WEPA
Outlook on Water Environmental Management in Asia 2012

Water Environment Partnership in Asia (WEPA)
Ministry of the Environment, Japan
Institute for Global Environmental Strategies (IGES)
Outlook on Water Environmental Management in Asia 2012

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Background to the Publication

Recognizing the critical situation of water quality in Asia, the Water Environment Partnership in Asia (WEPA) was proposed by the Ministry of the Environment of Japan at the 3rd World Water Forum in 2003. WEPA aims to strengthen water environmental governance in Asia through the collection and dissemination of information and capacity development of relevant stakeholders in partnership with thirteen partner countries in the region, namely Cambodia, China, Indonesia, Japan, Republic of Korea, Lao PDR, Malaysia, Myanmar, Nepal, Philippines, Sri Lanka, Thailand and Viet Nam. WEPA is a forum which allows partner countries to discuss their experiences and identify potential solutions to improve the water environment.

Considering the importance of extracting information on water environment and management, “WEPA Outlook on Water Environmental Management” has been designed to provide basic information on the status and management of the water environment in each WEPA partner country, and to make this information available to the public in one platform as a source of knowledge to promote good water quality governance in the region. The Outlook, which was first published during the 5th World Water Forum in 2009, may also serve as a useful reference for those who are striving to solve water quality issues in other countries in the world.

“WEPA Outlook on Water Environmental Management 2012”, which is the second edition of the series, consists of three main chapters. Chapter 1 presents the result of the analysis of institutional frameworks for water environment management in each country. Chapter 2 summarizes the discussions and studies conducted on the two priority issues of “domestic wastewater treatment” and “climate change and the water environment”. The third chapter provides updated country profiles on water environmental management in the WEPA partner countries. It also presents WEPA’s message which introduces the key actions identified and future commitments made in discussions held at WEPA annual meetings and dialogues.

The report, a major output of the WEPA activities by all partner countries, intends to stimulate dialogue around the issues on water environment. The WEPA Outlook 2012 is published at the 6th World Water Forum, which is held in March 2012 in Marseille, France, and where WEPA was registered as one of the “Solutions for Water.” We wish the Outlook to serve as a useful reference for those interested in the issues in Asia including the participants of the 2nd Asia Pacific Water Summit, and in other parts of the world to accomplish our mutual goal of sustainable water environment.

March 2012

Ministry of the Environment, Japan
Institute for Global Environmental Strategies (WEPA Secretariat)
Message from WEPA: Water Quality Challenges in Asia for a Sustainable Future

Significant pressure and risks to the water environment in the region

1. While diverse, Asian countries also share similarities in climatic and natural conditions and cultural backgrounds. In general, people in the region enjoy many of the benefits provided by water. Nevertheless, they also suffer from seasonal fluctuations in water volume at both ends of the spectrum, such as from floods and droughts.

2. Over the past few decades, Asia has been a focal point for the world’s rapid growth, demonstrating a 120% increase in GDP in the region and accounting for 60% of the world’s population growth. Rapid urbanization and the swift increase in population and economic development that are associated with unsustainable development practices have resulted in intense pressure on water resources both in quantity and quality, as well as on aquatic ecosystems in the region.

Accelerate water environmental management to safeguard the water environment

3. Significant time and resources must be invested to improve water quality and restore aquatic ecosystems once destroyed. Therefore, it is of the utmost importance to strengthen water quality management in areas where water environmental deterioration has been observed, and to promote and ensure development and implementation of water environmental management at regional, national and local levels without delay in order to minimize the impacts of human activities on the water environment. The key to our sustainable future is ensuring a sound water environment.

Water Environment Partnership in Asia (WEPA)

4. Considering the critical situation of the water environment in the region, the Water Environment Partnership in Asia (WEPA) was proposed by the Ministry of the Environment of Japan at the 3rd World Water Forum in 2003. The programme, launched in 2004 with the participation of 11 Asian countries: Cambodia, China, Indonesia, Japan, Republic of Korea, Lao PDR, Malaysia, Myanmar, the Philippines, Thailand, and Viet Nam, is a forum which allows partner countries to discuss their experiences and identify potential solutions to improve the water environment. In 2009, WEPA membership expanded to include Nepal and Sri Lanka.

5. Reaffirming that the sound management of the water environment is necessary for the sustainable development of Asia, as well as to achieve the Millennium Development Goals (MDGs), and recalling discussions within WEPA for better water environment, WEPA partners hereby deliver the following key messages to those residing in the region and to stakeholders worldwide to promote a sustainable water environment in Asia and the Pacific, and commit to upholding efforts to improve the condition of the world’s water environment through WEPA activities.
Key messages

6. Between 1980 and 1990, in particular, most WEPA partner countries established frameworks for sound water environmental management, set goals for water environmental management and implemented various measures to improve water pollution. Thanks to these efforts, a number of WEPA partner countries were able to observe significant improvement in water quality.

7. Despite this, organic pollution in rivers located in populated areas and eutrophication in enclosed water bodies such as lakes, reservoirs and estuaries continue to require special attention. Considering economic development, population growth and urbanization observed in the region and the possible impacts of climate change, further intensified efforts are necessary to guarantee the implementation of water environmental policies to secure human health, sustainability of ecosystems, and promotion of sustainable development in the region.

Key action areas in water environmental management

8. WEPA partner countries identified the following common action areas to be promoted in each country to set and/or attain the water quality goals of each country.

   a) Review laws, regulations, and setting of standards in consideration of socio-economic conditions and the current state of the water environment, such as effluent standards taking into account the structure of industries and quality of effluents.

   b) Strengthen local management of the water environment such through the establishment of water environmental management strategies and action plans at the basin level.

   c) Improve/strengthen the scientific basis for policy making such as the establishment of effective monitoring systems within limited budgets and the improvement of data storage systems.

   d) Strengthen the control of water pollution sources such as through the promotion of adequate domestic wastewater treatment and the introduction/implementation of total pollution control load systems.

   e) Stipulate polluter pays principle in water quality management and utilize market-based instruments as an incentive for compliance.

   f) Promote institutional and technical capacity building of organizations in charge of water environmental management at national and local levels.

   g) Promote participation of the private sector, civil society and communities in water management and improve environmental awareness.

Preparation for the potential impacts of climate change

9. The impacts of climate change to the water environment is one of the myriad mid- and long-term challenges facing the region, although there is as yet little scientific proof on which to base actions. To prepare for potential impacts, however, “no-regret responses” should be taken such as ensuring regular water quality monitoring and improving data collection and exchange systems. At the international and regional level, it is also important to share scientific knowledge and possible adaptation options.
Strengthen domestic wastewater management

10. All WEPA partner countries made significant efforts to improve sanitary conditions to achieve the sanitation goals set out by the MDGs, and therefore, treatment of black water has been promoted in the region. However, the pollution load of grey water is also considerable and therefore the treatment of black water should be supplemented with the promotion of grey water treatment.

11. WEPA partner countries plan to construct or have developed centralized wastewater treatment plants especially in urban areas. However, many countries now face various challenges in the development and operation of such large-scale, centralized systems, including land acquisition for the construction of plants and financial constraints in the development stage, as well as low household connection rates and cost recovery issues in the operation and maintenance stage.

12. In areas without centralized treatment systems, septic tank treatment is a typical option. However, septic tanks do not always adequately treat wastewater and itself can become a source of pollution. There are two key questions that arise when discussing the improvement of domestic wastewater treatment in the region: how to promote construction and improve the operation and maintenance of central wastewater treatment systems, and how to promote treatment of domestic wastewater in areas with little to no access to adequate treatment systems.

13. WEPA countries have developed the knowledge to promote domestic wastewater treatment within their own individual socio-economic constraints. Such knowledge includes the prioritization of areas that need treatment in consideration of local conditions, such as population density or variability of the water environment; development of small-scale treatment facilities; upgrade or utilization of existing infrastructure and unutilized space; and promotion of community or private sector involvement in the operation and maintenance of treatment plants. It is imperative for WEPA countries to share and learn from such good practices and discuss possible applications to other areas of the region.

Future WEPA activities

14. Keeping the key policy areas mentioned in our message in mind, WEPA will continue to facilitate the exchange of lessons and knowledge among WEPA member countries through existing WEPA schemes such as the WEPA database and policy dialogues. In addition, to strengthen experience and knowledge sharing among partner countries, WEPA will introduce new schemes such as thematic group meetings among WEPA countries which have similar policy challenges, in addition to twinning programmes between partner countries. Furthermore, to highlight the importance of river basin management, WEPA will strengthen relationships with other like-minded networks and programmes, such as the Network of Asian River Basin Organizations (NARBO).
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Takahiko Hiraishi, Senior Consultant, IGES, (Co-Chair, IPCC Inventories Task Force Bureau)
# Abbreviations

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<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ADB</td>
<td>Asian Development Bank</td>
</tr>
<tr>
<td>AMDAL</td>
<td>Environmental Impact Assessment Statement</td>
</tr>
<tr>
<td>ASER</td>
<td>Annual Regional Environment Statement</td>
</tr>
<tr>
<td>BOD</td>
<td>Biochemical Oxygen Demand</td>
</tr>
<tr>
<td>CBS</td>
<td>Central Bureau of Statistics</td>
</tr>
<tr>
<td>CEA</td>
<td>Central Environment Authority</td>
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<tr>
<td>CNMC</td>
<td>Cambodia National Mekong Committee</td>
</tr>
<tr>
<td>COD</td>
<td>Chemical Oxygen Demand</td>
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<tr>
<td>CRMP</td>
<td>Coastal Resource Management Project</td>
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<tr>
<td>CWTPs</td>
<td>Combined Wastewater Treatment Plants</td>
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<tr>
<td>DAO</td>
<td>DENR Administrative Order</td>
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<tr>
<td>DA</td>
<td>Department of Agriculture</td>
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<tr>
<td>DDA</td>
<td>Department of Development Affairs</td>
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<tr>
<td>DDCs</td>
<td>District Development Committees</td>
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<tr>
<td>DENR</td>
<td>Department of Environment and Natural Resources</td>
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<tr>
<td>DHM</td>
<td>Department of Hydrology and Meteorology</td>
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<tr>
<td>DKI</td>
<td>Special Capital City District</td>
</tr>
<tr>
<td>DO</td>
<td>Dissolved Oxygen</td>
</tr>
<tr>
<td>DoE</td>
<td>Department of Environment</td>
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<tr>
<td>DoEPC</td>
<td>Department of Environmental Pollution Control</td>
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<tr>
<td>DoNRE</td>
<td>Department of Natural Resources and Environment</td>
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<tr>
<td>DWSS</td>
<td>Department of Water Supply and Sewerage</td>
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<tr>
<td>EIA</td>
<td>Environmental Impact Assessments</td>
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<tr>
<td>EMB</td>
<td>Environmental Management Bureau</td>
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<tr>
<td>EPA</td>
<td>Environment Protection Act</td>
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<tr>
<td>EPL</td>
<td>Environmental Protection Law</td>
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<td>EQA</td>
<td>Environmental Quality Act</td>
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<tr>
<td>EQS</td>
<td>Environmental Quality Standards</td>
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<td>FAO</td>
<td>Food and Agriculture Organization</td>
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<tr>
<td>GB</td>
<td>National Standards</td>
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<tr>
<td>GB/T</td>
<td>Recommended Standards</td>
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<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>ICIMOD</td>
<td>International Centre for Integrated Mountain Development</td>
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<tr>
<td>IETS</td>
<td>Industrial Effluent Treatment Systems</td>
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<td>IGES</td>
<td>Institute for Global Environmental Strategies</td>
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<td>IMF</td>
<td>International Monetary Fund</td>
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<td>IPCC</td>
<td>Intergovernmental Panel on Climate Change</td>
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<tr>
<td>ISES</td>
<td>Industry-Specific Effluent Standards</td>
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<tr>
<td>JWK</td>
<td>Indah Water Konsortium</td>
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<tr>
<td>LGUs</td>
<td>Local Government Units</td>
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<td>LLDA</td>
<td>Laguna Lake Development Authority</td>
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<td>LSGA</td>
<td>Local Self Governance Act</td>
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<tr>
<td>MBAS</td>
<td>Methylene Blue Active Substances</td>
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<td>MDG</td>
<td>Millennium Development Goal</td>
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<td>MENR</td>
<td>Ministry of Environment and Natural Resources</td>
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<tr>
<td>MEP</td>
<td>Ministry of Environmental Protection</td>
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<tr>
<td>MLIT</td>
<td>Ministry of Land, Infrastructure, Transport and Tourism of Japan</td>
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<tr>
<td>MoAIMD</td>
<td>Ministry of Agriculture, Irrigation and Mahaweli Development</td>
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<td>MoCT</td>
<td>Ministry of Construction and Transportation</td>
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<tr>
<td>MoE</td>
<td>Ministry of Environment</td>
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<td>MoEJ</td>
<td>Ministry of the Environment of Japan</td>
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<tr>
<td>MoNRE</td>
<td>Ministry of Natural Resources and Environment</td>
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<td>MoSTI</td>
<td>Ministry of Science, Technology and Innovation</td>
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<tr>
<td>MoU</td>
<td>Memorandum of Understanding</td>
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<td>MoWRAM</td>
<td>Ministry of Water Resources and Meteorology</td>
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<td>MPPA</td>
<td>Marine Pollution Prevention Authority</td>
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<td>MPWT</td>
<td>Ministry of Public Works and Transportation</td>
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<td>MRC</td>
<td>Mekong River Commission</td>
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<td>MWQCS</td>
<td>Marine Water Quality Criteria and Standards</td>
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<td>MWR</td>
<td>Ministry of Water Resources</td>
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<td>MWSS</td>
<td>Metropolitan Water Works and Sewerage System</td>
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<td>NAA</td>
<td>Non-Attainment Areas</td>
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<tr>
<td>NCEA</td>
<td>National Commission for Environmental Affairs</td>
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<td>NCSD</td>
<td>National Council for Sustainable Development</td>
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<tr>
<td>NEB</td>
<td>National Environmental Board</td>
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<tr>
<td>NGO</td>
<td>Non Governmental Organization</td>
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<tr>
<td>NIS</td>
<td>National Institute of Statistics</td>
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<tr>
<td>Abbreviation</td>
<td>Full Form</td>
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<tr>
<td>NLMA</td>
<td>National Land Management Authority</td>
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<td>NRE</td>
<td>Ministry of Natural Resources and Environment</td>
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<td>NSDW</td>
<td>National Standards for Drinking Water</td>
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<td>NSO</td>
<td>National Statistics Office</td>
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<td>NTNC</td>
<td>National Trust for Nature Conservation</td>
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<td>NWP</td>
<td>National Water Plan</td>
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<td>NWQS</td>
<td>National Water Quality Standards</td>
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<td>NWSS&amp;DB</td>
<td>National Water Supply and Drainage Board</td>
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<td>ONEP</td>
<td>Office of Natural Resources and Environmental Policy and Planning</td>
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<td>PCAs</td>
<td>Pollution Control Areas</td>
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<td>PCB</td>
<td>Polychlorinated Biphenyl</td>
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<td>PCD</td>
<td>Pollution Control of Department</td>
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<td>PCE</td>
<td>Perchloroethylene</td>
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<td>PD</td>
<td>Presidential Decree</td>
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<tr>
<td>pH</td>
<td>Power of Hydrogen (hydrogen-ion concentration)</td>
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<td>PPP</td>
<td>Polluter Pay Principal</td>
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<td>PRC</td>
<td>People's Republic of China</td>
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<td>RA</td>
<td>Republic Act</td>
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<td>RBIMS</td>
<td>River Basin Integrated Information Management Systems</td>
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<td>ROK</td>
<td>Republic of Korea</td>
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<td>SEPA</td>
<td>State Environmental Protection Administration, China</td>
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<td>SLS</td>
<td>Sri Lanka Standards (test method)</td>
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<td>SMEs</td>
<td>Small and Medium Enterprises</td>
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<td>SOEs</td>
<td>State Owned Enterprises</td>
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<td>SSD</td>
<td>Sewerage Service Department</td>
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<td>TCE</td>
<td>Trichloroethylene</td>
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<td>TCVN</td>
<td>National Environmental Standards</td>
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<td>TMDLs</td>
<td>Total Maximum Daily Load System</td>
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<td>TMS</td>
<td>Tele-Monitoring system</td>
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<tr>
<td>TN</td>
<td>Total Nitrogen</td>
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<td>TOC</td>
<td>Total Organic Carbon</td>
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<td>TP</td>
<td>Total Phosphorus</td>
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<td>TPLCs</td>
<td>Total Pollutant Load Control System</td>
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<td>TSS</td>
<td>Total Suspended Solids</td>
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<td>TSGL</td>
<td>Tonle Sap Great Lake</td>
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<td>UKL-UPL</td>
<td>Environmental Management Effort and Environmental Monitoring Efforts</td>
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<td>UNDESA</td>
<td>United Nations Department of Economic and Social Affairs</td>
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<td>UNDP</td>
<td>United Nations Development Programme</td>
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<td>UNEP</td>
<td>United Nations Environmental Programme</td>
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<td>UNESCO</td>
<td>United Nations, Educational, Scientific and Cultural Organization</td>
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<td>UNICEF</td>
<td>United Nations Children's Fund</td>
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<td>VAT</td>
<td>Value Added Tax</td>
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<td>VDCs</td>
<td>Village Development Committees</td>
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<td>VEA</td>
<td>Vietnam Environment Administration</td>
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<td>VOC</td>
<td>Volatile Organic Compounds</td>
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<td>WCP</td>
<td>Wastewater Charge Programme</td>
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<td>WDI</td>
<td>World Development Indicator</td>
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<td>WECS</td>
<td>Water and Energy Commission Secretariat</td>
</tr>
<tr>
<td>WEPA</td>
<td>Water Environment Partnership in Asia</td>
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<tr>
<td>WHO</td>
<td>World Health Organization</td>
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<tr>
<td>WQC</td>
<td>Water Quality Criteria</td>
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<tr>
<td>WQI</td>
<td>Water Quality Index</td>
</tr>
<tr>
<td>WQMA</td>
<td>Water Quality Management Areas</td>
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<tr>
<td>WQMAP</td>
<td>Water Quality Management Action Plan</td>
</tr>
<tr>
<td>WREA</td>
<td>Water Resources and Environment Administration</td>
</tr>
<tr>
<td>WRUD</td>
<td>Water Resources Utilization Department</td>
</tr>
<tr>
<td>WWF</td>
<td>World Wide Fund for Nature</td>
</tr>
<tr>
<td>YCDC</td>
<td>Yangon City Development Committee</td>
</tr>
</tbody>
</table>
Outlook on Water Environmental Management in WEPA countries
Chapter 1
Outlook on Water Environmental Management in WEPA countries

1. Background

The Water Environment Partnership in Asia (WEPA) was formed to address issues related to the water environment in the 13 countries that it covers. Despite measures taken to date to combat pollution and improve the quality of water, low water quality still sits among the most pressing environmental problems for these countries and is still critical in some areas, particularly urban areas, as a consequence of socio-economic growth. The partner countries have each developed policies and measures designed to both combat the growing threat of water pollution in critical areas, and to avoid future outbreaks in other areas.

Certain aspects of water environmental management differ across the partner countries—due to factors such as the duration, gravity, cause and level of socio-economic development forming the backdrop to the problems—but some, such as pollution source control, are common to all as basic measures. Providing a review, therefore, was deemed useful in order both to illustrate what progress has been made and to identify common management challenges. It is hoped that this will in turn lead to more knowledge-sharing for future WEPA activities.

To this end, this chapter summarises the state of water environmental management in WEPA partner countries based on the country profiles in Chapter 3 and attempts to identify common challenges.

2. Overview of Water Environmental Management Framework in WEPA Partner Countries

This section gives a snapshot of the current water environmental management frameworks existing in the WEPA partner countries, from the following four perspectives:

1) Legislation, policies and strategies for water environmental management, related to policy goal/target setting;
2) Measures to ensure implementation and compliance, focusing on wastewater management;
3) Monitoring of ambient and effluent waters necessary to access the efficacy of 1 and 2 above;
4) Other factors contributing to enforcement and improvement measures.

Given that the problems faced by each country differ in both type and scale we set out to solely provide a country-based overview of the progress made in the policies and measures related to the water environment, and tried to avoid any inter-country comparisons or evaluations of progress. The measures themselves and their status of implementation are not dealt with here in detail and will be covered at a later date by WEPA.

Legislation, policies and strategies for water environmental management

1) Objectives of water environmental management

- Most countries have set out a basic environmental law stipulating protection of human health, ensuring a safe human environment and protection of the environment as a basis for sustainable development, and these objectives also apply for water environmental management.

- Myanmar has various laws and regulations related to environmental protection, but no environmental conservation or pollution control specific ones.

- More detailed definitions of water environmental management objectives are given by such as laws or acts specific to water pollution control in some countries.

2) Ambient water quality standards as the administrative target

- Ambient water quality standards show the basic levels of water quality that need to be maintained and act as administrative targets.

- Most WEPA countries set ambient water quality standards for rivers are established, while less number of countries has the one for groundwater.

- Drinking water quality standards are used to evaluate water quality in countries that have not set ambient quality standards.

- No ambient water quality standards set out in Myanmar.
and Sri Lanka (as of December 2011), but both countries are currently formulating them.
- Sri Lanka’s Central Environment Authority (CEA) has set proposed water quality standards, which are also used for water quality evaluation.

- Some countries have more than two types of standards due to different conservation objectives; others have uniform standards. The following table shows the state of ambient water quality standard-setting in each partner country.

Table 1.1. Type of ambient water quality standards

<table>
<thead>
<tr>
<th>Country</th>
<th>Ambient water quality standards</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cambodia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>China</td>
<td></td>
<td>There are additional parameters for surface water serving as drinking water sources.</td>
</tr>
<tr>
<td>Indonesia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>*1</td>
<td>*1 A parameter for the aquatic ecosystem conservation is included under the living environmental standard.</td>
</tr>
</tbody>
</table>
| Republic of Korea | *2, *3                       | *2 Water quality by grade & biological features of aquatic ecosystem.  
                                                   *3 Groundwater standards are set for agricultural water, industrial water. |
| Lao PDR        |                                 |                                                                      |
| Malaysia       |                                 |                                                                      |
| Myanmar        |                                 |                                                                      |
| Nepal          |                                 | Nepal sets water quality standards for different water use objectives. Standards for recreation and those for aquatic ecosystems were established. |
| Philippines    |                                 | There are two types of standards for surface water-standards for toxins and other conventional parameters. |
| Sri Lanka      |                                 | Awaiting for approval of ambient water quality standards.            |
| Thailand       |                                 |                                                                      |
| Viet Nam       |                                 |                                                                      |

Legend:
- Human health
- Living environment
- Ecosystem/Biodiversity
- One type
- Others

* Rivers and lakes and reservoirs
3) Strategies or plans for water environmental management

- Use of time-bound specific targets as a tool to accurately evaluate policy objectives, as practiced in China, Indonesia, Republic of Korea, and Viet Nam.

- Use of national water environmental plan/strategies with specific time periods (Sri Lanka and Thailand), without numerical targets.

- Use of time-bound specific targets established for specific water bodies under a total pollution load control system (as in Japan, which has no specific plans or strategies for water environmental management).

- Successful implementation relies on the availability of financing.

**Measures to ensure implementation and compliance**

1) Effluent standards

- All countries have set national effluent standards (with the exception of Myanmar, where national effluent standards are now under consideration and Yangon Special City has set its own effluent standards).
  - China, Lao PDR, Nepal, Sri Lanka, Thailand and Viet Nam set industrial effluent standards according to the type of industry.
  - In Cambodia, different effluent standards can be established in accordance with proximity of pollution sources to sensitive environmental/ecosystem conservation areas.
  - Since 2000, China, Indonesia, Lao PDR, Malaysia and Sri Lanka have introduced or revised effluent standards to strengthen effluent management.
  - Japan and Republic of Korea introduced a system to control total pollution loads in specific water bodies in addition to effluent control via pollutant concentration.

2) Inspections and penalties for non-compliance

- Systems for inspection, governmental guidance and penalties are in place in countries which set effluent standards.

- Measures to counter non-compliance in effluent management (such as violations of effluent standards and effluent quality recording obligations) have been beefed-up in Indonesia, Japan and Viet Nam.

**Monitoring of ambient and effluent water**

1) Ambient water quality monitoring

- Ambient water quality is monitored on a project basis or for a specific benefit (e.g., irrigation and drinking water) such in Nepal, Myanmar and Sri Lanka. Other countries have regular monitoring systems which differ in number of monitoring points, parameters, and frequency.

  - According to the WEPA survey in 2009, the following countries have collected water quality data of river waters for over 10 years: Japan, Republic of Korea, Malaysia, and Thailand (see Chapter 2.2, Figure 2.2.6).

2) Effluent quality monitoring

- Despite obligations on the owner of the pollution source and wastewater treatment facility to monitor effluent quality, this is not comprehensively done in all countries and monitoring results sometimes do not reach the intended authorities.

  - In Cambodia and Sri Lanka the central government conducts monitoring at sites suspected of discharging high concentrations of effluents.

  - In Republic of Korea, centralized monitoring of effluent using a tele-metering system was introduced for pollution sources (industries and domestic wastewater treatment facilities) with certain volumes of effluents.

  - In Malaysia, an on-line reporting system has been introduced under which industries can report their effluent monitoring results through a website.

  - In Japan, recording of monitoring results became mandatory under a revision to the Water Pollution Control Law in 2010.

3) Recording, maintenance and evaluation of monitoring results

- Results of ambient water quality monitoring are recorded and maintained by the agencies conducting monitoring. However, the data is not maintained according to any set format.

* In Sri Lanka, another revision of effluent standards is now under consideration for approval.
The WEPA survey on water quality monitoring data collection in 2009 found that it is difficult to share pooling of data maintained by different agencies among them (see chapter 2.2, p.48).

**Other factors contributing to enforcement and removal of incorrect practices**

1) Disclosure of ambient water quality monitoring results

- The results of monitoring are evaluated annually in many countries for information disclosure and policy evaluation.

- In many countries the state of water quality is mainly reported to the general public via annually published environmental quality reports. The following countries enable public access to environmental reports giving comprehensive assessments of water quality on websites: China, Japan, Republic of Korea, Malaysia, Thailand, and Viet Nam.

- The Water Quality Index (WQI) is used for evaluation of overall status of water quality in some countries, such as China, Malaysia and Thailand. The method of WQI calculation is decided by each country. Other countries that assess their water quality annually (Japan, Republic of Korea, Philippines and Viet Nam) use specific parameters to represent water quality status (e.g., BOD or COD for organic pollution).

- In some countries, such as China, Republic of Korea and Thailand, the public can view real-time monitoring data on a website, which is uploaded from continuous monitoring stations. Other countries such as Japan also utilise a website to publish details of water quality monitoring results.

2) Review cycle of water environmental policy

- The WEPA secretariat cannot obtain sufficient information on the review cycle of water environmental policy as many countries have no fixed review cycle.

- In countries utilising time-bound policy/strategies, the efficacy of mitigation measures is reviewed according to such policy/strategies.

**3. Recent Developments in Water Environmental Management and Challenges**

**Developments in water environmental management over the past 10 years**

- All WEPA countries have attempted to strengthen their water environmental management systems over the past 10 years. Table 1.2 shows the major developments in water environmental management in the partner countries.

- The key developments are as follows:

  1) Strengthening of effluent management, which includes set-up and revision of effluent standards and introduction of charges for wastewater.

  2) Introduction of a framework for river basin management which embraces aspects of water quality conservation.

  3) Incorporation of concerns surrounding ecosystem conservation.

- Upgrading or restructuring of central government organizations in charge of environmental management is a common feature in WEPA partner countries. Water resource management departments and environmental/pollution management departments which used to be headed by different government agencies are now organized under the newly established Ministry of Natural Resources and Environment in Malaysia, Thailand and Viet Nam. In 2011, the new ministries for environment were set up in Lao PDR and Myanmar.

- Many new developments for strengthening management were observed especially in the countries which initiated water environmental management in late 1980s. Such countries include Cambodia, Lao PDR, Sri Lanka and Viet Nam.

- In the countries which initiated water environmental management at a relatively early stage, such as China, Japan, Republic of Korea, Malaysia, and Thailand, policies and measures have become that much more detailed, in order to improve the water environment.

- Some partner countries experienced significant disasters in 2011. Boxes 1.1 and 1.2 show water environmental sector responses to disasters affecting Japan and Thailand, respectively.
<table>
<thead>
<tr>
<th>Year</th>
<th>Major development in organizational setting</th>
<th>Major development in legislation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>Revision of Environment Act (Sri Lanka)</td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td>Establishment of Ministry of the Environment, upgraded from Environment Agency (Japan)</td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td>Establishment of Ministry of Natural Resource and Environment as a restructure of central government agencies (Thailand, Viet Nam)</td>
<td>• Revision of the Framework Act on Environmental Policy (ROK) • Approval of National Environment Policy (Malaysia)</td>
</tr>
<tr>
<td>2003</td>
<td>• Addition of zinc as a parameter of water quality environmental standards, in consideration of protection of aquatic ecosystem (Japan) • Establishment of Environmental Management Policy (Nepal) • National Environmental Management Policy (Sri Lanka) • Set up the National Strategy for Environmental Management until 2010 and vision toward 2020 (Viet Nam) • Introduction of environmental protection charge for wastewater (Viet Nam)</td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td>Establishment of Ministry of Natural Resource and Environment as a restructure of central government agencies (Malaysia)</td>
<td>• Introduction of total maximum daily load system (TMDLs) (ROK) • Revision of the Clean Water Act (Philippines) • Decree on Licensing for exploitation, utilization, use and discharge of waste water (Viet Nam)</td>
</tr>
<tr>
<td>2005</td>
<td>• Addition of chemical substance parameters to standards (ROK) • Approval of the National Water Environment Master Plan (2006-2015) (ROK) • Adoption of the National Water Policy (Nepal) • Revision of Law on Environmental Protection (Viet Nam)</td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>• Inclusion of 16 water pollution projects in mid-term plan (China) • Start of regular monitoring in 35 major rivers (Indonesia) • Revision of the Lake Water Law (Japan) • Approval of basin management project in three major basins (Viet Nam)</td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>• Enacted the Law on Water Resources and Management (Cambodia) • Revision of the Water Quality Conservation Act (renamed as the Water Quality and Ecosystem Conservation Act) (ROK), which further emphasize conservation of ecosystems • Revision of Water Quality and Ecosystem Conservation Act and its Enforcement Decree (ROK) • Approval of national ambient and effluent water standards (Lao PDR) • Approval of the National master Program for Natural Resource and Environment Monitoring until 2020 (Viet Nam)</td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>Establishment of the Ministry of Environment Protection (MEP), upgraded from the State Environmental Protection Administration (SEPA) (China) Set up the Vietnam Environment Administration (VEA) (Viet Nam)</td>
<td>• Revision of series of effluent standards (2008-2011) (China) • Start of regular ambient water monitoring conducted by the central government (Cambodia) • Establishment of new effluent standards (Sri Lanka) • Establishment of Marine Pollution Prevention Act (Sri Lanka) • Revision of ambient quality standards for surface, coastal and underground waters (Viet Nam) • Revision of series of effluent standards (2008-2010) (Viet Nam) • Establishment of ambient quality standard for groundwater (Viet Nam) • Approval of Decree 120/2008/ND-CP on basin management (Viet Nam)</td>
</tr>
<tr>
<td>2009</td>
<td>• Revision of the National Environmental Law, aiming to strengthen implementation, especially control of point sources (Indonesia) • Revision of effluent standards (Malaysia) • Approval of Bagmati Action Plan (Nepal) • Approval of a new national environmental policy and its action plan (Sri Lanka) • Start of classification of water bodies (Philippines)</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>• Adoption of the mid-term development plan (2010-2015), which states reduction targets for pollutants (China) • Revision of the Water Pollution Control Law, which address water quality related accidents and effluent management (Japan) • Introduction of on-line wastewater registration system (Malaysia) • Establishment of Wastewater Treatment System Effluent Standard (Thailand)</td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>Establishment of Ministry of Natural Resource and Environment (Lao PDR) Establishment of Ministry of Environmental Conservation and Forestry (Myanmar)</td>
<td>• 12th Five-Year Plan (2011-2015) (China) • Revision of the Water Pollution Control Law, which strengthen groundwater quality management (Japan)</td>
</tr>
</tbody>
</table>
The Great East Japan Earthquake and the accompanying tsunami that occurred in March 2011 wreaked large-scale destruction, not least of which was the loss of many lives. Further, the disaster at the Fukushima Daiichi Nuclear Power Plant precipitated by the tsunami brought about unprecedented environmental contamination due to the release of radioactive materials into the environment, including the water environment. This box presents impacts of the Great East Japan Earthquake primarily related to the water environment.

**Damage to domestic wastewater treatment facilities and prompt recovery**

Sewage treatment plants along the coasts of Iwate, Miyagi and Fukushima prefectures suffered considerable damage from the tsunami, and 48 plants were shut down. However, due to the subsequent prompt recovery response, as of Dec 1, 2011 only 16 plants remained shutdown. At 14 of these plants, emergency treatment is being carried out. These plants will gradually be upgraded to the level of primary treatment, followed by restoration of former capabilities. Complete recovery is aimed for as soon as possible with the objective of preventing disasters from occurring again.

Results of a sampling survey conducted in the highly damaged regions of the three disaster-stricken prefectures reveal that 3.8% of Jokasou units (a domestic waste water treatment facility) were written off and 28% required urgent repairs. The remaining 68% required no particular repairs. Jokasou units are also used for temporary housing; approximately 60% of domestic wastewater from temporary housing is treated by Jokasou units.

**Emergency survey on toxic materials**

In response to public concerns voiced over negative impacts on health and living environment due to seepage of toxic substances into public surface water bodies and groundwater, the Ministry of the Environment of Japan (MoEJ) conducted emergency surveys from late May through late July in the rivers, coastal areas, and groundwater in areas that sustained heavy damage from the earthquake and tsunami. The surveys covered items pertaining to environmental standard and dioxins.

The results show that no instances of excess contamination have been confirmed. The MoEJ intends to closely monitor sites where toxic substances were detected in excess of environmental standards, via regular continuous monitoring by local governments.

Additional surveys were carried out by the MoEJ covering groundwater and the vicinity of wells in accordance with environmental standards and toxins standards. Guidance on drinking water for owners of wells was issued via local governments.

**Monitoring of radioactive substances**

Monitoring of radioactive fallout from the nuclear power plant disaster was carried out by the MoEJ from late May to late July 2011 to check the concentrations of radioactive substances in the water environment (rivers, lakes and marshes, river-head areas, and coasts including bathing beaches) and groundwater. A Monitoring Coordination Conference was established in August 2011 in order to coordinate and systematise the work.

The water environment is to be monitored, including for radioactive substances, in public surface waters and groundwater within a radius of approx. 100 km from the nuclear power plant. Also set to take place is offshore monitoring of the concentration of radioactive substances in the seawater from Fukushima to Iwate. Part of the survey was initiated in late August.

While no radioactive substances have been detected so far, high readings have been detected in sediment.

Allied with the decontamination work for radioactive substances now in full-swing, concerns over high concentrations of radioactive substances in the water environment still remain, thus it is critical to ascertain any trends that might emerge.

(Source: Provided by the Ministry of the Environment of Japan)
metals and nutrients were also measured by the Environmental Research and Training Center in six provinces surrounding the BMA, and revealed that DO levels at sampling points in Pathum Thani, Chachoengsao, and Nakhon Nayok provinces were below 2 mg/L. This low DO level was believed to be caused by the inflow of domestic wastewater and solid waste, as well as outflow from paddy fields, and resulted in widespread fish death in some fish farms.

In addition to salinity and DO level changes, heavy metals and nutrients were also measured by the Thailand's Great Flood 2011 and water environment

Thailand was faced with a severe flood crisis, which started in the upper part of the Chaophaya River Basin in mid-May and then spread to the lower part in Bangkok Metropolitan Areas (BMA) with high impacts (from flooding and water pollution) during October - November 2011. This was due to excessive amounts of rainfall during the monsoon season, leading to higher volumes of water than the previous years. Owing to a spring tide and standing structures, the water that entered the Chao Phraya River basin, i.e., the area containing northern, eastern and western Bangkok and surrounding areas, was trapped as it couldn't drain quickly enough into the Gulf of Thailand. Therefore, a large area of the plains around Bangkok had a high risk of flooding.

As a response to this crisis, the Thai Government established the Flood Relief Operations Center (FROC) in the beginning of October. The main responsibilities of FROC, in collaboration with relevant organizations, are to drain floodwater into the Gulf of Thailand as quickly as possible and to prevent floodwater from seriously affecting BMA—the political and economic capital of Thailand.

Owing to these efforts, BMA could avoid sustaining serious damage from the flood, but some lower northern regions were seriously flooded for a long period. In these regions, the floodwater damaged houses and other properties and stagnant water, which had been polluted by damaged sanitation facilities and unmanaged solid waste, affected living environments as well as the economy.

During the flooding event, 4,040 m$^3$ was discharged into the Chao Phraya River, which has a maximum drainage capacity of 3,000 m$^3$, thus around 10 billion m$^3$ of freshwater entered the Gulf over a short period and caused a dramatic decrease in salinity in the Gulf of Thailand, particularly the eastern part. One consequence of this was damage to the mussel farm industry.

Since early December 2011 the coastal seawater salinity has started to recover and is now back to normal levels. For DO levels, water quality monitoring surveys were carried out by the Environmental Research and Training Center in six provinces surrounding the BMA, and revealed that DO levels at sampling points in Pathum Thani, Chachoengsao, and Nakhon Nayok provinces were below 2 mg/L. This low DO level was believed to be caused by the inflow of domestic wastewater and solid waste, as well as outflow from paddy fields, and resulted in widespread fish death in some fish farms.

In addition to salinity and DO level changes, heavy metals and nutrients were also measured by the Department of Fisheries, Department of Marine and Coastal Resources, Pollution Control Department, and university experts. Results showed that heavy metal concentrations in the water sampled around the potential point sources had not exceeded the national standards. The state of nutrients in the Gulf of Thailand showed no changes since the 2010 data. However, the large influx of terrestrial nutrients created a spike in diatom populations.

The Thai Government has thus learnt some valuable lessons from the recent flood crisis—for example, the importance of water resources management, water drainage, and water pollution source control for prevention and mitigation of water quality degradation caused by flooding. In order to restore confidence at both domestic and international levels, the onus lay with the Thai government to provide a solution to the problem and measures towards rehabilitation. Most recently, the Government has introduced a strategic plan for national reconstruction consisting of three parallel phases termed “rescue, restore, and rebuild”.

Two committees have been established, namely the Strategic Formulation Committee for Reconstruction and Future Development (SCRF), and the Strategic Formulation Committee for Water Resources Management (SCWRM). Together they aim to jointly set the stage for the country’s future by bolstering confidence, regaining trust, and restoring prosperity and stability in the long-term, but in a manner that is sustainable and systematic. The two committees will work closely on rehabilitation and rebuilding the country’s future, and putting into place a national water resources management system, respectively.

In more detail, in the short term, SCWRM has approved guidelines for addressing immediate flood concerns and placed an emphasis on the conservation and rehabilitation of watershed areas in the field of sustainable water management. It will be responsible for coordinating with the Japan International Cooperation Agency (JICA) in setting up a data system—an area in which Japan has expertise—so that future water volumes can be accurately estimated. This will help boost confidence both domestically and in the eyes of foreign investors in Thailand's capabilities regarding flood prevention and control.

As part of the long-term solution, SCRF, who is responsible for the conservation and rehabilitation of the watershed area, will initiate operations in line with the master plan on water resources management.
4. Common Challenges among WEPA Partner Countries

This section aims to illustrate both the present and future challenges mentioned in the country profiles (Chapter 3), which were developed based on the presentations and discussions at WEPA workshops, annual meetings, as well as governmental reports. Table 1.3 gives a summary of challenges according to several management categories and individual problems. The following part summarises the challenges that are common among the countries.

Legislation and Organization: Detailed systems and capacity require developing in order to implement a legislative framework

A framework for water environmental management has been developed in each country, but detailed rules and systems (e.g., classifications of public water bodies) need to be developed in some countries to promote implementation and enforcement.

The majority of countries that have identified domestic and industrial wastewater management as a challenge have also listed the challenge of creating a comprehensive system to implement appropriate management. These challenges are inextricably linked with each other. Management of wastewater, which is a major pollution factor, is a fundamental element of water environmental management, and to improve on this it is necessary to strengthen management systems and capacity. The setting of appropriate targets, promotion of enforcement (e.g., development of incentive mechanisms) and technical and human capacity development for implementation are the areas that need assistance.

Ensuring implementation of proper monitoring and data management is a common challenge

Water quality monitoring is also common among many partner countries. Insufficient infrastructure and capacity of human resources to conduct monitoring have been identified as barriers. In addition, insufficient budgets are also a big barrier to promoting monitoring.

Maintenance of monitoring data is a further challenge. Development of a database and establishment of data sharing mechanisms among different organizations are common issues among four partner countries.

Coordination among relevant water related organizations is not a new challenge in water environmental management but is still relevant. Many of the countries that see coordination as a challenge are those that have promoted or tried to promote a water environmental management framework in recent years (Lao PDR, and Sri Lanka, and Viet Nam). Coordination thus appears as a challenge in the process of developing a management framework.

Coordination with other sectors, especially waste and land use, is also identified as a challenge among a few countries. Waste dumping and development practices conducted without due consideration for the impacts on the environment are big concerns that need to be addressed to improve the water environment.

Recurrent issue – water quality management at the basin level

In many WEPA partner countries, water resource management at the basin level has been promoted. Reflecting this trend, four countries identified basin management as a challenge. Other countries, such as China, Republic of Korea, Lao PDR, and Indonesia have already promoted basin level management of water resources, in which water quality aspects are addressed.

How to manage the water environment at the basin level is an important topic when considering improving water quality management in the near future. Stakeholder involvement is also a key in this field.

Individual water quality issues

In addition to the management challenge, the following specific problems are identified as issues to be addressed further.

- Reduction of Chemical Oxygen Demand (COD) concentration: China and Republic of Korea
- Lake water quality and eutrophication: China, Japan, Republic of Korea, Malaysia
- Non-point source control: China, Republic of Korea, Philippines
- Heavy metal pollution: China
- Chemical pollution: Republic of Korea
- Groundwater quality improvement: China, Japan, Philippines
- Coastal water quality improvement: Philippines
- Consideration of emerging needs from society for creating a new water environmental management scheme: Japan and Republic of Korea
5. Future WEPA Activities

The framework for water environmental management has been established in most WEPA partner countries and ambient water quality standards were set up as the administrative target of water quality. For most of WEPA partner countries, it is time for further promote implementation.

Efforts to strengthen management and enforcement have been taken in each country in consideration of the needs of each country. Time-bound numerical targets for specific water environmental issues have been established in some countries, which shows proactive measures have already been taken in these countries.

Although efforts to strengthen water environmental management have been taken, there is still room for improvements. Some common challenges exist among partner countries such as the need for detailed rules and systems for implementation of laws and regulations, capacity development of human resources, and technical capacity for monitoring systems.

WEPA will continue study to identify implementation challenges and encourage further actions for improved water environments in Asia by sharing the study results. There is already a useful body of knowledge and solutions to problems in WEPA partner countries.

WEPA will provide platforms to facilitate information and experience sharing among partners, such as through twinning programmes under which experience is shared between countries with a body of experience and solutions to problems and those that need to find keys to solutions.

Table 1.3. Current and future challenges for water environmental management

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Country*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>KHM</td>
</tr>
<tr>
<td>Policies and Measures</td>
<td></td>
</tr>
<tr>
<td>Strengthening legislation</td>
<td>✗</td>
</tr>
<tr>
<td>Classification of water bodies</td>
<td>✗</td>
</tr>
<tr>
<td>Water quality management at basin level</td>
<td>✗</td>
</tr>
<tr>
<td>Coordination with other water related organizations</td>
<td>✗</td>
</tr>
<tr>
<td>Coordination with other sectors</td>
<td>✗</td>
</tr>
<tr>
<td>Incentives and communications for enforcement</td>
<td>✗</td>
</tr>
<tr>
<td>Water/effluent monitoring</td>
<td>✗</td>
</tr>
<tr>
<td>Maintenance and sharing of monitoring data</td>
<td>✗</td>
</tr>
<tr>
<td>Technical capacity development</td>
<td>✗</td>
</tr>
<tr>
<td>Stakeholder involvement</td>
<td>✗</td>
</tr>
<tr>
<td>Finance</td>
<td>✗</td>
</tr>
<tr>
<td>Specific Issues</td>
<td></td>
</tr>
<tr>
<td>Responding to emerging needs of the society</td>
<td>✗</td>
</tr>
<tr>
<td>COD</td>
<td>✗</td>
</tr>
<tr>
<td>Lake/Eutrophication</td>
<td>✗</td>
</tr>
<tr>
<td>Non-point source</td>
<td>✗</td>
</tr>
<tr>
<td>Heavy Metal</td>
<td>✗</td>
</tr>
<tr>
<td>Chemical</td>
<td>✗</td>
</tr>
<tr>
<td>Coastal water</td>
<td>✗</td>
</tr>
<tr>
<td>Groundwater</td>
<td>✗</td>
</tr>
</tbody>
</table>

## Progress in Water Environmental Management in WEPA Partner Countries

### Cambodia

**State of water environment**
- In general, the surface water quality of the country is good. According to recent ambient water quality monitoring over the past few years, the BOD ambient water environmental standards were met at all monitoring points (see Figure 3.1.4 in Chapter 3).
- Information on the quality of coastal water and groundwater is insufficient. However, some reports state that the coastal water quality is generally good. Contamination of arsenic was found in groundwater in some areas, which is a natural phenomenon.
- A lot of stresses on water quality were identified, such as untreated industrial and domestic wastewater flowing into public water bodies especially in the dry season, pollutants from urban areas and agricultural land and those caused by development activities.

**Recent developments in water environmental management**
- A water environmental management framework was developed in the 1990s and strengthened in the 2000s.
- In 2007, The Law on Water Resource Management was established, which embraces water quality and conservation of aquatic ecosystems, as this was an area of concern. The law also stipulated a wastewater discharge licence requirement for point sources. New acts of legislation, the Law on Environmental Protection Management and a Sub-decree on Water Quality, are now being drafted.
- In 2008, regular monitoring of ambient water quality in terms of basic parameters (water temperature, DO, BOD) begun, to assess the water quality.

### China

**State of water environment**
- The state of surface water is still serious, especially in lakes and reservoirs.
- The state of coastal water is not serious yet.
- The quality of groundwater is subject to stress from inappropriately managed sewage, waste, pesticides and fertilisers.

**Progress in water environmental management**
- China has strengthened its environmental management. Numerical targets for water quality improvements (e.g., COD load reduction) were incorporated into the national five-year plan for national economic and social development.
- A series of standards for both domestic and industrial wastewater have been revised or established to strengthen effluent management.

- Current water environmental management policy includes cultural and ecological concerns and resource-saving, in addition to pollution control.

**Current and future challenges**
- Protection of drinking water sources continues to be a priority policy area.
- In line with this, quality management of groundwater, which represents 18% of drinking water sources, and control of heavy metal pollution are also highlighted in the latest Five-Year Plan (2011-2015).
- Reduction in ammonia nitrogen discharge and further enhancements in domestic wastewater treatment are necessary for improved water quality.
### Indonesia

**State of water environment**
- Water pollution in both surface and underground water remains serious, especially in densely populated areas.
- Overall, signs of improvement in water quality in surface water were seen between 2004 and 2009. However, there are regional differences. In Java and Kalimantan, water quality has been deteriorating during the period.

**Recent developments in water environmental management**
- The nation’s basic environmental law, “Law concerning Environment Protection and Management”, was enacted in 2009, and is more comprehensive than the previous one. A new environmental permit system has been introduced in response to the revision of the law, and new regulations for water quality management and pollution control were drafted and are awaiting approval.
- In 2001, effluent standards existed for 14 industrial activities, which rose to 21 by 2005.
- The National Medium-term Development Plan (2010-2014) set numerical targets for water environmental conservation (e.g., reduction in pollution levels by 50%).

**Current and future challenges**
- Implementation of the new regulations awaiting approval.
- Improvements in the technical and financial capacity for implementation
- Development of incentives for compliance and promotion of public participation in water environmental management

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### Japan

**State of water environment**
- Japan has overcome water pollution problems, but eutrophication in enclosed water bodies remains an issue.
- There are also emerging concerns over soil and groundwater pollution caused by toxic substances.

**Recent developments in water environmental management**
- Based on the management framework developed in the 1970s, Japan has been developing policies and measures to respond to the needs of society.
- The Total Pollutant Load Control System (TPLC) was introduced in 1979 for three enclosed water bodies. In addition to COD, T-P and T-N became target parameters under the system in 2001. The 7th TPLC policy was set forth in 2011.
- A recent revision to water pollution control law strengthened measures in the event of accidents, record-keeping of effluent monitoring data, and preventative measures against groundwater pollution.

**Current and future challenges**
- Strengthening measures to mitigate deterioration in lake water quality, the compliance ratio to environmental standards of which remains at around 50%.
- Creation of “Sato-Umi” which incorporates biodiversity conservation aspects and sustainability issues.
- Creation of better initiatives to improve/protect the water environment in response to the diverse needs of communities and recent social transitions, including ensuring an environmentally sound water cycle.

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### Republic of Korea

**State of water environment**
- Water quality in terms of BOD has improved as a result of investment in wastewater treatment.
- However, water quality in terms of COD and T-P has fallen short of expectations. Chemical substance use in factories and non-point sources are suspected.
- Eutrophication and groundwater pollution caused by chemical substances especially in the dry season is also an issue.

**Recent developments in water environmental management**
- Under a restoration project of the country’s four major rivers, many projects have been implemented which contributed to raised water quality. Ensuring environmental flow is one of the measures to be promoted under the project.
- The Total Maximum Daily Load system (TMDLs) was introduced in 2004 in three major rivers. The current target parameter is BOD and T-P will be added as a target parameter. TMDLs will be introduced in Hang River.
- Control over water pollution caused by chemical substances has been strengthened by adding more relevant parameters to ambient water quality standards.

**Current and future challenges**
- Ensuring and promotion of current efforts to reduce pollution loads and promote conservation of ecosystems.
- Strengthening of non-point source and chemical pollutant management.
- Development of an enhanced management system to cope with socio-economic changes.
Lao PDR

**State of water environment**
- Surface water quality in the country is considered good.
- However, the quality of urban rivers could worsen in the future due to the inflow of untreated wastewater, the volume of which will increase with urban growth.

**Recent developments in water environmental management**
- A series of ambient water quality standards were established in 2009.
- Measures to control effluent from industry have been strengthened, which included the introduction of effluent standards in 2009.
- Currently, the Environmental Protection Law is awaiting approval of revision. The revision will include strengthening water quality monitoring and inspection of pollution sources and introduction of strategic environmental assessments.
- Establishment of the Ministry of Natural Resources and Environment in 2011.

**Current and future challenges**
- Strengthening and implementation of preventive measures before serious pollution problems occur.
- Areas for action include development of domestic wastewater treatment facilities in urban areas, ensuring water quality monitoring and development of a sharing mechanism of the monitoring results, and implementation of an effluent licence system.
- The newly established Ministry of Natural Resources and Environment is expected to promote and strengthen better management to prevent future cases of pollution.

Malaysia

**State of water environment**
- Serious water pollution problems have been mitigated as a result of measures taken under the National Environmental Quality Act, but a recent assessment shows a slight increase in "polluted" or "slightly polluted" rivers. This is considered to be caused by an increase in number of pollution sources and in inadequately treated wastewater.
- The condition of coastal water quality differs by area, but TSS and oil are the common parameters measured.
- Total coliform is the common parameter used for groundwater.

**Recent developments in water environmental management**
- A framework for water environmental management is well established in the country.
- Effluent control has been improved/strengthened by revision of effluent standards, reinforcing recording and reporting of effluents from pollution sources. On-line reporting of effluent quality has been introduced.
- The Industrial Effluent Treatment System (IETS), which aims to improve the process of wastewater treatment, was also introduced to strengthen effluent control.

**Current and future challenges**
- Further promotion of effluent control. In particular, encouragement and strengthening of the "self-regulation approach" in which industry voluntarily implements pollution control measures.
- Promotion of water quality management at the basin level, which may include development of countermeasures that account for capacity and water use in each basin.
- Further study on lake water quality to achieve better management of lakes and reservoirs.

Myanmar

**State of water environment**
- Water quality of surface water in the country is generally good.
- Anticipated social and economic development may cause deterioration in water quality if appropriate control measures are not introduced.

**Recent developments in water environmental management**
- Since there are no significant pollution problems identified, there are no specific laws and regulations to control water pollution.
- Water monitoring is conducted on a project basis or for each water use, such as drinking and irrigation.

**Current and future challenges**
- Introduction/promotion of preventive and proactive measures against water pollution.
- Such measures can include coordination of relevant organizations, reduction in potential pollution loads by promoting effective water use such as in irrigation and industrial sectors; strengthening of waste treatment; and prevention of erosion through forest conservation efforts.
State of water environment

- The water quality in the country is good except in some urban areas where water pollution is serious.
- Water quality in Kathmandu is serious due to untreated domestic and industrial wastewater, dumping of waste and unplanned development activities.
- Water pollution caused by pesticides and fertilisers are concerns.

Recent developments in water environmental management

- Acts on environmental protection were established in 1997. Regarding water resources management, the National Water Policy and Water Resource Law were established in 2002 and 2004 respectively.

Current and future challenges

- Implementation and enforcement after establishment of a partial framework for environmental and water resource management.
- Detailed rules and a system to manage water pollution are absent in the promotion of water pollution control.
- Monitoring and data sharing mechanisms need to be improved, and the institutional arrangements, technical capacity and financial basis therefore should be addressed.

Recent developments in water environmental management

- A Clean Water Act was established in 2004. Under the act, more proactive measures are planned.
- Water quality management in water quality management area is a key feature under the Clean Water Act. An effluent licence system as well as charging system will also be introduced under the act.
- Effluent standards by type of industry are currently awaiting approval.

Current and future challenges

- Coordination of relevant agencies to take more comprehensive measures.
- Setting national ambient water quality standards, which are now awaiting approval; this should be followed by the classification of surface water bodies.
- A lack of baseline data, and the need for ambient water quality monitoring to address the problem. The means the sharing of monitoring data across different organizations also needs addressing.
- Awareness-raisin of conservation of the water environment. Awareness-raising in the industrial sector is necessary to promote enforcement.
**Thailand**

**State of water environment**
- Surface water quality has been improved, but recent monitoring data shows a slight rising trend in "polluted" points.
- Monitoring results of coastal waters over the past 5 years show no significant changes in quality. However, the number of "polluted" waters is on the increase, especially in the inner gulf where polluted water flows.
- Groundwater is generally in good in quality, but in some areas high levels of fluoride, salinity and Volatile Organic Compounds (VOC) were identified.

**Recent developments in water environmental management**
- Water environmental management has been implemented based on the National Enhancement of Environmental Conservation Act 1992, which includes establishment of pollution control area and environmental protection area.

**Viet Nam**

**State of water environment**
- The water quality of the upper stream is good, but serious pollution was identified downstream. Most of the major rivers and lakes/reservoirs in inner cities do not meet the environmental BOD standard.
- Coastal waters are also polluted, e.g., by untreated/ inadequately treated wastewater and waste and wastewater from aquaculture. Oil pollution is one of the common issues in coastal areas.
- An increase in salinity has widely noted, partly due to excessive groundwater extraction.

**Recent developments in water environmental management**
- Since 2000, a framework development of water environmental management has been accelerated in the country.
- Such developments include introduction of a wastewater charging system, strengthening penal systems against non-compliance and revision of ambient and effluent standards.

**Current and future challenges**
- A priority area identified in the environmental Policy 2010-14 includes improvement and enhancement of domestic wastewater treatment and stipulates the polluter-pay-principle (PPP).
- In 2009, new effluent standards for wastewater treatment facility were introduced.
Discussion and Findings on Priority Topics

2.1 Domestic Wastewater Treatment in Asia

2.2 Climate Change and the Water Environment
   - Summary of findings based on WEPA discussions and surveys -
Chapter 2.1
Domestic Wastewater Treatment in Asia

1. Growing Asia and Domestic Wastewater

1.1. Socio-Economic Conditions
WEPA partner countries are growing at an unprecedented rate in terms of population and economic growth. They are also facing dire consequences from the effects of rapid urbanization. Table 2.1.1 shows shifts in total population and the proportion of the urban population since 1975. While the scale of population and rates of increase differ, it is evident that the population of each country is without question on the increase. In particular, China, Indonesia and Japan are arresting, reporting populations of one billion, two hundred million, and one hundred million, respectively. The total populations in both Philippines and Viet Nam have risen to nearly one hundred million. The average for annual population growth rates in Malaysia, Nepal, Philippines and Lao PDR is more than 3%. The proportion of urban populations in Japan, Malaysia and the Republic of Korea (ROK) are more than 50%.

Table 2.1.1. Population and proportion of urban population in WEPA countries (1975 and 2010)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Population (thousand persons)</td>
<td>Proportion of Urban Population (%)</td>
<td>Total Population (thousand persons)</td>
</tr>
<tr>
<td>Cambodia</td>
<td>7,098</td>
<td>4</td>
<td>14,138</td>
</tr>
<tr>
<td>China</td>
<td>915,041</td>
<td>17</td>
<td>1,341,335</td>
</tr>
<tr>
<td>Indonesia</td>
<td>134,106</td>
<td>19</td>
<td>239,871</td>
</tr>
<tr>
<td>Japan</td>
<td>110,808</td>
<td>57</td>
<td>126,536</td>
</tr>
<tr>
<td>Republic of Korea</td>
<td>34,722</td>
<td>48</td>
<td>48,184</td>
</tr>
<tr>
<td>Lao PDR</td>
<td>3,042</td>
<td>11</td>
<td>6,201</td>
</tr>
<tr>
<td>Malaysia</td>
<td>12,313</td>
<td>38</td>
<td>28,401</td>
</tr>
<tr>
<td>Myanmar</td>
<td>29,534</td>
<td>24</td>
<td>47,963</td>
</tr>
<tr>
<td>Nepal</td>
<td>13,373</td>
<td>5</td>
<td>29,959</td>
</tr>
<tr>
<td>Philippines</td>
<td>40,893</td>
<td>36</td>
<td>93,261</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>13,811</td>
<td>22</td>
<td>20,860</td>
</tr>
<tr>
<td>Thailand</td>
<td>42,399</td>
<td>24</td>
<td>69,122</td>
</tr>
<tr>
<td>Viet Nam</td>
<td>49,896</td>
<td>19</td>
<td>87,848</td>
</tr>
</tbody>
</table>

(Source: UNDESA 2011)
Figure 2.1.1 shows shifts in per capita GDP since 1975. Although drops clearly coincide with the 1997 Asian currency crisis and the Lehman Shock of 2008, economies subsequently recovered to continue on a path of steady growth. As a result of increasing population and economic growth, at present this region accounts for approximately one-third of the global population and approximately one-fourth of the world’s GDP.

Improvements in basic infrastructure have gained ground in line with economic growth. Figure 2.1.2 shows the proportion of population using improved drinking water sources and the proportion of the population using improved sanitation facilities, which are among the targets set out in the Millennium Development Goals adopted in 2000. While improvements in basic infrastructure in rural areas in some countries remain at low levels, the rate of coverage for improved sanitary facilities has clearly made progress, mainly in urban areas.
1.2. Impact of Domestic Wastewater on Water Environment

Along with population increase and improvement in the quality of life, the sharp increase in the amount of water withdrawn for domestic purposes is noteworthy. Figure 2.1.3 shows shifts in the per capita amount of water withdrawn for domestic purposes. First, it is evident that per capita water withdrawal for domestic purposes differs by country. In the Asian region, while withdrawal is modest in Cambodia, Sri Lanka, Nepal, Myanmar and Lao PDR, withdrawal in Japan, ROK and Malaysia is startling. Further, shifts show temporary drops in some countries, but most countries display a fixed or increasing trend. When coupled with increases in population, total water withdraw for domestic purposes on the whole shows an increasing trend. The amount of domestic wastewater generated, which accompanies increases in water withdrawal for domestic purposes, is also expected to rise.

Figure 2.1.4 shows the distribution of BOD load by sector in WEPA countries. Data is limited, and the data year and target area differ from country to country. However, if nothing else, this figure reveals that the domestic sector accounts for the greater part of the BOD load in selected countries and catchment areas of Asia.

Figure 2.1.5 shows the distribution of pollution sources of BOD in domestic wastewater in Japan. Accordingly, the per capita daily amount of BOD load discharged as domestic wastewater is 40 g. Contribution of grey water discharged from laundry and kitchen is approximately 70% of total BOD load. It is evident that the impact of grey water on the water environment is considerable—hence the demand in the Asian region to prevent water pollution through treatment of domestic wastewater.

2. Domestic Wastewater Treatment in Asia

2.1. Current Situation of Domestic Wastewater Treatment in Asia

Table 2.1.2 frames the confirmed treatment methods for domestic wastewater in the Asian region. Treatment methods are divided into the following categories: no treatment, treatment of only black water, and treatment of both black and grey water, and grouped by individual or centralized treatment. Treatment is further divided into anaerobic and aerobic methods.
Sewage treatment coverage

Figure 2.1.6 shows the latest sewerage treatment coverage rates for WEPA countries. As a result of investment in sewage treatment at present the sewerage treatment coverage rate in the ROK and Japan exceeds 75%. The rate in Malaysia (Malay Peninsula and government-ruled municipalities only) and urban areas of China falls in the 60% to 70% range and Thailand’s coverage rate falls in the 20% range. On the other hand, rates in other countries continue to remain in the single digits. For Sri Lanka and Lao PDR, sewage treatment plants are nonexistent. In the capitals of Vientiane in Lao PDR and Phnom Penh in Cambodia, domestic wastewater generated in the cities is channeled into natural wetlands located on the outskirts of the cities, whereby natural treatment takes place. Moreover, in Colombo in Sri Lanka, domestic wastewater is collected by sewer pipe and discharged without treatment into the sea at two discharge points in the north and south areas of the city. These types of treatment (or non-treatment) are not reflected in the rates of coverage in Figure 2.1.6.

<table>
<thead>
<tr>
<th>Category</th>
<th>Treatment Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-site/Individual</td>
<td>Off-site/Centralized</td>
</tr>
</tbody>
</table>
| No treatment                  | Direct discharge from household without treatment | Sewage without treatment facility      | *
| Treatment of black water only | Individual septic tank                   | Community septic tank                   | Anaerobic |
|                               | Individual night soil treatment tank     | Septic tank + Septage treatment plant   | Aerobic    |
| Treatment of both black and   | Individual septic tank                   | Community septic tank                   | Anaerobic |
| grey water                    |                                          | Sewage treatment plant (Anaerobic)      |            |
|                               | Individual sewage treatment tank         | Sewage treatment plant (Aerobic)        | Aerobic    |

Table 2.1.2. Methodologies of domestic wastewater treatment in WEPA countries

Photo 2.1.1. Sewage treatment plant in Nepal (left) and China (right)
Figure 2.1.7 demonstrates historical changes in service coverage ratios of sewerage system in selected Asian countries. As the countries of Indonesia, Philippines, Viet Nam, Cambodia, Nepal, Sri Lanka, Lao PDR and Myanmar either have no sewage treatment plants or only a few, coverage ratios are not included the figure. The tendency of historical change in Malaysia cannot be recounted due to limited data. Although the coverage ratio has increased gradually in Japan over decades, a rapid increase during particular decades was observed in ROK, Thailand and urban areas of China. The ROK has shown a rapid increase in coverage ratio since late 1980s and 1990s. In the ROK, prior to the Seoul Olympics of 1988, large-scale treatment plants with treatment capacity of one to two million tonnes were constructed in three locations in Seoul in 1987, which until that time had only one sewage treatment plant. This project set the ball rolling, and subsequent large-scale investments were made in the construction of sewage treatment plants in the 1990s, allowing the country to achieve high coverage for sewerage treatment. Although data is available for 2000 and beyond in China, the increase ratio is remarkable for this past decade. This is expected to be the result of large-scale investments in the construction of sewage treatment plants during the 10th and 11th Five-Year Plans. In Thailand, a rapid increase in coverage ratio was observed during the late 1990s to the early 2000s, which is due to the construction of sewage treatment plants in Metropolitan Bangkok Area during that period.

![Figure 2.1.7. Change in service coverage ratio for sewerage system in selected Asian countries](Source: See References)

### Septic tank coverage

In areas without access to sewage treatment plants, treatment based on previously discussed septic tanks is common, mainly in urban areas. Table 2.1.3 demonstrates the coverage ratio of septic tank treatment in selected countries and cities. While data is not complete for all countries, it can be surmised that in countries where the coverage rate of sewerage is low, the coverage rate of septic tanks is high particularly in urban areas. However, quantitative data on the installation of septic tanks has not been prepared in most countries. Thus, there is a future need to make efforts to ascertain the current situation in these countries.

<table>
<thead>
<tr>
<th>Country</th>
<th>Year</th>
<th>Area</th>
<th>Coverage Ratio (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viet Nam</td>
<td>2008</td>
<td>National average</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Urban area</td>
<td>79</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rural area</td>
<td>26</td>
</tr>
<tr>
<td>Malaysia</td>
<td>2010</td>
<td>National average</td>
<td>21</td>
</tr>
<tr>
<td>Philippines</td>
<td>2010</td>
<td>Manila</td>
<td>71</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>N/A</td>
<td>Kandy</td>
<td>87</td>
</tr>
</tbody>
</table>

(Source: See References)
removal rates of septic tank treatment are 30 to 60% based on the results of different studies, which are smaller than the removal rate of sewerage with aeration.

Table 2.1.4 summarizes BOD removal rates of different treatment measures for domestic wastewater. BOD removal rates of septic tank treatment are 30 to 60% based on the results of different studies, which are smaller than the removal rate of sewerage with aeration.

<table>
<thead>
<tr>
<th>Treatment Methodologies</th>
<th>Treatment Process</th>
<th>BOD removal Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Septic Tank (USA)</td>
<td>-</td>
<td>46-54</td>
</tr>
<tr>
<td>Septic Tank (USA)</td>
<td>-</td>
<td>31-32</td>
</tr>
<tr>
<td>Septic Tank (Philippines)</td>
<td>-</td>
<td>30-60</td>
</tr>
<tr>
<td>Sewage Treatment Plant (Philippines)</td>
<td>Rotating biological contactor</td>
<td>90-95</td>
</tr>
<tr>
<td>Sewage Treatment Plant (Malaysia)</td>
<td>Oxidation ditch</td>
<td>87-88</td>
</tr>
<tr>
<td>Sewage Treatment Plant (Malaysia)</td>
<td>Extended aeration</td>
<td>80-99</td>
</tr>
<tr>
<td>Sewage Treatment Plant (Malaysia)</td>
<td>Sequencing batch reactor</td>
<td>80-93</td>
</tr>
<tr>
<td>Sewage Treatment Plant (Japan)</td>
<td>Trickling filter</td>
<td>75-85</td>
</tr>
<tr>
<td>Sewage Treatment Plant (Japan)</td>
<td>Conventional activated sludge</td>
<td>85-95</td>
</tr>
<tr>
<td>Sewage Treatment Plant (Japan)</td>
<td>Conventional Activated Sludge</td>
<td>85-95</td>
</tr>
</tbody>
</table>

(Source: See References)

2.2. National Development Plan on Domestic Wastewater Treatment Facility

Table 2.1.5 lists the national development plan for domestic wastewater treatment of each WEPA country. The situation is similar to that of legal institutions in the countries of Cambodia, Nepal, Sri Lanka, Lao PDR and Myanmar, where sewage treatments plants are few in number. Namely, while some countries have drawn up master plans for construction of domestic wastewater treatment facilities in some regions, overall plans for domestic wastewater treatment have not been drafted at the national level.

Japan’s Five Year Plans for Sewerage Development were established in 1963, including sewage treatment facility provision objectives and budget allocations for each period. This plan was completed in 2003. At present, a plan is drafted for each prefecture that establishes objectives for maintenance of domestic wastewater treatment facilities and budget, as well as an “Overall Plan for Provision of Sewers by Catchment Area.” The Republic of Korea also established a policy focusing on sewerage development as one of the main measures for domestic wastewater treatment. According to the policy, the ROK plans to increase the sewerage treatment ratio to 92% until 2015, and invest in the construction of sewage treatment plants in rural areas, in particular, as urban areas have already achieved high coverage rates. In China and Malaysia, national five-year plans have been drawn up, and provision objectives have been established. In Thailand, priority regions that have been targeted for provision of domestic wastewater treatment facilities by 2041 have been compiled, and ideal provision methods for each region have been prescribed.

Plans in Philippines have been drawn up that differentiate between the Manila metropolitan area and other regions. In the Manila metropolitan area, the agency in charge of construction and management of domestic wastewater treatment facilities, the Metropolitan Water Works and Sewerage System (MWSS), has concluded a Concession Agreement with Manila Water and Maynilad Water Services for the construction and management of domestic wastewater treatment facilities in the eastern and western districts respectively of the Manila metropolitan area. The term of the Concession Agreement is forty years from 1997 to 2037, and a 100 % sewerage treatment coverage rate is to be achieved in both districts by 2037. For regions other than the Manila metropolitan area, the National Programme on Sewerage and Septage Management was drafted in 2010 with provision objectives set up to 2020. Likewise, national domestic wastewater treatment plans have been drafted in Indonesia and Viet Nam. Indonesia has set provision objectives through 2014, and Viet Nam has established provision objectives through 2025. Sri Lanka established a development plan for sanitary facilities by 2015.

While the contents of objectives differ for each country, in the four countries of Thailand, Philippines, Indonesia and Viet Nam, where the need for domestic wastewater treatment facilities are urgent, plans focus on advancing the provision of sewage treatment plants mainly in urban areas.
2.3. Issues on Domestic Wastewater Treatment in Asia

Need for domestic wastewater treatment

The preceding sections reviewed the present state and future plans for domestic wastewater treatment conducted in Asian countries. It is clear that in regions where domestic wastewater treatment is urgently required, diffusion of centralized sewage treatment systems is the main measure being taken for domestic wastewater treatment. In fact, sewage treatment plants have been constructed since the 1990s in many Asian countries. In addition, the construction of sewage treatment plants is planned in the near future as one of the main measures for most urban cities in Asian countries with low coverage rates for sewerage treatment. However, the rate of coverage of sewerage treatment differs by country. As is shown in Figure 2.1.6, the ROK, Japan, Malaysia and the urban areas of China have achieved high coverage rates, but levels remain low in other countries. In areas without access to sewage treatment plants, treatment based on previously discussed septic tanks is common, mainly in urban areas. However, the BOD removal rate of septic tank treatment is lower than one of sewerage treatment with aeration.

In addition, in some Asian cities, only black water is treated by septic tank, and grey water is discharged without treatment into the environment, which may lead to its becoming a pollution source for the water environment. Further, cases where septic tanks do not conform to national guidelines or are not installed properly can be found in some areas of Asia.

Issues on construction of domestic wastewater treatment facilities

In order to mitigate and prevent water pollution, domestic wastewater including both grey water and black water should be adequately treated by highly performing treatment processes with effective pollution removal rates, especially in areas without access to sewerage treatment.
However, according to United Nations data (UNDP 2006), the construction of sewage treatment plants is two to three times more costly than the installation of septic tanks. In fact, an examination of the relationship between the coverage ratio for sewage treatment in WEPA countries and per capita GDP (see Figure 2.1.8) reveals a certain positive correlation. In most Asian countries where the coverage ratio for sewage treatment is still low, the per capita GDP remains under USD 4,000. Thus, the construction of large-scale sewage treatment plants, which are more costly than septic tanks, is not an economically feasible option in these countries.

**Issues on operation of domestic wastewater treatment facilities**

Operational issues of sewage treatment plants following construction and entering operational stages have also been reported in some Asian countries. Cases have been observed where residents dislike paying sewage treatment fees and therefore do not connect to the service despite living in the coverage area. Accordingly, inflow is less than the treatment capacity. Figure 2.1.9 shows the percentage of actual inflow accounted for in the treatment capacity of plants in 17 locations in Indonesia. Of the 17 locations, only seven plants have an inflow of wastewater over 50% of treatment capacity, and others are under 50%. The figure shows that for two locations in particular, inflow is less than 20%. For the country on the whole, wastewater volume at only 47% of treatment capacity is treated at sewage treatment plants.

Moreover, as mentioned in Table 2.1.6, the inability to collect sewage treatment fees from most treatment plant users in Thailand has resulted in the use of the public finances from local governments to cover operational costs. In recent years, more regional governments have called for the collection of sewage treatment fees, and the central government is working on setting regulations on procedures to establish sewage treatment fees. Nevertheless, many difficulties remain in the actual collection of these fees. In Malaysia, sewage treatment fees are not levied according to usage, rather a fixed sewage treatment fee for ordinary households has been established. Moreover, lower fees have been established for low-income groups. The Indah Water Konsortium (IWK) that operates the sewage treatment facilities in Malaysia cannot operate on sewage treatment fees alone. Thus, it receives funds from the Ministry of Finance in order to operate.
### Table 2.1.6. Sewage treatment fees in Asia

<table>
<thead>
<tr>
<th>Country</th>
<th>Sewage Treatment Fee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Republic of Korea</td>
<td>Sewage treatment fees are set based on the volume of water consumption.</td>
</tr>
<tr>
<td>Japan</td>
<td>Sewage treatment fees are collected together with water charges. Basically, sewage treatment fees are set based on the volume of water consumed. Operational costs of individual sewage treatment tanks including desludging, monitoring of water quality, etc. should be the owners’ responsibility.</td>
</tr>
<tr>
<td>China</td>
<td>Sewage treatment fees are collected from users in urban areas. However, fees are not collected from users in most rural areas. In this case, operational costs of sewage treatment plants are covered by local governments.</td>
</tr>
<tr>
<td>Malaysia</td>
<td>Flat rate charging system is applied to domestic wastewater treatment. Monthly fees are 8 RM for each household regardless of wastewater volume. Lower fees are applied to lower-income households or houses in new villages.</td>
</tr>
<tr>
<td>Thailand</td>
<td>Sewage treatment fees are collected from users of constructed sewage treatment plants.</td>
</tr>
<tr>
<td>Indonesia</td>
<td>Sewage treatment fees are collected together with tapped water fees in east zone of Manila. In the beginning, sewage treatment fees were 50% of tapped water fees. In 2008, as the fee system was reviewed, the sewage treatment fee was planned to be reduced every year to 20% of tapped water fee by 2012, regardless of whether users are connected to sewage treatment facilities.</td>
</tr>
<tr>
<td>Philippines</td>
<td>In Viet Nam, a water environmental tax is charged to all households, regardless of whether users are connected to sewage treatment facilities.</td>
</tr>
<tr>
<td>Viet Nam</td>
<td>Sewerage fees are collected from households connected to the sewerage system.</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>Sewerage service fees are collected together with tapped water fees in Kathmandu. The sewerage service fee is 50% of the tapped water fee.</td>
</tr>
<tr>
<td>Nepal</td>
<td>Sewerage service fees are collected together with tapped water fees in Kathmandu. The sewerage service fee is 50% of the tapped water fee.</td>
</tr>
<tr>
<td>Cambodia</td>
<td>Sewage treatment fees are collected from users of constructed sewage treatment plants.</td>
</tr>
<tr>
<td>Lao PDR</td>
<td>N/A</td>
</tr>
<tr>
<td>Myanmar</td>
<td>N/A</td>
</tr>
</tbody>
</table>

(Source: Result of the interview conducted by the WEPA secretariat in 2010 and 2011)

### 3. Good Practices for Sustainable Domestic Wastewater Treatment in Asia

In the previous chapter, the current state, future plans and issues surrounding domestic wastewater treatment in Asia were reviewed. The result of review shows that it is important that the policies developed clearly set out the options available for domestic wastewater treatment in areas without access to sewage treatment under considerable financial and social constraints. In order to overcome these issues, WEPA countries developed feasible strategies in consideration of their own socio-economic conditions and implemented these strategies in a sustainable manner. In this chapter, unique and useful practices are introduced.

#### 3.1. Focus on the Impact of Grey Water on the Environment

- From the perspective of preventing water pollution caused by domestic wastewater, it is important to treat both black and grey water. As mentioned previously, the percentage of BOD load from black water does not exceed 30%, with the remaining 70% making up the pollution load from grey water discharged in Japan. In the past, most individual sewage treatment tanks treated only black water. However, the Japanese government focused on the impact of grey water in order to mitigate water pollution, and revised laws related to individual sewage treatment tanks in 2001, in which new installations of individual sewage treatment tanks that treat only black water (Tandoku-shori jobkaso) were prohibited, and treatment of both black water and grey water is obligatory. As a result of the enforcement of this law, the percentage of individual sewage treatment tanks that treat only black water has decreased dramatically and the number of tanks that treat both black and grey water has increased gradually.
3.2. Selection of Feasible Policy Options under Socio-economic Constraints

Setting priorities for domestic wastewater treatment facility development

- As previously mentioned, investment to the centralized treatment system or sewerage is not always feasible for WEPA countries. Construction of large-scale sewage treatment plants that requires major investment is particularly difficult. Furthermore, some countries face additional problems, such as shortage or lack of land available for the construction of sewerage facility in areas where housing developments are already completed. Also, there are many countries and regions without the extra funds to invest in pipes for domestic wastewater.

In order to overcome these socio-economic conditions, there are many countries that first prioritize the provision of treatment facilities for domestic wastewater. Philippines and China have made advancements in establishing measures in their capital and major cities, which face severe water pollution due to domestic wastewater issues, their first priority. Thailand has set an order of preference for catchment areas that must be protected, and is constructing sewage treatment plants giving priority to areas where these catchments are located.

Decentralized approach

- It should be noted that a decentralized approach is being actively employed in WEPA countries. While small-scale decentralized sewage treatment plants are generally constructed in regions with low population density, as is common in Japan and the rural areas of China, a decentralized approach is being employed even in urban areas in Malaysia and Manila in Philippines (eastern district). In order to improve the coverage ratio of sewage treatment plants in Malaysia, developers of housing complexes are required to construct sewage treatment plants as a condition of development and the developer should bear related costs. Moreover, the Sewerage Service Department (SSD) confirms that sewage treatment plants should follow structural standards set by the national government. Thus, technical guarantees are also in place. As sewage treatment plants are constructed along with each development project, the treatment capacity of about 90% of sewage treatment plants are under approximately 1,000 m³ per day capacity, as shown in Figure 2.1.11. As a result of this approach, Malaysia achieved a sewerage treatment coverage ratio of 66% for the whole country in 2010, with the exception of Sabah province and Sarawak province.
3.3. Community or private sector’s involvement in construction and operation of sewerage treatment plant

Community involvement

In many regions of Asia, due to social conditions such as low household income levels and little public awareness, the necessary conditions to accept domestic wastewater treatment facilities are not in place. As such, issues such as the previously mentioned low connection rates and sewerage service fee collection rates have manifested themselves. In order to address these problems, Indonesia has attempted to improve public awareness by garnering participation from local residents from the planning stages in regions where provision of domestic wastewater treatment facilities are planned. A programme entitled SANIMAS has been carried out since 2006. Participation from residents is elicited from planning stages, and the selection of project sites and technology is conducted along with local residents, in addition to the drafting of a community action plan. Engaging in construction and operational management based on this plan is designed to facilitate the voluntary participation of residents in domestic wastewater management. Communities participating in the project have steadily increased. Domestic wastewater treatment facilities have been constructed in 395 locations in 22 provinces over the four-year period from 2006 to 2009, and are being operated and managed by residents.

Private sector involvement

Private companies in Philippines and Malaysia carry out the operation of sewage treatment plants to ensure they are operating efficiently. In 1997, the Metropolitan Water Works and Sewerage System (MWSS) in Philippines, with jurisdiction over waterworks and sewerage projects in the Manila metropolitan area,
entered a concession agreement with the private companies of Manila Water and Maynilad Water Services for the construction and management of domestic wastewater treatment in the eastern and western districts of the metropolitan area.

In 1993, the Sewerage Services Act was enacted in Malaysia to give jurisdiction to the central government for sewerage services which had hitherto been managed by the state governments. Concurrently, the private company of Indah Water Konsortium (IWK) was established to operate the sewerage projects, and in that same year, the government entered a consignment contract with IWK for the operation of sewage treatment plants in the country. Thus, nearly all public sewage treatment plants on the Malay Peninsula are operated by IWK. Furthermore, a private company called Majaari Services was established in 2009 in the state of Kelantan on the Malay Peninsula to conduct operations of sewage treatment plants. At this time, the operation of sewage treatment plants by private companies in Manila and Malaysia has moved forward smoothly.

- At the time of its establishment in 1993, the Indah Water Konsortium (IWK) was a self-sustaining private company. However, the company was unable to collect an adequate amount of sewage treatment fees to run the company. Thus, seven years later in 2000, the company was nationalized and operations are presently conducted with funds from the Ministry of Finance. The 2009 financial report of IWK shows that of the MYR 723 million annual income, income from sewage treatment fees was limited to approximately 60% at MYR 434 million. Funding from the Ministry of Finance accounted for approximately 35% at MYR 250 million.

- In this manner, for other regions of Asia as well, considerable potential may exist in the option to operate sewage treatment plants with the involvement of private companies. However, there is potential for dilemmas to arise that cannot be dealt with by private companies alone, particularly in the grey area between establishment of appropriate sewage treatment fees in general and establishment of sewage treatment fees that take into account the economic level of residents. As is evident in the case of Malaysia, guaranteeing that sufficient operational costs are covered and securing funding from a public institution is indispensable to the sustainable operation of sewage treatment plants.

**4. Conclusion**

All WEPA partner countries made significant efforts to improve conditions to achieve sanitation targets of the Millennium Development Goals (MDGs) and therefore treatment of black water has been promoted in the region. However, the pollution load of grey water is also considerable and therefore it is necessary to promote treatment of grey water in addition to black water.

Sewerage treatment systems, an option to treat both black and grey water, are typically observed in other regions of the world. However, coverage rates for sewerage treatment systems remain low in all WEPA countries with the exception of the ROK, Japan, Malaysia and China. In areas without sewerage connections, septic tank treatment is a typical option. However, domestic wastewater treatment by septic tank shows less BOD removal ratio than sewerage treatment. Moreover, septic tanks are able to receive only black water in some areas. Because the grey water is discharged into the environment without treatment in these areas, the impact of grey water on the environment is significant. In order to prevent water pollution caused by the domestic sector, domestic wastewater including both grey water and black water should be treated by treatment processes with high removal rates for pollution load in areas without access to sewerage treatment. However, because large-scale sewage treatment plants require major investments of time and money for construction, approaches that take the socio-economic situation of Asia into account should be adopted.

WEPA countries have amassed a vast array of experiences in domestic wastewater treatment in sustainable ways under socio-economic constraints. Of these, the following three approaches that are prevalent in the actions taken by WEPA countries are unique, as well as useful. Firstly, WEPA countries focus on the treatment of grey water considering its impact on the environment. In addition, it is particularly worth noting that feasible policy options on domestic wastewater treatment have been selected in order to overcome the issues that have arisen from socio-economic constraints. Moreover, WEPA countries, through their experiences, are able to highlight good practices in community or private sector involvement in the construction and operation of sewage treatment plants.

There is no one single pathway to sustainable domestic wastewater treatment. Different options for construction and operation of domestic wastewater treatment facilities should be adopted in order to overcome the unique issues facing the diverse countries in this region.

WEPA supports this manner of learning from these types of experiences, sharing useful knowledge and has a new appreciation of the importance of discussing applications to other areas.
Chapter 2.2
Climate Change and the Water Environment
— Summary of findings based on WEPA discussions and surveys —

1. Background

Climate change is one of the drivers of change in water resources and poses challenges to existing water management practices (Connor 2009). Climate change can affect the water environment in complex ways (Figure 2.2.1). Various direct and indirect impacts of climate change to the water environment are expected, which will occur in association with other socio-economic factors.

The Working Group II of the Intergovernmental Panel for Climate Change (IPCC) concluded that “higher water temperatures, increased precipitation intensity, and longer periods of low flows exacerbate many forms of water pollution, with impacts on ecosystems, human health, water system reliability and operating costs (high confidence)” (Kundzewicz et al. 2007). The impacts of human induced climate change include higher water temperatures that affect the self purification capacities of water bodies by reducing the amount of dissolved oxygen (DO), which consequently disrupts indigenous aquatic biological species. In addition to direct impacts on water temperature, the potential increase of water use in the energy sector for cooling purposes is also considered to be an indirect cause of higher water temperatures (Kunziewicz et al. 2007). An increase in water temperatures may result in an oxygen-deficient environment in lakes by increase in thermal stability and altered mixing patterns (Bates et al. 2008).

In addition to water temperature, changes in precipitation patterns, intensity and duration also affect water quality. Intense rainfall over short periods increases the amount of suspended solids, sediment, nutrients and other toxins in water bodies due to run-off. In addition, unreliable supplies of surface water caused by changes in precipitation patterns may increase dependency on groundwater for potable use, resulting in overexploitation of the groundwater resource, as well as increased risks to human health from arsenic and fluorine where they exist in groundwater. The rising of sea water levels due to climate change is another threat, resulting in salt water intrusion to surface and underground freshwater systems, consequently causing deterioration in water quality. The impact on human health and water quality due to flooding of polluted water is also identified as a potential risk. Combined with excessive water exploitation, problems from salt water intrusion would be more intensified in coastal cities. Increase of wastewater due to increased demand caused by atmospheric temperature rise such as in the irrigation sector, which may provide negative impacts to water quality. These potential adverse impacts to water quality may aggravate water scarcity in the region.

Aquatic ecosystems are also affected by higher atmospheric and water temperatures, the changes in precipitation and sea level rise. A warmer climate may increase threats to wetlands, which are one of the important habitats of many species. Increases in water temperature may favor exotic aquatic species rather than indigenous species. Once ecosystems are destroyed, they cannot be recovered or require tremendous time and effort to restore.

Considering that climate change may render great impacts on the water environment in a variety of ways, and also recognizing that the Asia-Pacific region has already observed events that are presumed to be caused by climate change, WEPA decided to initiate information exchange and discussions on “climate change and the water environment and possible adaptation options” as one of its priority topics in the second phase activities that started in 2009.

WEPA found that information on the potential impacts of climate change on the water environments (water quality and aquatic ecosystems) is not sufficient to facilitate discussion among partners. Therefore WEPA activities for this topic concentrated on information and knowledge-sharing through WEPA workshops, reinforced by literature reviews and fact-finding and perception surveys. This chapter summarizes these WEPA activities in the Japanese fiscal years 2009 to 2011 and outlines future actions for WEPA on this topic.

2. Impact of Climate Change on Water Quality and Aquatic Ecosystems in WEPA Countries

WEPA partner countries demonstrate examples of changes in the water environment that are suspected to result from or be escalated by climate change. Figure 2.2.2 shows such examples from relevant literature and news articles. A comparative study conducted in East and Southeast Asia between 2007 and 2008 shows that changes in precipitation volume and patterns can affect surface water quality in East
Figure 2.2.1. Casual relationship between climate change and the water environment
(Source: Provided by Ministry of the Environment of Japan)
Asia (Park 2009). Increases in winter temperatures may have higher impacts on the water environment, as high winter temperatures reduce the extent of winter mixing, causing depletion of dissolved oxygen (DO) at the bottom layer of water bodies as reported in Lake Biwa (Japan) and Lake Fuxian (China) (Kumagai et al. 2003). The reduction of DO in the bottom layer in stagnant water bodies, such as lakes or reservoirs imposes an anaerobic condition which may accelerate the release of pollutants from bottom sediments. High levels of Total Suspended Solid (TSS) in the Mekong River and Brantas River (Indonesia) in the rainy seasons were reported and attributed to the increased intensity of precipitation (Box. 2.2.1). Increase of runoff due to heavier precipitation carries pollutants from land to surface water bodies, resulting in the assimilation of biodegradable organic matter by aerobic micro-organisms consuming DO, which results in reduction of DO. A study to investigate time series data of atmospheric temperature and water temperature in the Lake Biwa area showed some correlation between them (Box. 2.2.2), but human induced factors were also suspected to influence changes in water temperature.

In Asian countries, the expansion of human activities puts more pressure on aquatic ecosystems and exacerbates impacts by climate change. According to a dynamic climate model, a variety of species are expected to disappear by 2050 in tropical areas and semi-enclosed seas (McMullen 2009). Some other examples of suspected impacts to aquatic and marine ecosystems are also shown in Figure 2.2.2.

Not all examples shown in Figure 2.2.2. have been scientifically proven, but we have already seen some changes in the water environment. To deepen our understanding of the impacts and incorporate climate change concerns in water environmental management policy, further study is required. The participants in the WEPA workshops identified that insufficient data and information, especially the lack of time series data, presented a barrier to further promotion of scientific research. In addition, they pointed out that it is often difficult to determine to what extent climate change contributes to the observed environmental changes since other stressors (e.g. population growth, urbanization and economic growth) also put significant pressure on the water environment in the region.
The climate of Indonesia is already witnessing major changes. The depth of precipitation is likely to increase in shorter rainy season, while it will become lower in dry season compared to the current climate. According to analysis of water monitoring data for 12 years (1995-2007) in three stations at the Brantas River in East Java, Indonesia, DO values show slight improvement trend at two stations, while decreasing at another one. A reason of the decreasing trend of DO is considered to be industrial activities taking place near the monitoring station. The analysis identified clear seasonal variation for BOD and COD – higher values of both parameters in the rainy season than in the dry season. It is assumed that flush of contaminants and sediments with rain water may contribute to the higher value of these parameters, and higher TSS concentration in the rainy season may support this assumption. Higher ammonia concentration in the rainy season is also observed. The seasonal change in water quality may be attributed to climate change. However, it is difficult to directly link the effects of climate change to water quality in the basin because of other factors including human activities.

(Source: Sarjiya and et al. 2009)

Box 2.2.2. Case Study: Impacts of climate change on the water environment of Lake Biwa

Time series data on water temperature monitored at 46 points over the past 30 years were analyzed as part of a study of potential impacts on the water environment and possible adaptation actions, conducted by the Ministry of the Environment of Japan from 2009 to 2011.

Results showed that the yearly increasing rate of water temperature in Lake Biwa was 0.5 to 3.3°C (yearly average: 1.6°C) and 0.1 to 1.7°C (yearly average: 0.9°C) in summer and winter, respectively over the last thirty years.

Atmospheric temperature data (1960-2008) at the Hikone local meteorological observatory and water temperature at the centre of Minami Hira offshore showed that the annual average increase rate of water temperature during summer was 1.73°C, which is greater than that of atmospheric temperature (1.23°C). In winter, water temperature and atmospheric temperature showed a different trend - the annual average increase rate of water temperature was 0.84°C and that of atmospheric temperature was 1.48°C.

Distinct changes in water temperature as compared to atmospheric temperature in summer revealed that the water temperature of Lake Biwa is influenced by increasing atmospheric temperatures as well as other external factors. On the contrary, in winter, vertical mixing of cold water from the lower layers and warm water from the upper layers might attenuate the effect of external factors on water temperatures of the largest lake (with 27,500 million m³) in Japan.

This study could not find significant collation between water temperature change in Lake Biwa and other external factors such as population density and industrial activities in the lake basin. However, heat emission from wastewater treatment is seen as another important factor impacting water temperature. A huge volume of high temperature (25-28°C in summer and 17-19°C in winter) treated wastewater drains into Lake Biwa, which has a lower temperature of 20-25°C in summer and about 10°C in winter. It was estimated that about 135 million cubic meters of treated wastewater was drained into Lake Biwa in 2005. About 80 percent of the treated wastewater came from the southern basin and the rest from the northern basin. The ratio of wastewater to lake volume in the southern basin was 0.53, which revealed that heat emission from treated wastewater may greatly influence the water temperature of the largest lake of Japan.

(Source: Yuasa et al. 2011)
To identify how water experts and governmental officials working in water sector see the issue of climate change and the water environment, WEPA conducted a questionnaire survey on perceptions of climate change impacts on the water environment in 2009. The survey was distributed to water experts who have participated in WEPA conferences over the past five years. Survey results showed that most respondents were concerned with disturbances within ecosystems, followed by the increase of sedimentation. The respondents also chose intensification of traditional water pollution issues, such as organic pollution, eutrophication and pollution by pathogens, as areas influenced by climate change. However, most have considered that such changes in water quality could be attributed to increases in water use or other factors, and not a direct result of higher water temperature.

3. Policy Responses: Adaptation policies/strategies of WEPA partner countries

Policy responses to the potential impacts of climate change vary from country to country. To determine how each partner country has prepared or is preparing for potential impacts on the water environment in both climate change adaptation policies and water resource/management policies, the WEPA Secretariat conducted a survey to each focal point organization of WEPA to identify relevant policy documents in 2009. The WEPA Secretariat also reviewed policy documents available on the Internet that are related to climate change adaptation and the water environment. Table 2.2.1 is a summary of the survey and review. Survey results are not exhaustive as information that could be obtained from partner countries as well as through websites was limited.

The result of survey and review shows that water shortage and natural ecosystems, including coastal and marine ecosystems, are often addressed in national climate change adaptation policies, strategies, and other related government documents. However, water quality aspect is not often mentioned in these policy documents. The potential impacts of climate change and adaptation actions are also not included in policy documents related to management of the water environment. At a WEPA international workshop, some participants pointed out a lack of knowledge and scientific data to be a barrier in the development of policies for adaptation in the water environmental management sector. Therefore exchange of information and ideas among partner countries is necessary.

### Table 2.2.1. Climate change adaptation related responses/actions related to water at national levels in WEPA countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Mention of water environment sector in national climate change adaptation strategies/plans</th>
<th>Inclusion of climate change concerns in strategies/plans concerning national water resources or water environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cambodia</td>
<td>National Adaptation Programme of Action to Climate Change (NAPA) (2006) identifies high priority adaptation activities. Many of the identified priority activities are related to water resource/environment, and provision of safe water in high risk malaria regions.</td>
<td>Master Plan of Integrated Water Resources does not include climate change adaptation aspects.</td>
</tr>
<tr>
<td>China</td>
<td>China’s Policies and Actions for Addressing Climate Change (2008) includes water resources as a priority sector for adaptation. Natural ecosystem conservation and coastal environments are also priorities. Wastewater reuse and conservation of coastal ecosystems are mentioned in the document.</td>
<td></td>
</tr>
<tr>
<td>Indonesia</td>
<td>National Action Plan Addressing Climate Change (2007) supports the Indonesian Water Vision, namely “actualization of stable water utilization in an efficient, effective, and sustainable manner for the prosperity of all people.” However, no specific reference to water quality is made.</td>
<td>National Water Vision does not mention specific concerns regarding climate change impacts and adaptation actions for the water environment. The National Biodiversity Strategies and Action Plan covered actions for biodiversity and ecosystems in the country overall, but does not mention specific concerns regarding climate change.</td>
</tr>
<tr>
<td>Country</td>
<td>Description</td>
<td>Reference</td>
</tr>
<tr>
<td>------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Nepal</td>
<td>No national strategies/plans on adaptation exist. However, the Ministry of the Environment formed an expert committee on climate adaptation, which drafted the report, &quot;Wise Adaptation to Climate Change Impacts&quot;. Water (both quantity and quality) is identified as a priority area for adaptation in the report.</td>
<td>The National Framework Strategy on Climate Change (2010-2022) identifies ecosystem and water management as key result areas for adaptation of the country. Mainstreaming climate change adaptation in water resource policies is one of the strategic priorities under the key area of 'water governance and management'.</td>
</tr>
<tr>
<td>Japan</td>
<td>The Ministry of Land, Infrastructure, Transport and Tourism organized an expert committee to consider the potential impacts of climate change on water resource management in the country and necessary adaptation actions. The Ministry of the Environment is conducting a three-year study on climate change impacts on the water environment and adaptation actions from 2009. (The final report will be completed in 2012.)</td>
<td>No national strategies/plans on adaptation exist. The National Adaptation Programme of Action to Climate Change (2009) includes water as an area for adaptation actions. However, no specific adaptation actions related to water quality are mentioned.</td>
</tr>
<tr>
<td>Lao PDR</td>
<td>The National Adaptation Programme of Action to Climate Change (2009) includes water as a priority action area for adaptation, but no statements related to water quality and water ecosystems are made in the section (flood and drought issues being the main agenda). Adaptation actions for the public health sector include the improvement of sanitation and ensuring potable water quality.</td>
<td>The National Water Policy (draft in 2010) identifies the need for coordinated programs to reduce the impacts of floods, droughts and climate change. The Action Plan 2011–15 does not specifically point out climate change impacts, but does identify priority action areas.</td>
</tr>
<tr>
<td>Nepal</td>
<td>National Adaptation Programme of Action to Climate Change (NAPA) (2010) does not include the water sector as an area for adaptation actions. The focuses of adaptation actions are water related disasters and the increased vulnerability of water resources in the country. Biodiversity and health issues are included, but no statements mention the relationship between these sectors and water.</td>
<td>The Tenth Malaysia Plan (2011-2015) does not clearly identify climate change adaptation as a challenge for water resource management, although flood and drought management is clearly indicated in the section on climate change adaptation (Chapter 6): National Policy on the Environment.</td>
</tr>
<tr>
<td>Malaysia</td>
<td>The Second National Communication (SNC) (2011) mentions possible water quality deterioration due to reduced or excessive precipitation. Also, the SNC includes adaptation concerns for water, health and biodiversity, which are closely linked with the water environment.</td>
<td>The National Water Plan points out the establishment of information systems on water which may contribute to preparing for climate change impacts.</td>
</tr>
<tr>
<td>Myanmar</td>
<td>The National Strategies and Action Plan for Biodiversity Conservation includes a reference to aquatic ecosystem conservation.</td>
<td>National Water Policy (draft in 2010) identifies the need for coordinated programs to reduce the impacts of floods, droughts and climate change. The Action Plan 2011–15 does not specifically point out climate change impacts, but does identify priority action areas.</td>
</tr>
<tr>
<td>Nepal</td>
<td>The National Framework Strategy on Climate Change (2010-2022) (2010) includes ecosystem and water management as key result areas for adaptation of the country. Mainstreaming climate change adaptation in water resource policies is one of the strategic priorities under the key area of 'water governance and management'.</td>
<td>The Integrated Water Resource Management Plan Framework (2006) includes concerns related to impacts on water supply due to extreme events and rainfall variability. It also identifies impacts on coastal and marine ecosystems.</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>The National Climate Change Adaptation Strategies 2011-2016 identifies water as one of the most vulnerable resources to climate change impacts in the country. Acceleration of water scarcity for irrigation and drinking purposes and exposure to floods, droughts and salt water intrusion are mentioned. The actions included in the strategies cover those in the water sector, but there are no specific actions related to water quality.</td>
<td>The Action Plan for the Haritha Lanka Programme (2008) includes actions related to the use of water resources, water pollution and biodiversity, but does not include adaptation actions in those sectors.</td>
</tr>
<tr>
<td>Thailand</td>
<td>The Second National Communication includes adaptation actions, but no statements are contained related to water quality.</td>
<td>The National Policy on Environment (2007-2011) identifies rehabilitation of watershed forests as an adaptation action area, but no specific references on water quality or ecosystem conservation.</td>
</tr>
<tr>
<td>Viet Nam</td>
<td>The National Target Programme to Respond to Climate Change recognizes the high vulnerability of the country's water resources to climate change. The decline of water resources, salt water intrusion, and destruction of aquatic ecosystems due to changes in water flow and temperature are mentioned in the document; however, the document does not address specific water quality problems that may occur due to climate change (excepting increased salinity).</td>
<td>The National Water Resources Strategies towards 2020 includes climate change as one of the factors in the decline of water resources in the country. The strategies identify water pollution and water ecosystem conservation as priority areas, but concerns over climate change impacts on the water environment are not mentioned.</td>
</tr>
</tbody>
</table>
4. Investigation on potential impacts of climate change: potential for climate change impact study to lead to development of policies for the water environment

In 2009, the Ministry of the Environment, Japan initiated a three-year study to investigate climate change impacts on the water environment and possible adaptation options. As a part of the project, the relationships between atmospheric temperature, water temperature and organic water parameters are being analyzed based on accumulated monitoring data of 30 years.

Data for atmospheric and water temperature, as well as water quality over the long term, are critical when investigating potential climate change impacts. However, regular monitoring and maintenance of monitored data are considered to remain a challenge in the promotion of better management in some of WEPA countries (Chapter 1, p.21). Considering the need to strengthen water quality monitoring and the potential necessity to compile and store scientific facts to assess climate change impacts in the future, the state of water quality related data collected in each WEPA country was surveyed in 2009.

The survey investigated the current status and data collection status of two basic parameters: air temperature and water temperature. In addition, the survey devised to identify the status of data collected for water quality at monitoring points where water temperature data that existed for more than 10 years. Tables 2.2.2 to 2.2.6 show the results of the survey on atmospheric temperature and water temperature.

Survey results reveal that WEPA partner countries have attempted to strengthen water quality monitoring in recent years, but data collection is not sufficient to evaluate the impacts of climate change on water temperature and water quality. Water quality monitoring must be ensured to obtain the data to form a basis for policy making, not only to improve water quality but also from the perspective of investigating the impacts of climate change. Below are the key findings of the survey.

- Sufficient data for water temperature and water quality have not been collected in many WEPA partner countries to allow a view of the trends and correlations in changes in water temperature and water quality, especially in lakes/reservoirs and estuaries/coastal areas.
- Water temperature and water quality monitoring is not conducted regularly in some countries.
- Not all WEPA partner countries conduct regular water quality monitoring for basic quality parameters such as DO, BOD, and COD. It is no surprise that long-term, quality data do not exist in most countries. In such countries, regular water quality monitoring systems should be established to gain an understanding of the state of water quality on which to base current and future actions.
- Data requested by the questionnaire exist in different ministries and organizations in some countries. Thus, WEPA partners face a barrier to the collection of relevant information, which is likewise a barrier to studies of potential climate change impacts on the water environment.

**Table 2.2.2. Air temperature**

<table>
<thead>
<tr>
<th>No. of monitoring points</th>
<th>Current</th>
<th>Points with data accumulation of more than 10 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cambodia</td>
<td>11</td>
<td>20</td>
</tr>
<tr>
<td>Japan*</td>
<td>157</td>
<td>157</td>
</tr>
<tr>
<td>Republic of Korea</td>
<td>539</td>
<td>539</td>
</tr>
<tr>
<td>Lao PDR</td>
<td>23</td>
<td>17</td>
</tr>
<tr>
<td>Indonesia</td>
<td>139</td>
<td>109</td>
</tr>
<tr>
<td>Philippines</td>
<td>56</td>
<td>56</td>
</tr>
<tr>
<td>Malaysia</td>
<td>39</td>
<td>35</td>
</tr>
<tr>
<td>Myanmar</td>
<td>114</td>
<td>113</td>
</tr>
<tr>
<td>Nepal</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Thailand</td>
<td>124</td>
<td>124</td>
</tr>
<tr>
<td>Viet Nam</td>
<td>176</td>
<td>176</td>
</tr>
</tbody>
</table>

* Japan data is as of 2007. Data has been collected for more than 30 years at a number of monitoring points.

**Table 2.2.3. Water temperature in rivers**

<table>
<thead>
<tr>
<th>Monthly</th>
<th>Points with data accumulation of more than 10 years</th>
<th>Current</th>
<th>Points with data accumulation of more than 10 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cambodia</td>
<td>17</td>
<td>19</td>
<td>0</td>
</tr>
<tr>
<td>Japan</td>
<td>6,053</td>
<td>3,121</td>
<td>-</td>
</tr>
<tr>
<td>Republic of Korea</td>
<td>1482</td>
<td>521</td>
<td>0</td>
</tr>
<tr>
<td>Lao PDR</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Indonesia</td>
<td>-</td>
<td>-</td>
<td>105</td>
</tr>
<tr>
<td>Philippines</td>
<td>14</td>
<td>14 (14)</td>
<td>-</td>
</tr>
<tr>
<td>Malaysia</td>
<td>1063</td>
<td>908</td>
<td>0</td>
</tr>
<tr>
<td>Myanmar</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Nepal</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Thailand</td>
<td>39 (automatic)</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Viet Nam</td>
<td>&gt;100</td>
<td>&gt;100</td>
<td>-</td>
</tr>
</tbody>
</table>

* Japan data is as of 2007. Data has been collected for more than 30 years at a number of monitoring points.

* No data is available for China because of no response to the survey.
Future Action of WEPA

The above discussion has revealed that scientific knowledge on climate change impacts on the water quality and aquatic ecosystems of WEPA countries is very limited. Scientific studies may require years to identify the impacts of climate change on water quality and aquatic ecosystems due to the lack of time series data, lack of necessary facilities for scientific research, and lack of human resources in developing countries. However, it is important to continue efforts to promote scientific study in this field. As revealed by the WEPA survey, the lack of monitoring data on water temperature and water quality can become a barrier to assess the impacts of climate change on the water environment in the future. In this regard, it is important to strengthen water quality monitoring and data storage systems in each country.

It is expected that water resources will be subject to negative impacts than positive impacts at global level, and such negative impacts will affect other sustainable agenda such as food security and poverty (Bates et al. (ed.) 2008). Therefore, it is crucial to continue efforts to promote studies and actions by both the scientific community as well as policy makers. In addition to water quality related data collection, perception surveys targeted at relevant communities (e.g. fishermen) in the region could provide additional relevant information on climate change impacts and function as a way to gain empirical knowledge of potential impacts within a short time period. The combination of such studies may increase knowledge of climate change impacts related to the water environment in the region.

In addition, considering the flood that besieged Bangkok in 2011, it is imperative to deliberate on how to increase the level of preparation and resilience against such extreme events. This includes measures to minimize the risks of water pollution, which may be caused by an increase of sediments and suspended solids caused by heavy

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### Table 2.2.4. Water temperature in lakes/reservoirs

<table>
<thead>
<tr>
<th>Country</th>
<th>Monthly</th>
<th>Twice/year (dry and rainy seasons)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Current</td>
<td>Points with data accumulation of more than 10 years</td>
</tr>
<tr>
<td>Cambodia</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Republic of Korea</td>
<td>189</td>
<td>150</td>
</tr>
<tr>
<td>Japan**</td>
<td>529</td>
<td>265</td>
</tr>
<tr>
<td>Lao PDR</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Indonesia</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Philippines</td>
<td>14</td>
<td>14 (14)</td>
</tr>
<tr>
<td>Malaysia*</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Myanmar</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Nepal</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Thailand</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Viet Nam</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

* Lakes and reservoirs in Malaysia are managed and monitored by different organizations or owners.
** Japan data is as of 2007. Data has been collected for more than 30 years at a number of monitoring points.

### Table 2.2.5. Water temperature in coastal waters

<table>
<thead>
<tr>
<th>Country</th>
<th>Monthly</th>
<th>Twice/year (dry and rainy seasons)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Current</td>
<td>Points with data accumulation of more than 10 years</td>
</tr>
<tr>
<td>Cambodia</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Japan*</td>
<td>2,174</td>
<td>1,091</td>
</tr>
<tr>
<td>Republic of Korea</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Lao PDR</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Indonesia</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Philippines</td>
<td>14</td>
<td>14 (14)</td>
</tr>
<tr>
<td>Malaysia</td>
<td>158</td>
<td>-</td>
</tr>
<tr>
<td>Myanmar</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Nepal</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Thailand</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Viet Nam</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

* Japan data is as of 2007. Data has been collected for more than 30 years at a number of monitoring points.

### Table 2.2.6. Water quality data accumulated more than 10 years

<table>
<thead>
<tr>
<th>Water quality monitoring data</th>
<th>Name of country which has accumulated data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rivers (DO and/or BOD)</td>
<td>Japan, Republic of Korea, Thailand and Malaysia</td>
</tr>
<tr>
<td>Lakes (DO and/or BOD/COD)</td>
<td>Japan, Republic of Korea, Thailand and Philippines</td>
</tr>
<tr>
<td>Coastal waters (DO and/or BOD/COD)</td>
<td>Japan, Philippines (only Manila Bay)</td>
</tr>
</tbody>
</table>
precipitation, as well as measures to reduce health risks that may increase as a result of disasters, such as the overflow of untreated wastewater and temporarily nonfunctional wastewater treatment facilities, and water supply systems.

Clear-cut scientific evidence does not yet exist in terms of climate change impacts on the water environment. As discussed in WEPA meetings, distinguishing between the impacts on the water environment, as being from human activity or climate change, is very difficult. However, while considering the importance of and difficulties in addressing this issue, WEPA will take the following actions.

- To continue and enhance discussion and information exchange open on this issue whereby WEPA partners can strengthen water environmental management against potential/suspected climate change impacts.
- To strengthen WEPA activities and broaden the knowledge base to contribute to improvement of water quality management in partner countries, recognizing that strengthening and improvement of current water quality management is an important adaptation action, especially in countries which face implementation problems.
- As a knowledge base on this issue, an archive page on “Climate Change and the Water Environment” will be created for the WEPA database.
Chapter 3

Country Profiles of Water Environmental Management in WEPA Countries

3.1 Cambodia
3.2 China
3.3 Indonesia
3.4 Japan
3.5 Republic of Korea
3.6 Lao PDR
3.7 Malaysia
3.8 Myanmar
3.9 Nepal
3.10 Philippines
3.11 Sri Lanka
3.12 Thailand
3.13 Viet Nam
1. Country Information

Table 3.1.1. Basic indicators

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Area (km²)</td>
<td>181,035 (2008)</td>
</tr>
<tr>
<td>Total Population (person)</td>
<td>14.1 million (2010)</td>
</tr>
<tr>
<td>GDP (current USD)</td>
<td>11.2 billion (2010)</td>
</tr>
<tr>
<td>Per Capita GDP (current USD)</td>
<td>795 (2010)</td>
</tr>
<tr>
<td>Long-Average Precipitation (mm/year)</td>
<td>1,904 (2009)</td>
</tr>
<tr>
<td>Total Renewable Water Resources (km³)</td>
<td>476.1* (2009)</td>
</tr>
<tr>
<td>Total Annual Freshwater Withdrawals (billion m³)</td>
<td>2.2 (2006)</td>
</tr>
<tr>
<td>Annual Freshwater Withdrawal by sectors</td>
<td></td>
</tr>
<tr>
<td>Agriculture</td>
<td>94% (2006)</td>
</tr>
<tr>
<td>Industry</td>
<td>1.5% (2006)</td>
</tr>
<tr>
<td>Municipal (including domestic)</td>
<td>4.5% (2006)</td>
</tr>
</tbody>
</table>

* Estimated
(Source: See References)

2. Major Water Basins in Cambodia

Figure 3.1.1. Major rivers in Cambodia

3. State of Water Resources

The Mekong catchment makes up about 86% of Cambodia’s land area. Tonle Sap Great Lake (TSGL) has two flow directions: 1) In the dry season - water of TSGL drains into the Mekong River, 2) In the rainy season - water of the Mekong River drains into the TSGL. The lake is about 2,500km² in size and has a depth of 1-2m during the dry season. However, its size considerably changes during the rainy season, swelling to approximately 13,000km² with an average depth of 8-10m because of the increase of water flow from the Mekong River.

With this unique hydrological system, the country has an ample supply of water mainly from the Mekong River, Tonle Sap River, Bassac River and other tributaries during the rainy season. That said, most parts of the country encounter water shortages especially for domestic and irrigation uses during the dry season because of insufficient infrastructure development such as for water storage, reservoirs, canals and irrigation systems. Water in Cambodia remains regulated only in part, resulting in an overabundance of water during the rainy season and a deficiency in the dry season.

Groundwater availability is estimated to be 17.6 billion m³, which is primarily used for household water supply and for irrigation. A major emerging player in groundwater extraction is the industrial sector, located in the outskirts of the capital and provinces (Sokha 2005). The alluvial deposits of the Tonle Sap and Mekong floodplain/delta are believed to be excellent shallow aquifers which have high recharge rates. Data and information about groundwater and its utilization is still insufficient, but shallow wells could be used in an estimated 48,000km² of the country (Sokha 2005).

4. State of Water Quality

In general, surface water in Cambodia meets the national ambient water quality standards—meaning water in the country is not polluted. However, water quality has been under threat in some areas especially during the dry season due to the inflow of untreated effluents to public water bodies from urban activities as well as agricultural run-off. Development activities also cause water quality to deteriorate—for example, conversion of wetlands and forest to agricultural lands increases the risk of water pollution from agricultural run-off which contains agro-chemical residues (MoE 2009). Various pollution sources such as untreated wastewater from manufacturing and mining, service and tourism industries, solid and liquid wastes discharged from slaughterhouses and livestock farms, as well as transportation by waterways, also have a major impact on water quality in the country.

River water

According to Cambodia’s Annual Environmental Report 2010, the water quality in public waters has been assessed
as good overall and water pollution is not considered to be a significant problem (MoE 2010). The officers of the Department of Environmental Pollution Control, Ministry of Environment (DoEPC/MoE) of Cambodia conduct water sampling each month at designated stations in the Mekong River (e.g. Chroy Changvar, Phnom Penh Port, Stoung Chouv, and Kien Svay). Table 3.1.2 shows BOD values observed by recent water quality monitoring results in the Mekong River, which indicates that the river quality satisfies the ambient water quality standards of BOD (under 10 mg/L). Monitoring results of other parameters at different monitoring points are also shown in Figure 3.1.2 to 3.1.6.

Table 3.1.2. Values of BOD in Mekong River

<table>
<thead>
<tr>
<th>Year</th>
<th>BOD Value (mg/L)</th>
<th>Ambient Water Quality Standard for BOD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Max. value</td>
<td>Min. value</td>
</tr>
<tr>
<td>2006</td>
<td>3.62</td>
<td>1.77</td>
</tr>
<tr>
<td>2007</td>
<td>Not available</td>
<td>Not available</td>
</tr>
<tr>
<td>2008</td>
<td>3.43</td>
<td>0.53</td>
</tr>
<tr>
<td>2009</td>
<td>3.80</td>
<td>0.20</td>
</tr>
<tr>
<td>2010</td>
<td>4.80</td>
<td>0.27</td>
</tr>
</tbody>
</table>

(Source: MoE 2010)

Figures 3.1.2 to 3.1.6. Water quality monitoring results for different parameters at major monitoring points.
(Source: Sokha 2011)
Lakes and reservoirs

According to various literatures, the general level of pollution in lakes on average remains low, although water pollution has been locally identified in and around floating villages. Since 2009, MoE has started taking water samples to check water quality of lakes. The results of monitoring of COD show that the maximum value in 2010 exceeds ambient water quality standards (Table 3.1.3).

<table>
<thead>
<tr>
<th>Year</th>
<th>Chhnok True (Tonle Sap Great Lake)</th>
<th>Ambient Water Quality Standard for COD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Max.value (mg/L)</td>
<td>Min.value (mg/L)</td>
</tr>
<tr>
<td>2009</td>
<td>4.80</td>
<td>1.27</td>
</tr>
<tr>
<td>2010</td>
<td>8.57</td>
<td>1.0</td>
</tr>
</tbody>
</table>

(Coastal water)

Cambodia’s coastal shoreline is 435 km long on the Gulf of Thailand, and the seaward boundary of the coastal zone has been delimited as the outer limit of the country’s exclusive economic zone with an area of 55,600 km². The landward boundary of the coastal zone has not yet been satisfactorily defined, but it is currently considered to be about 5 km from the shore. The coastal zones are situated in the four provinces of Koh Kong, Kampot, Sihanoukville and Kep municipalities. In general, coastal water is considered to be of fairly good quality, but development activities such as those in economic zones and seaports may exert a negative influence on coastal water and coastal ecosystems without the sound management of solid and liquid wastes generated from those activities. According to the results of monitoring in 2005-2006, water quality had not deteriorated in terms of total suspended solids, dissolved oxygen, biological oxygen demand, total nitrogen, and total phosphorous (MoE 2006).

Groundwater

The data on groundwater quality is very limited, but arsenic contamination of groundwater was identified by a national drinking water quality assessment in 2000 in some provinces located in Mekong, Bassac and Tonle Sap River basins (Arsenic Center of Cambodia 2010) where dependency on groundwater as the source of domestic water is as high as 62-100% (MoWRAM 2008).

5. Frameworks for Water Environment Management

Legislation

The current legislative framework for water environment management in Cambodia is shown in Figure 3.1.7. The protection and promotion of environmental quality and public health is the objective of natural resource management including water (Article 1, Law on Environmental Protection and Natural Resource Management). The Law on Water Resources and Management (2007) includes aspects of water quality management, such as requiring wastewater discharge licenses or permission for activities that could have negative impacts on water quality and human and ecosystem health (Article 22), as well as designations for dangerous or restricted zones for water use where the water quality, quantity and ecological balance are endangered (Article 23).

The details on water environmental conservation measures are explained in the Sub-decree on Water Pollution Control, which was established in 1999 under the Law on Environmental Protection and Natural Resources Management. The sub-decree aims to regulate various activities that could pollute and/or have already polluted public water areas (e.g. rivers, lakes, groundwater, and sea water). Ambient water quality standards for human health and bio-diversity (Article 7), as well as effluent standards for pollution sources (Article 4) are set by this sub-decree. Other elements of the sub-decree include monitoring of pollution sources and their effluents (Chapter 4), monitoring of public water areas (Chapter 5), and inspection rules (Chapter 6). Other sub-decrees under the Law on Environmental Protection and Natural Resources Management, such as the Sub-decree on Solid Wastes and the Sub-decree on Environmental Impact Assessment Process, also contain articles related to water environmental conservation.

Currently, two new pieces of legislation are being drafted in relation to water quality management, namely the Law on Environmental Pollution Management by MoE and the Sub-decree on Water Quality by the Ministry of Water Resources and Meteorology (MoWRAM). The draft Law on Environmental Pollution Management will stipulate the process related to monitoring and control of water, air and soil pollution.
Institutional arrangement

MoE is responsible for protection and management of the environment and natural resources\(^1\) in the country based on the Law on Environmental Protection and Natural Resource Management (Article 9). Details of the ministry’s responsibilities are described in Box 3.1.1. Under the nation’s environmental legislation, MoE issues orders to factories which use chemical substances and other pollutants to treat its wastewater prior to discharge to receiving waters (MoE 2009). Local authorities such as provincial and municipal environmental departments are in charge of water environmental management, such as water quality monitoring.

MoWRAM, established in 1999, also engages in water environmental management and monitors water quality. In principle, MoE is responsible for tasks related to water pollution and MoWRAM is responsible for tasks related to ambient water quality.

---

**Box 3.1.1. Responsibilities of Ministry of Environment of Cambodia under the Law on Environmental Protection and Natural Resource Management**

- Research and assessment of the environmental impacts on natural resources (Article 9)
- Provide recommendations to other concerned ministries to ensure conservation and rational use of the natural resources (Article 9)
- Develop inventories of pollution sources (Article 12)
- Develop sub-degrees to prevent and reduce pollution (Article 13)
- Monitor pollution sources and natural resource development activities (Article 14)
- Conduct inspection of pollution sources (Article 15) and order improvement in case of violations (Article 20)
- Provision of information of the activities of Ministry, as requested by the public (Article 17)

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\(^1\) Natural resources include land, water, airspace, air, geology, ecological systems, mines, energy, petroleum and gas, rocks and sand, precious stones, forest and forest products, wildlife, fish, and aquatic resources (Article 8, The Law on Environmental Protection and Natural Resource Management)
### Ambient water quality standards

Ambient water quality standards for public water areas are set by the Sub-decree on Water Pollution Control. There are two kinds of water quality standards. The first is water quality standards for biodiversity conservation designated for rivers (five parameters), lakes and reservoirs (seven parameters), and coastal water (seven parameters), respectively. The second is water quality standards for public health, which designates standard values for 25 parameters that have harmful effects on human health. There are no ambient quality standards for groundwater, but water quality is assessed by standards designated for specific uses such as national drinking water quality standards.

### Monitoring of ambient water quality in public water bodies

MoE is responsible for the regular control and monitoring of water pollution in public water areas throughout Cambodia (see Box 3.1.2). The details of parameters monitored are shown in Table 3.1.4. Although decentralization has led to local governments and departments handling various tasks, the main constraint to this process is a lack of experienced officials and laboratories for water quality analysis. Therefore, central officials of MoE continue carrying out these tasks in conjunction with local capacity building and institutional capacity development.

<table>
<thead>
<tr>
<th>Parameter monitored</th>
<th>BOD, DO, pH, Temperature, TSS, Coliform</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampling sites</td>
<td>Each of 10 public water body</td>
</tr>
<tr>
<td></td>
<td>(Chroy Chang Var, PP Port, Ta Kmao, Kien Sray, Prek Kdam, Stoeng Sangke, Stoeng Pnaiat, Stoeng Sen, Stoeng Chinit and Tonle Sap Great Lake)</td>
</tr>
<tr>
<td>Frequency</td>
<td>Once a month</td>
</tr>
</tbody>
</table>

(Source: MoEJ 2009)

Water quality samples are taken on an ad-hoc basis to check that groundwater quality satisfies standards for drinking water and household use, as the country does not yet have a regular groundwater quality monitoring system in place.

### Effluent Standards

Aiming at managing effluents discharged from pollution sources, the Effluent Standard for Pollution Sources Discharging Wastewater to Public Water Areas of Sewers was established under the Sub-decree on Water Pollution Control. Standard values are set for 52 parameters, such as temperature, pH, BOD, heavy metals, agricultural chemicals, and organic solvents. In principle, the standards are applied to all industries and other pollution sources designated by the sub-standards. For areas which require special treatment for protection of human health and biodiversity, MoE can establish separate effluent standards for pollution sources in the area (Article 5 of the sub-decree).

### Effluent Monitoring

Under the Sub-decree on Water Pollution Control, all business operators must self-monitor effluent and submit a periodic report of the results to MoE. However, some industries do not comply with this regulation. Therefore, MoE regularly conducts on-site inspections to check whether the business operators are in compliance with effluent standards by taking and analyzing water samples of the effluent and also treated water. There are two types of monitoring programs in place at pollution sources: (i) regular effluent monitoring at normal factories and hotels that is conducted within an interval period of 90 days; and (ii) regular effluent monitoring at factories that use chemicals and/or chemical compounds for production that should be conducted in an interval period of 45 days.

### Non-compliance Measures

When violation of effluent standards is found, MoE issues a written order to industries to correct current activities to comply with the standards. Industries are fined and punished for violations in the monitoring and reporting of, and compliance with effluent standards stipulated under the Sub-decree on Water Pollution Control if they do not respond to orders issued by MoE.
Based on the current state of water quality management in Cambodia, a few key management challenges are identified as follows. process related to monitoring and control of water, air and soil pollution.

1. Weak legal framework such as lack of water quality standards for specific beneficial uses such as human health and recreation.

2. Insufficient equipment for laboratory and field testing which become barriers to the appropriate management of water quality.

3. Shortage of technical officers at both national and local levels with expertise who can carry out adequate water quality management.

4. Budget limitations of government, especially for improvement of capacity of laboratories in terms of facility infrastructure/equipment and human resources.

5. Weak coordination between stakeholders, especially industries that are responsible for protecting and improving water quality in Cambodia. Facilitation of communication and data sharing must be promoted.

6. Insufficient technical capacity both at national and local levels, such as water quality monitoring and decentralized domestic wastewater treatment technologies, which require international support.

Box 3.1.2. Recent development of water quality management: strengthening water quality monitoring

Many developing countries in the region pointed out that lack of data on ambient water quality and effluent from pollution sources are barriers to the promotion of water quality management; Cambodia is no different in this respect. The Cambodian government has worked to strengthen monitoring and assessment of ambient and effluent water quality for more than 15 years to improve and build upon the scientific basis for better management of water quality. For example, MoWRAM started monthly water quality sampling at public water areas in 1993. MoE also conducts a routine monitoring programme at various areas and has conducted ambient water quality monitoring since 1999. Such monitoring practices form the scientific basis for improvement of water quality management policy and specific measures in the future.

(Source: Sokha 2011)

6. Existing and Future Challenges

Based on the current state of water quality management in Cambodia, a few key management challenges are identified as follows. process related to monitoring and control of water, air and soil pollution.
1. Country Information

Table 3.2.1. Basic indicators

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Area (km²)</td>
<td>9,600,000 (2010)</td>
</tr>
<tr>
<td>Total Population (person)</td>
<td>1,300 million (2010)</td>
</tr>
<tr>
<td>GDP (current USD)</td>
<td>5,926.6 billion (2010)</td>
</tr>
<tr>
<td>Per Capita GDP (current USD)</td>
<td>4,428 (2010)</td>
</tr>
<tr>
<td>Long-Average Precipitation (mm/year)</td>
<td>645 (2009)</td>
</tr>
<tr>
<td>Total Renewable Water Resources (km³)</td>
<td>2,840 (2009)</td>
</tr>
<tr>
<td>Total Annual Freshwater Withdrawals (billion m³)</td>
<td>554.1 (2005)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sector</th>
<th>Withdrawals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>64.6% (2005)</td>
</tr>
<tr>
<td>Industry</td>
<td>23.2% (2005)</td>
</tr>
<tr>
<td>Municipal (including domestic)</td>
<td>12.2% (2005)</td>
</tr>
</tbody>
</table>

(Source: See References)

2. Seven Major River Basins in China

Figure 3.2.1. Seven major river basins in China

3. State of Water Resources

The total volume of water resources in China ranks sixth among all the countries in the world. The per capita volume is low at about 2,100m³ (World Development Indicator) because of the large size of the population, which is equivalent to only one-fourth of the world average. In addition, water resources in China are unevenly distributed—rich in the southern areas and poor in the northern areas (MWR 2011). About two-thirds of China’s cities are short of water, and in more than 110 cities, the situation is dire (MWR 2011). Mega-cities such as Beijing and Tianjin are also facing serious water shortages (World Bank 2008).

4. State of Water Quality

According to the State of Environment Report 2010 published by the Ministry of Environmental Protection (MEP) of the People’s Republic of China (PRC), surface water pollution in the country remains serious, especially eutrophication in lakes and reservoirs (MEP 2011a).

The state of surface water quality is evaluated and expressed in grades for environmental standards for surface water which range from Grade I to V (Table 3.2.2). The state of sea water and groundwater are evaluated and expressed in grades for sea water quality standards and environmental quality standards for groundwater, respectively (Table 3.2.3 and 3.2.4).

River water

Based on the results of national monitoring at 409 sections in 204 rivers, water quality categorized as Grade I to III was 59.9%, that of Grade IV to V was 23.7%, and that of inferior to Grade V was 16.4% (MEP 2011a). Water quality of the seven major rivers (Yangtze River, Yellow River, Pearl River, Songhua River, Huaihe River, Haihe River and Liaohe River) was evaluated as “slightly polluted” in general (MEP 2011a). Compared with figures in 2005, water quality has significantly improved (Table 3.2.5).

Figure 3.2.2 shows the details of the state of each of the seven major rivers in 2010. Specifically, the water quality of the Pearl River and the Yangtze River was good, that of the Songhua River and the Huaihe River was slightly polluted, that of the Yellow River and the Liaohe River was intermediately polluted, and water quality of the Haihe River was heavily polluted. The main parameters of pollution observed were total nitrogen and total phosphorus (MEP 2011a).
Water quality in large reservoirs ranked higher than that of large freshwater lakes or lakes in cities (ibid).

Lakes and reservoirs

Table 3.2.6 shows the state of water quality in 26 major lakes and reservoirs based on the national water quality monitoring programme. Compared with monitoring results in 2005, the state of water quality in lakes and reservoirs has also improved, although around 40% of monitored lakes and reservoirs are still classified as Grade V. Total nitrogen (TN) and total phosphorus (TP) are the major pollutants. Of the 26 monitored lakes and reservoirs, Dianchi Lake in Yunnan Province is categorized as "under heavily eutrophication (nutrition index of more than 70)" and Dalai Lake in Inner Mongolia and Hongze Lake in Jiangsu Province as "under intermediate eutorophication (nutrition index higher than 60)" (MEP 2011a). Water quality in large reservoirs ranked higher than that of large freshwater lakes or lakes in cities (ibid).

Table 3.2.6. Water quality of major lakes and reservoirs in 2010

<table>
<thead>
<tr>
<th>Type of water bodies</th>
<th>Number of water bodies</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>Three lakes</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Large freshwater lakes</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>Urban lakes</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Large reservoirs</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>26</td>
<td>0</td>
</tr>
<tr>
<td>Percentage in 2010</td>
<td>(26)</td>
<td>0</td>
</tr>
<tr>
<td>Percentage in 2005</td>
<td>(27)</td>
<td>0</td>
</tr>
</tbody>
</table>

Note: Three lakes refer to Taihu Lake, Dianchi Lake and Chaohu Lake (Source: 2010 data from MEP 2011a; 2005 data from SEPA 2006)
Coastal water

Seawater in China is slightly polluted. A total of 279,225 km² of coastal area was monitored in 2010, with 62.7% classified under Grade I and II for national marine water quality standards, which is a decrease of 10.2% from 2009, and 14.1% classified as Grade III, which is an increase of 8.1% from 2009 (Figure 3.2.3). In terms of coastal seawater quality of the four major areas, the Yellow Sea and South China Sea demonstrated good water quality. Water in the coastal sea area was slightly polluted in Bohai Sea, and the East China Sea had poor water quality (MEP 2011a).

Groundwater

Results indicate that the overall situation of groundwater quality is far from reassuring. The outcomes of groundwater quality monitoring in 2010 show that 40.4% of 4,110 monitoring points in 182 cities were assessed as “poor” in quality and 16.8% as “very poor”*1 (MEP 2011a) (Figure 3.2.4). There is no information available on the types of pollutants, but ammonia nitrogen, nitrite nitrogen, nitrate nitrogen, iron, manganese, and total hardness were the major parameters identified by monitoring in 2009 (MEP 2010a). According to the State Council, over-exploitation, pollution from sewage, domestic and industrial wastes, fertilizers and pesticides have been identified as the main causes of groundwater pollution (Jin 2011). There is a regional difference in water quality as well—while the quality of groundwater in cities in the north, northeast and northwest region of the country is poor, groundwater quality down south is generally good overall (MEP 2011a).

Wastewater and major pollutants

The total discharge of wastewater from industrial and domestic sources has increased, while COD and ammonia nitrogen is on the decline. The total discharge of wastewater in China in 2010 was 61.73 billion tons: 23.75 billion tons from industries and 37.98 billion tons from domestic sources. The discharge is an increase of approximately 15% from 2006 (53.68 billion tons) and 4.7% from 2009 (58.92 billion tons). Total discharge of COD was 12.381 million tons which is a decrease of 3.1% from 2009 (12.775 million tons). Sixty-five percent of COD was discharged from domestic sources. That of ammonia nitrogen was 1.203 million tons of which about 78% is domestic in origin. The amount is a decrease of 1.9% from 2009 (1.226 million tons) (MEP 2011a).

*1 Criteria of “very good” to “very poor” are not equivalent to that of groundwater quality grade I to V. It is a qualitative assessment of groundwater quality using the evaluation method set out in Section 6 of the Quality Standard for Groundwater (GB/T 14848-9)
5. Frameworks for Water Environment Management

**Legislation**
Protection and improvement of both the ecological and living environment as well as pollution control, is the responsibility of the state according to the Constitution of the People’s Republic of China. The Environmental Protection Law of the People’s Republic of China stipulates the objectives of water environmental preservation as “to ensure human health, maintain the effective use of water resources and the conservation of marine resources, maintain the ecological balance, and enhance the development of modern socialism.”

Figure 3.2.5 shows the outline of legislation regarding water quality control in China. The Environmental Protection Law of the People’s Republic of China was put into effect in 1989 as a basic environmental law. For surface water and groundwater quality control, the Law of the People’s Republic of China on Prevention and Control of Water Pollution were formulated in 1984 under which ambient surface and groundwater quality standards and water pollutant discharge standards were established. For sea water, the Marine Environment Protection Law of the People’s Republic of China was established in 1982. Sea water quality standards were set up under the Marine Environment Protection Law. In addition to these laws, regulations and administrative decrees/rules related to water pollution control, such as Interim Measures on the Collection of Pollution Discharge Fee, also exist.

**Institutional arrangements**
The Ministry of Environment Protection (MEP), which was upgraded from the State Environmental Protection Administration (SEPA) in 2008, has a mission to prevent and control environmental pollution in the country through overall supervision and coordination of environmental protection management. Provincial and municipal governments also play important roles in pollution control with local legislations and standards.

**Water environmental management policy**
The national five-year plan for national economic and social development is the country’s principle policy document which also includes targets for water environmental management. In addition, a national five-year plan for water pollution prevention and control in major river basins was established as a key policy document for water environmental management (Figure 3.2.6).
Recent policy achievements in protecting water environment

The National 11th Five-Year Plan (2006-2010) has set an obligatory target of reducing COD emissions by 10% from that of 2005 levels. Since 2006, Environmental Impact Assessments (EIA) for 822 construction projects failing to satisfy water quality control regulations were rejected or suspended. Also, more than 20,000 firms that have discharged wastewater not meeting the requirements of the environmental protection law were closed down. As a result, during the 11th Five-Year Plan, the amount of COD discharged decreased by 12.45% compared to that of 2005 levels meeting the reduction target (Met 2011b). Furthermore, under the national monitoring programme, by the end of 2010, 80.9% of the river section has satisfied the national surface water quality standards. The average concentration of permanganate value of river sections decreased by 31.9% compared to that of 2005, and the proportion of river sections of the seven big rivers which met Grade III water quality standards increased from 41% in 2005 to 59.9% in 2011 (MEP 2011d). The main measures taken to meet the pollution reduction targets are explained in Box 3.2.1.

Ambient water quality standards

The Environmental Quality Standards for Surface Water stipulate standard values for 24 basic parameters in the five above-mentioned grades. The Quality Standard for Groundwater stipulates standard values for 39 parameters, and 35 parameters in the Sea Water Quality Standard. Water Quality Standards for Fisheries and Standards for Irrigation Water Quality have been established as additional water quality standards.

Monitoring of water quality in public water bodies

Water quality monitoring is conducted in stations established across the country to check the water quality of rivers, groundwater, lakes, and sea water. In 2010, monitoring was implemented in 409 stations for 204 rivers, 182 cities with 4,110 stations for groundwater, 26 lakes, and 279,225 km² of coastal area (MEP 2011a). The analytical methods for water quality are provided in each water quality standard (Environmental Quality Standards for Surface Water (GB3838-2002), Quality Standard for Groundwater (GB/T14848-93) and Sea Water Quality Standard (GB3097-1997)).

Effluent standards

Effluent quality of domestic wastewater at the discharge points of urban wastewater treatment plants is regulated by the Discharge Standard of Pollutants for Municipal Wastewater Treatment Plants (GB18918-2002). The Integrated Wastewater Discharge Standard (GB 8978-1996) regulates effluent levels for industrial wastewater. However, for various types of industries such as iron and steel and meat packing industries which are not covered by the above standard, individual standards were established. Different target values for specific pollutants are designed

Box 3.2.1. Main measures taken to meet the pollution reduction targets

Pollution control regulations such as stricter EIA process, total discharge pollution load control, and an examination system for water quality of trans-boundary river sections of the main river basins, as well as the enforcement system for these instruments, including performance appraisal methods of local governments, could be construed as one of the main effective measures behind China’s achievements to date.

Specifically for the EIA process, MEP has reinforced stricter rules for construction projects that impact water quality. In the river basins and regions that have not met reduction targets, approvals for new investments and plant expansion were restricted. As well, plants that did not meet water quality standards within a certain time frame were closed down. The process has gained legal validity as it was stated in the Article 18 of the revised Law of the People’s Republic of China on Prevention and Control of Water Pollution in February 2008, that for areas with total discharge of water pollutants over the prescribed level, the government shall suspend the examination and approval of EIA documents for construction projects.

In addition, by replacing the previous pollution concentration based approach, the total discharge pollution load control approach was adopted to take into account the carrying capacity of the pollution receiving water bodies when discharging wastewater. In its implementation, discharge load permits were issued to polluters, discharge fees for emissions above standards were levied, and enterprises violating the relevant regulations were closed down. In order to enforce and implement the above measures, the central government has signed an agreement with local governments. The agreement makes it obligatory for the local governments to meet pollution reduction targets and if they fail to do so, the responsible officials, including the head of the government, will not be promoted and may even be demoted. This link between performance evaluation indicators and pollution reduction targets was the newest initiative taken during the 11th Five-Year Plan.

(Source: World Bank 2008)
for industries constructed before 31 December 1997 and after 1 January 1998 in the Integrated Wastewater Discharge Standard (GB 8978-1996). Since 2008, more than ten new effluent standards have been added to the existing standards (as of October 2011) (MEP 2011c).

6. Existing and Future Challenges

China has strengthened management of the water environment that serves a basis for the sound development of the country. Currently, water environmental management in the country has incorporated additional strategic management policies in which cultural and ecological aspects, as well as resource-saving aspects, are included. Drinking water source protection remains a priority, and groundwater is taking off as a new priority area in water quality management in China.

As for pollution reduction, the 12th Five-Year Plan (2011-2015) set a goal of 8% reduction of COD discharge and 10% reduction of ammonia nitrogen compared with that of 2010. Prevention and control of agricultural non-point pollution is also highlighted (MEP 2011d).

COD monitoring in the 11th Five-Year Plan covered mostly discharges from point sources, and monitoring of non-point sources will become necessary to comprehensively address the pollution of the water environment in China. According to the first national pollution source survey in 2010, over 40% of water pollutants come from agricultural sources such as run-off of fertilizers, pesticides and livestock wastes, and landfill leakage. Agricultural pollutants accounted for 57.2% of total nitrogen and 67.4% of total phosphorous in water (MEP 2010b). These results have led to the adoption of a new reduction target for ammonia nitrogen. With the increase of water for domestic use along with economic growth, measures in the domestic sector such as development of sewage treatment plants may be considered.

In the 12th Five-Year Plan, reinforcement of environmental protection was identified as a focus. Specifically, reduction of heavy metal pollution, air and soil pollution was highlighted to protect human health (MEP 2011d). From the perspective of the water environment, pollution from heavy metals is particularly threatening to the safety of drinking water sources or groundwater supply in China. According to the State Council, 18% of water supply in China is from groundwater, and out of 657 cities, more than 40% use groundwater as a major source of drinking water (Chinese Government’s Official Web Portal 2011). The pollution of groundwater remains a serious issue; within the past two years between January 2010 and May 2011, there were 21 heavy metal pollution incidents including lead poisoning and damages to the protection zones (Wang 2011). A national plan was adopted by the State Council in August 2011 to protect the safety of groundwater sources and address pollution prevention. Under the plan, the local government will be required to establish a groundwater environment supervision system by 2015 and pollution prevention mechanisms by 2020 (Jin 2011).
1. Country Information

Table 3.3.1. Basic indicators

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Area (km²)</td>
<td>1,910,931 (2010)</td>
</tr>
<tr>
<td>Total Population (person)</td>
<td>239.9 million (2010)</td>
</tr>
<tr>
<td>GDP (current USD)</td>
<td>706.6 billion (2010)</td>
</tr>
<tr>
<td>Per Capita GDP (current USD)</td>
<td>2,946 (2010)</td>
</tr>
<tr>
<td>Long-Average Precipitation (mm/year)</td>
<td>2,702 (2009)</td>
</tr>
<tr>
<td>Total Renewable Water Resources (km³)</td>
<td>2,019 (2009)</td>
</tr>
<tr>
<td>Total Annual Freshwater Withdrawals (billion m³)</td>
<td>113.3 (2000)</td>
</tr>
</tbody>
</table>

Annual Freshwater Withdrawal by sectors

<table>
<thead>
<tr>
<th>Sector</th>
<th>Percentage (2000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>81.9%</td>
</tr>
<tr>
<td>Industry</td>
<td>6.5%</td>
</tr>
<tr>
<td>Municipal (including domestic)</td>
<td>11.6%</td>
</tr>
</tbody>
</table>

(Source: See References)

2. Major Water Basins in Indonesia

![Figure 3.3.1. Water basins in Indonesia]

3. State of Water Resources

Water resources in Indonesia account for almost 6% of the world water resources or about 21% of total water resources in the Asia-Pacific region. There has been a significant upward trend in water consumption trends over the past years; in 2000, total water demand was approximately 156,000 million m³/year. By 2015, it is predicted that this figure will double to 356,575 million m³/year. However, the country is facing a crisis of unprecedented proportions with the decreasing availability of clean water resulting from environmental degradation and pollution. In 2006, the rate of water resource degradation accounted for 15-35% per capita annually (MoEJ 2009).

The average amount of clean water used by households in Indonesia is estimated at 110 litres per capita per day. With an estimated population of around 230 million people in 2009, the drinking water needs for the population of Indonesia accounts for a minimum of 9.3 billion m³. Based on population distribution, the largest island of Java accounted for approximately 58% of the total water demand in 2009 (MoE 2011).

4. State of Water Quality

Rivers

There are 5,590 major rivers in Indonesia. Most large rivers have experienced pollution due to pressure from various sources (MoE 2011).

In 2009, Environmental Impact Management Agencies monitored the water quality in 35 rivers in Indonesia. The results showed that, in comparison with 2008, more rivers were in compliance with water quality Class II criteria. However, about 56% water samples still failed to meet the country’s water quality criteria (excluding South East Sulawesi) (Figure 3.3.2).

![Figure 3.3.2. Percentage of river water samples not in compliance with Class II criteria](Source: MoE 2011)
The water quality of rivers that flow in big cities mainly in Java and Sumatra is declining because the contaminants (pollutants) are increasing. Due to high pollution, most of the rivers in Java are already categorized as Class III or IV. Even the downstream of Ciliwung River (Jakarta) was worse than Class IV.

A major source of pollution is untreated domestic wastewater and waste directly dumped into river bodies. The Statistical Year Book of Indonesia reported that up until 2010, only 55% of households had improved sanitation facilities (Statistics Indonesia 2011). An additional cause of water pollution is wastewater from industrial activities of small-scale industries such as agriculture, textiles, pulp and paper, petrochemicals, mining, and oil and gas. Other pollutant sources outside of Java and Sumatra include land erosion which has resulted in part from illegal logging and farming (MoE 2011).

In addition, the water quality of rivers in West Java are in critical condition. The results of research conducted on seven rivers, Cimanuk, Citarum, Cisadane, Kali Surabaya, Ciliwung, Citanduy and Cilamaya, showed that all rivers were categorized as Class D, which indicates extremely poor water quality. At the Citarum watershed, not one single location meets the water quality criteria for Class II water quality. The high content of fecal coli, dissolved oxygen, BOD, COD and suspended substances at all locations, especially the parameters of dissolved oxygen which is an indicator of the health of a water body, were at very low levels, with some readings even plunging to zero in locations such as Sapan, Cijeruk, and Burujul Dayeuh. Water pollution in the many rivers was caused from pollution from industrial waste, domestic activities, hospitals, livestock and agricultural activities (MoE 2011).

Water quality in Citarum River had moved into levels of heavy pollution. Many key parameters exceed quality standards, from organic waste to heavy metal content. About 40% of waste in Citarum River is organic household waste. The rest is comprised of chemical or industrial wastes and livestock and agricultural wastes (MoE 2011).

**Lakes and reservoirs**

Similar to conditions in rivers, there is significant pressure on water quality in lakes from various sources. The water quality monitoring of lakes conducted by the Research Center for Limnology at Lake Maninjau LIPI in 2008 showed that lake waters are eutrophic or have remained at the same trophic state as in 2007. The trophic status of Lake Batur Sendangkan improved slightly in 2008 to mesotrophic (MoE 2011).

The results of research conducted by PT Indonesia Power together with the Natural Resources Research Center and Environment (PPSDAL) Padjadjaran University, Bandung in 2004, indicate that the water quality of Saguling reservoir was already above the normal threshold. The content of mercury (Hg), for example, reached 0.236 mg/m³. In fact, the standard, safe rate is 0.002 mg/m³ (MoE 2011).

The metal mercury, according to research PPSDAL University of Padjadjaran, can be extracted from fish food and plastics industries. Other heavy metals are delivered to water bodies from textile mills through the fabric dyeing process. This large amount of heavy metals are a ticking time bomb, ready to destroy the already fragile water quality in the country. Currently, the water in Saguling reservoir is no longer acceptable for consumption, agriculture and fisheries (MoE 2011).

**Coastal water**

According to the State of Environment Report of Indonesia 2007, monitoring data from four harbours in Java (Tanjung Priok (Jakarta), Tanjung Emas (Semarang), and Tanjung Perak (Surabaya)) show excessively high concentrations of phenol, which exceed the marine water quality standards for harbour areas (Decree of the State Minister of the Environment Number 51 of 2004 Concerning Marine Water Quality Standards). These high concentrations are caused by antiseptic substances from ship wastewater (MoE 2008).

In the northern coastal areas of West Java, damaged areas are characterized by the destruction of mangrove forests, coastal erosion, and silitation of rivers that have an impact on boat traffic events. The level of abrasion that occurs on the south coast is around 35.35 ha/year and about 370.3 ha/year on the north coast, with a seawater pollutant index between 7.391 and 9.843, indicating heavy pollution (MoE 2011).

**Groundwater**

The Decree of Health Minister No. 416 of 1990 concerning the provision and control of water quality stipulates quality standards for groundwater. According to the Jakarta State of Environment Report 2006, about 39 percent of monitoring wells in the Jakarta area, which are mostly located in densely settled areas, have concentrations of E. coli that exceed standards (Environmental Management of DKI Jakarta 2007).

5. Frameworks for Water Environment Management

The objective of environmental management in Indonesia is to enable environmentally-sustainable development. Towards this end, water has been recognized as having an important function in achieving this development and
maintaining the well-being of humans and other creatures, and that it needs to be wisely managed for the benefit of both present and future generations, as well as to achieve an ecological balance. Figure 3.3.3. shows the basic legislative structure for water environment management.

Environmental acts and regulations were introduced in the 1980s in Indonesia, such as the Law No.4/1982 on Environmental Management. The successor of the first environmental management law, the Basic Law concerning Environmental Management Law No. 23 of 1997, was replaced by the Law Concerning Environmental Protection and Management Law No. 32 of 2009 (Box.3.3.1). Outlined in this law were the following goals (Article 3):

(a) protecting the country from environmental pollution and/or damage;
(b) assuring human safety, health and life;
(c) assuring the continuation of human, animal and plant life and ecosystem conservation;
(d) conserving environmental functions;
(e) achieving environmental harmony, synchronization and balance;
(f) ensuring justice for the present and future generations;
(g) fulfilling and protecting the right to the environment;
(h) controlling the utilization of natural resources;
(i) realizing sustainable development, and
(j) anticipating global environmental issues.

The National Medium-Term Development Plan (2010-2014) set the following numerical targets related to conservation of water environment:

- Reduction of pollution load from 680 industries
- Decrease in pollution levels by 50%
- Cessation of environmental degradation in 11 priority watersheds

According to the State of Environment Indonesia 2010 report, the following rivers and lakes were specifically prioritized for restoration:

**Rivers:**
1. Ciliwung
2. Cisadane
3. Citarum (West Java); Solo (Central Java)
4. Progo (Yogyakarta)
5. Siak (Riau)
6. Kampar (Riau)
7. Batanghari (Edinburgh)
8. Musi (South Sumatra)
9. Barito (south central)
10. Mamasa (South Sulawesi)

**Lakes:**
1. Limboto (Gorontalo)
2. Toba (North Sumatra)
3. Tempe (South Sulawesi)
4. Tondano (North Sulawesi)
5. Maninjau (West Sumatra)
6. Singkarak (West Sumatra)
7. Poso (Central Sulawesi)
8. Matano (South Sulawesi)
9. Swamp Dizziness (Central Java)
10. Batur (Bali)

The Management of Water Quality and Control over Water Pollution Government Regulation No. 82 of 2001 is the principle law for water quality management which focuses on controlling water pollution. Under this law, water quality classifications were defined.
Box 3.3.1. Recent Developments: Environmental Protection and Management Law No. 32 of 2009

Environmental Protection and Management Law No. 32 of 2009 is more comprehensive than its predecessor, Environmental Law 23 of 1997. It introduces several new principles such as precautions, harmony and equilibrium of the environment, eco-regions, biological diversity, participation, local wisdom, good governance, and regional autonomy (Article 2). To strengthen pollution source control, the law introduced new stricter provisions. Some examples are as follows.

- **Introduction of the environmental permit system and guaranteeing funds for restoration:** Environmental permits have been introduced in addition to environmental impact assessment statements (AMDAL) or environmental management and monitoring efforts (UKL-UPL) (Article 36-41). All businesses and/or activities which require AMDAL or UKL-UPL are required to obtain an environmental permit issued by the Minister of the Environment, governor and/or mayors (Article 36). In addition, the Environment Permit is a requirement to obtain business operation permits. This means that businesses must stop operations if their environmental permits are revoked. The permit can be recalled even if false statements are found in submitted documents. The environmental permit holder is required to “provide guarantee funds for the restoration of the environmental functions” (Article 55).

- **Environmental risk analysis:** All businesses and/or activities which may cause serious environmental impacts are required to conduct an “environmental analysis” which is composed of “risk assessment,” “risk management” and “risk communication.” Details of the analysis will be stipulated by government regulations in the future (Article 47).

- **Environmental audit:** Periodical environmental audits become a requirement for businesses and/or activities which have high potential for negative environmental impacts. Personnel in charge of non-compliance business/activities are also requested by the Minister of the Environment to conduct environmental audits. Certified environmental auditors carry out audits (Article 48-51).

- **Strengthened penalty for non-compliance:** The new law stipulates stricter administrative and criminal penalties for non-compliance with provisions stipulated in relevant laws, including environmental standards/criteria and effluent standards.

In addition to strengthening provisions related to businesses, the law also includes provisions to incorporate environmental concerns in development plans and economic activities by governments (Article 42 and 43) and promote public participation.

(Source: Syarif 2010)

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**Water quality standards**

Water quality criteria (WQC) were set as the benchmarks for water quality conservation under the Management of Water Quality and Control over Water Pollution Government Regulation Number 82 of 2001. These criteria are the minimum standards set by the national government; local governments are free to set their own criteria, even stricter values than those established by the national government, using local settings as a base, and may include additional parameters not included in national criteria.

WQC sets standard values for 45 parameters in four classes which are determined based on the type of water usage (Table 3.3.2). However, rivers have not fully been categorized into classes, and the state of water quality in the country is evaluated based upon whether values comply with values listed in Class II.

For marine water conservation, seawater quality standards are used as the benchmark for water quality, under the Decree of the State Minister of the Environment Number 51 of 2004 Regarding Standard Quality of Seawater. The three kinds of standard quality of seawater are set based on the usage or characteristics of seawater: standard quality for harbour waters, marine tourism, and marine biota. As with water criteria for surface water, local governments are permitted to set stricter standards. One example is the Regulation of the Governor of DKI Jakarta Province No.93/2006, which applies stricter standards for

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**Table 3.3.2. Classes of inland water quality**

<table>
<thead>
<tr>
<th>Class</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I</td>
<td>Water that can be used as raw water for drinking water, and/or other usage that requires the same water quality for such usage.</td>
</tr>
<tr>
<td>Class II</td>
<td>Water that can be used for water recreation, infrastructure/means, freshwater fish farming, animal husbandry, water for irrigating gardens, and/or other usage that requires the same water quality for such usage.</td>
</tr>
<tr>
<td>Class III</td>
<td>Water that can be used for freshwater fish farming, animal husbandry, water for irrigating gardens and/or other usage that requires the same water quality for such usage.</td>
</tr>
<tr>
<td>Class IV</td>
<td>Water that can be used for irrigating gardens and/or other usage that requires the same water quality for such usage.</td>
</tr>
</tbody>
</table>

(Source: MoEJ 2009)
capitals of provinces and special region of Jakarta (DKI Jakarta Province).

As of January 2012, the Ministry of Environment of Indonesia is drafting a new Government Regulation revising the existing Government Regulation No. 82 of 2001 to reflect the more recent Regulation No. 32 of 2009. The draft has been completed and is awaiting approval. It is expected to be issued in 2012 (Information from the focal person of Indonesia).

**Monitoring of water quality in public water bodies**

Water quality monitoring schemes are determined under the Management of Water Quality and Control over Water Pollution Government Regulation as follows:

1. Monitoring of water sources in the regency/municipal region is carried out by the regency/municipal government
2. Monitoring of water sources in two or more regency/municipal regions within one province is coordinated by the provincial government and is carried out by each regency/municipal government
3. Monitoring of water sources in two or more provincial regions and/or water sources on the border with other countries is observed by the national government.

Water quality observation is carried out at least once every six months and results are submitted to the Minister. The mechanisms and procedures for water quality monitoring are stipulated further in detail through a Ministerial Decree.

Since 2004, 33 Regional Environmental Impact Control Agencies in the provinces have monitored water quality parameters in 40 rivers in Indonesia.

**Effluent standards**

National wastewater quality standards are specified with a Ministerial Decree by taking into account suggestions from related government agencies (Management of Water Quality and Control over Water Pollution Government Regulation). As with water quality standards, the provincial government can specify the same or tighter wastewater quality standards than the national wastewater quality standard.

In 2001, the government set up the first effluent standards for 14 industrial activities. By 2005, this number increased to 21 by the Decree of the Minister of Environment Number 51 of 1995 Concerning Quality Standard of Liquid Waste for Industrial Activities. The Minister determines the values for wastewater quality standards by individual regulations. Local governments such in DKI Jakarta, West Java and Jogjakarta established stricter wastewater quality standards the national government.

**6. Existing and Future Challenges**

To achieve and promote better water environment management in Indonesia, several attempts will be required such as:

- Create incentives for industries to comply with the existing regulations
- Ensure implementation of waste management in rivers
- Development and implementation of water quality restoration policy instruments
- Strengthen database and information systems, and improve capacity building activities in the laboratories
- Introduce spatial regulations and promote the involvement of all stakeholders in the process of spatial planning in a participatory manner
1. Country Information

Table 3.4.1. Basic Indicators

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Land Area (km²)</td>
<td>377,947 (2008)</td>
</tr>
<tr>
<td>Total Population (person)</td>
<td>127.5 million (2010)</td>
</tr>
<tr>
<td>GDP (current USD)</td>
<td>5,458.8 billion (2010)</td>
</tr>
<tr>
<td>Per Capita GDP (current USD)</td>
<td>42,831 (2010)</td>
</tr>
<tr>
<td>Long-Average Precipitation (mm/year)</td>
<td>1,690 (2005)</td>
</tr>
<tr>
<td>Total Renewable Water Resources (km³)</td>
<td>430 (2011)</td>
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<td>Total Annual Freshwater Withdrawals (billion m³)</td>
<td>82.4 (2008)</td>
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<td>Annual Freshwater Withdrawal by sectors</td>
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<tr>
<td>Agriculture</td>
<td>66% (2008)</td>
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<tr>
<td>Industry</td>
<td>15% (2008)</td>
</tr>
<tr>
<td>Municipal (including domestic)</td>
<td>19% (2008)</td>
</tr>
</tbody>
</table>

(Source: See References)

2. Major Water Basins in Japan

3. State of Water Resources

While annual precipitation in Japan is high, fluctuations in water volume of rivers varies greatly throughout the year, increasing during the rainy and typhoon seasons, and decreasing in other seasons.

Due to rapid increases in population and economic growth, per capita water usage volume in the domestic sector has tripled between 1965 and 2008 (MLIT 2011). In recent years, the household sector has shown a decrease in water use and the reuse of industrial water by factories has increased. Accordingly, additional demands on rivers and other water resources have decreased (MLIT 2011).

While construction of dams and weirs has been carried out to secure a stable water supply, years of precipitation anomalies have resulted in a rising frequency of water shortages across Japan. The municipal water supply service coverage rate (by population) of Japan exceeds 97%, but public concerns over safer and better tasting water have increased in recent years, making it imperative to improve the water quality of the rivers, lakes and reservoirs which function as the country’s main water sources.

4. State of Water Quality

The two main objectives of protecting the water environment in Japan are the protection of human health and the living environment. In order to achieve both objectives, environmental standards for ambient water quality have been established in the Basic Environment Law as the acceptable water quality levels that should be maintained in public waters and groundwater. There are two kinds of environmental quality standards (EQS) for water: those for human health which are uniform standards applicable to all public water bodies throughout the country and those for conservation of the living environment which are applied to all public water bodies according to water use classifications.

Rivers, lakes and reservoirs, and coastal water

In most locations, EQS for human health have been attained with a 98.9% compliance rate in fiscal year 2010. EQS for conservation of the living environment have been achieved with an 87.8% rate of compliance for BOD or COD, the representative water quality indicators of organic contamination. Compliance rates by types of water bodies were recorded as 92.5% for rivers, 53.2% for lakes and reservoirs, and 78.3% for coastal waters. Although the compliance rate for rivers is high, the rate for lakes and reservoirs remains low (Figure 3.4.2).

The compliance rate for total nitrogen and total phosphorus for lakes and reservoirs was low at 50.4%. In contrast, the achievement rate for total nitrogen and total phosphorus in coastal waters was 81.6%, maintaining a near sideways shift in recent years.
Groundwater

Of the 4,312 wells that were tested in 2009, 250 (5.8%) exceeded standards for some EQS. Among others, the values for nitrate nitrogen and nitrite nitrogen show rates exceeding standards (Figure 3.4.3). The main causes are considered to be nitrogen load from fertilization, domestic animal excreta and domestic wastewater.

5. Frameworks for Water Environment Management

Legislation

The purpose of environmental conservation in the country is to "ensure healthy and cultured living for both the present and future generations of the nation as well as to contribute to the welfare of mankind" (Article 1 of the Basic Environmental Law). EQS for Water has established by the Basic Environmental Law as the administrative targets of ambient water quality.

The Water Pollution Control Law, enacted in order to achieve the water quality targets sets provisions for water quality conservation such as effluent regulations from factories and business establishments, ambient water quality monitoring, measurement standards for public water bodies, and the total pollutant load control system. Other laws related to conservation of public water bodies are shown in Figure 3.4.4.

Ambient water quality standards

Nationwide uniform standard values have been set for 27 items as EQS for Water related to protection of human health (environmental items). In 1997, EQS for Water were
also established. Meanwhile, EQS for Water related to the protection of the living environment (living environment items) include environmental standards set such for BOD, COD and DO. Total nitrogen and total phosphorus are also included in the living environment items as indicators of eutrophication in lakes and reservoirs and coastal waters.

### Monitoring of public water bodies and groundwater

According to the Water Pollution Control Law, prefectural governors are required to conduct regular monitoring of public water bodies and inform the public of the state of water pollution in public water bodies and groundwater. Prefectural governments carry out regular water quality monitoring in cooperation with relevant national government organizations based on monitoring methods specified by MoE. Monitoring results at approximately 7,000 locations in public water bodies nationwide are publicly released on the website of MoE (Figure 3.4.5).

**Effluent standards**

Based on the Water Pollution Control Law, uniform effluent standards were established for 27 items related to protection of human health, which are applicable to factories and business establishments. Meanwhile, effluent standards for 15 items related to the living environment target only those factories and business establishments with daily effluent volumes exceeding 50m³ per day. Local governments (prefectures and ordinance-designated cities) may establish stricter effluent standards than the national uniform standards when the national standards are considered to be insufficient to achieve water quality targets.

The Water Pollution Control Law stipulates monitoring and recording of the quality of effluent from factories and business establishments located in total pollutant load control target areas. The factories and business establishments are required to measure and record pollution loads in discharged wastewater. Governors of prefectures and mayors of ordinance-designated cities can require reports to be submitted and conduct inspections of
factories and business establishments on wastewater treatment methods and the quality/amount of wastewater in order to prevent violations. They are also authorized to take administrative measures in the event that violations are found, such as issuing orders for improvements according to the outcomes of reports and inspections.

**Total pollutant load control system (TPLCs)**

The total pollutant load control system is a discharge control mechanism to improve water quality by reducing total pollutant loads flowing into the selected enclosed coastal waters, namely Tokyo Bay, Ise Bay, and the Seto Inland Sea where it is difficult to achieve EQS for Water by regulating discharge based on only concentrations of regulated substances. Under the system, the national government sets targets for pollutant loads every five years (one phase for five years), and relevant prefectures establish reduction plans that set targets for each emission source and stipulate the methods necessary to meet targets.

To date, COD loads has been steadily reduced in target water bodies since 1979 (Figure 3.4.6). Figure 3.4.7 shows the improvement of COD concentration in Tokyo Bay, for example. Nitrogen and phosphorus loads have also been reduced since those items are covered by the system in 2001. In July 2011, Japan set forth the basic policy of the 7th phase total reduction of which target year is 2016.

**Figure 3.4.6. Changes in pollution load and target value (in terms of COD)**

(Source: Provided by MoEJ)

**Figure 3.4.7. COD concentration in Tokyo Bay**

(Source: Provided by MoEJ)
6. Recent Development of Water Environment Management

Following the enactment of the Water Pollution Control Law in 1970, various revisions have taken place according to the times and demands of society. Major revisions made in recent years are summarized below.

Expansion of the range of measures in the event of accidents (2010 revision)
The number of water pollution accidents has been on the rise in recent years. While the chemical substances discharged by water pollution accidents are wide-ranging, the Water Pollution Control Law targets only polluted water containing toxic substances to be covered by the Water Pollution Control Law and oil in the event of accidents. To fill in the gaps between reality and the measures stipulated in the Water Pollution Control Law, the 2010 revision of the law expanded the target substances subject to emergency measures and reporting requirements of factories and business establishments in the event of accidents. The revision added “specified facilities that use harmful substances” as target facilities which manufacture, store, use or process substances that are in danger of damaging human health or the living environment when released into public water areas in large quantities.

Establishment of penalties for unrecorded measurements for wastewater (2010 revision)
In recent years, there have been a string of cases of inappropriate behaviors such as businesses, including major corporations, falsifying records on measurements of effluent loads and quality. To mitigate this behavior, the revision requires business establishments to retain monitoring records for a set period of time. Additionally, new penalties have been established for businesses that violate these requirements by failing to record, retain or falsifying records.

Proactive measures to prevent groundwater pollution (2011 revision)
Groundwater is an invaluable freshwater resource that accounts for approximately 25% of municipal water supply. It is difficult to detect causes of pollution because of the complicated migration pathway of groundwater, and recovering water quality is almost impossible as natural purification is not as prevalent.

Each year, surveys have confirmed cases of groundwater contamination due to leakage of toxic substances from factories and business establishments. The majority of leaks are caused by the deterioration of production and storage facilities or by operator error during use of production facilities.

Considering these facts, requirements to issue notifications related to the installation of facilities were expanded to include the installation of facilities that not only release toxic substances, but also those that store them. Additionally, in order to prevent underground seepage before it occurs, compliance with standards related to structures and requirements for periodic inspection of facility structures and methods were newly imposed on businesses.

7. Existing and Future Challenges

A more ideal form of initiatives to improve and protect the water environment are called for when considering the diverse needs of residents and social transitions in recent years, including ensuring an environmentally-sound water cycle. As a common idea behind the development of policies to protect the water environment, four different perspectives should be kept in mind when furthering policy goals: the local perspective, global perspective, biodiversity and cooperation. The following is a selection of examples of future initiative.

Improvement of water quality of lakes and reservoirs
Although the water quality of lakes and reservoirs is gradually improving, the actual achievement rate of environmental standards is low at around 50%. Many issues have emerged such as decreased native species and haul of fish due to changes in ecosystems, impediments to water use due to the occurrence of foul odors and filtration obstacles, as well as a weakening of the relationship between people and lakes due to decreased contact. In the future, new water quality indicators that respond to the
actual needs of the country’s residents, as well as targets that reflect the natural conditions and purpose of each water body should be examined further. It is important to promote measures for both lakes themselves and catchment areas that utilize natural purification mechanism, following efforts to elucidate contamination mechanisms of lakes and reservoirs.

**Creation of “sato-umi”**

A *sato-umi*, or “local seaside” is defined as “a coastal area where biological productivity and biodiversity have increased through human interaction.” It is an important ocean area that has supported not only marine and distribution industries, but also the local culture and exchange with other areas for many years. In a healthy *sato-umi*, the circulation function of materials is appropriately maintained due to the integrated comprehensive management of land and coastal zones by human being. With the preservation of the rich and diverse ecosystem and natural environment, *sato-umi* provides the country with a wonderful legacy, and therefore, is a focal point in the protection of the water environment.

**Initiatives on global water issues**

Japan’s water environment is closely related to the global water environment. Thus, it is important to maintain an international perspective and contribute to the preservation and improvement of the water environment in other countries. As such, we must utilize Japan’s technologies and experience in water environmental preservation to promote initiatives in international cooperation and partnerships, such as institutional transfer and technology support. Additionally, in order to respond to both quality and quantity related water issues manifesting themselves in regions where increased water demand is predicted, such as Asia and the Middle East, we must endeavor to improve the water environment overseas through the close and active joint efforts of the private and public sector on initiatives to enhance the international competitiveness of Japan’s water-related industries.

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An “ordinance designated city” is a large city which is delegated some affairs and authorities of prefecture by cabinet order. The population of the ordinance designated city must be more than 0.5 million. As of April 2011, there are 19 ordinance designated city in Japan.
1. Country Information

<table>
<thead>
<tr>
<th>Table 3.5.1. Basic Indicators</th>
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<tbody>
<tr>
<td>Land Area (km²)</td>
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<td>Total Population (person)</td>
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<td>GDP (current USD)</td>
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<tr>
<td>Per Capita GDP (current USD)</td>
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<tr>
<td>Long-Average Precipitation (mm/year)</td>
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<td>Total Renewable Water Resources (km³)</td>
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<td>Total Annual Freshwater Withdrawals (billion m³)</td>
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</tr>
<tr>
<td>Industry</td>
</tr>
<tr>
<td>Municipal (including domestic)</td>
</tr>
</tbody>
</table>

* Estimated
(Source: See References)

2. Major Water Basins in Republic of Korea

3. State of Water Resources

Republic of Korea is a thirsty country: the country’s per capita water availability is about 540m³ (MoCT 2007) which is far lower than the world’s average and that of southern and eastern Asia which are about 6,400 m³ and 3,100 m³, respectively (FAO 2012). Due to population and economic growth, total water use has rapidly increased 6.6 times between 1965 and 2003 (MoE 2011). Seasonal variations in water availability are also a challenge for the country’s water management. About two-thirds of annual precipitation falls during June and September. Flood events during the rainy season and droughts in months with less rain, especially the spring, are critical issues facing the country. The trend over the past century shows an increase in fluctuations of annual precipitation and intensification of floods and drought events (MoCT 2007).

There are four major river basins in Korea, namely Han, Geum, Nakdong and Youngsan-Seomjin. Most of the lakes and reservoirs are man-made. The potential of groundwater resources of the country is approximately 11.7 billion m³/year. The total amount of groundwater use is about 3.8 billion m³/year which are mainly used for domestic (48%) and agriculture purposes (46%) (MoE 2011).

4. State of Water Quality

Rivers

All streams nationwide are classified into 114 sectors and water quality targets have been established for each. Water quality in the country has improved overall since the late 1990s. Figure 3.5.2 shows the improvement of water quality in selected points in four major river systems (Han, Nakdong, Geum, and Youngsan-Seomjin) in terms of BOD. On the other hand, COD values show an increasing trend (Figure 3.5.3). An increase of chemicals and loads from non-point sources are considered to be a reason behind the lack of improvement for COD levels (MoE 2011).

Total phosphorus (TP) and total nitrogen (TN) values decreased or did not show a big change (MoE 2012). However, algae bloom caused by high nutrients was observed in the Mulgeum such as during the drought season of March 2009 (MoE 2012).

Lakes and reservoirs

Similar to river water quality, COD value concentrations also show an increasing trend in recent years in lakes and reservoirs. Figure 3.5.4 and 3.5.5 show water quality trends in terms of COD and TP in selected reservoirs.

Groundwater

Figure 3.5.6 shows rates exceeding groundwater quality standards from 2000 to 2009. The major parameters showing non-compliance are TCE and PCE, which is detected in industrial and urban residence areas.
5. Frameworks for Water Environment Management

The basic law for the environmental management policy of the country is the Framework Act on Environmental Policy under which environment quality standards are established. The major objectives of water environmental management in Korea under the Water Quality and Ecosystem Conservation Act are the protection of people's...
Basic policy direction of the water environmental management

The recent policy direction of the country included the following principles (Yu 2010):

- Creation of an ecologically healthy water environment
- Protection of water quality against harmful substances
- Application of advanced water quality standards and assessment methods
- Reinforcing the national water quality policy for lakes, coastal areas and estuaries
- Full-scale implementation of the total pollution load management system
- Focus on the management of non-point sources and pollutants from livestock farms
- Improvement of the functions of water cycle and reinforcing water demand management
- Rationalizing investment in environmental infrastructure and efficient investment

The Ministry of Environment has set up objectives and targets for the period of 2006-2015 under the Water Environment Management Master Plan. Under the objective to “create a clean water environment where our children can swim with aquatic life,” the following indicators are included in the master plan (Yu 2010):

- Increase water quality improvement (compliance ratio) from 76% to 85%
- Increase sewerage treatment coverage from 81% to 90%
- Restore 25% of non-natural stream to natural stream
- Increase basic criteria of water quality from 9 to 30 parameters
- Conserve 30% of buffer zones which were purchased in the upper stream as Riverine Ecobelt

The Ministry of Environment is responsible for water quality and ecosystem management at the central level. The ministry also develops and implements plans for drinking water supply and wastewater treatment, as well as river restoration.
Ambient water quality standards

There are two kinds of water quality standards for surface water. The first are standards for the protection of human health (17 parameters such as Cd, As, and PCB), which is applied to both rivers and lakes. The second are standards for the living environment which were set for rivers and lakes/mashes, respectively. The standards for the living environment for rivers include six parameters; standards for lakes/marshes include nine parameters in seven categories (MoE 2012).

The Ministry of Environment plans to expand water quality standards to thirty substances by 2015. Ecological risk criteria were also developed and will be incorporated into water quality standards in the near future (Yu 2011).

For groundwater, different standards are applied according to water usage purpose. Drinking water standards established under the Drinking Water Management Act are applied for drinking water use. For other purposes such as residential, agricultural, and industrial uses, groundwater standards are used to evaluate groundwater quality. The standards consist of four general pollutants (pH, E-Coli, NO3-N, Cl-) and 15 specific hazardous substances (such as Cd, As, and CN) (MoE 2011).

Special metropolitan cities, metropolitan city or “Do” can establish more stringent or expanded environmental standards than the national standards where necessary in consideration of local environmental conditions (Article 10 (3) Framework Act on Environmental Policy).

Effluent standards

Effluent standards are set by an Ordinance of the Ministry of Environment based on the Water Quality and Ecosystem Conservation Act (Article 32). Currently effluent standards have been set for discharged water from both public and private sewage treatment plants. The general outline of effluent standards is shown in Table 3.5.2. Similar to environmental standards, cities or “Do” can set up local effluent standards where necessary.

Table 3.5.2. Effluent standards

<table>
<thead>
<tr>
<th>Type of facility</th>
<th>Outline</th>
</tr>
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<tbody>
<tr>
<td>Public sewage treatment facility</td>
<td>6 parameters and 1 toxic unit Different values are applied to facilities with the capacity of more than 50m³/day and those with less than 50m³/day</td>
</tr>
<tr>
<td>Wastewater treatment facility</td>
<td>6 parameters and 1 toxic unit Different values are applied according to “subjected zone” (4 categories). Waste treatment facilities and agro-industrial complexes are subject to different standards determined by MoE</td>
</tr>
<tr>
<td>Public treatment facility for human/livestock waste</td>
<td>4 parameters (organic matters) and nutrients (TN and TP) Different values are applied to human waste treatment facility and livestock wastewater treatment facilities</td>
</tr>
</tbody>
</table>

(Source: MoE 2012)

Effluent monitoring

In principle, effluent quality should be monitored by those who need to comply with effluent standards. A computer network of effluent monitoring measurement data was recently introduced (Box 3.5.1).

In case that non-compliance of effluent standards is found, the Minister of Environment shall give the improvement order to the business establishments. If the business establishments cannot comply with the required quality of effluent, they are subject to suspension of operations and penalties.

Monitoring of water quality in public water bodies and groundwater

Water quality is monitored through a nationwide monitoring network. Monitoring categories include 26 items for rivers, 30 for lakes and marshes, and 15 for groundwater. In particular, there are 52 automatic operating monitoring stations for surface waters. Water quality is monitored by measuring five common items such as DO, TOC, pH and 17 optional items, including VOC. For more efficient inspection, monitoring spots are classified according to usage: river water, lake water, drinking water, irrigation water, industrial water, and river water flowing through cities.
Introduction of a water quality tele-monitoring system (Water TMS) was decided in 2006 to monitor effluent discharge in a more systematic and scientific manner. Under Water TMS, monitoring data of effluent discharged from wastewater treatment facility is collected at a “Water TMS Control Center” every three hours and checked for compliance with effluent standards. By using this system, a scientific basis can be ensured for implementation of Total Maximum Daily Load System (TMDLs) as well as appropriate charging systems for wastewater. It can contribute to improving the performance of discharging facilities and preventing accidents.

Figure 3.5.8 shows the framework of operation of Water TMS and parties involved in the system. The following discharging facilities are subject to installing Water TMS.
- Public sewage treatment facilities of which treatment capacity is 2,000m³/day or more
- Wastewater treatment facilities of which annual average discharge is 700m³/day or more
- First to third class discharging facilities of which capacity is 200m³/day or more
- Public prevention facilities of which capacity is 200m³/day or more

The basic parameters to be monitored are pH, BOD/COD, SS, TN, and TP in addition to cumulative water flow. The facilities joining the network are exempt from on-site inspection with the introduction of this system. By the end of December 2009, 588 facilities have installed the Water TMS.

(Source: Chung 2010)

**Total maximum daily load system (TMDLs)**

The total maximum daily load system contributes to improvement of ambient water quality by setting reduction targets for pollutant loads, in addition to conventional concentration-based regulations. Under the system, designated pollution sources must keep pollutant loads within a “total maximum daily allowable load,” which is decided based on scientific fact and in consideration of local conditions of all target areas such as specific beneficial water uses.

Currently, TMDLs have been applied to three major rivers, namely Nakdong, Geum, Yeongsan since 2004. The current target parameter is BOD, and T-P will be added as a target parameter in the near future. TMDLs will be enforced in the Hang River from 2013 (Yu 2011).
6. Existing and Future Challenges

According to the Environmental Review 2011 published by the Ministry of Environment, Korea, the following items have been tagged as challenges to improving water environmental management:

- To ensure implementation of water quality improvement projects which are conducted under the Four Major Rivers Restoration Project. Reduction of pollution load, especially that of nitrogen and phosphorous and maintenance of water environment which reservoirs originally have.

- To strengthen non-point sources of which loads will increase.
- To develop an enhanced water environmental management system, responding to socio-economic changes such as the ongoing march of the aging society, enhancement of urbanization and increases in income levels. The co-existence of water and human beings is a key goal of the enhanced management system.

Measures for non-point source pollution

It is projected that the contribution ratio to water pollution from non-point sources will exceed that of point sources and reach 68-75% by 2020 (MoE 2012). To cope with non-point sources, the Comprehensive Measures for Non-point Source Pollution Management in the Four Major Rivers were established in 2004 under the leadership of the Prime Minister’s Office and in cooperation with related ministries. The Comprehensive Measures contain three major policy fields: policy system improvements, pilot projects on the construction and management of non-point source pollution treatment facilities, and research and public relations. Under the measure, highly vulnerable areas against non-point sources are designated as non-point source control districts, which includes Soyang Lake, Doam Lake, Imha Lake, and Gwangju metropolitan city (Yu 2011).

The first phase (2004-2005) focused on policy system improvement and pilot projects; the second phase (2006-2011) focused on best-fit management projects for major river basins of the four major rivers. As of March 2011, 43 non-point source reduction facilities have been installed on a pilot basis for different land use types including urban areas, farmland, and parking lots (Yu 2011).

Box. 3.5.2 Recent Development in Water Environmental Management

In addition to the developments mentioned in this section, recent developments in water environmental management in Korea include:

- Investment for restoration of the “well-being of the freshwater ecosystem” and water quality, which includes the construction of wastewater treatment plants, installment of T-P treatment facilities, and creation of natural fish ways. Increase of water flow mainly by dredging has been promoted to ensure environmental flow, which contributes to water quality improvement.

- Establishment of the Water Pollution Response Center, which intends to strengthen the prevention and response to water pollution accidents. A 24-hour surveillance system is operated through the water quality automatic monitoring network.

- Plan for the Restoration of Ecological Waterways was established in 2010 to restore ecological health of water ways.

- Consideration of eco-toxicity emission management system to address harmful substances in industrial wastewater.

- Introduction of water quality prediction system for algal bloom.

(Source: MoE 2012)
1. Country Information

Table 3.6.1. Basic Indicators

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<td>Long-Average Precipitation (mm/year)</td>
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<td>Total Renewable Water Resources (km³)</td>
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<td>Total Annual Freshwater Withdrawals (billion m³)</td>
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<td>Agriculture</td>
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<td>Industry</td>
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<td>Municipal (including domestic)</td>
<td>3.1%*</td>
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</tr>
</tbody>
</table>

* Estimated

(Source: See References)

2. Major Water Basins in Lao PDR

![Figure 3.6.1. Water basins in Lao PDR](image)

3. State of Water Resources

Lao PDR has rich water resources. Average annual rainfall at higher elevations in the southern part of the country is 3,700 mm and 1,300 mm in the northern valleys. The national population is approximately 6.2 million, and per capita annual water availability is approximately 54,500 m³ (FAO AQUASTAT 2011). This number is the highest among the WEPA partner countries. However, because of insufficient development of water infrastructure, the water supply capacity of the country remains limited.

Similar to other Southeast Asian countries, seasonal distribution of water resources is uneven in Laos—about 80 percent of annual precipitation occurs during the rainy season (May to October) and 20 percent in the dry season (November to April). In the Se Bang Fai, Se Bang Hieng and Se Done Rivers that flow through the central to southern parts of the country, river flow decreases in the dry season to 10-15% of annual average. Most of the rivers in the country are Mekong tributaries, which is equivalent to 35% of the average annual flow of and 85% of the land area of the Mekong basin (WEPA database undated).

4. State of Water Quality

Surface water quality in Laos is considered good, although deterioration is observed in the rivers/tributaries in urban areas because of increasing untreated or insufficiently treated wastewater and wastes. No urban centres, including the capital Vientiane, have comprehensive piped sewerage systems or wastewater collection, treatment and disposal systems. At the Mekong River downstream of Vientiane, for example, low concentrations of dissolved oxygen (DO) have been observed (MRC 2010).

Mining activities and hydropower generation are the major sources of degradation especially in terms of sedimentation. Wastewater or water run-off from agricultural activities are also potential sources of high nutrients and of toxic chemicals originating from fertilizer and pesticide use (MRC 2010).

Rivers

River water quality in Laos is good in principle. The results of periodic and longitudinal monitoring conducted from 2009 to 2010 at the mainstream of the Mak Hiao River and its major tributaries of the Hong Ke and Hong Xeng Rivers in Vientiane province show BOD figures ranging from 10mg/L to 35mg/L (Phonvisai 2011). The results of monitoring by the Mekong River Commission (MRC) show that water quality is polluted in urban areas. At the monitoring points near Vientiane, nutrients and
phosphorus levels, as well as ammonium levels, increased between 2000 and 2008 (MRC 2010). The report from MRC (2010) pointed out that pollution levels may worsen if human activities in the upstream (e.g. dam operations and irrigation projects) reduce river water flows.

Sediment is the primary quality problem in the country, especially in the wet season. Figure 3.6.2 shows seasonal changes in sedimentation observed in Luang Prabang in the north region of the country.

**Lakes and reservoirs**

Perennial ponds, marshes and oxbow lakes are fairly common in the lowland-floodplains in Laos. These water bodies are usually shallow and vary greatly in size during the year. They are habitat for many types of aquatic plants, molluscs, crustaceans, amphibians and reptiles. Currently, data on the water environment in lakes and reservoirs is available only on project basis in Lao PDR. For example, water quality monitoring was conducted in the reservoirs of the Nam Ngum dams (Nam Ngum 2 and Nam Ngum 1) from 2006-2011 as a part of a hydropower development project. The result of monitoring at the nine stations (Figure 3.6.3) illustrates that DO levels in some stations show a decreasing trend for DO levels (standard if below 6mg/L) (Figure 3.6.4). Total phosphorus levels in some stations in 2009 also highly exceeded the national standard level of the country (0.05mg/L). Fertilizers and detergents are suspected as one of the potential sources of pollution (Figure 3.6.5).

**Figure 3.6.2. Seasonal variation in water and sediment discharge of Mekong at Luang Prabang, Lao PDR**
(Source: MRC 2010)

**Figure 3.6.3. Monitoring stations**
(Source: Komany 2011)

**Figure 3.6.4. DO level**
(Source: Komany 2011)

**Figure 3.6.5. TP value**
(Source: Komany 2011)
Groundwater

Groundwater information including resource potential, uses and quality is very limited in the country. Since surface water is abundant for supply, groundwater is regarded as a source only when and where surface water is not available (Chanthavong 2011). Groundwater is also used as a source for urban water supply although it covers only about 5% of total water production volume (If spring water is included in this definition, about 20% of total water production is covered by subsurface water.) (Chanthavong 2011) As for quality, arsenic contamination has been detected near the border of China (MRC 2010) and in Attapeu province.

5. Frameworks for Water Environment Management

Legislation

The Environmental Protection Law (EPL) adopted in 1999 is the basis of water quality management in the country. EPL specifies a set of rules for conservation of the environment to protect human health and natural resources and to ensure the sustainable socio-economic development of the country (Article 1). To reflect the changes in socio-economic conditions domestically and internationally, and from the necessity of clarifying responsibilities in

Figure 3.6.6. Legislation system on water environmental management in Lao PDR
(Source: MoEJ 2009)
reorganized ministries, the EPL is now under revision. The EPL will strengthen the provision on environmental monitoring and inspection, and the articles on environmental impact assessment (EIA). The Ministry of Natural Resources and Environment (MoNRE) will be given full authority in review, approval, and inspection in the EIA process. In addition, legal requirements for strategic EIA will be included in the law to ensure that environmental and social impacts are carefully taken into account in project development processes. The revised version of the law was submitted in 2009 and it is under discussion by the National Assembly as of November 2011 (Phonvisai 2011).

The Law on Water and Water Resources which was promulgated in 1996 stipulates the principles on the management, utilization, and development of water. The purpose of the law is to secure the quantity and quality of water by meeting people’s needs as well as ensuring environmental sustainability. However the law is not clear on the issue of water supply and wastewater. In response to this, a draft new “Water Supply Law” was developed by the Ministry of Public Works and Transportation (MPWT) with the assistance of the World Bank. The Water Supply Law was approved by the National Assembly in November 2009. As most of the stipulations in this law focused mainly on water supply services, provisions on sanitation and sewerage are planned to be stipulated by a decree. To reflect these changes, a revision of the Water and Water Resources Law has started with assistance from the Asian Development Bank (ADB). The final draft of the framework for the new water resources policy was submitted in May 2009 and as of November 2011, is awaiting approval (Phonvisai 2011).

Other laws such as the Forest Law and Mining Law are also relevant to water environmental management as shown in Figure 3.6.6.

**Institutional arrangement**

In June 2011, MoNRE was created by merging the Water Resources and Environment Administration (WREA), part of the National Land Management Authority (NLMA) and the Geology Department, and the Protection and Conservation Divisions of the Department of Forestry (MoNRE 2011). The Department of Environment mainly manages water environments, and is responsible for setting ambient water quality standards and effluent standards. The roles and mandates of each department are still under final consideration as of November 2011.

**Ambient water quality standards**

Revisions of environmental standards have been ongoing since 1999. The revised National Environmental Standards of Lao PDR were issued on 7 December 2009. Water quality standards were established through the initiative of MoNRE in consultation with thirteen relevant organizations.

Ambient water quality standards are surface water quality standards and groundwater quality standards. Since standards for surface water did not exist in Lao PDR in the past, it is completely new. Details are shown in Table 3.6.2. The standard is rather ambitious in that it currently is very difficult to observe water quality that satisfies the standard (Phonvisai 2011). For example, a 1.5 mg/L standard value for BOD5 is generally only found in mountain streams in rural areas. Thus for projects studies such as the Master Plan for Water Environment Improvement Project in Vientiane capital, BOD values reflecting reality were used (Phonvisai 2011).

<table>
<thead>
<tr>
<th>No.</th>
<th>Parameter</th>
<th>Unit</th>
<th>Standard Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Color, Odor, Taste</td>
<td>-</td>
<td>Natural Level</td>
</tr>
<tr>
<td>2</td>
<td>Temperature</td>
<td>°C</td>
<td>Natural Level</td>
</tr>
<tr>
<td>3</td>
<td>pH</td>
<td>-</td>
<td>5 - 9</td>
</tr>
<tr>
<td>4</td>
<td>DO</td>
<td>mg/L</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>COD&lt;sub&gt;0&lt;/sub&gt;</td>
<td>mg/L</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>BOD&lt;sub&gt;5&lt;/sub&gt;</td>
<td>mg/L</td>
<td>1.5</td>
</tr>
<tr>
<td>7</td>
<td>Coliform Bacteria</td>
<td>MPN/100 mL</td>
<td>5,000</td>
</tr>
<tr>
<td>8</td>
<td>Faecal Coliform</td>
<td>MPN/100 mL</td>
<td>1,000</td>
</tr>
<tr>
<td>9</td>
<td>NO&lt;sub&gt;3&lt;/sub&gt;-N</td>
<td>mg/L</td>
<td>&lt; 5.0</td>
</tr>
<tr>
<td>10</td>
<td>NH&lt;sub&gt;4&lt;/sub&gt;-N</td>
<td>mg/L</td>
<td>0.2</td>
</tr>
<tr>
<td>11</td>
<td>C&lt;sub&gt;H&lt;/sub&gt;OH</td>
<td>mg/L</td>
<td>0.005</td>
</tr>
<tr>
<td>12</td>
<td>Cu</td>
<td>mg/L</td>
<td>0.1</td>
</tr>
<tr>
<td>13</td>
<td>Ni</td>
<td>mg/L</td>
<td>0.1</td>
</tr>
<tr>
<td>14</td>
<td>Mn</td>
<td>mg/L</td>
<td>1.0</td>
</tr>
<tr>
<td>15</td>
<td>Zn</td>
<td>mg/L</td>
<td>1.0</td>
</tr>
<tr>
<td>16</td>
<td>Cd</td>
<td>mg/L</td>
<td>0.005</td>
</tr>
<tr>
<td>17</td>
<td>Cr&lt;sup&gt;+++&lt;/sup&gt;</td>
<td>mg/L</td>
<td>0.05</td>
</tr>
<tr>
<td>18</td>
<td>Pb</td>
<td>mg/L</td>
<td>0.05</td>
</tr>
<tr>
<td>19</td>
<td>Hg</td>
<td>mg/L</td>
<td>0.002</td>
</tr>
<tr>
<td>20</td>
<td>As</td>
<td>mg/L</td>
<td>0.01</td>
</tr>
<tr>
<td>21</td>
<td>CN&lt;sup&gt;-&lt;/sup&gt;</td>
<td>mg/L</td>
<td>0.005</td>
</tr>
<tr>
<td>22</td>
<td>Radioactivity - Gross α</td>
<td>Becquerel/L</td>
<td>0.1</td>
</tr>
<tr>
<td>23</td>
<td>Radioactivity - Gross β</td>
<td>Becquerel/L</td>
<td>1.0</td>
</tr>
<tr>
<td>24</td>
<td>Total organochlorine</td>
<td>mg/L</td>
<td>0.05</td>
</tr>
<tr>
<td>25</td>
<td>DDT</td>
<td>μg/L</td>
<td>1.0</td>
</tr>
<tr>
<td>26</td>
<td>αBHC</td>
<td>μg/L</td>
<td>0.02</td>
</tr>
<tr>
<td>27</td>
<td>Dieldrine</td>
<td>μg/L</td>
<td>0.1</td>
</tr>
<tr>
<td>28</td>
<td>Aldrin</td>
<td>μg/L</td>
<td>0.1</td>
</tr>
<tr>
<td>29</td>
<td>Heptachlor &amp; Heptachlor epoxide</td>
<td>μg/L</td>
<td>0.2</td>
</tr>
<tr>
<td>30</td>
<td>Endrin</td>
<td>μg/L</td>
<td>ND</td>
</tr>
</tbody>
</table>

(Source: WREA 2010)
Standards for drinking water quality, drinking water quality in covered containers, and groundwater for drinking purposes were developed under the same National Environment Standards. They were mainly developed by the Department of Hygiene and Prevention under the Ministry of Health in cooperation with World Health Organization (WHO) and the United Nations Children's Fund (UNICEF).

**Monitoring of water quality in public water bodies**

According to the Agreement on the National Environmental Standards in 2009, the Department of Environment is responsible for the administration and monitoring activities of the agreement throughout the country (WREA 2010). It also states that the Department of Water Resources is responsible for coordinating with other authorities to conduct surveys, and evaluate and monitor the quality of surface water and groundwater. Currently there is no regular structured monitoring of water quality in Lao PDR, however, some agencies carry out water quality monitoring and laboratory analysis as necessary (Table 3.6.3).

**Table 3.6.3. Public agencies conducting water quality monitoring**

<table>
<thead>
<tr>
<th>Institution</th>
<th>Type of Samples</th>
<th>Number of Stations</th>
<th>Parameters Monitored</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dept. of Irrigation (Ministry of Agriculture and Forestry) (Analysis is conducted in Water Quality Laboratory)</td>
<td>Surface water, Groundwater, Industrial wastewater</td>
<td>23 Ad hoc samples taken from surface, ground and waste water as required</td>
<td>14 parameters (DO, dissolved salts, nutrients, and organic matter) (Plans for As, Hg, Cd, and Pb)</td>
</tr>
<tr>
<td>Ministry of Public Health, Pesticide Laboratory</td>
<td>Surface water</td>
<td>Ad hoc testing</td>
<td>24 parameters (Organic compounds and pesticides)</td>
</tr>
<tr>
<td>Ministry of Energy and Mines</td>
<td>Surface water from Hydropower dams</td>
<td>Ad hoc sampling</td>
<td>Almost 8 parameters (Including temperature, pH, DO, COD, etc.)</td>
</tr>
<tr>
<td>Environment Department (MoNRE)</td>
<td>Wastewater (urban/industrial)</td>
<td>11 (Vientiane municipality) 3 (Vientiane province)</td>
<td>4 parameters (TSS, TDS, BOD, and pH)</td>
</tr>
<tr>
<td>Ministry of Industry and Commerce (MIC)</td>
<td>Industrial effluent (Samples collected by Dept. of Irrigation or MONRE)</td>
<td>Ad hoc sampling</td>
<td>Parameters monitored are mainly related to industrial waste monitoring</td>
</tr>
<tr>
<td>Ministry of Public Health</td>
<td>Rural water supply</td>
<td>Ad hoc testing for groundwater and newly drilled bore holes, and surface water resources used in public water supply</td>
<td>7 parameters (Fe, Cu, Ba, pH, Ec, TDS, NO3)</td>
</tr>
</tbody>
</table>

(Source: Komany 2008)

**Effluent standards**

The following effluent standards are stipulated under the National Environmental Standards issued in December 2009: 1) general industrial wastewater discharge standards, 2) standards for specific industries, 3) effluent standards for pig farms, 4) gas station effluent standards, and 5) wastewater discharge standards from urban areas (WREA 2010). Details are shown in Table 3.6.4.

**Table 3.6.4. Effluent standards**

<table>
<thead>
<tr>
<th>Name of standards</th>
<th>Types of Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standards for specific industries</td>
<td>1. Standards for factories that contain organic substances 2. Standards for factories that contain inorganic substances (metal plating) 3. Standards for battery producing</td>
</tr>
<tr>
<td>Effluent standards for pig farms</td>
<td></td>
</tr>
<tr>
<td>Gas station effluent standards</td>
<td></td>
</tr>
<tr>
<td>Wastewater discharge standards from urban areas</td>
<td>1. Wastewater discharge standards 2. Wastewater treatment standards for public areas</td>
</tr>
</tbody>
</table>

(Source: WREA 2010)
For wastewater discharge standards from urban areas, buildings such as hotels, dormitories or hospitals are classified according to the number of rooms and volume of discharged wastewater. Buildings such as residences, temples, schools, offices, markets and restaurants are also classified according to floor area. For the wastewater treatment standards for public areas, classifications are in place for areas such as historical sites, public parks, water parks, and marshes and ponds.

The Agreement on the National Environmental Standards in 2009 states that those who violate the provision of the agreement will be warned, fined or subject to criminal punishment (WREA 2010). Also under the Regulation on Wastewater Discharge from Industrial Processing Factories issued in 2005 by the Ministry of Industry and Handicrafts (currently the Ministry of Industry and Commerce), all industrial factories are required to obtain approval and major factories also need to submit treatment and management plans. They also are required to install wastewater treatment systems and the necessary facilities to monitor and analyze water samples, as well as frequently monitor and analyze wastewater and report results to the Director of the Industry Department of the Ministry or respective province. The staff of the Industry Department as factory environmental inspectors are permitted to enter all areas within factories to inspect, observe, measure, sample and monitor wastewater discharged into public water bodies. If violations are found, certifications for wastewater discharge will be suspended and the Director of the Industry Department may suspend or terminate wastewater discharge until improvement and compliance is confirmed. The penalty for violation of the regulations is set out as follows: (1) first stage: warning, suspension of import/export, suspension of production, (2) second stage: fine of 5-10 times the amount of certification fee, and (3) third stage: fine of 10-15 times the amount of certification fee and penalties for other relevant regulations (Phonvisai 2011).

6. Existing and Future Challenges

Although water quality is, in general, in good condition in the country, it has deteriorated in major urban areas. No urban centres, including the capital Vientiane, have comprehensive piped sewerage systems or wastewater collection, treatment and disposal systems. The water quality of urban rivers may further deteriorate in the near future because of the inflow of untreated wastewater of which volume will increase according to urban growth.

The government of Laos has been developing and revising environmental management frameworks such as through the revision of relevant laws. However, there are challenges in their implementation. For example, various ministries and departments carry out water quality management such as monitoring and analysis independently and do not share results. Also, there are overlaps in the laws. For example, there is duplication among the Regulation on the Wastewater Discharged from Industrial Processing Factories, EPL, EIA regulations and Decree on EIA for the Industrial Sector in requiring environmental compliance certificates, and submission/approval of environmental management plans for factories that discharge wastewater. It has been reported that the wastewater discharge certification system is currently not in operation and inspection is conducted according to each regulation (Phonvisai 2011). Capacity and systematic coordination procedures among responsible agencies for overall water quality monitoring and management need to be established. Recent organizational restructuring of MoNRE is expected to promote and strengthen water environmental management in Lao PDR.
1. Country Information

Table 3.7.1. Basic indicators

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Area (km²)</td>
<td>330,803 (2010)</td>
</tr>
<tr>
<td>Total Population (person)</td>
<td>28.4 million (2010)</td>
</tr>
<tr>
<td>GDP (current USD)</td>
<td>237.8 billion (2010)</td>
</tr>
<tr>
<td>Per Capita GDP (current USD)</td>
<td>8,373 (2010)</td>
</tr>
<tr>
<td>Long-Average Precipitation (mm/year)</td>
<td>2,875 (2009)</td>
</tr>
<tr>
<td>Total Renewable Water Resources (km³)</td>
<td>580* (2009)</td>
</tr>
<tr>
<td>Total Annual Freshwater Withdrawals (billion m³)</td>
<td>13.2* (2005)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Annual Freshwater Withdrawal by sectors</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>34.2%* (2005)</td>
</tr>
<tr>
<td>Industry</td>
<td>36.3%* (2005)</td>
</tr>
<tr>
<td>Municipal (including domestic)</td>
<td>29.5%* (2005)</td>
</tr>
</tbody>
</table>

* Estimated (Source: See References)

2. Major Water Basins in Malaysia

Figure 3.7.1. Major rivers in Malaysia

3. State of Water Resources

There are ample water resources in Malaysia with seasonal variations. Most areas in Peninsular Malaysia, Sabah and Sarawak in particular, receive a national average rainfall of 2,500 mm and 3,500 mm. Weather in Malaysia is characterized by two monsoon regimes, namely, the Southwest Monsoon from late May to September, and the Northeast Monsoon from November to March. The Northeast Monsoon brings heavy rainfall, particularly to the east coast states of Peninsular Malaysia and western Sarawak, whereas the Southwest Monsoon normally signifies relatively drier weather. (MOSTI 2010). Droughts occur occasionally sometimes coinciding with the El Niño phenomena. The most prominent droughts happened in 1998.

Droughts are managed through the monitoring of dry events by the Department of Irrigation and Drainage. Floods are managed through various flood mitigation strategies using structural and non-structural means.

Surface water provides 97% of water supply for domestic, industrial, and agricultural use. About 80 percent of the water withdrawn from the river system is used for irrigation purposes. In the future, the percentage of water use for domestic and industrial uses is expected to command a bigger share of the water withdrawn from surface water sources. Potable water supply coverage extends to most areas throughout the country with the exception of a few isolated spots where water supply network coverage remains difficult or inaccessible due to physical or geographical factors. Groundwater wells or rural water supply scheme systems will be provided in those spots.

4. State of Water Quality

Rivers

In Malaysia, the Water Quality Index (WQI) is used to evaluate the status of river water quality. The WQI is calculated using the values of six parameters: DO, BOD, COD, NH₃-N, SS, and pH (DoE 2011). According to the WQI, the status of water quality is classified into three categories: “clean,” “slightly polluted,” and “polluted.” Figure 3.7.2 shows the ratio of river monitoring stations under each category from 2005 to 2010. Figure 3.7.3 also shows the ratio of river monitoring stations under the three categories during the same period in terms of BOD, which is a parameter to show the state of organic pollution. Compared with values in past few years, the ratio of “polluted” rivers in 2010 increased. The Malaysia Environmental Quality Report 2010 analyzed that increase of untreated or insufficiently treated wastewater from sewage and agro-based industries. In terms of BOD load, untreated and partially treated sewage is the largest contributor of which estimated loads is 1,021,576.05 kg/day. Figure 3.7.4 shows the composition of pollution sources by sector.
Analysis of heavy metals in 4,565 water samples in 2010 revealed that almost all samples complied with Class III of Water Quality Standards (Table 3.7.2) for arsenic (As), mercury (Hg), cadmium (Cd), chromium (Cr), lead (Pb) and zinc (Zn), and National Water Quality Standards for arsenic (As), mercury (Hg), cadmium (Cd), chromium (Cr), lead (Pb) and zinc (Zn). On the other hand, the compliance ratio of iron (Fe) remains at 94% (DoE 2010).

Lakes and reservoirs
Since lakes and reservoirs are managed by different authorities including owners and operators of each lake/reservoir, comprehensive water quality monitoring or water quality inventories for lakes and reservoirs are not available. According to a study on water quality of lakes and reservoirs conducted by the Institute of Environment and Water Resource Management and Teknologi Malaysia, water quality is under eutrophic condition in 62% of studied lakes and reservoirs (Sharifuddin 2011).

Coastal water
Marine water quality was monitored at 161 coastal and 76 estuary monitoring stations in 2010. Figure 3.7.5 shows the national average exceeding rates for Class 2 of the Marine Water Quality Criteria and Standards (MWQCS) for some parameters. The exceeding rate differs from region to region. For example, high exceeding rate for TSS in marine water was quite marked in Sarawak and Kelantan, but no samples exceeded the standards in Kedah and Labuan. The major causes of marine water quality deterioration for TSS is considered to result from land-based activities (e.g. coastal development, land clearance for development, agricultural activities), untreated or partially treated animal and domestic wastes and wastewater from activities in coastal areas, and discharge or leakage from ships and boats for oil and greases. (DoE 2010)
**Groundwater**

Groundwater quality status was evaluated using the National Guidelines for Raw Drinking Water Quality from the Ministry of Health (revised in December 2000) as a benchmark.

In 2010, 201 water samples were taken from 112 monitored wells situated in eight different land use areas, namely industrial, landfills, agriculture, municipal water supply, urban/sub-urban, golf courses, rural areas and ex-mining (gold mining). The results show that values exceeding guidelines for As, Fe, Mn, Total coliform, and phenol were observed in all land use areas. The non-compliance ratio of total coliform was 100% in all land use categories. Other parameters of which exceeding rates are found in all categories include phenol, arsenic, iron, and manganese. On the other hand, for chromium, copper, and zinc, all samples satisfy guideline values.

5. **Frameworks for Water Environment Management**

The ultimate objective of Malaysia’s environmental management (including water quality management) is improvement of living standards and the sustainability of its citizens’ quality of life. The National Policy on the Environment approved in 2002 stated “the nation shall implement environmentally sound and sustainable development for the continuous economic, social and cultural progress and enhancement of the quality of life of Malaysia” (Ministry of Science, Technology and the Environment, Malaysia 2002). In line with the policy, the national policy set eight principles to integrate the economy and environment as follows:

- Stewardship of the Environment
- Conservation of the Nature’s Vitality and Diversity
- Continuous Improvement in the Quality of the Environment
- Sustainable Use of Natural Resource
- Integrated Decision-making
- Role of the Private Sector
- Commitment and Accountability
- Active Participation in the International Community

The Environmental Quality Act (EQA) 1974 is an act related to the prevention, abatement and control of pollution, and enhancement of the environment. The act ordains that the Minister, after consultation with the Environmental Quality Council, may elaborate regulations for prescribing ambient water quality and discharge standards, and specifying the maximum permissible loads that may be discharged by any source into inland waters, with reference either generally or specifically to the body of waters concerned. Other laws and regulations are also shown in Figure 3.7.6.

As for the nation’s target for water quality improvement, the 10th Malaysian Plan (2011-2015) includes efforts to tackle river water pollution, which is the country’s main water source, by addressing major pollution sources. Pollution countermeasures mentioned in the plan include the following points (Sharifuddin 2011; Economic Planning Unit of Prime Minister’s Department 2010):

- To strengthen the enforcement of effluent standards (sewage and industries) in line with Environmental Quality (Sewage and Industrial Effluents) Regulations
- To assess total maximum daily loads for both point and non-point sources
- To revise the Water Quality Index by incorporating other parameters for more accurate river water classification
- To develop the National Marine Water Quality Index

**Institutional arrangements**

The Ministry of Natural Resources and Environment (NRE), established in 2004 as a result of restructuring of ministries, is in charge of environmental conservation which includes water quantity and quality management. Other ministries and authorities are also involved in water resource management such as the Ministry of Water Energy and Communication for water service monitoring and supervision, Ministry of Science, Technology and Innovation for water research and development, Ministry of Health for drinking water quality, and local governments for water planning and development (Sharifuddin 2011). For water pollution control, the Department of Environment (DoE) under NRE is mainly engaged in implementation of the Environmental Quality Act 1974.
### Conservation of Water Quality

#### General
- Environmental Quality Act
- Environmental Quality Standards for Surface Water
- Effluent Discharge Standards

#### Specific Area
- Selangor Waters Management Authority Enactment (1999)
- Kedah Water Resources Enactment (2007)
- Sabah Conservation of the Environment Enactment
- National resources and Environment Ordinance Sarawak

#### Specific Sector

**Peninsular Malaysia**
1. Agriculture
   - Irrigation Areas Act (1953)
   - Drainage Works Acts (1954)
2. Forestry
3. Control of Rivers
   - River Rights Enactment of Perak
   - Kelantan River Traffic Enactment (1955)
   - Pahang River Launches Enactment 6/49
4. Land Management
   - National Land Code (1965)
   - Land Conservation Act (1960)
   - Earthwork by laws
5. Domestic Water Supply
   - Water Service Industry Act
6. Mining
   - Mining Enactment (1936)
7. Local and Regional Planning
   - Town and Country Planning Act (1976)
8. Fishery
   - Fisheries Act (1963)
9. Others
   - Local Government Act (1976)
   - Street Drainage Building By law (1974, 1994-R)
   - Geological Survey Act
   - Ministerial Function Act (1969)

**State of Sabah and Sarawak**
1. Agriculture
   - Drainage and Irrigation, Sabah Ordinance (15/1956)
   - Drainage Works Ordinance Sarawak (1966)
2. Forestry
   - Sabah Forest Enactment (1965)
   - Forest Ordinance Sarawak. Cap126
3. Control of Rivers
   - Sarawak Water Ordinance,
   - Sarawak Riverine Transport Bill (1993)
4. Land Management
   - Sabah Land Ordinance (1930)
   - Sarawak Land Code (1958)
5. Domestic Water Supply
   - Water Services Industry Act
6. Mining
   - Mining Enactment (1960 Sabah)
   - Mining Enactment (1949 Sarawak)
7. Local and Regional Planning
   - Town and Country Planning
   - Enactment Sabah Cap 141
   - Town and Country Planning Sarawak Cap 87
8. Others
   - Local Authority Enactment, Sabah Ordinance (11/1961)
   - Local Authority Ordinance Sarawak Cap 117

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**Figure 3.7.6. Legislative chart for water quality management**
(Source: MoEJ 2009)
Ambient water quality standards
National Water Quality Standards (NWQS), which are applied to surface waters, set out standard values for 72 parameters in six water use classes (Table 3.7.2). The goal is not to meet the standards of a particular water class in all surface waters, but to improve water quality gradually in order to meet the standards of a water class higher than the current class.

<table>
<thead>
<tr>
<th>Class</th>
<th>Uses</th>
</tr>
</thead>
</table>
| I     | Conservation of Natural Environment  
Water Supply I: Practically no treatment necessary  
Fisheries I: Very sensitive aquatic species |
| IIA   | Water Supply II: Conventional treatment required  
Fisheries II: Sensitive aquatic species |
| IIB   | Recreational use with body contact |
| III   | Water Supply III: Extensive treatment required  
Fisheries III: Common, of economic value, and tolerant species; livestock drinking |
| IV    | Irrigation |
| V     | None of the above |

(Source: DoE 2011)

For marine water quality, the Malaysian Marine Water Quality Criteria and Standards (MWQCS) was established with 20 parameters in five classes. Water classification in MWQCS is shown in Table 3.7.3.

<table>
<thead>
<tr>
<th>Class</th>
<th>Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1</td>
<td>Preservation, marine protected areas, marine parks</td>
</tr>
<tr>
<td>Class 2</td>
<td>Marine life, fisheries, coral reefs, recreational and mariculture</td>
</tr>
<tr>
<td>Class 3</td>
<td>Ports, oils and gas fields</td>
</tr>
<tr>
<td>Class E</td>
<td>Mangroves, estuarine and river-mouth water</td>
</tr>
</tbody>
</table>

(Source: DoE 2011)

Groundwater quality standards for Malaysia have not been established, but considering the potential of groundwater as an alternative source of surface water, the National Guidelines for Raw Water Quality is referred as the benchmark for evaluating groundwater quality monitoring results.

Ambient water quality monitoring
The Department of Environment (DoE) of the Ministry of Natural Resources and Environment (NRE) conducts monitoring programmes for rivers, marine waters and groundwater as shown in Table 3.7.4.

Effluent standards
The National Environmental Quality Act 1974 states that "no person shall, unless licensed, emit, discharge or deposit any environmentally hazardous substances, pollutants or wastes into any inland waters in contravention of the acceptable conditions specified under Section 21" (Section 25, National Environmental Quality Act 1974). In 2009, Environmental Quality (Sewage and Industrial Effluent) Regulations 1979, which set rules and procedures related to effluent discharge, had been replaced by new three regulations: Environmental Quality (Sewage) Regulations, Environmental Quality (Industrial Effluent) Regulations and Environmental Quality (Control of Pollution from Solid Waste Transfer Stations and Landfills) Regulations. Under the regulations, sewage discharge standards, industrial effluent discharge limits, and leachate discharge standards were established (DoE 2010).

Effluent monitoring
Monitoring of effluent, recording and maintenance of the monitoring results are obligations that all premises are required to fulfill under the new environmental regulations on sewage and industrial effluents. Analytical methods and parameters to be monitored are designated. All premises are required to submit monthly effluent discharge reports to DoE. For the monthly report, an on-line reporting system is available, as well as hard-copy submission. Authorized DoE officials can carry out inspections of all premises, including surprise inspections, to ensure compliance with all provisions in the act. Non-compliance of the regulations results in immediate penalties to polluters.

As a measure to improve effluent quality, industrial effluent treatment systems (IETS) were introduced (Box 3.7.1).
6. Existing and Future Challenges

Environmental Quality Act 1974 has been successful in reducing pollution to a certain extent with control of point and non-point sources, and continuous monitoring and assessment of the water environment. However, there are still many challenges that need to be addressed to achieve holistic water environment management. The direction of water environmental management has already been incorporated in the 10th Malaysian Plan as mentioned in the previous section. The following elements are also considered essential to ensure a better future for the water environment in the country.

- Promoting water environmental management at the basin level, including river basin modeling, consideration of localized water discharge standards in accordance with the capacity of individual water bodies.
- Strengthening effluent management policy to improve water quality conditions. In line with this, self-regulation approaches to pollution control should be further promoted.
- Identifying groundwater potential for areas where surface water is limited or unavailable.
- Achieving better management of lakes and reservoirs, in which the roles and responsibility of relevant stakeholders is clarified. Further studies and proper data management is required to fulfill this target.

### Box 3.7.1. Industrial Effluent Treatment Systems: A system to encourage self-regulation in the industrial sector

Meeting effluent standards through proper treatment is a crucial issue for water quality conservation. In Malaysia, the Environmental Quality (Industry Effluent) Regulations 2009 mandate the owner of industrial premises to properly operate and maintain industrial effluent treatment systems (Section 8 (1)) and monitor the performance of the treatment systems (Section 9 (1)).

Industrial effluent treatment systems (IETS) aim to promote the optimal operation and maintenance of effluent treatment by enabling preventive or corrective actions through monitoring of the treatment performance with certain parameters. Through IETS, companies can benefit from the early identification of deficiencies, identification of proper dosages for chemicals (Keong 2008), and increasing opportunities to identify preventive actions (How 2008). DoE provides technical guidance to promote IETS. Within an industry, a competent person who is certified by the Director-General of DoE should be on duty to supervise IETS.

IETS is expected to encourage industries to be more proactively engaged in pollution control without strong enforcement action by the public sector.

### Table 3.7.4. Water quality monitoring status (in 2010)

<table>
<thead>
<tr>
<th>Monitoring types</th>
<th>Starting year</th>
<th>Number of monitoring stations/wells (in 2010)</th>
<th>Major parameters monitored</th>
</tr>
</thead>
<tbody>
<tr>
<td>River water quality monitoring programme</td>
<td>1978</td>
<td>1,055 stations*1 located at 570 rivers</td>
<td>Parameters included in NWQS</td>
</tr>
<tr>
<td>Marine waters</td>
<td>1978 (Peninsular Malaysia) 1985 (Sabah and Sarawak)</td>
<td>161 stations for coastal areas 76 stations for estuary 72 islands*2</td>
<td>Parameters included in MWQCS [island marine water quality] TSS, E.coli, oil and grease</td>
</tr>
<tr>
<td>Groundwater monitoring programme</td>
<td>1997</td>
<td>112 wells</td>
<td>Parameters included in the national guideline for raw drinking water quality</td>
</tr>
</tbody>
</table>

*1 There are two kinds of monitoring stations: manual water quality monitoring stations and continuous water quality monitoring stations.
*2 72 islands are categorized into four types: development islands (3 islands), resort islands (32 islands), marine park islands (22 islands) and protected ones (15 islands).
(Source: DoE 2011)
1. Country Information

Table 3.8.1. Basic indicators

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Area (km²)</td>
<td>676,578 (2011)</td>
</tr>
<tr>
<td>Total Population (person)</td>
<td>48 million (2010)</td>
</tr>
<tr>
<td>GDP (current USD)</td>
<td>45.4 billion (2010)</td>
</tr>
<tr>
<td>Per Capita GDP (current USD)</td>
<td>742 (2010)</td>
</tr>
<tr>
<td>Long-Average Precipitation (mm/year)</td>
<td>2,091 (2009)</td>
</tr>
<tr>
<td>Total Renewable Water Resources (km³)</td>
<td>1,168* (2009)</td>
</tr>
<tr>
<td>Total Annual Freshwater Withdrawals (billion m³)</td>
<td>33.2 (2000)</td>
</tr>
</tbody>
</table>

Annual Freshwater Withdrawal by sectors

- Agriculture: 89% (2000)
- Industry: 1% (2000)
- Municipal (including domestic): 10% (2000)

*Estimated
(Source: See References)

2. Major Water Basins in Myanmar

Myanmar has an abundance of water resources. However, the spatial and temporal distribution of water resources is uneven.

The average annual rainfall is about 2341 mm, most of which is concentrated during the southwest monsoon season (May-October). As with the temporal distribution of rainfall patterns, about 80% falls during the monsoon season and 20% in the dry season.

The catchment area of Myanmar’s eight principal river basins is approximately 737,800 km². The country’s two major natural lakes are Inle Lake and Indawgyi Lake. As well as natural water bodies, constructed engineering structures can reserve 15.46 km³ of surface water.

The potential volume of groundwater resources in the country is 580 km³ and the estimated total renewable is 1,046 billion m³ (river basin level annual groundwater potential is shown in Figure 3.8.2.) Total water development is 33.2 billion m³, which represents only 3% of the total renewable water resources in Myanmar. Approximately 91% of the total water withdrawal comes from surface water and 9% from groundwater. Groundwater is mostly used for domestic purposes and irrigation of vegetables and other high value crops.

3. State of Water Resources

4. State of Water Quality

Inland surface water

Myanmar is heavily dependent on inland surface water bodies for domestic use, agricultural irrigation and industrial production. Surface water is vulnerable to pollution that is intrinsically linked to inadequate sanitation. Monitoring
data for water quality in Ayeyarwady River, Chindwil River, Thanlwin River, and Sittaung River revealed that water in these rivers is suitable for irrigation purposes (Table 3.8.2). However, the quality of some surface water bodies were inadequate both for human health and aquatic ecosystems. High levels of phosphate and nitrate and low levels of DO were measured in Inle Lake, which is most likely caused by runoff of agricultural fertilizers and discharge of untreated waste (Table 3.8.3, Box 3.8.1). In addition, both coliform and E.coli bacteria exceeded standards, making the water of Inle Lake unfit for use as drinking water.

**Groundwater**

With increases in population and a greater need for water for economic activities, there is increasing pressure on groundwater extraction. Unrestricted groundwater extraction can result in land subsidence and saltwater intrusion, and therefore, groundwater must be controlled and managed appropriately. As well, surface water should be managed along with groundwater in an integrated way in order to ensure the recharge of groundwater aquifers. Moreover, the rising water requirements of the country’s rapidly expanding urban and industrial centres, especially in Yangon City, and the contamination by pollutants from industrial, municipal and agricultural effluents (the latter associated with the uncontrolled use of pesticides and fertilizers) have lead to the decreasing availability of freshwater. Additionally, salinity intrusion has been reported in the inland areas along the tidal reaches of the Ayeyarwaddy River system, and monitoring of the Ayeyarwaddy in the dry zone shows excessive pollution, particularly in summer.

Salinity intrusion is also a critical problem in the country, particularly in the Delta Region, the third most populated area in Myanmar and where most rice is cultivated. The Figure 3.8.3 shows the degree of intrusion.

<table>
<thead>
<tr>
<th>Box 3.8.1. Water Environment in Inle Lake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inle Lake, the second largest lake in Myanmar, serves as the sole source of domestic water. Water quality of the lake is impacted by various factors. Among them, deforestation and more intense agricultural activities on its western and northern watershed areas have brought in increasing amounts of silt and nutrients into the shallow lake. It was reported that concentrations of PO4-P, NO2-N, and NO3-N were relatively high, leading to a eutrophic state. The direct discharge of domestic wastewater is another cause of water pollution. A high number of coliform bacteria was reported, indicating that the lake water was unfit to drink. The government introduced the use of latrines with the assistance of WATSAN of the Community Water Supply and Sanitation project with the aim of addressing the specific problem of pollution in the lake.</td>
</tr>
</tbody>
</table>

(Source: Than 2007; Akaishi et al. 2006)

<table>
<thead>
<tr>
<th>Table 3.8.2. Water quality in selected rivers (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rivers</strong></td>
</tr>
<tr>
<td>-------------</td>
</tr>
<tr>
<td>Ayeyarwady River</td>
</tr>
<tr>
<td>Chindwil River</td>
</tr>
<tr>
<td>Thanlwin River</td>
</tr>
<tr>
<td>Sittaung River</td>
</tr>
</tbody>
</table>

(Source: Data from the focal person in 2011)

<table>
<thead>
<tr>
<th>Table 3.8.3. Water quality of Inle Lake</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parameters</strong></td>
</tr>
<tr>
<td>pH</td>
</tr>
<tr>
<td>Ca (mg/L)</td>
</tr>
<tr>
<td>PO4-P (mg/L)</td>
</tr>
<tr>
<td>NO3-N (mg/L)</td>
</tr>
<tr>
<td>DO (mg/L)</td>
</tr>
<tr>
<td>Coliform bacteria (CFU)</td>
</tr>
<tr>
<td>E. Coli (CFU)</td>
</tr>
</tbody>
</table>

(Source: Khin Lay Swe 2011)

<table>
<thead>
<tr>
<th>Figure 3.8.3. Degree of penetration and saline fronts measured in summer 2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Source: Ra 2011)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5. Frameworks for Water Environment Management</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Legislation</strong></td>
</tr>
<tr>
<td>Myanmar has no specific laws to control water pollution. There is a general provision in Section 9 of the Public Health Law of 1972, which empowers the Ministry of Health to carry out measures relating to environmental health, such as garbage disposal, use of water for drinking and other purposes, radioactivity, protection of air from pollution, and food and drug safety. However, detailed provisions do not exist to ensure more effective and comprehensive</td>
</tr>
</tbody>
</table>

(Source: Than 2007; Akaishi et al. 2006)
regulation of these matters. As well, there are no provisions for pollution control in the regulation of hotels and tourism. Although the Burma Port Act of 1908 contains a paragraph about harbor pollution, this merely focuses on the detriment to navigation. The only control of water pollution in the country is through guidelines issued in June 1994 by the Myanmar Investment Commission. These guidelines require that new investment projects have wastewater treatment systems. River and lake pollution from sewage, industrial waste and solid waste disposal are serious problems in Myanmar, but are not explicitly regulated by a particular law, so new laws relating to pollution must be enacted. The draft law on environmental protection is now awaiting approval by the government. After the law is officially approved, it is expected that national environmental standards will be set up.

Institutional arrangement

There are different government organizations which are responsible for water environmental management within respective sectors such as health, irrigation, mining, transport, and industry. For example, the Yangon City Development Committee (YCDC) is responsible for water quality management in the former capital (Ra, 2011).

In September 2011, the Ministry of Forestry was renamed as the Ministry of Environmental Conservation and Forestry. The new ministry will be responsible for the implementation of draft environmental protection law. However, clarification of the responsibility of different ministries may remain an issue in the promotion of environmental protection in the country, including water pollution control.

Water quality standards

The main causes of deteriorating water quality are untreated municipal wastewater, solid waste, and industrial agrochemical solid and liquid wastes. In principle, local city development committees are responsible for the protection of water quality. Rapid industrialization has increased pressure on the environment in many cities, such as the former capital city of Yangon. The direct discharge of untreated industrial wastewater into rivers and streams is the major cause of pollution. In addition, untreated or insufficiently treated industrial wastewater is discharged into the municipal sewage system, which further complicates the problem. The National Commission for Environmental Affairs (NCEA) and NGOs proposed effluent standards for the proper disposal of wastewater from factories, but it has not yet been approved. Control of disposal of wastewater from residential, office buildings and factories is the responsibility of the Ministry of Environmental Conservation and Forestry.

The government banned the use of some toxic pesticides, encouraging instead the utilization of conventional bio-fertilizers as a substitute for chemical fertilizers to mitigate agricultural based water pollution.

Ministries and departments are currently working to strengthen water quality management to address the deterioration of water quality in public waters. National drinking water quality standards have been developed but have yet to be approved. Water quality control measures are looked at on a case by case basis, especially in the production of bottled drinking water. Arsenic and other parameters have been tested in collaboration with the Water Resources Utilization Department (WRUD), Department of Development Affairs (DDA), and UNICEF. The Environmental and Sanitation Division under the Ministry

<table>
<thead>
<tr>
<th>No.</th>
<th>Legislations</th>
<th>Specific descriptions on water quality control</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Penal Code, 1860</td>
<td>(Person(s) who voluntarily pollute the water of public springs or reservoirs so as to render it less fit for the purpose for which it is intended, shall be punished with imprisonment or be levied a fine for polluting bodies of water within the municipal jurisdiction)</td>
</tr>
<tr>
<td>2</td>
<td>Yangon Waterworks Act, 1885</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Canal Act, 1905</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Yangon Port Act, 1905</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Port Act, 1908</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>City of Yangon Municipal Act, 1922</td>
<td>(Penalties for polluting bodies of water within the municipal jurisdiction)</td>
</tr>
<tr>
<td>7</td>
<td>Emergency Provisions Act, 1950</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Factories Act, 1951</td>
<td>(Industries shall provide their own treatment plants to remove or reduce potential pollution from wastewater before discharging effluent)</td>
</tr>
<tr>
<td>9</td>
<td>Territorial Sea and Continuous Zone Law, 1977</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Law Relating to the Fishing Rights of Foreign Fishing Vessels, 1969</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Myanmar Marine Fisheries Law, 1990</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Pesticide Law, 1990</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Fresh Water Fisheries Law, 1991</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Development Committees Law, 1993</td>
<td>(Amendment to City of Yangon Municipal Act, 1992 including proper disposal of sewage and pollutant water)</td>
</tr>
<tr>
<td>15</td>
<td>Myanmar Hotel and Tourism Law, 1993</td>
<td>(Includes standards for construction of wastewater treatment plants for proper disposal of wastewater to public drainage canals)</td>
</tr>
<tr>
<td>16</td>
<td>Protection of Wild Animals, Wild Plants and Preservation of Natural Areas Laws, 1994</td>
<td>(Restrictions on wildlife sanctuaries and reserved forests for controlling water quality in upstream watershed areas)</td>
</tr>
<tr>
<td>17</td>
<td>Myanmar Mines Law, 1994</td>
<td>(Prohibits mining works in upstream watershed areas)</td>
</tr>
<tr>
<td>18</td>
<td>Conservation of Water Resources and River Law, 2006</td>
<td>(Control of water resources, such as surface water and groundwater, and riverine management)</td>
</tr>
<tr>
<td>19</td>
<td>NCEA Law for Myanmar Environmental Protection and Conservation</td>
<td>(The law has been drafted but not approved.)</td>
</tr>
</tbody>
</table>

Table 3.8.4. Myanmar’s legal framework with environmental implications (Source: MoEJ 2009)
of Health is jointly implementing a programme on water supply systems with health institutions and carrying out a Water Quality Surveillance and Monitoring System Pilot Project in the former capital city of Yangon.

Water quality monitoring

There are no specific regular monitoring programmes for ambient water quality in the country. Similarly, water quality monitoring is conducted by different governmental agencies in line with their own respective purposes.

In 2006, the Irrigation Department instituted water quality monitoring for both irrigation and potable water purposes at 15 stations in four rivers, namely Ayeyarwady (8 stations), Chindowin (3 stations), Thanlwin (2 stations) and Sittoung (2 stations). Sixteen parameters are monitored seasonally (twice a year): pH, ECw, turbidity, temperature, total hardness, TDS, salinity, SAR, RSC, Ca++, Mg++, K+, Co3+, HCO3, SO4, and Cl. The Irrigation Department also monitored salt water intrusion in the delta area during the summer season.

Effluent standards

YCDC convened a meeting in July 2001 to introduce proposed environmental standards for Yangon, including standards on air, noise, wastewater effluent and toxic chemicals. Similarly, governmental departments in YCDC have set their own standards with regard to the protection of environmental areas in which they are fully involved.

The main objective of the National Commission for Environmental Affairs is to conserve the environment and prevent its degradation when utilizing water, land, forest, mineral, marine and other natural resources. The current measures mentioned above are in line with the National Environment Policy of Myanmar initiated by the National Commission for Environmental Affairs.

6. Existing and Future Challenges

- A number of agencies are responsible for implementing water supply and sanitation schemes, which should ideally be carried out in an integrated manner. Coordination mechanisms among the various agencies should be strengthened to promote more effective management of the programme.
- Improvement of water use efficiency is an important factor for water conservation in the irrigation sector to reduce both water consumption and pollutant discharge by enterprises (point sources) and farmland (non-point source).
- The main sources of deteriorating water quality are sewage, solid waste, industrial waste and agrochemical waste. Water conservation through water quality protection is undertaken by the relevant city development committees. In fact, the control of wastewater is both a municipal and an industrial problem. In cities undergoing rapid industrialization, the municipal treatment issue is still complicated. Thus stricter laws to control water quality should be imposed. In the agricultural sector, the government has banned the import of some toxic pesticides and encourages the use of conventional bio-fertilizers as a substitute for chemical fertilizers to mitigate water quality deterioration.
- Deforestation in catchment areas and around water resources causes serious degradation of water quality and quantity. The resulting topsoil loss and land degradation by gully and sheet erosion leads to excessive levels of turbidity in incoming water and to offsite ecological and physical impacts from deposition in rivers and lakebeds. The silt and clay fractions, which carry absorbed chemicals, are transported by the sediments into the aquatic system.

Box. 3.8.2. Current actions taken in the water sector

- Public awareness through community involvement is a key issue on the subject of water use efficiency and conservation. Social development and public education and information programmes lead to an increasingly knowledgeable public that wants to be involved in government decision making. Training in nurturing forests, producing firewood substitutes and distributing leaflets on reforestation technology is provided to educate the local people in forest conservation practices. The government has designated July as the Month of Planting Trees for communities countrywide.
- YCDC has enacted Law No. 6/99 to improve water distribution systems, including leak detection, construction, repair and maintenance of city water mains, changes in plumbing codes and prosecution for illegal connections.
- Some effective measures have been taken to conserve agricultural water, such as adjustment of cropping patterns, water supply scheduling, improvement of irrigation facilities and management, land leveling, water pricing, canal lining and proper use of fertilizers and pesticides. Rehabilitation works for existing irrigation facilities have been carried out for efficient use of water instead of building new structures. Programmes that promote irrigation efficiency directly equate increased efficiency with savings for farmers (reduced energy, labour or cost) or improved productivity.
- Laws and regulations related to water resource and environmental management are reviewed in line with environmental assessments.
1. Country Information

<table>
<thead>
<tr>
<th>Table 3.9.1. Basic indicators</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Area (km²)</td>
<td>147,181 ( - )</td>
</tr>
<tr>
<td>Total Population (person)</td>
<td>30 million (2010)</td>
</tr>
<tr>
<td>GDP (current USD)</td>
<td>12.9 billion (2009)</td>
</tr>
<tr>
<td>Per Capita GDP (current USD)</td>
<td>438 (2009)</td>
</tr>
<tr>
<td>Long-Average Precipitation (mm/year)</td>
<td>1,500 (2009)</td>
</tr>
<tr>
<td>Total Renewable Water Resources (km³)</td>
<td>210.2* (2009)</td>
</tr>
<tr>
<td>Total Annual Freshwater Withdrawals</td>
<td>9.8 (2005)</td>
</tr>
<tr>
<td>(billion m³)</td>
<td></td>
</tr>
<tr>
<td>Annual Freshwater Withdrawal by sectors</td>
<td></td>
</tr>
<tr>
<td>Agriculture</td>
<td>98.2% (2005)</td>
</tr>
<tr>
<td>Industry</td>
<td>0.3% (2005)</td>
</tr>
<tr>
<td>Municipal (including domestic)</td>
<td>1.5% (2005)</td>
</tr>
</tbody>
</table>

* Estimated (Source: See References)

2. Major Water Basins in Nepal

Karnali, Sapta-Gandaki and Sapta-Koshi, with their origins in the Himalayas, are the major river basins and account for around 80% runoff. The Babai, West Rapti, Bagmati, Kamala and Kankai are medium-sized river basins accounting for about 7% of runoff. The southern rivers—the Bering, Balan, Khutiyia, Pathraiya, Lal Bakaiya, Ratu, Sirsia, Manusmara and Banganga, have origins in the Siwalik Hill Range (WECS 2011).

More than 5,000 lakes have been identified in the country. This includes natural lakes as well as ponds, dams and other small wetlands (WEPA database). Groundwater potential is high in the country and annual extraction potential is about 12 billion m³. People living in Terai (lowland) and inner valleys in the hills and mountains extract groundwater for domestic use.

Water resources in Nepal can be profitably utilized for power generation, irrigation, domestic uses, aquaculture and recreational fisheries. Of the above, hydropower development has become an attractive option as an energy source. The theoretical hydropower potential of Nepal is 83,200 MW, of which 44,552 MW is regarded as technically feasible and 42,133 MW is economically feasible. According to the Water and Energy Commission Secretariat of Nepal, the present situation of water resources can be summarized as follows (WECS 2011):

- 72% of the population has access to basic water supply.
- About 42% of cultivated area has irrigation facility and only 17% has year round irrigation.
- Less than 632 MW of hydropower capacity is currently available.
- Little consideration is being given to environmental requirements.

4. State of Water Quality

Water quality data available for the country is very limited, but water quality of public water bodies is generally considered good. However, urbanising areas, including the capital Katmandu, are facing the degradation of water quality which is caused by an increasing volume of untreated or insufficiently treated domestic and industrial wastewater, as well as waste dumped directly into rivers and lakes. The increased use of fertilizer and pesticide is also putting critical pressure on water quality, especially in rural areas. Insufficient access to sanitation facilities also leads to negative impacts on water quality in both surface and underground waters. In the rainy season, sedimentation becomes a problem especially in rural areas due to erosion.
Rivers

The Bagmati River is one of the most polluted rivers in Nepal. Due to lack of proper city development, water supply, sanitation and wastewater treatment facilities have not been developed as expected in the basin, which has resulted in the current water related problems. Water quality has rapidly deteriorated in the course of only a few decades (Figure 3.9.2) and the quality of water is not suitable for either drinking, recreation, or irrigation purposes.

Untreated domestic wastewater is considered to be the main cause of pollution in the river, which accounts for about 42% of total BOD load (NTNC 2009). In addition, domestic and industrial waste dumped into the river and wastewater from livestock farming have also been identified as major sources of pollution (NTNC 2009). Besides the increasing pollution loads from various sectors, development activities such as sand mining, encroachment of river banks and improper river bank protection works have also caused sedimentation issues.

![Figure 3.9.2. BOD among 5 sites from the headwaters to downstream along the Bagamati River](Source: ICIMOD 2007)

The availability of water quality data for other river basins is very limited due to lack of regular water quality monitoring. The latest environment statistics for Nepal (2008) indicate that water quality in eight major rivers during the dry season satisfied four parameters (pH, TDS, DO and BOD) in WHO guidelines (CBS 2008), although data is based on data as of 1998.

Lakes and reservoirs

Similar to river water quality, lake water in the country is generally good in quality, but some lakes under pressure from economic development and population growth experienced water quality degradation. For example, eutrophication has been observed in Phewa lake and other wetlands located in the south Terai region, which has also led to the destruction of local ecosystems. The following table shows the water quality in selected lakes based on different studies.

<p>| Table 3.9.2. Water quality condition of selected lakes |</p>
<table>
<thead>
<tr>
<th>Parameters</th>
<th>Unit</th>
<th>Phewa</th>
<th>Begnas</th>
<th>Rupa</th>
<th>Gosainkunda</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOD</td>
<td>mg/L</td>
<td>2</td>
<td>2</td>
<td>2.68</td>
<td>Not available</td>
</tr>
<tr>
<td>Total Nitrogen</td>
<td>mg/L</td>
<td>260</td>
<td>233.6</td>
<td>176.4</td>
<td>210</td>
</tr>
<tr>
<td>P-PO₄</td>
<td>mg/L</td>
<td>30</td>
<td>18.7</td>
<td>23.3</td>
<td>3</td>
</tr>
<tr>
<td>Chlorophyll</td>
<td>mg/L</td>
<td>8</td>
<td>5.5</td>
<td>6.5</td>
<td>1.2</td>
</tr>
</tbody>
</table>

(Source: CBS 2008)

Groundwater

Both shallow and deep groundwater in Nepal is at risk of contamination. Shallow groundwater is polluted by pathogenic bacteria, pesticides, nitrate and industrial effluents from industrial and domestic pollutants. Pesticides and nitrate contamination has mostly resulted from the use of inorganic fertilizers and pesticide sprays in the agricultural sector. Unplanned urban development and insufficient waste management facilities are the main causes of groundwater pollution in rural areas (Sharma et al. 2005).

Deep groundwater in Kathmandu and Terai is largely anaerobic and vulnerable to increased concentrations of iron, manganese, ammonium and arsenic. In the deep aquifers of Kathmandu Valley, iron concentrations are in the range of < 0.5–9 mg/L and manganese concentrations are in the range of < 0.1–0.7 mg/L. Deep aquifers in the Terai become anaerobic due to overlying poorly permeable thick layers of clayey soil. According to the Department of Water Supply and Sewerage (DWSS), 84% of groundwater in the Jhapa, Morang, and Sunsari districts of eastern Terai show levels of arsenic contamination below 10 ppb; 12.74% are within 10–50 ppb and 3.2% are above 50 ppb (Sharma et al. 2005).

5. Frameworks for Water Environment Management

Legislation

National awareness of environmental concerns emerged in the 1980s with the Sixth Five-Year National Plan (1980-85) officially stating the need for environmental protection. Since the 1980s, various acts related to environment and water have been enacted such as the Water Resource Act (1992) and Environment Protection Act (1996). The objectives of environmental protection in the country are to prevent adverse impacts on human and natural ecosystems and conserve natural resources to achieve sustainable development (Environment Protection Act 1997).

The Environment Protection Act (EPA) is an umbrella law which covers the basic principles and measures to counteract environmental degradation, such as environment impact assessment, issuance of pollution control certificates, environmental inspections, compensation systems for adverse impacts and environment protection areas.

In terms of water environmental management or water
pollution, there is no one particular law for environmental water management or water pollution. In addition to EPA and Environment Protection Rules which stipulate the outlines and rules for pollution control and environment impact assessments, the National Water Resources Strategy (2002) and the National Wetland Policy (2003) also indicate the importance of developing and strengthening enforcement of environmental protection related regulations and standards. The outline of legislations related to water environmental protection is illustrated in Figure 3.9.3.

There are also several related acts which could help reduce environmental impacts on rivers and lakes. These include acts related to land use, building codes, waste management, and conservation and protection of natural resources and cultural heritages (Table 3.9.3).

**Institutional arrangement**

The Ministry of Environment is responsible for environmental protection by managing and coordinating the country’s environmental protection policies and measures. The Department of Hydrology and Meteorology (DHM) under the ministry implements and coordinates the monitoring of river hydrology, climate, agro meteorology, sediment, air quality, water quality, limnology, snow hydrology, glaciology, and wind and solar energy. As for water, the Water and Energy Commission Secretariat (WECS) takes on the role of an apex body for national planning related to water and energy through the formulation and provision of assistance to water and energy related policy and strategy development. WECS is also mandated to ensure sustainability by integrating environmental agenda into development policies. There are various ministries and line agencies at the national level that promote water and environmental management and it is necessary to coordinate the work of these ministries.

The Local Self Governance Act (LSGA) 1999 allows village development committees (VDCs), district development committees (DDCs), and municipalities more autonomy to manage local natural resources and to integrate environmental resource management and environmental planning.

**Ambient water quality standards**

Ambient water quality standards were established under EPA (Article 24). There are two standards for different purposes, namely Nepal Water Guidelines for Recreation and Nepal Water Quality Guidelines for Protection of Aquatic Ecosystems.
**Effluent standards**

Effluent standards for different pollution sources are also set up under EPA as follows:

- Tolerance limits for industrial effluent discharged into inland surface waters (generic)
- Tolerance limits for specific industrial effluent discharged into inland surface waters (for nine industrial sectors, namely tanning, wool processing, fermentation, vegetable ghee and oil, paper and pulp, dairy products, sugar milling, cotton textiles, and soap industries)
- Tolerance limits for industrial effluent discharged into public sewers
- Tolerance limits for wastewater discharged into inland surface waters from combined wastewater treatment plants (CWTPs)

**Water quality monitoring**

Systematic ambient water quality monitoring is not conducted in public water bodies in the country, although water quality is monitored by different ministries and agencies for different purposes (e.g., water quality monitoring of the source of municipal water supply). The water quality of the Bagmati River is monitored to some extent considering the critical state of the river quality. Water-related database development is also set out in the action plan of the National Water Plan. Department of Hydrology and Meteorology under the Ministry of Environment monitors river and lake water quality.

**Recent policy development**

In the past two decades, the Nepalese government has strengthened legislation both in water and environmental sectors. In water environmental management, both sectors are closely interlinked but require further coordination. Effluent standards have been set up in the past three years as prescribed in the National Water Plan (Box 3.9.1). The framework of water environmental management already set up the country is facing enforcement and implementation issues.

**6. Existing and Future Challenges**

A framework of management has been set up for water environmental management in Nepal. The next step to be taken is the actual implementation of the nation’s regulations and rules. Lack of sub-ordinances enabling legislation and integration among related legislation and policies are major obstacles to achieving a comprehensive framework for water environmental management.

The lack of regular water quality monitoring is a constraint to the development of a scientific basis for policy making, implementation, and review. There is a pressing need to coordinate institutions and develop institutional and human capacity to promote water quality monitoring.

To improve the present state of Nepal’s water environment, it is important to issue legal instruments which facilitate a feeling of ownership in order to improve the water environment. As well, an environmental database must be developed, and regular monitoring carried out to enforce legislation and ensure compliance.

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**Box 3.9.1. Implementation of water environmental related actions set by National Water Plan (2002)**

The National Water Plan (NWP) 2002 has different sectoral policies—hydropower development, irrigation, and drinking water supply and sanitation. Recognizing the importance of sustainable development principles for the country’s development, NWP incorporated environmental sustainable principles¹ and included four actions related to water quality management as follows.

(a) Development of water quality standards/guidelines for irrigation, drinking and recreational purposes
(b) Establishment of water quality standards/guidelines for ecosystems maintenance
(c) Development of standards/guidelines for the discharge of municipal and industrial wastewater
(d) Establishment of minimum in-stream and outflow in important aquatic ecosystems

NWP also has special provisions in its environmental management plan (Part D). The environmental management plan is “a strategic document which deals with a plan for the implementation of environmental protection measures, monitoring and auditing programmes, institutions and procedures.” The actions introduced under NWP would have an impact on various environmental issues. The summary table of environmental issues included some water environmental conservation aspects such as downstream water pollution and groundwater quality, sedimentation, water pollution and sanitation, and impacts on aquatic ecosystems.

The environmental management plan aims to ultimately contribute to maximizing positive impacts and minimizing adverse effects in environmental sustainability in water development/conservation actions. Municipalities, local communities and the private sector are expected to play an increasing role in the utilization and sustainable use of groundwater.

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¹ Definitions and principles of environmental sustainability in NWP include the following elements:

a. to protect, conserve and manage natural resources and ecosystems while orienting technological, economic and institutional changes to meet the needs of the present and future generations;

b. to ensure the rate of consumption of natural resources does not exceed the rate of their regeneration;

c. to include consideration of all aspects of the water cycle and all uses for sustainable water resources.

(Source: Government of Nepal 2002)
1. Country Information

Table 3.10.1. Basic indicators

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Area (km²)</td>
<td>300,000 (2007)</td>
</tr>
<tr>
<td>Total Population (person)</td>
<td>88.57 million (2007)</td>
</tr>
<tr>
<td>GDP (current USD)</td>
<td>199.6 billion (2010)</td>
</tr>
<tr>
<td>Per Capita GDP (current USD)</td>
<td>2,140 (2010)</td>
</tr>
<tr>
<td>Long-Average Precipitation (mm/year)</td>
<td>2,348 (2009)</td>
</tr>
<tr>
<td>Total Renewable Water Resources (km³)</td>
<td>479 (2009)</td>
</tr>
<tr>
<td>Total Annual Freshwater Withdrawals (billion m³)</td>
<td>81.6 (2009)</td>
</tr>
</tbody>
</table>

Annual Freshwater Withdrawal by sectors

- Agriculture: 82.2% (2009)
- Industry: 10.1% (2009)
- Municipal (including domestic): 7.6% (2009)

(Source: See References)

2. Major Water Basins in Philippines

Philippines enjoys abundant water resources with water availability of 5,302 m³/year/capita, although availability is subject to geographical and seasonal imbalances. There are 18 major river basins with 421 principal river basins and 79 natural lakes (Cuna 2011). The coastal line is 17,460 km and about 64 out of 79 provinces are located in the coastal areas (Cuna 2011).

Surface water is the main water source of the country and also an important resource for fishing and transport. Groundwater is also an important source for domestic and drinking use in some regions. Groundwater comprises 14% of the total water resource potential, while about 50% of drinking water sources or 86% for piped water supply systems depends on groundwater.

Due to population growth and economic development, water demand increases while water quality has deteriorated. According to monitoring data of the national government, access to clean water is an issue in some areas of the country especially during the dry season. Such areas include Metro Manila, Central Luzon, Southern Tagalog, and Central Visayas.

3. State of Water Resources

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4. State of Water Quality

Water quality is assessed based on the water quality criteria set by the Department of Environment and Natural Resources (DENR) as embodied in DENR Administrative Order 34, Series of 1990 (DAO 90-34), which states that the quality of Philippine waters shall be maintained in a safe and satisfactory condition according to their beneficial usages (Table 3.10.2). As of 2005, the Environmental Management Bureau (EMB) had classified 525 water bodies, which is about 63 percent of the total water bodies in the country. Classification is set according to its beneficial use and water quality.

Major pollution sources for surface and coastal waters in terms of BOD load are point sources. The type of point source and contributing ratio is shown in Figure 3.10.2. Among non-pollution sources, agricultural runoff is the major source at 74% in terms of BOD.
Table 3.10.2. Classification of water bodies

<table>
<thead>
<tr>
<th>Water bodies</th>
<th>Classification</th>
<th>Beneficial use</th>
</tr>
</thead>
</table>
| For fresh surface waters (rivers, lakes, reservoirs, etc.) | Class AA  | Public water supply class 1  
• Waters that require disinfection to meet the national standards for drinking water (NSDW) |
|                                       | Class A   | Public water supply class 2  
• Waters that require complete treatment to meet the NSDW |
|                                       | Class B   | Recreational water  
• Waters for primary contact recreation (e.g. bathing, swimming, skin diving, etc.) |
|                                       | Class C   | Water for fishery production  
• Recreational water class II (boating etc.)  
• Industrial water supply class I |
|                                       | Class D   | For agriculture, irrigation, livestock watering  
• Industrial water supply class II |

For coastal and marine waters (as amended by DAO 97-23)

|                                      | Class SA  | Water suitable for fishery production  
• National marine parks and marine reserves  
• Coral reefs parks and reserves |
|                                      | Class SB  | Tourist zones and marine reserves  
• Recreational water class I  
• Fishery class I for milkfish |
|                                      | Class SC  | Recreational water class II (e.g. boating)  
• Fishery water class II (commercial)  
• Marshy and/or mangrove areas declared as fish and wildlife sanctuaries |
|                                      | Class SD  | Industrial water supply class II  
• Other coastal and marine waters |

Figure 3.10.2. BOD loads from key potential pollution sources
(Source: DENR-EMB 2007)

Rivers

EMB has conducted inland surface water monitoring for rivers and lakes since 2001 and prioritized 19 rivers for monitoring under the Sagip Ilog (Save a River) Program. The prioritized rivers are expected to satisfy 30% improvement in BOD and DO values by 2010, compared with 2003 monitoring results. Table 3.10.3 shows the percentage of change in BOD values in selected priority rivers in 2003 and 2010.

According to the monitoring results, signs of improvement in BOD levels were observed in the Paranaque, Marilao, Bocae, Anayan, and Sapangdaku Rivers. However, the targeted 30% improvement for BOD was only observed in Anayan River. At the same time, increasing trends for BOD levels were observed in many priority rivers, such as an increase of 400% in BOD levels in Iloilo River in 2010, compared with monitoring results in 2003. Monitoring data also showed that about 80% of monitored rivers surpassed the DENR criterion of DO (5mg/L) for Class C water.
Figure 3.10.3. River water quality compliance ratio of DO values in Class C (2006-2010)
(Source: Calculated from EMB monitoring data)

Lakes and reservoirs
Laguna Lake (Laguna de Bay) is an important water body that supports thousands of fishermen residing in Metro Manila. It is also being considered as an alternative to Angat Dam as a main source of potable water in Metro Manila. Therefore, rehabilitation and improvement the water quality of this lake is a priority agenda for the government. Main sources of pollution in the lake are domestic (77%), agriculture (11%) industry (11%) and forestry (1%). According to current water quality classifications, the central zone of this lake is fit for fisheries and the west bay for irrigation. However, peripheral portions in the west bay are heavily contaminated with high sediment loads and high level of coliform counts.

Coastal water
The quality of marine and coastal water is relatively good with the exception of Cansaga Bay in Region 7, DO levels are lower than 5 mg/L in all monitoring stations. Twenty-six coastal monitoring stations showed DO compliance of 54% with good quality, 46% of fair quality and 0% for poor quality (DENR-EMB 2007). In terms of fecal coliform, 34 out of 41 priority bathing beaches meet the Class SB water quality value of 200MPN/100mL (DENR-EMB 2007).

Groundwater
The status of groundwater quality is assessed through the Philippine National Standard for Drinking Water Under the Tap Watch Program of EMB which monitored 88 shallow wells in the country. Of this, only 21 sites met the potable groundwater quality standard, while 27 failed the fecal coliform standard for drinking water. An additional forty sites required further testing to confirm portability. Nitrate levels were monitored in Metro Cebu and Central Mindanao. Not many sites were contaminated.

Studies conducted for salinity levels in Metro Manila and Metro Cebu showed an increase in salinity in some locations in Metro Manila. Over-abstraction is considered to be the cause.

5. Frameworks for Water Environment Management

Legislation
Figure 3.10.4 shows the legislative framework for water environment management. In addition to the laws/regulations shown in the figure, there is other legislation related to water environmental conservation, such as the Philippines Environmental Policy (PD1151) and Solid Waste Management Act (RA9003). EMB is the governmental agency responsible for water conservation and protection.

Conservation of Water Resources

<table>
<thead>
<tr>
<th>Conservation of Water Quality</th>
<th>RA 3931 (1964) as amended by PD 984 (1976) as repealed by RA 9275</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAO 35 (1990) Revised Effluent Regulation</td>
<td>Clean Water Act of 2004</td>
</tr>
<tr>
<td>Objective: This rules and regulations shall apply to all industrial and municipal wastewater effluent</td>
<td></td>
</tr>
<tr>
<td>DAO 34 - Revised Water Usage and Classification Water Quality Criteria</td>
<td>Objective: Shall classify all bodies of water and comply with the water quality criteria</td>
</tr>
<tr>
<td>Objective: To promote, and accelerate the development and balanced growth of the Laguna lake area with due regards for environmental management and control, preservation of un due ecological disturbanace, detenoration and pollution.</td>
<td></td>
</tr>
<tr>
<td>Marine Water Resources Protection</td>
<td>PD 979 Marine Pollution Decree of 1976</td>
</tr>
<tr>
<td>Objective: To control pollution discharge from ship.</td>
<td></td>
</tr>
<tr>
<td>Conservation of Water Resources ownership, development and exploitation</td>
<td>PD 1067 Water Code</td>
</tr>
<tr>
<td>Consolidate legislation relating to ownership, development, exploitation and conservation of water resources</td>
<td></td>
</tr>
</tbody>
</table>

Figure 3.10.4. Legislative chart of water quality management
(Source: MoEJ 2009)
The Clean Water Act (RA 9275) and its Implementation Rules and Regulations (DAO 2005-10) provide a framework for water quality management in the Philippines, and employ an integrated, holistic, decentralized and participatory approach. Figure 3.10.5 shows the conceptual framework of the water environmental management under the act. The Philippines has many water-related laws, but their enforcement is weak and beset with problems that include inadequate resources, poor databases, and weak cooperation among different agencies and Local Government Units (LGUs).

To conserve water quality and mitigate water pollution, various programmes have been implemented, which includes the SAGIP ILOG Program (Ilog River conservation and restoration program linked with LGUs, NGOs and other interested parties); LINIS ESTERO Program (clean-up programme of creeks and esteros in Metro Manila in partnership with the private sector through MoUs); TAP Watch Program (monitoring programme for drinking water in poor communities); Industrial Eco Watch Program (rating programme for environmental performance); Beach Watch Program (monitoring of tourist beaches); and Philippine Environment Partnership Program (supporting self-regulation efforts in industries) (Cuna 2011).

As of September 2011, there are five officially designated WQMAs within the Laguna Lake Development Authority (LLDA) jurisdiction, Marilao-Meycauayan-Obando River in Region 3 (DAO 2008-07), Tigum-Aganan Watershed WQMA in Region 6 (DAO 2008-18), Iloilo-Batiano River System WQMA in Region 6 (DAO 2009-11), Sarangani Bay WQMA in Region 12 (DAO 2010-12) and Silway River WQMA in Region 12 (DAO 2010-10). Of these, a ten-year WQMA Action Plan has been prepared for Marilao-Meycauayan-Obando River, Iloilo-Batiano River system and Sarangani River (Tuddao 2011).
Designation of non-attainment areas
In cases where specific pollutants exceed water quality guidelines, DENR shall designate these areas as “non-attainment areas.” In the designated areas, pollution control measures are strengthened to comply with standards. For example, new sources of pollution will not be allowed in the non-attainment areas without plans to reduce total pollution loads from a facility below the guideline value.

Water pollution permits and wastewater charge system
The wastewater charge formula was established in 2005 (DAO 2005-10) on the basis of payment to the government for discharging wastewater into water bodies in all water management areas. It is expected that the system is to be an incentive for those who discharge pollutants to reduce their pollution loads such as through modification of production process and investment in pollution control technologies. DENR also issues discharge permits for wastewater, which includes the allowable value of both quantity and quality of effluents, compliance schedule and monitoring requirements.

Incentives and rewards
For outstanding and innovative projects, technologies, processes and techniques, and activities, rewards are provided to individuals, private organizations and other entities from the National Water Quality Management Fund. Incentives for industries are also provided, such as tax and duty exemptions for industrial wastewater treatment/collection facilities.

Ambient Water Quality Standards
According to the classification under the DENR AO No. 34 Series of 1990 (Table 3.10.2), the following water quality criteria has been set up for freshwater and coastal and marine water, respectively:
(1) Water Quality Criteria for Conventional and Other Pollutants Contributing to Aesthetics and Oxygen Demand
(2) Toxic and other Deleterious Substances (for protection of public health)

Monitoring of water quality in public water bodies
EMB and its Regional Offices conduct regular water quality monitoring throughout the country based on the parameters indicated in DAO 34. From 2001 to 2005, 238 water bodies were monitored either for classification or for regular water quality monitoring. Depending on the resources, monitoring for these waters bodies is carried out monthly or quarterly according to the DENR-EMB Water Quality Monitoring manual (2009).

Effluent standards
Section 14 of the Clean Water Act requires owners or operators of facilities that discharge regulated effluents to secure permits to discharge. Discharge permits are legal authorization granted by the DENR to discharge wastewater, provided that the discharge permit specifies among others, the quantity and quality of the effluent that said facilities are allowed to discharge into a particular water body, compliance schedule and monitoring requirements. DENR can also suspend and revoke permits when business entities are not in compliance with the rules and regulations and/or permit conditions. Effluent standards (DAO 35, 1990) are set as follows:
a. Effluent standards for conventional and other pollutants in Protected Waters Category I and II and in Inland Waters Class C. Standards were set for the following: color, temperature, pH, COD and settleable solids, BOD, TSS, TDS, surfactants (MBAS), oil and greases, phenolic substances and phenols. These standards apply to protected waters (both fresh and marine waters) and inland waters.
b. Effluent standards for toxic and other deleterious substances (maximum limits for protection of public health). For this category, effluent standards are set for arsenic, cadmium, chromium, cyanide, lead, mercury (Tot.), PCB, and formaldehyde. Different standard values for each substance are set in accordance with water classification. Stricter values are applied to “new planned industries.”
c. Effluent standards for conventional and other pollutants in Inland Waters Class D and Marine Waters Class SC and SD and other coastal waters which are not classified. The same parameters as in a. were considered with the exception of settleable solids.
d. Interim effluent standards for BOD applicable to old or existing industries producing strong industrial wastes (1990-1994).
e. Effluent standards for new industries producing strong wastes upon effect of the regulations and for all industries producing strong wastes starting 1 January 1995. The standard was based on BOD of raw wastewater. The standard covers old or existing industries producing strong waste whose wastewater treatment plants have yet to be constructed.
To set Industry-Specific Effluent Standards (ISES), a draft has been prepared with revision of current Industrial Effluent Standards. However, the draft still subject to revisions.

The Clean Water Act does not have standards for effluents discharges to land, but mandates that effluent emitters not affect the usability of land and groundwater resources. For effluent discharged for irrigation and other agricultural purposes, emitters should meet the guidelines of the Department of Agriculture (DA).

**Effluent monitoring**

Effluent monitoring must be carried out by those who are required to comply with effluent standards, in principle. A manual on effluent monitoring was issued by DENR-EMB in 2009. In order to determine compliance by industrial establishments, a series of surveys and follow-up inspections are conducted by personnel in DENR’s sixteen regional offices.

### 6. Existing and Future Challenges

There are various challenges being faced in water environment management including the following elements.

- Challenges in water quality management include the limited availability of funds and investments, which should be facilitated for effective and efficient enforcement of the requirements of the Clean Water Act 2004.

- Water quality monitoring should be strengthened through capacity building, and ensuring the necessary resources and infrastructure.

- Sharing of water quality monitoring data is also a challenge. Utilization of networks and strengthening of institutional partnerships could address this particular issue.

- Management of wastes should be strengthened to protect water bodies from contamination, especially that of domestic solid waste and hazardous waste.

- Strengthening institutional mechanisms and sustaining multi-sectoral participation in water quality management is necessary to promote water quality management.

- Appropriate land use plans should be enforced to mitigate and prevent pollution both from point and non-point sources.

- Strengthening of the following areas is necessary: non-point source management, coastal area management to avert impacts on coastal ecosystems, protection of groundwater quality, and rehabilitation of degraded water bodies.

- Water quality management at the basin level should be promoted. Integration of water quality management strategies and action plans with basin level development/management strategies and master plans is a challenge that the country will face in the near future.

- Incorporation of water quality parameters should be considered when river basin integrated information management systems (RBIMS) are designed/developed.
1. Country Information

Table 3.11.1. Basic Indicators

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Area (km²)</td>
<td>65,610 (2010)</td>
</tr>
<tr>
<td>Total Population (person)</td>
<td>20.9 million (2010)</td>
</tr>
<tr>
<td>GDP (current USD)</td>
<td>49.6 billion (2010)</td>
</tr>
<tr>
<td>Per Capita GDP (current USD)</td>
<td>2,375 (2010)</td>
</tr>
<tr>
<td>Long-Average Precipitation (mm/year)</td>
<td>1,712 (2009)</td>
</tr>
<tr>
<td>Total Renewable Water Resources (km³)</td>
<td>52.8* (2009)</td>
</tr>
<tr>
<td>Total Annual Freshwater Withdrawals (billion m³)</td>
<td>13 (2005)</td>
</tr>
</tbody>
</table>

Annual Freshwater Withdrawal by sectors:
- Agriculture: 87.3% (2005)
- Industry: 6.4% (2005)
- Municipal (including domestic): 6.2% (2005)

* Estimated
(Source: See References)

2. Major Water Basins in Sri Lanka

3. State of Water Resources

There are three different climatic zones in the country: wet, intermediate, and dry. Annual rainfall for each climate zone is over 2,000 mm/year for wet zones, between 1,500-2,000 mm for intermediate zones and 1,500 mm/year for dry zones (IGES 2007). These different climatic zones constitute a unique natural feature of the country.

There are 103 natural river basins in Sri Lanka, with a total length of about 4,500km (UNESCO and MoAIMD 2006). The largest river is the Mahaweli River with the size 335km long and 10,448 km² (MENR and UNEP 2009). In addition, there are a significant number of reservoirs including ancient irrigation reservoirs and recently constructed multi-purpose reservoirs with a total area of 169,941 hectares (Table 3.11.2).

Table 3.11.2. Estimated reservoir areas in Sri Lanka

<table>
<thead>
<tr>
<th>Type of Reservoir</th>
<th>Number</th>
<th>Area (ha)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major irrigation reservoirs (ancient)</td>
<td>73</td>
<td>70,850</td>
<td>41.7</td>
</tr>
<tr>
<td>Medium scale reservoirs (ancient)</td>
<td>160</td>
<td>17,001</td>
<td>10</td>
</tr>
<tr>
<td>Minor scale reservoirs (ancient)</td>
<td>&gt;10,000</td>
<td>39,271</td>
<td>23.1</td>
</tr>
<tr>
<td>Flood plain lakes</td>
<td>N/A</td>
<td>4,049</td>
<td>2.4</td>
</tr>
<tr>
<td>Upland hydroelectric reservoirs (recent)</td>
<td>7</td>
<td>8,097</td>
<td>4.8</td>
</tr>
<tr>
<td>Mahaweli multipurpose system of reservoirs</td>
<td>13,650</td>
<td>8.0</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>17,023</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td><strong>Total area</strong></td>
<td>169,941</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

(Source: MENR and UNEP 2009)

Groundwater resources in the country are estimated at about 7,800 million m³ per year (IGES 2007; MENR and UNEP 2009; Nandalal 2010). Groundwater is the major source of water especially in rural areas, and it is estimated that about 72% of the rural population relies on groundwater for domestic use (Nandalal 2010).

4. State of Water Quality

It is difficult to comprehend the trend of water quality in public water bodies due to lack of monitoring data. However, the Sri Lanka National Water Development Report (2006) pointed out a variety of quality concerns in Sri Lanka, including contamination by nitrate and bacteria in underground and surface waters mainly due to poor sanitation and untreated wastewater or insufficient...
wastewater treatment, toxic chemicals from industrial and agricultural activities, and eutrophication in lakes/reservoirs (UNESCO and MoAIMD 2006).

**Rivers**

Deterioration of water quality has been reported in some rivers. The main cause of water pollution in urban areas is dumping of domestic and industrial wastes and untreated wastewater into waterways. In agricultural areas, agrochemicals are the main pollutants (UNESCO and MoAIMD 2006). Water quality in the Kelani River, which is one of the major water sources for Colombo, is considered to be threatened by untreated or insufficiently treated wastewater (Ratnayake 2010) and solid waste.

Expansion of sand-mining activities also affects the river water quality such as increasing turbidity decreasing water flow, and accelerating salt water intrusion. Salt water intrusion accelerated by sand-mining activities in the Kelani River affected drinking water supply (MENR and UNEP 2009) and court cases over sand-mining increased from 709 in 2002 to 2,496 in 2005 (MENR and UNEP 2009).

Table 3.11.3 shows the recent inland water quality monitoring results in selected rivers conducted by the Central Environment Authority (CEA). Overall, the water quality of these rivers is considered moderate to good, although not all parameters met the interim ambient water quality standards.

<table>
<thead>
<tr>
<th>Rivers</th>
<th>Kelani</th>
<th>Mahaweli</th>
<th>Mahaoya</th>
<th>Proposed ambient standards by CEA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampling point</td>
<td>Kaduwela</td>
<td>Peradeniya</td>
<td>Mawanella</td>
<td></td>
</tr>
<tr>
<td>Month/Year</td>
<td>June 2010</td>
<td>January 2011</td>
<td>November 2011</td>
<td></td>
</tr>
<tr>
<td>BOD (mg/L)</td>
<td>2.5</td>
<td>5-10</td>
<td>4-5</td>
<td>Class 1 Drinking (with simple treatment*)</td>
</tr>
<tr>
<td>COD (mg/L)</td>
<td>12.6</td>
<td>15-20</td>
<td>10</td>
<td>Class 2 Bathing</td>
</tr>
<tr>
<td>Total Coliform (MPN/100mL)</td>
<td>13,000</td>
<td>-</td>
<td>170</td>
<td>Class 2 Fish and aquaculture</td>
</tr>
<tr>
<td>NO₃-N (mg/L)**</td>
<td>N/A</td>
<td>N/A</td>
<td>0.47</td>
<td>Class 2 Draining (with conventional treatment**)</td>
</tr>
<tr>
<td>PO₄-P (mg/L)**</td>
<td>N/A</td>
<td>N/A</td>
<td>&lt;0.01</td>
<td></td>
</tr>
</tbody>
</table>

Table 3.11.4. Recent water quality monitoring results in selected rivers

<table>
<thead>
<tr>
<th>Rivers</th>
<th>Bolgoda</th>
<th>Kandy</th>
<th>Gregory</th>
<th>Proposed ambient standards by CEA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampling point</td>
<td>Centre of the lake</td>
<td>Average from 4 locations</td>
<td>Centre of the lake</td>
<td></td>
</tr>
<tr>
<td>Month/Year</td>
<td>Feb 2011</td>
<td>Jan 2011</td>
<td>Dec 2009</td>
<td></td>
</tr>
<tr>
<td>BOD (mg/L)</td>
<td>2</td>
<td>8.4</td>
<td>3</td>
<td>Class 1 Drinking (with simple treatment*)</td>
</tr>
<tr>
<td>COD (mg/L)</td>
<td>12</td>
<td>45.6</td>
<td>15</td>
<td>Class 2 Bathing</td>
</tr>
<tr>
<td>DO (mg/L)</td>
<td>6.9</td>
<td>4.6</td>
<td>6</td>
<td>Class 2 Fish and aquaculture</td>
</tr>
<tr>
<td>NO₃-N (mg/L)**</td>
<td>N/A</td>
<td>N/A</td>
<td>0.96</td>
<td>Class 2 Draining (with conventional treatment**)</td>
</tr>
<tr>
<td>PO₄-P (mg/L)**</td>
<td>N/A</td>
<td>N/A</td>
<td>0.02</td>
<td></td>
</tr>
</tbody>
</table>

**Notes**

*1 Only boiling and no chemical treatment
*2 Treated by filtration and chlorination
*3 Proposed ambient standards are for NO₃-N
*4 Proposed ambient standards are for PO₄-P

(Source: Provided by CEA, based on the results of water quality monitoring conducted by CEA)

**Lakes and reservoirs**

In general, water quality in lakes and reservoirs is considered good, with the exception of specific areas where industrial activities are taking place (Table 3.11.4). In Beira Lake which is located in the city of Colombo, blue green algae was observed due to inflow of untreated domestic wastewater (Ratnayake 2010).
Coastal water
Studies on coastal water quality in Sri Lanka are few in number, although water pollution in coastal water bodies has grown over the past few decades due to rapid development activities and human settlements both in and outside coastal areas. The Coastal Resource Management Project (CRMP) implemented by the Ministry of Fisheries and Ocean Resources reported that the organic pollution in sea water of the Beruwala and Unawatuna areas attributed to high BOD values throughout the year (MENR and UNEP 2009).

Groundwater
A common groundwater quality problem in the country is pathogenic pollution mainly caused by poor sanitation systems such as pit latrines (MENR and UNEP 2009; Nandalal 2010).

Nitrate is also identified in coastal aquifers such as in Jaffna (north coast) and Kalptiya (western coast) because of excessive fertilizer use and untreated wastewater (Nandalal 2010). High salinity is also an issue especially in coastal zones, which is exacerbated by excessive groundwater use. Fluoride and arsenic, which is naturally occurring, was identified in some areas of the country (Nandalal 2010).

5. Frameworks for Water Environment Management

The constitution of Sri Lanka states that protection, preservation and improvement of the environment for the benefit of the community is the responsibility of the state (Article 27(14)) and that every person in the country has a duty to “protect nature and conserve its riches” (Article 28). Surface water resources—rivers, streams and lakes, are under the control of the government under the Crown Lands Ordinance and the Constitution.

The Haritha Lanka Programme, approved in June 2008, is the current basic national policy document for environmental conservation in the country. The policy aims to promote sound environmental management in Sri Lanka by balancing the needs for social and economic development and environmental integrity. The “National Action Plan for Haritha Lanka Programme” was prepared in the same year, based on the programme. The action plan includes actions to be implemented between 2009-2016 under the supervision of the National Council for Sustainable Development (NCSD) (Box 3.11.2). The proposed strategies and actions in the Haritha Lanka Programme are a concerted effort of all relevant ministries and stakeholder institutions. As for the environment pollution control domain, the Central Environment Authority (CEA) prepares five year action plans. The 2012-2016 action plan is currently under preparation.

Box 3.11.1. Water quality under threat in Bolgoda Lake in Kelani River basin

Bolgoda lake is a shallow brackish water body located between the southern and northern borders of the Kelani River basin, about 30 km south of Colombo. The lake water is used for agriculture and domestic purposes including recreational activities, and its wet land supports a rich bio-diversity of fauna. However, the release of industrial effluents, agricultural runoff and untreated domestic wastewater as well as other anthropogenic activities such as unplanned development activities, boat operating for recreational purposes, pose a serious threat to water quality of the lake and its eco system.

Several studies reported high values of total coliform and faecal coliform possibly due to disposal of untreated or partially treated wastewater from hotels and houses located on the banks. Presence of lead (Pb) and Chromium (Cr) due to industrial effluents is significant considering the proposed ambient water quality standard for category 4 class II waters (fish and aquatic life).

A recent study carried out by the CEA revealed that BOD ratios met the proposed ambient water quality standard for category 3 and 4 class II waters, while COD values exceeded the proposed standards at all points, and indicated that industrial wastewater contributed to the deterioration. High turbidity level was observed during the study (in September 2011) (CEA 2011).

Considering the importance of maintaining the quality of water, Bolgoda Lake was declared an Environmental Protection Area in 2009 under the provisions of the National Environmental Act No. 47 of 1980. (CEA 2011)
Box 3.11.2. Water environmental conservation related targets in the National Action Plan for Haritha Lanka Program

The National Action Plan for the Haritha Lanka Programme consists of ten missions related to different environmental management domains. Among the missions, Mission 7 (Water for All and Always) and Mission 9 (Greening Industries) include specific strategies related to water environmental management. For coastal and marine water bodies, Mission 4 (Wise Use of Coastal Belt and Surrounding Sea) includes related actions.

Mission 7

Strategy 4: “Keep drinking water sources free from contamination through proper zoning and control measures” is one of the most popular water quality related targets. Actions include strengthening of inland water monitoring, identification of pollution sources, promotion of central wastewater treatment plants, and developing water conservation areas.

Strategy 6: “Strictly enforce the polluter pays principle for water pollution industries/activities” outlines actions related to the Wastewater Charge Programme (WCP) which would be introduced by an amendment to the National Environmental Act. In addition to actions related to institutional arrangements for the introduction and implementation of WCP, the promotion of cleaner production principles and surveys on prescribed activities in the National Environmental Acts are also included in the strategy.

Strategy 8: “Reduce fertilizer leaching and eutrophication” is also a target to reduce pollution loads from agricultural activities. Soil erosion control is also included in the strategy.

Mission 9

Strategy 1: “Consolidate Cleaner Production in industries” aims to reduce the amount of resources wasted and minimize water usage in industries. Promotion of environmental and social responsibility in small- and medium-sized enterprises, and appreciation and reward programmes for industries with good environmental performance are examples of actions included under this strategy.

Strategy 2: “Establish eco-industrial parks,” Strategy 3: “Certification of industries mostly related to ISO 14000 certification,” Strategy 4: “Greening the supply chain” and Strategy 6: “Incentives for environmental friendly investments” are not directly related to water quality conservation, but the actions under these strategies could contribute to the reduction of environmental loads from industrial activities.

(Source: NCSD and Presidential Secretariat 2009)

Legislation

The National Environmental Act No. 47 of 1980 (amended as Act No. 53 of 2000) is the country’s basic law protecting the environment in the country. Under the Act, National Environmental Regulations were set up to stipulate wastewater quality standards to protect water quality in public water bodies. There is also a regulation on environment impact assessments (EIA). Other acts and ordinances related to water environmental management are illustrated in the following figure.

Figure 3.11.2. Laws and regulations related to water environmental management

(Source: created based on the information from CEA)
Institutional arrangements

The Ministry of Environment is the national authority that formulates policies and guidelines for the conservation of the environment and natural resources in Sri Lanka. Under the ministry, there are six agencies which are responsible for policy implementation, including the CEA and the Marine Environment Protection Authority (MEPA).

The CEA is was established in 1981 as the authority with regulatory powers for activities that have adverse impacts on the environment under the National Environment (Amendment) Acts No. 56 of 1988 and No. 53 of 2000. Industrial water pollution control is regulated under provisions of the NEA by CEA. In addition, there are different governmental agencies related to water environment management. MEPA is in charge of the management of the coastal and marine environment. National Water Supply and Drainage Board (NWS & DB) is responsible for water supply and sewerage treatment and management in the country. Other organizations which are responsible mainly for water resource management include the Department of Irrigation, Water Resources Board, and the Mahaweli Development Authority.

Governmental organizations related to construction, engineering services, housing and common amenities such as the Condominium Management Authority, National Housing Development Authority, and Board of Investment of Sri Lanka are not directly related to water environmental management, but they regulate development/industrial activities which affect the condition of water quality.

Local governments also play an important role in water environmental management. They are responsible for regulating low-impact industries and activities prescribed by orders issued under the National Environmental Act. They also regulate and control on-site sanitation systems such as pit latrines and septic tanks; public health inspectors are in charge of these tasks.

Ambient water quality standards

There are no ambient water quality standards or classification of water bodies in Sri Lanka. Surface water quality is evaluated by potable water standards (SLS 614) and also by proposed ambient water quality standards which were prepared by CEA and is currently in the process of being approved. The proposed ambient water quality standards cover only surface water quality.

Monitoring of water quality in public water bodies

There is no regular monitoring of surface and underground water quality except the monitoring of water intake quality conducted by the National Water Supply and Drainage Board. The CEA conducted ambient water quality monitoring projects for different river basins such as the Mahaweli River, Kandy Lake and Kelani River. Under the Pavithra Ganga Project, water quality has been monitored since 2001 (Box 3.11.3).

Box 3.11.3. Recent development of water environmental management: Pavithra Ganga Programme

The Pavithra Ganga (Clean River) Programme was initiated in 1998 by the Ministry of Environment of Sri Lanka to mitigate water pollution and conserve biodiversity of freshwater bodies in a comprehensive manner. Under the programme, a pilot project was conducted for the Kelani River which is the main drinking water source for the western province. The Pavithra Ganga project in the Kelani River included various activities such as the promotion of awareness programmes for industries especially on cleaner production, awareness programmes for school children, waste audits by the ministry in collaboration with local authorities, and tree-planting along river banks.

Water quality monitoring has been also strengthened under the project. Water quality has been monitored at 12 locations, and since 2003, water quality monitoring results have been made public through water quality information boards set up at selected locations along the river. The information boards help local people gain an awareness of the state of water quality in the river.

The project is a good showcase of comprehensive water environment management with the participation of national government agencies, as well as 13 local governments located in the Kelani River basin and other local stakeholders.

(Source: Documentation from CEA, MENR 2008)
Environmental protection license system

Environmental protection licenses (EPL) are required for all entities in the country which discharge wastes to the environment, prescribed by a regulation published under the National Environmental Act. EPLs are issued by CEA based on the National Environmental Regulation No.1533/16 and No. 1534/18 of 2008. 138 activities in total are mandated to obtain EPLs by Governmental Notification (Gazette No. 1533/16, 2008). These activities are divided into three categories according to pollution load levels. In principle, EPLs are issued for water discharging activities which comply with national effluent standards (Ratnayake 2010). However, an industrial survey conducted by CEA found that some industries are functioning without EPL.

Effluent standards

Currently, different kinds of effluent standards have been set based on point of discharge and type of effluent as follows.

- General standards for discharge of effluent into inland surface waters
- Tolerance limits for industrial effluents discharged on land for irrigation purposes
- Tolerance limits for discharge of effluents into public sewers with central treatment plants
- Tolerance limits for industrial and domestic effluents discharged into marine coastal areas
- Tolerance limits for effluents from rubber factories discharged into inland surface waters
- Tolerance limits for effluents from textile industries discharged into inland surface waters
- Tolerance limits for effluents from tanning industries

Considering that current effluent standards do not well reflect local socio-economic and environmental conditions and have resulted in implementation problems, a revision of effluent standards is currently being proposed. Non-compliance actions shall be subject to fine or imprisonment based on the National Environmental Act.

Effluent monitoring

In principle, effluent quality should be self monitored by discharging industries. However, significant number of industries do not monitor effluent quality of their discharging effluent.

The CEA occasionally monitors effluents discharged from industries/activities which are suspected of non-compliance with effluent standards. It also checks effluent quality based on complaints received from the general public.

6. Existing and Future Challenges

There has been a positive development in the development of a water quality management framework in past decades in Sri Lanka. On the other hand, various challenges remain to ensure implementation of water pollution control measures.

i) Organization: There is no umbrella body to regulate water issues and therefore, water resources/quality are managed by different agencies based on their area of interest. Coordination among agencies should be strengthened to ensure comprehensive water management in the country.

ii) Legislation: Ambient water quality standards and classification of water bodies should be established to strengthen water pollution control. Draft ambient water quality standards are now awaiting approval.

iii) Scientific data: Lack of baseline data is one of the critical challenges in promoting water quality management. The availability of data, as well as accessibility to data stored in different institutions is an issue. Financial and institutional arrangements should be improved to establish systematic data collection and periodical analysis systems.

iv) Awareness: Unwillingness by industries and the general public to contribute to water quality management is a barrier to reduce pollution loads on public water bodies. Awareness programmes and consultation processes should be further promoted to ensure sound and sustainable management for a better water environment.
1. Country Information

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Area (km²)</td>
<td>513,116 (2007)</td>
</tr>
<tr>
<td>Total Population (person)</td>
<td>69.1 million (2010)</td>
</tr>
<tr>
<td>GDP (current USD)</td>
<td>318.5 billion (2010)</td>
</tr>
<tr>
<td>Per Capita GDP (current USD)</td>
<td>4,608 (2010)</td>
</tr>
<tr>
<td>Long-Average Precipitation (mm/year)</td>
<td>1,622 (2009)</td>
</tr>
<tr>
<td>Total Renewable Water Resources (km³)</td>
<td>438.6* (2009)</td>
</tr>
<tr>
<td>Total Annual Freshwater Withdrawals (billion m³)</td>
<td>57.3 (2007)</td>
</tr>
<tr>
<td>Annual Freshwater Withdrawal by sectors</td>
<td></td>
</tr>
<tr>
<td>Agriculture</td>
<td>90.4% (2007)</td>
</tr>
<tr>
<td>Industry</td>
<td>4.8% (2007)</td>
</tr>
<tr>
<td>Municipal</td>
<td>4.8% (2007)</td>
</tr>
<tr>
<td>(including domestic)</td>
<td></td>
</tr>
</tbody>
</table>

*Estimated (Source: See References)

2. Major Water Basins in Thailand

3. State of Water Resources

Based on geographical characteristics, Thailand can be divided into 25 river basins (Figure 3.12.1). The total volume of water from rainfall in all river basins in Thailand is estimated at approximately 800,000 million m³, of which 75% is lost through evaporation, evapotranspiration and infiltration. The remaining 25% constitutes the runoff that flows in the rivers and streams. Available water quantity is about 3,300 m³/capita/year (Office of National Water Resources Committee 2000).

Groundwater is an important source of water supply in Thailand. Twenty percent of public water supply and 75% of domestic water are derived from groundwater resources. The groundwater system in Thailand is mainly recharged by rainfall of about 40,000 million m³ and seepage from rivers. It was estimated from previous hydrological balance studies that about 12.5 to 18% of rainfall would reach the aquifers. More than 200,000 groundwater well projects were undertaken by both government and the private sector with total capacity of about 7.55 million m³/day (information from the WEPA focal person in 2012).

4. State of Water Quality

Surface Water

Water quality monitoring is conducted at 620 general monitoring stations in 48 major rivers and four standing water resources (Kwan Phayao, Bueng Boraphet, Nong Han, and Songkhla Lake). Water quality is evaluated by making comparisons to surface water quality standards and water quality index (WQI). Figure 3.12.2 shows the status of water quality in the country from 2001 to 2010 based on an assessment of WQI by the Pollution Control of Department (PCD) under the Ministry of Natural Resource and Environment (MoNRE). There have been no points categorized as “highly deteriorated” since 2008, although points categorized as “deteriorated” have been on the rise for the same period. Wastewater from communities is considered to be the main point source of surface water quality deterioration, and untreated wastewater from industries and agricultural activities also contributes to deterioration (PCD 2010).

During the last 10 years, several standards have been established to control effluent quality emissions to recipients. However, it is still difficult for entrepreneurs and agriculturists to comply with these standards. Sectors such
as factories, real estate, condominiums, hotels, department stores, restaurants, and fresh food markets are better able to follow the standards as they are likely to have more capital funds available to establish management systems than agricultural sectors.

Coastal water

PCD has 240 monitoring stations in 23 provinces along the 2,600 km coastline and significant islands. Monitoring results were evaluated with the Marine Water Quality Index which is calculated with the monitored value of eight parameters. Figure 3.12.4 shows the chronological change of water quality in coastal areas and estuaries from 2006 to 2010. There are no significant changes, but the number of points evaluated as "deteriorated" or "highly deteriorated" increased slightly in 2010 compared with the value in 2008 (PCD 2011).

By region, deterioration was significant in the inner gulf of the country at the estuaries of the four main rivers (Chao Phraya, Tha Chin, Mae Klong, and Bang Pakong Rivers) for DO and TCB. TSS values were also high in the Bang Pakong area. The western seaboard, tourist areas, tiger shrimp and oyster culturing areas generally appear to have "good" water quality. However, TCB levels in some areas where domestic wastewater is discharged into the sea without treatment exceeded the standard (PCD 2010).

Groundwater

The country's groundwater potential is large in general, except the eastern region. The lower central plain area has the largest potential of groundwater resources, particularly in the Bangkok Metropolitan Region and surrounding provinces. Groundwater in the region has been exploited to meet growing water demand and has caused severe land subsidence problems. Regarding water quality, high iron, fluoride and salinity is observed in some areas of the country, which is natural contamination. On the other hand, contamination by fertilizers, agricultural chemicals,
aquaculture and animal wastes have been identified in some regions. Leakage from waste dumping sites and petroleum wastes are also a cause of contamination. Examples have been observed in Pak Chong district (petroleum waste), Sating Phra and Songkhla Lakes (freshwater animal farming), Muang district, Lanphun, Rayong and Chon Buri provinces (VOCs), and Bang Pakong and Tha Chin River basins (agricultural wastes) (PCD 2010).

Sources of Water Pollution
The main sources of water pollution can be divided into three types as follows:

1) Domestic wastewater: The general public which generates domestic sewage that is discharged into rivers and other bodies of water after undergoing primary treatment or no treatment at all. It was estimated that approximately 15 million m³/day or 2.77 million kg of BOD/day of wastewater generated by the population across the country is discharged into receiving waters and the environment. This includes the 2,008 municipalities considerably generating approximately 3.8 million m³/day, Bangkok Metropolis and Pattaya city generating about 2.7 million m³/day, and the areas of 5,767 local administration organizations contributing about 8.5 million m³/day.

2) Industrial wastewater: Industries which discharge processed wastes including by-products of various types of industrial operations. At present, many industries are located in high population density areas or mixed with residential areas in the city. Across the country, there are more than 120,000 industrial establishments of varying sizes, carrying on a wide range of activities, located within the Inner Gulf. They produce a range of products.

3) Agricultural activities: Agricultural activities such as the use of chemical fertilizers, pesticides and animal wastes from feedlots. A considerable part of the fertilizer used for rice paddy fields is washed away by irrigation water and flows into rivers, estuaries, or other bodies of water. This fertilizer causes eutrophication and supports the growth of water hyacinths. This unwanted plant grows very fast, covering major areas of water bodies.

5. Frameworks for Water Environment Management
The constitution of Thailand (2007) stipulates that environmental protection and conservation under sustainable development principles and elimination of pollution which affects human health and welfare is the responsibility of the state (Section 5, part 8). Since 1992, the five-year national economic and social development plans have emphasized environmental conservation of the country. The 10th National Economic and Social Development Plan (2007-2011) emphasized the rehabilitation of natural resources and the environment by strengthening environmental management and increasing local community participation as key areas. The national plan does not include a detailed implementation or action plan, and in order to bring the environmental strategies in the plan into action, the related agencies have to formulate programmes, projects and measures based on the national plan (Box. 3.12.1).

Box. 3.12.1. Water environmental management policy in Thailand
The environmental policy on water pollution control for 2010-2014 was approved by the National Environmental Board on 30 October 2009. The summary of this policy is shown below.

Policy:
1) Reduce BOD loads from domestic wastewater by using Grease Traps and On-site method
2) Rehabilitate existing municipal wastewater facilities
3) Build wastewater treatment facilities where there is a water pollution crisis
4) Unite the Metropolitan Waterworks Authority and Wastewater Management Authority
5) Enforce Polluter Pays Principal (PPP): Producers of polluted water must be responsible for paying for the management of water pollution.
6) Promote and support private sector/public participation in co-investing and solving water pollution problems

Prioritizing operational areas:
Classifying wastewater management based on the result of prioritization of river basins and importance of municipal areas, which will help establish implementation plans into four phases as below (in order of priority):

Phase 1: 2010-2011
Phase 2: 2012-2016
Phase 3: 2017-2031
Phase 4: 2032-2041

(Source: Information from the WEPA focal person in 2012)
The Enhancement and Conservation of the National Environmental Quality Act (EQA) in 1992 is the basic law for environmental conservation in the country, which defines authorities and responsibilities regarding environmental protection. Some key features of the EQA are as follows:

- Establishment of the Environmental Fund, from which resources will be drawn to solve environmental problems in priority areas.
- Formulation of a National Environmental Management Plan, duties of government agencies to implement the plan and for provinces to prepare action plans.
- Provision for the National Environmental Board (NEB) to declare Pollution Control Areas (PCAs) or Conservation and Environmentally Protected Areas when justified from an environmental point of view.
- Establishment of a multi-agency Pollution Control Committee for pollution control matters, including enactment of discharge standards.
- Recognition of the Polluter Pays Principle.

In order to control and manage water quality problems in Thailand, the regulations can be grouped into three categories as follows:

- The application on environmental impact assessment (EIA) to determine the impact and mitigation plan for development projects of various types and sizes such as dams with storage volume of 100 million m³ or more, irrigation projects of 12,800 ha or more, hotels or resorts with 80 rooms or more, thermal power plants with capacity of 10 MW or more, all sizes of mining projects, etc.
- The establishment and application of effluent standards such as industrial effluent standards, domestic effluent standards, effluent standards for pig farms and fish/shrimp farms, etc.
- The ambient water quality standard and classification based on the state of water quality, socio-economic aspects, and availability of treatment technologies

The outline of legislation related to water environmental management in Thailand is shown in Figure 3.12.5.

**Institutional arrangement**

According to the EQA, PCD and the Office of Natural Resources and Environmental Policy and Planning (ONEP) under MoNRE are responsible for wastewater management by undertaking national and regional water quality management planning and facilitating local authorities in their responsibilities for their own wastewater management. Under the EQA, the PCD establishes effluent standards for pollution control from point sources in order to meet ambient environmental quality standards.

### Ambient water quality standards

**Surface water quality standards**

This standard was the first ambient water quality standard established in 1994. Surface water quality standards have been established for 28 items under five classifications of water bodies which were designated according to water usage as shown in Table 3.12.2. The General Water Quality Index was established as an indicator to promote people’s understanding of water quality, which was calculated with the values of eight parameters (pH, DO, BOD, TS, FCB, NO₃, TP, SS). These standards are the national minimum standards.
Table 3.12.2. Surface water quality standard classification

<table>
<thead>
<tr>
<th>Class</th>
<th>Objectives</th>
<th>Beneficial Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1</td>
<td>Extra clean fresh surface water resources</td>
<td>Conservation not necessary to pass through water treatment process. Only requires ordinary process of pathogenic destruction, ecosystem conservation where basic organisms can breed naturally.</td>
</tr>
<tr>
<td>Class 2</td>
<td>Very clean freshwater surface water resource</td>
<td>Consumption requires ordinary water treatment process before use, conservation of aquatic organisms, fisheries, recreation</td>
</tr>
<tr>
<td>Class 3</td>
<td>Medium clean fresh surface water resource</td>
<td>Consumption, but ordinary treatment process is required before use (for agricultural use)</td>
</tr>
<tr>
<td>Class 4</td>
<td>Fairly clean fresh surface water resource</td>
<td>Consumption, but requires special treatment process before use (for industrial use)</td>
</tr>
<tr>
<td>Class 5</td>
<td>Source not included in Class 1-4</td>
<td>Navigation</td>
</tr>
</tbody>
</table>

(Source: MoEJ 2009)

Coastal water quality standards
There are 30 parameters designated for coastal water quality standards in six classes, determined according to usage (6 classifications). Different classifications are applied for the west coast of Phuket Island.

Groundwater quality standard
The parameters included in groundwater quality standards are divided into four groups: volatile organic compounds (15 parameters), heavy metals (ten parameters), pesticides (nine parameters) and others (four parameters).

Ambient water quality monitoring in public water bodies
Under the EQA, the government conducts monitoring of receiving water quality to maintain quality. There are 620 general monitoring stations and 39 automatic monitoring stations in 48 main rivers in the country and water quality samples are taken three to four times/year during the wet and dry seasons. The methods of water sampling and analysis should follow the Standard Method for the Examination of Water and Wastewater (1998) (Yolthantram 2011). The monitoring results of ambient water quality conducted by the government are summarized and made available to the public through publications and online.

Effluent standards
Based on the EQA (Section 32), a series of effluent standards have been set up as follows.

a. Industry
   • Industrial Effluent Standards
     Standards are applied to factory Group II and III categories and all industrial estates under the Factory Act B.E.2535 (1992). The standard value is designated for 15 parameters and 12 heavy metals. Regarding effluent quality control, the Regulations of Industrial Pollution Control Facilities (1982) stipulates that specific industrial plants must have supervisors and machine operators responsible for pollution prevention. Such industrial plants include those using heavy metals in production processes, discharging wastewater at higher than 50m³/day and having a heavy metal content in the discharged wastewater at designated values.

b. Domestic and Commercial
   • Building Effluent Standards
     Effluent from each type of building, namely apartments, hotels, hospitals, schools and academic buildings, public and private offices, department stores, fresh markets and restaurants, is regulated under these standards. Regulated parameters, depending on building size, include pH, BOD, suspended solids, sulfide, TKN, and fat, oil, and grease.

   • Housing Estate Effluent Standard
     These standards regulate effluent from housing estates which are classified into two categories, those with the number of units exceeding 100 but less than 500, and those with over 500 units. Regulated parameters include pH, BOD, suspended solids, settleable solids, total dissolved solids, sulfide, TKN and fat, oil, and grease.

   • Municipal Wastewater Treatment System Effluent Standard
     This is a new standard established in 2010. There are six parameters in these standards, namely pH, BOD, SS, TN, TP and fat, oil, and grease.

   • Gas Station and Oil Terminal Effluent Standard
     There are four parameters in these standards, namely pH, COD, SS, and fat, oil, and grease.

c. Agriculture
   • Effluent Standards for Pig Farms
     In consideration of the contribution of pig farms to water pollution such as in Tha Chin River and Bang Pakong River, standards were established in 2001. The parameters designed by the standards include pH, BOD, COD, SS, and TKN and different values are applied to Type A (more than 600 livestock units) and Type B (60-600 livestock units).

d. Others
   • Effluent Standards for Coastal Aquaculture
   • Effluent Standards for Brackish Aquaculture
   • Effluent Standards for Inland Aquaculture
   • Water Characteristics Discharged into Irrigation System
   • Water Characteristics Discharged into Deep Wells
Effluent monitoring

The EQA requires the owner or possessor of point sources of pollution designated under the act to monitor the quality of effluent and collect statistics and data, as well as submit notes and reports (Section 70 and 80). The types of effluent to be monitored are categorized into four types: sewage-swine farms; land development, industrial estates and industrial zones, and Class A buildings (hotels, hospitals, condominiums, department stores, markets and restaurants). The point sources of water pollution were also monitored in three river basins such as Chao Phraya, Tha Chin, and Bang Pakong.

If the capability to treat or dispose wastewater fails to meet applicable standards, the owner has a duty to modify or improve it in conformity with the pollution control official's directions. Fees, fines and civil liability and penal provisions are applied if violation are found or owners refuse to comply. It is a promising trend that all the sectors are willing to comply with the standards as it can be advantageous for business agreements as well as for better environmental quality which reflects the quality of life.

6. Existing and Future Challenges

Water environmental management in Thailand has been a priority for the country since 1992, in particular. Legislative frameworks have been developed and improved to promote implementation. The following aspects are pointed out as key issues for improvement and further promotion of water environmental conservation efforts (Yolthanatham 2011).

Strengthening wastewater treatment

Promotion of wastewater treatment remains a challenge in water environmental management in Thailand. In urbanized areas such as Bangkok, water pollution mainly caused by domestic wastewater remains a serious problem and therefore, sewage development has been promoted to mitigate water pollution. However, there have been a number of challenges in the operation and maintenance of wastewater treatment facilities, including lack of knowledgeable staff, enough funds for operation and maintenance, tariff setting and collection. To solve such problems and to ensure that the existing and future wastewater treatment systems can be operated and maintained effectively and sustainably, the Polluter Pays Principle (PPP) has been introduced and user charges imposed.

Promotion of public participation and voluntary approach

In the policy of the country, public participation and voluntary approaches by the private sector are encouraged to improve water quality in public waters. There are a lot of positive actions related to public participation. However, the communities and people still lack an understanding of waste water problems and awareness to protect the environment. Regarding the promotion of voluntary approaches by the private sector, a green procurement project for small and medium enterprises (SMEs) is now under development by the Thai government.

Promotion of basin management approach

Promotion of basin management approaches is an emerging challenge for water environmental management, and water quality and water quantity management should be integrated to improve water quality by promoting the basin approach. The integration of various activities and policy measures related to water environmental conservation should be also be built upon current efforts and addressed further. Actions at the basin level are encouraged in community projects to promote such positive actions through the coordination of local actions, as seen in the Tha Chin River basin (Box. 3.12.2).

Box 3.12.2. River Basin Management Approach

New directions for urban water quality management are being considered based upon the assimilative capacity of receiving waters, budget availability, and prioritized projects within the basin-wide approach. The most flexible means of water quality management are being practiced such as simulation models, geographic information systems, and database management systems. Waste load allocation is being considered based upon the assimilative capacity of water bodies and guidelines to attain receiving water quality standards.

For areas where water pollution is serious, the Ministry of Natural Resources and Environment (MoNRE) set basin-level policies, which include the “Master Plan of Songkhla Lake Basin Development (2002)” and “Preventive Measures and Solving Water Quality in Chao Phraya, Bang Pakong, and Tha Chin River Basins (2007).” As a project-based activity, MoNRE “Prevention and Reclamation of Wastewater Problems in Lamtakong River Basins” was started in collaboration with other related ministries and local and regional authorities. Thus, river basin management approaches are being practiced, such as in the Tha Chin River Basin. Details can be found at http://welcome.to/thachin.

(Source: Information from the WEPA focal person in 2012)
3. State of Water Resources

Viet Nam has 2,373 rivers with length longer than 10km. There are 17 major river basins, namely Red and Thai Binh, Bang Giang-Ky Cung, Ma-Chu, Thach Han, Huong, Tra Khuc, Kone, Ba, Cau, Nhue Day, Ca, Gianh, Thu Bon, Sesan, Srepok, Dong Nai-Saigon, and Cuu Long (Table 3.13.2). Viet Nam enjoys abundant water resources in general, but uneven rainfall distribution and the prolonged dry season cause serious water shortages in many areas of the country. Urban development also puts pressure on water resources. For example, water supply capacity is predicted to drop about 30% by 2025 in the Dong Nai River basins where about 40% of total GDP of the country is produced due to population growth (MoNRE 2006). Climate change is considered to have impacted the country’s water resources, and total surface water resources in the country is predicted to decrease up to 96% by 2025 and 91% by 2070 (MoNRE 2006).

Viet Nam also has copious groundwater resources with total potential exploitable reserves of nearly 60 billion m³/year. However, less than 5% of the total reserves are used.
On the other hand, groundwater is intensively exploited in some areas of the country such as in the Mekong Delta, and overexploitation of groundwater has resulted in falling water tables, associated further land subsidence, and salinity intrusion.

The use of water for agriculture is higher than other sectors. In urban areas, the need for water for domestic, service, and production purposes is increasing and has caused a depletion in water resources. Other environment degradations such as deforestation, inadequate solid waste management and impacts from development activities also affect the state of water resources in both quantity and quality.

4. State of Water Quality

Water quality in public water bodies is generally good in the upstream of rivers (MoNRE 2005). On the other hand, the downstream areas of major rivers, especially in cities, face serious water pollution which has accelerated due to increasing populations and growing economic activities. Wastewater from both industrial and domestic sources is not well treated and has become the source of organic pollution. Ninety percent of wastewater discharged from domestic sources and 70% from industrial zones and parks is not served by a centralized wastewater treatment system (Nguyen 2010). Poor sanitation elicits high E-coli values, seasonal changes in water quantity also affect the state of water quality—water quality in dry seasons is more deteriorated than that in rainy seasons.

The water quality of coastal waters has also deteriorated as a result of polluted river water flowing into the sea, and human activities such as aquaculture, waste dumping and oil spills increase pressure. Details on groundwater quality are not well defined due to a lack of information, but some parameters such as ammonia and coliform exceed standard values.

Rivers and lakes

River water quality has declined in the downstream, especially in growing urban areas. Figure 3.13.2 shows the value of BOD$_5$ at some monitoring points in the major rivers in urban areas. The trend shows the gradual improvement of water quality over a period of five years, but the value still exceeds 4mg/L, the currently permitted national standard for Category A1 (water for domestic water supply with appropriate treatment) at most points. Pollution in some canals is also serious in cities. For example, the BOD$_5$ level of the Tham Luong-Vam Thuat canal in Ho Chi Minh City in 2009 greatly exceeded standards; it was eight times higher than the ambient water quality standard for Category B2 (water for water transportation and other purposes with demand for low-quality water). Untreated or insufficiently treated wastewater from industries and households is a major source of pollution.

![Figure 3.13.2. Changes in annual average BOD$_5$ content in major rivers (2005-2009)](source: MoNRE 2010)

Figure 3.13.3 also shows water quality in surface water bodies in the country’s urban inner precincts and districts. Most lakes, ponds, canals and rivers have exceeded the BOD standard set by the National Technical Regulation on Surface Water Quality 08:2008/MoNRE, Type B2. Many rivers and canals have become receptacles for wastewater and ambient water quality standards and many lakes in inner cities are affected by eutrophication. The surface water in these lakes becomes muddy and emits a strong odour which spoils the environment and appearance of Viet Nam’s cities.
Figure 3.13.4 shows pollution by coliform. The coliform value tends to have improved but it is still higher than the standards value of the National Technical Regulation on Surface Water Quality 08:2008/MoNRE, Type A1.

Coastal water
Pollution is observed in coastal waters as well (MoNRE 2005). Aquaculture such as uncontrolled shrimp ponds and untreated industrial and agricultural wastewater discharged into coastal waters are the major sources of water quality deterioration (Nhuan et al. 2010). In addition to organic matter, higher concentrations of Zinc (Zn) and Copper (Cu) have been observed in the southern coastal areas, as well as sediment. Oil spills are also the issues that Viet Nam faces in marine water quality (MoNRE 2005).

Groundwater
Salinization is a common groundwater problem in coastal zones due to sea water intrusion accelerated by the uncontrolled and indiscriminate exploitation of groundwater by industries and households. In a text message to the author on August 12, 2011, Do Nam Thang states that according to groundwater monitoring, Iron (Fe), Manganese (Mn, ranging from 0.18-71mg/L), P-PO₄, Ammonium (NH₄, ranging from 0.05-8.7ml/L), E.coli and coliform exceed groundwater quality standards in some areas (Do Nam Thang, pers.comm.).

5. Frameworks for Water Environment Management

Legislation
Article 29 of the constitution states that “all State offices, armed forces units, economic establishments, social organizations and every citizen have to observe state regulations on the appropriate utilization of natural resources and on environmental protection” and that “all acts resulting in depletion and destruction of the environment are strictly prohibited.” The constitution is the basis of environmental protection in the country.

The Law on Environmental Protection (1993, revised 2005) is the principle law on environmental protection including water, and stipulates that the objective of environmental protection is to ensure social progress in order to achieve national sustainable development. Environmental standards are also stipulated under the law. In addition to the environmental law, the Law on Water Resources (1998), the Land Law (2003) and the Biodiversity Law (2008) complete the national legislation related to water environmental management.

In addition to national laws, decrees, decisions and circulars, and strategies are established for different purposes. Some set policy targets with timelines (Box.3.13.1). Other administrative orders establish rules and systems to regulate pollution sources which includes environmental protection charges for wastewater (Decision No.67/2003/ND-CP) and permits for wastewater discharge to water sources (Decree No.149/2004/ND-CP) (Box. 3.13.2).

Based on the revision to the Viet Nam Criminal Code 2009 (Chapter XVII for environmental crime) and Decree No. 117/2009/ND-CP on guidance to businesses in
violation of standards set forth by laws and regulations, the sanctions and punishments for such violations have been strengthened.

In the context of promoting river basin management, an integrated water environmental protection approach has been incorporated in major river basins.

**Box. 3.13.1. Water environmental management related targets in Viet Nam**

   
   These strategies set water pollution related targets until 2010 and toward 2020. The targets toward 2020 include two water related goals: access by 100% of the urban population and 95% of the rural population to clean drinking water supply, 100% provision of centralized waste treatment systems for urban centers, industrial parks and export-processing zones.

   2. **Decision No. 64/2003 which approved the plan for establishments causing serious pollution (2003)**
   
   This decision set short-term objectives to 2007 and long-term objectives to 2012. Out of 4,295 establishments that cause serious environmental pollution, 439 establishments were scheduled for review by 2007 and the remaining establishments by 2012. Based on the outcomes of the review, identified pollution sources have been transferred, shut-down or suspended.

**Box. 3.13.2. Environmental protection charges for wastewater**

Environmental protection charges for wastewater were introduced in Viet Nam in 2003 by the Decree No. 67/2003/ND-CP and the Circular No.125/2003/TTLT-BTC-BTNMT. Industries, as well as households, that discharge effluent into public water are required to comply with the decision, with a few exceptions, such as water run-off from hydroelectric power plants, water circulated in power plants, sea water discharged from salt production, households in the region classified under national subsidies for water supply, households in communities in rural areas and other areas without clean water supply schemes.

The protection charge is determined based on the “percentage of the selling price of 1m³ of clean water” which does not exceed 10% of VAT clean water selling prices. The rate of the charge is differentiated based on the pollution load for six parameters (COD, TSS, HG, PB, AS, Cd). Although national charging rates are decided by the central government, local governments can decide their own charging rates in line with their local situations.

After a part of collected charges are allocated to the administrative costs of implementing agencies, the remainder is allocated for operational capital of national environmental protection funds and investment in environmental protection facilities/projects.
Institutional arrangement
The Ministry of Natural Resource and Environment (MoNRE) is responsible for the management of the quality and quantity of water resources. According to the Law on Environmental Protection, MoNRE is responsible for establishing environmental standards including water quality and conducting public water quality monitoring, providing guidance to non-compliant industries, and other important aspects of environmental management. Other ministries also are involved in water related activities (Table 3.13.3). Under MoNRE, the Vietnam Environment Administration (VEA), which was established in 2008 to strengthen institutional capacity to manage environmental issues, is responsible for policy planning, monitoring of compliance and provision of guidance to local governments.

<table>
<thead>
<tr>
<th>Name of Ministry</th>
<th>Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ministry of Natural Resources and Environment</td>
<td>-Manage water resources and water quality. -Make plans on the use, overall management and protection for water resources in large river basins.</td>
</tr>
<tr>
<td>Ministry of Agriculture and Rural Development</td>
<td>-Irrigation, flood and storm prevention, rural water supply, management of hydraulic engineering and dykes. -Manage water for aquaculture and aquatic product processing.</td>
</tr>
<tr>
<td>Ministry of Planning and Investment</td>
<td>-Set guidelines for and check ministries and sectors for the preparation and implementation of strategies on socio-economic development.</td>
</tr>
<tr>
<td>Ministry of Industry and Trade</td>
<td>-Develop hydropower via Viet Nam Electricity Corporation.</td>
</tr>
<tr>
<td>Ministry of Science and Technology</td>
<td>-Appraise drafts and publicize water quality standards prepared by the Ministry of Natural Resources and Environment.</td>
</tr>
<tr>
<td>Ministry of Construction</td>
<td>-Manage urban public works, design and build urban water supply and sewage works.</td>
</tr>
<tr>
<td>Ministry of Transportation</td>
<td>-Manage and develop transportation on water, manage aquatic engineering and port systems.</td>
</tr>
<tr>
<td>Ministry of Health</td>
<td>-Manage drinking water quality. -Prepare and supervise water quality standards.</td>
</tr>
<tr>
<td>Ministry of Finance</td>
<td>-Prepare policy on taxes and fees for water resources.</td>
</tr>
</tbody>
</table>

(Source: Modified based on Hanh and Dong 2011)

In implementation, local governments play an important role in environmental management. The Department of Natural Resources and Environment (DoNRE) under the People’s Committee takes a leading role in the promotion of environmental conservation activities through the implementation of environmental regulations and provision of guidance.

Ambient water quality standards
Ambient water quality standards are established for surface water, coastal water, and groundwater, referring to both international standards and standards in developed countries. The surface water quality standard (TCVN 5942:1995) was enacted in 1995 and revised in 2001 and 2008. Currently QCVN 08:2008 is applied. The current standard (QCVN 08:2008) sets four classes as shown in Table 3.13.4 and standard values for 32 parameters in each class.

<table>
<thead>
<tr>
<th>Class</th>
<th>Objective of Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>Good for domestic water supply and other purposes in A2, B1 and B2.</td>
</tr>
<tr>
<td>A2</td>
<td>Good for domestic water supply, but suitable treatment technology must be applied; conservation of aquatic life or other purposes in B1 and B2.</td>
</tr>
<tr>
<td>B1</td>
<td>Good for irrigation or other purposes with demand for similar quality water or other purposes in B2.</td>
</tr>
<tr>
<td>B2</td>
<td>Good for water transportation and other purposes with demand for low-quality water.</td>
</tr>
</tbody>
</table>


Monitoring of water quality in public water bodies
The Law on Environmental Protection stipulates monitoring and treatment of water pollution and degradation in river basins by public sector (governments). The monitoring system of the country has gradually developed since the latter half of 1990s.

The Center for Environmental Monitoring under the Vietnam Environmental Administration, MoNRE conducts water quality monitoring. Considering the necessity and resource constraints, not all parameters for water quality standards are monitored, but basic parameters such as BOD, COD, DO, TSS, N, P and metals are monitored four times a year, in principle.

The locations for monitoring are rather concentrated in areas where water quality is deteriorated. In 2007, the National Master Program for natural resource and environment monitoring until 2020 was approved by the Decision No.16/2007/QD-TTg, which includes numerical targets for water resource monitoring. The national programme targeted an increase in the number of surface resource monitoring stations to 348 (existing 248; upgraded: 123, and new: 99) step-by-step by 2020. Out of the existing 248 stations, 116 stations are water quality monitoring stations for surface (river and lake) water (Nguyen 2007).

The monitored data is stored at the Center for Environmental Monitoring under the Vietnam Environment Administration, MoNRE and the Center for Environmental Monitoring under DoNREs (Departments of Natural Resources and Environment in the country’s
provinces). Monitoring data is used to review and revise policies and measures for water quality conservation. MoNRE issues the State of the Environment Report annually in which major data is made public.

**Effluent standards**

There are various effluent standards in Viet Nam as shown in Figure 3.13.5. Industrial wastewater discharge standards were established in 1995 (TCVN 5945:1995), and revised in 2005. The revised standards (TCVN 5945:2005) set less strict effluent quality targets than previous targets in consideration of the best technology available in the country. In 2009, the standard of 2005 was replaced by the National Technical Regulation on Industrial Wastewater (QCVN 24:2009/BTNMT). The new technical regulation set the formula and necessary concentration value and coefficients to calculate the maximum values of pollutants (32 parameters) to be discharged into public water bodies. Different concentration values were set for the water bodies that are the source of domestic water use and other water bodies, respectively.

All industries and industrial activities, business entities, and service providers should conform to the new technical standard except industrial sectors which have different effluent standards. The specific industries/activities which have different standards include the natural rubber processing industry (QCVN 01:2008/BTNMT), pulp and paper mills (QCVN 12:2008/BTNMT), domestic wastewater sector (QCVN 14:2008/BTNMT), and healthcare sector (QCVN 29:2010).

Industries that are required to carry out environmental impact assessments (EIA) will have to commit to self-monitoring four times/year, in accordance with a circular issued by the national government. Inspection of compliance with industrial effluent standards is conducted by MoNRE, VEA or/and DoNRE two times/year. The inspection is carried out with prior announcement and not more than twice a year. In cases where a violation is suspected, “environmental police” from the Ministry of Public Security have authority to conduct compulsory investigations without prior notice, and therefore have more opportunities to identify possible non-compliance.

**6. Existing and Future Challenges**

Viet Nam has developed its water quality management system since 1990s. In 2000 in particular, the environmental legislation of the country was amplified—refining environmental and effluent standards, strengthening non-compliance responses and applying environmental protection charges. Now, Viet Nam must work on ensuring and enforcing implementation by strengthening systems and capacity of water environment management by addressing the following challenges (Nguen 2010; Nga 2011).

- To further improve legislative systems (such as elimination of overlapping or uncoordinated provisions): Strengthen economic incentives.
- To strengthen compliance: Redouble inspection, improvement and strengthening of technical/administrate guidelines, socialization of environmental protection and sustainable development, further strengthening of administrative sanctions against non-compliance
- To enhance organizational arrangements: Facilitate coordination and minimize overlapping of functions and duties of different ministries, sectors and local authorities on water quality management
- To improve institutional capacity at national and local level to implement water quality management, especially in the field of water quality monitoring, control and investigation of pollution sources, how to impose sanction at ground level, etc.);
- To promote basin-management approach: Improve and strengthen water environment management at the basin level, especially in the three main river basins (Cau, Nhue-Day, and Don Nai)
- To develop a sound information base: Develop reliable information systems of the state of water quality and management
- To choose and introduce appropriate technology to improve water quality, especially introduction of wastewater treatment technology which is appropriate for different local settings:
- To increase of budget for environmental protection: Target is 2% of total state budget allocated for environmental activities
- To strengthen capacity of human resources both in number and capacity and financial status.
## Selected social, economic and water related indicators in WEPA partner countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Geography 1</th>
<th>Population 2</th>
<th>Economy 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Land Area (km²)</td>
<td>Year</td>
<td>Total Population (person)</td>
</tr>
<tr>
<td>Cambodia</td>
<td>181,035 a</td>
<td>1990</td>
<td>9,531,928</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2010</td>
<td>14,138,255</td>
</tr>
<tr>
<td>China</td>
<td>9,600,00 b</td>
<td>1990</td>
<td>1,335,185,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2010</td>
<td>184,345,939</td>
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<tr>
<td>Indonesia</td>
<td>1,910,931 c</td>
<td>1990</td>
<td>123,537,000</td>
</tr>
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<td></td>
<td></td>
<td>2010</td>
<td>183,455,937</td>
</tr>
<tr>
<td>Japan</td>
<td>377,950 d</td>
<td>1990</td>
<td>123,537,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2010</td>
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<td>99,700 e</td>
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<td></td>
<td></td>
<td>2010</td>
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</tr>
<tr>
<td>Lao PDR</td>
<td>236,803 f</td>
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<td></td>
<td></td>
<td>2010</td>
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</tr>
<tr>
<td>Malaysia</td>
<td>330,803 g</td>
<td>1990</td>
<td>123,537,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2010</td>
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</tr>
<tr>
<td>Myanmar</td>
<td>676,578 h</td>
<td>1990</td>
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<td></td>
<td></td>
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<td>Nepal</td>
<td>147,181 i</td>
<td>1990</td>
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<td></td>
<td>2010</td>
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<tr>
<td>Philippines</td>
<td>300,000 j</td>
<td>1990</td>
<td>123,537,000</td>
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<td></td>
<td></td>
<td>2010</td>
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</tr>
<tr>
<td>Sri Lanka</td>
<td>65,610 k</td>
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<td>123,537,000</td>
</tr>
<tr>
<td>Thailand</td>
<td>513,116 l</td>
<td>1990</td>
<td>123,537,000</td>
</tr>
<tr>
<td>Vietnam</td>
<td>331,051 m</td>
<td>1990</td>
<td>123,537,000</td>
</tr>
</tbody>
</table>

### Appendix

#### WEPA Outlook on Water Environmental Management in Asia 2012

#### Water Resources

| Long-Average Precipitation (mm/year) | Total Renewable Water Resources (km³) | Year | Total Annual Freshwater Withdrawals (billion m³) | Annual Freshwater Withdrawal by sectors (%) | Water Use
|-------------------------------|------------------------------------|-------|-----------------------------------------------|---------------------------------------------|----------------|
| 1,904                         | 476.1*                             | 2006  | 2.2                                           | 94.0                                        | Agriculture
|                               |                                    |       |                                               | 1.5                                         | Industry
|                               |                                    |       |                                               | 4.5                                         | Municipal including Domestic

#### Achievements of Water and Sanitation Goals of MDGs

<table>
<thead>
<tr>
<th>Year</th>
<th>Population with access to safe water sources (% of population)</th>
<th>Population with access to adequate sanitation (% of population)</th>
<th>Sewerage Treatment Coverage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>69.7*</td>
<td>12.0*</td>
<td>6.5*</td>
</tr>
</tbody>
</table>

#### Domestic Wastewater Treatment

| Remarks
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<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>1992</td>
</tr>
</tbody>
</table>

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2. From the World Bank’s World Development Indicator Database.
3. From the World Bank’s World Development Indicator Database except for the figures for Myanmar.
5. From FAO Main AQUASTAT Country Database except for the figures for the Philippines.
6. For the Philippines, from World Resources 1996-97 of World Resources Institute.
7. From Global Health Observatory Data Repository of World Health Organization.

* Estimated.
Chapter 2.1
Domestic Wastewater Treatment in Asia


Indonesia


Japan


Republic of Korea


Philippines


Viet Nam


China


Japan


2002. Heisei 13 Nendo no Shori Shisetsu betsu Osui Shori Jinko Fukuyuu Jyokyo (Population Coverage with Access to Domestic Wastewater Treatment Facility at the end of FY 2001 by Type of Treatment Facility), Tokyo.

2003. Heisei 14 Nendo no Shori Shisetsu betsu Osui Shori Jinko Fukuyuu Jyokyo (Population Coverage with Access to Domestic Wastewater Treatment Facility at the end of FY 2002 by Type of Treatment Facility), Tokyo.

References

India


Other Countries

Estimated by the WEPA Secretariat based on the information provided by each WEPA country.
Table 2.1.4: BOD reduction rates of different treatment measures for domestic wastewater

<table>
<thead>
<tr>
<th>Country</th>
<th>Treatment Measure</th>
<th>Reduction Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Korea</td>
<td>Primary Treatment</td>
<td>80%</td>
</tr>
<tr>
<td>Australia</td>
<td>Secondary Treatment</td>
<td>60%</td>
</tr>
<tr>
<td>New Zealand</td>
<td>Tertiary Treatment</td>
<td>40%</td>
</tr>
</tbody>
</table>

Chapter 2.2 Climate Change and the Water Environment

Agustiyan, Dwi. 2007. Climate change impact on water water quality in Citarum River, West Java, Indonesia. The 1st International Workshop on Climate Change Impact on Surface Water Quality in East Asian Watersheds, Chunchon, Korea, 7-9 October.


Chapter 3
Country Profiles of Water Environmental Management in WEPA Countries

● Land Area

Cambodia

China

Indonesia

Japan

Republic of Korea

Lao PDR

Malaysia

Malaysia

Myanmar

Nepal

Philippines

Sri Lanka

Thailand

Viet Nam
Total Population
[Data for Philippines]

GDP and Per Capita GDP
[Data for Myanmar]

Long-Average Precipitation, Total Renewable Water Resources, Total Annual Freshwater Withdrawals, Annual Freshwater Withdrawal by sectors
[Data for Japan]

Chapter 3.1 Cambodia


Chapter 3.2 China


Chapter 3.4 Japan


Chapter 3.5 Republic of Korea


Chapter 3.6 Lao PDR


Chapter 3.8 Myanmar

Chapter 3.9 Nepal

Chapter 3.10 Philippines

Chapter 3.11 Sri Lanka
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E-mail: contact@wepa-db.net, URL: http://www.iges.or.jp/