve various stakeholders effectively in decision-making processes to attain sustainable development.

Decentralisation was defined as the “transfer of responsibilities to civil society and the private sector” (UN World Water Development Report 2006, p. 75). In the field of natural resources management, decentralisation is depicted as a process of “transfer empower and accountable representation” (Ribot 2002). The key principle of decentralisation, therefore, is to transfer decision-making power and resources from a centralised state authority to a representative and accountable local institution. Although decentralisation is interpreted in several forms (Ribot 2002), this process is expected to enable local people to become more self-governing, self-reliant and self-managed (Lane 2003; Ribot 2002). In the water sector, the concept of decentralisation should be perceived as a process in which lower levels of government, private sector or community and civil society organisations handle some management responsibilities and decision-making powers from government (UN World Water Development Report 2006). Decentralisation in the water sector, therefore, requires the full involvement of public participation, local community, and the private sector and should incorporate public-private partnerships in the implementation of management practices.

However, the implementation of decentralisation is not easy to achieve because for several reasons. Firstly, in most large river basins, the exercise of water management typically involves different political and administrative boundaries as well as different political parties (UN World Water Development Report 2003). Secondly, local governments and institutions often fail to become autonomous. It is difficult to achieve in developing countries because environmental authorities have less "technical capacity or political power to enforce compliance with the full range of environmental laws" (O'Rourke 2004). Even when they have the training and capacity, local environmental agencies are seldom autonomous or given adequate power and authority to implement regulations on industry (O'Rourke 2004, p. 10). Furthermore, the retention of real powers over local governments, the lack of political empowerment and needed revenues are impediments to decentralisation working in practice (UN World Water Development Report 2003).

6.3.2 Decentralisation of Water Control and Decision-making

Public Participation and Local Governance

Hansen and Do Hong Phan (2005) argue that the roles of local authorities can be strongly enhanced if decentralisation and democratization of planning and resource management are exercised; public participation is a means to achieve this. In both developed and developing countries, public participation in the form of civil society is desirable in the decision-making process. This process enables citizens or civil groups to have a say in issues that influence their daily lives. Delli Priscoli (2004) discussed five areas of public participation in the water sector that play an important linkage role between water management and civil society: (i) ethical dimensions of water management; (ii) water management and civic culture; (iii) tension between the technical and political; (iv) reconciling the discontinuities between geographical and jurisdictional boundaries; and (v) the need for better conflict management (Delli Priscoli 2004).

Jansky et al. (2005) claimed that public participation has a key role in water governance. The more stakeholders are involved in decision-making processes, the more decisions and implementations are sustainable (Dubois-Taine 2003). While there may have been some levels of public participation (public-at-large or more specific interest groups, including non-public stakeholders), it is important to learn from local residents through different attitudes and experiences, and to achieve relevant win-win situations (Jansky et al. 2005). Such population involvement can take a wide range of forms, such as local unions (women and youth), community-based organisations, private enterprises, and non-government organisations or NGOs.

Not surprisingly, the involvement of stakeholders is explicitly highlighted was one of the four key principles of water security at the 12th Stockholm Water Symposium in 2002: 'water users must be involved in the governance of water resources' (Stockholm International Water Institute 2002). In this respect, the aphorism "water is everyone's business" was discussed in the session on water and local government at the Second World Water Forum, which made clear that while governments play an important role in water management, other participants must be involved. Moreover, it was acknowledged that water management is much more successful if local governments play an important role whilst users must be involved in all actions where sustainable policy for water management is pursued (Boyd 2001).

Local authorities can take advantage of participation in the process of setting up urban environmental infrastructures (recycling, reduction and reuse) which stand as key factors of water management policy (Dubois-Taine 2003). Johnson et al. (2001) claimed that many international development projects on water resources have been implemented ineffectively because they did not consider the needs, constraints and practices of local people. For developing countries in Southeast Asia, which are blessed with abundant natural water resources, the critical issue is not so much insufficient investment in water infrastructures, as the governance of water (Liongson 2001).

Governments would benefit from user involvement. These benefits can comprise a set of criteria, identification of priority constraints, assessment of possible solutions and monitoring and evaluation of impacts. However, it is not an easy task to involve all stakeholders in participating in water resources management at the local level, particularly ordinary people. The participation of ordinary people closely relates to their water rights and benefits. Such participation is good evidence of an effective governance of water. For example, during the dry season, South Australians were encouraged to participate in activities encouraging less water use. However, failure in user participation usually leads to poor water management and allocation (Srinivas 2003). Another example is the sanitation service in HCMC which was observed during my fieldwork in 2005. The urban residents expressed their anger over their urban sanitation services due to the fact that payments for this service are inequitable. While the urban water supply service is provided and billed by Sai Gon Water Supply Company (SAWACO), the sanitation service is provided by Urban Drainage Company. Both of them are subsidiary service providers for the Department of Transport and Public Works of Ho Chi Minh City. Most households with connected pipe water have to pay an additional fee for the maintenance of urban drainage systems. This fee is paid on top of the water supply fees for the same bill of water meters. In contrast, many households do not pay this service fee though they share the same drainage pipeline network. The reason is simply that they use water from their own wells, and are not connected to the municipal water supply system. Therefore, these unserved households cannot be billed by the government water provider.

In addition, user involvement is promoted because of the relationship between user responsibility and government obligation (Dubois-Taine 2003). This is a practical reason for any new or changing water regulation to meet local and national sustainable goals. Once a new or updated water regulation has been released or adopted, the understanding of the wider user is necessary to achieve the participation. Cohen (1996) claimed that a participative approach is crucial for improving the local environment through local responsibility, education and through public policy and economic incentives to improve the industrial sector's behaviour. Moreover, the challenge that water resources management usually faces (the issues of availability and allocation), can be tackled by incorporating the consultation, cooperation and experience of local users (Jansky and Uitto 2005). Pragmatically, local people are given a central role in promoting environmental protection effectively at the local level (Iyer-Ranigar and Treloar 1999). This is useful to developers, planners and policy-makers who take these public responses into account in the governance of water.

Thus, it can be argued that effective governance of water will not occur unless real public consensus and user involvement is achieved. There might be several ways of expanding public involvement. As observed during my fieldwork, community awareness raising programmes is evident in Ho Chi Minh City, and is an effective tool for involving people in water issues. This is an informal education approach and a primary measure which can be adopted in the developing world where the level of public environmental awareness is low. For instance, public awareness programmes can be cited as a good example of a fruitful programme in HCMC (People's Committee of Ho Chi Minh City 2002). Key persons in the community are educated. They act as advocates for the important role of water and the imperative of preventing water pollution. These people also play a very useful role in local liaison to disseminate and raise environmental awareness in the communities.

Privatisation and Partnership

Privatisation in the water sector means the transfer of the production, distribution or operations of water or water services from public agencies into the private sector (Gleick et al. 2002). Privatisation can be partial, as in so-called public-private partnership or fully participative (private sector participation). In many developing nations, the move toward privatisation in the water service sector is included in water reforms (UN World Water Development Report 2006). While the water supply service is a basic responsibility of governments, the trend to privatisation is occurring around the world. In the water community, this trend is strongly promoted for several reasons. Firstly, it is argued that government water agencies are unable to serve their citizens the basic needs for water with affordability (Gleick et al. 2002; OECD 2003; The Economist 2003). Secondly, the opening up of the water sector to private companies or entities is regarded as a magic bullet solution. On the one hand, the mobilisation and use of financial resources to manage water resources can be managed effectively by privatisation (Stottmann 2000; The Economist 2003; UN World Water Development Report 2006). It also benefits significantly from the involvement of the private sector in that businesses bring skills, experienced management practices and know-how technologies, and have links to international operators (Plummer

2002). Both large and small-scale water providers play positive roles. Large-scale water providers can deliver better efficiency and effectiveness in reducing unaccounted-for-water and improving the reliability, quantity and quality of water. Small-scale providers, at the same time, can expand options and coverage of services. Particularly, small-scale water providers can offer flexible choices to poor households (Plummer 2002). The potential roles of small-scale water suppliers are presented in Table 6.2.

However, there are opposing arguments over the role of private sector involvement. Several concerns over the privatisation of water resources include the risk to ecosystems, the power of coalition players, and inequities of access to water (Gleick et al. 2002). Some arguments against privatisation resulted from the concern of water price and monopolistic abuses (Dardenne 2006; UN World Water Development Report 2006). Nevertheless, private operators have long had a role in water management in some countries such as France, the United Kingdom and Chile (The Economist 2003; UNDP 2006). Increasingly, it is reported that international agencies such as the World Bank or the World Water Council are promoting privatisation (Gleick et al. 2002). It is evident that privatisation can improve access to water services of low-income households in Port Vila, Vanuatu (UN World Water Development Report 2006). The Phuc Doan Company, the first private drinking water supplier in Ho Chi Minh City, Vietnam, is performing well in its water supply service (McIntosh 2003). However, there are not many private water providers operating in Ho Chi Minh City.

Table 6.2 Potential Roles of Small-scale Water Providers

To allow flexibility of consumption
Small-scale providers generally allow low-income households to vary their consumption. The (informal) supply system allows the poor to opt in or out of the service. Water supplied by standpipe attendants and water carriers is a consumable that can be varied on a daily basis-the choice is with the household. Purchasing from resellers may commit households to a greater degree but they are normally able to discontinue/resume consumption without significant loss. Small-scale provision means that the poor can (and do) use different qualities of water for different types of consumption.
To provide flexibility in payment
Small-scale providers generally allow a level of flexibility in payment terms and conditions far beyond the scope of utility. These terms are structured in regular (daily or weekly) payments to suit the way the poor manage their money. Payment is convenient as it is always collected within the neighbourhood. The small-scale independent provider (SSIP) may also provide a source of short term (although high interest) credit during lean times. Utilities, on the other hand, require customers to pay up-front charges, make payment after long (monthly/quarterly) intervals and make trips (during their working day) to pay at central offices. The poor struggle to manage their finances, regulate their consumption and are rarely given any flexibility for the time and place of payment.
To provide options for vulnerable households
In the situation where a policy of disconnection is enforced, the network supply can make vulnerable households more vulnerable. If utilities enforce exclusivity clauses and remove service options, vulnerable households may loss access to services. In some countries water reselling is not exploitative but in other it is a means of marginalising the most vulnerable. Other option such as communal water kiosks, and water carriers provide an important alternative.
To provide affordable services
The cost of household (private) connections is often unattainable by the poorest households, who then need to access an alternative form of supply. The recurrent costs of water (and sewerage) bills can be prohibitive if the pricing and subsidy system is not structured to enable them to consume and pay within their capacity. Poor households also fear the unknown costs of water-borne sewerage and facilities. Many poor households pay more per unit of water bought from water carriers and resellers than they would from the utility- but they do so because the utility service may not meet all their needs.
To expand the choices available
Collectively, small-scale providers provide poor households with choice. Choice is critical to their coping strategies and to the development of an empowering approach to service delivery. When public-private partnership initiatives rigidly promote network provision for all and remove existing service options, they are inevitably marginalising the very poorest groups.

Source: Plummer (2002).

According to Taylor (2002), a changing regulatory arrangement requires social support in order to achieve sustainable water management. Any directive arrangement will be successful only if user participation is achieved and encouraged to cooperate. In order to achieve an effective governance of water, a feasible water planning strategy must be clearly laid down in terms of transparency and accountability. Government can act as enabler, partner or facilitator (Chiu 2003) whilst private sector participation is intensively encouraged. There is increasing attention to private and public partnership in all public services particularly in water supply and sanitation services (Dubois-Taine 2003). The private sector is playing an important role in providing water services. The challenge remains how to set effective guidelines and principles for privatisation.

6.4 Water Values and the Rights to Water

It is widely recognised that water is a basic human need and access to adequate water is a human right (Gleick 1999; Langford 2005). The United Nations Committee on Economic, Social and Cultural Rights declared a few years ago that “the human right to water entitles everyone to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic use” (CESCR -Committee on Economic Social and Cultural Rights 2002). Access to clean and safe water is fundamental to human survival and well-being and this is made possible by reducing many water-related diseases.

However, water has been considered as a gift from God because water falls freely from the sky (Dubois-Taine 2003; The Economist 2003) and is often provided at a marginal price (Gleick et al. 2002; UN World Water Development Report 2003). The economic value of water was enunciated in the four Dublin Principles: “Water has an economic value in all its competing uses and should be recognised as an economic good” (ICWE 1992). When treated as a commodity, water is held hostage by the free market, which has been the subject of much debate. The economic value of water may cause vulnerability to people who cannot afford clean water and this value should encourage water conservation and efficient allocation among competing users (Gleick 2000a; Gleick et al. 2002; McIntosh 2003). Water is valued in various ways by different people (Moss et al. 2003). There are many perspectives regarding water, such as environmental, social, health and economic. Even though people view water in different ways, it cannot be denied that water is part and parcel of people’s daily activities. The core principle of water management is how to utilise value from available water, whilst providing people with sufficient and adequate water to satisfy their basic needs (Gleick 1996). Therefore, the challenge in water governance is how water can be managed as both a social and an economic good.

6.5 Water Demand Management

The management of water resources is discussed in Chapter 18 of Agenda 21 in which a high priority was given to the “protection of water resources from depletion, pollution and degradation” (United Nations 1992). In this regard, matching available water sources to demand is one of the challenges in water resources management, which has already reached a critical phase. Past water management investments were traditionally supply-driven such as developing new supplies, or expanding and increasing abstractions from existing sources. However, these approaches are identified as the “hard path” which is no longer efficient for several reasons (Gleick 2003a). Firstly, many massive engineering water projects were blamed for causing widespread ecological disruption and devastation. Secondly, huge water investments need intensive capital finance (Gleick 2000a, 2002). Thirdly, rapid population and urbanisation growth associated with accelerated water degradation are leading to imbalance between available water and demand (Stockholm Environment Institute 1997).

As a result, securing sustainable water sources and increasing the efficiency of water use poses challenges to water management. Conserving available water resources and reducing demand for them is known as water demand management (UN World Water Development Report 2006). The water demand management approach influences water demand in several ways (UN World Water Development Report 2003):

- Reducing and controlling leakage from the utility’s mains network;
- Encouraging industrial and commercial users to reduce their dependency on potable water supplies by increasing the level of recycling and implementing waste minimization strategies;
- Encouraging domestic users to reduce their usage;
- Recycling of rainwater by users;
- Recycling of domestic wash-water (grey water systems) by users; and

- Volumetric charging by revenue metering of users.

Water demand management includes economic instruments for water exploitation and use, application of technology for improving delivery services and expanding alternative sources (Gleick 1998, 2000a; UN World Water Development Report 2006). New approaches to the management of water resources, a so-called “soft path”, have been recently advocated. Such approaches propose a shift in changing water management, including decentralisation of decision-making process, low cost-scale projects; efficient technologies and water market and pricing (Gleick 2003a). In the pursuit of augmenting supply sources, international water professionals have discovered several ways to satisfy water needs. Solutions include fixing leaks in urban water distribution systems, increasing crop per drop in agricultural practices, utilizing non-conventional supplies (reuse and recycling wastewater) and harvesting rainwater (Gleick 1998; UN World Water Development Report 2006; UNDP 2006).

However, these practical conservation measures have not been implemented in the developing world. Many developing countries in fact face considerable constraints in financial and technological capability (Kazmi and Furumai 2005). Apart from traditional water sources, non-conventional sources of supply from wastewater reclamation, recycling and reuse have been identified as one of the promising options in urban integrated water resources management (Asano 2000, 2005; Kazmi and Furumai 2005). Reuse of reclaimed wastewater is increasingly recognised as a driving force for water management and planning (Asano 2005; Kazmi and Furumai 2005). This world-wide trend arose from the growing realisation that: (i) water is a finite resource; (ii) society can no longer afford the extravagance of using water only once; (iii) wastewater reuse more appropriately meets water use application with water quality resulting in more effective and efficient use; (iv) the sustainability of water resources is more attainable when wastewater reuse options are implemented (Asano 2006; UNEP 2005). Furthermore, reusing treated wastewater creates several benefits and potential applications in the urban context, including agricultural and landscape irrigation, recreational and non-potable uses (see Box 6.4 and Table 6.3)

Box 6.4 Benefits of Water Reclamation and Reuse

- *Water recycling conserves water supplies*: water recycling increases the total available water supply. High-quality water supplies can be conserved by substituting reclaimed water where appropriate.
- *Water recycling is environmentally responsible*: water recycling can preserve the health of waterways, wetlands, flora and fauna. It can reduce the level of nutrients and other pollutants entering waterways and sensitive marine environments by reducing effluent and storm water discharge.
- *Water recycling makes economic sense*: reclaimed water is at the doorstep of the urban development where water supply reliability is most crucial and water is priced highest.
- *Water recycling can save resources*: recycled water originating from treated effluent contains nutrients; if this water is used to irrigate agricultural land, less fertilizer needs to be applied to the crops. By reducing pollution and nutrient flows into waterways, tourism and finishing industries are also helped.

Sources: Asano (2005, 2006); Kazmi and Furumai (2005); UNEP (2005)

However, in countries endowed with plentiful water resources, the implementation of water demand management has not occurred because water was perceived as an abundant resource (UN World Water Development Report 2006). The need for better governance of demand management remains due to different local contexts and approaches (Table 6.4).

The central issue of water resources management - the governance of water - has been widely debated. Sustainability in water resource use is the principle of sustainable development in which the present generation has an obligation to future generations. Implementation of governance issues in water policies vary from country to country depending on each country's specific conditions. UNDP (2006) suggests five broad factors that need to be taken into account:

- Developing effective national water strategy and planning;
- Reducing subsidies in water use and restructuring water pricing;
- Enforcing polluters pay principle;
- Enabling water value in ecological services;
- Regulating water resources abstraction (particularly groundwater extraction) via the introduction of supply-demand management.

(UNDP 2006).

Table 6.3 Potential Applications for Reclaimed Wastewater

Application Settings	Example
Urban use	
Unrestricted	Landscape irrigation (parks, playgrounds, school yards), fire protection, construction, ornamental fountains, recreational impoundments, in-building uses (toilet flushing, air conditioning)
Restricted-access irrigation	Irrigation of areas where public access is infrequent and controlled (golf courses, cemeteries, residential, green belts)
Agricultural irrigation	
Food crops	Crops grown for human consumption and consumed uncooked
Non-food crops, food crops consumed after processing	Fodder, fibre, seed crops, pastures, commercial nurseries, sod farms, commercial aquaculture
Recreational use	
Unrestricted	No limitations on body contact (lakes and ponds used for swimming, snowmaking)
Restricted	Fishing, boating, and other non-contact recreational activities
Environmental use	artificial wetlands, enhance natural wetlands, and sustain stream flows
Groundwater recharge	Groundwater replenishment, saltwater intrusion control, and subsidence control
Industrial reuse	Cooling system make-up water, process waters, boiler feed water, construction activities and wash down waters
Potable use	Blending with municipal water supply (pipe to pipe supply, surface water or groundwater)

Sources: Asano (2000, 2005); Asano and Leavine (2004).

Table 6.4 Different Approaches to Demand Management in the Urban Water Sector

NOTE: This table is included on page 175 of the print copy of the thesis held in the University of Adelaide Library.

Source: UN World Water Development Report (2003, p. 183).

6.6 Challenges of Water Governance in Vietnam

In response to Chapter 18 of Agenda 21 of the Rio conference, Vietnam has made progress in its water governance management system and recognition of IWRM. Most importantly, the Law on Water Resources was developed by using the key principles of Agenda 21 for sustainable water resources management: (i) identifying the lowest appropriate level of management; (ii) creating a holistic view of water resources in terms of both quantity and quality; and (iii) introducing the concept of water resources as an economic good in management practice (Miller et al. 1999). In addition, the National Water Resources Council and the three largest and most important river basin organisations were established between 2000 and 2001 (Hansen and Do Hong Phan 2005; UN World Water Development Report 2006). In the agricultural sector, Svendsen (1995) noted that there are four basic issues guiding policy reform that need to be considered: decentralisation, privatisation, financial autonomy and farmer involvement.

It is clear that the management issues concerning water resources have received fairly adequate attention from the Vietnamese government. However, many local stakeholders such as communities, farmers and urban dwellers are not really part of the decision-making processes. Consequently, they are not effectively involved in real dialogue or interaction with government bodies and other authorities regarding water-related projects (Hansen and Do Hong Phan 2005). Local governance in Vietnam needs to be considerably improved before good water governance can be said to actually exist. It is reported that local governance in Vietnam is still embryonic and the structure of local governance is driven by politics (Mattner 2004).

The shortcomings of water governance in Vietnam suffer from the defects of development and environment policy. While paying attention to economic development and promoting industrialisation, environmental policy in Vietnam did not reflect domestic perceptions of environmental problems, autonomous actions of local environmental authorities and the participation of civil society (Forsyth 1997). In the urban water sector, local urban public authorities have little managerial autonomy in financial planning and limited accountability for providing sufficient services (Hansen and Do Hong Phan 2005; Trinh Xuan Lai 2005). Moreover, public participation is not yet fully exercised; ‘there is little opportunity for participation by the communities to make decisions on their development priorities and participate in planning, implementation and maintenance of local infrastructure' (Trinh Xuan Lai 2005).

6.6.1 Institutional Arrangement

The Law on Water Resources and the River Basin Organisation (RBO) have been the major institutional arrangements since 1998. The management of water resources is based on different economic sectors' strategies and action plans, including (Truong Thi Quynh Trang 2005):

- National Strategy on Socio-economic Development 2001-2010;
- Direction and Tasks on Water Resources Development to 2010;
- Forestry Development Strategy 2001-2010;
- Hydropower Development Strategy to 2010;
- National Strategy on Rural Clean Water Supply and Environmental Hygiene

More importantly, the Vietnamese government has set out ambitious targets to be achieved by 2010 to increase water supply for agriculture, industry and domestic consumption and controlling water pollution. However, several key challenges remain and need to be addressed in the pursuit of national water vision and targets, including: (i) reinforcing the policy framework for IWRM; (ii) expanding and diversifying investment in infrastructure for the water sector, while paying more attention to economic instruments on the demand management side; (iii) improving compliance with the law and enforcement of water regulations; (iv) increasing public participation and involvement (World Bank et al. 2003).

6.6.2 Ineffective Governance

As discussed in Chapter 4, governance in the water sector in HCMC suffers from fragmentation of institutional arrangements, inconsistencies and overlapping regulations and mechanisms between government agencies. In 2002, the Government Decree No. 91/2002/ND-CP specified the functions, responsibilities, authority and organisational structure of MONRE (see Appendix 6). This newly formed Ministry will replace MARD to play a key role in the state function of water resources management in particular and other key resources in general. MONRE's establishment was expected to resolve the fragmentation of state management for water resources. However, the coordination between government agencies has not yet improved as MARD and MONRE still debate who should be in charge of water resources and water-related activities (Truong Thi Quynh Trang 2005). The inadequate arrangements of state functions and government bodies' responsibilities before and after the establishment of MONRE was summarised in Table 5.16.

In HCMC, the degradation of water resources is now a major urban environmental issue. HCMC will pay a high price for serious water exhaustion due to poor management and uncontrolled pollution practices (Mai Vong 2007; Quang Khai 2007; Quoc Thanh 2007, 2007). The imbalance between policy on economic development and that on environmental protection is causing water pollution:

> Prior to June 2006, industrial parks were not forced to set up centralised wastewater treatment plants if the parks have not yet fully occupied 50% of the area. This unforced policy is considered as a special preferential treatment given to investors. This sign of "green light" created a safe legal corridor of waste discharge causing environmental degradation[1] (Quoc Thanh 2007).

Furthermore, the management of industrial wastewater in Vietnam and particularly in HCMC has experienced significant constraints. The majority of companies in industrial estates in HCMC are small and medium scale enterprises for which independent wastewater treatment facilities are not affordable. Most industrial parks usually charge companies for the quantity of incoming water used but not for the quantity of wastewater discharged. Additionally, enforcement of compliance with environmental standards of

[1] These words were translated from Vietnamese into English by the researcher, based on a newspaper article titled "Economic Growth and the Quality of Life in Ho Chi Minh City", issued on 4th October 2007, available at URL www.tuoitre.com/vn/Tianyon?index.aspx?ArticleID=222646&ChannelID=87.

wastewater is not fully conducted on a regular basis (Economy and Environment Program for Southeast Asia (EEPSEA) 2004; Le Quang Thong and Nguyen Ngoc Anh 2004).

Adding to this critical constraint, public participation is rarely exercised in environmental regulatory processes (Ho Chi Minh City Environmental Protection Agency-HEPA 2006; O'Rourke 2004). In Vietnam, there are not many local non-government organisations involved in pollution issues. Also, not much effort goes into creating effective or inclusive forms of public participation (O'Rourke 2004, p. 14) and there is little interest in democratisation among investors (Forsyth 1997). It is claimed that most public comment procedures in HCMC are merely superficial (Ho Chi Minh City Environmental Protection Agency-HEPA 2006). One researcher stated that community participation does not have any influence on many development projects. The project on "Environmental Improvement of Nhieu Loc-Thi Nghe Canal System, HCMC" is an example of the informal public participation procedure (Ho Chi Minh City Environmental Protection Agency-HEPA 2006).

Another drawback of water governance in Vietnam is the lack of effective exchange and management of data and information on water resources. While data and information collection is conducted and managed by different institutions, it is often difficult to access and utilise such data (Hansen and Do Hong Phan 2005). It is widely recognised that efficient exchange of data and information by agencies and effective access to information by stakeholders are prerequisites in the successful implementation of IWRM (Hansen and Do Hong Phan 2005; Petkova et al. 2002). From my own experience while conducting this research, I faced many impediments in finding information and data on urban water supply from SAWACO.

It is noted that the successful implementation of integrated water resources management in Vietnam will depend upon the government's willingness to initiate effective reforms (Hansen and Do Hong Phan 2005). Such reforms remain substantial challenges in the governance of water resources and environmental issues, including:

- Decentralising decision-making on development processes of central level in alignment with local levels (provinces and districts);

- Enabling decentralisation of ownership and autonomy in operation and management systems;
- Recognising and involving the intended roles and responsibilities of citizens and communities in water management;
- Improving coordination and collaboration between government sectors and across administrative boundaries;
- Improving effective mechanisms and practices for sharing knowledge, information and data among stakeholders;
- Restructuring redundant and ineffective government institutions dealing with water resources and environmental management.

Sources: Compiled by the author based on Hansen and Do Hong Phan (2005); World Bank (2002); World Bank et al. (2003).

With reference to water governance, urban water services in HCMC will be a critical point of water management. To achieve principles of IWRM: meeting inhabitant's basic needs and promoting their awareness in water conservation, a good scheme of water tariff should be an important tool. Makino (2002, pp. 1-4) proposes four key objectives for designing an efficient municipal water tariff and sanitation (Box 6.5). In addition, a successful model of municipal water supply in Hai Phong, Vietnam (ESCAP 2004) and the Singaporean experience in minimising water loss (McIntosh 2003) should be good approaches for Ho Chi Minh City. These models will be discussed in detail in Chapter 8.

Box 6.5 Key Objectives of Municipal Water Tariff Design

NOTE: This box is included on page 181 of the print copy of the thesis held in the University of Adelaide Library.

Source: Makino (2002, pp. 1-4).

6.7 Concluding Remarks

This chapter has explored the problems associated with sustainable water resources management, and in particular their origins in governance issues. For the management practice of water resources in HCMC specifically, the governance of water has no easy solutions. While it is not an insurmountable problem, seeking appropriate strategies to water management remains a considerable challenge. The challenges in the management water resources in HCMC include rethinking the way water resources can be governed effectively and redressing governance-related issues such as institutional frameworks, legislative systems, regulations and mechanisms for the concerted promotion of decentralisation, efficient participation of public, community and private sector. This objective is discussed in more detail in Chapters 7 and 8.

CHAPTER 7

RESULTS OF FIELDWORK AND SURVEY

7.1 Introduction

This chapter presents the results of fieldwork and survey conducted in Ho Chi Minh City during February and April 2005. The survey comprises two different sets of questionnaires (Appendix 9 and 10) for two groups: urban residents and government officials working in government water-related management agencies (Appendix 11). The questionnaire design, survey method and samples were described in Chapter 2. The first questionnaire set for urban dwellers consists of two parts and its aim is to find information on how residents value water resource, domestic water sources, status of urban water resources, urban water service practicalities, and its impact on their lives. Information on urban inhabitants' involvement in local practices of water usage, public awareness and participation in water resources issues is also described.

The questionnaire for government officials was designed to gather information regarding their agencies' responsibilities for water management, current water resources problems, causes of water problems, and obstructions to management. The study also used personal and interactive interviews with officials from local government authorities and researchers, experts and consultants from universities and institutions who have been working in the water field in HCMC. The interview was unstructured (covering key points) and flexible according to government officials' availability. During discussions, the author took many notes and cross-checked with government documents and reports. Most respondents discussed their concerns over water issues from their own perspective.

124 questionnaires (out of a total of 200) were returned from urban respondents and 46 questionnaires from government officials (out of a total of 60) with response rates of 62% and 75% respectively. The questionnaire was designed with many open questions and multiple questions where respondents can give more than one answer. The total sample size is 200 for public respondents in both inner and outer districts. There are more returned questionnaires from respondents who reside in districts facing with leading water issues.

Therefore, the results were calculated in percentage of respondents' responses of each question. For government respondents, the survey was designed to gather information from key government departments and divisions of natural resources and environment in 24 districts. The survey was supplemented by 17 sessions of formal discussions with government officials, university researchers, experts and consultants. The survey results presented below are the views of respondents on water or related issues in HCMC. After the fieldwork, respondents' responses were analysed, translated and recorded in Microsoft Word documents. The survey results are presented in charts, graphs and tables.

7.2 Geographical Setting of Field Site

7.2.1 Urban setting

Ho Chi Minh City, the biggest municipality in Vietnam, covers a total area of about 2,100 km^2 with 6.2 million people in mid-2005. With an annual population growth of 3.5%, the urban population is estimated to reach around 8-10 million in 2010. The administrative boundary comprises four levels: urban district (Quan), suburban district (Huyen), ward (Phuong) and commune (Xa). There are 19 urban districts and 5 outlying suburban districts (Table 7.1). Half of the urban districts are named by number from 1-12. Suburban districts occupy 79% of the city's total area and 16% of the total urban population. Eighty-four percent of the people lives in urban districts. There are five districts newly established from rural parts, including District 2, 7, 9, 12 and Thu Duc District.

Table 7.1 Urban Setting

Outlying Suburban Districts (Huyen)	Urban Districts (Quan)	
	Inner Districts (8)	Outer Districts (11)
Can Gio, Nha Be (coastal zone), Binh Chanh, Hoc Mon, Cu Chi	Dist 1, 3 , 4, 5, 10, 11, Phu Nhuan Dist, Binh Thanh Dist.	Dist 2, 6, 7, 8, 9, 12, Go Vap Dist, Tan Binh Dist, Tan Phu Dist, Binh Tan Dist, Thu Duc Dist.

The distribution of respondents in inner urban districts, outer urban districts and suburban districts is shown in Figure 7.1 and Figure 7.2.

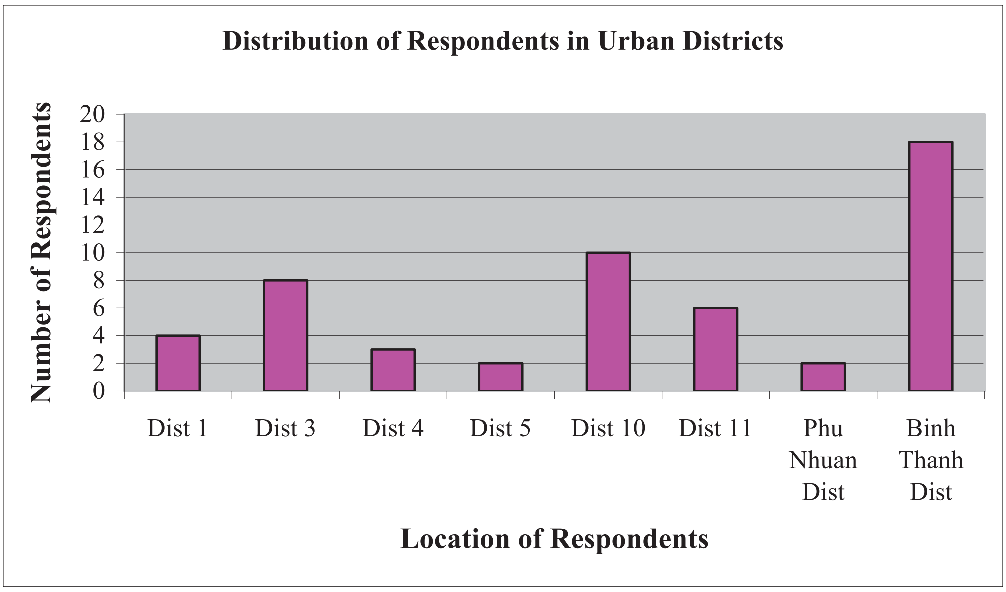


Figure 7.1 Distribution of Respondents in Urban Districts

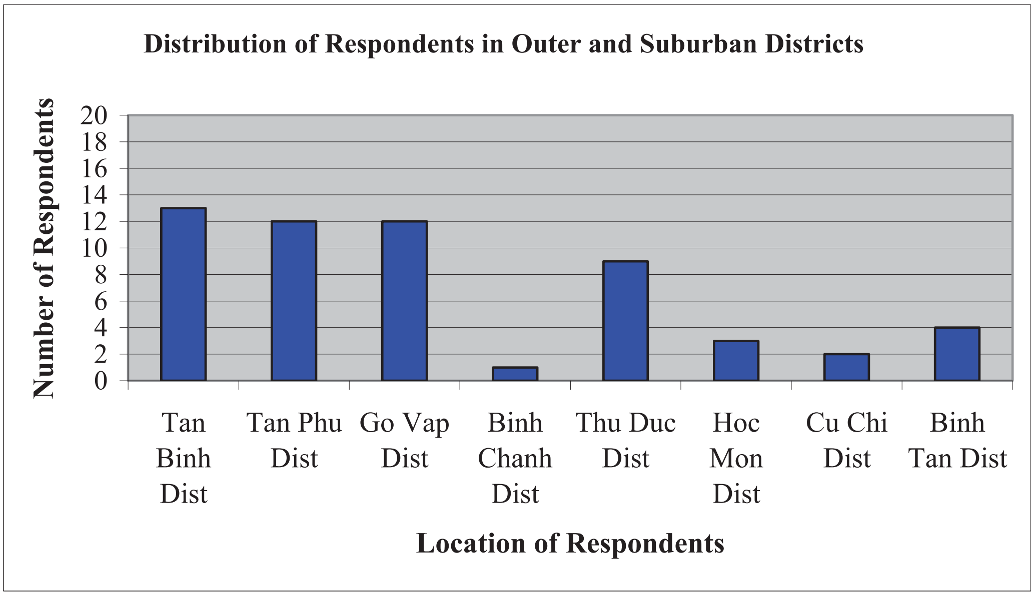


Figure 7.2 Distribution of Respondent in Outer Districts and Suburban Districts

7.2.2 Residency period of Respondents

Half of the respondents had been resident in Ho Chi Minh City for more than 20 years (50.8%). This means that their responses and comments on water resources issues reflect their personal experience in facing the issues concerning urban water resources. About 17% and 14% of respondents resided in HCMC between 10-15 years and 5-10 years respectively. Less than 10% of respondents had lived in HMC between 2 and 5 years.

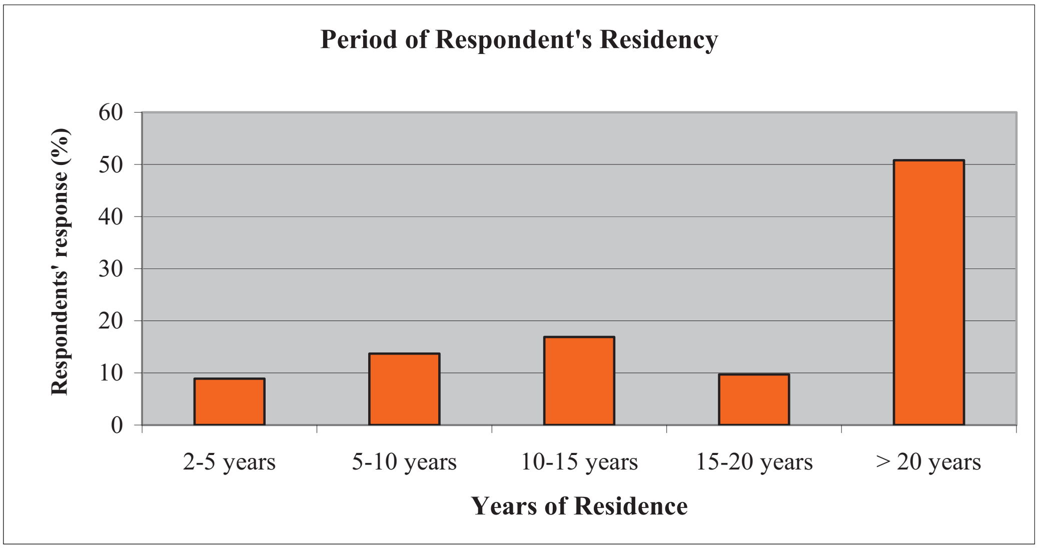


Figure 7.3 Respondents' period of Residency

7.3 Results from Public Responses

7.3.1 Urban Water Issues and Supply Services

7.3.1.1 Perception of Water Resource

The respondents have given three different perceptions on water resources. About 56% of respondents stated that water is a natural resource that needs to be preserved. Forty-two percent of respondents valued water as both a resource and an economic good or tradable good. Only a limited number of respondents (2%) considered that water is a resource for free use. Different people put different values on water resources, and so would behave differently in their use of water. This is the first investigation on how people in HCMC put a value on water resources. Most respondents said that water is simply a matter of turning on a tap and they are not concerned where water comes from and how can water be delivered to their taps. This finding has implications for local government and future water conservation programmes for which water resources should be viewed as both a social and economic good.

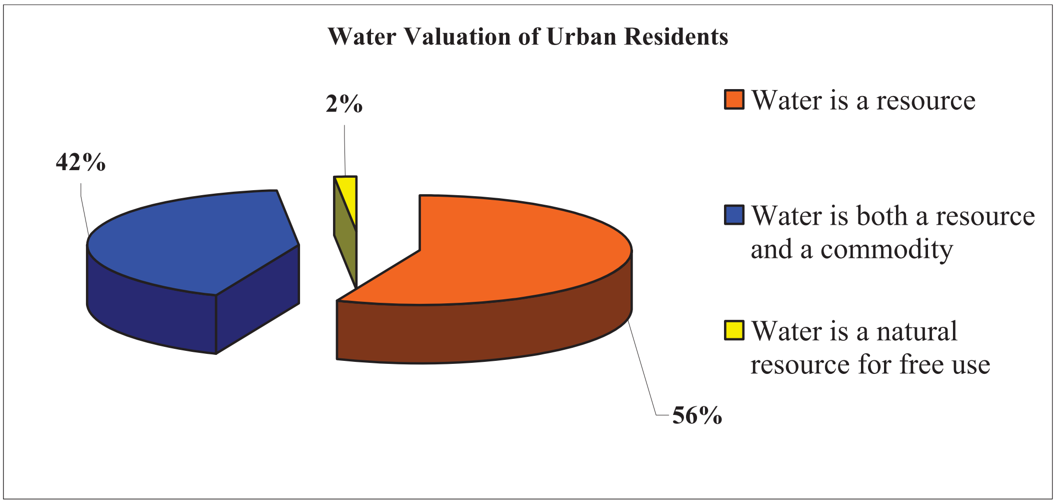


Figure 7.4 Respondents' Valuation of Water Resources

The majority of respondents put much emphasis on the current pattern of water use in HCMC as shown in Figure 7.5. Eighty-five percent (85%) of respondents believed that water is being wasted. While there is little emphasis on saving water, about 9% of respondents were unsure what to answer.

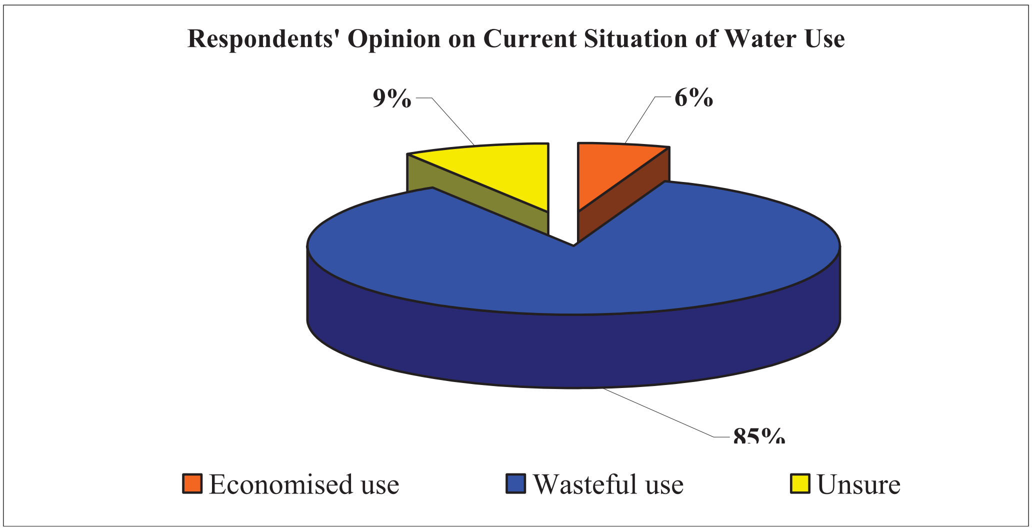


Figure 7.5 Current Water Use Pattern

7.3.1.2 Source of Water for Domestic Use

Piped water is currently the main source for domestic use in HCMC. About 48% of respondents are using mains water provided by the government-owned company, Sai Gon Water Supply Company (SAWACO). However, 35.5% of respondents use groundwater for domestic use from their own wells. Another 16% of respondents claimed that both piped water and groundwater were the main sources for their domestic use.

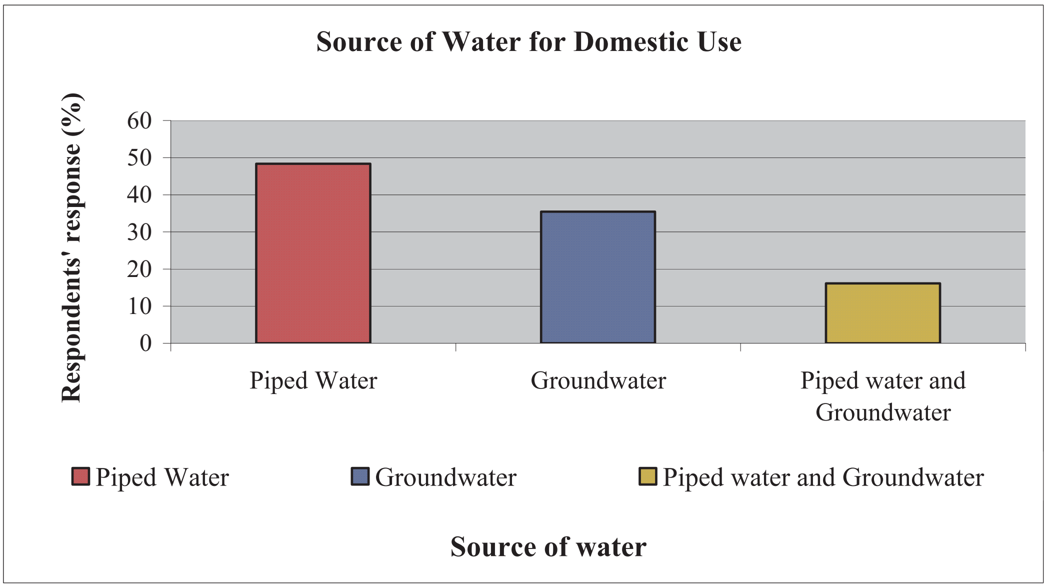


Figure 7.6 Source of Water for Domestic Use

7.3.1.3 Water Quality and Quantity

While piped water is the main source for urban dwellers, the overall quality and quantity of water vary across HCMC's suburbs. An average of 42% of respondents stated that water for domestic use is not good quality, although there is sufficient quantity. Conversely, only 17% of respondents claimed the quantity of water is insufficient. While 26% of respondents were satisfied with both the quantity and quality of water supply, about 15% of respondents believed that both the quantity and quality of water did not satisfy their domestic purposes.

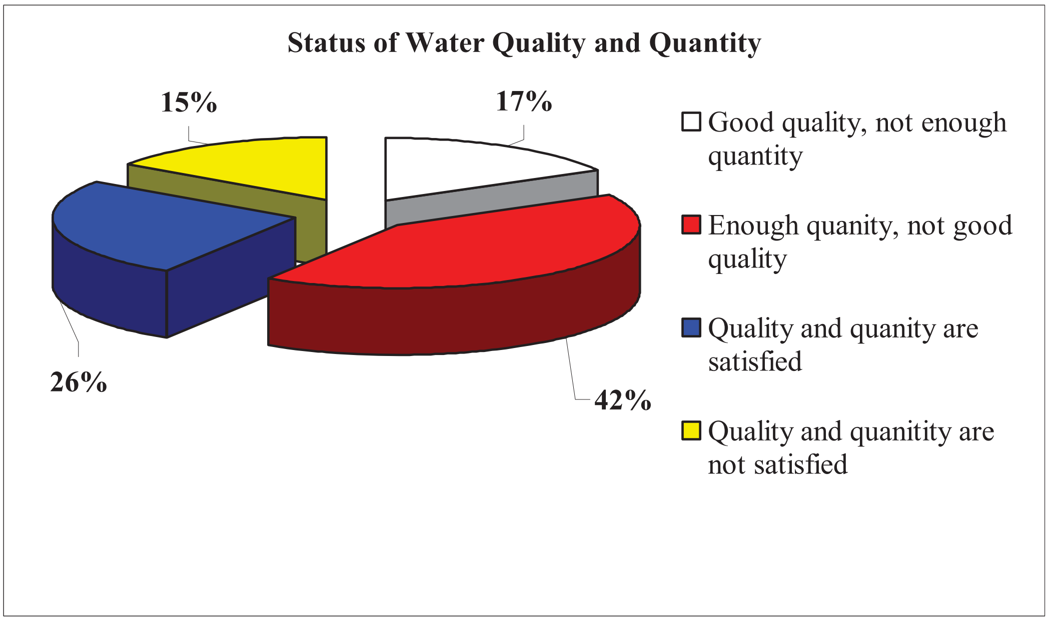


Figure 7.7 State of Urban Water Quantity and Quality in Ho Chi Minh City

7.3.1.4 Concerned Issues of Urban Water Supply Services

There were different opinions regarding urban water supply services. Respondents claimed that they had experienced various supply problems during the dry season, including insufficient water for domestic purposes, inadequate quality and intermittent supply. About 48% of mains water respondents put much emphasis on the quality of water and 12% of responses referred to clean water provided by the Sai Gon Water Supply Company (SAWACO). This reflects the fact that quality of water supply emerged as a key issue for HCMC's residents via the local media during 2005-2006 (Mai Vong and Dinh Muoi 2006; Tuoi Tre Online 2006; VNexpress 2006c, 2006d). There were many debates over the reasons for contaminated mains water in HCMC. Media news on this issue is presented in Appendix 12. Increased turbidity and the presence of bacteria were the factors causing contaminated water for which the Sai Gon River was the main intake source for the Tan Hiep Water Treatment Plant (operated by SAWACO).

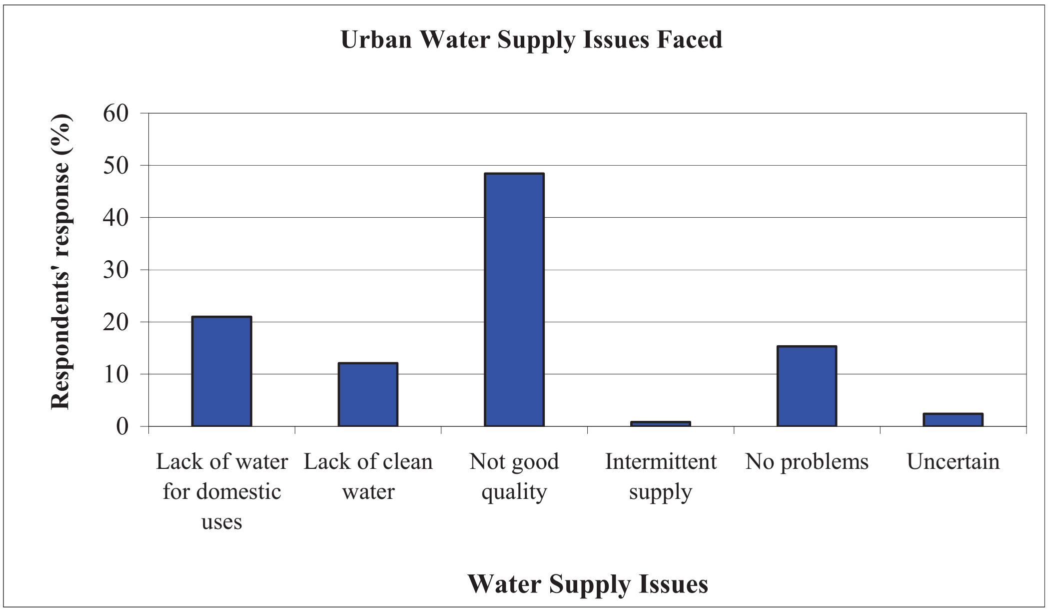


Figure 7.8 Concerns over of Urban Water Supply

Approximately 21% of respondents were faced with insufficient water for household use. At the same time, about 15% of respondents believed that they did not face any issues of water supply and nearly 2.5% of respondents were not sure (Figure 7.8). Adding to the concerns over water supply, there are significant complaints about difficulties in using mains water (Figure 7.9). These respondents' complaints include an unavailable pipeline system (22%), leakage and weak pressure of water supply (31% and 35% of respondents).

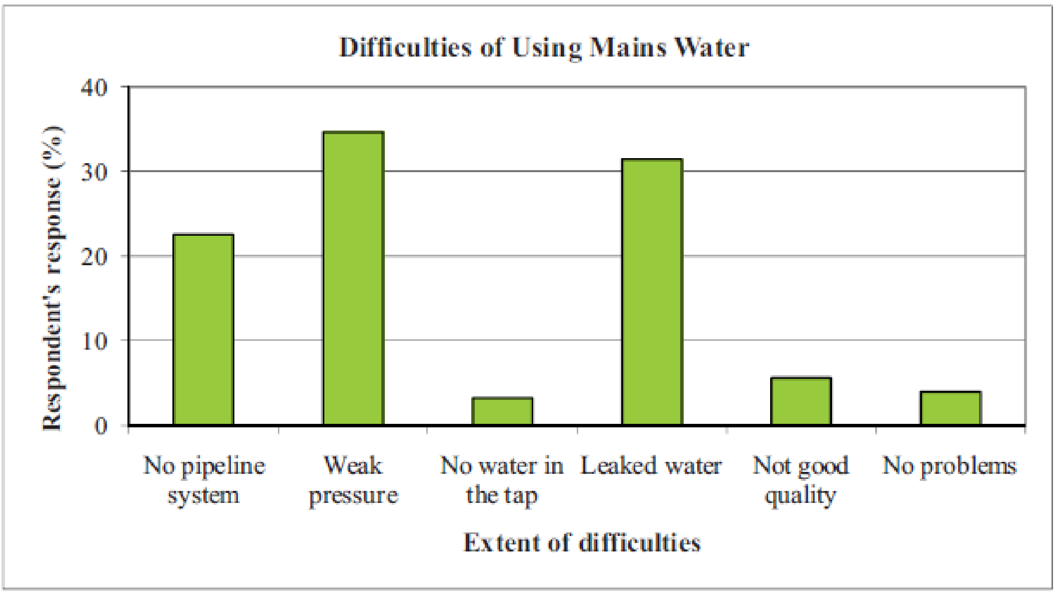


Figure 7.9 Difficulties of Using Mains Water

NOTE: This figure is included on page 191 of the print copy of the thesis held in the University of Adelaide Library.

Nha Be, a suburban district, faced water shortage reported in an article titled "*Nha Be: People are thirsty!*", Tuoi Tre, Friday 18 March 2005.

Tapping and storing clean water for household use in District 7. Photo was taken by the author in March 2005.

7.3.1.5 Water Price and Willingness to Pay for Good Service

Apart from concerns over the supply service, the price of supplied water and the willingness to pay for better service are also addressed by respondents who are using mains water provided by SAWACO. While 37% of respondents viewed the price of water as expensive, 33% of them believed water was supplied at a reasonable price. However, about 30% of respondents did not comment on this issue. This can be interpreted as meaning that urban residents are still unsure or unaware of the cost of water paid by them.

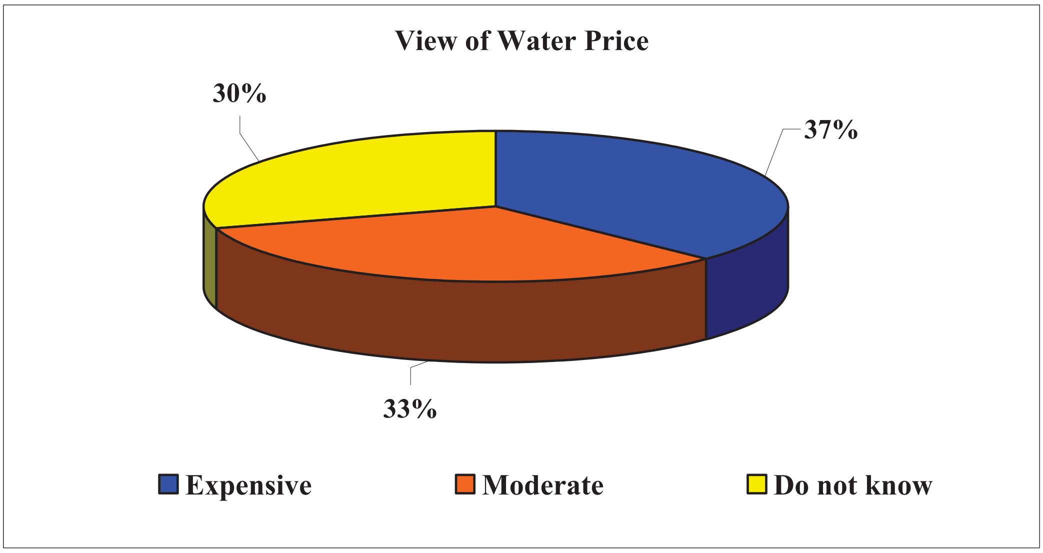


Figure 7.10 Views of Water Price

In relation to the willingness to pay for better services, the majority of respondents (56.5%) were willing to pay for future improvement and better quality of supply services. However, 33% of respondents were not willing to pay and about 10% of them wavered on this point (Figure 7.11).

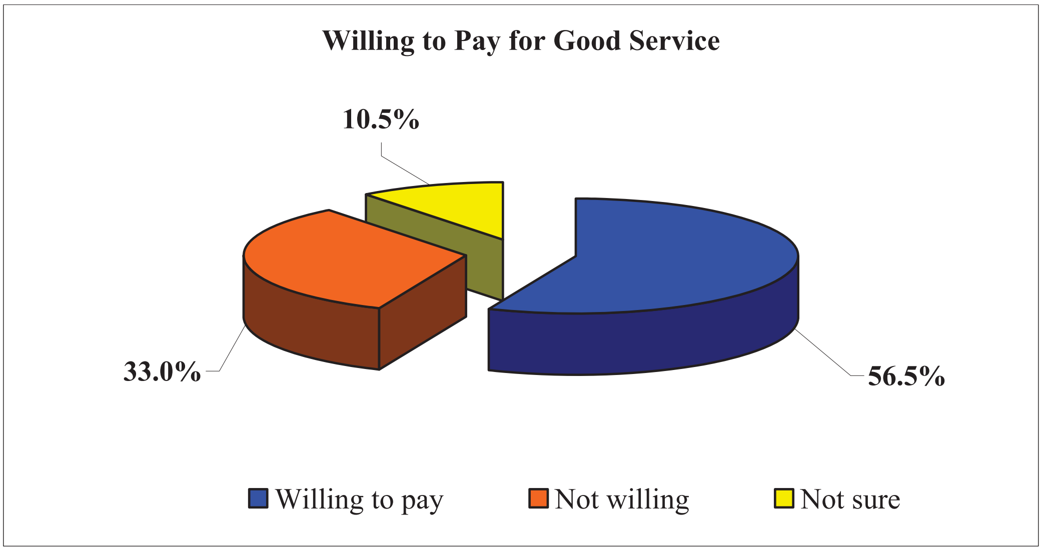


Figure 7.11 Respondents' Willingness to Pay for Service

7.3.1.6 Public Content of Water Supply Service

The overall level of public content with the current water supply services varied greatly (Figure 7.12). The majority of respondents (46.8%) maintained that they were not pleased with the service supplied by the water company (SAWACO). In contrast, 36% of respondents were content with the service and about 17% of them did not know about the activities supplied. These results have implications for urban water supply service. Firstly, the state-owned water supply company (SAWACO) should review and improve its supply services to end users in terms of quality, availability and pricing. Secondly, public awareness of water supply, as a basic service need, is poor.

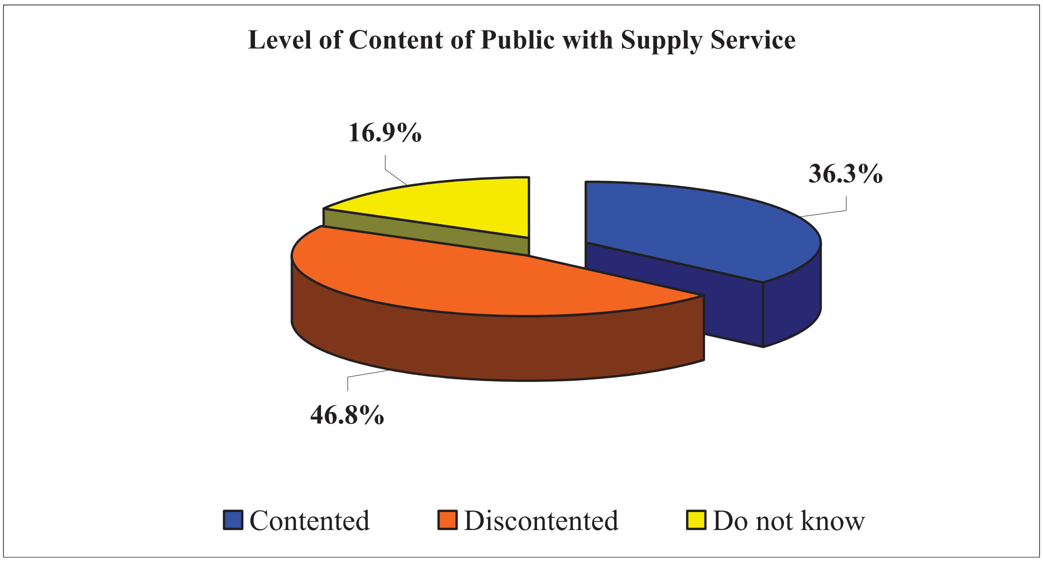


Figure 7.12 Contentedness of Public regarding Water Supply Service

7.3.1.7 Drawbacks of Using Groundwater

For those urban inhabitants using groundwater, most respondents (64%) believed that the quality of groundwater was not satisfactory. Less than 10% of respondents (8.1%) claimed that they have not had enough water from groundwater withdrawals. However, 20% of respondents were uncertain about how to answer.

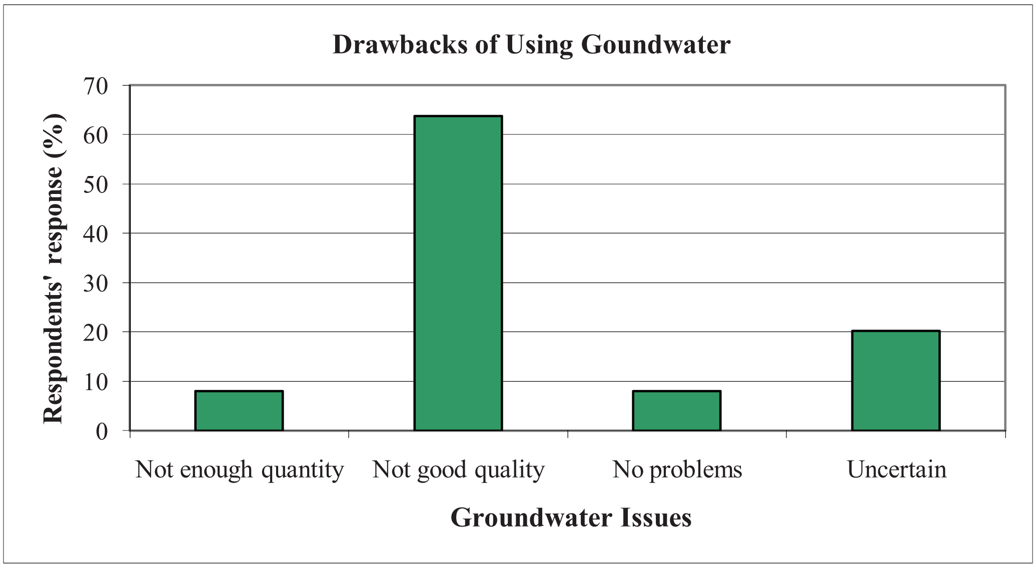


Figure 7.13 The Extent of Groundwater Issues

7.3.2 Related Issues of Water Resources

The various responses relating to water resources and awareness are discussed below.

7.3.2.1 Public Perception of Water Resource Issues

Most respondents (93.6%) stated that they were aware of water resource issues, but did not have much knowledge about them. Only 6.5% of respondents did not have any knowledge about water resources. Figure 7.14 shows respondents' perceptions of water issues and it means that the majority of respondents do not adequately understand the issues. The local government of HCMC should act on how to deliver sufficient and relevant knowledge and to improve public involvement.

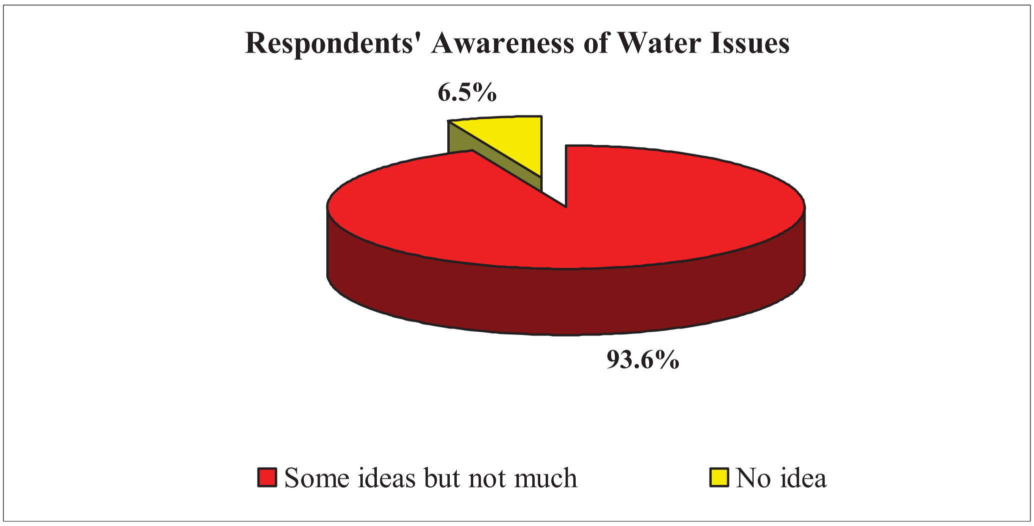


Figure 7.14 Respondents' awareness of Water Issues

More importantly, just over half of respondents (53%) claimed that they never receive information on the city's water resources. About 30% of respondents can access water information while 16% of respondents were uncertain (Figure 7.15). This can be understood as respondents having few channels to access adequate information. Future approaches to water resources management in HCMC should consider how information can be channeled to the inhabitants.

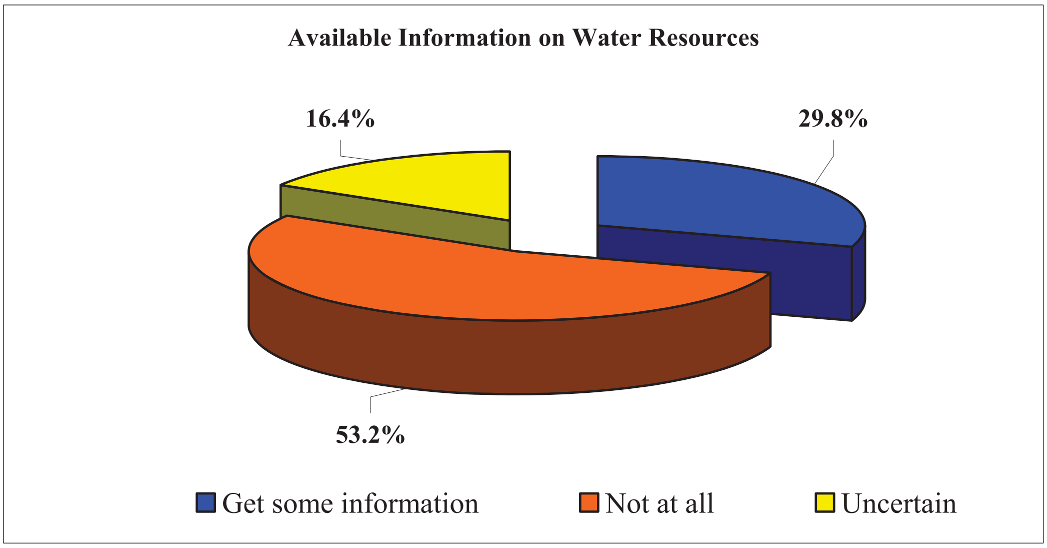


Figure 7.15 Available Information on Water Resources Issues

7.3.2.2 Problems Encountered with Water Resources

The comments shown in Figure 7.16 identify some respondents' perceptions of water resources problems. A majority of respondents (53%) considered water pollution (rivers and canals) as one of the most critical water issues facing them during their residency in HCMC. Similarly, more than 50% of respondents believed that there was not enough water and about 27% of respondents stressed inadequate quality for domestic use. At the same time, 26% of respondents indicated that too much water also caused floods in the wet season. In addition, the degradation and diminution of groundwater also drew a significant response by respondents (34%). These results fairly reflect the existing water resources problems as discussed in Chapter 4.

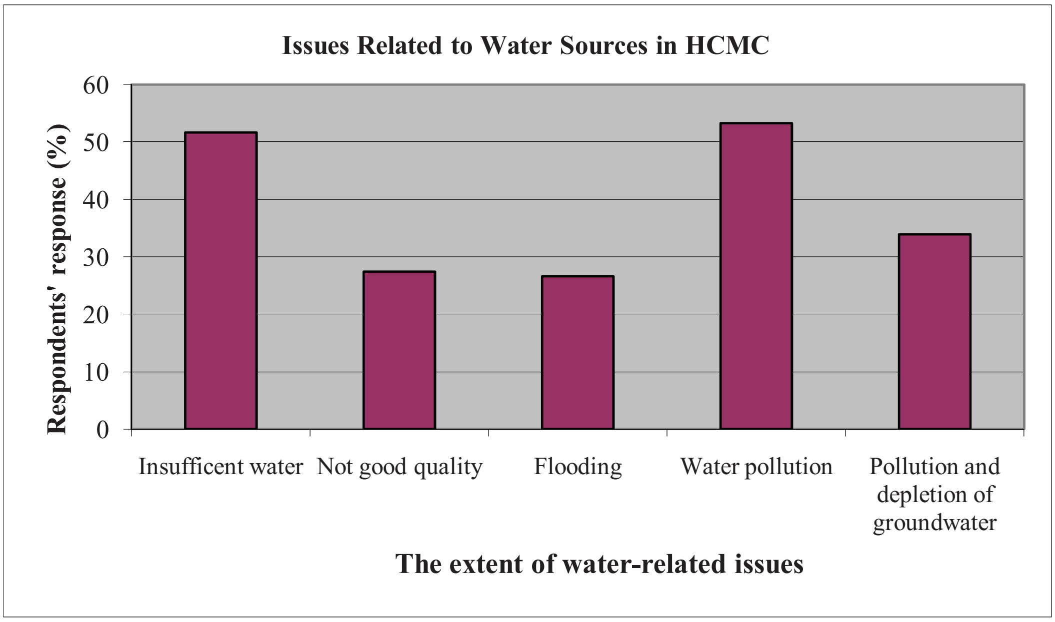
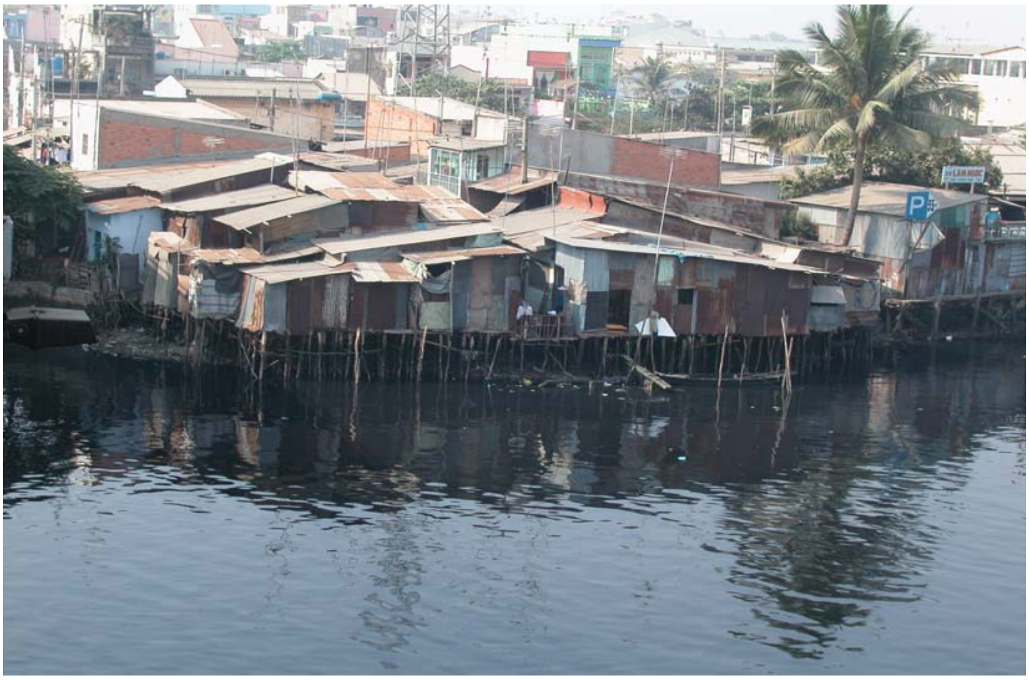


Figure 7.16 Issues Related to Water Resources in HCMC



Marginal settlements causing serious pollution of the Tau Hu- Ben Nghe canal system (black colour), District 8, HCMC. Photo was taken by the author, February 2005.

Municipal solid wastes were dumped in the Tau Hu- Ben Nghe canal, District 8, HCMC. Photo was taken by the author, February 2005.

Domestic wastewater discharged directly into the Nhieu Loc-Thi Nghe Canal system, District 3, HCMC. Photo was taken by the author, February 2005.

Industrial wastewater caused ‘red colour’ to appear in the Tham Luong- Vam Thuat Canal system, District 12, HCMC. Photo was taken by the author, February 2005.

Furthermore, most respondents (83.9%) emphasised the threat of water stress in the dry season. There is little emphasis (7.3%) put on the possible threat of water scarcity, while less than 10% of respondents were uncertain about how to answer.

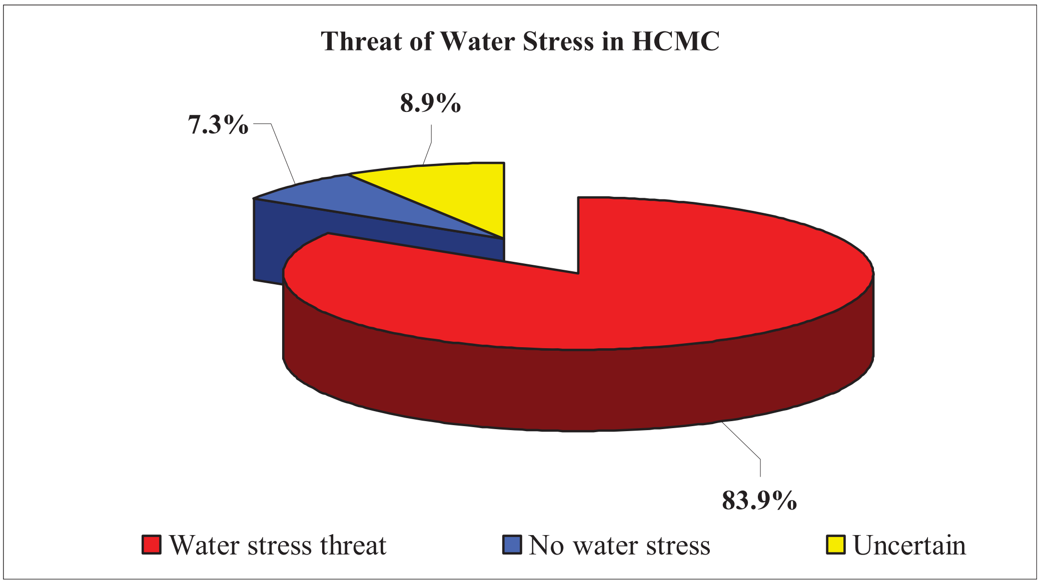


Figure 7.17 Threat of Water Stress in Ho Chi Minh City

7.3.2.3 Public Concerns about Local Government Management Practices

It is interesting to explore why most respondents (76.6%) said that they had many concerns as to how the government authority manages the city's water resources; Figure 7.14 shows they have little knowledge of water. About 21% of respondents were not concerned with the government's management. A minority of respondents (2.4%) were uncertain (Figure 7.18). For those who were interested in government action, 26.6% of respondents reported that they were satisfied with management as it was conducted while approximately 44% were not satisfied and 29% were unsure.

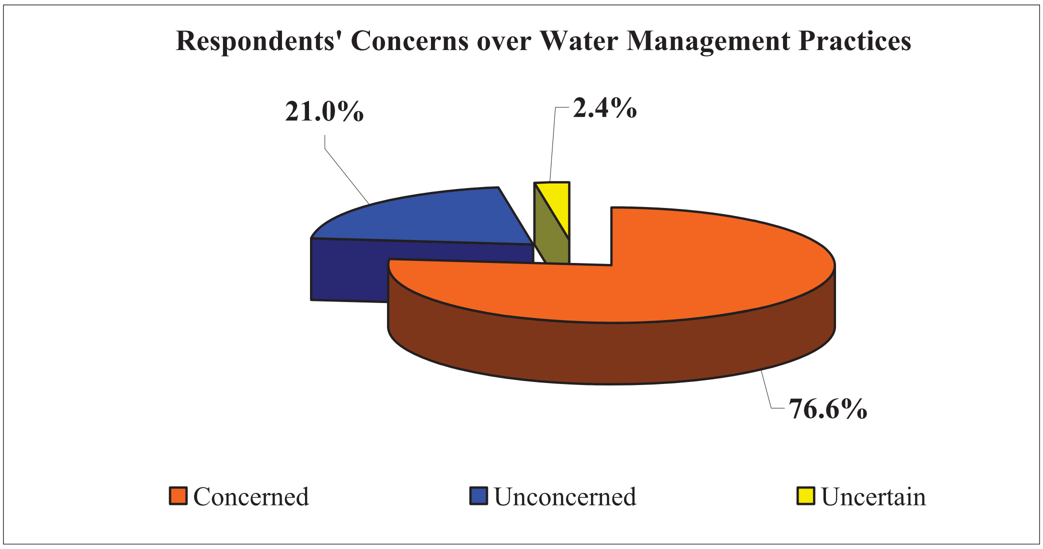


Figure 7.18 Concerns about Water Management Practices

7.3.2.4 Privatisation in the Water Sector

In terms of privatisation in the water sector, the majority of respondents (79%) strongly supported the participation of the private sector in water management. Less than 10% of respondents did not put a strong emphasis on the private sector, and 12% of respondents were still unsure. Figure 7.19 presents respondents' opinions on privatisation in the household sector.

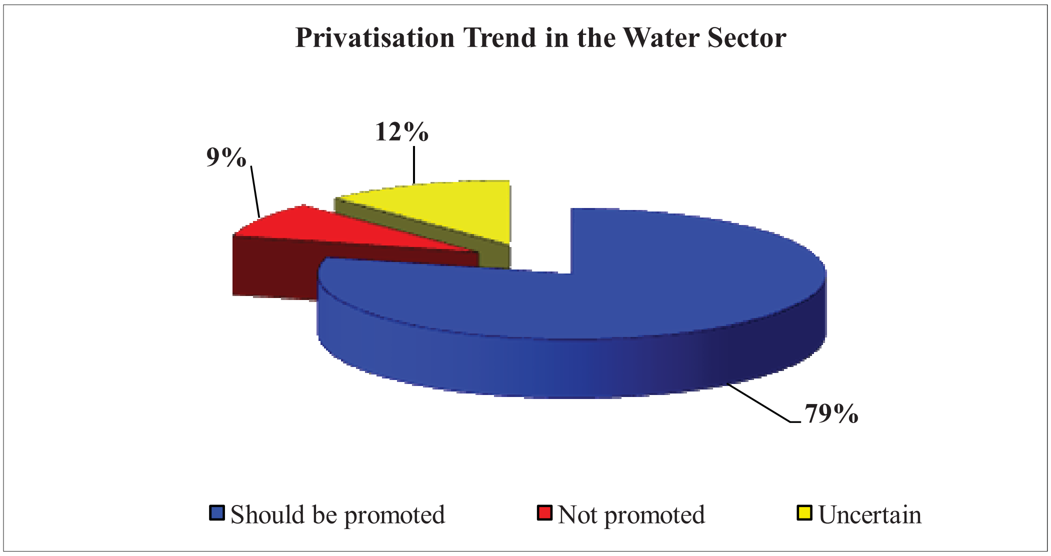


Figure 7.19 Respondents' Opinions on Involvement of the Private Sector

7.3.2.5 Awareness of and Preference for Alternative Sources

Residents were asked in the questionnaire to comment on the potential harvesting of rainwater because HCMC is endowed with abundant rainwater with 85% of rainfall in the wet season. Figure 7.20 shows that about 40% of respondents believed that they would use rainwater if it was clean. In contrast, 44% of respondents were not ready to harvest rainwater for use, and 15% of respondents remained unsure.

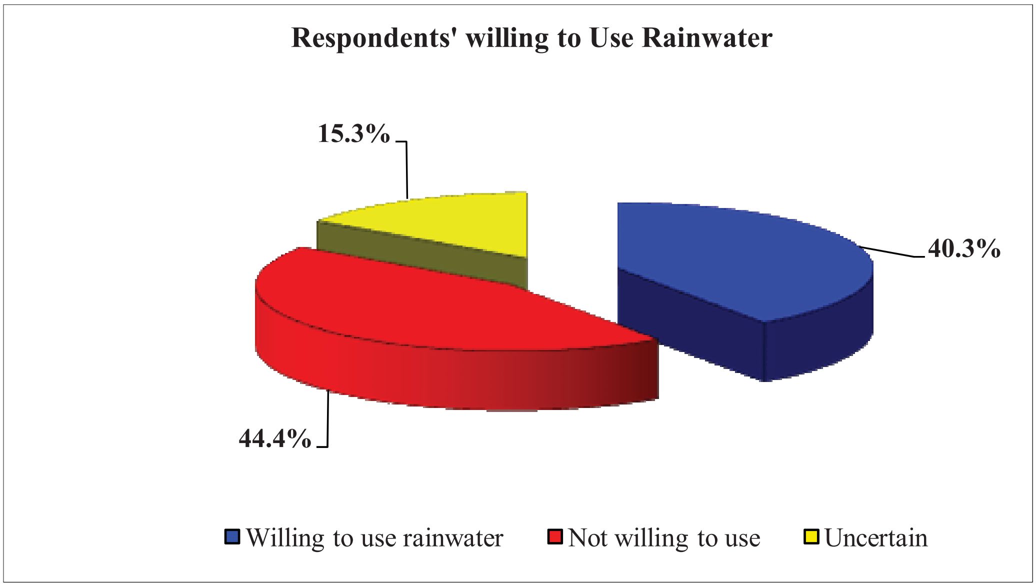


Figure 7.20 Potential Utilisation of Rainwater

Interestingly, rainwater received a high preference as an alternative supply source (Figure 7.21). The majority of respondents (71%) were ready to choose rainwater as an alternative source if it was well collected, properly treated and separated from domestic wastewater systems. Twelve percent of respondents were unsure and about 16% of respondents would not choose rainwater for future use.

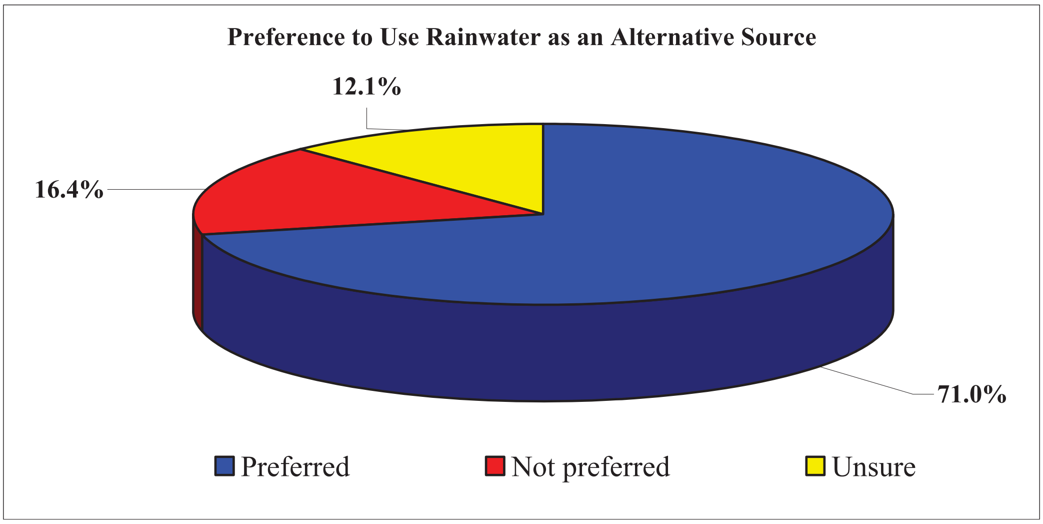
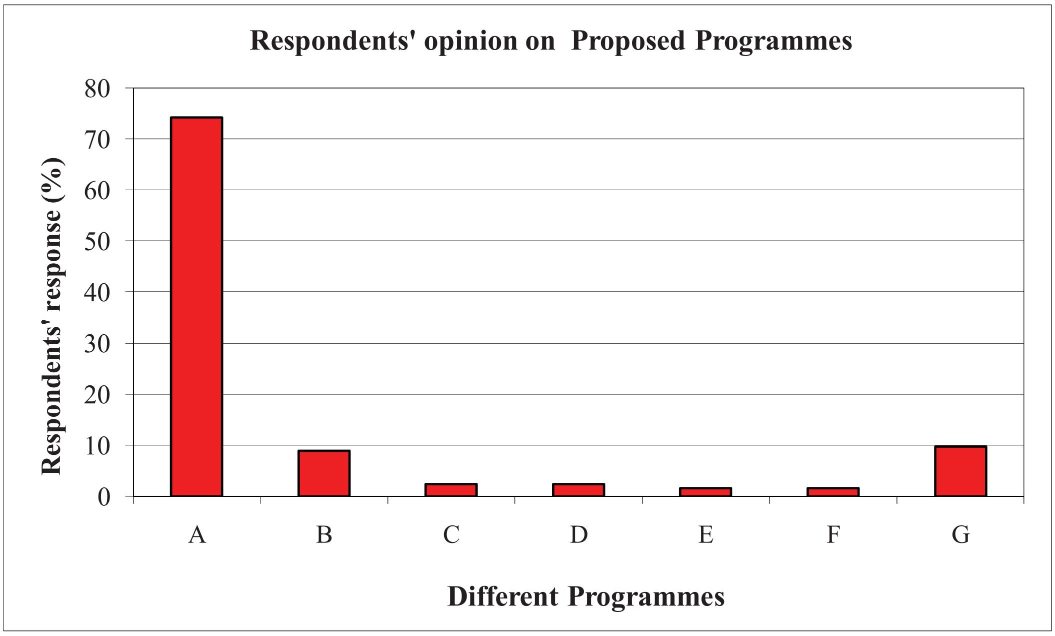


Figure 7.21 Preferences regarding Rainwater Use

7.3.2.6 Community's participation in Water Conservation

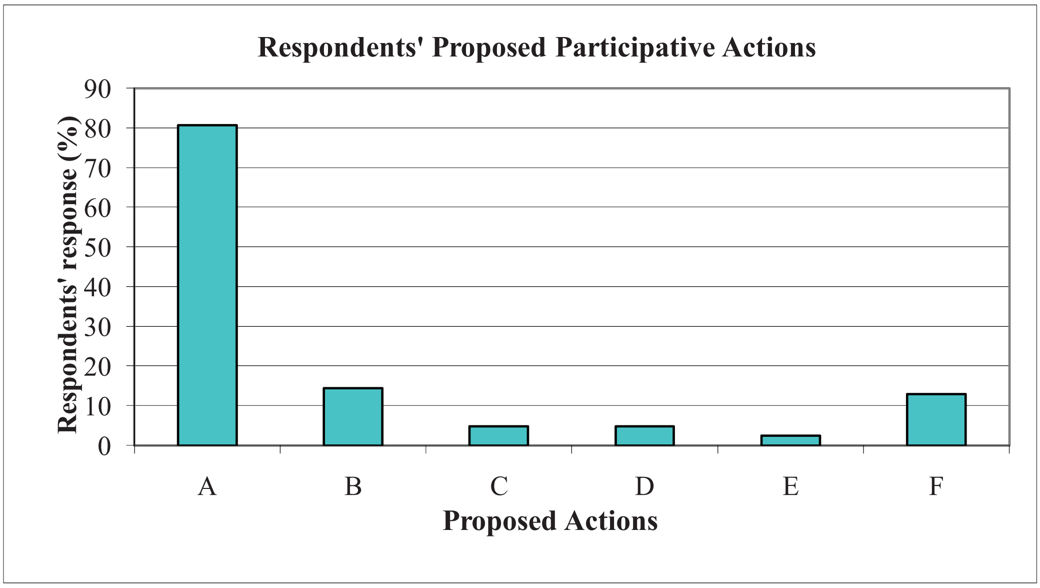
Figures 7.14 and 7.15 show that respondents are limited in accessing knowledge about the city's water resources. This is explored through respondents' opinions on the ways in which local government should act to enhance community understanding (Figure 7.22). The majority of respondents (74%) suggested that the city's authority should disseminate information to various stakeholders. Nine percent of respondents claimed that knowledge of environmental awareness should be delivered at all levels of school. A minority of respondents believed that they would become well informed about water issues through government programmes on distribution network systems (2.4%), and supply service improvement (2.4%). However, 10% of respondents were unsure.



A- Disseminating knowledge and information on water resources issues.
B- Introducing environmental education into all schoo levels.
C- Distribution pipeline network improvement.
D- Water supply services improvement. E- Private promotion programme.
F- Water conservation programme. G- Uncertain.

Figure 7.22 Government Programmes on Raising Community Awareness

Urban dwellers expressed their proposed contribution when they were asked about the challenge of future water scarcity. The results show varying respondents' opinions on actions for water conservation (Figure 7.23). Most respondents (80.7%) indicated that they would contribute to the protection and management of water resources by preserving water in daily use; 14.5% of respondents stated that active participation in community campaigns for water conservation is possible. Both harvesting of rainwater and re-using water for other purposes were proposed (5%). However, 13% of respondents remained unsure.



A- Preserving water through daily uses.
B- Active participation into community's campaigns.
C- Using rainwater as an alternative source.
D- Reuse water for other purposes.
E- Treating water before discharging
F- Uncertain.

Figure 7.23 Proposed Actions to Conserve Water

7.4 Findings from Government Agencies and Officials

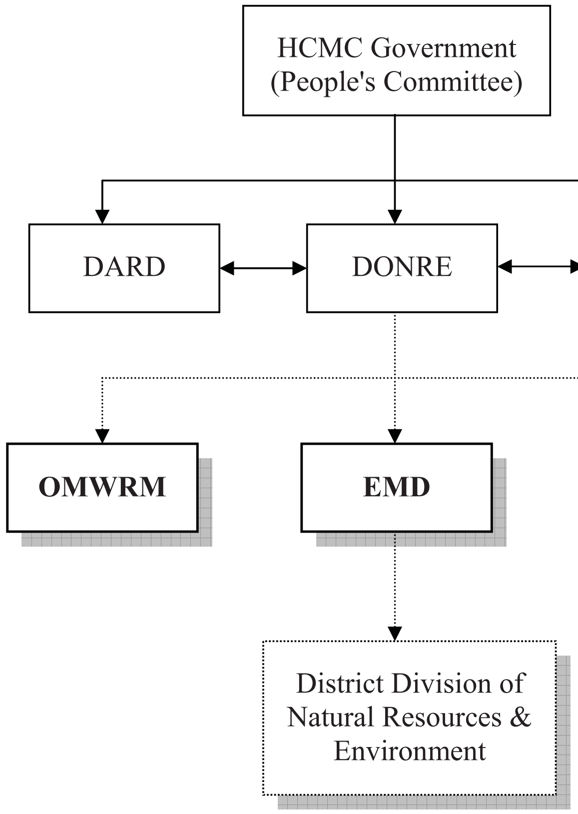
7.4.1 Government Organisations and Responsibilities for Water Resources

The question was designed to elicit information on water resources issues and management practices as viewed by government/agency officials. Only 46 officials returned the survey questionnaire and 17 senior people agreed to further discussions (Table 7.2). These people are managers in government agencies, researchers in government institutions and consultants from universities. The list of respondents and interviewees is provided in Appendix 11.

Table 7.2 Name of Government Water Management Agencies

Name of organisation	**Number of respondents**	**Percent (%)**
Environmental Management Division (EMD), Department of Natural Resources & Environment (DONRE)	5	11
Ho Chi Minh City Environmental Protection Agency (HEPA), DONRE	5	11
Districts' Divisions of Natural Resources & Environment	22	48
Office of Mineral and Water Resources Management (MWRM), DONRE	10	21.5
Tan Tao Industrial Park	4	8.5
Total	**46**	**100**

Responsibilities for water resources issues vary between agencies. Some agencies have multiple functions in terms of regulating and implementing. In HCMC, the Department of Natural Resources & Environment, known as DONRE, is an umbrella government agency taking various responsibilities in the management of land and water resources. Its missions combine regulating and implementing practices. The Environmental Management Division (EMD), the HCMC Environmental Protection Agency (HEPA) and Office of Mineral & Water Resources Management (OMWRM) are subordinate bodies under the auspices of DONRE. The organisational structure of DONRE in HCMC is illustrated in the following flow chart.



DARD :Department of Agricultural & Rural Development

DI : Department of Industry

DONRE : Department of Natural Resources & Environment

EMD : Environmental Management Division

HEPA : Ho Chi Minh City Environmental Protection Agency

OMWRM : Office of Mineral & Water Resources Management

Both EMD and HEPA are mandated to act as consulting bodies to the director of DONRE. Functions and missions of EMD and HEPA are discussed in Chapter 4. However, in terms of practical activities, HEPA and EMD are an implementing agency and a regulating agency, respectively. In addition, each urban district has a managerial unit for natural resources and the environment - the District Division of Natural Resources & Environment - which is responsible for land and water resources management within the administrative district's boundary. District Divisions are directly regulated by EMD. The following officials' responses depict various legislative responsibilities that agencies have. Table 7.3 presents the functions and responsibilities of government organisations.

- For water resources management, OMWRM is responsible for a wide range of activities, comprising: baseline investigating, monitoring, assessing water resources in accordance with guidelines of MONRE. It also takes responsibility for appraising, inspecting environmental impacts caused by water exploitation projects; and managing water utilisation pilots, water resource protection projects. OMWRM is reserving data on groundwater in Ho Chi Minh City, which is transferred from DARD (OWRMM, 2005).

- Basically, HEPA has responsibilities for water and air quality monitoring, cleaner production promotion and education. HEPA is also responsible to inspect and collect fees/charges on wastewater discharge from industrial companies, enterprises both small and medium scale (HEPM1, 2005).

- The function of the Division is to be an advisory division to the director of DONRE. Its responsibilities cover a wide range of environmental issues, including issuing environmental regulations, documents; appraising, licensing and revoking permits as well as dealing with environmental risks (EMDM, 2005).

- With respect to water resource management, there is an overlapping function between DEM and HEPA. DEM is empowered to inspect policy compliance from industrial sectors regarding wastewater discharge and water use. This function commonly repeats action taken by HEPA towards industries. HEPA takes its authority to inspect and inventory the volume of wastewater discharge into the environment based on current industries wastewater charges (EMDM, 2005).

- The Unit of Natural Resources & Environment was assigned to undertake functions of environmental management in which water management is a part. However, activities of the Unit are under the guidance of EMD, DORNE, and it has to report directly to District People's Committee and EMD in urgent situations (DNREO1, 2005).

- I have been working at HEPA as a staff in charge of on-site inspection in many industrial factories. As far as it goes, my major duty is to collect fees/charges on wastewater discharge from various enterprises. You may ask me how and on what basis we implement this regulation. Simply, we conduct inspections based on industries' reports on environmental assessment, and we ask that they comply with what was reported (HEPO1, 2005).

- My organisation is a state company, managed by the Department of Transport and Public Works (DTPWs). It is responsible for building and maintaining urban drainage systems in Ho Chi Minh City. Its function and responsibility are to ensure drainage systems work well and to mitigate floods in urban areas during the wet weather (UDCO, 2005).

Table 7.3 Responsibilities for Water Resources Issues

Organisations' responsibility	Frequency	Percent (%)
Managing water resources in HCMC	14	27.5
Managing water resources within administrative district's boundary	16	31.4
Monitoring and assessing the city's water resources quality	6	11.8
Consulting to DONRE	4	7.8
Exploiting groundwater and providing services to industrial purposes within industrial park area	4	7.8
Collecting domestic levy and groundwater exploitation fee	3	5.9
Collecting industrial wastewater levy	1	1.9
Uncertain responsibilities	3	5.9

Most respondents (91.3%) believed that their agencies' functions are closely related to the management practices of water resources in HCMC. Only 8.7% of respondents stated that their organisations' responsibilities are non-water-related.

7.4.2 Provision of Information and Data on Water Resources

There were important findings from government officials when they were asked to provide information on the distribution of water for HCMC and pattern of water use between sectors. Data provided by the respondents are totally different from ones in the literature (government reports and guidelines) that the author retrieved. Data provided are also patchy between respondents. A significant number of respondents did not provide any data with some statements marked "unsure" and others left the question blank. This means information sharing did not exist in practice and government agency respondents did not receive any help in their sphere of management. The responses from government managers and officials also indicate capacity constraints. In terms of water sources and distribution of water use between sectors, about 61% and 52% of respondents provided answers although there are many disparities in data given. Forty percent and 48% of respondents could not provide data on water use and sources in HCMC.

- Despite various functions and responsibilities, HEPA is lacking in human resources. Most of its staff are young, inexperienced and have inadequate background knowledge. This is associated with new organisations; HEPA would face challenges in dealing with environmental issues (HEPM1, 2005).

- Water is a key resource of this city. However, this subject has not received significant attention from the city's leadership. It relates to the management of government capacity rather than know-how technology (IRER, 2005).

- In my opinion, many government staff are certainly under trained, have not enough experience, lack relevant background knowledge and might not conduct their obligations thoroughly (IPO1, 2005).

7.4.3 Valuation Pattern of Water

There is not much difference of opinion in the valuation of water between residential respondents and government respondents (Figure 7.24). Nearly half of respondents (49%) believed that water should be valued as both a resource (social resource) and an economic good. Forty-seven percent of respondents emphasised that water is a specific resource, but only 4% of respondents defined water as a (tradable) good.

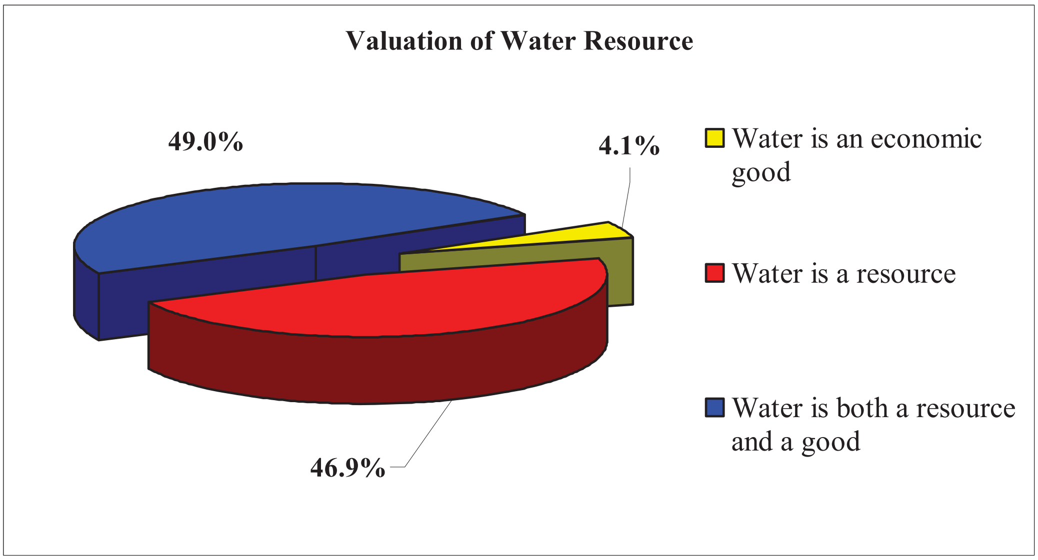


Figure 7.24 Different Values Attached to Water

7.4.4 Water Availability and Water Shortage

Fifty percent of respondents (50%) stated that there are insufficient supplies, and about 35% of respondents believed that HCMC has enough water supplies. In contrast, a limited number of respondents (2%) maintained that it is insufficient at present, but will be enough in the future. About 13% of respondents were uncertain (Figure 7.25).

- It is paradoxically said that Ho Chi Minh City will not have enough water to use. But it is true for recent years, as people have faced water shortage during the dry season (DNREO2, 2005).

- The issues of water stress were repeatedly and extensively mentioned in the media. They are local issues as different urban areas face different water problems. However, they can be categorised into typical issues encountered by urban residents: water shortage in the dry weather; surface water pollution; groundwater pollution and exhaustion; flooding in the wet season and tidal surge (UCON1, 2005).

- As a suburban district and located in brackish water-adjacent region, Can Gio always faces freshwater shortage around the year. People have to buy water from vendor or private providers who convey freshwater from the inner City to sell here by boats (DNREO2, 2005).

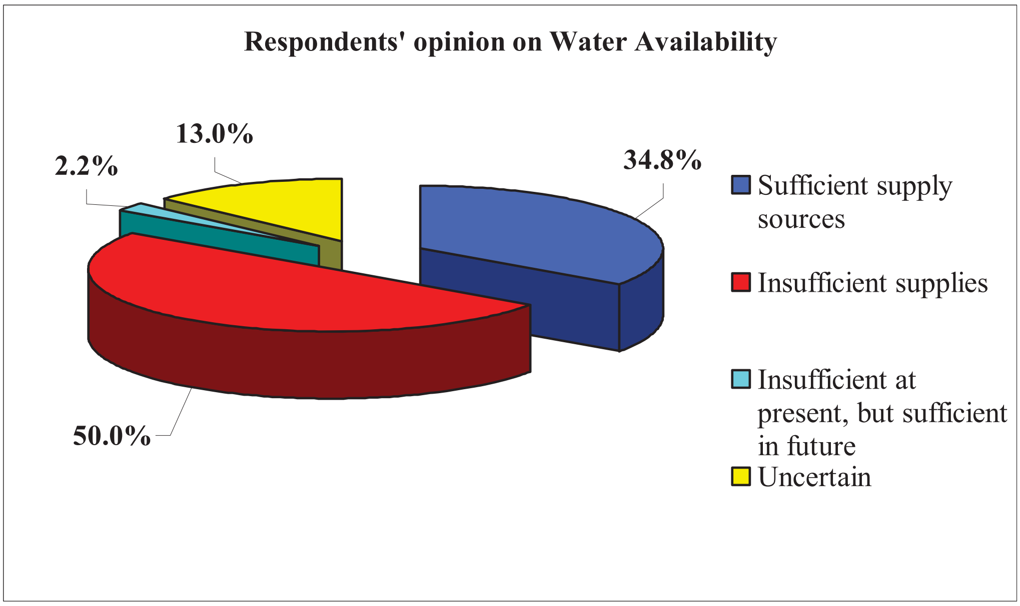


Figure 7.25 Water Availability

Regarding water and household consumption, there were different opinions over satisfaction with water quality and quantity. Fifty percent of respondents (50%) claimed that both the quality and quantity of water were not satisfactory, and only 13% of respondents stated that both quantity and quality met domestic purposes. Conversely, 28% of respondents believed that the city's water is of good quality but there is not enough. Eight percent of respondents said water quality is not good enough for household use (Figure 7.26).

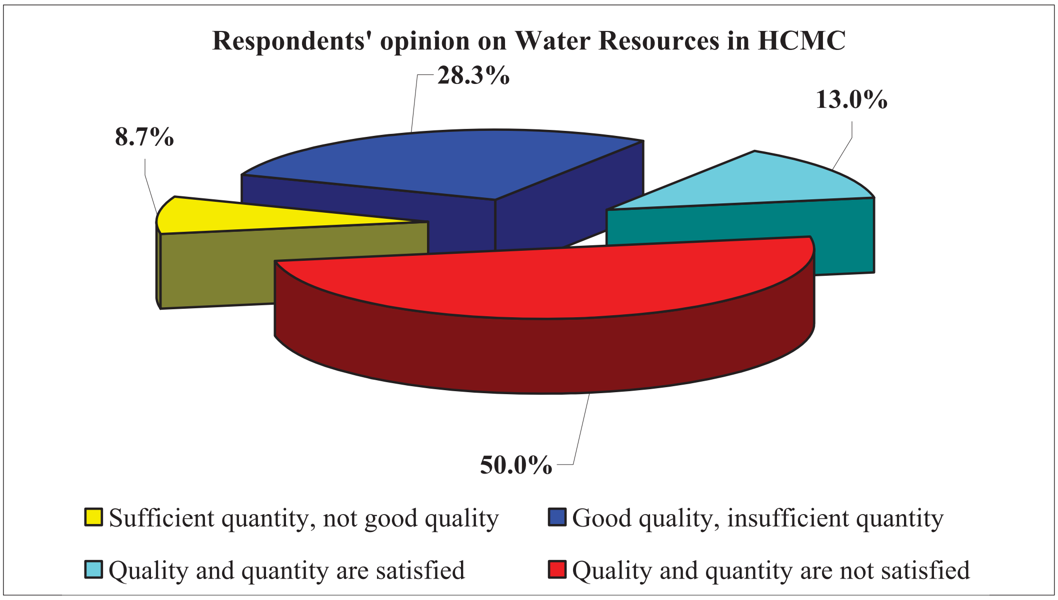
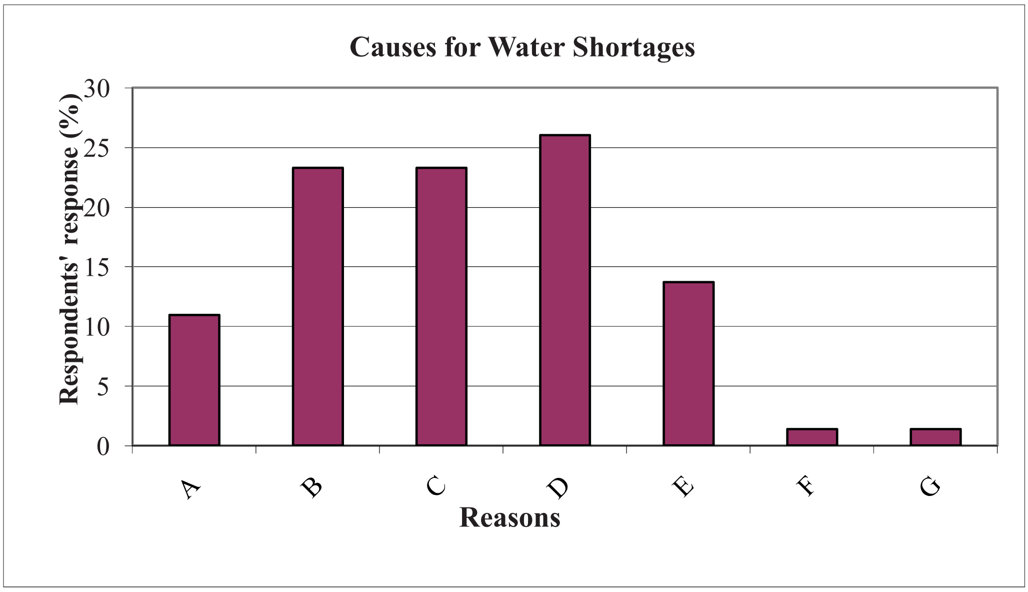


Figure 7.26 Opinions on Water Quantity and Quality

There is also a wide range of reasons given for the causes of water shortages during recent dry seasons in HCMC. While 26% of respondents stated that the city has not enough clean water sources, about 11% of respondents claimed that rapid urbanisation and population growth is one of the reasons leading to water shortage. Uncontrolled groundwater extraction and poor distribution network systems constitute 23.3% of responses, which are attributable to serious water shortage in the dry weather. Nearly 14% of respondents believed that the reason for water shortage is deforestation and climate change and a minority of respondents (1.4%) maintained that rainwater, as an alternative source, is not harvested for use. A limited number of respondents were unsure about the answer.



A: Rapid urbanisation and population growth
B: Uncontrolled groundwater exploitation
C: Poor distribution network system
D: Inadequate clean water sources
E: Deforestation and weather affected
F: Rainwater is not harvested
G: Uncertain

Figure 7.27 Reasons for Water Shortage

7.4.5 Water Pressures, Present and Future Difficulties

The majority of respondents (93.5%) believed that HCMC will face rising water pressures and management difficulties, while 6.5% of respondents were unsure of the answer.

- Water use is wasteful and the way people value water is very poor. A great deal of people argues that annual rainfall is massive and causing floods in the rainy season. This results in a bad habit of water use (UCON2, 2005).

- In recent years, the urbanisation trend is concomitant with water problems in HCMC such as water shortage in summer, water pollution and the exhaustion of surface and groundwater sources. These issues are placing pressures on management aspects in both the old and the new urban areas of the city. Not surprisingly, water resource has become a 'hot spot issue' of urban environmental management (IRER, 2005).

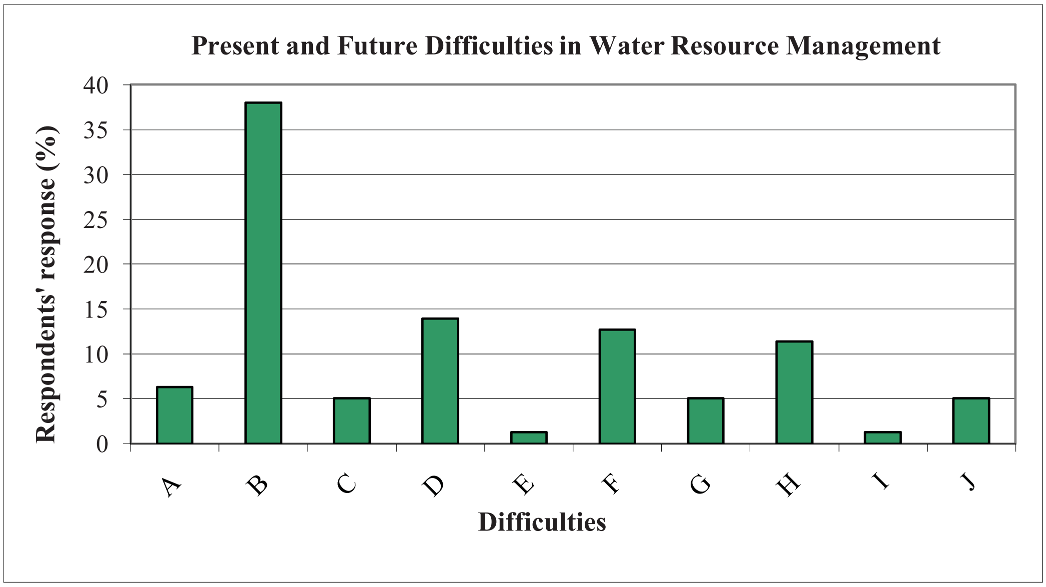
- In the context of HCMC, with the continuation of urbanisation and industrialisation, there will be a huge demand for water for domestic and industrial purposes. The increasing demand will be very high in the next 10 years (HCMUR1, 2005).

- Personally, I conducted a number of study works on wastewater treatment projects in industrial factories. It is widely recognised that water pollution caused by industrial wastewater is the most important issue. Wastewater pollution from industrial activities has been receiving much attention from the city's leaders and DONRE due to its huge amount of volume and pollutants (HCMUR2, 2005).

- Recently, demand for water is growing as a result of urban population growth and industrial activities. While water resources are increasingly depleted and polluted. In terms of urban water supply, there are two important aspects: insufficient clean water and very high water demand in the dry season (HEPM2, 2005).

- At a district level, the issue of water resources is viewed as the emerging trend of wastewater pollution and insufficient clean water for urban citizens. Within the district scale, wastewater pollution caused by industrial factors in Binh Thanh District is drawing much attention from the public and DONRE's managers (DNREO3, 2005).

Respondents expressed various opinions on pressures and difficulties. About 38% of respondents claimed that accelerated water pollution and uncontrolled exploitation of groundwater are one of the worst difficulties (Figure 7.28). Other significant factors included weak enforcement of regulations, lack of human and financial resources and poor public awareness ranked 13.9%, 12.7% and 11.4% respectively.

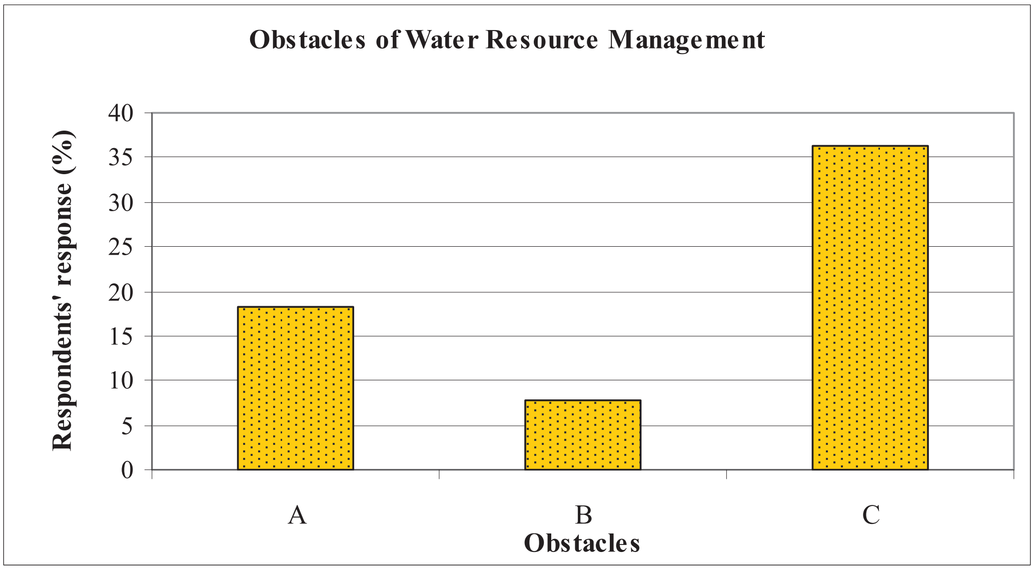


A: High demand for water resulting from urbanisation and population growth
B: Accelerated water pollution and uncontrolled groundwater exploitation
C: Ineffective water policy and legislation
D: Weak enforcement of regulations
E: Ineffective coordination across sectoral agencies
F: Lack of human and financial resources
G: Poor urban infrastructure
H: Poor public awareness
I: Water levy and tariff
J: Deforestation and climate change

Figure 7.28 Difficulties of Water Management

7.4.6 Challenges and Opportunities for Water Resources Management

About 36% of respondents stated that there were six major factors facing the city's sustainable development, including: uncontrolled wastewater from industrial, domestic and agricultural activities; salt intrusion; over-abstraction of groundwater; poor community awareness; lack of infrastructure for supply service; and ineffective institutions, regulations and mechanisms. While 18% of government respondents maintained that public awareness of water resource conservation is still low. Only 7.8% of respondents believed that the city lacks effective water governance.



A: Low community awareness
B: Ineffective institutions, policies and mechanisms
C: All above factors

Figure 7.29 Challenging Factors in Water Management

- (…) the management of water resources in Ho Chi Minh City is currently inadequate due to a lack of legislative documents at large. As a result of this, OMWRM is in process of compiling and completing a number of necessary regulatory documents (OWRMM, 2005).

- As an official in the environmental division of an industrial park, I have paid much attention to governmental documented papers, guidelines, regulations on water use, water exploitation and wastewater discharge. However, there are unclear guidelines and inconsistencies between documents and departments (IPO1, 2005).

- The reasons for mismanagement reflect the lack of knowledge and the lack of scientific information. Some projects present this limitation because they are not well studied. This results in inappropriate decisions. For example, Nhieu Loc-Thi Nghe Canal Project was not a feasible study. This project was over delayed and it caused enormous social impacts for residents in this canal basin (IRER, 2005).

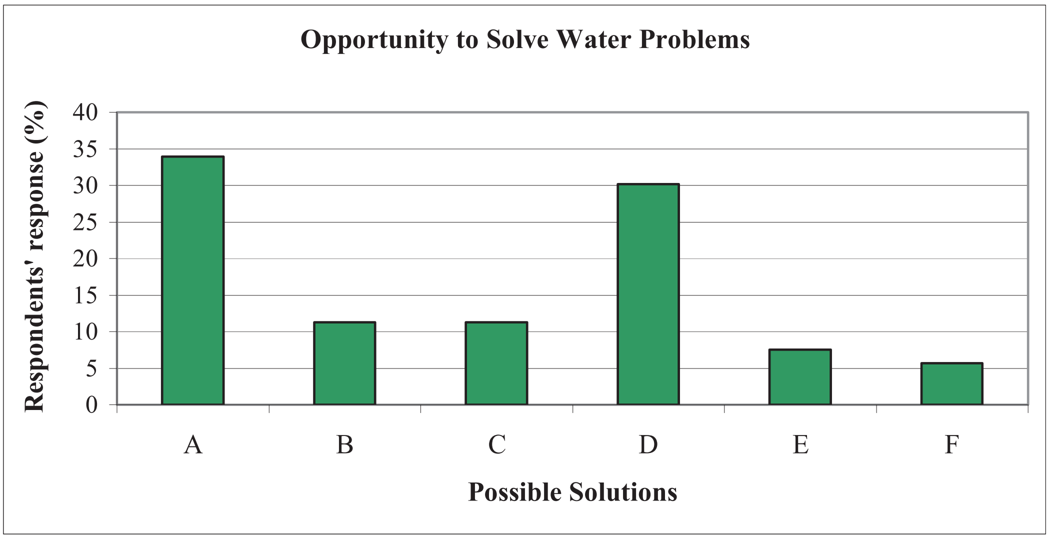
- I and my colleagues took part in some related studies on the management of water resources in HCMC. One of these studies was a research project on sustainable management of groundwater resource in HCMC which was conducted by the Institute for Global Environmental Strategy-IGES, Japan. This study resulted from the fact that the exploitation of groundwater in HCMC reached a sustainable limit. Groundwater protection was identified as a priority mission in the 2002 Environmental Management Strategy of HCMC (HCMUR1, 2005).

- From my point of view, there are two important aspects to the wastewater problem. Firstly, there is a low awareness by the industrial community on the environment and wastewater pollution. Secondly, the enforcement of environmental law is very weak or inadequate. This entails the fact that industries usually defy government management agencies (HCMUR2, 2005).

- (…) the current state of water resource management in HCMC faces a number of constraints, including insufficient regulations, inadequate planning and human resources. In future, the sustainable management of water resources in HCMC requires broader measures of legal, planning, economic and technical dimensions (HCMUR1, 2005).

- (…) many industries have been reluctant to comply with the regulation, some of them were unaware of what they stated or committed to the environment report (HEPO1, 2005).

Most government respondents proposed a number of possible solutions to overcome the recently acute water shortage in HCMC. Thirty-four percent of respondents believed that the local government should review control-command regulations. About 30% of respondents stated that the city's government should rethink policies on water and urban planning. The need for improvement in government practices and public participation in water resources management was mentioned by 11.3% of respondents. Only 7.5% of respondents put emphasis on promotion of privatisation in the water sector.

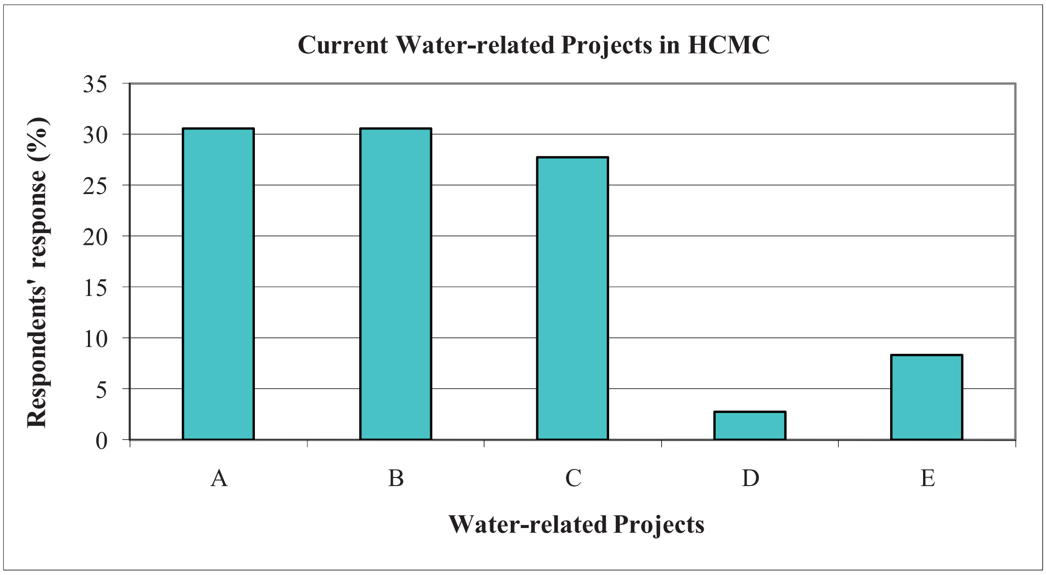


A: Setting control-command regulations
B: Improving government capacity in WRM
C: Improving public awareness in WRM
D: Rethinking in policies on water and urban planning
E: Promoting privatisation
F: Mobilising capital for urban services

Figure 7.30 Possible Solutions to Overcome Water Shortage

7.4.7 Water-related Projects and Stewardship

Most government respondents are aware of existing projects being undertaken by the city's administration in relation to water management. Figure 7.31 presents several respondents' opinions on current water-related projects, which relate to management practices and supply services. These projects include water supply (30.6%), canal improvement (30.6%), river basin management (27.8%) and socialization programmes to reduce water loss (2.8%). However, 8% of respondents were unsure of the answer.



A: Water Supply Projects
B: Urban Canal Improvement
C: River Basin Projects
D: Water loss Reduction Programme
E: Uncertain

Figure 7.31 Several Types of Current Water-related Projects

The majority of respondents (78.4%) believed that such projects have benefited water governance; 2.7% of respondents did not recognise any good outcomes of water-related projects. About 19% of respondents were uncertain.

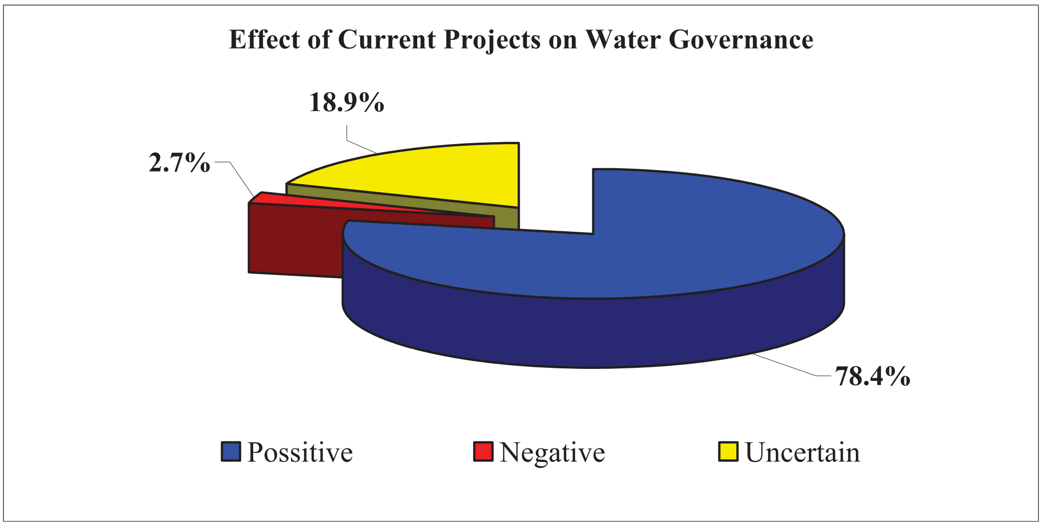


Figure 7.32 Effect of Water-related Projects on Water Governance

- There are current water-related projects under implementation in HCMC. However, these projects are mainly urban drainage upgrade or improvement (EMDM, 2005).

- Many existing water projects in HCMC focus on the environmental improvement of urban canal systems because the degradation of these major urban canals has profound effects on a vast majority of urban dwellers. Such effects include public health issues, water-related diseases, and urban landscape. Serious deterioration of urban canals is evidenced by bad odour, black colour of water, high concentration of pollutants and faecal coliform (HCMUR3, 2005).

- I cannot tell exactly what kinds of water-related projects exist in HCMC, but there have been opportunities to deal with seasonal water shortage in urban areas. One such solution is to invest intensively in water supply facilities and pipe networks (HEPM2, 2005).

7.4.8 Decentralisation and Privatisation in the Water Sector

To deal with the challenges of water management in coming years, most respondents (78.3%) believed that the autonomy and empowerment of managing water resources should be transferred to lower levels. In contrast, 13% of respondents did not agree with decentralisation of water management, while 4.4% of respondents claimed that private participation should be promoted. Only 4.4% of respondents were unsure (Figure 7.33).

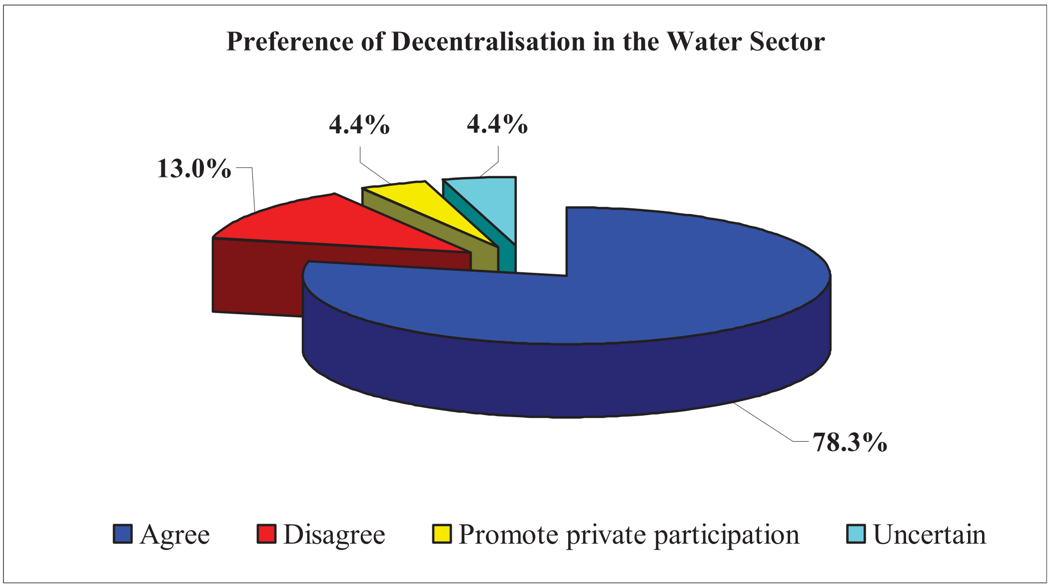


Figure 7.33 Preference for Decentralisation in Water Management

The promotion of privatisation drew most government respondents (63%) who emphasised the participation of the private sector. This finding shows a relationship between privatisation and a high preference for decentralisation (Figure 7.34). While more than 30% of respondents think that privatisation is necessary but needs further consideration, 4.4% of respondents showed no preference for it. Only a small number of respondents were uncertain.

- Future policy for water management in HCMC should be a more user-oriented approach, with privatization and accountability (EMDM, 2005).

- In my opinion, there are two aspects which need to be addressed for future action within the urban sector. Low awareness of water resource protection among stakeholders, particularly in public and industrial community, is a first basic factor. Secondly, participation of public or stakeholders is not in place, even where it is, the participation is not strongly encouraged and does not receives adequate attention (UCON2, 2005).

- Actually, we faced many pressures of public complaints and constraints of mechanism, in which inadequate investment, insufficient financial autonomy, lack of human resources, and mechanism constraints are major challenges and obstructions to our capacity (UDCO, 2005).

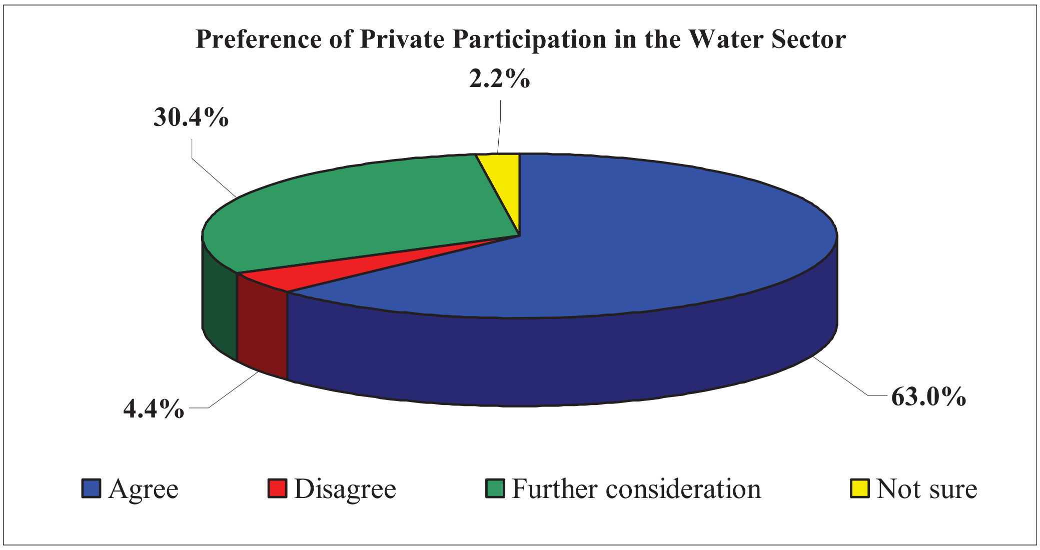


Figure 7.34 Privatisation Trend in the Water Sector

7.4.9 Water Management Practices

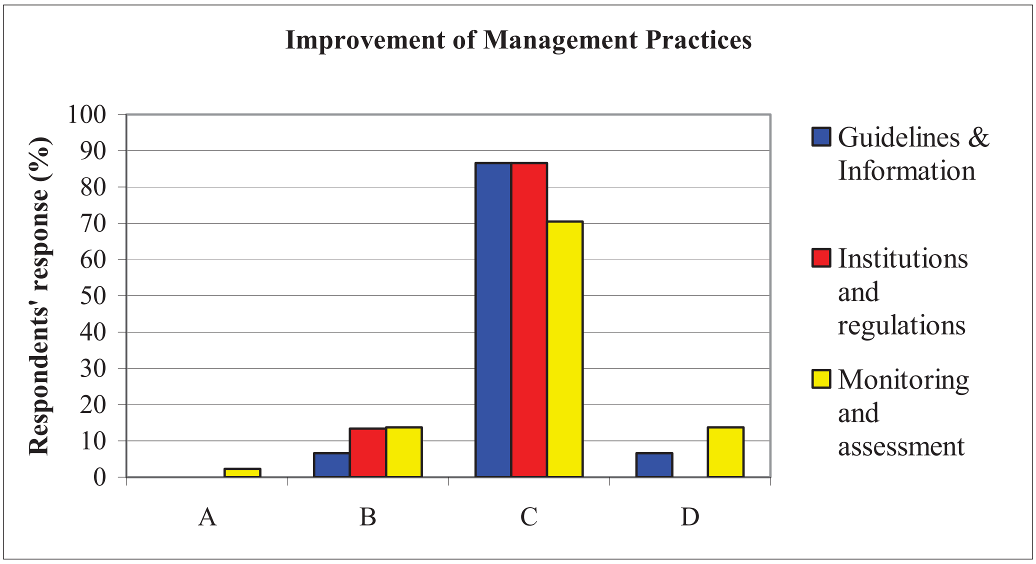
With respect to improvement of water management practices, three sub-questions were designed to gather respondents' opinions on which areas of government management practices should be improved (Figure 7.35). The majority of respondents (86.7%) stated that detailed guidelines and information to the community needs to be considerably improved; 86.7% of respondents ascertained that the institutional frameworks and regulations require upgrading. Most respondents (70.5%) think that monitoring and assessment programmes on water resources should be improved.

- (…) the management of water resources in Ho Chi Minh City is a big challenge to the government both at city level and district level. The underlying problems are very complicated as it is a multi-related issue, including social perception, privatization, governance, technology and management (EMDM, 2005).

- With respect to water management, the government spent a lot of money to invest in infrastructure such as pipeline systems, and treatment plants. However, I found that it was not an effective solution as “water shortage” is more serious and stark year after year (DNREO2, 2005).

- (…) many industries have been reluctant to comply with the regulations, some of them were unaware of what they stated or committed in the environment report (HEPO1, 2005).

- In the course of inspection implementation, I found that many industrial factories seem to be confused with the required inspection. The reason is that they sometimes encountered action taken by EMD. The difference is the HEPA requires industries to pay fees for the total volume of their wastewater discharge (HEPO1, 2005).



A: No Improvement B: Minor Improvement
C: Considerable Improvement D: Unsure

Figure 7.35 Needed Improvements in Water Management Practices

7.4.10 Potential of Alternative Sources

Water is becoming a scarce resource and therefore alternative sources are increasingly important to HCMC. Rainwater and recycled water were being recognised as a potential source for urban purposes. While most respondents (83%) think that alternative sources are necessary, only 2% of respondents said it is needed in new urbanised areas. However, 4.4% of respondents said no to alternatives and more than 10% of respondents were uncertain.

- Rainwater is recently considered as an alternative source. However, HCMC still has abundant surface water supplies. Therefore, rainwater will not be a first priority source in formulating policy and strategy for water management (HCMUR1, 2005).

- In my opinion, how can we promote the use of rainwater while there is not much space for residency? For most densely populated districts, residency space is limited with very small and narrow areas where one cannot install rainwater harvesting facilities or systems (DNREO1, 2005).

- (…) there is not enough attention to explore how we can ensure enough freshwater in the long term. I urge both the local government and scientists to look for feasible approaches to water supply. Rainwater is an interesting topic, and would be an alternative solution to water supply in Can Gio. It is evident that many rich people in Can Gio can afford large tanks for rainwater harvesting (DNREO2, 2005).

- For coastal district areas such Can Gio, Nha Be, rainwater is probably suitable for residents because they find it hard to get enough freshwater. Of course, it will be not easy to implement engineering constructions for collection at large scale as it is financially and technologically costly (HCMUR1, 2005).

- (…) other alternative water sources have not received any adequate attention by managers and scientists. In my opinion, rainwater can be collected and stored for many purposes. This source has good quality and abundant quantity (UCON2, 2005).

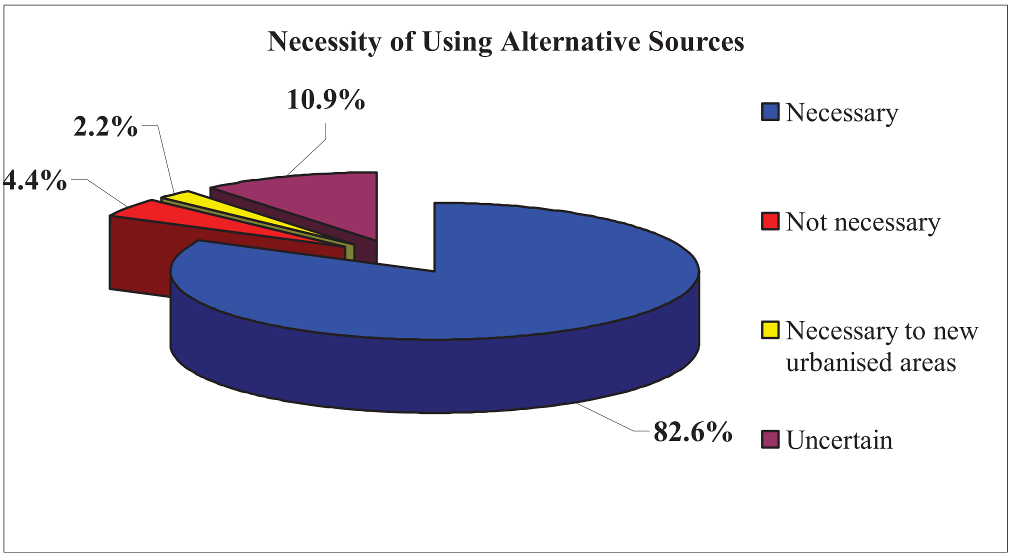


Figure 7.36 Necessity of Alternative Water Sources

The majority of respondents (91.3%) put an emphasis on the preference to use rainwater if it is harvested and treated properly. A limited number of respondents (2.2%) did not prefer using rainwater. However, 6.5% of respondents were still unsure (Figure 7.37).

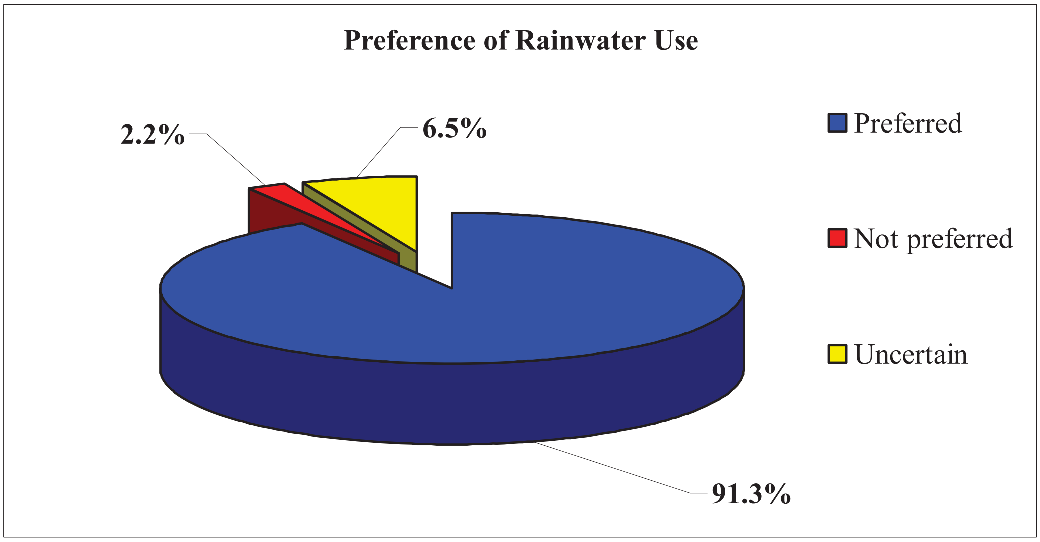


Figure 7.37 Potential Preference of Rainwater Use

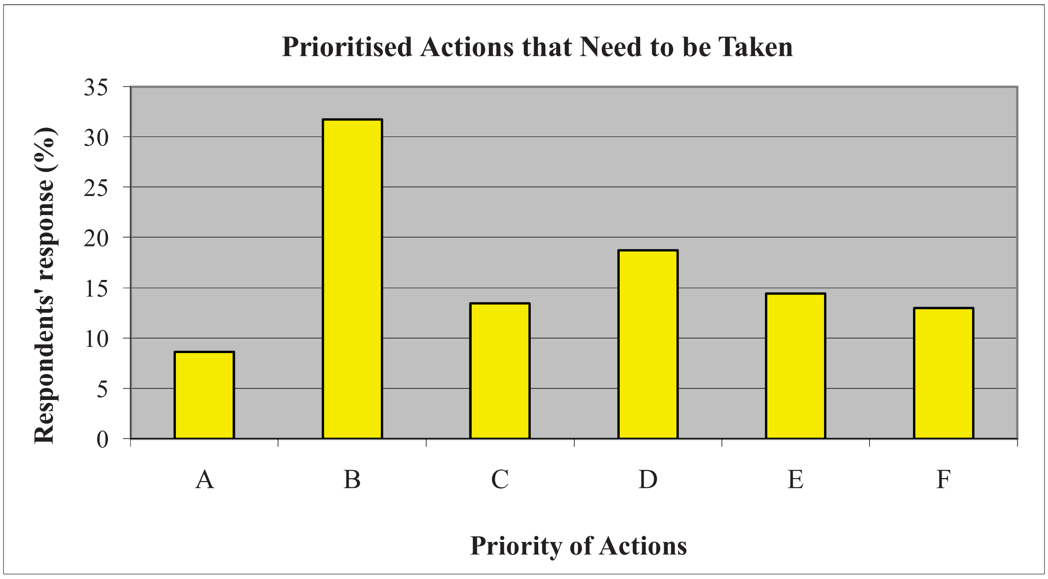
7.4.11 Local government actions in water management and development

A number of future water management and development strategies were proposed by respondents. These vary between government agencies and officials (Figure 7.38). Most respondents (32%) think that there is a need for increasing strict enforcement of existing laws and regulations on water pollution. This finding reflects the accelerated deterioration of water resources as discussed in Chapter 4. Improvement of community participation, awareness and improving behaviour were proposed by 18.8% of respondents. Thirteen percent of respondents believed that the local government of HCMC should plan detailed programmes on urban water resources use and management. This helps to explain why many government officials across agencies could not give data and information on the ratio of water sources and use between sectors as discussed above. 14% of respondents claimed that private sector involvement should be promoted, and nearly 13% of respondents considered rainwater as an alternative future source.

- There are also some departments implementing overlapping functions and responsibilities. However, many management practices are not sufficient and effective due to the large lack of coordination, cooperation, and sufficient institutions and mechanisms (EMDM, 2005).

- More importantly, institutional frameworks and regulatory documents are incomplete and undergoing review as well as being updated. This task is imperative but it takes a lot of time (HEPM1, 2005).

- I think the problem of wastewater pollution cannot be solved quickly. The industrial relocation programme of the city is a good long term measure. This will relocate polluting industries in planning areas for industrial purposes (DNREO3, 2005).



A: Improving water policy
B: Enhancing existing legal and regulatory instruments
C: Establishing detailed programmes on urban water resources use and management
D: Raising public awareness and improving behaviour
E: Promoting private sector participation
F: Harvesting rainwater as an alternative source
G: Enforcing economic instruments for pollution control

Figure 7.38 Local Government Water Resources Management Strategies

7.5 Conclusion

The research findings presented in this chapter are based on quantitative analyses of: firstly, urban residents and government officials; and secondly, qualitative analyses of a limited sample of interviewed participants working in government agencies. The survey results confirmed that HCMC is experiencing serious water constraints in both the supply service and resource management. These issues can be generalised as follows:

i) First, most respondents considered water as both an economic good and a social good. However, the valuation of water is still defined as a social resource by most of public respondents (56%) and government officials (47%);

ii) Second, most public respondents indicated that they have very little knowledge of water resources because there are few channels to access adequate information;

iii) Third, the functions and responsibilities for managing water resources vary between government agencies, but in practice overlap due to ineffective mandatory regulations and mechanisms. In addition, most respondents from government bodies did not have a shared information channel;

iv) Fourth, limited public involvement and weak institutions, ineffective regulations and mechanisms aggravate problems of water management in HCMC. Strong support to promote decentralisation and privatisation is another highlighted outcome of the survey;

v) Fifth and finally, both public respondents and government officials put strong emphasis on alternative sources. Rainwater is a favoured alternative because HCMC has abundant rainfall in the rainy season.

Overall, the survey results demonstrated a wide range of water issues faced by the local government of Ho Chi Minh City, Vietnam. These findings are consistent with issues discussed in Chapters 4, 5 and 6. The survey findings will be further discussed in the following chapter.

CHAPTER 8

DISCUSSION AND CONCLUSION

This chapter discusses the water resource issues and management practices in Ho Chi Minh City, Vietnam based on the findings presented in Chapter 7. It proposes recommendations for sustainable water management in HCMC based on the research findings and discussion in Chapters 4, 5 and 6.

8.1 Water Resources As a Social and Economic Good

As noted in Chapter 1, the Dublin Statement (1992) was one of the earliest international community efforts to define guiding principles of water management and sustainable development. The introductory section of the Dublin Statement declared that scarcity and misuse of freshwater pose a serious and growing threat to sustainable development and protection of the environment. Human health and welfare, food security, industrial development, and the ecosystems on which they depend, are all at risk, unless water and land resources are managed more effectively in coming decades than in the past (Young et al. 1994).

To achieve sustainable development and protection of the environment, the Dublin Conference identified the economic value of water in its fourth principle, stating: "Water has an economic value in all its competing uses and should be recognised as an economic good" (ICWE 1992). In the context of water management, this principle is the key to sustainable management. Furthermore, following the Dublin meeting, the economic value of water was clearly recognised as integral to efficient water management in Chapter 18.8 of Agenda 21, which was produced at the United Nations Conference on Environment and Development held in Rio de Janeiro: "integrated water resources management is based on the perception of water as an integral part of the ecosystem, a natural resource, and a social and economic good…" (United Nations 1992, p. 167).

Arguments about the economic value of water often arise from debates over human rights and access to water. Partisans of human rights believe that water is essential for basic human needs and all forms of life, and therefore it is immoral to charge for water. It is argued that the dignity of human beings must come first and governments should be responsible for providing sufficient water for people's basic needs (Langford 2005). However, when water scarcity arose, the commodity value of water was reiterated at The Hague World Water Forum in 2000 and several other international forums (Meinzen-Dick and Appasamy 2002) where it was argued that water must be treated as an economic good (Dinar 2000). Treating water solely as a social good can result in waste and insufficient supplies (Gleick et al. 2002). In other words, managing water as an economic resource becomes a key principle to encouraging users to be more water efficient (Dinar and Subramanian 1998; Gleick et al. 2002; Meinzen-Dick and Appasamy 2002).

In terms of governance, it is arguably stated that solving inadequate attention to water value will play an essential role in effective water governance (Moss et al. 2003). Different people have different perceptions of water value, and the perceptions of water value also change with socio-economic conditions. The government's responsibility is to implement good water management practices and get people to understand what these are. Inappropriate perceptions of water will have adverse consequences. For example, low perception of water value leads to an equally low awareness of water conservation and unwillingness to pay for it. These, in turn, lead to insufficient investment and inadequate quality service. Therefore, a vicious cycle will be created when the water service is degraded and people's demand is unsatisfied (see Figure 8.1).

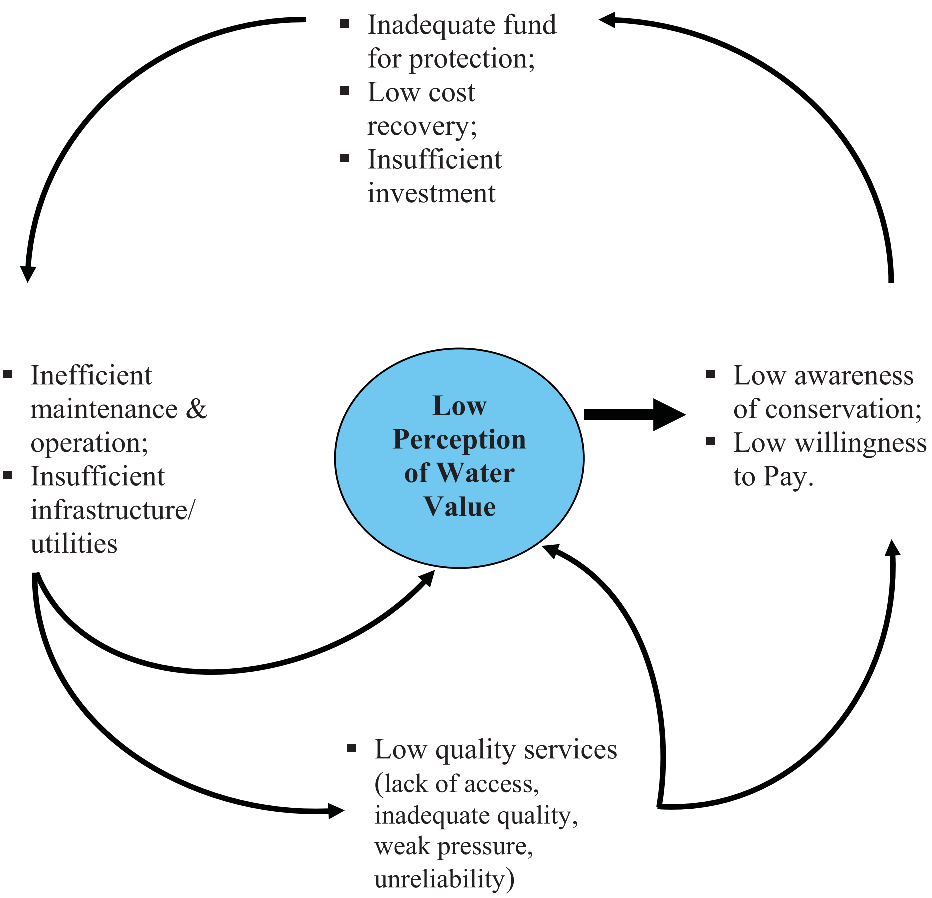


Figure 8.1 Vicious Cycle of Inappropriate Perception of Water Value

Source: The author

The government of Vietnam issued laws for the implementation of water resources management in which the economic value of water was explicitly stipulated, for example Decree No. 179/1999/ND-CP dated 30 September 1999 (see Appendix 3). However, it is not yet effective in practice, as people believed it only applied to industrial entities. Recently, Decree No. 67/2003/ND-CP, dated 13 June 2003, has placed more emphasis on the monetary side of water use. Article 2 of this decree declared that industrial wastewater and daily-life wastewater dischargers are subject to an environmental protection levy.

Nevertheless, most of HCMC's citizens still view the water issue as simple as turning on the tap. The public is accustomed to say that water is a free natural resource. Because water is important for socio-economic development, the state often accepted that water should be provided at a subsidised price. This leads to a financial burden because society has to pay for the subsidy and it promotes water waste. More importantly, underestimating economic value will result in the misuse of available water and careless disposal of wastewater. Society then pays a high cost in the form of degradation of the ecosystems.

Since Decree No. 67 became effective in 2003 (but only for Hanoi and HCMC), people's perceptions have changed significantly because they have to pay not only for the supply cost but also for the discharge fee. However, it has not been an effective regulation in practice. Regarding the urban water service, urban residents in Hanoi and Ho Chi Minh City pay a water discharge fee of only 10% of the water supply tariff. This surcharge is calculated in the water bill and cannot compensate for the cost of operation and maintenance (Pham Sy Liem 2001). Moreover, not many urban residents realise the existence of mandatory legal documents. Exploiting groundwater is a way of avoiding the wastewater levy, because the levy can only be issued for those using mains water from distribution supply networks. In addition, the industrial community often defies the mandatory water levy due to the weak enforcement of regulations.

Therefore, educating stakeholders to the economic and social value of water resources is the key to creating a positive community perception. This requires the local government to act. Strengthening public perception over water as a tradable good through wider propagation of government documents is one of the necessary measures. As there are no commonly shared documents on HCMC's water profile in place, mandatory regulations should be recognised. They can be stipulated in an annual report or a pamphlet in which the value of water is detailed explicitly with financial consequences for causing pollution. The economic value of water can be deployed in several ways, including the value in production, actual water prices, user's willingness to pay, and the cost of recycling or tapping alternative sources (Meinzen-Dick and Appasamy 2002). Such economic tools are part of the water pricing approach which is an integral part of water policy reform in both developed and developing countries (Dinar and Subramanian 1998; García 2005). It is important because it can affect water use efficiency at both individual and social levels (Dinar and Subramanian 1998), since inappropriate pricing does not encourage public awareness of water conservation (Gleick et al. 2002; McIntosh 2003).

Perception of water value is in a transition stage in Vietnam, with water perceived as a social good and a commodity through regulatory systems of permits and economic instruments. It is an imperative for the local government of HCMC to treat this water value as both a social and tradable good that is consistent with future water management strategy and policy. For sustainable management of water to occur, a conceptual framework of water value is depicted in Figure 8.2. The current water resources management strategy, which was launched in 2002, can be achieved by addressing public and stakeholders' perceptions of the value of water.

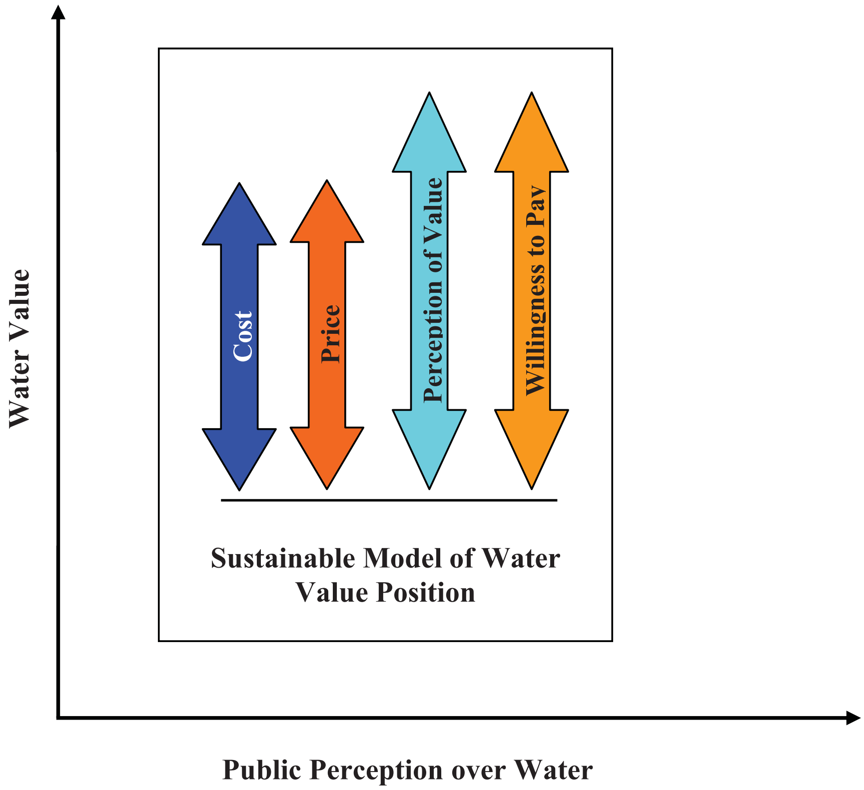


Figure 8.2 Conceptual Framework of Sustainable Water Value

Source: The author

In this model, the component concepts are denoted as follows:

Water Cost: The cost of capturing, treating and delivering water, and the value of the resource itself.

Water Price: The real price of water which people are being asked to pay by. This water price should not exceed the total water cost.

Willingness to Pay: The price which people are willing to pay for water supply systems that satisfy people in terms of reliability, quality and quantity.

Perception of Value: Water value should be perceived by people as a social good (the basic human right to have water for living), but at the same time as an economic good because water cannot be distributed to the end-users without the cost of capturing, treating and delivering it to the users.

8.2 Improvement of Urban Water Use Efficiency

8.2.1 Water Loss Minimisation

It is reported that the capacity of the local water authority has greatly improved as shown in the rising number of urban dwellers served clean water, which rose up to 86.5% at the end of 2006 (Saigon Water Supply Company-SAWACO 2007). However, the evidence from the fieldwork showed that most residential respondents had concerns with the water service, including an inadequate pipeline system (22%), inadequate quality (48%), weak pressure (35%) and high leakage (31%) (see Figures 7.8 and 7.9). This contradiction can be explained by the fact that only 76% of inner urban citizens are served by the SAWACO's distribution network, the remaining 10% of suburban residents are accessing clean water via UNICEF projects. Furthermore, it is claimed that this figure is inconsistent because a large number of people in outlying urban districts do not have a clean and safe water service (Ministry of Natural Resources & Environment (MONRE) 2006a).

SAWACO has developed a number of water utilities to meet the growing demand for the last five years (Saigon Water Supply Company-SAWACO 2007). However, the urban supply service faces considerable challenges. These challenges have several causes. Firstly, the HCMC's main intake water source has declined as a result of increasing levels of pollution in the Dong Nai-Sai Gon River as well as other major water sources surrounding the city (Mai Vong 2007; Quang Khai 2007; Quoc Thanh 2007). Secondly, it is argued that water is under-priced and most water supply projects are tending to increase the coverage area of provision and allocation rather than improving distribution networks (Pham Sy Liem 2001). The local water authority in practice does not understand household demand for water - another reason for the water supply crisis in urban areas (Pham Khanh Nam and Tran Vo Hung Son 2005). In reality, local households still consume unreliable and poor quality piped water, but have to pay for this service (Ngoc Hau 2007; Pham Khanh Nam and Tran Vo Hung Son 2005). High subsidization and high rate of water loss are additional factors of inefficient supply service (Andrews and Yñiguez 2004; McIntosh 2003; Pham Sy Liem 2001). As a result, cost recovery is not fully covered to maintain better services, in turn leading to the failure of existing water projects in HCMC (Pham Khanh Nam and Tran Vo Hung Son 2005; Pham Sy Liem 2001).

In order to improve the urban water service, it is important that the local water authority of HCMC look at ways to use the existing supply more efficiently by minimizing water losses and improving the efficiency of water tariffs. Water loss is one critical area to start improving water use efficiency in HCMC, because public conservation awareness is unlikely to be achieved if water users realise that their supply utility is inefficient and wasteful. The figure for water losses in HCMC is inconsistent in the literature, ranging from 33% (Saigon Water Company -SAWACO 2005), 35-37% (Nguyen Phuoc Dan et al. 2007) to 38% (Andrews and Yñiguez 2004; McIntosh 2003) and 40% (Pham Sy Liem 2001). Nonetheless, this figure is higher than the average level of water loss in Asian cities, at 30% (McIntosh 2003). It is reported that water unaccounted for will be reduced 1-2% each year and further reduced to 26% and 25% in 2010 and 2020 respectively (Saigon Water Supply Company-SAWACO 2007). This will be one of the great challenges.

Water loss may include leaks, illegal taps and uses, inadequate measurement and free authorized use. McIntosh (2003) observed that the average rate of water loss in Asian cities ranges from 4% to 65%. Most importantly, a high water loss ratio is closely related to low coverage of water supply in most Asian urban areas (McIntosh 2003). Although SAWACO has not yet identified solutions specifically for water loss prevention, a network-decentralised approach was chosen as a major solution to minimise water loss. In this regard, the city's distribution network was divided into six zones for better control and management. However, there are only two zones where advanced measures to control the loss are being applied, the remaining four zones have not yet implemented such measures because of inefficient privatisation (Saigon Water Supply Company-SAWACO 2007).

Several remedial measures have been suggested to improve water unaccounted for and better physical efficiency of the supply system, including leak detection, metering all production and consumption and preventing illegal connections (McIntosh 2003; Meinzen-Dick and Appasamy 2002). HCMC's water supply authority should refer to best practices in water loss minimization such as in Singapore (McIntosh 2003, pp. 59-65) and in Hai Phong, Vietnam (see Box 8.1).

Box 8.1 Leak Control and Network Improvement in Hai Phong, Vietnam

NOTE: This box is included on page 237 of the print copy of the thesis held in the University of Adelaide Library.

Source: ESCAP (2004, p. 46)

8.2.2 Water Tariff as an Economic Instrument in Water Management

SAWACO recently proposed a new water tariff structure to provide urban inhabitants with better and more reliable water supply services. Accordingly, water prices have risen considerably for all end-users, including household, industry, trading and commercial services (Duc Trung 2007). SAWACO maintained that there were two main reasons for this increase. Firstly, residents are paying only 60% of the average current price for water. The state company subsidised the rest (Ngoc Hau 2007). Secondly, the costs of clean water rose by 39% in comparison with the 2004 price. It is argued that the water price needs to rise to cover the costs of new infrastructure/utilities and their maintenance and operation (Duc Trung 2007). However, the new water tariff structure has become controversial. The most important debate is that the authority should implement the necessary reduction of water losses instead of increasing water prices (Quang Khai 2007). Furthermore, the poor are the most affected and least able to afford new water prices (Duc Trung 2007).

Many governments have adopted an IWRM approach and put IWRM principles into practice. The adoption of economic value should be sufficiently applied in the context of IWRM. It was stated that "economic valuation of water should be seen within the context of its social and economic implications, reflecting the importance of meeting basic needs" (United Nations 1997). When water is valued as a tradable good, this promotes conservation, equity and sustainability. For this reason, a water tariff as part of municipal water services is an important management tool (Makino 2002) and can facilitate the reform of water supply and sanitation (Whittington 2003). Raising water charges or water tariffs is the right way to make users aware of the benefits of water use efficiency. It is simply because water cannot be supplied to users without collecting, treating and delivering costs. The cost of water comprises two components: the cost of the delivering service and the cost of the resource itself (Meinzen-Dick and Appasamy 2002). However, water should be properly priced to reflect the value of the resource.

It is stated that an efficient water tariff will promote incentives in which users can obtain the most possible benefits for a given water supply cost (Makino 2002). Therefore, a good tariff structure for Ho Chi Minh City should be designed in the light of four main objectives: (i) cost recovery, (ii) economic efficiency, (iii) equity and (iv) affordability (see Box 6.5, Chapter 6). Pham Khanh Nam et al. (2005) observed that urban residents in

HCMC are willing to pay a significant amount for improvements in the quality and reliability of their water supply. Piped households were willing to pay 3.5% of their monthly income for improved water service, while households not connected to piped water were willing to pay between 4.1 and 4.6%. This finding provides very useful information to decision-makers about urban residents' water supply priorities and their willingness to pay for services. It means the government is responsible for delivering better urban water services.

8.2.3 Community-based Model in Household Supply Service

Elsewhere in Vietnam, Hai Phong city has developed a *phuong* model in which the urban water supply service has been improved to an impressive degree. The *phuong* (ward level) is the lowest administrative level of municipality. Prior to the 1990s, the Hai Phong Water Supply Company (HPWSCo) was a state-owned company under the direct supervision and guidance of the provincial authorities. The water supply authority faced various problems in satisfying water for urban dwellers. These problems included insufficient clean water, poor quality water and weak pressure, unreliable supply, illegal connections and high water losses (up to 70%) (ESCAP 2004). The Hai Phong Water Supply Company was established as a legally distinct economic entity following the implementation of reforms. The *phuong* model was introduced as a process of corporatization, which led to changing public behaviour and minimizing risks of water-related diseases from polluted water sources (see Box 8.2). SAWACO is a state-owned company having a similar administrative structure to the Hai Phong Water Company. *Phuong* (ward) represents the lowest municipal administrative structure. HCMC is much bigger than Hai Phong with ongoing population growth and urban expansion, and is well suited to adopt the *phuong* model so that household sector water supply services can be improved (Box 8.2).

Box 8.2 Water-related Service to Urban Residents in Hai Phong, Vietnam

NOTE: This box is included on page 240 of the print copy of the thesis held in the University of Adelaide Library.

Source: ESCAP (2004, pp. 12-13)

8.3 Participation of Stakeholders and Availability of Information

Full public consultation and stakeholder involvement in the water sector is in the second principle of the Dublin Statement: "water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels" (ICWE 1992). Moreover, the wider participation of stakeholders and availability of information are the key factors in environmental management that were identified in principle 10 of Agenda 21 (see Chapter 6). Stakeholders consist of civil groups, including local communities, indigenous groups, women's unions and young people.

The study results in Chapter 7 showed that while general issues relating to water are perceived, the majority of urban respondents have insufficient knowledge and very limited information on water issues (Figures 7.14 and 7.15). Additionally, most residential respondents (74%) expected that knowledge and information on water issues should be publicly disseminated (Figure 7.23). Although the scope of knowledge and information is not identified, the responses of public respondents have very significant policy implications for the water sector.

8.3.1 Community Involvement in Urban Water Supply

Public or community participation has been widely recognised as one of the most important factors in water development and planning projects. The participation of a community can be defined as “a process through which stakeholders influence and share control over development initiatives, decisions and resources that affect them” (Rietbergen-McCracken and Narayan 1998, p. 4). Locally, it is observed that participatory bottom-up approaches provide a meaningful tool for effective urban environmental management (Iyer-Ranigar and Treloar 1999). With respect to water and sanitation projects, it is emphasised that community participation should involve the following: (i) communities in the planning of projects; (ii) communities responsible for the implementation, operation and maintenance; (iii) the benefits of the projects to be shared among entire the community; (iv) the community to participate in the evaluation and modification stage of projects (Whyte 1986). In addition, Gomez et al. (2002) claimed that water and sanitation projects can achieve significant results with community involvement. These results can occur through empowerment, providing training and education to women, and enhancing the skills of community-based organisations (Gomez et al. 2002).

For urban water supply services, the *phuong* model of Hai Phong, Vietnam should be considered as an appropriate one for HCMC to consider. The promotion of community participation in the ‘Phuong Water Management Model’ by HPWSCo has resulted in substantial achievements in reducing unaccounted for water and improving the physical efficiency of supply services (see Box 8.4).

Box 8.3 Phuong Model-Consumer Participation in Hai Phong, Vietnam

NOTE: This box is included on page 242 of the print copy of the thesis held in the University of Adelaide Library.

Source: ESCAP (2004, p. 33)

8.3.2 Participation in Water Resources Management

According to article 10.3 of the National Law on Water Resources, the Vietnamese people's responsibility for water protection was stated as follows: "organisations and individuals have the responsibility to regularly protect the water resources directly exploited or used by them" (see Law on Water Resources in Appendix 3).

Apart from this key legislation, several legislative frameworks and sectoral guidelines have been issued to enhance stakeholders' legal responsibility. Decree No. 179/1999/ND-CP (dated 30 September 1999, see Appendix 4) refers to the implementation of Law on Water

Resources, Decree No. 34/2005/ND-CP (dated 17 March 2005) regarding administrative fines for violation of water resources and Law on Water Resources Tax (1990, amended 1998). However, it is not easy to interpret successfully in practice because of the implementation itself. Firstly, Vietnamese people have been accustomed to treating water as a free and infinite resource or a heavily subsidised good that is the government's responsibility. Secondly, the practical realisation of government guidelines is a local authority responsibility, but one about which the industrial community is fairly ignorant.

There is a growing literature on the need for the engagement of communities and civil societies in the practice of natural resource management. Local communities and members are playing a greater role in governing natural resources as a result of the state's failures in control and regulation (Taylor 1998). Increasingly, the important role of local communities is conceded because of their experience and intimate knowledge of local conditions (Brosius et al. 1998; Jansky et al. 2005). The community can participate in different levels of the decision-making process of water management (Table 8.1)

Table 8.1 Levels of Public Participation

NOTE: This table is included on page 243 of the print copy of the thesis held in the University of Adelaide Library.

Source: Mostert (2006).

The participatory approach was successfully addressed in Vietnam through a research project on local planning resource governance in the Tam Giang lagoon, central Vietnam.

The impetus for this project sprung from the failure of traditional government top-down measures (Truong Van Tuyen et al. 2006). The research focused on community-based natural resource management. It attained productive achievements, including full scale engagement of local stakeholders, changes in the processes of local planning and resource governance and the facilitation of new roles of key stakeholders. The participation of local groups and their knowledge are key factors in solving conservation and ecological issues. While local government officials took on a new role as facilitators in providing technical assistance, the capacity of local researchers was enhanced through learning, negotiation and consensus-building (Truong Van Tuyen et al. 2006).

McIntosh (2003) noted that public awareness, transparency and the involvement of civil society are the key elements in sustainable water management. The inhabitants of HCMC lack relevant information on water issues. Thus, improvement of water governance will lead to a major involvement of civil society in which government authorities should raise public awareness by:

- *Raising the public understanding of water use and water service levels;*
- *Promoting public awareness of water conservation and reduction of wasteful use of water at home;*
- *Providing appropriate information on water cost and the reasons for tariff increases;*
- *Informing the public about the performance of the water operator's responsibilities;*
- *Widely publicizing government policies and plans as well as development funding sources*.

Source: Summarised by the author from McIntosh (2003, pp. 122-124).

8.4 Private Sector Participation in the Water Sector

Private businesses or organisations may become either fully or partially involved in conserving water by entering into a partnership with the public sector. McIntosh (2003) observed that private participation is not effective in most Asian city water authorities due to the lack of transparent policy and tariff reform. The concept of privatisation of water was discussed in Chapter 6. This section refers to public-private partnership and the need for this type of participation in the water sector in HCMC. The history of private enterprise involvement in the water sector dates back several decades in Europe (United Kingdom, France) and the United States (Stottmann 2000; The Economist 2003). The emergence of private participation resulted from the failure of the public sector to improve economic efficiency in both operating performance and the use of capital investment. Therefore, many large cities in the developing countries of Southeast Asian (Manila and Jakarta), Africa (Dakar, Abidjan) and Latin America (Buenos Aires) have turned to the private sector for several reasons: (i) to attain technical and managerial experience and better technologies; (ii) to mobilise investment capital; (iii) to obtain the advantage of private capital markets, and (iv) to restructure inefficient public entities (Stottmann 2000).

However, there is resistance to the participation of the private sector in terms of economic and social factors. It is claimed that privatisation can lead to inequity and the poor in developing countries not being able to afford water, and to pressures on freshwater ecosystems and downstream water users (Gleick et al. 2002; Thompson 2001). Nonetheless, public-private partnerships have been widely recognised as the best available option to ameliorate constraints in the water supply services of rapidly developing cities (McIntosh 2003; Memon 2002; Stottmann 2000).

Although private sector participation in the water sector poses some risks and challenges (see Box 8.4), the privatisation of water promises can proceed in the light of the following principles and guidelines:

(i) A regulatory agency must be set up before pursuing private contracts;

(ii) Private sector participation (PSP) should be appropriately selected;

(iii) Transparency, public awareness and reliable water supply sources are important for maintaining a long term strategy;

(iv) Appropriate tariff structures should be introduced and tariff setting mechanisms agreed upon;

(v) There is no common model for privatisation, rather the process of privatisation should be adapted to the local political, cultural, legal and regulatory framework;

(vi) Water should be managed as a social good in order to:

- Meet basic human needs for water. All residents in a service area should be guaranteed a basic quantity of water under any privatisation agreement.
- Meet basic ecosystem needs for water. Natural ecosystems should be guaranteed a basic water requirement under any privatisation agreement.
- The basic water requirement for poverty-stricken users should be provided at subsidised rates when necessary.

(vii) Economic tools should be applied in water management:

- Water and water services should be provided at fair and reasonable rates.
- Whenever possible, link proposed rate increases to agreed improvements in service.
- Subsidies, if necessary, should be economically and socially sound.
- Private entities should be required to demonstrate that new water supply projects are not more expensive than projects to improve water conservation and water use efficiency before they are permitted to invest and raise water rates to repay the investment.

(viii) Government regulation and oversight should be strongly maintained:

- Governments should retain or establish public ownership or control of water sources;
- Public agencies and water service providers should monitor water quality. Governments should define and enforce water quality laws;
- Contracts that lay out the responsibilities of each partner are a prerequisite for the success of any privatisation;
- Clear dispute resolution procedures should be developed prior to privatisation;
- Negotiations over privatisation contracts should be open, transparent, and include all affected stakeholders.

Source: Compiled by the author from Gleick et al. (2002); McIntosh and Yñiuez (2000); McIntosh (2003).

The fieldwork results showed that most residential respondents (79%) and governmental respondents (63%) believed that participation of the private sector should be promoted in HCMC. Moreover, several concerns over water supply services were raised by residential respondents, such as inadequate quality, weak pressure, leakage and outage supply (Figures 7.8 and 7.9, Chapter 7). These concerns resulted from a poor distribution network system as identified by government respondents (Figure 7.28). These findings have implications for policy reform in which private sector participation should not be neglected in future water policy in HCMC.

Furthermore, the local water authority (SAWACO) is facing a high rate of water which is unaccounted for and is seeking investment capital (Saigon Water Supply Company-SAWACO 2007). While demand for water is expected to accelerate, SAWACO proposed ambitious goals of upgrading production capacity to 2 million kL per annum, minimizing water loss by 26%, increasing supply coverage to 85-90% in urban areas and 60% in suburban districts in 2010 (Saigon Water Supply Company-SAWACO 2007). These will be one of the greatest challenges in management capacity of the local water authority. To achieve these goals in the context of rapid urbanisation in HCMC, the government should radically reshape water institutions to promote private sector participation. Traditional policies (supply-side policy) and public-based approaches alone will be unlikely to raise enough resources and techniques to manage water and wastewater utilities effectively as well as operate and maintain the network systems more efficiently.

Box 8.4 Key Challenges and Risks of Private Sector Participation (PSP)

NOTE: This box is included on page 248 of the print copy of the thesis held in the University of Adelaide Library.

Source: Compiled by the author from Gleick et al. (2002)

8.5 Institutional Restructure Is Crucial to Water Governance

Effective governance has drawn the attention of water professionals in developed and developing countries (see Chapter 6). Accountability, transparency, responsiveness and participation are the central factors of urban governance in developing countries (McCarney et al. 1995). In line with this perspective, restructuring and strengthening of institutions and mechanisms play an important role in developing effective urban environmental governance (Imura et al. 2005). Most importantly, Porio (1996) observed that governance in urban environmental issues is occurring in Southeast Asia and is showing signs of being taken seriously in Vietnam owing to of the country's recent economic growth and rapid urbanisation.

Water governance is implicitly incorporated in the concept of IWRM which was developed by the Global Water Partnership (GWP). Accordingly, water governance is inextricably linked to political, social, economic and administrative systems that develop and manage water resources, and the delivery of water services at different levels of society (Black and Hall 2004). According to GWP, water governance can be strengthened through the improvement of institutional structure (see Box 6.3, Chapter 6). The adoption of IWRM indicates that water governance and the widespread reform of water policies and institutions in developed and developing countries are the key principles to sustainable water management. Many problems in Asian urban centres are anchored in ineffective water governance systems (McIntosh 2003, pp. 99-105).

The survey findings showed that a large number of respondents from government agencies provided incomplete information concerning their use of water at both the city and district levels. This means that there are no existing documents which were shared or circulated among government regulating agencies or district government bodies. In addition, most respondents from government agencies placed a strong expectation on the improvement of water management practices, including guidelines and information, institutional arrangement and regulations, monitoring and assessment programmes (see Figure 7.36, Chapter 7). From this perspective, future effective water governance in HCMC should be focused on clearly defining responsibilities in the water management system. This means restructuring the water resources management body is needed for HCMC.

One of the institutional weaknesses in water resources management in the developing world is the lack of an peak authority responsible for integrating sub-sector agency plans and programs (Arriens 2002). Most poor water resources management practices in HCMC can be traced to overlapping responsibilities and vague obligations between local authorities and sectors (Hiep Nguyen Duc and Truong Phuoc Truong 2003). DORNE of HCMC has been the key local government agency responsible for managing natural resources. However, the responsibility for water resource management in HCMC is that of several government departments (see Table 4.9, Chapter 4). This structure results in overlapping and conflicting duties between agencies as discussed in Chapter Four.

Water resource management in HCMC should be restructured in a comprehensive manner. An apex government agency should be in place to take responsibility for coordination and integration rather than single independent agencies in each sector. Figure 8.3 shows a proposed management structure where the Department of Water Resources (DWR) is the key authority responsible for integrating sub-sector strategies and plans. This apex body is also a key agency for the horizontal coordination between governmental departments having regulatory and implementing agencies (DARD, DONRE, DI) and a service delivery body (SAWACO).

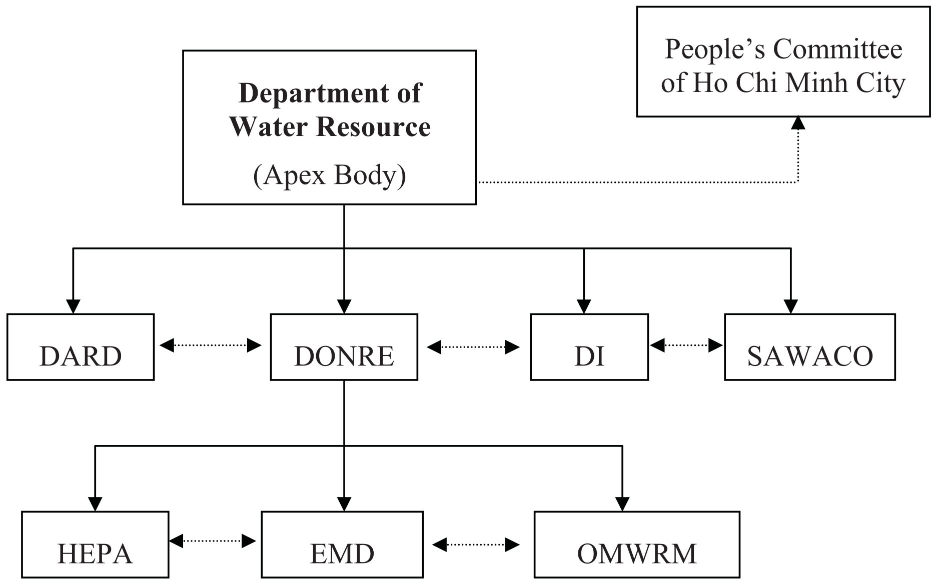


Figure 8.3 Proposed Structure of Apex Body for Water Management

Source: The author

DONRE	: Department of Natural Resources & Environment	DARD	: Department of Agricultural & Rural Development
DI	: Department of Industry	EMD	: Environmental Management Division
HEPA	: HCMC Environmental Protection Agency	OMWRM	: Office of Mineral & Water Resources Management
SAWACO	: Sai Gon Water Supply Company		

The apex authority or body should be in charge of implementing annual reports as well as determining appropriate long-term and short-term strategies on water resources management. The main feature of this arrangement is the interdependence between these agencies in which DONRE will be the focal point. DONRE will be also an integrated office for its subordinate divisions (HEPA, DEM and OMWRM). Given such a context, the subordinate divisions of DONRE should be strengthened in terms of enforcing 'holistic' quantity and quality management.

However, such a proposed authority - Department of Water Resources - will face challenges in its ability to govern. Firstly, the apex body could be confused with or misinterpreted as the amalgamation of line agencies. Unforeseeable bureaucracy and possible conflicts of interest may be spawned. Secondly, as an overarching agency, this body has to create a channel of shared data and information across government departments as this is an important component of water resources management and development. Thirdly, the apex organisation has to take a vital role in disseminating knowledge and information on the city's water resources to the grass-roots level. To avoid or minimise more bureaucracy which may be introduced by the new structure, service delivery, policy and planning and regulation functions should be separated to clearly establish accountabilities between sectoral agencies.

8.6 Sustainable Approach to Water Resource Management

8.6.1 Conceptual Framework of Strategic Planning and Management of Water Resources

The pressures on water management in HCMC are complex and intertwined with both development interests (industry, agriculture and household), social concerns (public perception, education and participation) and with management or government (institutions, mechanisms and regulations). The total water demand for industrial and domestic purposes is estimated at 2.4 million kL/day in 2010 and 3.6 million kL/day in 2020, respectively (see Chapter 4). At the same time, the total volume of industrial and domestic wastewater was 750,000 kL/day in 2000 and is estimated at 2.1 million kL/day in 2020. The effluent discharges directly to canal systems and the Dong Nai-Sai Gon river- a major supply source for HCMC. This will be a pressing challenge in managing water to satisfy growing demand for water, coupled with industrial and urbanisation growth. It is necessary to take a strategic planning approach regarding the management of (SPM) water resources in HCMC. The above-mentioned recommendations on water management will then be consolidated and enhanced.

According to ESCAP (2004), strategic planning and management has the following key features:

> (i) Resources are focused on achieving a Mission, often embedded in a Vision, which is clear and realistic. Specific time frames are often attached to mission achievement.
>
> (ii) The Mission is based on issues (failures to meet expectations) identified collaboratively by key stakeholders rather than pre-set objectives determined by the bureaucracy in isolation (ESCAP 2004, pp. 1-2).

Accordingly, strategic planning and management is defined as increasing accountability of government agencies in which each agency is required to develop a mission statement. Such a statement is essentially a commitment to future actions and performance.

Like other Asian developing countries, instead of planning design horizons of 50 years or longer, Ho Chi Minh City usually sets short time frames of a 10-year design horizon. This approach will not secure water sources to satisfy increased demands resulting from rapid urbanisation. Strategic planning and management, therefore, will be necessary in HCMC as it will be advantageous at the local and sectoral level:

- *Taking into consideration different institutions, stakeholders, agendas of different sectors and encourage their participation;*
- *Achieving expected outcomes within the anticipated timeframe;*
- *Enabling rapid development competing for limited resources ;*
- *Coordinating long and short term activities;*
- *Improving the legal framework, reconciling laws;*
- *Conserving water resources for sustainable use; and*
- *Addressing the needs of different target groups with different abilities to pay.*

Source: Summarised by the author from ESCAP (2004, p. 5)

In order to produce good strategic planning and management, a sound conceptual framework is essential. A set of monitoring indicators is known as the DPSIR model, Driving forces-Pressures-State-Impact-Response (Figure 8.4), developed by the Organisation for Economic Co-operation and Development (OECD) (Giupponi et al. 2006). The DPSIR framework has been adopted by European countries, the United States, Australia, Japan and Malaysia (ESCAP 2004).

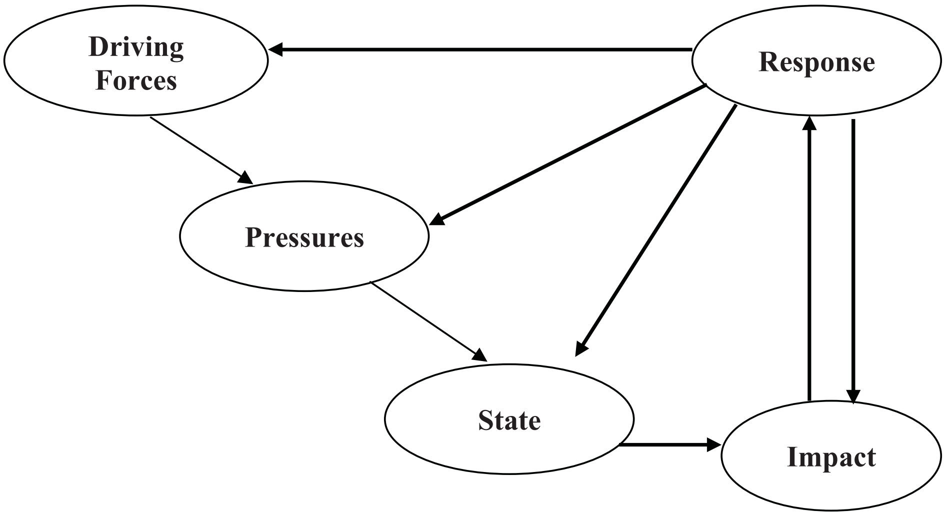


Figure 8.4 Conceptual Framework of DPSIR Model

Source: ESCAP (2004); Giupponi et al. (2006)

Driving forces (D): Describe the underlying causes that lead to pressures on water resources. Such forces include social, demographic and economic factors, urbanisation trends, industrialisation and corresponding changes in lifestyles, consumption and production patterns. These driving forces either directly or indirectly result in an increase in water demand.

Pressures (P): Describe pressures on the environment caused by the above drivers. These include the demand for water from economic, industrial and domestic activities that are associated with urban expansion. In HCMC these drivers have resulted in over-abstraction of groundwater and increasing quality deterioration of surface water sources caused by industrial and domestic discharges.

State (S): Driving forces place pressures on the environment (air, water, soil). Pressures, in turn, have an impact on the physical status of water resources including quantity and quality (BOD, COD, Nitrate, Ammonia, heavy metal traces, Coliform, etc).

Impact (I): The deterioration of water quality may compromise human health, integrity of ecosystems, biodiversity, amenities and finances, etc. In HCMC, severe degradation of water quality can be clearly observed in surface sources both at river basins and urban canal systems, and in contamination and exhaustion of groundwater.

Response (R): Reflects management practices, actions and effectiveness of local government and wider social measures to tackle water problems, including water pollution control, water efficient facilities, price, participation of stakeholders, and improvement of governance.

8.6.2 Integrated Approach

Most respondents from government agencies observed that uncontrolled groundwater exploitation, inadequate clean water sources and poor distribution network systems are the causes for water shortage in HCMC (Figure 7.28). The majority of respondents emphasised the fact that HCMC is facing pressing water challenges as a result of rapid urbanisation, population growth and industrial activities. These challenges include accelerated surface water pollution (rivers and urban canal systems), unbridled groundwater abstraction, and weak enforcement of regulations (Figures 7.28 and 7.29).

The SWOT analysis discussed in Chapter 4 showed that fragmented management practices is a major weakness. This institutional weakness has resulted in poor coordination between water-related government agencies and existing water programs. As urbanisation and industrialisation proceed, associated with growing water demand, HCMC will continue to face water stress (shortage, degradation and depletion) and management constraints. Future water resources policy in HCMC should take a new approach which integrates institutional, social, economic and technological factors. This approach is called the SMART model - an acronym for the following elements: (i) *Securing water sources* for future urban development; enabling (ii) *Multiple co-ordinations* between government agencies; creating (iii) *Affordable solutions* for all stakeholders; (iv) *Restructuring* urban water facilities; and implementing water (v)) *Tariff Reform* (see Figure 8.4). Each principle in the SMART model is interdependent. The principles of the SMART model should be considered as a conceptual one including institutional, technological, economic and social aspects of water management. The current water-stress problems could be eradicated or more easily managed if the principles of the SMART model were adopted. Furthermore, the SMART model could also be an oriented approach to improve the decision-making and management processes of water in HCMC.

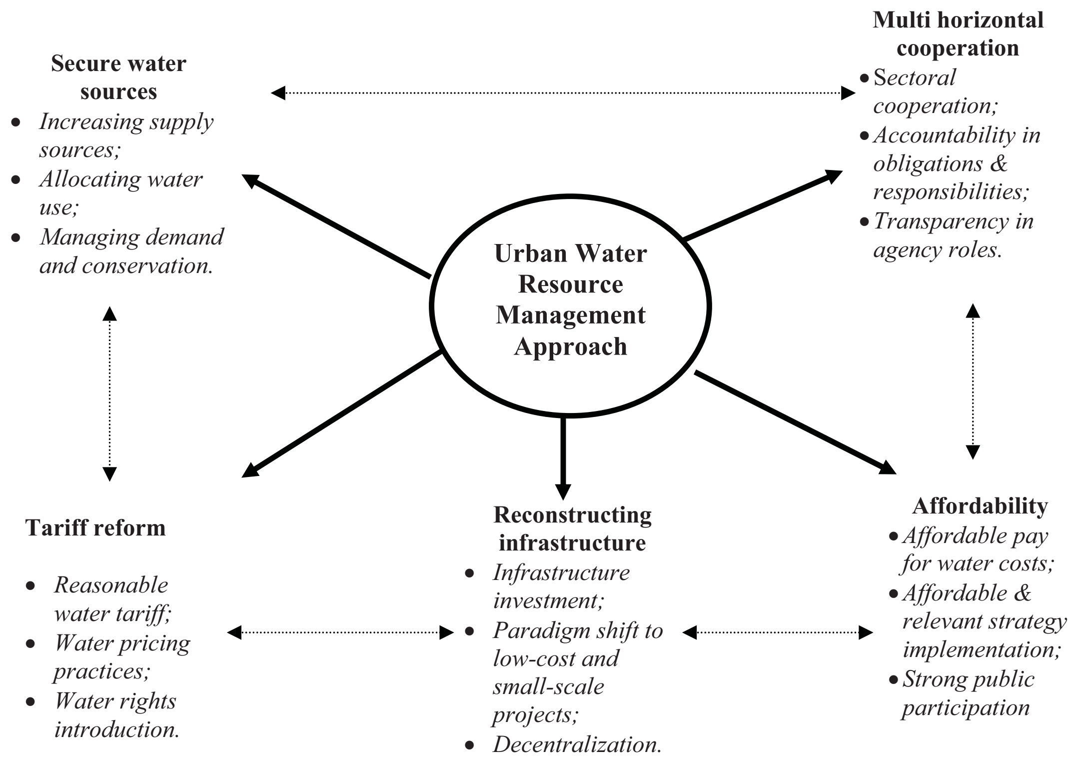


Figure 8.4 A Conceptual Model for Integrated Approach to Water Management

Source: The author

8.6.2.1 Secure water supply sources (S)

As discussed in Chapter 4, the severe strains on the city's water resources stem from the acceleration of water quality deterioration of the Dong Nai-Sai Gon river system- a major supply source, and the alarming level of groundwater abstraction. With respect to the current urban growth, exploring sufficient and secure water supply sources must be undertaken for the sustainable development of HCMC to proceed.

As a corollary of urbanisation and industrialisation, the city could look for more costly sources of water as its users are increasingly competing for scarce water resources. With constraints on available water quantity and quality, there are various technical and institutional means to satisfy growing demand for water. Supply sources can be increased from alternative sources such as harvesting rainwater, and reusing and recycling grey water for non-domestic use (Meinzen-Dick and Appasamy 2002; Niemczynowicz 1999, 2000). Catching rainwater or urban runoff and restoring it to aquifers for domestic and non-potable purposes is an example of an affordable application to a seasonally-wet climate country like Vietnam. However, one government district official stated that it is difficult to promote use of rainwater while residency space is limited with very small and narrow areas where one cannot install rainwater harvesting systems (interviewee, district official-DNREO1, 2005, see page 226, Chapter 7).

Nevertheless, most public and government respondents strongly emphasised a preference to use rainwater if it was collected and treated properly (see Chapter 7). This conclusion represents potential support for future water regulations in HCMC. In order to encourage using this alternative source, rainwater harvesting is feasible. What is required is for the HCMC government to establish bylaws or ordinances in which no new house is built that does not have a rainwater collection system from the full roof area and a storage facility. Such ordinances could also apply to existing households. The owners should be asked to comply with the bylaws by given time frames (for example, 5-10 years) for the modification of the roofs and storage facilities on-site. In addition, rainwater collection should be considered the best available option for coastal outlying districts (Can Gio, Nha Be) where they find it hard to collect enough freshwater.

The traditional approach to supply-driven methods will no longer be appropriate. In the pursuit of satisfying growing demand, there needs to be a shift to the demand management approach. Re-allocating water from different users and managing urban water demands are also options. These options can be implemented through a wide range of institutional and economic-based mechanisms such as water rights trading, in-house improvement, water price reform and decentralisation (Gleick 2003a; Malano et al. 1999; Meinzen-Dick and

Appasamy 2002). Though it will take a long time to implement such measures, they are important and their application will underpin sustainable urban development. The best available technical applications are in place around the developed world and could be adopted in HCMC, as long as they are financially affordable for the local context and capacity.

8.6.2.2 Multiple co-ordination (M)

Overlapping responsibilities and vague obligations between local authorities and sectors can be traced to a lack of collaboration, accountability and transparency between government line agencies. These factors contribute to slow progress regarding water management and enforcement of regulations for polluters and all water end-users. More importantly, many existing water-related projects in HCMC are not integrated. These projects include the water supply development plan (headed by SAWACO), urban canal hygiene upgrading (managed by the Department of Transport and Public Works), river basin management (managed by the Department of Agriculture and Rural Development-DARD). Given the rapid urbanisation, the management of water resources in HCMC requires a synergistic cooperation between local departments. Such cooperation will help identify current weaknesses and opportunities for government action and promote the constructive involvement of stakeholders.

8.6.2.3 Affordability (A)

The perception of affordability in this study is defined as users pay for affordable water costs and the implementation of water management strategy is feasible and relevant to all stakeholders. Regarding the first term, many poor residents in outlying districts find it difficult to connect to the piped distribution system, and they have to pay more for water. The high cost of water includes collection time and high health-related costs from using polluted water sources (Whittington 2003).

Public participation could be involved in devising an affordable strategy. Southeast Asian cities tend to use state-driven and top-down solutions for urban environmental challenges (Storey 2005). Like other cities in the region, the traditional command and control approach have not been very successful in dealing with environmental issues in HCMC. In reality, community involvement in urban environmental issues has not really occurred. Therefore, it is necessary to develop a socially and economically sound water tariff structure. A public awareness scheme relating to water conservation must be designed to draw public attention to the quality of water resources and other urban water receiving bodies. In such a scheme, the local government of HCMC should define local water issues for communities and establish channels of communication with local authorities such as the district division of natural resources and environment.

8.6.2.4 Reconstructing water infrastructure (R)

Water development projects have brought enormous benefits to human societies. Vietnam is coping with infrastructure problems caused by an inappropriate centralised infrastructure that still exists today (Malano et al. 1999). Therefore, to obtain secure water sources for increasing urban water demand, it is crucial to reconstruct a pathway to water facilities through low cost community-based projects (Gleick 2003a). The option of rainwater harvesting as discussed above can be implemented in small community-based contexts in which ten households can be grouped into one cluster and sharing the same on-site collecting system. This should provide an effective cost-benefit solution.

Reasonable infrastructure investment will have cumulative benefits for urban society in regard to flooding and water scarcity. One interesting outcome of the survey is that most existing water projects are viewed as urban upgrading and improvement of the open canal network. Some projects are merely attempting to meet growing demand for water.

In urban areas, many detention areas that acted as regulation facilities have disappeared or been encroached upon for housing construction due to rapid expansion. Consequently, urban flooding is bad in the rainy season (May-October), and even worse in low-lying urban districts associated with seasonal tidal surges. Thus, the concept of urban watershed should be developed to solve this problem in HCMC. A watershed can be defined as the entire land area and urban water systems that drain into a given watercourse or a body of receiving waters. These receiving water bodies may include constructed wetlands or detention facilities that play a regulation role in the alleviation of inner urban floods during the rainy season as well as replenishment of groundwater. The watershed approach is also essential for effective wastewater pollution control from point sources and non-point pollutant runoff. However, this approach requires empirical research to determine the water-flow balance and level of high capital investment. Environmental funds and investment bonds can provide financial assistance to such infrastructure in some Asian countries (Imura et al. 2005). There are already two kinds of environmental funds in HCMC, specifically the Revolving Fund and the Pollution Minimisation Fund, which have effectively assisted cleaner production projects for the past several years. This mechanism should be adopted by the water sector in HCMC.

8.6.2.5 Tariffs reform (T)

A pricing mechanism for water resources will become a fact of life because water rights have recently been introduced in Vietnam. Water rights will be a positive effect on changing people's perceptions of water as a social and economic good. Water use is also being regulated by permit and license mechanisms in the form of fees on extraction and charges on consumption. The need for water tariff reform is essential to groundwater management. As discussed in Chapter 4, the abstraction of groundwater has exceeded the sustainable limit (People's Committee of Ho Chi Minh City 2002). Therefore, the situation could be ameliorated if water prices and tariffs are strictly applied to groundwater users.

According to Decree No. 67/2003/ND-CP, water use charges have existed in HCMC since 2004. These charges comprise a range of fees such as a groundwater exploitation fee and an industrial and domestic wastewater discharge levy. The introduction of a levy on water resources was the local government's effort to strictly regulate urban water demands and to minimise water pollution. However, this has not yet been thoroughly implemented owing to lack of public and industry awareness and insufficient political will.

The research findings indicated that the concept of water protection is poor among the public and industrial community (interviewee-UCON2, 2005, page 223, Chapter 7). Once water pricing and appropriate water tariffs are in place they will provide incentives for water conservation among users. Furthermore, a paradigm shift in water pricing and tariffs also promotes stakeholder awareness of effective and appropriate water use rather than seeking alternative water sources.

8.7 Conclusion

This study has explored various constraints on water management in HCMC by examining the local institutional, management and government arrangements and carrying out a survey on the city's water issues and the valuation of water. In conclusion, an integrated approach was formulated for sustainable water management in HCMC based on the following research findings.

8.7.1 Summary of Key Findings

(i) This study is the first investigation in HCMC into how people value water resources. Different social groups have varying perceptions about water. The valuation of water is still perceived as a social good rather than as a commodity by the majority of respondents ranging from urban dwellers to government officials.

(ii) Most urban citizens had very little knowledge of water resources and had limited access to information on the city's water issues.

(iii) Household supply services faced several problems, including inadequate water quality, unreliable pressures and high water loss. At the same time, water resources have suffered from acceleration of surface water pollution and over-abstraction of groundwater owing to rapid growth of urbanisation and industrialisation.

(iv) Government agencies have poor managerial expertise due to inadequate implementation of the mandatory regulations and mechanisms. The management capacity of government officials is also weak due to a lack of shared information on the city's water resources.

(v) Fragmented management practices are aggravating problems of water management as a result of weakness in institutional frameworks and ineffective water governance systems. The weakness of governance has caused problems in cooperation between agencies, community involvement and public/private sector participation.

(vi) While pressures placed on surface water and groundwater sources have increased, rainwater harvesting is receiving attention from stakeholders. This is a promising alternative source for future water planning and management in Ho Chi Minh City, a city with an abundance of rainfall in the wet season.

8.7.2 Further Research

Economic liberalisation of HCMC has proceeded over the past two decades. This city will continue to rapidly urbanise and industrialise. The research in this thesis reveals noticeable tendencies in the management of water resources through a survey using a limited sample. Therefore, future research on the water sector in HCMC needs to take into consideration three major themes. First, a detailed investigation into water demand and supply scenarios needs to be carried out since industrialisation and urbanisation is an ongoing process. Second, a study of the decentralisation of functions and responsibilities between line government agencies and transparent, accountable outcomes is essential to long-term water management. Third, the use of non-conventional water sources (reclaimed and recycled water) in the future needs to be explored further at timeframes, for examples 20, 30 and 50 years.

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APPENDICES

Appendix 1 - Publication in GeoJournal and Conference:

(1) *Urbanization and Water Management in Ho Chi Minh City, Vietnam- Issues, Challenges and Perspectives*. GeoJournal, DOI: 10.1007/s10708-008-9115-2.

(2) *An Integrated Approach to Urban Water Resource Management in Ho Chi Minh City, Vietnam*, at the 3rd Asia-Pacific Association of Hydrology and Water Resources (APHW), Bangkok, Thailand, 16-18 October 2006.

Vo, P.L. (2007) Urbanization and water management in Ho Chi Minh City, Vietnam - issues, challenges and perspectives.
GeoJournal, 70(1), pp. 75-89

NOTE: This publication is included in the print copy of the thesis held in the University of Adelaide Library.

It is also available online to authorised users at:

http://dx.doi.org/10.1007/s10708-008-9115-2

Vo, P.L. & Williams, M (2006) An Integrated Approach to Urban Water Resource Management in Ho Chi Minh City, Vietnam
Presented at the 3rd Asia Pacific Association of Hydrology and Water Resources (APHW) Conference, 16-18 October 2006, Bangkok, Thailand.

NOTE: This publication is included in the print copy of the thesis held in the University of Adelaide Library.

LUẬT BẢO VỆ MÔI TRƯỜNG

CỦA NƯỚC CỘNG HÒA XÃ HỘI CHỦ NGHĨA VIỆT NAM

SỐ 52/2005/QH11 NGÀY 29 THÁNG 11 NĂM 2005

NOTE: This publication is included in the print copy of the thesis held in the University of Adelaide Library.

Socialist Republic of Vietnam

THE LAW ON WATER RESOURCES

(No. 8/1998/QH10 of May 20, 1998)

DECREE No. 67/2003/ND-CP OF JUNE 13, 2003 ON ENVIRONMENTAL PROTECTION CHARGES FOR WASTE WATER

NOTE: This publication is included in the print copy of the thesis held in the University of Adelaide Library.

Socialist Republic of Vietnam

Hanoi, 30 December 1999

DECREE No. 179/1999/ND-CP

STIPULATING THE IMPLEMENTATION OF

THE LAW ON WATER RESOURCES

NOTE: This publication is included in the print copy of the thesis held in the University of Adelaide Library.

VIETNAM STANDARD- TCVN 5942-1995

PARAMETER LIMITS AND MAXIMUM ALLOWABLE CONCENTRATIONS OF POLLUTANTS IN SURFACE WATER

VIETNAM STANDARD-TCVN 5943-1995

PARAMETER LIMITS AND ALLOWABLE CONCENTRATIONS OF POLLUTANTS IN COASTAL WATER

VIETNAM STANDARD-TCVN 5944-1995

PARAMETER LIMITS AND MAXIMUM ALLOWABLE CONCENTRATIONS OF POLLUTANTS IN GROUND WATER

VIETNAM STANDARD-TCVN 5945-1995

Industrial Waste Water Discharge Standards

LIMIT VALUES OF PARAMETERS AND MAXIMUM ALLOWABLE CONCENTRATIONS OF POLLUTANTS IN INDUSTRIAL WASTEWATER

NOTE: This publication is included in the print copy of the thesis held in the University of Adelaide Library.

Notes:

- Industrial waste waters containing the values of parameters and concentrations of substances which are equal to or lower than the values specified in the column A may be discharged into the water bodies using for sources of domestic supply.

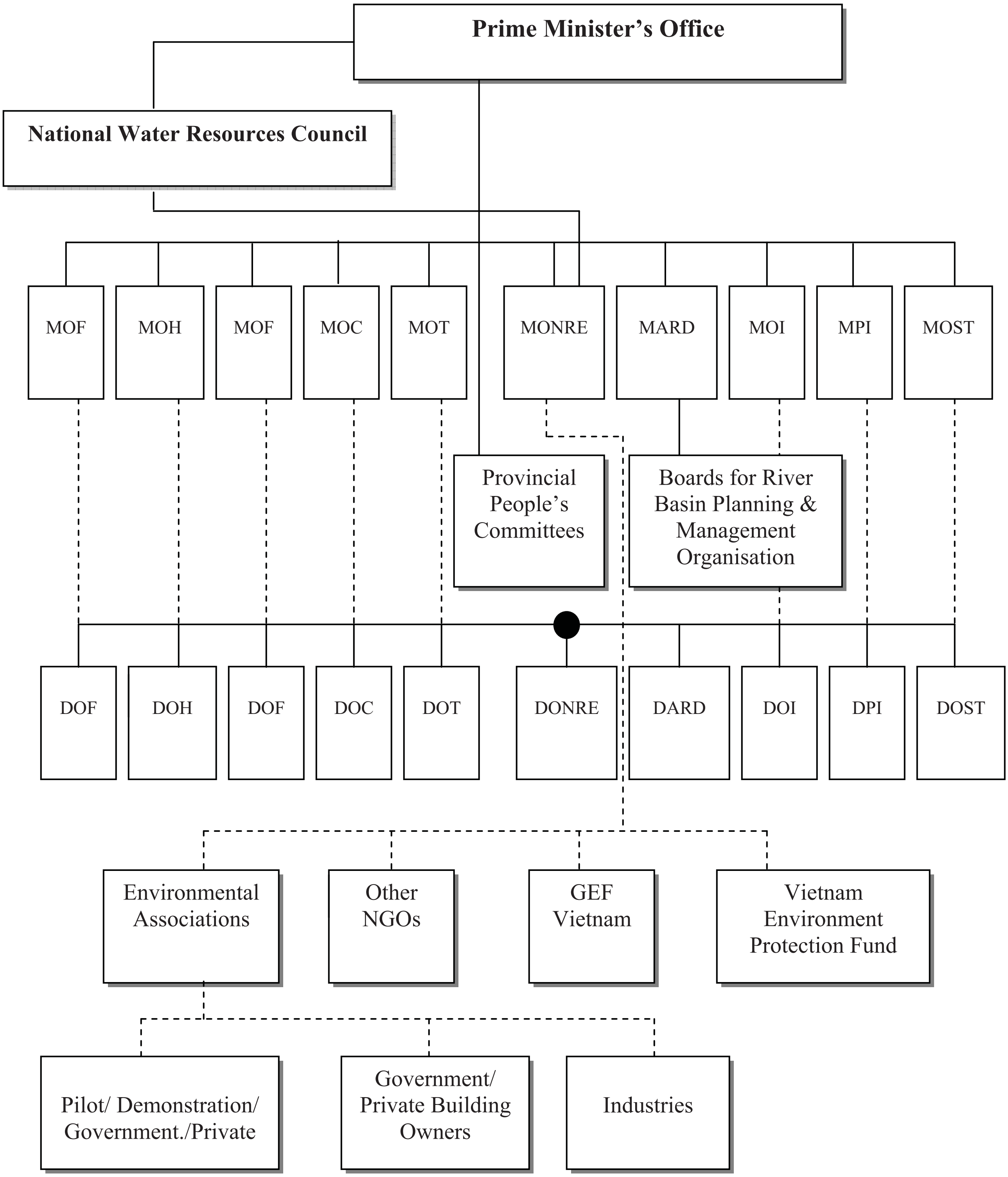
- Industrial waste waters containing the values of parameters and concentrations of substances which are lower or equal to those specified in the column B are discharged only into the water bodies using for navigation, irrigation purposes or for bathing, aquatic breeding and cultivation etc.

- Industrial waste waters containing the values of parameters and concentrations of substances which are greater than those specified in the column B but not exceeding those specified in the column C are discharged only into specified water bodies permitted by authority agencies.

- Industrial waste waters containing the values of parameters and concentrations of substances which are greater than those specified in the column C shall not be discharged into surroundings.

Source: Vietnam General Agency for Standards and Quality (1995). *Vietnam Standards on the Environment. Volume 1: Water Quality*. Hanoi, Vietnam.

ORGANISATIONAL CHART OF WATER-RELATED INSTITUTIONS



Notes:

MOF/DOF: Ministry/Dept of Finance
MOH/DOH: Ministry/Dept of Health
MOF/DOF: Ministry/Dept of Fishery
MOC/DOC: Ministry/Dept of Construction
MOT/DOT: Ministry/Dept of Transport
MI/DI: Ministry/Dept of Industry
MONRE/DONRE: Ministry/Dept of Natural Resources & Environment
MARD/DARD: Ministry/Dept of Agricultural & Rural Development
MPI/DPI: Ministry/Dept of Planning & Investment
MOST/DOST: Ministry/Dept of Science & Technology

KEY LEGISLATION ON WATER RESOURCES IN VIETNAM

Source: (World Bank et al. 2003)

NOTE: This publication is included in the print copy of the thesis held in the University of Adelaide Library.

LEGAL FRAMEWORK OF WATER RESOURCE MANAGEMENT IN HO CHI MINH CITY, VIETNAM

	Regulations	Status
1	Guidelines on Strengthening of Management of Groundwater Exploitation and Trade of Well Drilling	Under consideration by the People's Committee Ho Chi Minh City
2	Regulations on Water Resources Management in Ho Chi Minh City	Issued as Decision No.17/2006
3	Regulations on Limitation or Prohibition of Groundwater Exploitation in Ho Chi Minh City	Being compiled by the Department of Natural Resources & Environment (DONRE)
4	Draft Guidelines on Collection of Resources Tax in Ho Chi Minh City based on the Ordinance of Resources Taxes of Ministry of Finance	Under consideration by the People's Committee of Ho Chi Minh City
5	Draft Regulation on Charges of Groundwater Exploitation Fee in Ho Chi Minh City	Under compilation by the Department of Natural Resources & Environment (DONRE)
6	Decision on Stipulation for Water Resource Management in Ho Chi Minh City (Decision 17/2006/QD-UBND)	Issued by the People's Committee Ho Chi Minh City

EXAMPLE OF PRIVATE PIPED SYSTEM IN THE WATER SECTOR IN HO CHI MINH CITY, VIETNAM

source: (McIntosh 2003)

NOTE: This publication is included in the print copy of the thesis held in the University of Adelaide Library.

THE UNIVERSITY OF ADELAIDE AUSTRALIA

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CRICOS Provider Number 00123M

Date: …..

Dear (name of participant/ urban dwellers),

My name is Phu Le Vo and I am currently undertaking a research project as part of a Ph.D degree in Environmental Studies at The University of Adelaide, South Australia, Australia.

The purpose of my project is to formulate an integrated approach to the sustainable management of water resources in Ho Chi Minh City. Thus, I am going to conduct surveys in HCMC, and hopefully gain useful and active responses to draw out my research results in the area of urban water management.

In recent years, the City has been facing water stress and scarcity in the dry season while its urban areas are inundated in the wet weather. As an urban dweller, you might be aware of the above water issues that may have impact directly or indirectly on your basic amenities. Given that context, I am investigating of how urban water can be used and managed effectively.

To this end, I would like to forward you a copy of the questionnaire for survey. I would be grateful if you would be agreeable to assisting my study. If you would like to participate, but would prefer not to be identified, please let me know and this can be arranged. This survey forms a component of my PhD research project at the University of Adelaide. Any input received from you through this survey will contribute significantly in completing my Doctoral Dissertation. Should you choose take part, you would be free to withdraw at any stage before the study has been completed, without any justification on your part.

Please return the completed questionnaire to my address below (in Vietnam) or I am happy to pick up at your door at your convenient time. If you would like to make sure or need any more information, please feel free to contact myself or my supervisor, Professor Martin Williams, at the details below to address any concerns you may have.

Yours sincerely,

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Ph.D Candidate
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CRICOS Provider Number 00123M

Ngày tháng năm 2005.

Kính thưa qúy Ông/ Bà,

Tôi tên là Võ Lê Phú, hiện đang học tiến sĩ về Nghiên Cứu Môi Trường tại Trường Đại Học Adelaide, Nam Úc, Australia.

Tôi đang thực hiện đề tài nghiên cứu "Xây dựng cách tiếp cận tổng thể cho việc quản lý bền vững tài nguyên nước tại Thành Phố Hồ Chí Minh". Do đó, tôi đang tiến hành các khảo sát thông qua bảng câu hỏi điều tra về hiện trạng sử dụng và quản lý tài nguyên nước hiện nay tại TPHCM. Tôi hy vọng sẽ thu được những ý kiến và thông tin hữu ích qua cuộc khảo sát này. Kết quả này sẽ rất quan trọng trong việc nâng cao kiến thức hiểu biết của tôi về hiện trạng quản lý tài nguyên nước hiện nay của TPHCM.

Trong những năm gần đây, TPHCM đã và đang gặp nhiều sức ép liên quan đến tài nguyên nước, điển hình là sự khan hiếm nước cho các nhu cầu sinh hoạt và sản xuất công nghiệp trong mùa nắng và vấn đề ngập lụt đô thị trong mùa mưa. Là người dân của thành phố, hẳn Ông/Bà có thể nhận thấy được những vấn đề nêu trên mà có thể tác động trực tiếp hoặc gián tiếp đến cuộc sống hằng ngày của chúng ta. Trong bối cảnh đó, mục tiêu chính của đề tài mà tôi đang thực hiện là nhằm tìm ra các giải pháp quản lý hiệu quả tài nguyên nước sẵn có của TPHCM.

Vì vậy tôi xin trân trọng gởi đến qúy Ông/Bà một bảng câu hỏi khảo sát. Ông/Bà chỉ cần 20 phút để hoàn thành bảng câu hỏi này. Tôi rất biết ơn thời gian qúy báu của qúy Ông/Bà dành sự quan tâm, hỗ trợ và hợp tác cho đề tài nghiên cứu của tôi. Các ý kiến đóng góp của quý Ông/Bà sẽ rất quan trọng và có ý nghĩa trong việc hoàn thành đề tài nghiên cứu của tôi tại Đại Học Adelaide, Nam Úc.

Nếu Ông/Bà sẳn lòng tham gia trả lời bảng câu hỏi, nhưng không muốn nêu tên thì Ông/Bà không cần điền tên vào bảng câu hỏi. Nếu Ông/Bà không muốn tham gia cuộc khảo sát này, Ông/Bà có thể rút lui bất cứ lúc nào Ông/Ba muốn.

Xin Ông/Bà vui lòng gởi bảng câu hỏi đến địa chỉ tại TPHCM nêu dưới đây hoặc tôi sẵn sàng đến nhận tại nhà của quý Ông/Bà. Nếu Ông/Bà muốn biết thêm các thông tin chi tiết hoặc có thắc mắc gì liên quan đến đề tài nghiên cứu này, xin quý Ông/Bà đừng ngần ngại liên lạc trực tiếp với tôi hoặc thầy giáo hướng dẫn tôi- Giáo Sư Martin Williams, theo các địa chỉ nêu chi tiết dưới đây.

Xin chân thành cảm ơn và mong nhận được sự hợp tác của quý Ông/Bà.

Chào trân trọng

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SURVEY OF WATER USE AND MANAGEMENT IN

HO CHI MINH CITY, VIETNAM

(Group: Urban dwellers)

Date: ……………………………… **Time:**………………………..

Name (Optional): ……………………… **Gender:** ❑ Male ❑ Female

PART ONE: RELATED WATER SUPPLY ISSUES

1. How do you define ***water resources*** by which ways as follows *(please tick one appropriate box)*:

   a) Water is a natural resource for free use ❑

   b) Water is a type of tradable good ❑

   c) Water is a resource which needs to be reserved ❑

   d) Water is both a resource and a good ❑

2. In your opinion, current water use in Ho Chi Minh City can be seen as *(please tick one appropriate box)*:

   a) Economical and saving ❑

   b) Wasteful ❑

   c) Do not know ❑

3. What source of water are you using now for your family's daily activities? *(please tick one appropriate box)*:

   a) Piped water (the City's main water) ❑

   b) Groundwater (from your own well) ❑

   c) Vendor water (water from vendor machine) ❑

   d) Both piped water and groundwater ❑

   e) Rainwater ❑

   f) Other sources ❑

4. If you are using any above water sources, how do you rate the quality and quantity of water in Ho Chi Minh City? *(Please tick one appropriate box):*

   a) Good quality, but not enough quantity ❑

   b) Enough quantity, but not good quality ❑

c) Both quality and quantity are satisfied ❑

d) Both quality and quantity are not satisfied ❑

e) Other, please comment:……………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………

5. Have you faced with any water use problems in the dry season during you living in Ho Chi Minh City? *(please tick one appropriate box)*:

   a) Lack of water for domestic purposes ❑

   b) Lack of clean water for drinking ❑

   c) Get water but not good quality ❑

6. Do you think Ho Chi Minh City will face with water scarcity during the dry season in the near future? *(Please tick one appropriate box)*

   a) Yes, there will have water stress threat ❑

   b) No water stress ❑

   c) Others, please comment:……..……………………………………………………...
   ………………………………………………………………………………………...
   ………………………………………………………………………………………...

7. Have you encountered in any related-issues of ***water source*** during you living in Ho Chi Minh City? *(you may tick more than one box)*:

   a) Lack of water source for urban domestic uses ❑

   c) Quality of water is not satisfied for domestic uses ❑

   d) Too much water in the wet weather, causing floods ❑

   e) Water becomes polluted (river and canals) ❑

   f) Groundwater is polluted and depleted ❑

   g) Others, please comment: ……..……………………………………………………...

If you are using main water, please provide your answers to Questions 8 – 13.

8. Have you ever faced with any difficulties when using main water? *(you may tick more than box)*

   a) No pipeline system reaches to your premise ❑

   b) Not enough water pressure from distribution pipelines/systems ❑

   c) No water in the pipeline ❑

d) Too much water being leaked from the systems ❑

e) Other difficulties, please provide your comments: …………………………………

…………………………………………………………………………………………...

9. How much are you being charged (in average) for water supply ($/cubic meter)? …….. $/ m^3

10. How do you think this range of water price is being applied? *(Please tick one appropriate box)*

    a) Expensive and not satisfied ❑

    b) Cheap ❑

    c) Moderate ❑

    d) Other, please comment: ……………………………………………………………

    …………………………………………………………………………………………...

    …………………………………………………………………………………………...

11. According to your current water price, how do you think of water supply services? *(You may tick more than one box):*

    a) Water quality is not stable ❑

    b) Water pressure is not strong enough ❑

    c) Water is intermittent ❑

12. Are you pleased with existing water supply service of HCMC Water Company?

    a) Yes, we are pleased ❑

    b) No, we are not pleased ❑

    c) Do not know ❑

13. Are you willing to pay more for better improvement of managing water quality, services and supplies in the future?

    a) No, I am not willing ❑

    b) Yes, I am willing to pay more ❑

    c) Other reasons: ………………………………………………………………………

    ………………………………………………………………………………………

    ………………………………………………………………………………………

14. If you are using groundwater, do you have any drawbacks? *(Please tick one appropriate box):*

a) Not enough water for domestic use ❑

b) *Groundwater quality is not satisfied for daily activities* ❑

c) *Others (please clarify): ……………………………………………………………….*

……………………………………………………………………………………………

PART TWO: GENERAL ISSUES OF WATER RESOURCES

15. Do you have any idea about ***water resources*** in Ho Chi Minh City? *(Please tick one appropriate box)*

a) Yes, I have some ideas but not much ❑

b) No, I do not have any knowledge of water resources ❑

c) Other, please give your comments: …………………………………………………..

………………………………………………………………………………………...

16. Are you interested in knowing who or which body is taking responsibility for water resources management in Ho Chi Minh City?

a) Yes, I am concerned ❑

b) No, I am not concerned ❑

c) Other reasons, please give your comments: …………………………………………

………………………………………………………………………………………...

17. If you are interested in mentioned issue in Question 16, are you pleased with its actions? *(please tick one appropriate box)*

a) Yes ❑

b) No ❑

c) Other, please comment: ………………………………………………………..

………………………………………………………………………………………...

18. Have you got any information of water resources of the City?

a) Yes, I have got some information ❑

b) No, I never got any information on water issues ❑

c) Do not know (not sure) ❑

19. In your opinion, in order to public/community get understanding and adequate information on ***water resources***, what does the City's authority need to do? *(Please provide your comments)*:

……………………………………………………………………………………………...

……………………………………………………………………………………………...

20. How do you think if ***private*** taking participation into water sector (including water management and water supply services)?

    a) Agree and foster ❑

    b) Do not agree ❑

    c) Other reasons: ……………………………………………………………………….

    ……………………………………………………………………………………………..

21. Rainwater (urban stormwater) is considered as a ***clean water source*** and could be an alternative for water use in urban areas in the future; will you and your family use rainwater for other domestic purposes?

    a) Yes ❑

    b) No ❑

    c) Other reasons ❑

22. If rainwater is collected and separated from domestic wastewater and properly treated, will you choose this source as preferred alternative water?

    a) Yes ❑

    b) No ❑

    c) Other reasons ❑

23. If water become a scarce resource and challenged to the sustainable development of the City, how and what action will you contribute to ***the protection and management of water resources*** in Ho Chi Minh City?

    ……………………………………………………………………………………………...

    ……………………………………………………………………………………………...

24. How long have you been living in Ho Chi Minh City?

2-5 years	5-10 years	10-15 years	15-20 years	More than 20 years
❑	❑	❑	❑	❑

25. Where is your current residency address, please clarify District where you are living.

………………………………………………………………………………………………

………………………………………………………………………………………………

Thank you for your time.

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CRICOS Provider Number 00123M

Date: …..

Dear (name of organisation or person on behalf of organisation),

My name is Phu Le Vo and I am currently undertaking a research project as part of my Ph.D degree in Environmental Studies at The University of Adelaide.

The purpose of my project is to formulate an integrated approach to sustainable water management in Ho Chi Minh City, Vietnam. In order to achieve the objectives of the study, I am going to undertake a fieldwork and surveys in HCMC, including 24 districts of the City, and hopefully gain valuable responses as well as practical results to build up a solid contribution to the knowledge of the field of urban water management.

Recently, the City has been facing water stress and scarcity in the dry season while its urban areas are inundated in the wet weather. Given that context, I am conducting a study on how urban water resources can be managed effectively and appropriately.

One of my objectives is to explore the existing management practices of water resources and potential threats of water constraints and scarcity in HCMC in the future. I am interested in investigating current formulation of institutional frameworks and the implementation of legislation documents in the field of water management in HCMC. In addition, I want to explore what is your view and response to future possible implications of water policy changes in terms of water governance, privatisation and rainwater harvesting. I hope to obtain comprehensive information and data for the analysis of strengths, weaknesses, opportunities and threats in water resource management practices.

To this end, I am proposing to conduct a series of surveying questionnaires and interviews with a number of people in organisations and government bodies, which are responsible for water resources management in HCMC. **Mr Tran Nguyen Hien – Head of Environmental Management Division (EMD)** provided your name and your incorporating agency. Thus, I am wondering if you would be agreeable to assisting my study. I am envisaging interviews of approximately half an hour in length, beginning with some formal questions common to all interviewees and leading to a more open-ended discussion of your experience and involvement in this area.

I would like to forward you a copy of the questionnaire set for discussion. If you would like to participate, but would prefer not to be identified, please let me know and this can be arranged. Likewise, I plan to record the interviews for the purposes of making notes, however, this would also be at your discretion. Should you choose take part, you would be free to withdraw at any stage before the study has been completed, without any justification on your part.

If you would like to make sure about any more information, please feel free to contact myself or my supervisor, Professor Martin Williams, at the details below to address any concerns you may have.

Yours sincerely,

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SURVEY OF WATER MANAGEMENT IN

HO CHI MINH CITY, VIETNAM

(Group: Governmental organization/bodies)

Date: ……………………………… **Time:**………………………..

Name (Optional):………………….. **Gender:** Male Female

Name of organisation: ……………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

1. Does your organization's activity relate to water resources management in Ho Chi Minh City?
   a) Yes
   b) No

2. If it does, what extent is your organization responsible for?

……………………………………………………………………………………………

……………………………………………………………………………………………

3. What are the water sources for urban domestic uses in Ho Chi Minh City?
   a) Surface water (Sai Gon river, Dong Nai river) ❑
   b) Groundwater ❑
   c) Rainwater ❑
   d) Other sources (please specified): ……………………………………………………

4. What are distributions of water for domestic purposes?
   a) Domestic purposes …….. %
   b) Industrial uses …….. %
   c) Agricultural uses …….. %
   d) Commercial uses …….. %
   e) Entertainment …….. %
   d) Other purposes ……... %

5. In your opinion, does HCMC have enough water for its economic and social development (including domestic, industrial, commercial and agricultural uses)? *(Please tick one box)*
   a) Adequate water source for supply ❑
   b) Inadequate water source supply ❑

c) *Other comments:……………………………………………………………………………….*

6. How do you rate the current state of water quality and quantity for domestic consumption in Ho Chi Minh City?

   a) Good quality, but not enough quantity ❑

   b) Enough quantity, but not good quality ❑

   c) Both quality and quantity are satisfied ❑

   d) Both quality and quantity are not satisfied ❑

7. In recent years, the City has faced with ***water shortage*** during the dry seasons, what are the reasons for this? *(Please provide in details of your comments):*

   ………………………………………………………………………………………

   ………………………………………………………………………………………

   ………………………………………………………………………………………

8. If you address those reasons, do you think these can be solved and overcome? *(please provide in details of your comments)*:

   ………………………………………………………………………………………

   ………………………………………………………………………………………

   ………………………………………………………………………………………

9. How do you define ***water resources*** by which ways as follows (please tick appropriate boxes):

   a) Water is a natural resource for free use ❑

   b) Water is a type of tradable good ❑

   c) Water is a resource which needs to be reserved ❑

   d) Water is both a resource and a good ❑

   e) Other definitions: ………………………………………………………………

10. In your opinion, what following factors can be considered as main obstacles for **water management** to meet water demand for the City's development *(Please tick appropriate boxes)*:

    a) Surface water becomes polluted by industrial, domestic and agricultural wastes ❑

    b) Surface water is being salt intrusion ❑

    c) Groundwater is depleting due to over-exploitation/over-draft ❑

    d) Community's awareness of resource preservation is still low ❑

    e) Lack of utilities and infrastructure for urban water supply ❑

    f) Lack of institutions, policies and regulations for water governance ❑

g) All above reasons ❑

11. Do you know any kind of the following ***fee*** that is being applied for water resources management? *(please tick appropriate boxes)*:

a) Fee for domestic uses ❑

b) Fee for industrial consumption ❑

c) Fee for domestic discharge ❑

d) Fee for industrial discharge ❑

e) Fee for groundwater exploitation and use ❑

f) Other fees (please specify): ……………………………………………………………..

………………………………………………………………………………………………..

12. Do you thank any fee or water tariff should be applied for the City's water management? *(Please provide your comments)*:

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

13. Are there any current projects or programs that relate to urban water resources management and use? *(Please provide in details your comments)*:

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

14. If there are such projects, do you think they have brought impacts on ***the management practices*** of urban water resources?

    a) Positive impacts ❑

    b) Negative impacts ❑

    c) Other comments: …………………………………………………………………………..

15. In your opinion, do you think Ho Chi Minh City is facing with ***pressures and difficulties*** of water resources management?

    a) Yes ❑

    b) No ❑

    c) Other comments: …………………………………………………………………………..

16. If there are any, please specify those difficulties *(please provide separate sheets if not enough space)*:

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

17. To deal with above difficulties, do you agree with approach to ***decentralisation*** of managing and using water resources in lower level (districts or basins)? *(Please tick one appropriate box)*:

    a) *Concerned* ❑

    b) *Unconcerned* ❑

    c) *Other comments:………………………………………………………………………*

18. For urban water supply sector, do you agree with ***private participation*** into urban water sector?

    a) *Yes, I totally agree* ❑

    b) *No, I do not agree* ❑

    c) *I agree but need further consideration* ❑

    d) *Other comments: ……………………………………………………………………..*

19. In respect of current water governance of the City, is there any area which should be improved?

    a) *Providing the detailed guidelines and information on urban water resources (for community):*

No improvement needed	*Minor improvement needed*	*Considerable improvement needed*	*Do not know*
❒	❒	❒	❒

b) Providing legal institutions and regulation of managing, using urban water resources for all water users, interest stakeholders and community:

No improvement needed	*Minor improvement needed*	*Considerable improvement needed*	*Do not know*
❒	❒	❒	❒

c) Implementing monitoring and assessment programs on water resources use and management annually of the City:

No improvement needed	*Minor improvement needed*	*Considerable improvement needed*	*Do not know*
❒	❒	❒	❒

Other comments (please specify):

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

20. Currently, to match water demand for social and economic development goal is becoming a central concern of the City. In order to meet this goal, do you think the authority needs to take which following actions? *(You can tick more than one box)*:

a) Improving current policy for urban water resources ❑

b) Enhancing legal and economic instruments for the existing water policy ❑

c) Building more detailed programs on managing and using urban water resources ❑

d) Implementing education projects on public awareness and community behaviour ❑

e) Publicising and encouraging private sector participating into water sector ❑

d) Advocating rainwater as an alternative source for polluted and depleted surface water and groundwater ❑

e) Applying strict and rigorous economic instruments for water pollution control ❑

f) Other comments: ………………………………………………………………………..

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21. ***Alternative sources***- As water is increasingly becoming a scarce resource, do you think using rainwater and recycled water is necessary for Ho Chi Minh City in the future? *(Please tick appropriate box)*:

a) Yes, it is necessary ❑

b) No, it is not necessary ❑

c) Other comments: ……………………………………………………………………….....

22. **Rainwater** is considered as a clean water source, if it is collected and separated from domestic wastewater, do you support the application of rainwater use as an alternative source for other urban purposes (for example, fire extinguish, park watering, urban landscape and fountain, etc)?

   a) Yes, I totally agree ❑

   b) No, I do not agree ❑

   c) Other comments: ……………………………………………………………………….....

23. If water become a scarce resource and challenged to the sustainable development of the City, how and what action will you contribute to ***protection and management of water resources*** in Ho Chi Minh City?

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Thank you for your time.

Questions for Interviewing Water-related Agency Officials

1. Ho Chi Minh City is facing many urban environmental problems in which water resources management is one of such leading issues. Do you think this is a prominent issue?

2. In the context of urbanisation and industrialisation, how do you recognise the importance of water in the course of socio-economic development of Ho Chi Minh City?

3. What is your view on the current water issues in Ho Chi Minh City? What are your most concerns over water resources?

4. In what extent does your agency relate to the management practices of water resources? If it does so, what are your agency's responsibilities and duties?

5. In terms of state function and management, what are the advantages and the disadvantages of your agency's capacity?

6. In your opinion, what are the constraints and weaknesses of management practices in water resources? How effectively and efficiently are they implementing in your agency's responsibilities?

7. What is your view on the principle of integrated water resources management? How appropriately and efficiently will it be applied for water management in Ho Chi Minh City?

8. What are your comments on the awareness of the public, the industrial community and various stakeholders on the environment and water management?

9. What is your view of points on the advocates of empowering participation of the public and the private sector in the field of water management?

10. Do you think should any improvements of existing water institutions and regulations be taken? Please give your opinions on which area should be improved.

11. Should an apex body be established in performing the integration and horizontal coordination between government agencies of regulatory and implementing?

12. If your view of points on Question 10 is negative, please give your comments in what way could the institutional arrangement and mechanism be strengthened?

Thank you most kindly for your time and cooperation.

LIST OF GOVERNMENT OFFICIALS RESPONDING TO THE SURVEY

	Full name	Government Agency
1.	Nguyen Dinh Tuan	Ho Chi Minh City Environmental Protection Agency (HEPA), Department of Natural Resources and Environment (DONRE)
2.	Le Van Khoa	Ho Chi Minh City Environmental Protection Agency (HEPA), Department of Natural Resources and Environment (DONRE)
3.	Tran Ngoc Dinh	Ho Chi Minh City Environmental Protection Agency (HEPA), Department of Natural Resources and Environment (DONRE)
4.	Vo Thanh Hang	Ho Chi Minh City Environmental Protection Agency (HEPA), Department of Natural Resources and Environment (DONRE)
5.	Nguyen Thi Tam Lang	Ho Chi Minh City Environmental Protection Agency (HEPA), Department of Natural Resources and Environment (DONRE)
6.	Ngo Tien Phuong	Division of Environmental Management (DEM), Department of Natural Resources and Environment (DONRE)
7.	Hoang Canh Duong	Division of Environmental Management (DEM), Department of Natural Resources and Environment (DONRE)
8.	Nguyen Van Thao	Division of Environmental Management (DEM), Department of Natural Resources and Environment (DONRE)
9.	Nguyen Thi Huong	Division of Environmental Management (DEM), Department of Natural Resources and Environment (DONRE)
10.	Pham Thanh Phuong	Division of Environmental Management (DEM), Department of Natural Resources and Environment (DONRE)
11.	Nguyen Thi Thu Hang	Division of Environmental Management (DEM), Department of Natural Resources and Environment (DONRE)
12.	Anonymous	Department of Natural Resources & Environment (DONRE)
13.	Nguyen Van Nga	Office of Mineral & Water Resources Management (OMWRM), Department of natural Resources & Environment (DONRE)
14.	Vo Ngoc Chau	Office of Mineral & Water Resources Management (OMWRM), Department of natural Resources & Environment (DONRE)
15.	Ngo Thi Viet Hoang	Office of Mineral & Water Resources Management (OMWRM), Department of natural Resources & Environment (DONRE)
16.	Tran Thanh Phong	Office of Mineral & Water Resources Management (OMWRM), Department of natural Resources & Environment (DONRE)
17.	Vo The Trung	Office of Mineral & Water Resources Management (OMWRM), Department of natural Resources & Environment (DONRE)

18.	Nguyen Nhat Tuan	Office of Mineral & Water Resources Management (OMWRM), Department of natural Resources & Environment (DONRE)
19.	Nguyen Xuan Huy	Office of Mineral & Water Resources Management (OMWRM), Department of natural Resources & Environment (DONRE)
20.	Tong Viet Thanh	Office of Mineral & Water Resources Management (OMWRM), Department of natural Resources & Environment (DONRE)
21.	Nguyen Minh Hoi	Tan Tao Industrial Park
22.	Pham The Nhan	Tan Tao Industrial Park
23.	Tran Quang Duc	Tan Tao Industrial Park
24.	Nguyen Thanh Truoc	Tan Tao Industrial Park
25.	Ly Anh Tam	Natural Resources & Environment Office, Can Gio District
26.	Truong Ngoc Thuy	Natural Resources & Environment Office, District 7
27.	Anonymous	Natural Resources & Environment Office, District 3
28.	Pham Hoang Minh Loc	Natural Resources & Environment Office, District 11
29.	Nguyen Gia Hien	Natural Resources & Environment Office, District 11
30.	Vo Thi Bich Van	Natural Resources & Environment Office, District 10
31.	Nguyen Thi Nhung	Natural Resources & Environment Office, District 5
32.	Nguyen Thi Phan	Natural Resources & Environment Office, District 5
33.	Ngo Huynh Phuc	Natural Resources & Environment Office, Binh Thanh District
34.	Ho Thi Hoa	Natural Resources & Environment Office, Binh Thanh District
35.	Nguyen Thi Phuong	District Urban Management Office, Binh Thanh District
36.	Nguyen Thi Cuc	District Urban Management Office, Binh Thanh District
37.	Nguyen Thi Thanh Thanh	District Urban Management Office, Binh Thanh District
38.	Nguyen Thi Ngan	District Urban Management Office, Binh Thanh District
39.	Ha Uyen Khanh	District Urban Management Office, Binh Thanh District
40.	Tran Ha Trung	Head of Natural Resources & Environment, Binh Thanh District
41.	Le Thi Chi	Natural Resources & Environment Office, District 8
42.	Anonymous	Natural Resources & Environment Office, District 6
43.	Nguyen Van Tai	Natural Resources & Environment Office, District 2
44.	Pham Thanh Phuoc	Natural Resources & Environment Office, District 9
45.	Do Thi Cam Tien	Natural Resources & Environment Office, Tan Binh District
46.	Vo Phi Hai	Natural Resources & Environment Office, Tan Phu District

LIST OF INTERVIEWEES

	Full name	Position and Government Agency
1.	Nguyen Dinh Tuan	Head of Ho Chi Minh City Environmental Protection Agency (HEPA), Department of Natural Resources and Environment (DONRE)
2.	Le Van Khoa	Vice-head of Ho Chi Minh City Environmental Protection Agency (HEPA), Department of Natural Resources and Environment (DONRE)
3.	Tran Ngoc Dinh	Official of Ho Chi Minh City Environmental Protection Agency (HEPA), Department of Natural Resources and Environment (DONRE)
4.	Nguyen Minh Hoi	Person in charge of Environmental Management Unit, Tan Tao Industrial Park
5.	Tran Nguyen Hien	Head of Environmental Management Division (EMD), Department of Natural Resources & Environment (DONRE)
6.	Nguyen Van Nga	Head of Office of Mineral and Water Resource Management (OMWRM), Department of Natural Resources & Environment (DONRE)
7.	Nguyen Thi Nhung	Head, Natural Resources & Environment Office, District 5
8.	Ly Anh Tam	Head, Natural Resources & Environment Office, Can Gio District
9.	Nguyen Van Thao	Official, Environmental Management Division (EMD), Department of Natural Resources & Environment (DONRE)
10.	Tran Van Son	HCMC Urban Drainage Company, Department of Transport and Public Works (DTPWs)
11.	Le Huy Ba	Scientist, Institute for Resources and Environment (IRE), Ho Chi Minh City
12.	Nguyen Van Phuoc	Head of Department of Environment, HCMC University of Technology
13.	Nguyen Phuoc Dan	Consultant and Lecturer, Department of Environment, HCMC University of Technology
14.	Nguyen Thi Van Ha	Consultant and Lecturer, Department of Environment, HCMC University of Technology
15.	Lam Vinh Son	Consultant and Lecturer, Department of Environmental Engineering, Private University of Technology, Ho Chi Minh City
16.	Duong Pham Hung	Consultant and Lecturer, Ho Chi Minh City College of Industry
17.	Tran Ha Trung	Head of Natural Resources & Environment Office, Binh Thanh District

Appendix 12 – Local Media Coverage on Water Issues in Ho Chi Minh City, Vietnam.

(Titles of Newspaper were translated from Vietnamese into English by the Author)

Series: ***Báo Động Nguồn Nước Ô Nhiễm*** (Water Pollution is Alarming):

- *Trả giá bao nhiêu cho vừa?* (How much is enough for Pollution?).
- *Sông Thị Vải không còn .... thở* (The Thi Vai River is seriously polluted).
- *Cảnh báo "cái chết" của một nhà máy nước* (Warning the "death" of a water supply plant).
- *Nước đen ... bao vây TP.HCM* (Black wastewater covers Ho Chi Minh City).
- *Nguồn nước TP.HCM đang bị ô nhiễm* (Ho Chi Minh City's water sources are being polluted).