WATER RESOURCE MANAGEMENT IN HO CHI MINH CITY, VIETNAM: AN OVERVIEW

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ABSTRACT: *Water is a resource needed in all aspects of life and is regarded as a decisive factor for Earth's ecosystems survival. However, water resource has also become a limiting factor of social and economic development. For cities of the developing world, water is increasingly playing a vital role in sustainable urban development. Since economic reform known as "Doi Moi" (renovation) in 1986, Ho Chi Minh City, Vietnam, has undergone the rapid growth of urbanization and industrialization. As a result, the City has experienced critical environmental challenges in which water use and management have placed constraints on its sustainable development. These striking challenges include water shortage, pollution and depletion of surface and groundwater sources. The underlying reasons can be attributed to inadequate management practices. The purpose of this paper is to provide an overview of rapid urbanization and growing water resource problems. It also examines the management practices and analyze the root causes of water resource issues in the course of sustainable development.*

Keywords: *Ho Chi Minh City, pollution, sustainable development, urbanization, water resources management.*

Abbreviations: *SAWACO - Sai Gon Water Supply Company; MARD - Ministry of Agricultural & Rural Development; MONRE – Ministry of Natural Resources & Environment; DONRE - Department of Natural Resources & Environment.*

1.BACKGROUND TO HO CHI MINH CITY

Ho Chi Minh City (HCMC), formerly known as Sai Gon, was founded in 1698. After reunification in 1975, Sai Gon was renamed as HCMC. It was originally a small fishing village known as Prey Nokor (means "forest city" or "forest land"). The area that the city now occupies was originally marsh and swamp land, and was inhabited by Khmer people for centuries before the arrival of the first Vietnamese settlers in 1698 [1].

Since economic reform known as "Doi Moi" (renovation) in 1986, it has experienced fast industrial and urbanization. Increasingly, HCMC has become an important hub for political, economic, cultural activities and the heart of the Mekong Delta region [2] & [3].

The renovation policy triggered the so-called 'industrialization and modernisation' process which created momentum and impetus for social transformation and radical economic development. Accordingly, this process is the driving force of rapid economic and urban growth of HCMC, bringing both opportunities and challenges.

In token of challenges, HCMC's water sources are coming under stress, an anomaly given that on an annual basis it has abundant water supplies. The major water stresses include water shortage, degradation and depletion of the surface and aquifer sources. This paper will provide an overview of these urban water problems, and examine the existing constraints of management practices.

1.1.Precipitation

Yearly average rainfall is about 2,000 mm. The rainy season accounts for 80-85% of yearly rainfall. However, the rainfall is not distributed evenly, and tends to increase in the southwest-northeast axis. Most central districts and northern districts usually have higher rainfall than districts in the south and southwest. [4].

Seasonal fluctuations in annual precipitation result in variation of water quantity and quality in Vietnam's major urban centers, particularly in HCMC. Generally, Vietnam's rainfall is highly distributed in a short period of the year and causing water shortages and floods [5].

1.2.Urbanization trend

The demography and the population pattern of HCMC have dramatically changed. Its population has doubled over 25 years from 2.5 million in 1975 to 5.17 million people in 2000 [6]. During the last two decades, rapid urbanization is concomitant with its burgeoning population. By 2004, the urban population figure has accelerated to 6.1 million people, accounting for 7% of the country's population in which 5.2 million inhabitants live in urban Districts and 0.9 million people in outlying Districts. Due to the rapid population growth, the density pattern steadily increases up to 2,987 inhabitants per km^2 in mid 2005 [7]. The urban population growth is depicted in the Figure 1.

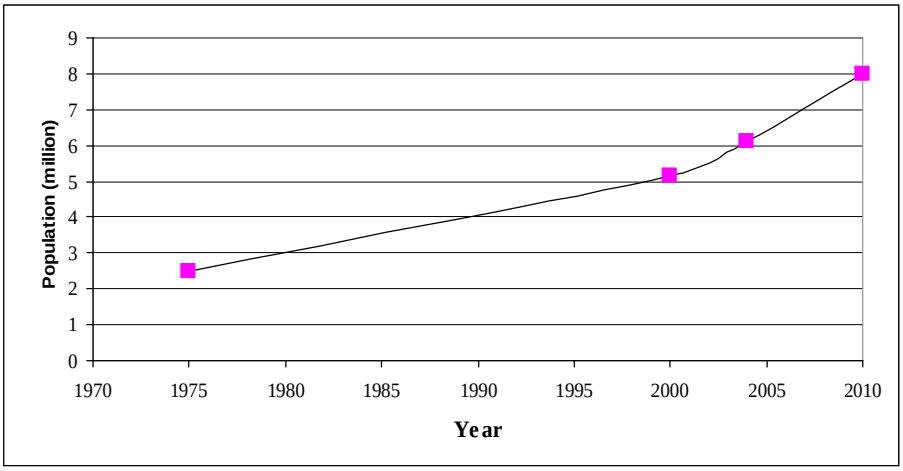

Figure 1. Evolution of urban population growth in HCMC, 1975-2010

Source: this was compiled by the author from different cited sources.

Urbanization has promoted economic and social changes as urban centers are the hub of a nation's economic growth, culture, innovation, knowledge and political power. It is claimed that most Asian countries have benefited from urbanization in terms of employment, lifestyles, welfare, social structures and institutions [8]. Additionally, Biswas (2000) noted that the large urban centers of the developing world contribute to 60% of total national economic growth [9]. Urbanization, on the other hand, is responsible for a wide range of environmental consequences, including water resource deterioration, inadequate drinking water and sanitation, coupled with health problems from water-related diseases, air pollution and solid waste management [9] & [10]. Not surprisingly, most governments of the developing world have failed to cope with the high rate of urbanization concomitant urban water issues. Most

importantly, they are unable to develop a good governance scheme, management capacity and efficient financial resources to provide urban dwellers basic water-related services [11] & [12].

In the Southeast Asian perspective, dense population and massive urbanization are the fundamental reasons contributing to growing stresses on the management of natural resources and have overwhelmed the capacities of water policy [13].

By 2010, HCMC's population is projected to be around 8-10 million people taking into account of the un-registered City's population [3] & [14]. This will result in pressures on securing adequate water sources, ensuring basic human needs and managing water resources will pose challenges on the City's urban planners, managers and water professionals as well as burdens on urban water infrastructure.

2.WATER RESOURCES AND URBAN HYDROLOGY

HCMC is geographically situated in a well-watered region with abundant swamps and marshes. It has been maintained by abundant surface and subsurface water. There are three major water sources are used for supply in HCMC: surface water (from the Dong Nai and Sai Gon river system), groundwater and rainwater [14] & [15].

2.1.Groundwater sources

Apart from surface supplies, aquifer sources have been increasingly exploited for domestic and industrial purposes, accounting for 30-40% of water demand in HCMC. Aquifers in HCMC are categorized into 5 layers, namely, Holocene, Pleistocene, Upper- Pliocene, Lower-Pliocene and Mezozoi, in which the 3 latter aquifer layers are important sources for water supply [17].

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 bores in 2003, equivalent to 530,000 m^3/day, of which 100,000 m^3/day is withdrawn for domestic use [17], [18] & [19]. However, the aquifer source has been haphazardly exploited at an alarming level, evidenced by the abstraction volume, 520,000 $m^{3/}$day, which surpassed the sustainable limits [6]. The over pumping of groundwater has jeopardised the available quantity of aquifer sources. The groundwater decline is evidenced by salt intrusion being observed in monitoring wells [6] & [20].

2.2.Rainwater

Rainwater is currently harvested by residents in coastal districts: Can Gio, Nha Be and District 7. It can be argued that rainwater is abundant and should be considered as an alternative source for HCMC as the rainy season accounts for 80-85% of the annual rainfall. However, it is not easy to harvest and store in the context of HCMC due to highly investment and large facility required [17]. The utilization of rainwater is only small scale in most of households in Can Gio district because of no freshwater sources and distribution network [16].

3.OVERVIEW OF URBAN WATER ISSUES

Despite the fact that it is located in a humid tropical region with abundant water resources, HCMC has recently been facing an acute water stress resulting from rapid industrialization and urbanization. It is claimed that water shortage is a striking issue of economic development in the Southeast Asian region [21] & [22].

3.1.Water use and demand

Total water demand for domestic and industrial purposes in 2006 was 1.75 million m^3, and was estimated to be 3.6 million m^3 in 2020 [23]. The major water sectors are industries, agriculture, households and services. The largest component of HCMC's water supply sources comes from upstream sources of the Sai Gon-Dong Nai river system. The ratio of river and groundwater contribution in HCMC's water supply before and after 2003 is presented in Figure 2.

The coverage of water supply in HCMC increased from 52% in 1997 [24] to 84% in 2004 [25]. However, the proportion of unaccounted flow is relatively high in comparison with other Asian cities as presented in Table 1. However, only 76% of urban dwellers are provided with clean water by SAWACO, 10.5 % of suburban residents have access to clean water from the UNICEF program. The real figure remains unmeasured because a large number of citizens in outlying Districts still lack access to clean and safe drinking water.

Table 1. Water Supply Service in Selected Southeast Asian Cities

	Bangkok*	**HCMC**	**Jakarta**	**Kuala Lumpur**	**Manila**
Production/population (m^3/d/c)	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	80	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)

Sources: (Andrews and Yñiguez, 2004) and (*) (McIntosh and Yñiguez, 1997).

Notes: [(a)] Data in brackets ( ) are sourced in 1997; [(b)] n.a = not available

According to the projected population growth, municipal water consumption is projected to be 1.1 million and 1.6 million m^3 in 2010 and 2020 respectively [17]. This growing demand will lead to more abstraction of water from the Sai Gon-Dong Nai river system. Therefore, the City's government at all levels will face major challenges and management constraints on conserving aquifers at sustainable levels and protecting the main river system from pollution and degradation.

3.2.Urban inundation and water shortage

HCMC typifies a paradox of water issues and "stand with its feet in the water" [26]. On the one hand, there is too much water during the wet weather resulting in inundation in many urban districts. Due to historical and geographical location, many parts of urbanized areas are subject to flooding in the rainy season from May to October. The inundation condition is seriously exacerbated by tidal surges in low-lying urban districts that faced serious waterlogging and inundation after heavy storm events combined with tidal surges [6].

In contrast, suburban dwellers lack access to clean water supply or inadequate provision with clean water [27]. The reasons for water shortage include insufficient water sources and inadequate supply networks. District 7 and Nha Be District have suffered an ever water

shortage in the dry season 2006. These Districts' residents have paid approximately \$US 2/m^3 of clean water. The situation is severely aggravated for the two coastal districts of Can Gio and Nha Be where it is hard for clean drinking water to reach residential areas [28]. In addition, the proportion of residents with access to clean drinking water in outlying Districts is low. Among 5 outlying suburban Districts, Binh Chanh and Nha Be had only 10.64% and 22.14% of people have access to clean water.

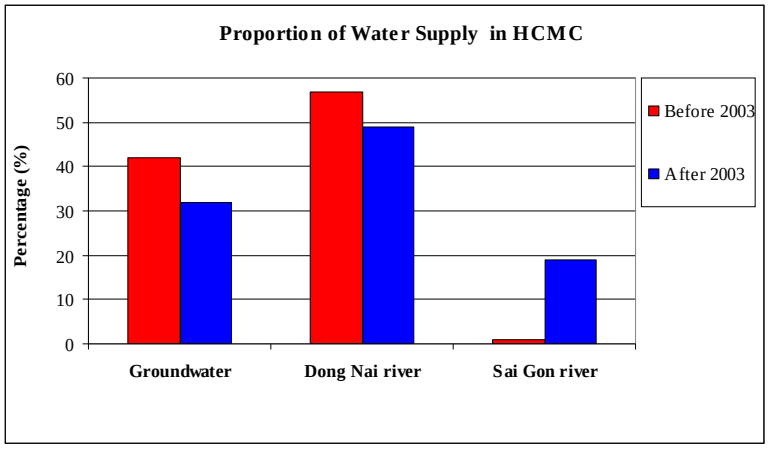

Figure 2. Proportion of water supply sources in HCMC [8]

3.3.Groundwater depletion and pollution

Groundwater is one of three main sources of water supply for social development in HCMC. This aquifer source will continue to play a crucial role in the city's water supply in the future [14]. However, the alarming diminution of groundwater is becoming apparent to water managers. The results of a 5 year monitoring project between 2001 and June 2006 indicate that the annual average drawdown of water table in HCMC is 2-3 m [29]. Table 2 shows the annual drawdown of water table in high bores density [15] and the withdrawal of groundwater over time in HCMC is presented in Figure 3.

The total recharge volume is only one-third of the extraction rate due to accelerated growth of impermeable urban surfaces and hydrological changes associated with rapid urbanization [29]. The overabstraction from aquifer sources has resulted in further lowering of the water table in suburban districts. The water table in Thu Duc and Go Vap, outlying Districts, has dropped 4-5 m during the last 5 years [18]. The root causes of this incidence are complex and intertwining. Inadequate water supply services and poor performance of infrastructure are among such reasons [14]. It can be said that insufficient water supply has resulted in an enormous number of private wells having been bored over urban districts to satisfy many domestic purposes.

Nevertheless, the quality of groundwater is also being worsened from both point and non-point sources. Tran (2001) stressed that the management and protection of aquifers is a pressing task for HCMC [30]. He also claimed that the quality of groundwater is threatened by major contaminant sources, including industrial wastewater impoundment, septic tank systems, leachate from landfills and polluted water wells. In addition, the presence of several contaminants was identified in shallow aquifers [31].

Additionally, salt intrusion and the fall in water table are observed in some areas. In 2002, there were 2,359 wells were unable used due to salt intrusion [15]. It is concluded that the

rapid expansion of urban areas, industrial zones associated with over abstraction are the causes of groundwater depletion and quality degradation [20].

3.4.Pollution of water sources

HCMC is ironically a hotspot area of environmental issues. Including water pollution and unsustainable urban habitats [21] & [26]. It is the home of about 30,000 small and medium scale enterprises and more than 800 large scale factories from industrial parks [6]. However, most of them are not equipped with any wastewater treatment facilities [16]. In addition, it is estimated that industrial wastewater effluent accounting for 20-30% of the total flows in Vietnam's river systems. The major industrial contributions to water pollution are oil refining, chemical and food processing industries [32] & [33].

Table 2. Drawdown of water table in monitoring stations in HCMC

Aquifer	Year	Groundwater table (m)				
		Binh Chanh Dist.	Binh Tan Dist.	Phu Nhuan Dist.	District 11	District 12
Pleistocene	2000	-2.69	-2.61	6.76	-5.27	4.85
	2004	-5.6	-7.8	1.23	-7.96	3.8
	Total drawdown	2.91	5.19	5.53	2.69	1.05
	Annual drawdown	0.73	1.3	1.38	0.67	0.26
Upper Pliocene	2000	-8.18	-9.25	-11.58	-15.79	-7.71
	2004	-14.99	-18.57	-22.56	-23.67	-19.26
	Total drawdown	6.81	9.32	10.98	7.88	11.55
	Annual drawdown	1.7	2.33	2.75	1.97	2.89
Lower Pliocene	2000	-14.36	-8.94	-12.49	-15.85	-8.5
	2004	-29.75	-19.01	-23.12	-28.77	-19.9
	Total drawdown	15.39	10.07	10.63	12.92	11.4
	Annual drawdown	3.85	2.52	2.66	3.23	2.85

The decline of water table was caused by industrial and domestic activities in areas: Binh Hung (Binh Chanh district), Tan Tao (Binh Tan district- newly formed district), Tan Son Nhat (Phu Nhuan district), Phu Tho (District 11) and Tan Chanh Hiep (District 12).

Source: [15]

3.4.1.Pollution of river basins

Pollution of water sources is also increasing in many rivers in and around HCMC by untreated wastewater from municipal and industrial activities [16] & [33]. It was estimated that about 200,000m^3 of industrial wastewater, 17,000m^3 of hospital effluent discharged into the Sai Gon-Dong Nai river daily [34] & [35]. This amount of wastewater comes only from industrial activities located along this river system. However, Environmental Management Division of DONRE identified that only 40% of this wastewater is treated [35]. The figure of pollution was aggravated starkly as over 50 tonnes of dead fish were found in the upstream of the Dong Nai river in April 2000 [16].

The Sai Gon-Dong Nai river system not only supplies with water, but is also a conveyor of wastewater [18]. An increase in pollution incidence resulted in a recent urgent response of the City's government controlling and protecting water quality of the Sai Gon from pollution [36].

3.4.2.Pollution of urban canal system

More than half of canal systems in HCMC are high density population and industrial polluting areas. Unfortunately, domestic sewage and industrial wastewater are directly released into watercourses and canal systems without treatment or with inadequate treatment [16] & [26].

The Tan Hoa-Lo Gom, Nhieu Loc-Thi Nghe, Tau Hu-Ben Nghe and Kenh Doi-Kenh Te canals receive daily about 700,000m^3 of municipal and industrial effluent with high levels of BOD, COD and heavy metals [6] & [26], well above Vietnamese standard levels [16]. This poses health threats to the inhabitants settled along this canal system [37]. DONRE noted that all HCMC's rivers and canals are heavily polluted by organic wastes and coliform, particularly in the dry season. The situation is likely to accelerate because of the rapid industrial growth and inadequate control mechanisms [20].

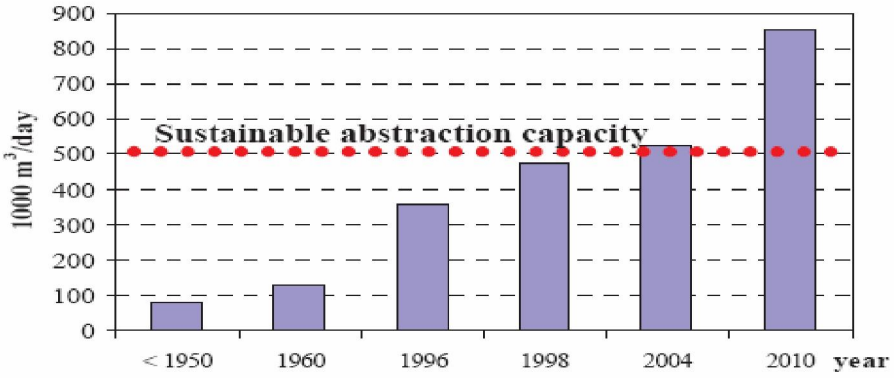

Figure 3. Groundwater extraction over time in HCMC [18]

Furthermore, the situation of canal systems is increasingly aggravated during the wet weather as the canals receive additional contaminated flows from urban and agricultural runoff. Not surprisingly, high concentrations of PCBs, DDT and heavy metals were found in canal sediments [33] & [38].

3.5.Institutional and Legal Frameworks of Water Resources Management Practices

Since 1993, the Vietnam government has introduced an overarching Law on Environment Protection (which was revised in 2005), standards on air and water quality, decrees on environmental fines and enforcement, and on the implementation of environmental impact assessment, as well as circulating, directives on environmental protection [21].

For the management of water resources, the most important institutional framework is the Law on Water Resources (LWR), which was enacted in May 1998, and became effective in 1999 [32] & [39]. The LWR establishes effective institutions and instruments for the comprehensive management practices of water resources. The objective of the LWR is to provide for the management, protection, exploitation and use of water resources and to protect,

combat and overcome the harmful effects of water. In addition, Article 58 of the LWR describes the responsibility of government for the management of water resources, and MARD is the government representative to perform the role of water resources management [39].

After 2002, the main function in the management of water resources in MARD was abolished and taken over by the new Ministry of Natural Resources & Environment (MONRE). Within MONRE, the Department of Water Resource Management (DWRM) has been formed to carry out the state management of water resources. However, the service function of irrigation and rural water supply still remains with MARD [37] & [39].

4.THE ROOT CAUSES OF WATER ISSUES IN HO CHI MINH CITY

It is widely argued that the rapid urban expansion in the developing world has exceeded the capabilities of the government management practices of water resources in terms of efficiency, equity and sustainability [11]. Therefore, the future major water challenges in cities of developing nations include the shrinkage of water sources, arising from increased water quality deterioration due to improper planning, inadequate management practices and the lack of political involvement [11]. Importantly, urban managers in developing countries often neglect their responsibilities for environmental concerns [40] & [41]:

In most cities, poorer groups' lack of piped water supplies is not the result of a shortage of fresh water resources but the result of governments' refusal to give a higher priority to water supply … A failure of governance underlies most environmental problems [40] (p. 382).

Within the context of HCMC, the causes the City's water resource problems are rooted in inadequate institutional frameworks of the urban sector, inappropriate institutional arrangements and insufficient mechanisms in the water sector. The underlying causes of any environmental concerns should be analyzed in accordance with the existing social development conditions and the management practices of local governments at all levels.

Firstly, over-abstraction of groundwater has sprung from the two major causes. The insufficient water supply network has resulted in an increasing number of dug wells over urban districts. The local government at all levels failed to control wells which have been bored haphazardly. There are more than 200,000 tube wells throughout the City supplying for domestic and industrial purposes [42]. In fact the real number of private wells in HCMC could be triple the reported figure [37]. These wells have caused a decline groundwater table has now evident in the outlying districts, Thu Duc and Go Vap [18]. In addition, the degradation of water quality and depletion of groundwater can be attributed to rapid urbanization coupled with the increase in urban impervious surfaces. This causes a reduction in recharge and natural replenishment [31]. The underlying reason is that the rapid urban expansion has overwhelmed the limited management capacities and existing resources of the City's government.

Secondly, the deterioration of water quality in surface water resources stems from institutional weakness. Weak enforcement of law against environmental violation from industries is one example of such inadequate institutions [16] & [22]. Water pollution upstream of the Dong Nai-Sai Gon river can be attributed to the lack of coordination between HCMC DONRE and its counterparts in neighbouring provinces evident in the lack of horizontal cooperation or overlapping responsibility across government agencies and departments in HCMC [16]. This causes confusion to many industries and leads to unpleasantness and avoidance rather than fear or compliance from industries. In addition, poorly trained staff and inconsistent implementation of regulations are also additional factors of the management constraints.

Thirdly, the inundation in the wet weather stems not only from topographical conditions but also from the unbridled expansion of many urban areas in the last two decades. The rapid expansion of urban boundaries has led to the level of canals, waterways and receiving waters which act as regulators and retention facilities during the high peak of rainfalls. The number of canals being filled up has accelerated throughout the city, particularly in outlying Districts. In June 2006, the total area of filled canals was 2,157 ha, and the city still has 105 inundated sites [43].

To most urban planners view urbanization as 'cementization' of urban area surfaces. It is argued that the replacement of the natural drainage canals for the concrete drainage pipe should be considered deliberately within the context of urban drainage and hydrology. Thus, it is hard to disagree that inadequate knowledge on environmental matters associated with economic development of local governments is a common characteristic of many developing nations [44]. Not surprisingly, this will result in policy failures. Government practices in urban planning lag behind the rapid degree of urban expansion. Thus, a number of consequences are inevitable, including changes in urban surface, hydrology and flow patterns and erosion associated with heavy rain events.

Additionally, HCMC's environmental regulatory system is the traditional 'command-and-control'-based system. Like other cities in the Southeast Asian region, a state-driven and top-down approach has long been applied to urban environmental challenges [45]. This traditional approach seems to be unsuccessful in dealing with the ubiquitous urban environmental issues in HCMC. More importantly, the combination of laws and subordinate decrees and regulations itself creates the traditional environmental regulatory system, 'command-and-control'. This system fails in developing countries because standards can be set, but are hard to enforce; fines and punishments can be stipulated, but they are not easy to implement in the real face of political involvement [21].

Furthermore, it is common that Asian nations usually set up a short term horizon for water source plans. A long term design plan of 50 or 100 years would be better to secure water for human needs rather than a 10-year design vision [46]. This is one of the stark challenges in water policy development and planning to keep up with rapid changes occurring in economic activities. In addition, O'Rourke (2004) claims that the lack of political power and technical resource of environmental authorities in the developing world results in weak enforcement of compliance with environmental regulations. Consequently, the policy and planning is not resilient enough to respond to emerging trends.

5.CONCLUSION

HCMC has faced with striking water source issues, including pollution, depletion and degradation. As a developing city, it is seeking to advance approaches to the management of water resources which raise more questions than answers. Such questions include to what extent the existing water policy is sustaining the balance of water resource protection during the process of 'industrialization and modernisation"? To what extent is the City intensively polluting and depleting water resources when it industrialises and urbanizes? How can the City deal with increased stresses and burdens on water resource management in the pursuit of social and economic development coupled with the rapid trend of urban expansion in a sustainable way?

Water is undoubtedly one of the key natural resources to underpin sustainable development of HCMC. Urban sustainable development has been deployed as a fashionable slogan of many government sectors and authorities. However, HCMC's authorities lack a

strategic formulation of water resources management. An increase in water demand, pollution control and conservation coupled with industrial growth, population and urbanization are problems facing HCMC's governments at all levels. A future effective strategy to the management of water resources should take into account of rethinking and reshaping government policies, regulations and institutional frameworks. The future management approach also needs to involve public and private partnership, market-based mechanisms, community participation and civil society factors. Therefore, the formulation of overriding institutional framework for water planning, management and development in HCMC is a vital and daunting task.

TỔNG QUAN VỀ QUẢN LÝ TÀI NGUYÊN NƯỚC THÀNH PHỐ HỒ CHÍ MINH, VIỆT NAM

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TÓM TẮT: *Nước là một tài nguyên cho sự sống và được xem là một nhân tố thiết yếu cho các hệ sinh thái. Tuy nhiên, tài nguyên nước đã trở thành một nhân tố hạn chế cho quá trình phát triển kinh tế xã hội. Đối với các đô thị tại các nước đang phát triển, nước ngày càng đóng vai trò quan trọng cho sự phát triển bền vững đô thị. Từ khi quá trình Đổi Mới bắt đầu năm 1986, Thành phố Hồ Chí Minh đã trải qua quá trình công nghiệp hóa và đô thị hóa nhanh chóng. Do đó, Thành phố đã và đang đối mặt với những vấn đề về môi trường đô thị trong đó việc quản lý và sử dụng nguồn nước là một trong những thách thức đối với quá trình phát triển bền vững, bao gồm: thiếu nguồn nước cấp, ô nhiễm nước mặt và cạn kiệt nguồn nước ngầm. Nguyên nhân sâu xa là do những bất cập trong công tác quản lý. Bài báo này nhằm tổng quan những vấn đề về tài nguyên nước song song với quá trình đô thị hóa mạnh trong thời gian qua. Bài báo cũng nhằm mục đích phân tích công tác quản lý và các nguyên nhân trong bối cảnh phát triển bền vững của Thành phố Hồ Chí Minh.*

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