IMPACTS OF WATER STRESS ON HO CHI MINH CITY, VIETNAM

Case study: Binh Thanh District, Ho Chi Minh City

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Declaration of academic honesty

I hereby declare to have written this Master's Thesis by my own, having used only the listed resources and tools. It is well known to me that a false declaration is deemed to be an offence against the examination regulations of the **Technical University Darmstadt**.

Darmstadt, 15th March 2015

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Abstract

Vietnam is a country ranking the 12th most populous country in the world. Ho Chi Minh City is a large city with a high rate of urbanization and rapid growth of population. The population is more and more concentrated in this city, and increases the demand for high water use. Most of people in the city are provided by piped water with safe quality. However, in some areas, with lack of clean water, people have to buy water from tankers carrying water or they have to use their own wells without any guarantee for the water quality.

Based on the results of the survey questionnaire and findings from in-depth interviews, the thesis describes the actual water supply situation particularly in Binh Thanh District, and generally in Ho Chi Minh City. Then, it points out the main causes of the water stress situation. It clarifies further, that the impacts of water stress depend on three sustainable development factors: economy, environment and social stability. The thesis concludes that the water reuse and the use of rainwater are alternative resources for the water supply sector in Ho Chi Minh City in the future. Finally, some recommendations to reach a more efficient and sustainable water supply governance are illustrated.

List of abbreviations

ADB – Asian Development Bank

ASEAN - Association of Southeast Asian Nations

BOO - Build – Own - Operate

BOT - Built-Operation-Transfer

COD – Chemical Oxygen Demand

cbm – cubic meter

CBD – Central business district

CEO - Chief Executive Officer

FDI – Foreign Direct Investment

FAO – The Food and Agriculture Organization

HCMC – Ho Chi Minh City

OECD - Organization for Economic Cooperation and Development

GDP – Gross Domestic Product

SAWACO – Saigon Water Supply Corporation

SWOT - Strengths, Weaknesses, Opportunities, Threats

SS – Suspended solid

UN – United Nations

UNICEF – United Nations Children's Fund

VND – Vietnam dong

WB – World Bank

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1. Introduction

1.1. Water and human life

In June 1992, the United Nations Conference on Environment and Development was held at Rio de Janeiro. In this conference, Agenda 21, a blueprint from global action of sustainable development was adopted. Water was mentioned in the Article 18.2 of this agenda:

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. (UN, 1992)

According to a report by the United Nations Children's Fund (UNICEF) launched ahead of World Water Conference in 2013 the world has 2.5 billion people thirsting for clean water, accounting for over one third of the global population. This is an alarming figure for just two years earlier, in 2011, the figure stopped at the 1 billion people. According to the Organization for Economic Cooperation and Development (OECD) this number will increase to 55% of the global population. The General Assembly of the United Nations has acknowledged that access to clean water and sanitation is a right to life of human beings. However, the process of urbanization taking place across the globe in a dizzy speed still hampers efforts to improve the water supply situation even in the big cities. Economic and social development, population growth, pollution and climate change cause water to become an alarming global issue. Many countries, including some countries in the tropics, lack clean water for production and daily life, besides that, a few countries suffer because of too much water due to floods and landslides. Meanwhile, a number of countries are worried because there region is arid because of drainage by other countries.

Water plays an important role in human life, is essential for life. Nothing on earth can survive without water. In the modern time, there are so many major water challenges over the world, including water availability, accessibility, stress and scarcity. Worldwide, there are 4 of 10

people who do not have access to water as a simple daily need, and nearly 2 of 10 live without any source of safe drinking water. Many statistics show that half of the human population (about 3.3 billion people) now lives in urban areas and the urbanization process is constantly increasing. By forecasts for the next two decades, nearly 60% of the world population (approximately 5 billion people) will become urban residents. All will face the risk of particularly severe water resource shortages, since the urban areas have a higher level of vulnerability to the effects of climate change and natural disasters. The Food and Agriculture Organization of the United Nations (FAO) warned that in the next 15 years, there will be about two billion people in water resource shortage. The World Bank (WB) recently published a report on this issue, entitled "preserve water for everyone" which called on the international community to better manage water resources in view of the risk of water scarcity on a global scale. The report of the World Bank stressed that water sources serving for fire born industrial and agricultural production are severely depleted. We have one sixth of the world's population without access to clean water and 30% of the world's population lack access to basic sanitation. The urbanization process will not be sustainable if there is no effective solution to deal with this challenge.

In Vietnam, as well as in other developing countries, despite the new industry development, urban and industrial areas are less and less the focus of the population but the public opinion is awoken for the country that suffers much by the impacts of climate change and in particular the burden of scarce water resources. The reasons behind the public interest are the increasing waste water from daily life and especially the change for the worse of the quality of food, due to the intense use of pesticides in agriculture. The contamination is everywhere visible. Additionally, other worth considering reasons are the shortage of drinking water by the treatment of plants, wastewater and infrastructure systems which are not dimensioned for the further development of the municipality. The process of urbanization, agricultural activities as well as the industrial and climate change cause an increasingly heavy pressure on water quantity and quality. Water scarcity, poor water quality and sanitation deficits will have a negative impact on food security, educational opportunities and career choices of poor people worldwide. Increasing water challenges in the coming years, in parallel with the explosion of population and economic

growth lead to an increase of water consumption. As a striking example water challenges will increase by the discharge of wastes into the environment.

1.2. Research design and methods

1.2.1. Research aims and objectives

The research is conducted with the aim of presenting the context of social-economic institutions and policies for urban development in Ho Chi Minh City, especially for Binh Thanh District. Then, it describes the needs of the urban communities and determines the main factors affecting the water supply of Binh Thanh District. Further, the research examines the impact of water stress situation on urban communities, assessing the vulnerability of communities due to the scarcity of water through survey questionnaires and in-depth interviews. After collecting and analyzing data, the different alternatives to improve the situations, the acceptances and the practicalities will be assessed. Finally, based on the results, we can suggest some recommendations to promote the providing of safe drinking water and we can offer some solutions for the water supply of the urban areas.

1.2.2. Research questions

The research processing is carried out based on the following questions:

Is there any water stress situation? Is there any threat of water-stress? How many people and from which community are affected by the water stress situation?

Which strategies and concepts are available and what can be formulated as new one? What approach, improvements and modifications can be suggested? How can the city proceed to get more efficiency in sustainable urban water supply and urban development?

1.2.3. Mixed methods

This research concentrates on qualitative data more than quantitative data. Qualitative data allow deep assessment in some aspects. Data collection and data analysis are carried out by:

- Review of the literature and secondary data
- Statistical analysis of the government issued statistics
- A policy – oriented review
- Field visits and observation
- Survey questionnaire (400 households)
- In-depth interview (30 cases)
- SWOT analysis

After collecting data from survey by questionnaire, data will be analyzed by SPSS software. The data and information from interviewing will also be analyzed.

1.2.4. Research framework

Based on research questions and objectives, the author constructed a framework for this research. It is not only the frame for assessment but also the thinking frame for the author. From that, the research started at the significant site at the city level with the policy, the organization and structure. After that, on the next lower level communities and households become the focus of attention. At this level, 3 aspects are taken into account: the actual situation to assess, i.e. the occurrence of water-stress and the threat of water-stress in the research area, the effects of water stress and the future potentials for the improvement and development. After discussing the alternative strategies, finally, some solutions and recommendations are suggested.

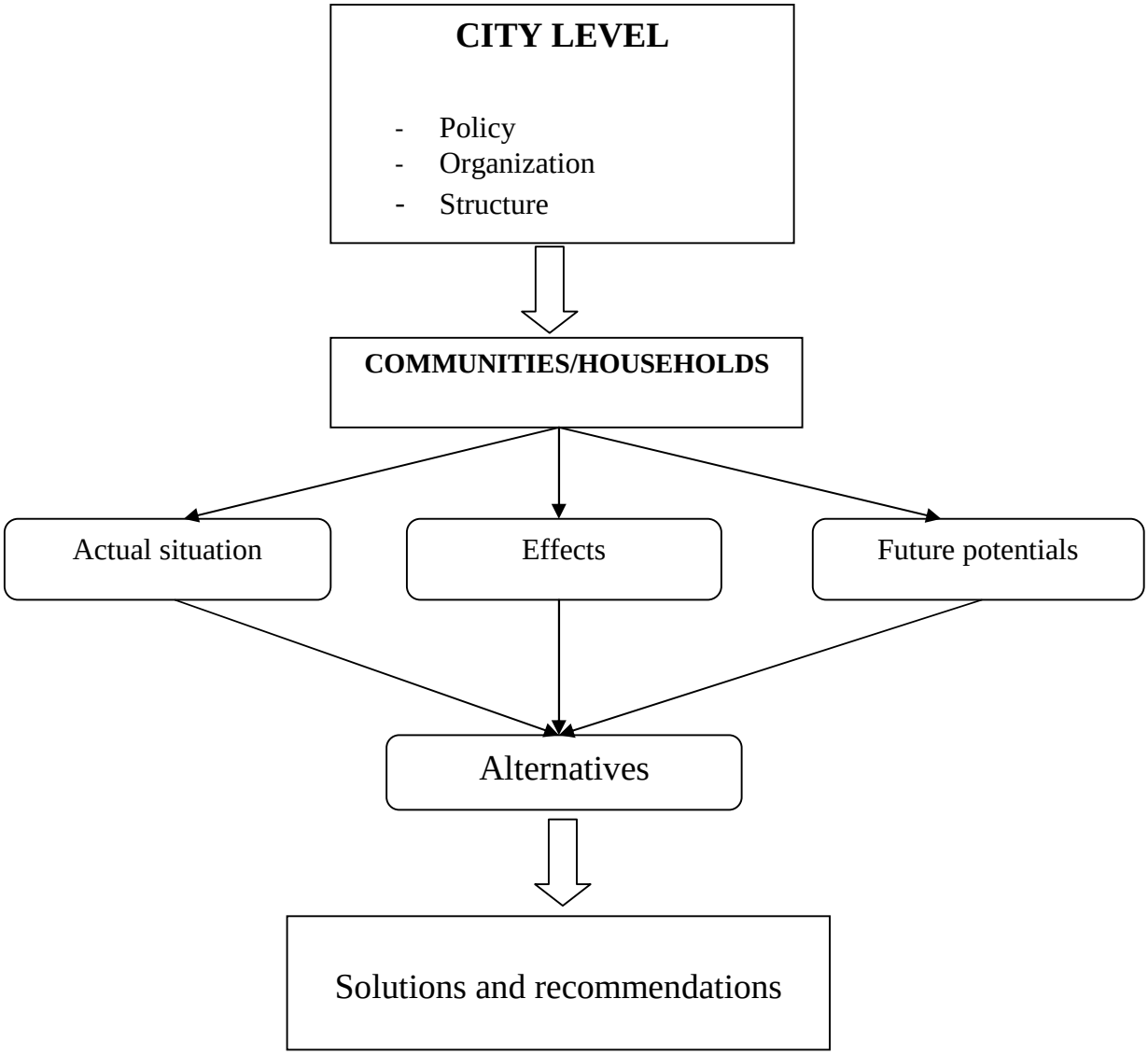

Figure 1-1: Research framework

1.2.5. Thesis structure

Besides the abstract and references, the main content of this thesis is divided into 5 chapters.

Chapter 1 is the introduction about water isssues, an overview of this thesis. This chapter also encapsulated the research methodology, the research framework and the mixed methods of the data collection. The next chapter, chapter 2 reviewed the history of water supply in general and water supply in Ho Chi Minh City. It describes some background of Ho Chi Minh City, the legal framework and some aspects of water supply sector like management structure, the demand,

resources, treatment, distribution network, water loss and water tariff. The third chapter describes the chosen study areas, details the current situation of water supply based on the results of the field work, the public survey questionnaires and the findings from in-depth interviews. At the end of chapter 3, the author also took a SWOT analysis of the actual situation in the research areas. In chapter 4, the author outlined the relationship between urbanization and water supply issues, climate changes as the causes of effects and challenges for water supply in the urban areas. Furthermore water stress and its impacts on urban areas are taken into consideration, as well as its impacts on social, economic, and environmental aspects of urban sustainable development. The chapter 5 proposed the potentials for the alternatives water resources. Finally, chapter 6 lines out the conclusions and recommendations of a more sustainable, more efficient water supply system.

1.3. Data collection design

Based on the research questions and specific objects, the needed data are listed out, after that, the appropriated methods were chosen for data collection. The author had several times visited the research area for observation and media recording. This research used a participant observation approach that is flexible and will lead to additional information being apart from the survey questionnaires and interviews. In parallel with observation and media recording, the literature review, survey questionnaire and in-depth interview also were carried out. The design of the data collection is described as following.

The survey questionnaire was designed with multiple questions mainly for member of households. The questionnaire was divided into 4 parts. The first part asks about individual information of the respondent like gender, respondent's position in household, education level. Secondly, the questionnaire considered the water supply consumption in the respondent's household, these questions asked about the connection of households with the piped water, the kind of water reservoirs, the main water resources of households and the frequency of supplying, the total water consumed and the total fees they have to pay monthly. Thirdly, the questionnaire asked about the assessment of respondent on the water supply service, costs, water quality, pipe

system, water-meter work and payment system. Finally, the questionnaire was designed with questions about the expectation for water supply improvement and development in the future.

In line with survey questionnaire, some in-depth interviews were carried out. The interview questions are unstructured and flexible according to respondent availability. These interviews asked staffs of water supply company, department of natural resources and environment, district and ward authorities. The interview also designed for gathering information from some members of households, who live in water shortage areas. During the interviews, the author took notes and checked with documents and reports.

After the fieldwork, the interview responses of respondents were analyzed and translated into English. The results of survey questionnaire are presented in charts, graphs and tables. They are also the views of citizens on water supply or related issues in their residential areas during their residency in Ho Chi Minh City.

1.4. Literature review

Water management, water governance, water issues are considered by many authors. Most of researches are individual researches and academic articles which published on the major magazines or legal documents or reports and guidelines of United Nation, World Bank or Asian Development Bank.

Kofi Annan, United Nations Secretary General, formulated the major important role in the development of developing countries as follows: *"Access to safe water is a fundamental human need and therefore a basic human right"* (UN, 2001). Consequently the United Nations have a lot of programs for safe water all over the world with an abundant number of documents about water and water accessibility. Some of these programs are Water Aid, Freshwater Action Network, Rights and Humanity, Wash United and End Water Poverty.

In the year 2011, World Health Organization (WHO) and United Nations Children's Fund (UNICEF) published *"Vietnam water and sanitation sector assessment report"*. This report shows an overview of the situation of water and sanitation in Vietnam (both areas, urban and

rural). The authors of this report mention the relationship between water, sanitation, development and environment under the health, social and economic aspects. Furthermore, the report also took interest in the institutional structure, legal framework and information in water and sanitation sector. From that, the report provided the provision of finance and investment for the sector in the future.

The World Bank brings out a lot of reports to assess the threat of water resource shortage in developing countries, especially for poor countries where people lack accessibility to safe water. World Bank not only published their own reports but also supported other authors to publish some guidelines for water governance and adaptation of water resources due to the effects of climate changes in near future.

First, we can mention the book *"Reaching across the waters – facing the risks of cooperation in international water"* (Ashok Subbramanian, Bridget Brown Aaron Wolf, 2012). This book is the result of the Water Partnership Program of The World Bank. This study reviews the experience of cooperation in five international river basins (i.e. Eastern Nile, Ganges, Niger, Syr Darya and Zambizi). The study focused on the understanding of risks, the use of historical events helping to avoid the risks, and recognizes the core versus operational risks. This study also considers the enhancing cooperation for reducing risks, representing future potentials. Therefore, these researchers can be helpful for countries and individuals who engage in international water issues, first of all because of the final part of the book. This part shows the pointer for partners, outlines the specific partner actions and additional considerations. From that, the countries and organizations can get experience in risk and risk reduction, future potentials and enhancement.

As well as The World Bank, Asian Development Bank has supported and helped developing countries by offering loan for the development projects. In Vietnam and over the world, these projects cover mainly environmental issues, urban development, and infrastructure construction. During the country programming mission, held in Manila 2012, the Government of Vietnam requested the Asian Development Bank for assistance to prepare Ho Chi Minh City Water Supply Project. With the support of Asian Development Bank, this project addresses the increased need for action and improves not only water supply but also sanitation. Ho Chi Minh

City required this project to cope with the high economic growth rate and the rapid urbanization. During the project period, Asian Development Bank released a huge amount of reports and documents which related to water supply governance, water resource management, environmental assessment and the adaptation of Ho Chi Minh City under the impacts of climate change.

One of the studies, which were published in the year 2000 by Asian Development Bank, is *"Environments in transition: Cambodia, Lao PDR, Thailand, and Vietnam"* (ADB, 2000). These countries were mentioned in the study as the mainland of Southeast Asia. They have significant resources, stable political socio-economy and cordial relationship with neighbors. There are varying stages of development. In the past time, the rapid economic changes and social conflicts, caused by the development and urbanization, have adversely impacted the region's nature resources. This study provides an overview of environmental issues with a view how to enhance sustainability through improving the nature resource management. By its program, Asian Development Bank identified the key environmental issues in each of the countries. The information include issues pertaining to forest and policy, biodiversity and protected parks, water resources, the management of coastal and marine resources, the pollution due to urbanization and industrialization and finally, the study considered the energy use. Besides that, the environment policies and institutional framework are described. From that, the development framework for environmental actions was taken into account for their resolution.

The book *"Water in Asian: Utilities' performance and civil society view"* (ADB, 2004), which was released in 2004, describes the performance of water supply and sanitation utilities in 18 Asian cities (included Ho Chi Minh City) and gives an impression how the civil society sees its role in increasing and improving water services in the cities. This book is the result of border performance dimensions including water resources management, policy and regulation, private sector participation, small-scale service provider, wastewater, sanitation and urban flood management. These are the comprised essential benchmarking indicators on service level, service quality, operation efficiency and financial management.

As well in Southeast Asia region, Arthur C. McIntosh researched about *"Urban water supply and sanitation in Southeast Asia – A guide to good practice"* (C. McIntosh, 2014). This research, which was supported by Asian Development Bank, updates the book *"Asian Water Supplies: reaching the Urban Poor"*. The research focuses on Southeast Asia countries (i.e. Cambodia, Indonesia, Lao PDR, The Philippines, Thailand, and Vietnam). The author considered water management and supply service coverage. These countries have considerable attention to problems that largely characterized Southeast Asia, among them, especially intermittent water supply, standpipe supplies and very low tariffs. Vietnam, in particular, has made strides in the management and governance of urban water supply, including the corporatization, full cost recovery and the connection fee waivers.

In 2006, aims to strengthen the protection, exploitation, use and development of water resources, as well as the prevention and mitigation of adverse impacts caused by water were formulated. The Prime Minister signed the decision and promulgated the national water resources strategy towards 2020. In order to support the aims of the national strategies, the publication named *"Water – Vital for Vietnam's future"* (ADB, 2009) was published in 2009. This publication presents the main findings in assessment of water sector in Vietnam, particularly in relation to the status of water resources and water-related environments i.e. ensuring adequate water supply and sanitation, managing floods and natural hazards, providing economic development like navigation, industry and craft villages, hydropower, irrigation and fisheries, and the sustaining agriculture and aquaculture. Moreover, the publication took into account the main issues facing the sector and sector management to adopt an international water resources management approach. Finally, the book shows the potential issues and options for the future that means the main measures that Vietnam could adopt to ensure a sustainable water future.

Sustainable water management is mentioned in the research *"Formulation of an integrated approach to sustainable water management in Ho Chi Minh City, Vietnam*" (Phu, 2007) by Phu Le Vo. The research is carried out like a Doctor of Philosophy's thesis. There is no handbook for the whole world on the way how to manage water resources, especially in different contexts and different countries. Developing countries can have the same problems due to the urbanization or development. However, they have not only a different socio-economy but also they differ in

demography, nature resources and other aspects. Therefore, they need particular solutions, which differ from country to country. The overall aim of Phu Le Vo in this research is to formulate an integrated approach to the sustainable water management of urban water resources management in Ho Chi Minh City. The thesis investigated the perceptions of water uses, in the past time and the present time (at the time when the research was carried out) and the existing government management practices that have posed potential water scarcity and stress as a result of urbanization and population growth. Phu Le Vo, in his own research also proposed affordable and feasible approaches to water resources governance in Ho Chi Minh City. These approaches help to create an efficient and sustainable policy, plan or program to manage water resources in Ho Chi Minh City. Besides that, the thesis also brings out what needs to be made a top priority and to be given high attention by the city government at all levels.

Based on the research on sustainable water management policy of Freshwater Resource Management Project, the Institute for Global Environment Strategies established a final report about *"Sustainable Groundwater Management in Asian Cities"* (IGES, 2007). This report is the summary of researches, which were formulated as policy recommendations for sustainable groundwater management regarding 6 Asian Cities (i.e. Tianjin (China), Bandung (Indonesia), Colombo & Kandy (Sri Lanka), Bangkok (Thailand), Ho Chi Minh City (Vietnam)) and considering both broad amplitude and persisting time period. At first, the author made the comparative analysis of the status of groundwater resources by existing policy measures and future challenges of six case study cities (Tokyo and Osaka were mentioned as reference cases). In the next chapter, the author suggested some policy recommendations for sustainable groundwater management in these case study cities. Finally, the report introduces the compilation of the summary reports, including background information, status of water resources, issues on groundwater management, issues on alternative water resources for groundwater and proposed policy options in each case study city.

Beside these above documents, Vietnam's government launched a lot of policy and legal documents in water management and water supply sector. This will be discussed in more detail in chapter 2.2 legal framework.

2. Water supply in Ho Chi Minh City

2.1. Background of Ho Chi Minh City

Ho Chi Minh City (the old name is Saigon) is located in the south of Vietnam, and is the biggest city in Vietnam. Ho Chi Minh City is 1.730km from Hanoi and is at the crossroads of international maritime routes. The city center is 50km from the East Sea in a straight line. It is a transport hub of the southern region and has the largest port system and airport in Vietnam.

With an area of 2095 km^2 Ho Chi Minh City covers 0.63% of the total area of Vietnam and has 6.6% of the total population (7.599 million people, according to the statistic on April 1st 2014). It borders Tay Ninh and Binh Duong provinces to the north, Dong Nai and Ba Ria - Vung Tau province to the east, Long An and Tien Giang province to the west and the Eastern Sea to the south with a coast 15km long.

Figure 2-1: Map of Ho Chi Minh City and surround areas

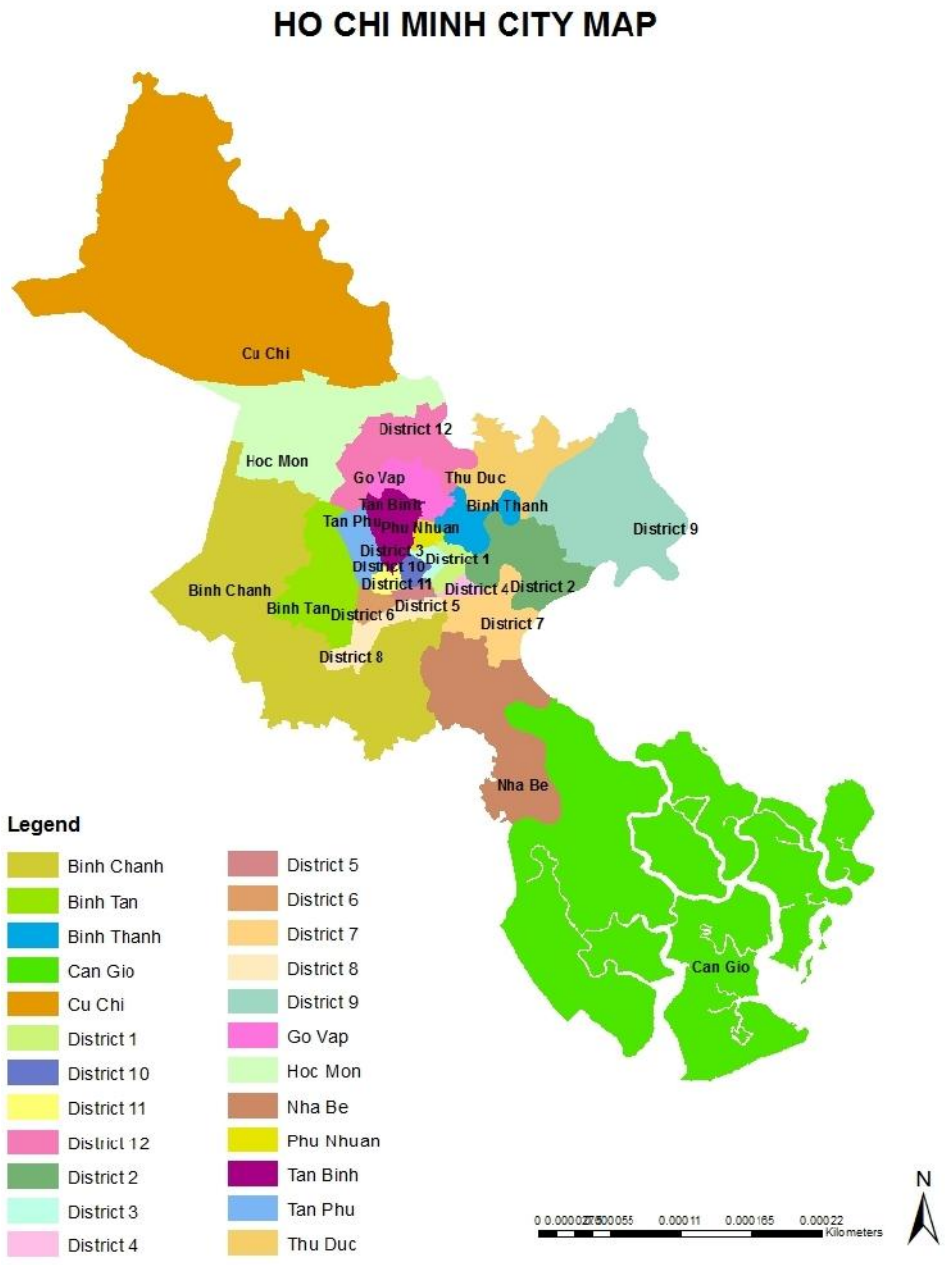

Figure 2-2: Map of Ho Chi Minh City

Ho Chi Minh City consists of 24 districts (including 19 urban districts and 5 outlying suburban districts). The locations of these districts are shown in the figure 2-2. The five suburban districts are named: Can Gio, Nha Be, Hoc Mon, Cu Chi and Binh Chanh. These suburban districts are accounting for 79% of the total area of the city and 16% of the total urban population. Can Gio and Nha Be are coastal districts.

After the national reunion in 1975, the population of Ho Chi Minh City reduced in the time period 1975-1980 due to the policy of economics, which encouraged people to go to other provinces. In the past years, since 1986, Ho Chi Minh City has rapid industrial and urban growth. The population reached almost 5.5 million in 1995 (exactly 5,247,900), and 10 years later, this number increased to over 7 million. From the national population statistic on April 1st, 2014 Ho Chi Minh City has about 7.955 million people. This number is forecast to reach 8.6 million in the year 2015. The growth of population in Ho Chi Minh City is showed in the figure 2-3. The United Nations predicted that in the next 10 years, Ho Chi Minh City will become a mega-city with a population of over 10 million. As a result of this development Ho Chi Minh City has become an important center of political, economic and cultural activities of Vietnam. It has attracted an increasing number of migrants from surrounding rural areas and from the whole country. Consequently, it is the heart of the Vietnam Southern areas with an agglomeration of economy and population. The rapid growth of population and urbanization development will result in pressure on not only the environment and infrastructure systems but also on the urban public services. This pressure poses challenges for water resources securing, basic human demands ensuring and water supply managing that will have to be addressed by city makers, urban planners, managers and experts.

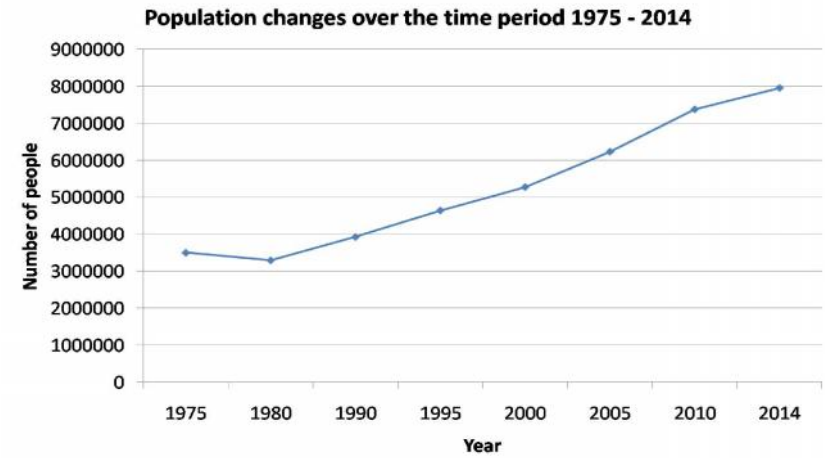

Figure 2-3: The growth of population in Ho Chi Minh City

The policy “industrialization and modernization”, which is the so-called name of the renovation policy in 1986, created the significant steps in the development of Ho Chi Minh City. Together

with the neighboring provinces (i.e. Dong Nai, Binh Duong and Ba Ria – Vung Tau), Ho Chi Minh City forms the Southern Focus Economic Zones of Vietnam. This region, which has been the most dynamic economic development area, has received priority and political support, both local and national, to become the leading economic zone of Vietnam. With the establishing and expension of many industrial factories, industrial parks, export processing zones, the economy of Ho Chi Minh City consists of abundant sectors i.e. mining, seafood processing, agriculture, and construction of tourism, finance, industry and trade. Let us now consider the Gross Domestic Product – GDP. In the year 2004, the GDP growth rate of Ho Chi Minh City reached 11.6% whereby the whole country's was 18.4% (Phu, 2007). According to Wikipedia (Wikipedia, 2014), on June 2006, the city has three export zones and twelve industrial parks. With 2,530 FDI projects worth USD16.6 billion at the end of 2007, the city has become the leading receiver of foreign direct investment. In 2007, the city's GDP was estimated at about USD 2,180/person, this amount accounted for 20% of the country's GDP in that year. The contribution of Ho Chi Minh city to the annual revenues in the national budget increased by 30%, this number accounted for about 20.5% of the total revenues. By the end of 2012, the city's GDP was estimated around USD 3,700/person. By the end of 2014, the GDP of the city contributes 9.5% in the country's GDP grew with GDP per capita of USD 5,100.

Ho Chi Minh City is situated on the Saigon River in the Northern part of the Mekong delta. This city has great potential for developing industry, exports, tourism and services. Ho Chi Minh is the industrial and commercial heart of Vietnam, accounting for a large percentage of the country's manufacturing output and retail trade. At present, residents of Ho Chi Minh City must confront flooding every year during the rainy season. Flooding may be caused by heavy rain, high tide, rain and tide, poor drainage, water release by hydroelectric dams and land subsidence combined with a global sea level rise.

According to Wikipedia, the city has a tropical climate, specifically a tropical wet and dry climate with an average humidity of 75%. The year is divided into two distinct seasons. The rainy season, with an average rainfall of about 1.800mm annually (about 150 rainy days per year), usually begins in May and ends in late November. The dry season lasts from December to April. The average temperature is 28°C, the highest temperature sometimes reaches 39°C around

noon in late April, while the lowest may fall below 16°C in the early mornings of late December into early January (Wikipedia, 2014).

2.2. Legal framework

Institutional documents and legal framework have significant effects on the governance and management in overall terms. The city authority and national governance launched a huge amount of support documents in water resources and water supply sector. The table 2-1 illustrates the key legislation on water supply in Vietnam.

No.	Date issued	Name of Legal Documents
1	20 May, 1998	Law on Water Resource
2	1998	Orientation for Urban Water Supply Development till 2020
3	1999	Orientation for Urban Drainage and Sanitation Development till 2020
4	07 Jan, 2005	Decision No.01/2005/QD – BYT on Promulgating the Regulation of food safety and hygiene conditions applicable to beverage establishments
5	25 Jan, 2005	Decision No.24/2005/QD-TTg
6	24 May, 2005	Ho Chi Minh City People's Committee No. 85/2005/QD-UB
7	27 Dec, 2005	Ho Chi Minh City People's Committee No. 6564/QD-HCMPC
8	28 May, 2007	Decree No.88/2007/ND-CP on urban and industrial-park water drainage
9	11 July, 2007	Decree No. 117/2007/ND-CP on clean water production, supply and consumption
10	18 Jan, 2008	Decision No.119/2008/QD-BTC on financial management regulation of SAWACO in the form of parent-subsidiary
11	03 Feb, 2009	Ho Chi Minh City People's Committee Decision CNN 408/UBND-CNN on Performance assessment of water supply joint stock companies under Saigon Water Supply Corporation
12	May, 2009	Circular 95/2009/TTLT-BTC-BXD-BNN on guiding the Principle, method to define and power to decide the clean water price in cities,

		industrial zones and rural areas
13	17 Jun, 2009	Circular No.05/2009/TT-BYT on the insurance of National Technical Regulation on Drinking Water Quality
14	20 Nov, 2009	Decision 1929/2009/QD-TTg on Approval of Water Supply Development Orientation for Urban and Industrial Areas in Vietnam to the year 2025 and vision to the year 2050 – sets out specific water supply development targets and objectives to the year 2015, 2020 and 2025.
15	24 Dec, 2009	Ho Chi Minh City People's Committee Decision No.103/2009/QD-UBND on water tariffs
16	24 Nov, 2010	Decision 2147/2010/QD-TTg National Unaccounted for water and Non-revenue water to 2025 (hard targets)
17	28 Dec, 2011	Decree 124/2011/ND-CP on amendments and supplements to a number of articles of decree no.117/2007/ND-CP dated July 11, 2007 of the government of the production, supply and consumption of clean water
18	21 Jun, 2012	The laws No.17/2012/QH13 on water resources
19	15 May, 2013	Joint circular No.63/2013/TTLT-BTC-BTNMT guiding implementation of the government's decree No.25/2013/ND-CP dated March 29, 2013, on environmental protection charges for sewage
20	Ministerial and inter-ministerial circulars including law on enterprise, Decree 199/2004, Decree 132/2005, Decree 111/2007, Decision 224/2006 and Circular 33/2005 and Circular 87/2006	

Table 2-1: Key legislation on water supply in Vietnam

Referring to these legal documents in table 2-1, the author identified 2 important documents, which have the significant impacts on the operation of water supply companies, and water supply management in Ho Chi Minh City. These documents are described in detail.

According to the Decree 117/2007/ND-CP of 11 July 2007, water tariffs shall become the economic driving forces for the investment of business entities for water supply development.

The Decree mentions that clean water tariffs are required not only to be adequate for water supplier to maintain and develop their business but also to encourage the improvement of service quality. These activities will help to save water and to grant support to poor people. Following the main content of this Decree, the legitimate rights and interests of supplier and customers will be ensured by the full costs recovery, which is calculated based on the costs of the production and distribution process. The Decree confirms that sufficiently calculated costs will enable water supply companies to have an effective operational potential and sustainable development.

In the Decree 117, the government sets out possible institutional measures to be adopted by water entities (i.e. investment encouragement, incentives and support). Decree 117 encourages the participation of all forms of ownership entities (including private sector) in water supply investment, operation, improvement and development.

Government of Vietnam Decision No 1929/2009/QD-TTg on *Approval of Water Supply Development Orientation for Urban and Industrial Areas in Vietnam to the year 2025 and vision to the year 2050* – sets out specific water supply development targets and objectives to the year 2015, 2020 and 2025. These are briefly summarized in the box below:

- Specific Targets and Objectives to the Year 2015
    - Service coverage in urban areas class III and above shall be 90%, with 120l/cap/day; urban areas class IV shall be 70%, with 100l/cap/day. Urban areas class V shall be 50% from central water supply systems, water quality shall meet required standards.
    - Non-revenue water shall be less than 25% in urban areas class IV and above, and on newly built water supply systems; less than 30% in urban areas class V with previously built water supply systems.
    - Water supply service shall be stable and continuous. In urban areas from class III and above, water supply service shall be 24 hours/day. For urban areas class IV, V water supply service shall meet demand and economic conditions.
    - Supply water to industrial areas with good pressure and volume are required.

- Specific Targets and Objectives to the Year 2020
    - Water service coverage for urban areas class IV and above shall be 90%, with 120l/cap/day; urban area class V shall be 70% from central water supply systems, with 100l/cap/day, water quality shall meet required standards.
    - Non-revenue water rate shall be less than 18%, for urban areas class IV and above, less than 25% in urban areas class V, continuous supply 24hours/day in urban areas class IV and above.
- Specific Targets and Objectives to the Year 2025
    - Service coverage in urban areas class IV and above shall be 100%, with 120l/cap/day; water quality shall meet stipulated standards.

Box 2-1: The briefly summary of Decision No 1929/2009/QD-TTg

Source: (ADB, 2010)

Related to the water tariffs, Joint-Circular No.95/2009/TTLT-BTC-BXD-BNN and Circular 100 take into account technical – economic norms for water production approved by functional management costs and sale costs in water tariffs calculation.

On the other hand, the Ministry of Health as a related ministry sets the drinking water quality standards. Currently, this is Circular No. 05/2009/TT-BYT dated on 17/06/2009 by the Ministry of Health on the insurance of National Technical Regulation on Drinking Water. This circular stipulates limits of quality criteria for drinking water and applies to water providers, who exploit, trade drinking water with capacity of 1,000 cbm/day or above.

In governance, the Ministry of Natural Resource and Environment takes responsibility for the management of water sources quantity and quality monitoring, wastewater controlling and environmental fees collection. This Ministry and its provincial are responsible for both groundwater and surface water resources.

2.3. Water supply in Ho Chi Minh City

Ho Chi Minh City water supply operations are managed by the Saigon Water Corporation (SAWACO), which was established in 1874, and most recently restricted in 2006. SAWACO has about 3,500 staffs, 1,800 working directly for SAWACO or SAWACO branches, with the balance working in affiliated joint-stock companies, consulting and contracting companies. SAWACO has a 5,460 kilometer (km) distribution network, with 974,000 connections. Overall, SAWACO has 5 staffs per 1,000 connections, a very low and efficient rate compared with regional benchmarks. The figure 2-4 illustrates the organization structure of SAWACO as below:

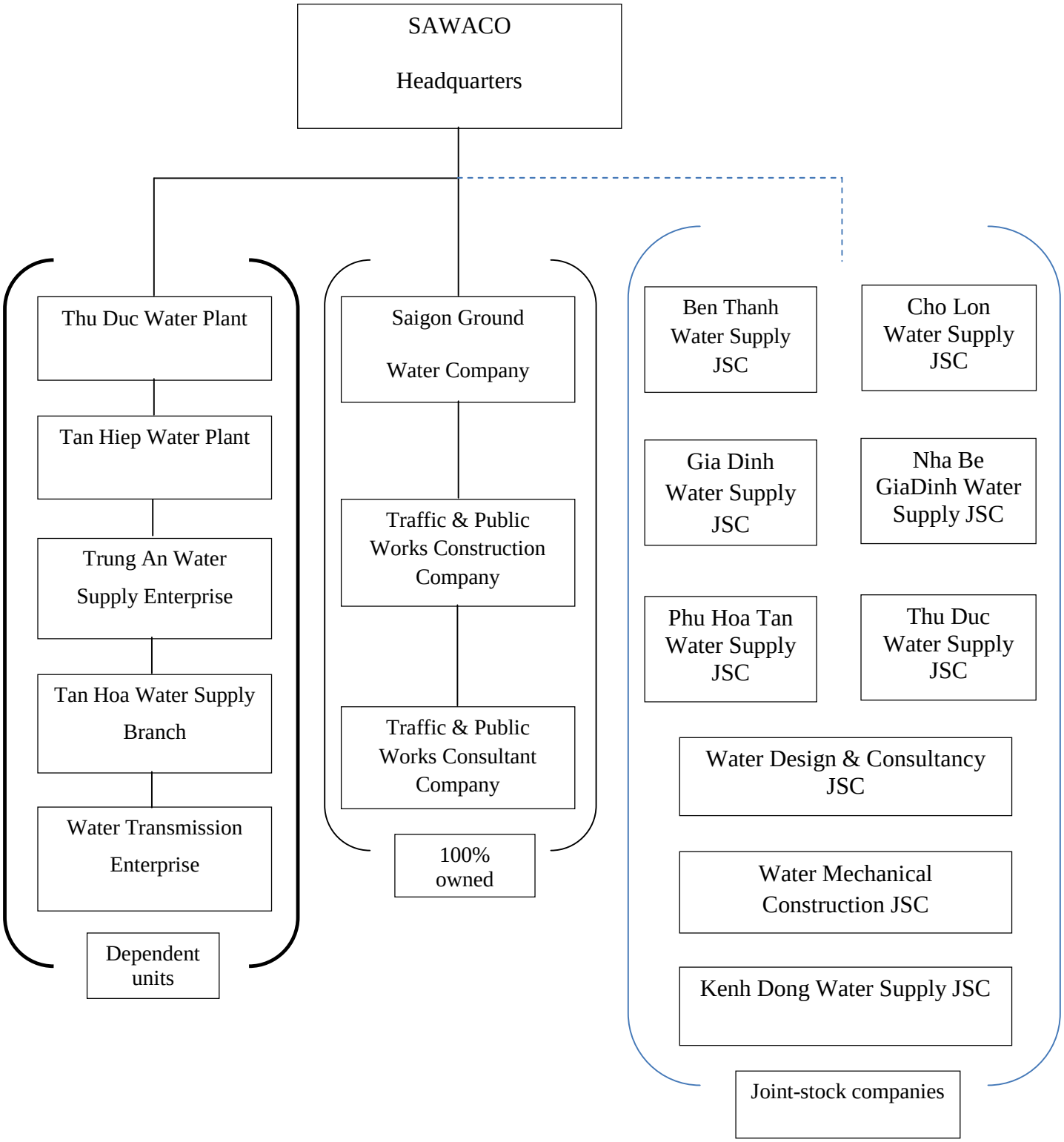

Figure 2-4: SAWACO organization structure

Source: (ADB, 2010)

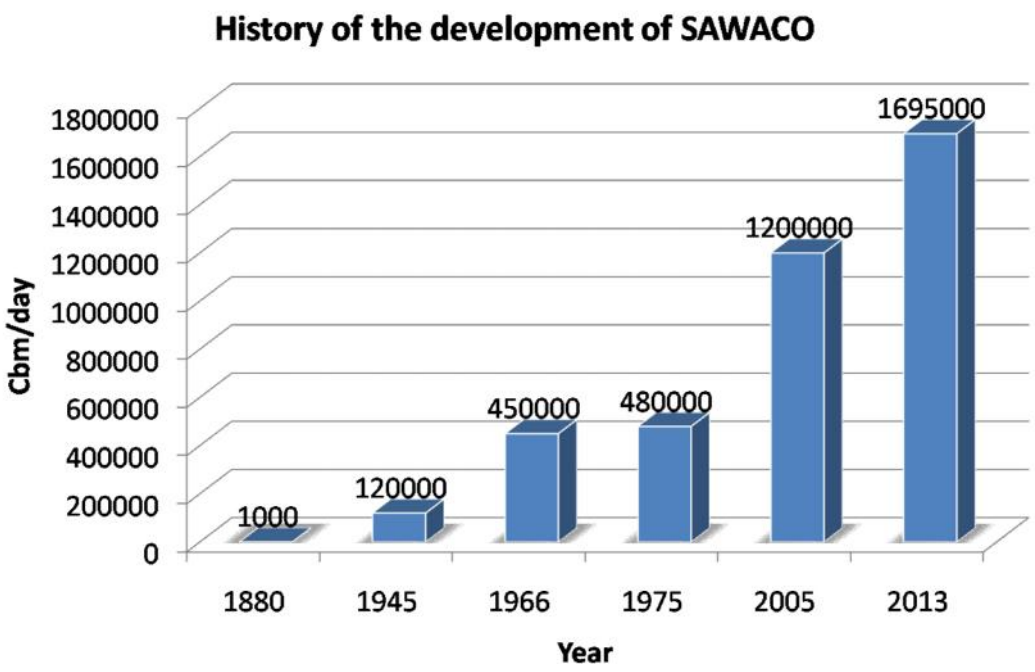

Figure 2-5: The development of SAWACO in great landmarks of development history

Source: (SAWACO, 2014)

SAWACO was the first water company owned by the Vietnam Government. It was the country's first water supply company to undergo equalization. SAWACO's roots go back to 1874, and it has gone through a number of organizational transitions in the intervening years. In 1945, the total capacity of water supply reached 120,000 cbm/day. Groundwater was the main resource which was supplied for about 450,000 people. In 1959, it transitioned to the Saigon Metropolitan Water Office, which was established with the main purpose to supply fresh water for citizens of Saigon and surrounds. One of dependent units of SAWACO, Thu Duc Water Plant has begun to activate in 1966 with the first capacity of 450,000 cbm/day, and exploited the Dong Nai River for that purpose. Few years later, in 1975 Saigon Metropolitan Water Office transformed to the Ho Chi Minh City Water Supply Company and was still keeping the capacity by 450,000 – 480,000 cbm/day. Almost 30 years later, in year 2004 Tan Hiep Water Plant was established, producing about 300,000 cbm/day. One year after that, in 2005, Ho Chi Minh City Water Supply Company transformed to Saigon Water Supply Corporation and the current structure was established as a holding company with subsidiaries. Concomitant with these transitions, the

company has transformed to a sprawling complex State Owned Enterprise today producing over 1.2 million cbm/day in the year 2005 and about 1.7 million cbm/day in the year 2013.

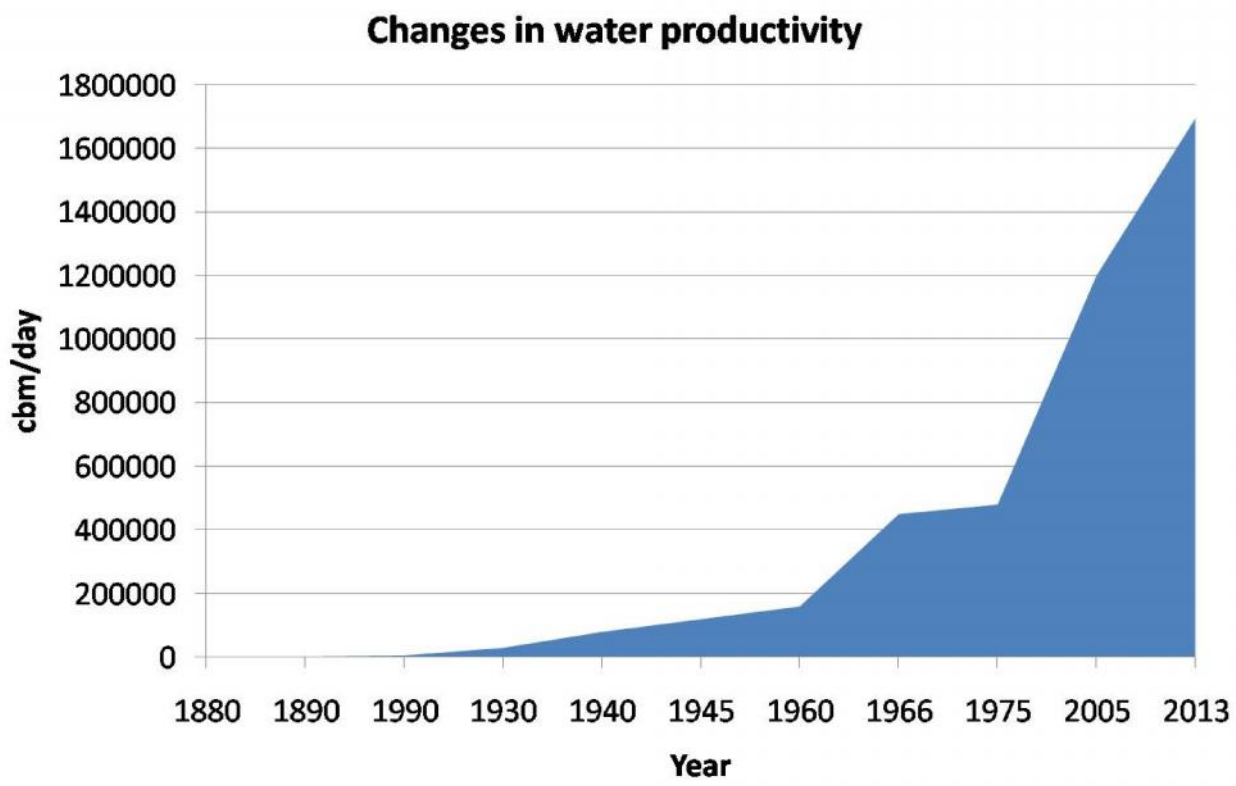

Figure 2-6: Changes in water productivity

60% of the households in the whole city are supplied with piped water, including in the old centre area 84%, in the new center area 43%, in suburbs 23% of the households. The average capacity per person calculated in the whole city is 112 liters/person/day (inside domestic usage is 79 liters/person/day). Including:

- Old centre areas: 145 liters/person/day (inside domestic usage is 106 liters/person/day)
- New centre areas: 103 liters/person/day (inside domestic usage is 63 liters/person/day)
- Suburbs: 26 liters/person/day (inside domestic usage is 23 liters/person/day)

Zone	Water resources %			
	Piped water	Ground water	Surface water (treated)	Rainwater
Thu Duc	40	60	-	-
District 2	30	50	20	-
District 7	50	-	-	50
District 9	45	55	-	-
District 12	10	90	-	-
Binh Chanh	10	90	-	-
Can Gio	-	-	-	100
Nha Be	2.5	44.5	15	38
Hoc Mon	1.0	99	-	-
Cu Chi	-	100	-	-

Table 2-2: Water resources used in some districts of Ho Chi Minh City

Source: (DONRE, 2014)

The proportion of water supply resources in Ho Chi Minh City not only piped water of SAWACO but also private wells and own water supply of industrial parks is shown in figure 2-6.

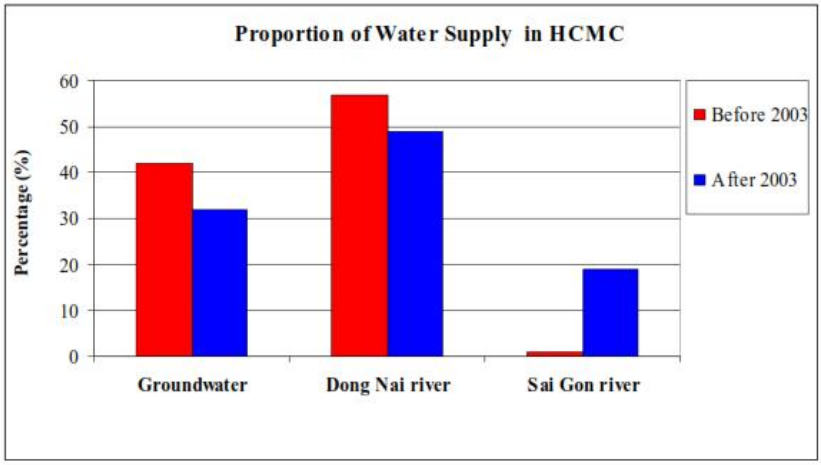

Figure 2-7: Proportion of water supply sources in Ho Chi Minh City

Source: (Roberts, B.& Kanaley, T. (eds), 2006)

At the present, Saigon Water Corporation has the ability to exploit and supply the water supply for Ho Chi Minh City over 1.6 million cbm/day from two main sources: surface water and groundwater.

- Surface water (exploiting of Dong Nai River and Saigon River): makes up about 95% of the total capacity

    - Dong Nai River: total capacity of raw water (directly from Dong Nai River) is about 1,150,000cbm/day. This source supplies Thu Duc Water Plant, Thu Duc B.O.O Water Plant and Binh An BOT Water Plant.

    - Saigon River: at this time, this source is exploited by about 300,000cbm/day. Saigon River supplies Tan Hiep Water Plant. Saigon River is also a resource for the Kenh Dong system (exploits water from Dau Tieng Reservoir and Upper Saigon River). By this way, Saigon River supplies raw water to Kenh Dong Water Supply Joint-stock Company.

Figure 2-8: Saigon - Dong Nai River System

Source: (IGES, 2007)

– Groundwater makes up 5% of total capacity of SAWACO:

- Groundwater is exploited in district 12 and supplies raw water to Tan Phu Ground Water Plant (dependent on Saigon Ground Water Company), with a designed capacity of 70,000 cbm/day. Besides that, SAWACO has other smaller water supply systems.

However, the number above just shows the total groundwater, which is exploited by SAWACO, according to Vo Le Phu (Phu 2009). Aquifer sources have been increasingly exploited for domestic and industrial purposes, accounting for 30-40% of water demand in Ho Chi Minh City. The exploitation rate of groundwater was accelerated to meet all domestic and industrial uses.

There were more than 95,828 wells in 1999 and about 150,000 bored in 2003, equivalent 530,000 cbm/day (Phu 2009). The important groundwater sources for water supply are 2 aquifer layers: Pleistocen and Upper Pliocen. The maps of wells in Pleistocen aquifer and Upper Pliocen aquifer are shown in figure 2-9 below.

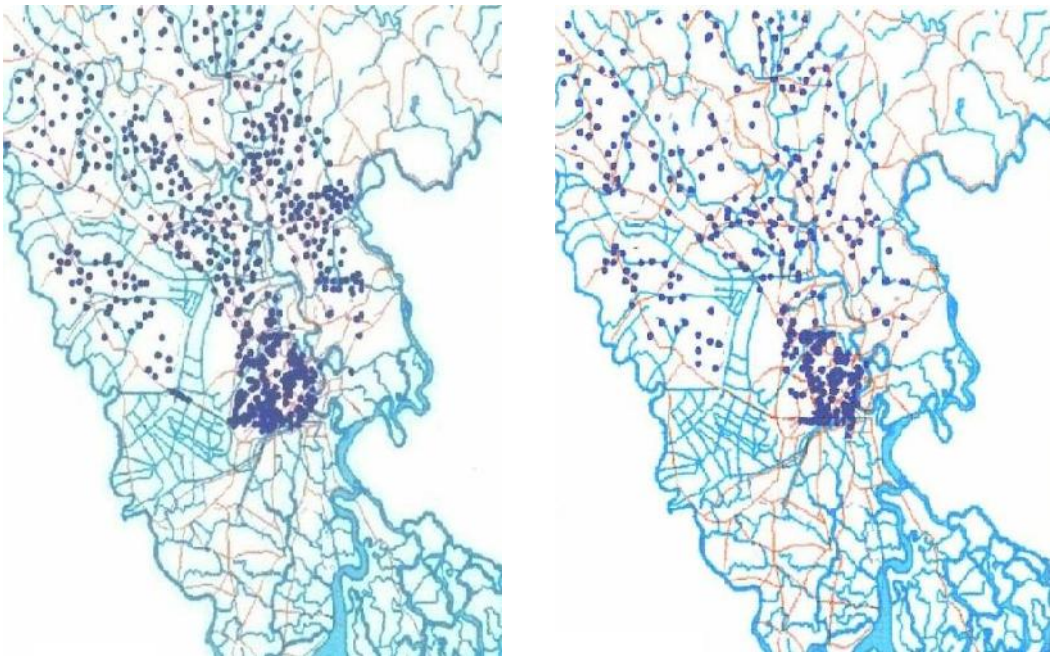

Figure 2-9: Maps of wells in Pleistocen aquifer and Upper Pliocen aquifer

Source: (IGES, 2007)

Beside the treated water from two main resources surface water and groundwater, in some suburban districts rainwater is currently harvested by residents. Especially concerned are the District 7 and the costal districts Can Gio and Nha Be, whereby the use of rainwater in most households of Can Gio District is only on a small scale. Generally, the use of rainwater is due to a lack of fresh water sources or missing connection to the distribution network.

93% of water supply of Ho Chi Minh City is treated at five major Water Treatment Plants, i.e. Thu Duc Water Plant, Tan Hiep Water Plant, Binh An BOOT Water Plant, Thu Duc BOO Water Plant and Kenh Dong Water Plant.

No.	Water Plants	Designed capacity (cbm/day)	Average capacity (first 6 months of 2014)	Relationship with SAWACO
1	Thu Duc Water Plant	750,000	674,451	Dependent
2	Tan Hiep Water Plant	300,000	199,970	Dependent
3	Tan Phu Ground Water Plant	70,000	67,356	Dependent on Ground Water Company
4	Thu Duc BOO Water Plant	300,000	322,596	Whole sale
5	Binh An BOT Water Plant	100,000	100,518	Whole sale
6	Kenh Dong Water Plant	200,000	150,030	Whole sale

Table 2-3: Capacity of Water Plants in Ho Chi Minh City in cbm/day

Source: (SAWACO, 2014)

The core operations performed by SAWACO are water production and water transmission to the distribution network. The distribution network of Ho Chi Minh City is a large system with 5,460km pipe length in total including the length of transmission pipes by 239km due to over 974,000 customer water-meters. Primary pipeline networks are operated and maintained by the Water Transmission Enterprise. The water supply units are responsible for the operation and maintenance of the tertiary pipelines (or distribution network) in their respective areas. In the areas where joint-stock companies have been established the joint-stock companies are responsible for the expansion of the distribution network. In the Tan Hoa Water Treatment Branch and the Trung An Water Supply Enterprise, SAWACO is responsible for network expansion. The distribution network is managed by 9 units:

No.	Units	General meters	Customer meters	Fireplugs	Valve	Pipe length
1	Ben Thanh	64	59,912	312	2,123	4,977
2	Gia Dinh	38	125,862	598	2,389	
3	Nha Be	19	99,957	360	2,059	
4	Thu Duc	30	130,335	1,373	2,660	
5	Trung An	29	110,653	931	2,002	
6	Tan Hoa	44	132,462	751	5,712	
7	Cho Lon	97	227,740	767	4,042	
8	Phu Hoa Tan	51	87,616	650	4,301	
9	Can Gio Water Supply Enterprise	-	-	-	-	-
10	Water Transmission Enterprise		239	39	586	485
Total		**372**	**974,796**	**5,781**	**25,889**	**5,462**

Table 2-4: Information about distribution system (statistic to 2013)

Source: (SAWACO, 2014)

Storage capacity for treated water consists of large reservoirs at each of Thu Duc Water Plant and Tan Hiep Water Plant representing about 20% of the average of daily demand. Existing provided storage capacity offers limited security of supply under system failure.

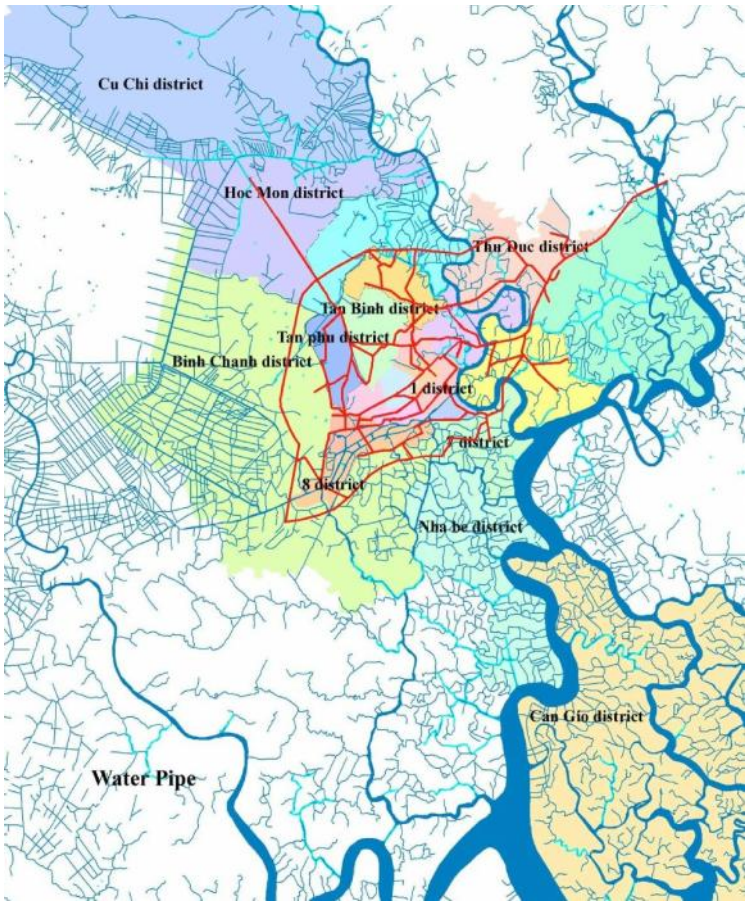

Figure 2-10: Map of water pipe network in Ho Chi Minh City

Source: (SAWACO, 2014)

The existing transport and main distribution are integrated into one large network. This integrated network is fed by the two main water plants (Thu Duc and Tan Hiep) located in the north east and the north west of the supply areas. As a result all transmission mains provide water for locations nearby the treatment plants and for distant areas. Because the mains are very long, pressures at the pumping stations have to be high. However, it is common that pressure is low on the southern fringes of the network.

The amount of water pumped into the system at the water treatment plants does not change when water demand changes. Most of the time, pumps are pumping water into the network at their maximum capacity, day and night, although at Thu Duc treated water pump station a lower flow

is pumped at night. This results in low pressures during times of peak demand and high pressures during the night when demands are low.

At present, there is no control of flows and insufficient metering of flows. Meters are being installed by the Transmission Enterprise at present to improve this situation. The distribution is divided into a number of administrative zones (presently 6 Joint-stock companies and 2 branches) but flows to these sectors cannot be controlled and they are not metered adequately. Pressure zones are therefore not used at present. However, the present 8 zones (6 joint-stock companies and 2 branches) do not match with 6 district metering zones. The table 2-5 shows the relationship between hydraulic zone, districts and joint-stock companies and figure 2-11 illustrates 6 hydraulic zones.

Hydraulic Zone (Based on World Bank Project)	**District**	**Joint-stock Company/ Branches**
1	1	Ben Thanh
	3	
	5	Cho Lon
	10	Phu Hoa Tan
2	11	
	Tan Binh	Tan Hoa
	Tan Phu	
3	12	Trung An
	Go Vap	
	Phu Nhuan	Gia Dinh
	Binh Thanh	
4	2	Thu Duc
	9	
	Thu Duc	
5	4	Nha Be
	7	
	Nha Be	
6	6	Cho Lon
	8	
	Binh Tan	
	Binh Chanh	

Table 2-5: Relationship between Hydraulic Zones, Districts and Joint-stock Companies

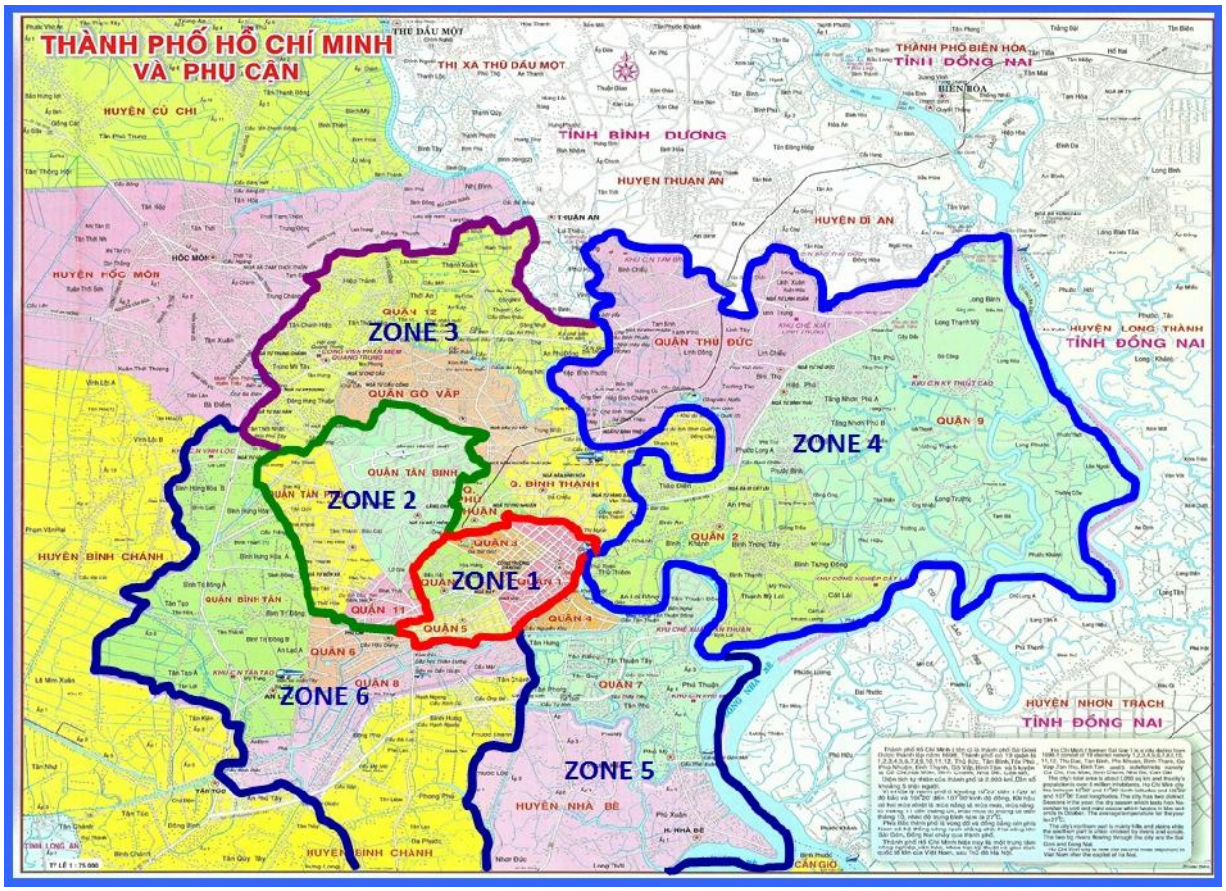

Figure 2-11: 6 hydraulic zones in Ho Chi Minh City

Source: (SAWACO, 2014)

Mainly due to the poor infrastructure and incompatible network, the water loss rate is still high. The reasons for this are the over taxation and overload of the existing urban infrastructure, water supply and sewerage systems. *"Water supply resources are abundant, however, the distribution network is extremely deficit*" said by Mr.Tran Dinh Phu – CEO of SAWACO (Phan, 2014). After installing general water – meters in the 6 hydraulic zones, the water loss rate could be calculated. This rate in the time period 2009 and predicted to 2020 is illustrated in the figure 2-12. As a result of the pipelines degradation, the current water loss rate of Ho Chi Minh City is about approximately 33%.

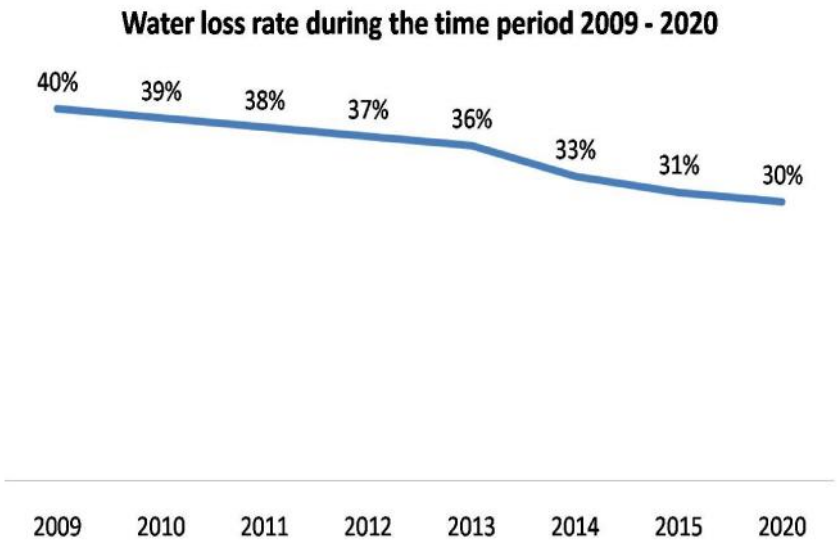

Figure 2-12: Water loss rate during the time period 2009 – 2020

The water tariff is typically lower than the actual cost of exploitation, treating, and distributing. One of the reasons is the government subsidization. The current water tariff came into use in 1st July 2004 and has not been changed since. Since then there have been small increases in the average tariff as a result of changing customer mix.

The breakdown of water supply operating expenses shows that bulk water and electricity costs are SAWACO's highest operating costs followed by salary costs. All these costs are steady increasing over the years. Water supply expense 2004 to 2008 increased by 61%, which provides in part an explanation for the decreasing gross margin of water operations. Another explanation however, is given by reduction in maintenance expenses, leading to the need for large capital expenditures in the future to reduce water losses to more acceptable levels of around 25-30% compared with current levels of 40%.

Ho Chi Minh City People's Committee released Decision No 103/2009/QD-UBND dated 24 December 2009 for water tariff for domestic and non-domestic customer classes as shown below:

	Percent Consumption	2009 Present	2010	2011	2012	2013
Domestic	68.4%	3,790	4,825	5,290	5,770	6,340
Institutional	16.3%	6,000	7,100	8,100	9,300	10,300
Industrial	4.8%	4,500	6,700	7,400	8,200	9,600
Commercial	10.5%	4,500	12,000	13,500	15,200	16,900
Average Tariff	100%	4,630	6,059	6,714	7,432	8,196

Table 2-6: SAWACO 2010-2013 HCMC Water Tariff (VND/cbm)

The tariff was introduced on 1st March 2010 and approved. The previous tariff had remained unchanged since July 2004. SAWACO has proposed an overall 62% increase of the previous tariffs to the Ho Chi Minh City People's Committee, but this was no accepted and the tariff as shown was substituted. The tariff runs from 2010 to 2013 with a 10% increase each year from 2011 to 2013. In addition to the proposed increase there is also a change in structure with the proposed tariff following that of Circular 95/2009, which sets out calculation methodologies and structures. This is a turning away from the past tariff structures for domestic consumption, which were based on an allocation (cbm/month) per person.

The water supply units are responsible for reading the meters and entering the readings into a data file for transmission to SAWACO. Meters are read on a monthly basis. SAWACO is using electronic meters reading devices which download the readings to a customer data file. Each water unit electronically transmits the data file to SAWCAO headquarters for processing. The Business Development and Cooperation Department is responsible for producing the customer invoice. The system determines the consumption and applies the appropriate tariff to determine the water bill.

The meter readings from all companies and invoices are calculated and printed at SAWACO headquarters. The invoices are printed and separated by company. Each company's invoices are bundled and delivered to each company for distribution to individual customers.

The invoices are delivered to the customer's residence. Generally, the company which individually distributes the invoices will collect the payment from the customer. Customers can pay at the bank, but most of customers prefer to pay the local collector. Collections are principally made by the individual bill collector. There are provisions for payment by bank draft, but these methods of payment comprise only a small number of payments. The collection by bill collectors is nearly 100% of the amount of payment.

3. Actual analysis

3.1. Case study description

A basic method in a research is data collecting and existing analysis. We need to know about the current situation in the main site. During the research time, the author had many times visited the research area and from the observation, some small interviews with local people and the data of previous researches, collected from internet, the author then has got the existing analysis.

As first, the case study of this research is Binh Thanh District, an urban district, now part of the city center, located at the gateway of the urban Northeast, influenced by the development of urbanization. Binh Thanh District has the advantage of natural conditions to create a network of canals and more favorable conditions for trade in services and tourism landscape. Furthermore, the city transport system is planned to pass through Binh Thanh District. The figure 3-1 and 3-2 below shows the typical residential space in Binh Thanh District.

Figure 3-1: Residential space, a typical house of local resident

Figure 3-2: Residential space, low-rise apartments block (Condominium)

The district has an area of 2.070,67 ha. The figure 3-3 shows the following borders of the site:

- The site's Northern borders with District 12 (Vam Thuat River) and Thu Duc District (Saigon River)
- The site's Eastern borders with Thu Duc District and District 2 (Saigon River)
- The site's Southern borders with District 1 (Thi Nghe Canal)
- The site's Western borders with Go Vap, Phu Nhuan District

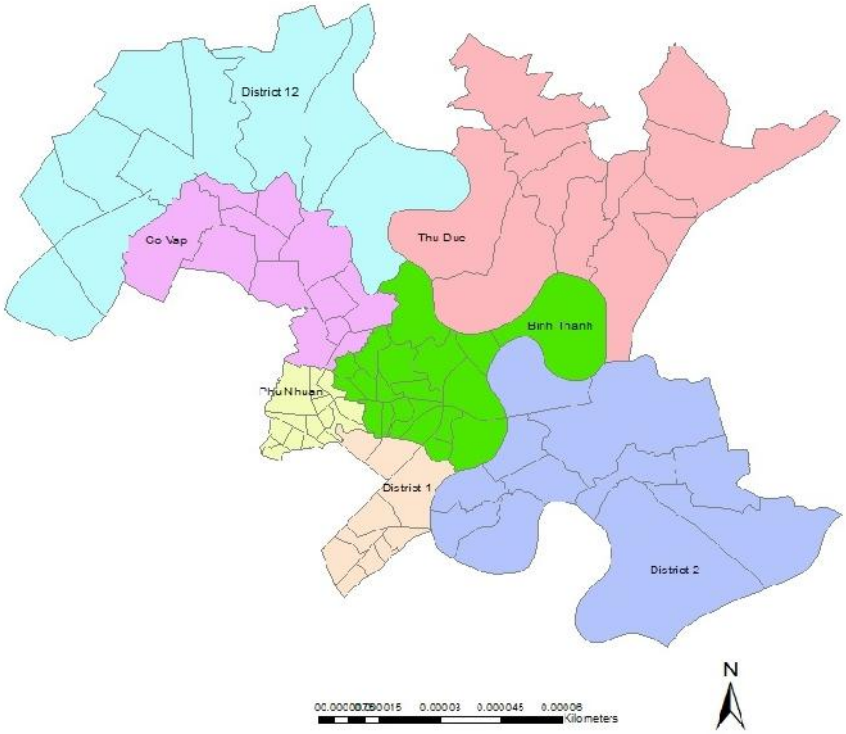

Figure 3-3: Binh Thanh District and surroundings

The whole district is divided into 20 administrative units at ward level. According to the annual statistics of the Statistical Division of Binh Thanh District, the average population of Binh Thanh District in 2009 was 467,460 people. The rate of overall population growth 1999-2009 was 1.55% per year, the rate of natural increase was 1.2%. The average population density in 2009 in Binh Thanh District was 225 people/ha, lower than the average population density of old urban areas (266 people/ha).

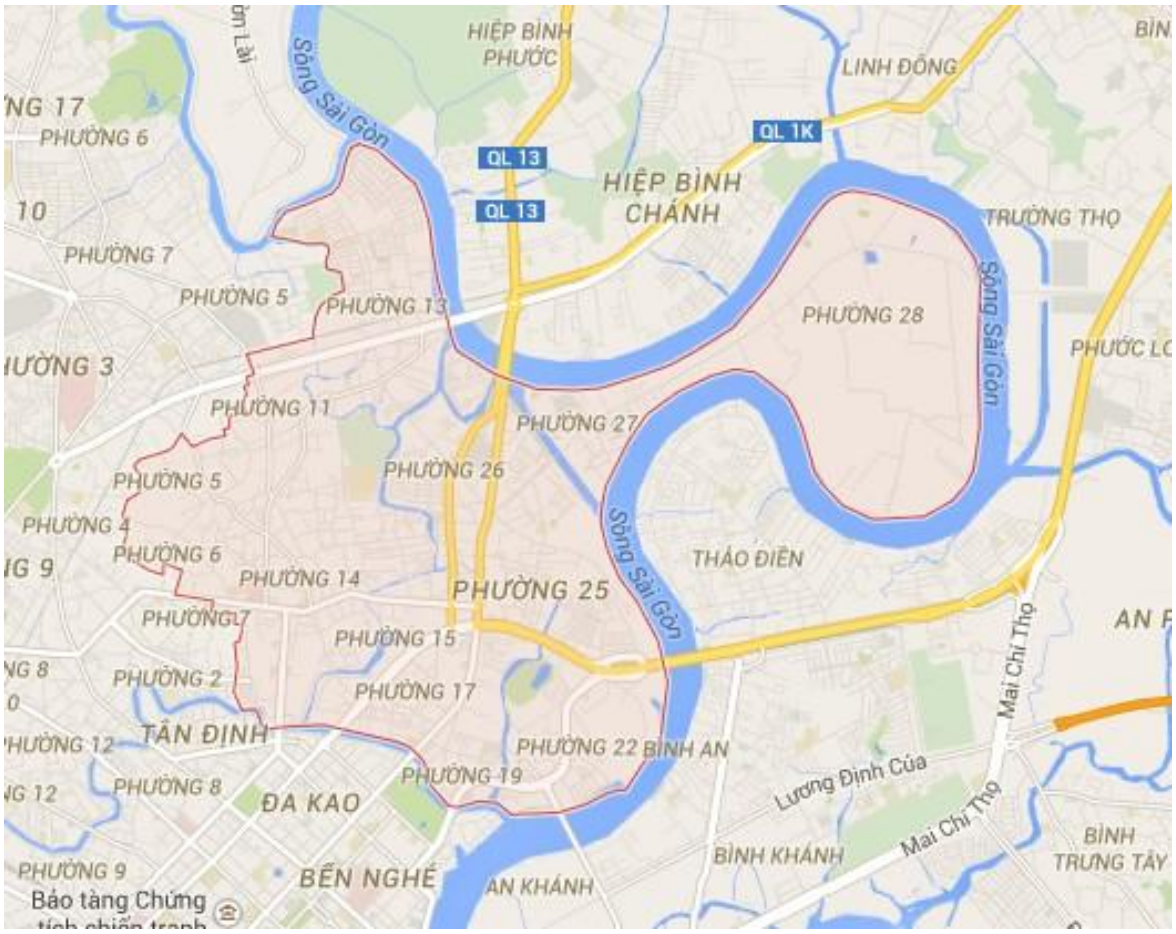

Figure 3-4: Map of Binh Thanh District

Source: (Google, 2014)

No.	Ward	Area		Population	
		ha	%	people	%
1	Ward 1	26.52	1.28	14,297	3.09
2	Ward 2	32.02	1.55	18,068	3.91
3	Ward 3	45.76	2.21	26,216	5.67
4	Ward 5	36.91	1.78	15,812	3.42
5	Ward 6	29.93	1.45	10,594	2.29
6	Ward 7	39.61	1.91	16,854	3.65
7	Ward 11	77.4	3.74	32,222	6.97
8	Ward 12	111.37	5.38	39,883	8.63
9	Ward 13	260.16	12.56	25,528	5.52
10	Ward 14	32.28	1.56	12,789	2.77
11	Ward 15	51.86	2.50	23,948	5.18
12	Ward 17	63.88	3.08	27,438	5.94
13	Ward 19	39.41	1.90	17,748	3.80
14	Ward 21	39.59	1.91	22,622	4.84
15	Ward 22	177.41	8.57	26,188	5.60
16	Ward 24	56.94	2.75	24,541	5.25
17	Ward 25	184.2	8.90	41,625	8.90
18	Ward 26	131.85	6.37	33,838	7.24
19	Ward 27	84.99	4.10	23,889	5.11
20	Ward 28	548.58	26.49	13,360	2.86
Total		**2070.67**	**100.00**	**467,460**	**100.00**

Table 3-1: Political organization, existing population (2009) and natural areas of Binh Thanh District

Source: (DOP, 2010)

Due to the size of population, a random sampling was conducted in Ward 12 and Ward 14 of Binh Thanh District. Ward 12 and Ward 14 are the wards, which currently have water stress situation such as water resource shortage and urban inundation in rainy season.

The number of respondents for this survey is 400 people. 45% of the respondents were female (181/400), and 55% (219/400) were male. The proportion of gender of respondents is shown in the figure 3-5 below.

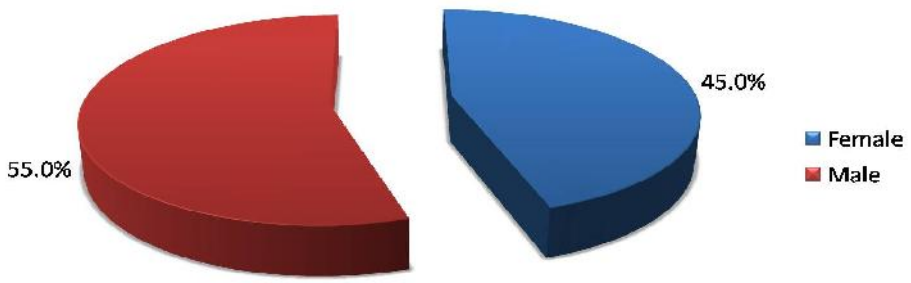

Figure 3-5: Gender of respondents

The figure 3-6 presents the education level of respondents. There are 39% of the respondents educated in vocational/college/university level. Almost a quarter (26%) of the responders has secondary school level, and 21% of the respondents studied at high school. The rest studied in primary school, or has post graduate level or has no formal education (6.8%, 5% and 2.5% respectively).

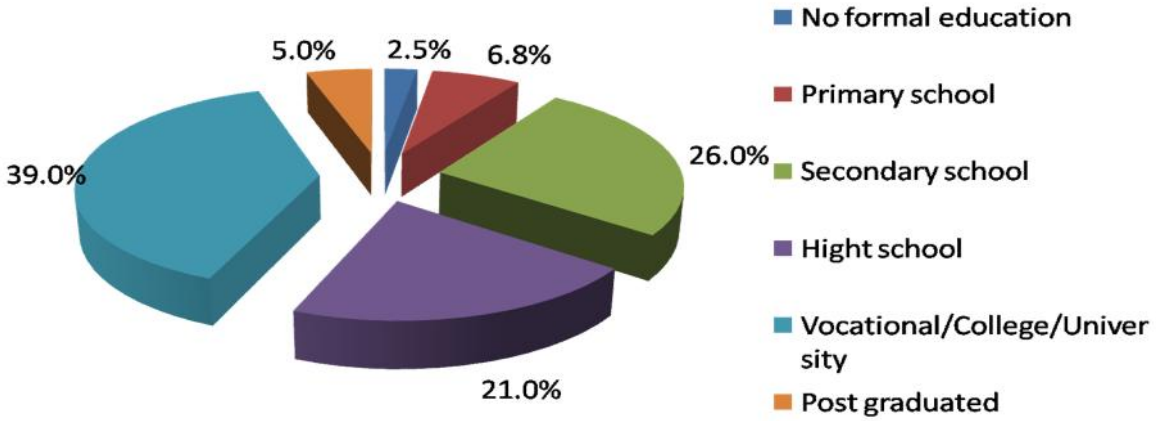

Figure 3-6: Education level of respondents

Overall, the current water supply situation in research area is shown in figure 3-7. The majority of respondents (86.8%) maintained that they were connected with the city piped water, which is supplied by Gia Dinh Water Supply Company – a joint-stock company of SAWACO. In contrast, 13.2% of respondents were not connected with piped water. There are a lot of reasons for this issue, which were asked in the in-depth interviews. People argued that they are illegal residents or they live too far from the main pipe or they do not have enough money for a connection to piped water. Another reason is that they think their own wells or rainwater have enough quantity and quality for them to survive. The main resources which are used in this area are discussed in part 3.2.

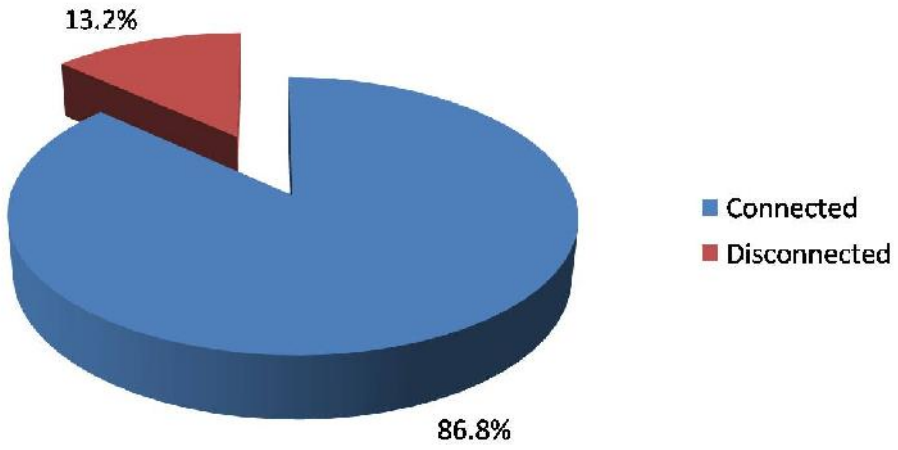

Figure 3-7: Proportion of household which are connected to piped water

3.2. Water supply actual situation

The kinds of water reservoir, which are used to store water, are illustrated in figure 3-8. It can be seen from the figure that most of people use water directly from the tap (58%). The proportion of respondents, who use ground water tank, is 17.5% and the proportion of elevated tanks is 14%. The rest of the amount is a divided balance for people who use water bucket, water jar and underground water tank. These tanks are usually made from concrete, steel or plastic.

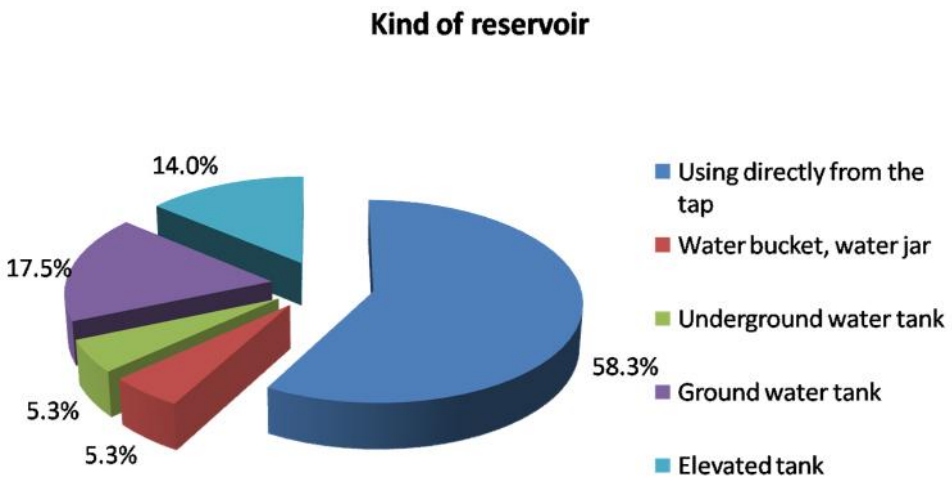

Figure 3-8: Kinds of water reservoirs

The results shown in figure 3-9 and 3-10 below are the main resources, which are used in the research areas and the supply frequency of these sources. People have given different perceptions on water resources. About 91% of respondents are using piped water, which is currently the main source for domestic use in Ho Chi Minh City. This water provided by Gia Dinh Water Supply Joint-stock Company. A half (51.4%) of the respondents use bottled water mainly for drinking purpose. Others, almost 17% of the respondents, use water vendor, water by truck, the same percentage for respondents who use some surface water such as stream, spring or lake. However, rainwater is also harvested for domestic use. Some households have their own well to exploit groundwater.

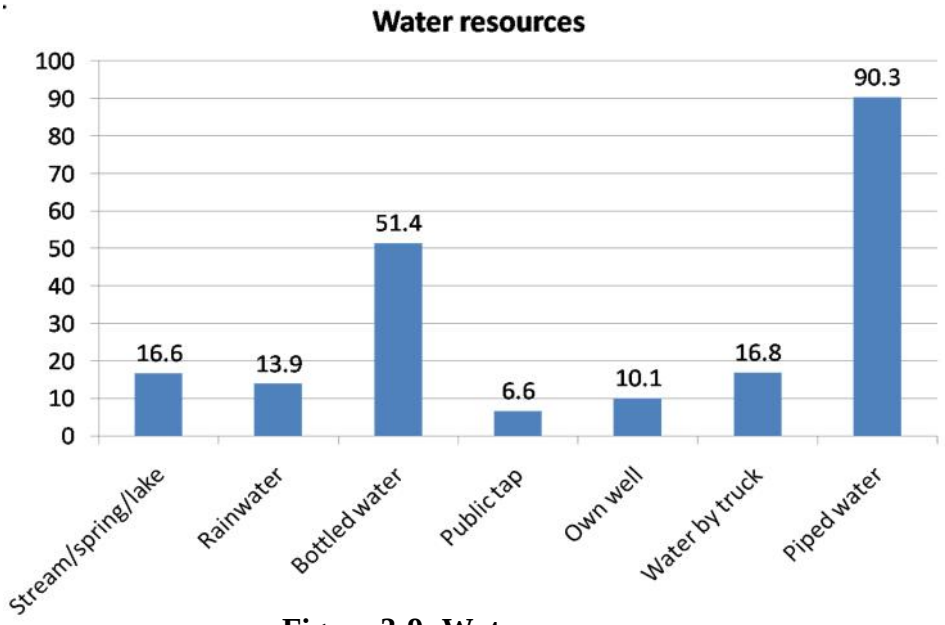

Figure 3-9: Water resources

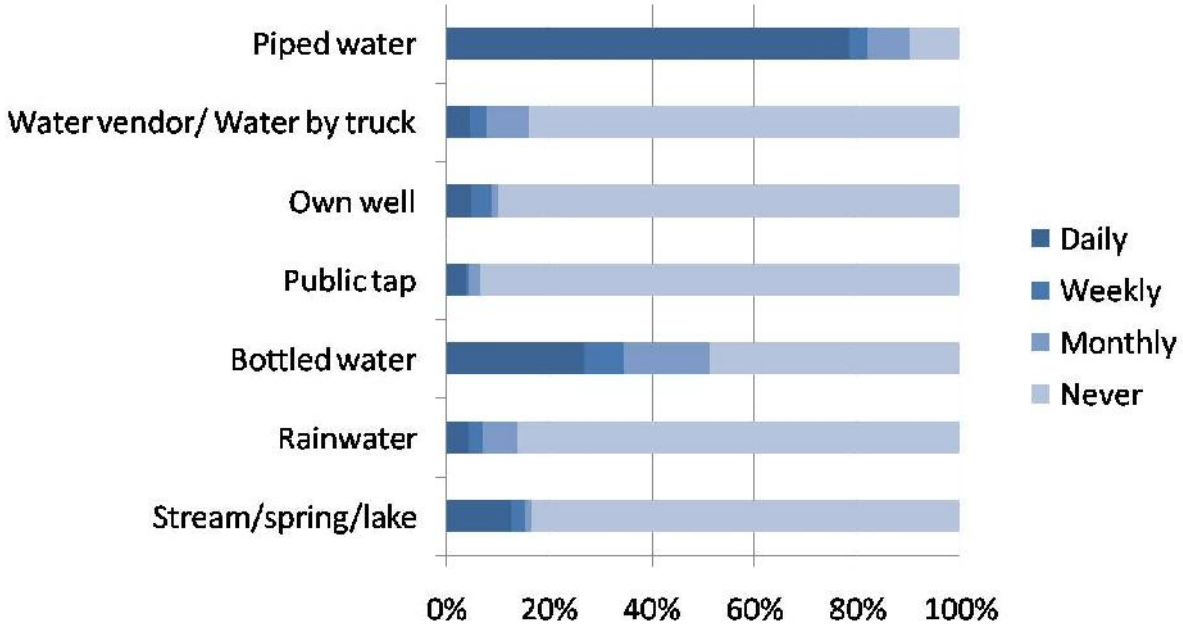

Figure 3-10: Water resources by supply time

The resources of water supply in Ho Chi Minh City were identified based on the Resolution no 20/2004/NQ-HD issued December 10th, 2004 by City People's Council. Binh Thanh District is an urban district of Ho Chi Minh City. Therefore, water supply resources for domestic use are supplied by the piped water system of the city. This water is supplied by Gia Dinh Joint-Stock Companies. The water supply resource of Binh Thanh depends on Thu Duc Water Plant System (Total capacity Q =718,000 cbm/day).

The water supply network of Binh Thanh District was constructed from 1964s. The water supply network has taken shape along the main road and lane.

- These pipes have diameter from Ø2000mm to Ø80mm.
- Water pressure on pipe 10m < P < 20m
- The percentage of households, which can access the piped water is 95.9%
- Current criteria of water from 130 liters/person/day to 140 liters/person/day
- Leakage rate on pipe system 32%

Besides that, at no. 175 Nguyen Van Dau, there is the elevated reservoir with a volume of 3827cbm, constructed in 1970. However, this reservoir has not been used for a long time due to the delicate water pressure and leakage in surface.

Figure 3-11: Elevated reservoir in Binh Thanh District

The main pipe system in Binh Thanh District included:

- Pipes Ø 2000mm along Dien Bien Phu Street (the transship pipe)
- Pipes Ø 900 mm to Ø750mm along Bach Dang – Hoang Van Thu
- Pipes Ø500 mm to Ø300mm along Ung Van Khiem – Nguyen Xi
- Pipes Ø400 mm along Xo Viet Nghe Tinh Street
- Pipes Ø450 mm to Ø750 mm along Le Quang Dinh Street

The table 3-2 illustrates the actual main pipes in Binh Thanh District.

No.	Road name	Stretch of road		Diameter of pipe Ø (mm)	Year of construction	Direction
		From	To			
1	Dien Bien Phu	Saigon Bridge	Dien Bien Phu Bridge	2000	1964	North
2	Xo Viet Nghe Tinh	Hang Xanh Cross Section	Bach Dang	900	1964	East
		Hang Xanh Cross Section	Ngo Tat To	400	1968	East
		Bach Dang	War Memorial	300	1964	West
		War Memorial	Thanh Da Bridge	400	1973	North
3	Binh Quoi	Thanh Da Bridge	Ward 28	350-200	1973	South
4	National Road no.13	War Memorial	Binh Trieu Bridge	500	1978	North
5	Nguyen Xi	War Memorial	No Trang Long	300	1977	North
6	Bach Dang – Phan Dang Luu	Xo Viet Nghe Tinh	Hoang Hoa Tham	900	1965	North
		Hoang Hoa Tham	End of border	750	1965	North
		Dinh Bo Linh	Xo Viet Nghe Tinh	300	1964	South
7	Le Quang Dinh	Phan Dang Luu	Nguyen Van Dau	450	1968	East
		Nguyen Van Dau	End of road	350	1968	East
8	No Trang Long	Phan Dang Luu	Nguyen Xi	300	1968	East
		Nguyen Xi	Rail way	350	1972	South
9	Binh Loi	Rail way	End of road	350	1972	West

Table 3-2: Actual main pipes

Source: (DOP, 2010)

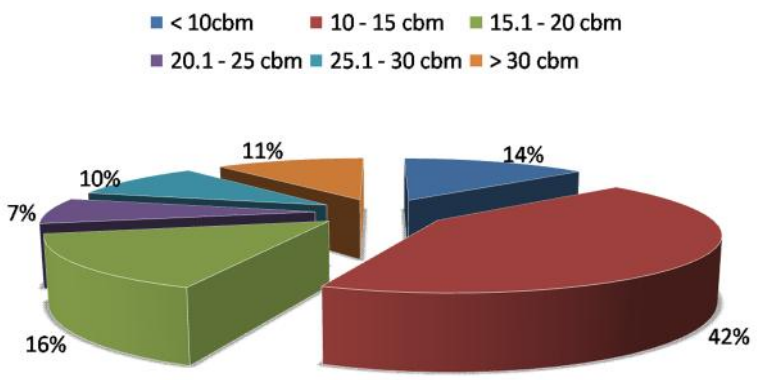

Figure 3-12: The average amount of water used per month

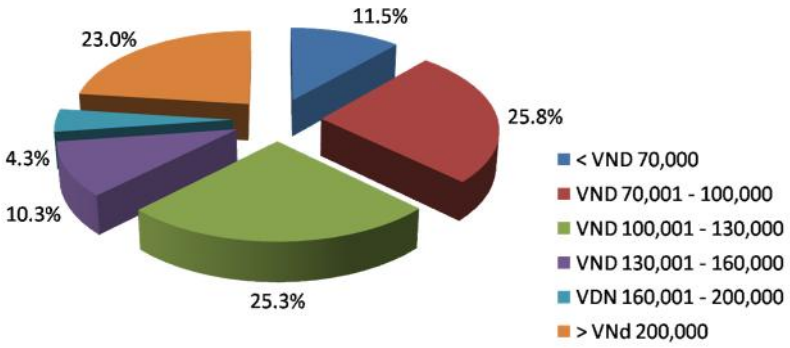

Figure 3-13: The average water fees per month

Figure 3-12 shows the average amount of water used per month. Approximately 42% of the respondents' households are using an average of 10-15 cbm water per month. At the same time, about 16% of the respondents consume less than 10 cbm/month, 14% of the respondents consume 15 cbm to 20 cbm. In general, nearly 28% of the respondents use monthly more than 20 cbm water. In the relationship with the amount of water used monthly, the majority of the respondents paid most from VND 70,000 to VND 130,000 and more than VND 200,000 per month for water. However, about 11.5% respondents' household paid less than VND 70,000 and 10.3% paid the amount between VND 130,000 and VND 160,000. This budget was calculated based on the current average water tariff.

Overall, Binh Thanh District has a good water supply system with a sustainable water resource situation, due to surface water from Dong Nai River. However, in some areas, especially poverty areas, people still cannot access the safe water. These areas are far from the main pipes, and people do not have enough money for the new connection pipes from the main pipes to their house. Drugging and drilling wells to exploit the groundwater are quite common in these areas. This groundwater is used without any treatment or quality analysis. In Binh Thanh District, currently, there are 3.741 drill wells with total exploit capacity Q = 36.076 cbm/day (DOP 2010). These wells are mainly exploited in Pleistocen Level (QI-III) and Upper Pliocen Level (N2b) (1.214 drill wells and 2.527 drill wells, respectively). Nevertheless, the exploiting of groundwater is not controlled, although it is a main cause of saltwater intrusion, water table descent and contamination of the shallow aquifer.

Facing the same problem, in some areas, people just can access safe water by water vendors. That means clean water is transported by truck. This water comes from water supply companies who sell it to a small distribution company. Therefore, the water has an adequate quality. The significant issue here is the water tariff. The price of water by truck is higher than the price of piped water.

Figure 3-14: Water by truck

Figure 3-15: A young boy is carrying water from the truck

3.3. SWOT analysis

STRENGTHS	WEAKNESSES
S1: Location nearby city centre, urban developing areas, suburban areas (District 1, District 2, District 12, Phu Nhuan District, Go Vap District and Thu Duc District) **S2**: Sufficient institutional and legal framework **S3**:High priorities of the local government on water supply as a human basic demand **S4**:The authorities of water management and river basin have been established **S5**: Water supply has drawn attention from various investors, stakeholders and interest groups **S6**: Quantity of water resources is abundant and stable **S7**: Water resources like surface water, groundwater and rainwater are strongly acceptable by community	**W1**: Extremely high population density **W2**: Old distribution network, which was constructed in 1964s, leads to high water loss rate. **W3**: The degradation of reservoirs and drainage system **W4**: Overload of capacity of infrastructure **W5**: Water quality is unstable, groundwater is intruded by saltwater, surface water is contaminated by pollutant sources **W6**: Ineffective water price structure and tariffs **W7**: Planning, development and management of water supply have been fragmented among agencies or departments **W8**: Overlapping responsibilities and missions due to lacking horizontal coordination **W9**: Some relationships and legal framework are under complied or enacted **W10**: The current groundwater exploitation is unsustainable **W11**: Lack of the economic instruments (i.e. exploitation fees, regulation on limitations, prohibition areas) to control the water exploitation, especially for groundwater **W12**: Poor governance of water and absence of well-defined responsibility for water supply resources and safe water

	services. **W13**: Under-trained and unqualified staffs and workers. **W14**: Lack of technical capacity and political power to enforce compliance with the regulation and rules to monitor.
OPPORTUNITIES	**THREATS**
O1: The government decided to re-plan Binh Thanh District after 20 years delayed. **O2**: The government has an attraction policy for local and foreign investors **O3**: There are existing water supply related projects **O4**: Water issues were addressed by the city's strategy **O5**: Considerations and investments of NGOs, WB, ADB… **O6**: Exchange of technologies with other countries **O7**: Rainwater can be a significant potential additional resource for water supply as annual rainfall is relatively high. **O8**: Up gradation of the distribution networks and increase efficiency in water resource use	**T1**: Community has given inadequate attention on water supply issues and their involvement in management is not fully engaged. **T2**: Urban areas are facing the uncontrolled population growth and urbanization, associated with the increase of water demands. **T3**: The increase of water demand has occurred in line with the growth of economy and population. **T4**: Water resource shortage, pollution, degradation and depletion is increasing. **T5**: Financial capacity problems **T6**: Climate change **T7**: Labor force shortage in future (workman)

4. Water stress and its impacts

Nowadays, sustainable development has become a trend in over the world. Sustainable development is the balancing of three determining factors: economic development, social stability and environmental preservation. In the context of urbanization, sustainable development aspects are taken into account. The economic aspects are services, household needs, industrial growth, agriculture growth and efficient use of labor. The social aspects are considered in equity, participation, empowerment, social mobility and cultural reservation. The environmental aspects include biodiversity, natural resources, carrying capacity, ecosystem integrity, clean air and water.

All these 3 factors have mutual influences on one another. The impacts can be in positive or negative according to the specific stage of development. In different stages, urbanization plays a different important role in defining relationships between economic development, environmental deterioration and socio-economic characteristics of residential areas. The relations in the context of urbanization are shown in the following figure 4-1.

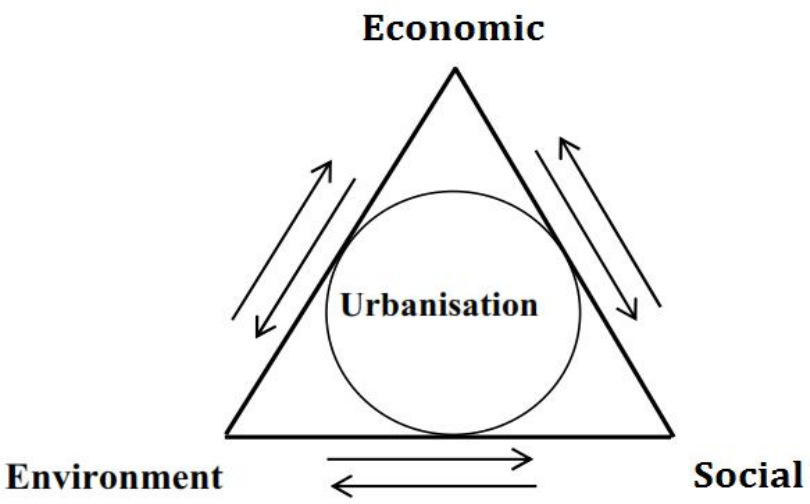

Figure 4-1: Sustainable aspects in the context of urbanization

Source: (Van, 2007)

4.1. Urbanization and water supply issues

Back to the early stages of social development, when the urban areas had begun to take a shape, at first, people gathered together nearby rivers, or roads. As other cities over the world, Ho Chi Minh City has begun nearby Saigon River. Water consumption was mainly for irrigation and livestock purposes. Water helped people for manufacturing and trading. That was the first step of urbanization. Urbanization is the most important social transformation in human history. Urbanization is the process of agglomeration of economic activities and population. The urbanization trend creates the economic and social benefits. However, the cities also are the engine of demographic growth. The urbanization has become the most pervasive population trend in 21st century, it reflected in the development of Asian Cities, in general, and in particular, in that of Ho Chi Minh City. From that, people have had their impacts on the natural resources and ecological systems. United Nations argued in their report that: *"Cities usually have serious environmental impacts far beyond their boundaries through the ecological impacts of the demand they concentrate for natural resources and the waste that they generate and dispose of outside their boundaries"* (HABITAT, 1996).

The cities have their own ecological footprints. The ecological footprint of a city is the sophisticated ecological understanding of how the city exploits natural resources (i.e. water, energy and land). It is also the way a city relies on ecosystem functions to absorb their wastes. The escalation of urbanization is one of the leading factors of urban environmental issues. As everything has two sides, the urbanization also has opportunities and challenges for the development of cities. The urbanization brings many benefits for dwellers like the job opportunities, employment, lifestyle changing, better welfare and social structure. In contrast, the rapid growth of population is raising the demand of water, and results in a wide range of environmental consequences by water deterioration. The urbanization is the cause of inadequate drinking water and sanitation. The air pollution and solid waste management are also the reasons for health problems from water-related diseases.

There are two crucial differences between the process of urbanization in developed countries and developing countries. The first difference is the rate of urbanization. In developed countries, urbanization is a gradual process and population growth was spread over a century. The developing countries towns expensed to large urban centers since the 1950s. The second

difference is the expansion of cities. In developed countries this expansion coincided with their economic development. The economics of cities in developing countries have progressed poorly during the period of rapid urbanization (Phu 2007). Therefore, the developed countries are in advanced of the developing countries in managing their urban water supply and sanitation service because they have the necessary infrastructure, capacities and financial resources. The governments in developing countries have more difficulties to develop a good governance system, capacity managing and efficient financial resources to provide a basic water-related service, because they have failed to cope with the high urbanization rate concomitant with urban water issues. The environmental issues due to urbanization are shown in the figure 4-2 below.

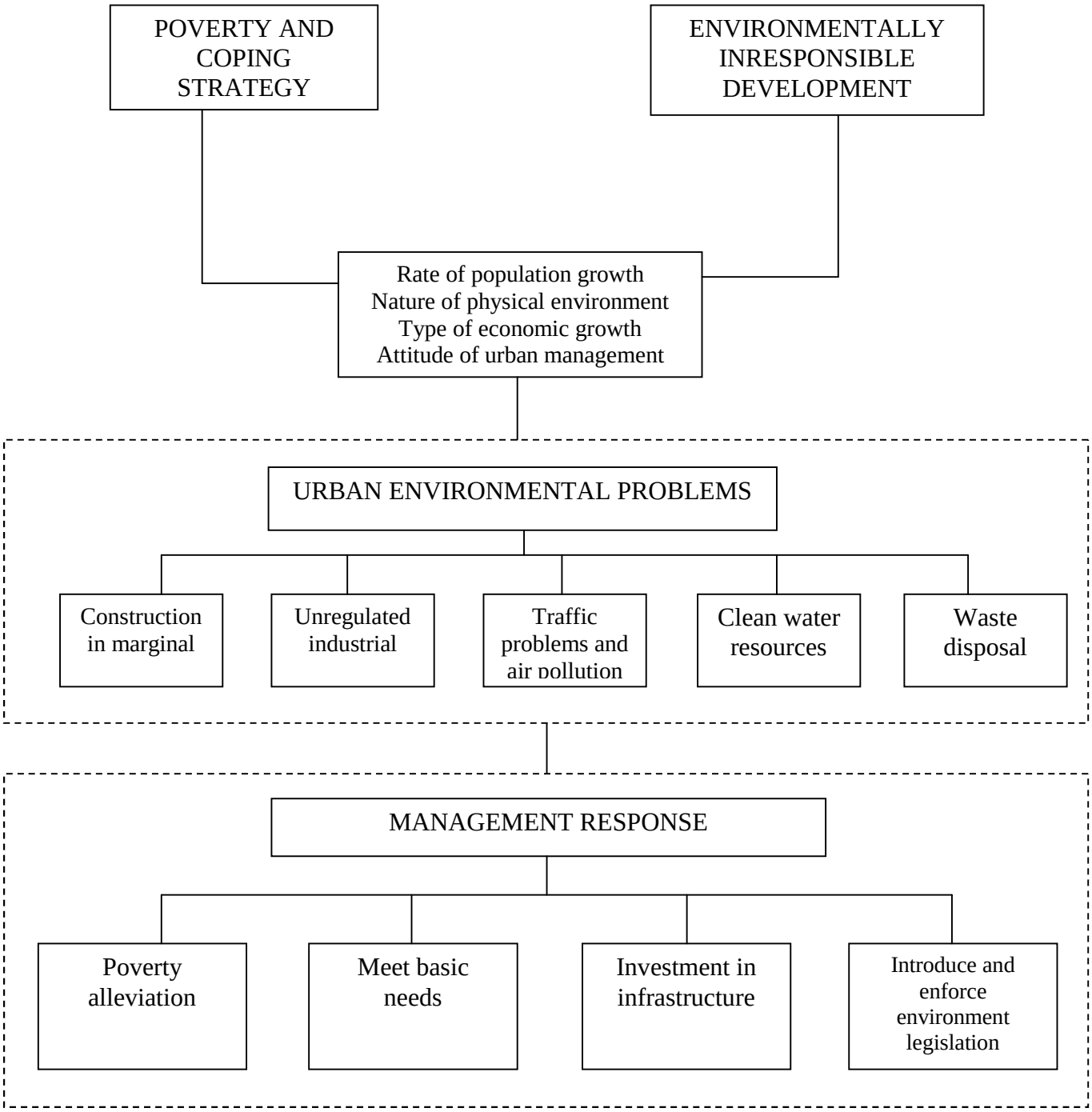

Figure 4-2: Environmental Pressure in Third World Cities

Source: Drakakos-Smith 2000

In line with the urbanization, the population growth is also the main cause of the natural resource overexploitation, environmental pollution… The development of the socio-economic situation is the root of climate change and global warming.

In accordance with the report "*Master plan for water supply and drainage for Ho Chi Minh City to deal with climate change*" (Hai, 2011), Ho Chi Minh City is assessed to be one of the most threatened cities in the world, which is effected by climate change. As reported by Vietnam Climate Adaptation Partnership Consortium (VCAPS, 2013), the impacts of climate change on Ho Chi Minh City are the raising of sea level, the increase of storm surges, the increase of precipitation peaks… These impacts are the main causes of groundwater salinization, river salinization, soil subsidence, sedimentation decrease. The figure 4-3 illustrated the relationship between the impacts of climate change in Ho Chi Minh City… Overall, these impacts have negative effects on water supply resources.

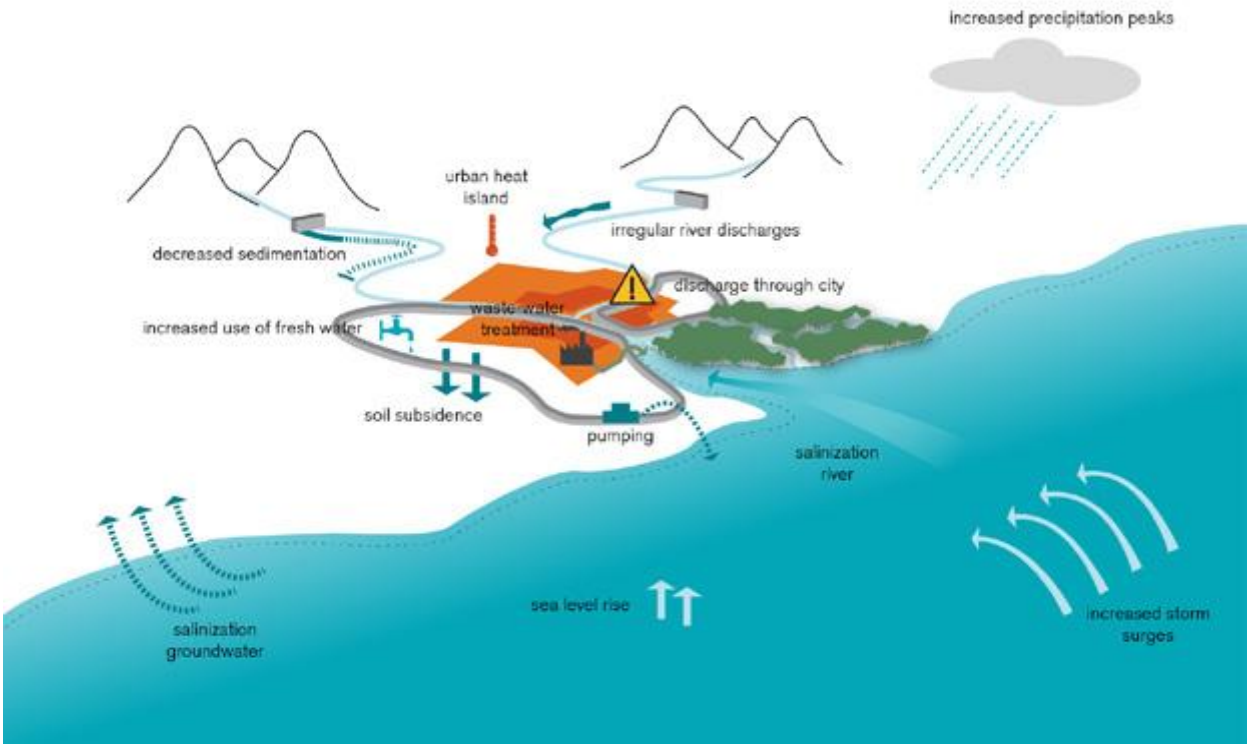

Figure 4-3: Climate change impacts Ho Chi Minh City

Source: (VCAPS, 2013)

These scenarios of climate change for the whole country of Vietnam are numerically predicted as follows: under climate change, global warming will cause the temperature

increased from 1 – 2°C in 2025 and 1.5 – 2.5^{o}C by 2070 (Hai, 2011). The global warming also causes the sea level rise from 30 – 35cm in 2025 and 40-50cm in 2070. Ho Chi Minh City and surrounding provinces will be particularly threatened by the raising of sea level (Hai, 2011). Specifically, Ho Chi Minh City is the largest urban area affected by flooding of 43% of the total area. That means more than 12% of the total population in Ho Chi Minh City would be affected by inundation. Ho Chi Minh City and surrounding areas have almost 65% of the national manufacturing enterprises, and due to the permanent flooding, their manufacturing would be disrupted with socio-economic implications (such as unemployment, productivity losses and reduced revenues…).

From the above evidences, we can conclude that the urban expansion associated with the environment degradation. "*The combination of urbanization and economic growth has resulted in many urban environment challenges, so that provision of water supply, sanitation, drainage and waste management is unable to meet the rapid pace of urbanization. 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 agriculture, industrial and domestic discharges*" (Roberts, B.& Kanaley, T. (eds), 2006).

Consequently, the urban areas have faced water stress. The plagues of this situation include water resource shortages, water pollution, floods and droughts. In this chapter, the author considered the water supply issues, which are caused by urbanization and urban development, as are the increase of water demand, the effects to water quantity and quality, so-called water resource shortage and water pollution.

4.1.1. Increase of water demand

In the case of Ho Chi Minh City, dense population and massive urbanization are the main reasons for growing management problems regarding natural resources (Phu, 2007). As in many cities in developing countries, the urbanization in Ho Chi Minh City occurs in a fuzzy way, without any sustainable plan. Ho Chi Minh City has become the biggest economic centre of southern education and economic zone, hence, the city has an attraction of people, who come not only from surrounding provinces but also from the whole country. Most of them immigrate to the city to find occupation opportunities or study. Due to the high living

standard, Ho Chi Minh City has become a good place for people to live. According to the development history of the city, it is not so difficult to recognize the growth of population in Ho Chi Minh City. Parallel with the increase of population, the area of the city also has been expanded. The table 4-1 illustrates that the growth of population in Ho Chi Minh City. E.g. in the time period from 1979 to 2009, the urban population doubled in 30 years. In the meanwhile, the percentage of the urban area in the whole city rose from 82% in 1979 to 83.2% in 2009.

Year	Total population	Urban population	% urban
1979	3,293,146	2,700,849	82.0
1989	3,294,435	2,899,753	73.9
1999	5,037,151	4,204,662	83.5
2009	7,123,340	5,929,479	83.2

Table 4-1: Urban population in Ho Chi Minh City in 1979 – 2009

Source: (VCAPS, 2013)

The population growth of Ho Chi Minh City and the city expansion are shown in the figure following. At the beginning, the Saigon City (the old name of Ho Chi Minh City) was designed for 500,000 people with an area including the inner city district 1, 3, 5. After that, during the government of the Republic of Vietnam (the government which was set up during Vietnam War), the population of the city increased to over 2 million people. On 30th April 1975, the war ended with a Communist victory. At that time, the city of Saigon, the province of Gia Dinh and two suburban districts of two nearby provinces were combined to create Ho Chi Minh City (Wikipedia, 2014). From 1975, during 40 years of liberty, Ho Chi Minh City has a great development, resulting in a large agglomeration of economy and population. As reported by the census 2014, Ho Chi Minh City has almost 8 million people in legal registration, and over 10 million including the illegal residents.

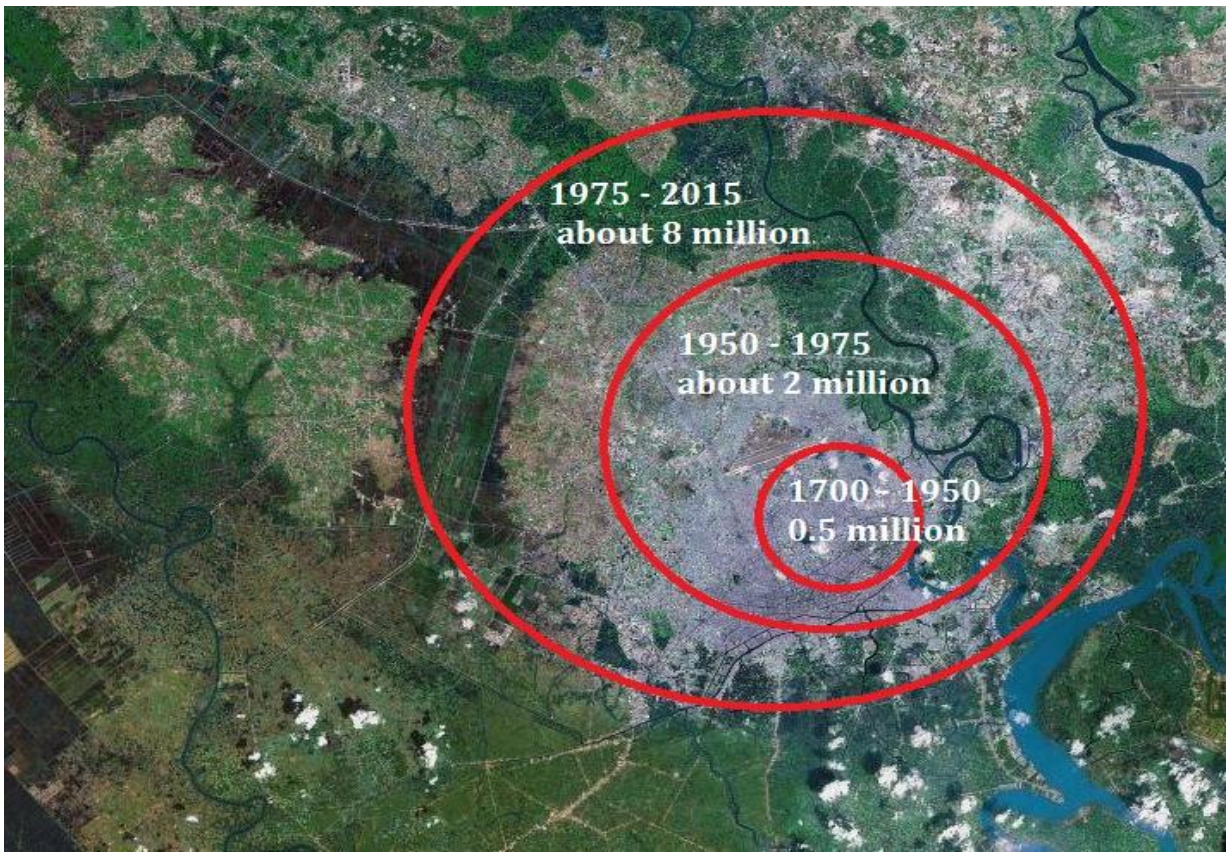

Figure 4-4: Population growth and urban expansion of Ho Chi Minh City

Source: (Storch, 2007) complete by the author

Rapid economic and population growth in Ho Chi Minh City have posed a formidable challenge. This challenge includes the achieving of continued economic development without social and environmental sustainability. With the rapid economic progress and the accelerated urban expansion, the population put more pressure on the use of natural resources. The water supply management will be one such stress (Phu, 2007). Like in other cities in developing countries, the rapid growth of the number of people has created excessive water demands. Due to the economic development, the government concentrates on many and large-scale economic activities, industrial production, hence, water demand for domestic use, industry and energy generation… increase exponentially.

Table 4-2 shows the data for water supply service in Southeast Asia, including Ho Chi Minh City. We can compare the water supply of Ho Chi Minh City in 1997 and 2004. The water coverage increased from 52% to 84% in the meantime, the water availability decreased from 24 hours/day in 1997 to 18 hours in the year 2004.

	Bangkok*	HCMC	Jakarta	Kuala Lumpur	Manila
Production/population (cbm/capita/day)	0.53	0.37	0.27	0.44	0.56
Water coverage (%)	82	84 (52)	51 (27)	100 (100)	58 (67)
Sewerage access (%)	n.a	12	2	89	7
Water availability (hours/day)	24	18 (24)	22 (18)	24 (24)	21 (17)
Consumption/capita (L/capita/day)	265	167 (136)	77 (135)	132 (146)	127 (202)

Table 4-2: Water supply service in selected Southeast Asian Cites

Source: (Andrews, C.T. & Yñiguez. C.E. (eds), 2004) and (*) (McIntosh, A.C. & Yñiguez, C.E. (eds), 1997) - Note: data in brackets () are sourced in 1997, n.a: not available

Beside the water supply service, we can see the growth of water demand during the past time to the future in table 4-3. The total water demand is increasing from time to time and is predicted to reach 4,750,000 cbm/day in year 2025.

Type of use	1995 (VIWASE, 2001)		2005 (DPA, 2007)		2009 (DPA, 2009)		By 2025 (DPA, 2007)	
	cbm/day	%	cbm/day	%	cbm/day	%	cbm/day	%
Household	383,558	85	1,260,000	66	1,600,000	64	3,400,000	72
Industrial zone	50,413	11	64,500	3	145,000	6	476,000	10
SMEs	19,624	04	380,000	20	263,000	10	40,000	1
Service and commerce	n.a	n.a	205,000	11	492,000	20	830,000	17
Total	**453,625**	**100**	**1,910,000**	**100**	**2,500,000**	**100**	**4,750,000**	**100**

Table 4-3: Water demands of Ho Chi Minh City in the past and in the future

Source : (N.P.Dan et al, 2011)

Note: SMEs – Small and medium scale enterprises/industries; n.a – not available

Beside the increase of water demand, there are two main aspects of water, which are affected by the urbanization, quantity and quality. The urbanization has produced the physical impacts, changes and modification to these aspects. These two issues are now investigated in detail, headlined by water resource shortage and water resource pollution.

4.1.2. Water resource shortage

Ho Chi Minh City is considered to "*stand with its feet in the water*" (Bolay, J-C, Cartoux, S. Cunha, A., Thai, T.N.D & Bassand, M, 1997). That is paradoxically when arguing that Ho Chi Minh City is facing water resources shortage. Despite of situating in a well-water region with abundant swaps and marshes and receiving high annual rainfall, this city is experiencing important issues regarding water supply, water quantity.

Climate in Ho Chi Minh City has two seasons, rainy season and dry season. In rain season, the city receives a high amount of rainfall, and in the dry season, the temperature is too high (over $30^{o}C$). Hence, the city is flooded in the rainy season and scared during the dry season. However, the water shortage in Ho Chi Minh City is not only caused by climate conditions but also by other reasons.

At first, the main causes are rapid urbanization and population growth. As be told in chapter 4.1.1, urban and population growth increase the water demand. This puts pressure on the water supply system. The city is suffering from water shortage due to insufficient water resources and inadequate supply networks.

As mentioned in chapter 3, in some areas people are poor or do not have enough money for piped water. They drilled or drugged well to take water from underground. Meanwhile, the government still does not have a good controlling system for groundwater exploitation. Uncontrolled groundwater exploitation results in an excessive extraction rate of all groundwater resources. As a result, water table is drawdown, constituting a threat of water shortage.

The degradation of water quality in Dong Nai River and Saigon River affects the handling of water supply companies. E.g. water must be treated because of high iron and manages content… In addition, the saline intrusion in water due to a rising sea level and overexploitation of groundwater affects to the operation of the water supply companies. Freshwater shortage is severe.

Furthermore, the water shortage in Ho Chi Minh City is also caused by the aging water supply distribution network. The soil in Ho Chi Minh City is weak and has a variable

geotechnical conditions. In some areas, the pipe life is affected by the pH of the soil (pH < 5), by the alum and saline intrusions. The pipeline system is located along the main road. The construction and maintenance have to be conducted at night to avoid the traffic obstruction. Therefore, the supervision is difficult. The degradation of pipelines affects the water quality and causes the loss of water. At this moment, the leakage rate of water distribution network is 33%, that means there is a leakage of about 561,000 cbm everyday by a total capacity of 1,650,000 cbm/day (VND 3 billion corresponding).

4.1.3. Water resource pollution

The urbanization puts a high pressure on water quality. The modification and utilization of water resources are increased as a result of population growth. The water quality bears on the availability of water for use. The water demand outstrips the existing infrastructure. Therefore, the water quality also has already been aggravated by the urban infrastructure's degradation. Water shortage is also a question of water quality. There is a limitation in capacity of water bodies to process the pollutant charges of effluents from industrial activities and agricultural uses. Some argued that water quality degradation is a significant cause of water shortage. It can be seen from the figure 4-5 that the index of pollution in Ho Chi Minh City was assessed with a high rate for drinking water pollution and inaccessibility (67.31%) and water pollution (75.96%).

Figure 4-5: Pollution index in Ho Chi Minh City

Source: (Numbeo, 2015)

Also according to the statistic about the pollution index in Ho Chi Minh City (Numbeo, 2015), the purity and cleanliness in Ho Chi Minh City were assessed low. The number

concretes that the index for drinking water quality and accessibility is 32.69% and that for the water quality is 24.04%. These numbers are figured out in figure 4-6 below.

Figure 4-6: Purity and Cleanliness in Ho Chi Minh City

Source: (Numbeo, 2015)

The consequences of the lack of sewerage, the absence of sewage treatment and uncontrolled storm water drainage are the primary causes for polluting water bodies, including surface water and groundwater aquifers (Xuyen.H.Ho, 2006). The indiscriminate exploitation of groundwater also affects groundwater quality. It increases the salt water intrusion and charging phenomena like alum in the water.

As a result of urban development, Ho Chi Minh City is a location of so many industrial parks and economic activities. These were constructed and established to produce goods for domestic and foreign markets. They help the city to create job opportunities to the citizen and attract the investment from local and foreign investors. However, these industrial zones are the main cause of the water pollution, due to the elimination of uncontrolled solid waste and wastewater into the rivers, especially, some industrial zones, which are located in the upstream provinces of Saigon – Dong Nai River system. Surface water resources like rivers, canals are also the shed of waste from domestic activities and high usage of fertilizers and pesticides of agriculture.

4.2. Water stress impacts

Due to the rapid increase of population, which is the result of fast urbanization and industrialization, Ho Chi Minh City and neighboring provinces in downstream of Dong Nai

River basin are facing water stress. The water stress situation is evaluated by Water Stress Index (WSI), which based on water demands and the exploitation rate of total safe fresh water of Dong Nai River system (including Dong Nai River and Saigon River). Table 4-4 shows Water Stress Index of Ho Chi Minh City and provinces in Dong Nai River basin. In 2010, this index was 10% and projected to be 23% in the year 2025.

Items	**Unit**	**1995**	**2000**	**2010**	**2025**
Population	Million people	7.8	8.8	13.4	22
Renewable freshwater availability per capita	Lit/cap/day	5058	4483	2944	1715
Total water demand	Million cbm/year	0.99	1.80	1.88	3.31
Total water demand per capita	Lit/cap/day	347	360	384	394
Water Stress Index (WSI)	**%**	**6.9**	**8.0**	**13.0**	**23.0**

Table 4-4: Water Stress Index of Ho Chi Minh City and neighboring provinces in Dong Nai River basin

Source: (N.P.Dan et al, 2011)

According to part 4.1., in the urbanization context, there are several water related issues such as the illegal groundwater extraction, the limited water network coverage, the degraded infrastructure for water and sanitation, the deficiency of investment and incomplete water pricing, the high rate of water loss and the disruption to water supply. Therefore, the truth be told, the water stress situation has serious negative impacts on urban areas and is a multi-dimensional question. These raise further questions: what are the main impacts that water stress causes with regard to sustainable aspects? How these impacts work on urban areas? The following parts content the answers.

4.2.1. Economic aspects

Water has become a scare commodity between competing users, including households, industry, agriculture and hydropower (Phu, 2007). Water is one of the key inputs to energy and industrial production. Lack of water implies that all economic activities like service, tourism, energy generation, industrial production will be restricted.

Water pollution caused economic losses in the agricultural production, mining and aquaculture. Dong Nai river stream is contaminated by substances discharged from seafood processing plants, industrial parks have caused damage to the economy of the private agriculture and aquaculture. Surface water (rivers, lakes, canals ...) is the main source of irrigation in agriculture. Contamination of this water system leads to significant damages to agricultural and aquaculture activities. In Binh Thanh District a part of the population is working in agricultural areas. Especially, in Ward 27 and 28, the main economic activities are planting rice, raising fishes and tourism. Under impacts of climate change, water stress will increase the frequency of floods and droughts. These also cause the collapse of fisheries and loss of biodiversity. In other words, water stress can be the reason of reducing incomes of people in particular and the annual revenue of the district in general.

There is no doubt that the scarcity of water resources causes the illegal groundwater extraction. This action affects an inefficient use of resources and a high marginal cost for end users. Moreover, water pollution increases the cost for water supply in collecting, treating, distributing and maintaining the system. Consumers must buy water at high marginal rates. Further, it causes the intergeneration payment issues. The responses of residents when asked about water and their finance: *"My household has lived here in 10 years. At the moment, we are still illegal residents. It is really difficult for us to have a private water-meter, because we are not registered for our residency. Additionally, my family does not have enough money for contracting". "I rent a room in a small house. My landlord is selling water for us with a high price. We know, but, we have no option". "I and my family live in the city. But, it looks like we were in the mountain. Every day, we have to go for carrying water from the truck. It cost us a lot time, money and effort".*

The water stress impacts on economic aspects are also assessed by the loss of money due to inadequate water supply. Water stress issues raise the costs of repairing or upgrading the water supply system. On the other hand, private citizens need to spend a huge amount of money to buy clean water from trucks or other areas. For example, a household with five members uses 60-80 liter water per day that means 2000 – 2500 liters per month. This water is used for domestic purpose (i.e. drinking, cooking, bathing…). The water is supplied by truck. The price of this water is VND 25.000 (almost USD 1.5) for 20 liters. We can calculate that they have to pay from VND 2.000.000 – 3.000.000 per month for the water. At this

moment, the current average capacity per person in Ho Chi Minh City is 120-150 liters/capita/day. The piped water tariff, which was adjusted in 2013, is VND 5.300/cbm. We can calculate for this household that they use 600-750 liters/day and about 20 cbm/month. From that, the total amount they must pay is about VND 150.000. This simple comparison reveals the situation of poor people. They have to pay 20 times more for a quantity that is 10 times less. The surface water (spring, canal, lake) and wells make up for lack of water supply.

Furthermore, the cost for social health care and the pressure on social welfare would be increased due to water resource shortage and pollution. This factor related to the impacts on social aspects, which is discussed in part 4.2.3.

4.2.2. Environment aspects

The high rate of urbanization includes the rapid growth of population and economic benefits to city and citizens. However, it causes significant damage on environment. These impacts include the changing of land use, depletion of nature resources, and the degradation of air, water and soil in general. As a result of the change of environment conditions, Ho Chi Minh City is facing some serious degradation of surface water and depletion of groundwater resources.

Undoubtedly, the increase of water demand leads to the water shortage and encourages the illegal groundwater exploitation. Uncontrolled extraction causes the potential disruption of groundwater flows. Groundwater is under the threat due to salt intrusion, water table descent and contamination by corrosion, leakages and spills. It is also the cause for subsidence risks. In a few areas, which have a large exploitation capacity by wells, there is the occurring of land subsidence. In Binh Thanh District, Thanh Da Island is such an area, which needs to be taken into consideration, due to the land slice and depression. For instance, the building VIII and IX of Thanh Da condominium group were seriously inclined.

Moreover, water stress, particularly water shortage and pollution, affects not only human life but also aquatic animals and plants. Considering to the activities of agriculture and aquaculture, besides reducing the productivity, water pollution also affects to the ecosystem and natural food chain. It could be a threat for biodiversities. Binh Thanh District, generally, Ho Chi Minh City has an abundant wetland and mangrove land. The water stress will damage

these areas, may shrink them or even make them disappear. We take into account some examples: Thanh Da Island of Binh Thanh District, Can Gio mangrove forest of Can Gio District, and Diamond Island of District 2. Furthermore, water stress also affects hydrogeological factors like water cycle, water vapour, cloud cover, rain, humidity or air atmosphere.

4.2.3. Social aspects

Following Maslow's hierarchy, people's needs are divided into 5 main groups: physiological needs, safety, belonging, esteem, and self-actualization. Water is one of physiological needs besides breathing, foods.... Physiological needs concern the human survival. Humans depend on water, but water is also a scarce resource and has become a limiting factor in economic and social development (Falkenmark,M & Lindh,G, 1993)

It is not so hard to find a link between water stress issues and social aspects. However, we can imagine that water is a fundamental factor for socio-economic development. In some developing countries, due to the scarcity of water, not only in countryside but also in big cities, people are forced to use low quality water from surface water like spring, lake, stream, etc. or untreated groundwater such as drugged well, drilled well. Either people face difficulties in piped water connection or they use with high tariffs.

There is a link between water and human health. Water is an important amenity to maintain human health and ensuring the provision of sanitation facilities. Moreover, the access to safe water has a profound impact on people's live (Phu, 2007). There are health risks for households and industrial installations using water in an unregulated manner (Xuyen.H.Ho, 2006). These risks occur in households using non reliable water sources. Lack of water creates psychological stress and uncertainty for the people. The health of people is threatened due to water resource problems. Diseases related to water pollution have long been seen as a major threat to public health, particularly for diseases like cancer, cholera, gastrointestinal diseases and skin diseases.

Currently, in Binh Thanh District, particularly and generally in Ho Chi Minh City, there are many households, who still use water from rivers, lakes, and canals for daily activities. When asked in the in-depth interview, people reply: *"We have been here for a long time. We drill a*

well and use water which is exploited by the well. I know this area used to be a cemetery, but for a long time, nothing happened to our health. So, it is okay, because it costs nothing". Therefore, affecting the health, the risk of gastrointestinal diseases is very large. People, taking a bath in a river or in a lake risk pathogen infections of eyes, ears and skin (e.g. scabies, tinea...).

The cost of medical treatment for these diseases is quite high. The diseases related to water pollution also affect the body, creating indirect costs due to off work or absence from school. Moreover, water pollution can cause a permanent uneasiness that makes it difficult for people to concentrate on work, in school as in business. Even these costs form part of economic aspects.

An increase of water shortage in agriculture, which goes along with lack of food nutrition, food restrictions and high production costs, leads to expensive food prices. For example, in Ward 27 and Ward 28 of Binh Thanh District, people need water for planting rice and fishing in ponds. Growing food and caring for animals need a lot of water. Lack of water means farming has lower yield. Lack of water results hunger and thirst. These impacts lead to a low quality of life.

The scarcity and water pollution not only cause serious consequences to the environment ecosystem but also give rise to social problems, the potential risk of social conflicts. These conflicts may occur in a transnational as well as in a national scope.

The formation of the production base is located in the residential area. The waste arising directly affects households around, causing conflicts, grievances. The problem of water stress also leads to political conflicts, due to the inconsistency of responses, which are less efficient in managing and processing information. Conflicts and social differences appear between users of water, with different goals and needs of water supply. These conflicts occur between people living near the water and people living far from water sources, between rich and poor, between urban and suburban and rural areas.

Some argued that water is recognized as a limiting factor in humanity and social welfare (Xuyen.H.Ho, 2006). The problems related to water stress lead to a change of the quality of life and changes in lifestyle. As poverty increases, the increased social conflict, the increase

of inequities in water access will lead to mass migration from areas with insufficient water supply to better situated areas. This migration and the increase of the population put the pressure on the social infrastructure like health care, welfare, insurance and the technical infrastructure like water supply, sewage system or drainage. These pressures affect the governance of city authorities, policy makers, urban planners or social workers.

5. Future potentials

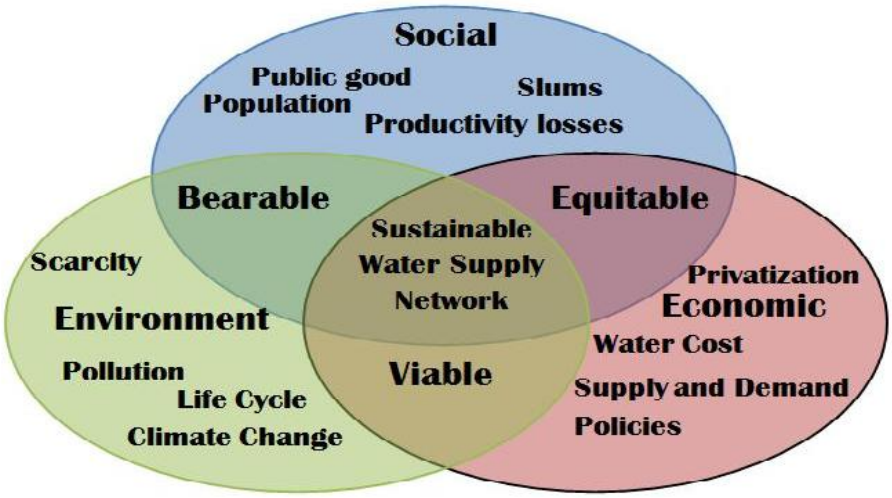

Figure 4-1: Sustainable development in an urban water network

Source: (Wikipedia, 2014)

Agenda 21, The United Nations Program Action from Rio claimed that *"Water is needed in all aspects of life"* (UN, 1992). This agenda outlined the general objectives of water for sustainability as: (1) ensure that adequate supplies of clean, safe water are maintained for the world's entire population, (2) preserve the hydrological, biological and chemical functions of ecosystems, (3) adapt human activities within the capacity limits of nature, (4) to combat vectors of water-related diseases (UN, 1992).

According to the United Nations World Water Development Report 2003 (UN, 2003), the water demand management approach influences water demand in several ways:

- Reducing and controlling leakage from the utility's mains network

- Increasing the level of recycling and implementing waste minimization strategies to encourage industrial and commercial users reduce their dependency on potable water supplies.
- 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

According to the report "Sustainable groundwater management in Asian Cities" (IGES, 2007), the selection of alternative water resources is based on the following criteria.

1) Water quantity, such as reserve capacity, exploitation rate, ability of water intake and stability of quantity.
2) Water quality, i.e. stability of raw water quality and principle key parameters of water quality
3) Water engineering, including water treatment technologies and clean water distribution engineering
4) Water economics, i.e. water exploitation charge, treatment/distribution costs, operation and management costs, and water tariffs.
5) Water management, compliance with master plans of water uses, management institution available water sources laws/ regulation, communities acceptance, water intake ability
6) Risks, subjective and objective risks of projects relating to water sources, exploitation and water use.

Box 5-1: The selection of alternative water sources is based on the following criteria

Source: (IGES, 2007)

Facing water stress means making efforts to find alternative strategies of the city water supply. As a result of this research, the author does not consider surface water and groundwater as alternative concepts, because they are currently used in Ho Chi Minh City. By the content of part 5.1 we can point out the alternative water sources, based on the nature

and development conditions of the city, the author mentions here two options for the future, water reuse and harvesting rainwater.

5.1. Water reuse

Water reuse is the reuse of treated wastewater. The most popular it is still used for purposes of non-drinking water, e.g. the irrigation of trees and crops, in industrial production, for flushing toilets. Furthermore, it is also used in parts of the cooling power plants, refineries, in the sanitation and construction (such as concretes mixing). However recycled water can be used indirectly for drinking purpose by returning it back to the natural water recycle.

Reusing water can reduce the diversity of an aquatic an ecosystem which is very vulnerable, and creates additional water. Additionally, it also reduces the wastewater discharge status of the environment and prevents the environmental pollution. The water, treated for reuse can fully satisfy the needs of most countries. Once treated, the water can ensure quality meets for different purposes. However, systems for wastewater treatment and reuse are more expensive than the water supply by natural resources.

First, this part mentions Singapore as a case study for water reuse. After that, from the experiences of water reuse in Singapore, the potential of reusing water can be assessed and applied.

The model city of the future opens up a more comprehensive view of the rapid development of technology. The concepts of the model city are widely applied in many aspects of the cities. Especially in the fields of architecture and construction, creative ideas, new technologies and new architectural concepts are applied to give municipalities a completely different sight. One of the significant achievements and contributions to the development of technologies is urban wastewater treatment. This is a big step forward for a country that has depleted almost all water resources, which is typical in Singapore.

Singapore is a small island country, which locates in Southeast Asia. This country has a population of approximately 5 million people and a total area of 750km^2. Singapore has a high economic growth rate in the ASEAN region, however, scarce water resources in the country. Singapore cannot provide sufficient water for its citizens. Almost a half of the water

in this country is imported from Malaysia. However, under the agreement, signed between Malaysia and Singapore, which will be invalid till the end of 2061, Singapore has enough time to prepare for the autonomy of water.

The Singapore government plans to provide 4 times more water than at the present. This process consists of several stages: construction of desalination plants, development of standards for rainwater harvesting systems and wastewater recycling systems.

Rainwater is salvaged and collected through the network of sewers, canals, lakes, rivers and reservoirs in the city. This system is used for the purpose of retaining at least 2/3 of the whole rainfall. However, the wastewater treatment technology is important. Wastewater can be treated and turned back from a useless by-product to a precious water resource.

Public Utilities Boards of Singapore is the agency, which has assumed the responsibility to recycle waste water. Through a 4-step filtration process, the solid waste, microorganisms and contaminants will be removed from wastewater. The result is clean water that can be used in daily life as well as in industrial production.

After decades, this technology has met 30% of the domestic demand for Singaporeans. With the year 2061 in view, the objective is to create 3 times of the current water capacity by this technology in order to meet the water quality of daily life for the whole national population. This source of water supply also ensures the needs of the industrial manufacturing. Water production is water reuse. The water quality depends on the requirements that have to be assured. Besides, wastewater from industrial production is collected every day and transported to the water treatment plants to reclaim.

In addition of water treatment technology, the Singapore government is encouraging people to participate in the 3P (People - Public - Private). The 3P approach is embodied in the slogan of Public Utilities Boards: "Water for all: Conserve, Value, Enjoy”. The focus of this new approach is the program Water ABC (Active, Beautiful, Clean water). The government also tried to make lakes and rivers cleaner and more beautiful. The purpose of this action is to convert the country into a country of gardens and water. Along with this action, the new public spaces will bring people closer to water, so people will appreciate this precious

resource more. More than 20 projects were completed on the island and many more projects will be implemented between now and 2017.

Vietnam is also a country in Southeast Asia, especially Ho Chi Minh City, with nature and climate conditions similar to Singapore. Accordingly, Vietnam may apply wastewater treatment models and the current standards in the approval process of wastewater. Reusing water can help to access the advantages of valuable water resources. However, there are two major challenges for planner and policy makers when deciding on the renewable water from wastewater. First is how to reduce the energy in the water treatment process. Second is how to improve the acceptance of this water resource by the people. Currently, water reuse is not widely accepted in the communities.

According to Institute for Global Environmental Strategy (IGES, 2007), in the present time, Ho Chi Minh City has a notable capacity of wastewater. Domestic wastewater is about 1,100,000 cbm/day (of which 30,000 cbm/day is treated). Meanwhile, industrial wastewater is only 32,600 cbm/day (of which 15,100 cbm/day is treated). The maximum exploitation capacity is projected to be more than 2 million cbm/day in the year 2020.

No.	Purposes	2025 (cbm/day)
Urban		**1,636,000**
1	Road washing and fire extinguishing	340,000
2	Garden and park watering	199,000
3	Toilet flushing and cloth washing	1,020,000
4	Watering golf courses and sport facilities	19,000
5	Greening belts	58,000
Industry		**1,032,000**
6	Industrial use	623,000
7	Cooling water	160,000
8	Others	249,000
Agriculture		**1,391,000**
9	Irrigation and aquaculture	1,391,000
Landscape creation		**46,000**
10	Ponds, water parks	46,000

11	Fishing ponds, boating and other entertainment activities	
Total		**4,105,000**

Table 5-1: The prediction of potential for reusing water in Ho Chi Minh City in 2025

Source: (DONRE, 2014)

The table 5-1 illustrates the statistic for prediction of potential for reusing water in Ho Chi Minh City. The total capacity of water, which will be produced in 2025, is 4,105,000 cbm/day. The reuse water is forecasted to be used by 4 main consumers: the urban area, industry, agriculture and landscape creation. Each area has its own purposes for using water. Urban areas (1,636,000 cbm/day) use water reuse for road washing or fire extinguishing, watering garden and park, flushing toilets and washing clothes, watering golf courses and sport facilities or greening belts. Industrial parks (1,032,000 cbm/day) need water for industrial use, cooling machines or other purposes related to production. Meanwhile, agriculture (1,391,000 cbm/day) needs water for irrigation and aquaculture. Finally, people also can use water reuse for creating landscape such as ponds, water parks or fishing ponds, boating and hospitality activities (46,000 cbm/day). Overall, the total amount of reusable water from the urban and the agricultural sector occurs as a large proportion (1,636,000 cbm/day and 1,391,000 cbm/day respectively). Hence, it can help to ameliorate the water stress situation in Ho Chi Minh City. However, reusing wastewater is not simple. The city has faced some major related issues.

First, currently, the reuse of water is not in compliance with the water master plant. The city has not yet considered water reuse in its water master plan 2020 for Ho Chi Minh City. The national standards and laws are unavailable for concerning the use of rainwater for water supply. In other words, waster water reuse is not available in suitability with the current management. The most important resistance against the reuse of water is that people still think that water treatment is not sufficient for a safe quality. Hence, reusing wastewater is difficult to be accepted due to lifestyle and awareness.

Based on some researches, wastewater in Ho Chi Minh City is still contaminated by non-biodegradable components, COD, trace, organics, heavy metals, pathogens, and color. The engineering of water treatment needs to have the ability for nutrient removal, SS removal, COD removal, adsorption, advanced oxidation… Moreover, the current quality of water after

treating was assessed as weak to medium. Water reusing in Ho Chi Minh City can face some risks due to failures of operation and maintenance. Hence, the city needs skilled staffs and high technology in operation and maintenance of the wastewater treatment, to ensure the safety for water quality.

There are variations of raw wastewater. Decentralization can help to collect the effluent of wastewater, to operate and manage the treatment more simple. However, the city has to separate sewage pipes for blackwater (wastewater from a toilet or urinal) and greywater (wastewater from sinks, showers, washing machines, dish washers and so on) and construct a distribution network for wastewater reuse. Therefore, water reuse needs high investment and maintenance cost.

In summary, it is not easy for city authority to reuse wastewater. Moreover, this kind of water resources is a suitable alternative source, which can help to reduce the pressure on the water supply system. For further development, Ho Chi Minh City needs to have a stable strategy for wastewater reusing. At first, the city needs to prepare laws, policies, standards and human resources in governance and management of water reclamation. Secondly, reusing water can only be carried out step by step, stage by stage: reuse for purposes not to drink, reuse for indirectly drinking purposes and reuse for directly drinking. Besides that, there will be some activities and policies to encourage industrial companies, communities to reuse their wastewater. Finally, the city authority needs to improve the awareness of households and individuals by publishing booklets, guidelines or education programs.

5.2. Rainwater

Some argued that rainwater is environmentally friendly and easy to approach for water requirements. There is no doubt that using rainwater can help to increase the level and improve the quality of groundwater. Under effects of climate change, rainwater using mitigates the effects of drought. Rainwater using also has notable benefits for communities, particular in urban areas, where most of surface are sealed. A part of the collected rainwater can help to reduce the water runoff, and reduces the flooding of roads and low-lying areas. Using the most of water from storm and rain, soil erosion will be reduced. When people can use rainwater, they will pay less for water and electricity bills. Therefore, rainwater is an ideal solution for water in areas having inadequate resources, especially in the context of

groundwater depletion and surface water pollution. Assessing the engineering for harvesting rainwater, its cost is effective and it is easy to maintain the system.

Rainwater using is not strange to people in over the world. In some countries, rainwater harvesting becomes a trend and more popular because of its ecological and financial importance. In this thesis, the author mentions the rainwater harvesting system in Bangalore, India like case study for illustrating the point that rainwater can be considered as an alternative source. Tensuison tank and Eco-roji in Japan are mentioned as experiences for rainwater catchment in Ho Chi Minh City in the next future.

The rainwater harvesting system in Bangalore, India was founded by S.Vishwanat, who is a Bangalore-based under planner. Bangalore's Rainwater Club is a group of architects and engineers, who interested in the incorporation of rainwater harvesting techniques into buildings. This club started in 1995, in the concept of making rainwater harvesting to become more popular and improve the awareness about rainwater of policy-makers, architects, engineers and general public.

In Bangalore case, they did not use the one-size-fits-all approach. In other words, they have various methods and applications for the system. At first, the Rainwater Club considered the rainwater harvesting system in some related issues like soil profile, hydrogeology of areas. After assessing, the specific methods were developed for specific sites. The harvesting systems in Bangalore are determined with 4 sections: a rooftop storage tank, a ground-level drum or masonry tank, an underground sump and a partially underground tank (Vishwanath, 2002). Finally, Bangalore authority published a booklet and launched a website as outcomes of rainwater harvesting project. The main content of the booklet is about basis rooftop rainwater harvesting. This booklet also provides the rainfall data on each district, so that the citizens are enable to design the specific harvest system for their specific locations.

Back to Ho Chi Minh City case, this city has abundant rainwater, which is about 4.7 million cbm. Rainfall ranges from 1,800 to 2,000 mm/ year, 80 – 85% from June to August. Figure 5-2 figures out the daily mean temperature and the annual rainfall in Ho Chi Minh City during a year, with the total annual rainfall is 1,931 mm/year.

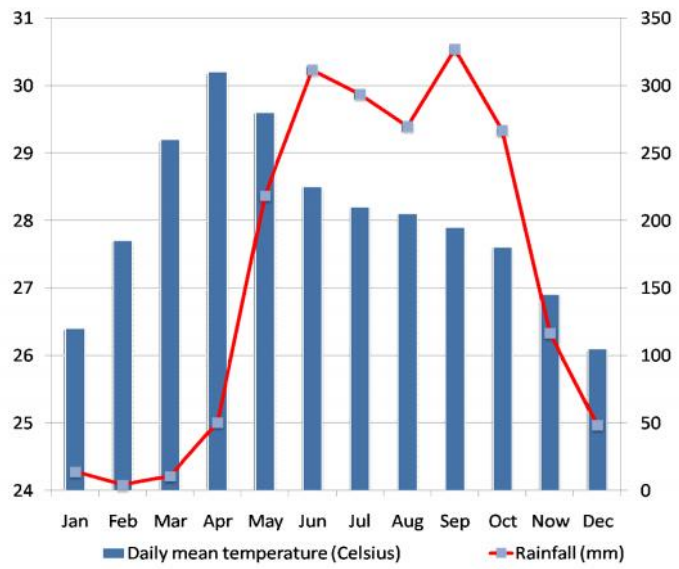

Figure 5-2: Daily mean temperature and rainfall in Ho Chi Minh City

Source: (Wikipedia, 2014) complete by author

Undoubtedly that high rainfall in Ho Chi Minh City is a good option for alternative freshwater source. However, it is not easy to harvest and store rainwater in the context of Ho Chi Minh City. Currently, rainwater is used in some coastal districts, where people have lack of piped water. This has some drawbacks as: High investment costs because large areas for rainwater harvesting and storages are required. The efficiency of rainwater use depends significantly on rainfall resulting in a low reliability in terms of sufficient water supply (N.P.Dan et al, 2011). Rainwater is easy to exploit, however, it just can be taken up only in the 6 months of rainy season, and people have a lack of water quantity in the dry season. Besides that, the harvesting is not really stable, depending on the rainfall, especially under the climate change effects.

As reported by some previous researches, rainwater is contaminated by some parameters, which need to be treated (i.e. pH, suspended solid and pathogens). The quality is good enough for conventional treatment technology**.** Conventional treatment includes coagulation, flocculation, filtration and disinfection. However, the assessment of rainwater quality needs to be executed regularly to guarantee clean water. Furthermore, in future, when the pollutants in air and surface water will increase, the rainwater will be affected by acids or the excreta of birds and other animals on the roofs.

At the present time, there is no master plan for rainwater available yet. Laws and Vietnamese standards concerning water resources are not suitable for the use of rain water for water supply. However, the community is willing and manifests a high acceptance for rainwater using.

The rainwater harvesting and treatment are simple. Therefore, the operation and maintenance costs are low. Additionally, rainwater after being treated in centralized or decentralized water treatment plants can be distributed by the available water distribution network. This will help to reduce the distribution costs.

On the other hand, rainwater can be harvested in the small scale. It means the government and city authority can support people to carry out the rainwater harvesting in individual or household or community scale. Rainwater will be collected in the rainy season and stored for personal use during the dry season. Rain water storages can be used for many different purposes such as for drinking, washing clothes, watering the garden. Rainwater harvesting technique depends on the characteristics of geography and meteorology of each particular region. The rainwater can be stored by the individual/household (using containers), the village or the community (construction of underground tanks or pond water filters). It is also possible to use traditional and modern methods to collect water.

After assessing the ability of Ho Chi Minh City for harvesting rainwater, the study case of Tokyo city is considered as a recommendation for using rainwater in Ho Chi Minh City in small scale.

Tokyo city is endowed with far more rainfall than the total water demand. Most of the surface of Tokyo is fully covered by asphalt and concrete. Therefore, this city has some problems with rainwater drainage, facing urban floods. The city authority had proposed to install tens of thousands of “mini dams” (rainwater tanks) for the whole city. In purpose to control urban flood and inundation, rainwater tanks store water from roofs and ground surface. This water can be used for non-drinking purpose or securing of water supply. There are so many ways to harvest rainwater which are proposed in Tokyo case, however, this research points out only examples, which can be applied in Ho Chi Minh City.

In consonance with GroupRaindrops (GroupRaindrops, 1995), in Japan, particularly in Tokyo, rainwater could be caught and stored in the tank, which is installed on the ground. Each rainwater tank has a hand pump and faucet. Similar in Vietnam, in Japan water is also thought as a free gift of God. The water tank in this case is called Tensuison, in Japanese means “respect the blessed rainwater” or “patron saint of water tank”. Along some streets in Tokyo, people can see the street furniture called Rojison. In Japanese, Rojison means “to respect alleys”. This system has an underground tank with hand pump and infiltration into the ground. This tank can store up to 10 cbm of rainwater. Storage water in these systems is available for all citizens, and used for various purposes. It could be used for irrigating plants or greening belts or in some emergency case like fire fighting. More advanced, it could be treated to be an alternative resource for drinking water.

Figure 5-3 and 5-4 show the illustration for Eco-Roji system and the way how to catch rainwater by walls and building window glass.

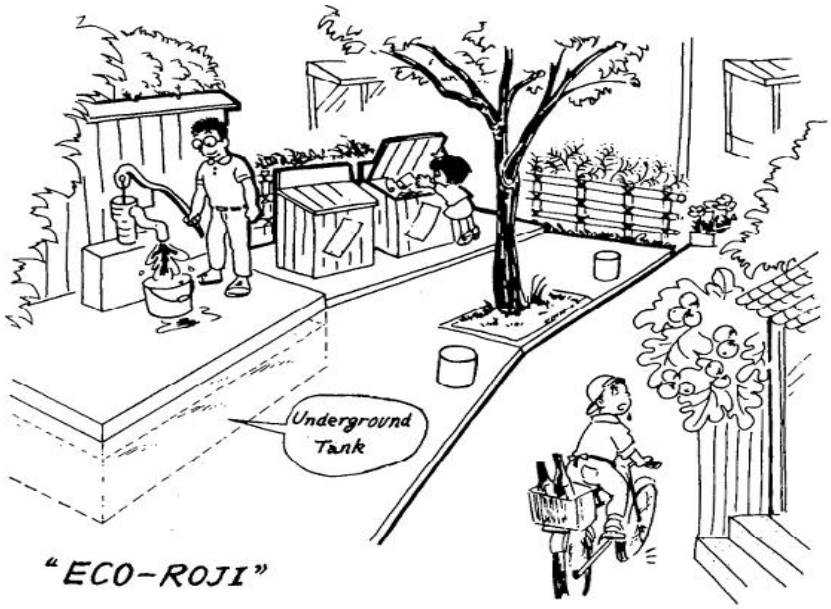

Figure 5-3: The Eco-Roji system

Source: GroupRaindrops 1995

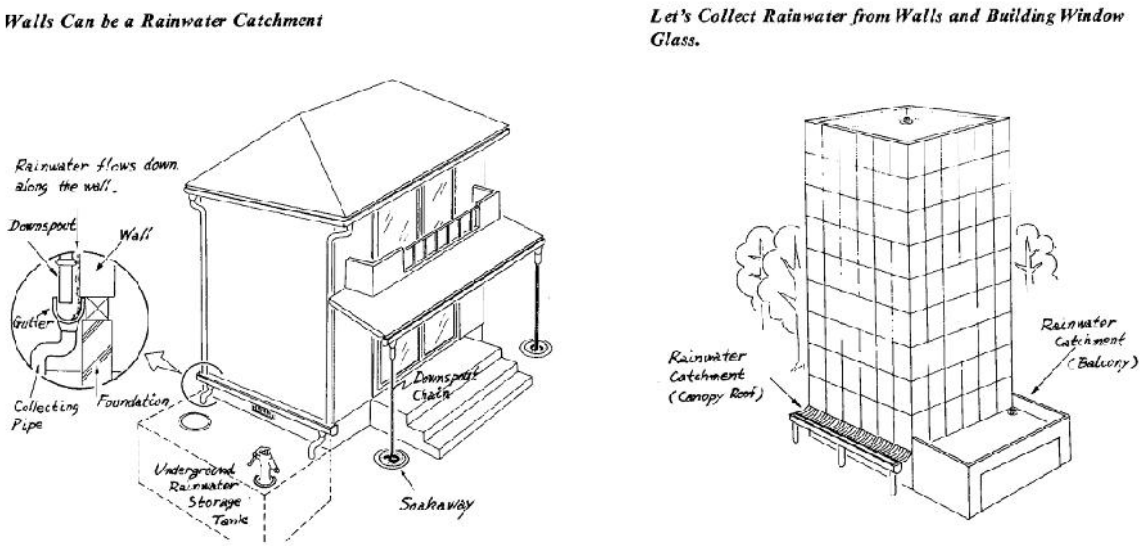

Figure 5-4: Rain water catchment by walls and building window glass

Source: GroupRaindrops 1995

6. Conclusions and recommendations

6.1. Conclusions

In recent years, the urban development in Ho Chi Minh City is characterized by the increases of some factors like investment, production, occupation, migration and annual revenue. Growth of population and economic has increased the demand for water, hence, they had given rise to major problems, which related to water stress issue.

Currently, water supply in Ho Chi Minh City is managed by Saigon Water Supply Corporation – SAWACO. This company has the total capacity of about 1.7 million cbm/day (in which 95% is exploited from surface water, 5% from groundwater) and is managing the distribution network of 5,460km length. The current leakage rate is 33%. The city's piped water reaches only a part of the population. A significant number of people in the city are unconnected to the clean water, which is provided by pipeline network. They have to exploit water from underground by wells or surface water like rivers, lakes, streams or buy water from the truck vendor with a high price…

Additionally, the surface water and groundwater resources are highly degraded for the reason of pollution. As a result of economic agglomeration, the surface water quality has been deteriorated by waste disposal from many sources (i.e. urban runoff, industrial, commercial wastewater and household waste water streams…). Besides that, the groundwater is depleted with saline intrusion and water table falling due to an uncontrolled overexploitation.

These major issues have impacts on the 3 factors of sustainable development namely economy, environment and social aspects. There is no doubt that economic activities are restricted by water shortage. The productivities of agriculture and aquaculture are reduced. Water stress also causes a decrease of income and an increase of poverty. Due to the increase of water demand, the groundwater overexploitation has occurred and leads to the depletion of groundwater (saline intrusion, fall of water table, land subsidence). The major impact of water stress on environment is pollution. Lacking of water, waste from households and industrial parks and pollutants from agriculture cause the pollution of water, in particular, and of environment in general. Water stress has potential impacts to the shrinking or disappearance of rivers, lakes, wetlands and mangrove areas… At last, water stress situation has negative effects on the security of the social system. Water stress not only puts pressure

on the technical infrastructure but also on the social infrastructure. The social system needs to bear the burden for health care, welfare, education due to diseases, poverty, thirsty, hunger and has to solve the social conflicts.

As an experience lesson from Singapore, the reclamation of water is mentioned as an alternative resource for water supply in Ho Chi Minh City. Wastewater can be collected from households, industrial factories and treated in decentralized or centralized water treatment plants. After treating, water can be used for non-drinking purpose like irrigating, washing, cooling or direct for drinking purpose. However, at the moment, water reuse is not acceptable by most of people in the city due to the quality of reuse water and the entrenched habit of the citizens.

Moreover, with the abundant annual rainfall, the city can use rainwater to prevent the cities from the plague of pollution and water shortage. Harvesting rainwater can improve the urban environment and contribute to water recharge. In case of Ho Chi Minh City, rainwater harvesting system cannot carried out in a large scale, however, with the experiences from the case study of Tokyo city, it could be harvested in small scale (individual, household or community). Carrying in small scale does not cost too much for construction, operation and maintenance. However, the education and training for technology of water collecting, treating… has to be encouraged.

6.2. Recommendations

As a result of the responses of the survey question, some future expectations for water supply sector are pointed out. Based on these results, some improvement actions are mentioned as following to lessen the impacts of water stress on economic, environment, and social aspects and toward to the sustainable urban water supply:

- Due to the pressure of water stress, the government needs to consider clean water as a consumer product which is essential for human life and for business. Urban water supply should be a natural monopoly without competition.
- The innovation activities of urban water supply in accordance with the policy of the regime are also peculiar. Enhanced control is needed to ensure harmony of interests of state, enterprises and consumers. The government needs to create a legal framework,

equality for all economic sectors to participate in activities in the field of water supply. Especially the author recommends encouraging the participation of private sectors in water supply business.

- A mass of people expect from city authorities and water supply companies to hold more meetings with the customers. In other words, the community can have a good attention and full involvement in water supply management and development. A further amelioration would be the publication of planning to gather community input. In accordance with the planning of urban development in stages, in accordance with the natural conditions favorable for water and effective economic sanctions in order to manage and protect water resources, water supply systems need a secure overall sustainability.
- To reduce the shortage of water and water interruption, water supply utilities need to minimize the water loss rate. This action can be carried out step by step. At first, they can begin with upgrading the water infrastructure system. It means replace the old pipes, expanse the system to cope with the increase of water demand. Iron and steel pipes should be used, which are more adapted to unfavorable soil conditions. Next, the water supply company needs to take into account the water reservoirs.
- The Saigon Water Supply Corporation has a step tariff structure, which is decided by the city government. However, this tariff is more appropriate for high-income people, and not suitable for low-income classes. It is recommended to change the water tariff and implement the water-for-all policy. This is the social strategy for addressing the needs of the poor. Water-for-all does not mean that water will be provided in free for people. It means that the social welfare will cover the tariff subsidization.
- Reforming water tariff as an economic instrument. Like all major issues in the world, finance is the root cause of everything. Water tariff can be divided into 2 parts, about 80% is fixed to ensure the operation and maintenance cost of water supply company, 20% is flexible to encourage the water saving, rainwater harvesting or combining with the fees, which people have to pay for sealed surface. A reasonable tariff can become a control instrument of groundwater exploitation.
- Secure water supply sources. As be mentioned in chapter 5, due to the degradation of surface water and depletion of groundwater, water reuse and rainwater should be taken into account as alternative resources for water supply.

- Encourage the education program for communities about the impacts of water stress and their responsibilities for water saving and protecting.

List of references

A.K, B., 1999. Water Crisis - Curent Perceptions and Future Realities. *Water International*, 24(4), pp.363-67.

ADB, 2000. *Environments in transition: Cambodia, Lao PDR, Thailand, Vietnam*. Manila: Asian Development Bank.

ADB, 2004. *Water in Asian: Utilities' performance and civil society view*. Manila: Asian Development Bank.

ADB, 2009. *Water - Vital for Vietnam's future*. Manila: Asian Development Bank.

ADB, 2010. TA 7091-VIE *TA 7091-VIE: HCM City Water Supply Project*. Final Feasibility Study Report. Ho Chi Minh City: Asian Development Bank.

Andrews, C.T. & Yñiguez. C.E. (eds), 2004. *Water in Asian Cities: Utilities's Performance and Civil Society Views*. Manila: Asian Development Bank.

Asano, Uitto, J.I & Biswas, A.K. (eds), 2000. Water for Urban Areas: Challenges and Perspectives. *Wastewater Management and Reuse in mega-cities*, United Nations University Press, pp.135-55.

Asano, 2005. Water Science and Technology. *Urban Water Recycling*, 51(8), pp.83-89.

ASEAN, 2005. *State of Water Resources Management in ASEAN*. Jakarta: ASEAN Secretariat.

ASEAN, 2006. *Third ASEAn State of Environment Report 2006*. Jakarta: ASEAN Secretariat.

Ashok Subbramanian, Bridget Brown Aaron Wolf, 2012. *Reaching across the waters-faceing the risks of cooperation in international water*. Washington DC: The World Bank.

Biswas A.K, 1984. Water and Sanitation: economic and Socialogical Perspectives. In B. P.G, ed. *Role of Water in Economic Development*. Orlando: Academic Press. pp.117-33.

Bolay, J-C, Cartoux, S. Cunha, A., Thai, T.N.D & Bassand, M, 1997. Sustainable Development and Urban Growth: Precarious Habitat and Water Management in Ho Chi Minh City, Vietnam. *Habitat International, Pergamon*, pp.185 - 197.

C. McIntosh, A., 2014. *Urban Water Supply and Sanitation in Southeast Asia*. Mandaluyong: Asian Development Bank.

Dong, N., 2015. *TPHCM: SAWACO muon tang gia nuoc 10.5% moi nam*. [Online] Available at:"http://www.congan.com.vn/?catid=681&id=532641&mod=detnews&p=" [Accessed 24 January 2015].

DONRE, 2014. *Water resource exploitation situation in Ho Chi Minh City*. Ho Chi Minh City: Department of Natural Resources and Environment.

DOP, 2010. *Binh Thanh District Master Plan 2010*. Ho Chi Minh City: Ho Chi Minh City Authority.

DOP, 2010. *Master Plan of Binh Thanh District*. Ho Chi Minh City: Department of Planning in Ho Chi Minh City.

Drakakos-Smith, 2000. *Third World Cities*. 2nd ed. London: Routledge.

Duerr, R.I., 2013. *Singapore's 'toilet to tap' concept*. [Online] Available at "http://www.dw.de/singapores-toilet-to-tap-concept/a-16904636" [Accessed 11 November 2014].

Falkenmark,M & Lindh,G, 1993. Water in crisis: A guide to the worlds's water resources. In P.H. Gleick, ed. *Water and Economic Development*. Ne York: Oxford University Press. pp.80-90.

Google, 2014. *Google map*. [Online] Available at: "https://www.google.de/maps/place/B%C3%ACnh+Th%E1%BA%A1nh,+H%E1%BB%93+Ch%C3%AD+Minh,+Vi%E1%BB%87t+Nam/@10.8129711,106.7000883,13z/data=!4m2!3m1!1s0x3175289f02a8eae9:0x34ec9d90e055cde3" [Accessed 23 November 2014].

GroupRaindrops, 1995. Rainwater and You: 100 ways to use rainwater. In *Tokyo International Rainwater Utilization Conference*. Tokyo, 1995. The Organising Committee.

HABITAT, 1996. *An Urbanizing World: Gloabl Report in Human Settlements*. Oxford: Oxford Universiity Press.

Hai, P.T.T., 2011. *Master plan for water supply and drainage for Ho Chi Minh City to deal with climate change*. Ho Chi Minh City: Urban Planning Institute of Ho Chi Minh City.

Hesse-Biber, S.N & Leavy, 2006. *The practice of Qualitative Research*. Thousand Oaks: SAGE Publications.

Hung, Q., 2014. *Binh Thanh: Gan 1000 ho dan phai dung nuoc gieng khoan*. [Online] Available at: "http://giaoduc.edu.vn/news/xa-hoi-680/binh-thanh-gan-1800-ho-dan-phai-dung-nuoc-gieng-khoan-234659.aspx" [Accessed 24 January 2015].

IGES, 2007. *Sustainable Groundwater Management in Asian Cities*. Final report. Kanagawa: Institute for Global Environmental Strategies.

Le, T., 2014. *Bao gio dam bao cung cap nuoc sach*. [Online] Available at: "http://www.sggp.org.vn/nhipcaubandoc/2014/12/370148/" [Accessed 18 December 2014].

Lu, P., 2014. *Thanh pho ma và chuyen nguoi dan xai nuoc nghia dia*. [Online] Available at: "http://cand.com.vn/Phong-su-Tieu-diem/Thanh-pho-ma-va-chuyen-nguoi-dan-xai-nuoc-nghia-dia-322852/" [Accessed 23 December 2014].

McIntosh, A.C. & Yñiguez, C.E. (eds), 1997. *Second Water Utilities Data Book: Asian and the Pacific Region*. Manila: Asian Development Bank.

N.P.Dan et al, 2011. Potential of wastewater reclamation to reduce fresh water stress in Ho Chi Minh City, Vietnam. *Journal of water sustainability 3*.

Nhu, H., 2014. *Quan Binh Thanh: Gan ngan ho dan moi mon cho nuoc sach*. [Online] Available at: "http://www.congan.com.vn/index.php?mod=detnews&catid=681&id=526059" [Accessed 12 December 2014].

Numbeo, 2015. *Pollution in Ho Chi Minh City*. [Online] Available at: "http://www.numbeo.com/pollution/city_result.jsp?country=Vietnam&city=Ho+Chi+Minh+City" [Accessed 1 31 2015].

Phan, T., 2014. *Lao Dong*. [Online] Available at: "http://laodong.com.vn/xa-hoi/xa-hoi-hoa-cap-nuoc-sach-tai-tpho-chi-minh-het-nac-con-xuong-190028.bld" [Accessed 2014 December 12].

Phu, V.L., 2007. *Formulation of an integrated approach to sustainable water management in Ho Chi Minh City, Vietnam*. Adelaide: The University of Adelaide.

Phu, V.L., 2009. Water resource management in Ho Chi Minh City, Vietnam, an overview. *Science and technology development magazine*, pp.51-63.

Quy, M., 2014. *Thieu nuoc sach vi thieu tien lap duong nuoc*. [Online] Available at: "http://plo.vn/ban-doc/thieu-nuoc-sach-vi-thieu-tien-lap-duong-nuoc-498424.html" [Accessed 10 December 2014].

R, B., 2006. *All the water in the world*. Sydney: The centre for Independent Studies.

Roberts, B.& Kanaley, T. (eds), 2006. *Urbaninzation and Sutainability in Asia: Case Studies of Good Practice*. Manila : Cities Alliance, Asian Development Bank.

SAWACO, 2014. *History and development of SAWACO*. Individual report. Ho Chi Minh City.

Storch, H., 2007. *Population growth of Ho Chi Minh City*. Ho Chi Minh City.

UN, 1987. The World Comission on Environmental and Development's (the Brundtlant Comission). In *Our Common Future*., 1987. Oxford University Press.

UN, 1992. *Agenda 21. The United Nations Programme of Action from Rio*. New York: United Nation.

UN, 2001. *Says Secretary - General in message on world water day*. [Online] Available at: "http://www.un.org/press/en/2001/sgsm7738.doc.htm" [Accessed 03 December 2014].

UN, 2003. *World Water Development Report 2003 Water for People, Water for Life*. Barcelona: UNESCO Pulishing and Barghahn Books.

UN, 2005. *World Urbanization Prospects: the 2005 revision*. Population Division.

UN-HABITAT, 2006. Water and shared responsibility. In *Water and Human Settlement in an Urbanizing World*. United Nations Human Settlement Prohram. pp.98-99.

Van, T.L., 2007. Economic development, urbanization and environmental changes in Ho Chi Minh City, Vietnam: Relations & Policies. *Urban population, development and environmental dynamic in developing countries*, 13 June.

VCAPS, 2013. *Atlas Ho Chi Minh City moving towards the sea with climate change adaption*. Final report. Ho Chi Minh City: Vietnam Climate Adaptation Partnership Consortium.

VCAPS, 2013. *Climate Adaptation Strategy Ho Chi Minh City moving towards the sea with climate change adaption*. Final report. Ho Chi Minh City: Vietnam Climate Adaptation Partnership Consortium.

Vishwanath, S., 2002. *Rainwater harvesting in Bangalore*. [Online] Available at: "http://infochangeindia.org/water-resources/features/rainwater-harvesting-in-bangalore.html" http://infochangeindia.org/water-resources/features/rainwater-harvesting-in-bangalore.html [Accessed 12 December 2014].

WASE, 2001. *Master of Planing and Development of the Ho Chi Minh City Water Supply Network*. Ho Chi Minh City: Water and Sanitary Engineering Consultants.

WB, 2014. *What is sustainable development*. [Online] Available at "http://www.worldbank.org/depweb/english/sd.html" [Accessed 20 January 2015].

Wikipedia, 2014. *Ho Chi Minh City*. [Online] Available at: "http://en.wikipedia.org/wiki/Ho_Chi_Minh_City" [Accessed 12 December 2014].

Wikipedia, 2014. *Water supply and sanitation in Singapore*. [Online] Available at: "http://en.wikipedia.org/wiki/Water_supply_and_sanitation_in_Singapore" [Accessed 1 February 2015].

Wikipedia, 2014. *Water supply network*. [Online] Available at: "http://en.wikipedia.org/wiki/Water_supply_network" [Accessed 28 December 2014].

Winstanley, D., 2007. Water supply planning and management: sustainability. In *Mohamet Aquifer Consortium*., 2007. Illinois State Water Survey.

Xuyen.H.Ho, 2006. *Achieving a Sustainable Water future for Ho Chi Minh City, Vietnam*. Master's thesis. Ho Chi Minnh City: RMIT University School of Civil, Environmental and Chemical Engineering.

Young, J.G., Dooger, C.J. & Rodda, C.J., 1994. *Global Water Resources Issues*. Cambridge: Cambridge University Press.

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6. In-depth interview questionnaire for authority – English version

TRƯỜNG ĐẠI HỌC VIỆT ĐỨC

CHƯƠNG TRÌNH CAO HỌC PHÁT TRIỂN ĐÔ THỊ BỀN VỮNG

PHIẾU THĂM DÒ Ý KIẾN

Mã số phiếu	
Phỏng vấn viên	
Ngày phỏng vấn	

Kính thưa Ông/Bà

Chúng tôi là học viên chương trình cao học Phát triển Đô thị Bền vững của trường Đại học Việt Đức. Chúng tôi đang tiến hành khảo sát phục vụ cho đề tài luận văn liên quan đến vấn đề cấp nước tại Thành phố Hồ Chí Minh. Chúng tôi hy vọng sẽ nhận được sự hợp tác giúp đỡ từ phía Ông/Bà. Ông/Bà vui lòng đánh dấu chọn (x, ✓ hoặc khoanh tròn) vào phương án mà Ông/Bà đồng tình nhất. Mọi thông tin trong phiếu thăm dò sẽ được sử dụng với mục đích phục vụ cho nghiên cứu, thông tin cá nhân sẽ được giữ kín.

Xin chân thành cảm ơn Ông/Bà.

Nhóm nghiên cứu

I. THÔNG TIN VỀ HỘ GIA ĐÌNH

1. Mô tả người được phỏng vấn

1.1. Giới tính

- Nữ ☐1 - Nam ☐2

1.2. Vai trò của người được phỏng vấn trong gia đình

- Chủ hộ ☐1 - Thành viên khác ☐2

1.3. Gia đình ông/bà có bao nhiêu người

- Từ 1 – 4 người ☐1 - Từ 6 – 10 người ☐3
- Từ 4 – 6 người ☐2 - Trên 10 người ☐4

1.4. Trình độ học vấn

- Không biết chữ ☐1 - Trung học phổ thông ☐4
- Tiểu học ☐2 - Trung cấp/cao đẳng/đại học ☐5
- Trung học cơ sở ☐3 - Sau đại học ☐6

2. Gia đình ông/bà có đấu nối với hệ thống cấp nước của thành phố không?

- Có ☐1 - Không ☐2

II. CẤP NƯỚC

3. Nguồn nước gia đình ông bà sử dụng là (có thể chọn nhiều trả lời)

Nguồn nước	Tần suất cấp nước		
	Hàng ngày	Hàng tuần	Hàng tháng
Nước máy	☐1	☐2	☐3
Nước xe bồn chở tới	☐1	☐2	☐3
Giếng đào/giếng khoan	☐1	☐2	☐3
Vòi nước công cộng	☐1	☐2	☐3
Nước đóng chai	☐1	☐2	☐3
Nước mưa	☐1	☐2	☐3
Ao/hồ/sông/suối	☐1	☐2	☐3
Nguồn khác:……..			

4. Gia đình ông/bà sử dụng loại bể gì để chứa nước?
   - Sử dụng trực tiếp từ ống ☐1
   - Xô, chậu ☐2
   - Bể ngầm ☐3
   - Bể trệt ☐4
   - Bể trên cao ☐5
   - Khác:……..
5. Trung bình hàng tháng, gia đình ông/bà sử dụng bao nhiêu mét khối nước?
   - Dưới $10m^3$ ☐1
   - Từ 10 – $15m^3$ ☐2
   - Từ 15 – $20m^3$ ☐3
   - Từ 20 – $25m^3$ ☐4
   - Từ 25 – $30m^3$ ☐5
   - Trên $30m^3$ ☐6
   - Khác:……
     …….
6. Hàng tháng, ông bà phải trả bao nhiêu tiền nước?
   - Dưới 70.000 đồng ☐1
   - Từ 70.001 – 100.000 đồng ☐2
   - Từ 100.001–130.000 đồng ☐3
   - Từ 130.001 – 160.000 đồng ☐4
   - Từ160.001 – 200.000 đồng ☐5
   - Trên200.000 đồng ☐6
   - Khác:……
     ……..
7. Ông/bà đánh giá như thế nào về việc cấp nước

	Rất tốt	Tốt	Bình thường	Không tốt	Rất không tốt	Khó trả lời	Không trả lời
Uy tín công ty	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Cung cấp thông tin	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Ký kết hợp đồng	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Chi phí hợp đồng	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Chi phí đấu nối	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Chất lượng đấu nối	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Chi phí đường ống	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Chất lượng đường ống	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Công tác bảo trì đường ống nước	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Chi phí bảo trì đường ống	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Công tác sửa chữa đường ống	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Chi phí sửa chữa đường ống	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Công tác khắc phục sự cố	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Chi phí khắc phục sự cố	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Chất lượng đồng hồ nước	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Đọc đồng hồ nước	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Bảo trì đồng hồ nước	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Sửa chữa đồng hồ nước	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Tần suất cấp nước	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Giá nước	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Thời gian giao hóa đơn	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Thanh toán hóa đơn	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Thái độ nhân viên	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Quá trình xử lý nước	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Áp lực nước	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Màu sắc của nước	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Vị của nước	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Mùi của nước	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Xét nghiệm nước	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Thông báo kết quả xét nghiệm	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Giải quyết khiếu nại, tranh chấp	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Khác:…….	☐1	☐2	☐3	☐4	☐5	☐6	☐7

8. Mong muốn của ông/bà đối với dịch vụ cấp nước trong tương lai (có thể chọn nhiều trả lời)

Kết nối đường ống nước đi thẳng đến nhà	☐1
Lắp đặt vòi nước công cộng	☐2
Cung cấp thông tin cho khách hàng đầy đủ hơn	☐3
Ký kết hợp đồng đơn giản, nhanh chóng hơn	☐4
Giảm hoặc trợ giá các chi phí như chi phí hợp đồng, đấu nối	☐5
Nâng cao chất lượng cácđấu nối và đường ống nước	☐6
Thay mới và cải thiện hệ thống đường ống cũ, mở rộng mạng lưới đường ống	☐7
Sử dụng các bể chứa nước, thủy đài để trữ nước, hạn chế việc gián đoạn cấp nước	☐8
Bảo trì đường ống nước thường xuyên và giảm chi phí bảo trì	☐9
Khắc phục, sửa chữa đường ống khi xảy ra sự cố nhanh chóng và giảm chi phí sửa chữa	☐10
Kiểm tra, bảo trì đồng hồ nước thường xuyên và đọc đồng hồ chính xác	☐11
Có chính sách trợ giá nước cho người dân	☐12
Hóa đơn chính xác và gởi hóa đơn đúng hạn	☐13
Thanh toán hóa đơn nước tiện lợi hơn	☐14
Cải thiện thái độ của nhân viên công ty	☐15
Cải thiện quá trình xử lý nước	☐16
Nâng cao tiêu chuẩn nước sau xử lý (màu, mùi, vị của nước)	☐17
Lấy mẫu phân tích xét nghiệm nước thường xuyên và công khai kết quả xét nghiệm nước cho khách hàng	☐18
Cải thiện áp lực nước	☐19
Hạn chế việc cúp nước	☐20
Tổ chức các buổi igặp gỡ với khách hàng	☐21
Khác:……..	☐22

9. Với những thay đổi trên, ông/bà sẵn sàng chi trả ở mức nào?
   - Không ☐1
   - Dưới 100.000VND ☐2
   - Từ 100.001 đến 500.000 ☐3
   - Từ 500.001 đến 1.000.000 ☐4
   - Từ 1.000.001 đến 2.000.000 ☐4
   - Trên 2.000.000VND ☐5
   - Khó trả lời ☐6
   - Khác:…….

10. Ý kiến khác

.....

.....

.....

Xin cảm ơn ông/bà đã dành thời gian hoàn thành phiếu thăm dò ý kiến này.

Phỏng vấn viên (ký, ghi rõ họ tên)	Người được phỏng vấn (ký, ghi rõ họ tên)	Người kiểm phiếu (ký, ghi rõ họ tên)

VIETNAMESE – GERMAN UNIVERSITY

SUSTAINABLE URBAN DEVELOPMENT STUDY PROGRAMME

SURVEY QUESTIONNAIRE

Code	
Interviewer	
Interview date	

Dear Sir/Madam

We are master students of Vietnamese – German University major in Sustainable Urban Development. We are carrying out our research related to water supply sector in Ho Chi Minh City. It seems to be difficult to construct questions equally suitable for everyone. But we would be grateful if you answer to the best of your ability, even if the questions seem to be not very well suited to your situation. All the information received in this interview will be kept strictly confidential and none of this information will be presented in a way making traceable back to you.

Thank you so much.

Researchers.

I. INDIVIDUAL INFORMATION

1. Description of the interviewee

1.1. Name: …….. Phone number:……

1.2. Sex of person interviewed

- Female ☐1 - Male ☐2

1.3. Her or his position in household

- Head of household ☐1 - Other ☐2

1.4. How many member in her or his household

- Less than 4 people ☐1 - From 7 – 10 people ☐3
- From 4 – 6 people ☐2 - More than 10 people ☐4

1.5. Education level

- No formal education ☐1 - High school ☐4
- Primary school ☐2 - Graduated ☐5
- Secondary school ☐3 - Post graduated ☐6

2. Is your household connected to the public water network

- Yes ☐1 - No ☐2

II. WATER SUPPLY

3. What is the resource of water for your household (multiple responses are possible)

Water resources	Frequency of supplying		
	Daily	Weekly	Monthly
Piped water	☐1	☐2	☐3
Water vendors/water by truck	☐1	☐	☐3
Own well	☐1	☐2	☐3
Public tap	☐1	☐2	☐3
Bottled water	☐1	☐2	☐3
Rainwater	☐1	☐2	☐3
Stream/spring/lake/wadi	☐1	☐2	☐3
Others:…….……..			

4. What kind of reservoir your household is using to storage water
   - Use directly from the pipe ☐1
   - Water bucket, water jar ☐2
   - Underground reservoir ☐3
   - Ground reservoir ☐4
   - Elevated reservoir ☐5
   - Other…….☐6
5. How much water your household uses per month (cubic meter)?
   - Less than 10m^3 ☐1
   - From 10 – 15m^3 ☐2
   - From 15 – 20m^3 ☐3
   - From 20 – 25m^3 ☐4
   - From 25 – 30m^3 ☐5
   - More than 30m^3 ☐6
   - Other……
     …….
6. How much you have to pay for water per month?
   - Less than VND 70.000 ☐1
   - From VND 70.000 – 100.000 ☐2
   - From VND 100.001–130.000 ☐3
   - From VND 130.001 – 160.000 ☐4
   - From VND160.001 – 200.000 ☐5
   - More than VND200.000 ☐6
   - Other……
     …….
7. How do you evaluate the water supply

	Very good	Good	Normal	Bad	Very bad	Difficult to answer	Non response
The popularity of the supply company	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Information	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Contract	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Contraction cost	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Connection cost	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Connection quality	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Pipe system cost	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Pipe system quality	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Pipe system maintenance	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Pipe maintenance cost	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Pipe reparation	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Pipe reparation cost	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Trouble shoot	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Trouble shooting cost	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Quality of water-meter	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Water-meter reading	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Water-meter maintenance	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Water-meter repairing	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Frequency of supplying	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Water tariff	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Time for bill delivery	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Bill paying	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Staff's attitude	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Water treatment	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Water pressure	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Color of water	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Taste of water	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Odor of water	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Water testing and analyzing	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Water testing information	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Complaint solving	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Other……	☐1	☐2	☐3	☐4	☐5	☐6	☐7

8. What is your expectation on water supply in the future?

The piped water connect directly to house	☐1
Set up public taps	☐2
Information	☐3
Signing the contract quickly and simply	☐4
Reduce the cost (connection cost, maintenance…)	☐5
Improve the quality of connection and pipe system	☐6
Replace and improve the existing pipe system, expand the new one	☐7
Use more reservoirs to storage water, reduce the interruption	☐8
Maintain the pipe system more often	☐9
Trouble shooting and reparation quickly, reduce the cost	☐10
Check and read the water-meter clearer	☐11
Create the policy in tariff subsides	☐12
Bill printed correctly	☐13
Improve the paying system	☐14
Improve the attitude of staff	☐15
Improve water treating	☐16
Improve the standard of water after treatment (color, taste, odor)	☐17
Test water more often and inform the result to customers	☐18
Improve the water pressure	☐19
Reduce the interruption rate	☐20
Holding more meeting with customers	☐21
Address the complaints quickly	☐22
Other……..	☐23

9. Are you willing to pay for all of changes above?

- No ☐1
- Yes, less than VND 100,000 ☐2
- Yes, from VND 100,001 to 500,000 ☐3
- Yes, from VND 500,001 to 1,000,000 ☐4
- Yes, from VND 1,000,000 to 2,000,000 ☐5
- Yes, more than VND 2,000,000 ☐6
- Difficult to answer ☐7
- Other:……. ☐8

Thank you for your time!

Interviewer (signature and name)	Interviewee (signature)	Surveyor (signature and name)

TRƯỜNG ĐẠI HỌC VIỆT ĐỨC
CHƯƠNG TRÌNH CAO HỌC PHÁT TRIỂN ĐÔ THỊ BỀN VỮNG

BẢNG CÂU HỎI DÀNH CHO HỘ GIA ĐÌNH

STT	Câu hỏi	Kiểm tra	Ghi chú
1.	Gia đình ông/bà có đấu nối với hệ thống nước cấp của thành phố không?		
2.	(Nếu không), tại sao gia đình ông/bà lại không đấu nối với hệ thống nước cấp của thành phố?		
3.	Ngoài nguồn nước máy, gia đình ông/bà có sử dụng nguồn nước nào khác không?		
4.	(Đối với hộ có vườn/ hoạt động nông nghiệp) Gia đình ông/bà sử dụng nguồn nước nào để tưới vườn?		
5.	Trung bình gia đình ông/bà sử dụng bao nhiêu mét khối nước một ngày?		
6.	Có luôn đủ nước dùng cho cả gia đình không?		
7.	Có bị cúp nước thường xuyên không? Tần suất cấp nước như thế nào? Ông/bà có được nhà cung cấp báo trước lịch cúp nước không?		
8.	Ông/bà có nghĩ chất lượng nước uống tốt? - Nếu có, vui lòng giải thích - Nếu không, vui lòng cho biết lý do		
9.	Ông/bà có xử lý/nấu sôi nước uống không?		
10.	Ông/bà có nghĩ mình sẽ bị bệnh từ nước uống không?		
11.	Ông/bà có sử dụng nước đóng chai không?		
12.	Hàng tháng, ông/bà phải trả bao nhiêu tiền cho nước uống đóng chai?		
13.	Ông/bà có sử dụng đồng hồ nước không?		
14.	Hàng tháng, ông/bà phải trả bao nhiêu tiền cho nước máy?		
15.	Ông/bà có được nhận hay tiếp cận kết quả kiểm tra phân tích nước? Nếu có, ông/bà được nhận kết quả phân tích nước có thường xuyên không?		
16.	Gia đình ông/bà có sử dụng bể chứa nước? loại ống dẫn nước gia đình ông/bà sử dụng (đường kính, vật liệu)?		
17.	Ông/bà có ý kiến gì về chất lượng cung cấp nước uống không?		
18.	Những mong đợi của ông/bà trong việc cải thiện hệ thống cấp nước?		

VIETNAMESE – GERMAN UNIVERSITY
SUSTAINABLE URBAN DEVELOPMENT STUDY PROGRAM

QUESTIONNAIRE FOR HOUSEHOLD

No.	Questions	Check	Note
1.	Is your household connected with the piped water system?		
2.	If not, please give specific reasons		
3.	What is the main water resources of your household		
4.	(For household have garden) What are the water resources for irrigation?		
5.	How much water your household uses average per day?		
6.	Do you have enough water?		
7.	How about the water cut/interruption? Frequency of water cut? Are you informed in advance for the water cut?		
8.	Do you think the quality of water is good? - If yes, please explain - If not, please give specific reasons		
9.	Do you treat water before using?		
10.	Do you think you will get sick from water?		
11.	Do you use bottled water?		
12.	How much you have to pay for bottled water per month?		
13.	Do you have the water meter?		
14.	How much you have to pay for piped water per month?		
15.	Are you informed about the results of water analysis?		
16.	Do you have water reservoirs? What kinds of pipe are used in your house?		
17.	Do you have any complain or idea about water supply?		
18.	What are your expectations for water supply?		

TRƯỜNG ĐẠI HỌC VIỆT ĐỨC
CHƯƠNG TRÌNH CAO HỌC PHÁT TRIỂN ĐÔ THỊ BỀN VỮNG

CÂU HỎI DÀNH CHO CÁN BỘ

No.	Questions	Check	Note
1.	Có bao nhiêu hộ gia đình kết nối với hệ thống cấp nước?		
2.	Có bao nhiêu hộ gia đình không kết nối với hệ thống cấp nước?		
3.	Nguồn nước được sử dụng cho việc sản xuất nước cấp?		
4.	Quá trình xử lý nước ra sao? Áp lực nước?		
5.	Mỗi ngày, công ty cung cấp bao nhiêu mét khối nước cho sinh hoạt hộ gia đình, công nghiệp và hành chính?		
6.	Hệ thống đường ống phân phối nước được xây dựng từ khi nào?		
7.	Có bao nhiêu thủy đài, bể chứa nước trong khu vực? Toàn thành phố? Chất lượng các thủy đài này như thế nào?		
8.	Về tỷ lệ thất thoát nước?		
9.	Đâu là nguyên nhân của việc thất thoát nước?		
10.	Ông/bà có chiến lược gì để giảm thất thoát nước không?		
11.	Các loại ống được sử dụng cho hệ thống phân phối nước?		
12.	Bao nhiêu lâu thì nước được lấy mẫu để kiểm tra phân tích?		
13.	Kết quả kiểm tra phân tích nước có được thông báo đến người dân không?		
14.	Ai là người chịu trách nhiệm cho việc quyết định giá nước?		
15.	Có đủ nước cho người dân trong khu vực không?		
16.	Công ty có đủ tài chính cho việc vận hành và bảo trì không?		
17.	Có đủ nhân viên được đào tạo?		
18.	Ông/bà có chiến lược gì cho việc bảo vệ nguồn nước?		
19.	Ông/bà có ý tưởng/ý kiến gì cho việc phát triển nước cấp trong tương lai?		

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QUESTIONNAIRE FOR AUTHORITY

No.	Questions	Check	Note
20.	How many households connect with the water supply system of the town/city?		
21.	How many households are not connect with the water supply system of the town/city		
22.	What are the water supply resources?		
23.	How about the water treatment process? Water pressure?		
24.	How much water do you supply for domestic, institutional, industrial daily?		
25.	Where was the distribution system constructed?		
26.	How many elevated reservoir, water tank in the whole town/city? How about their quality?		
27.	What about the leakage rate?		
28.	What are the reasons for the leakage?		
29.	Do you have any strategy for the leakage reducing?		
30.	What kind of pipe do you use for distribution system?		
31.	How often do you do the water analysis?		
32.	Are the water analysis results informed to citizen?		
33.	Who has the responsibility in water price decide?		
34.	Do you have enough water for all citizens?		
35.	Do you have enough financial conditions for operation and maintenance?		
36.	Do you have enough trained staffs?		
37.	Do you have any strategy for water resources protection?		
38.	Do you have any ideas for the development of water supply in the future?		