Sustainable Groundwater Management in Asian Cities

Freshwater Resources Management Project
Institute for Global Environmental Strategies

IGES
Institute for Global Environmental Strategies

a final report of Research on Sustainable Water Management Policy

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Preface

Asian cities have faced problems caused by rapid urbanization for decades. While urbanization can bring economic development to the cities, it also produces decrease of natural resources or environmental deterioration. From the perspective of fresh water related issues, Asian cities are suffering from scarcity of water resources and water degradation.

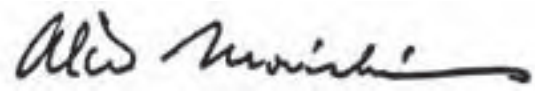
Under these circumstances, groundwater has played an important role in the Asian cities. Groundwater has been used for domestic, industrial and agricultural purposes as a reliable resource in terms of quantity and quality. However, groundwater is also now under severe stress caused by excessive abstraction and contamination in the course of socio-economic development in the city. Problems such as water table depletion, land subsidence, seawater intrusion, and water degradation are emerging due to over-exploitation and contamination of water. Many efforts have already been made in order to address these groundwater related issues. Although some results were realized, their scope was limited and effects lasted for short time.

A research project, the Freshwater Resources Management Project at the Institute for Global Environmental Strategies (IGES), led by Professor Ohgaki launched a policy research, "Sustainable Water Resource Management Policy (SWMP)" in view of this situation in 2004, with the cooperation of research partners in the following case study cities, namely Tianjin (China), Bandung (Indonesia), Colombo and Kandy (Sri Lanka), Bangkok (Thailand), and Ho Chi Minh City (Vietnam). The objective of this research is to formulate policy recommendations for sustainable groundwater management in Asian cities affecting both broad amplitude and persisting time period.

This report entitled "Sustainable Groundwater Management in Asian Cities" is the final research report summarizing results of the past three years. It consists of mainly three chapters, Chapter 1 "Comparative Study of Groundwater Management", Chapter 2 "Changes in Groundwater Management to Enhance Sustainability of Water Resources in Asian Cities", and Chapter 3 "Summary of Case Studies". Chapter 1 presents a summary of comparative analysis of the status of groundwater resources, existing policy measures and future challenges of six case study cities in addition to Tokyo and Osaka as reference cases. Chapter 2 explains in detail policy recommendation for sustainable groundwater management in Asian cities which was the main theme of the three-year research. Chapter 3 introduces the compilation of the summary reports from each SWMP case study city. Each summary report includes 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.

Finally, I would like to extend my deepest appreciation for the research partners who directed the case studies in each country for their contribution to the research. It is my sincere wish that this report will contribute to sustainable development in Asian cities.

March 2007



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List of Abbreviations

ADA	Agricultural Development Authority, Sri Lanka
ADB	Asian Development Bank
AWLR	Automatic Water Table Recorder
BOD	Biological Oxygen Demand
CEA	Central Environmental Authority, Sri Lanka
COD	Chemical Oxygen Demand
CP	Cleaner Production
DARD	Department of Agriculture and Rural Development, Viet Nam
DGR	Department of Groundwater Resources, Thailand
DI	Department of Industry, Vietnam
DIW	Department of Industrial Works, Thailand
DONRE	Department of Natural Resource and Environment, Vietnam
DOSTE	Department of Science, Technology and Environment, Vietnam
DS	Divisional Secretariat, Sri Lanka
DTPW	Department of Transportation and Public Works, Viet Nam
EC	Electric Conductivity
EIA	Environmental Impact Assessment
EPZ	Export-Processing Zones
GDF	Groundwater Development Fund
GDP	Gross Domestic Product
GPP	Gross Provincial Product
GPS	Global Positioning System
HCMC	Ho Chi Minh City
HEPA	Ho Chi Minh Environment Protection Agency, Vietnam
IEAT	Industrial Estate Authority of Thailand, Thailand
IP	Industrial Park
IWMI	International Water Management Institute, Sri Lanka
IWSW	Industrial Water Supply Works
IWTI	Industrial Water Technology Institute, Thailand
JICA	Japan International Cooperation Agency, Japan
MARD	Ministry of Agriculture and Rural Development, Viet Nam
MC	Ministry of Construction, China
MI	Ministry of Industry, Thailand
MLR	Ministry of Land and Resources, China
MONRE	Ministry of Natural Resources and Environment, Thailand/Viet Nam
MWA	Metropolitan Water Works Authority, Thailand
MWR	Ministry of Water Resources, China
NCWR	National Water Resources Council
NEB	National Environment Board, Thailand
NEDO	New Energy and Industrial Technology Development Organization, Japan
NEPA	National Environment Protection Agency, China
NGO	Non-governmental Organisation
NRW	Non-revenue Water, Sri Lanka
NWS & DB	National Water Supply and Drainage Board, Sri Lanka
OMWRM	Office of Minerals and Water Resources Management
PC	People's Committee, Viet Nam
PDAM	Regional Water Company, Indonesia
PWA	Provincial Waterworks Authority, Thailand
RBO	River Basin Organization
RGDP	Regional Gross Domestic Product
RID	Royal Irrigation Department, Thailand
RTSD	Royal Thai Survey Department
RW	Reclaimed Water
RWH	Rain Water Harvesting
SAWASCO	Saigon Water Supply Company, Vietnam
SDPC	State Development Planning Commission, China
SEA	Strategic Environmental Assessment
SWOP	Strength – Weakness – Opportunity – Potentials
TEDA	Technologic-Economic Development Area, China
UNEP	United Nations Environment Programme
UNICEF	United Nations Eductional, Scientific and Cultural Organisation
VOCs	Volatile Organic Compounds
WHO	World Health Organisation
WRB	Water Resources Board, Sri Lanka
WSE	Water Supply Enterprise, Indonesia
WTP	Water Treatment Plant

[Symbols]

μ	Micro
Ag	Silver
Al	Aluminum
As	Arsenic
Cd	Cadmium
Co	Cobalt
Cr	Chromium
Cu	Copper
F	Fluorine
Fe	Iron
Hg	Mercury
Mn	Manganese
Ni	Nickel
P	Phosphorous
Pb	Lead
Se	Selenium
Zn	Zinc

[Units]

mm	millimeter
cm	centimeter
m	meter
m^2	square meter
m^3	cubic meter
km	kilometer
km^2	square kilometer
km^3	cubic kilometer
^oC	degree Celsius
%	percent
ml	mili liter
l	liter
mg/l	milligram per liter
MPN	most probable number
CFU	colony forming unit

Editorial Notes

The name of the city and what we called "case study cities" described in the report do not necessarily correspond with the administrative boundary of the respective cities. The following is the description of the actual coverage area of each case study city.

[Coverage area of each case study city]

Bangkok (10,315 km^2)**:**	7 Provinces namely, Bangkok, Nonthaburi, Samut Prakan, Pathumthani, Samut, Sakhon, Nakhon Pathom, and Ayutthaya
Bangkok Metropolitan Region (2,844 km^2)**:**	3 provinces namely, Bangkok, Nonthaburi, and Samut Prakan
Ho Chi Minh (2,095 km^2)**:**	Ho Chi Minh City
Bandung (2,341 km^2)**:**	Bandung Basin which includes a part of Bandung regency, Sumedang regency,Bandung city and Cimahi city
Tianjin (11,919 km^2)**:**	Tianjin municipality
Colombo (1,575 km^2)**:**	Twenty one divisional secretariat divisions*, namely Aththanagalla, Biyagama,Colombo, Divulapitiya, Dompe, Gampaha, Hanwella, Homagama, Ja Ela, Kaduwela, Katana, Kelanlya, Kollonnawa, Negombo, Mahara, Maharagama, Minuwangoda,Meerigama, Padukka, Wattala, and Sri Jayawardanapura Kotte
Kandy (322 km^2)**:**	Five divisional secretariat divisions*, namely Gangawata Korale, Harispattuwa,Kundasale, Udunuwara, and Yatinuwara
Osaka (1,894 km^2)**:**	Osaka Prefecture
Osaka City (222 km^2)**:**	Osaka city
Tokyo (1,781 km^2)**:**	Tokyo (Tokyo 23 Wards and Tama Area)
Tokyo 23 Wards (621 km^2)**:**	Tokyo 23 Wards

** Sri Lanka has nine provinces which are subdivided into districts. The districts are further divided into the divisional secretariat areas.*

The report uses the local currency unit for each case study country. The currency rate of each unit in US dollar is as following

[Currency Equivalents]
1 JPY (Japanese Yen) = 0.008481 USD (US Dollar)
1 THB (Thai Baht) = 0.03116 USD (US Dollar)
1 IDR (Indonesian Rupiah) = 0.0001098 USD (US Dollar)
1 VND (Vietnamese Dong) = 0.00006486 USD (US Dollar)
1 CNY (Chinese Yuan Renminbi) = 0.12952 USD (US Dollar)
1 LKR (Sri Lanka Rupee) = 0.009208 USD (US Dollar) as of March 2007
1JPY (Japanese Yen) = 0.003293 US Dollar as of March 1972

It should be also noted that there was a limitation in data availability and reliability in the case studies, although all the efforts have been made to obtain necessary and the most reliable data, and to appropriately interpret the data into the analysis conducted.

INTRODUCTION

Groundwater is a reliable source of water for drinking and production both in quantity and quality if the resource is properly managed. However, this resource is now under stress in some Asian cities because of unregulated and excessive abstraction occurring alongside socio-economic development. Problems such as water table drawdown, decreasing well yield, land subsidence, and salinity intrusion have emerged as the results of overexploitation of groundwater. Groundwater quality degradation caused by coliform and heavy metals has also been observed. Such problems may incur socio-economic losses and disturb the development of the cities. These problems are either irreversible in nature or require extended periods to abate, and therefore it is better to take actions to mitigate or prevent them.

However, information on groundwater, such as actual groundwater use and management practices, is currently very limited. This constitutes a barrier to sound discussion on what action is necessary for sustainable use of groundwater, which is to say, what actions are necessary to conserve this precious resource while taking full advantage of it for the development of Asian cities. Sustainable use of groundwater is also important in the pursuit of integrated water resource management.

With the significance of sound groundwater management in Asian cities in mind, the Freshwater Resources Management Project of the Institute for Global Environmental Strategies placed its research focus on groundwater management, particularly in the urban and peri-urban areas of Asian cities. The research entitled "Sustainable Water Resource Management Policy in Asia" (SWMP) aimed to show the state of groundwater and its management in Asian cities.

The state of water resources and how they are used is closely related to the local social, economic, and environmental conditions and, therefore, there is no panacea for the current groundwater issues. Keeping this in mind, we focused on case studies as a core research element of the SWMP research. The case studies were conducted in Bangkok, Thailand; Ho Chi Minh City, Viet Nam; Bandung, Indonesia; and Tianjin, China. Colombo and Kandy in Sri Lanka, and Osaka and Tokyo in Japan were also studied. Based on the case studies, and targeted at those involved in groundwater management, i.e. policy makers, we conducted a comparative study and recommended necessary actions for the sustainable use of groundwater. Throughout the three-year research we held stakeholder meetings in the respective case study cities and discussed our research findings with local stakeholders.

This report entitled "Sustainable Groundwater Management in Asian Cities for Sustainability" contains the main outputs of the three-year research. This report consists of three main chapters. The first chapter comprises highlights of the comparative analysis, the second chapter presents recommendations for sustainable groundwater management based on our research findings, and the final chapter contains summaries of the respective case studies. This report shows that groundwater is still used as an important resource in social and economic activities in cities, even while it becomes increasingly stressed. Considering that current groundwater management practices are not well integrated with management of other water resources and other policy areas such as land use, we recommended that groundwater should be integrated with these other water management policies and other policy areas. In addition, we highlighted that promotion of the rational use of water, especially in the industrial sector in which water demands are increasing, is essential for the sustainable future of water resources, including groundwater.

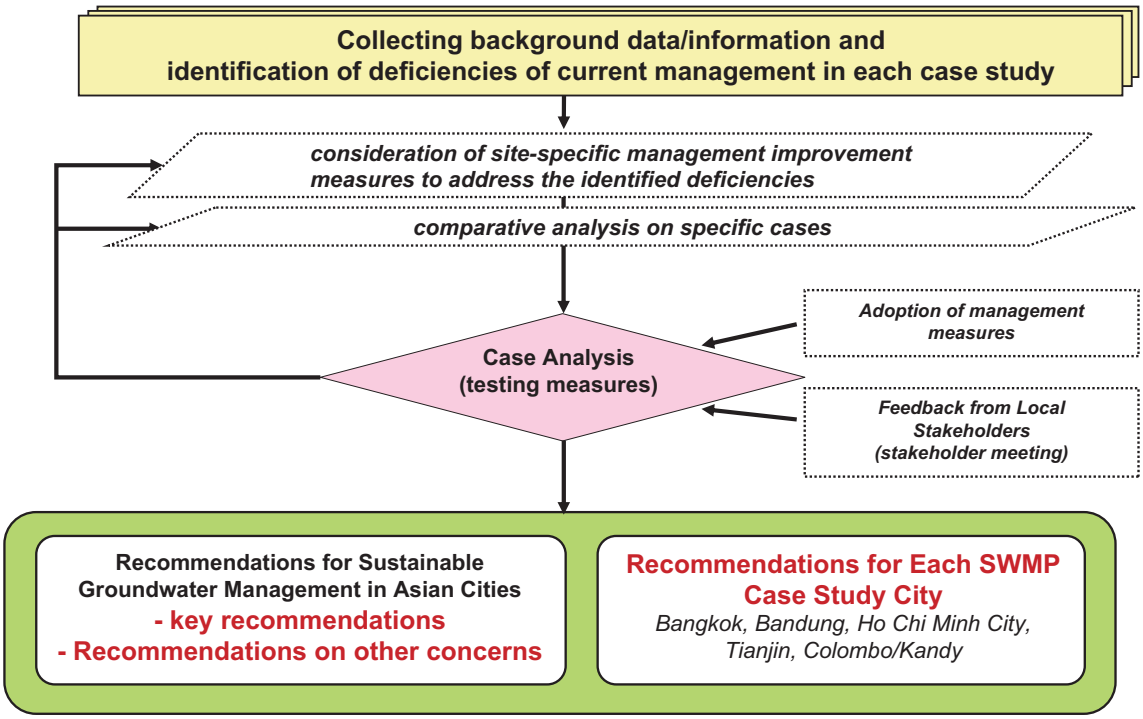

Figure 1. Outline of the Reserch