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WEPA

Outlook on Water Environmental Management in Asia

2024

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2024

Water Environment Partnership in Asia

WEPA

Cambodia • China • Indonesia
Japan • Lao PDR • Malaysia
Myanmar • Nepal • Philippines
Republic of Korea • Sri Lanka
Thailand • Viet Nam

Outlook on Water Environmental Management in Asia 2024

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Table of Contents

Background to the Publication

In recognition of the need for a higher level of water environment management to address water degradation issues in the Asian region, at the Third World Water Forum in 2003 the Ministry of the Environment of Japan proposed the establishment of an initiative called the Water Environment Partnership in Asia (WEPA). WEPA was subsequently launched in 2004 and, over two decades later, entered its fifth phase in April 2024, its 21st year, having completed 20 years of activities in four phases. Each phase set goals to strengthen the water environment governance of the partner countries. The first phase (FY2004–2008) prioritized the establishment of a network of government officials involved in water environment management in the Asian region. In the second phase (FY2009–2013), WEPA strengthened the information and knowledge sharing platform to elicit solutions from the experiences of partner countries. More specifically, progress in water environmental management in the partner countries was reviewed through regular meetings such as the annual meeting, questionnaire surveys and expert interviews, and the results were published in the WEPA Outlook on Water Environmental Management, launched at the 5th World Water Forum in 2009. Through communication between the partner countries, industrial wastewater management, in particular the enforcement and implementation of pollution control measures, was identified as a common management issue. WEPA has responded by focusing on this issue in its ongoing discussions since 2012. In the third phase (FY2014–2018), the WEPA Action Programme (AP) was introduced as a mechanism to support partner countries in solving their water environment problems based on the combined knowledge and resources of the partner countries. In the fourth phase (FY2019–2023), WEPA emphasized the need to establish a stable public policy cycle and to ensure enforcement of regulations stated in policy in the respective partner countries.

Currently, the partnership is comprised of 13 Asian countries, namely Cambodia, China, Indonesia, Japan, Republic of Korea, Laos, Malaysia, Myanmar, Nepal, Philippines, Sri Lanka, Thailand, and Viet Nam. In addition to annual meetings and workshops, another key component of the platform is the WEPA database for knowledge sharing. WEPA also periodically publishes the WEPA Outlook on Water Environmental Management, which provides useful information on aspects such as the state of the water environment and policies in WEPA countries. The first edition was published in 2009 with an intended readership of government officials, experts, and others in the water sector of the region. The Outlooks of 2009, 2012, 2015, 2018, and 2021 were each published in the same year as the respective World Water Forum (WWF) was held, starting in Istanbul, then Marseille, Daegu-Gyeongbuk, Brasilia, and Dakar, with this sixth edition coinciding with the WWF organized in Denpasar.

Over the 20 years since WEPA's launch, while water resources management in the partner countries has undergone change, recognition by the international community of the importance of water for all forms of life, for ecosystems and for exercising the most diverse human activities has remained. The COVID-19 pandemic from 2020 to 2023 revealed just how stressed water bodies have become due to human activities, as water quality improved in many countries as a result of restrained economic activities. On the other hand, WEPA countries have made efforts in the management of wastewater generated by human activities through policy development and implementation, and improvements in water quality in many countries have been made. However, at the same time, as homes to billions of people and hubs of industry and agricultural production, the partner countries each face challenging issues that cannot be solved by existing policies alone, such as strengthening and enforcing water quality and effluent standards, and thus face the need for alternative solutions. As such, WEPA acts a problem-solving platform through its accumulated pool of knowledge and experience, with the Outlook informing of efforts to address water degradation problems in the partner countries as well as the outcomes achieved.

This Outlook for the year 2024 consists of two main chapters: Chapter 1—Outlook on Water Environmental Management in WEPA Countries, and Chapter 2—Country Profiles of Water Environmental Management in WEPA Countries. The first chapter summarizes the current governance framework in each country, describes the key legislation related to water quality management, and gives information on wastewater treatment systems as well as the current status of pollution control based on water loads, with the aim of providing practical information to relevant stakeholders in water resource management. The details of the policies, the governance framework and the state of the water environment in the partner countries are presented in Chapter 2.

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Ministry of the Environment, Japan
Institute for Global Environmental Strategies (WEPA Secretariat)

Key Messages from the Water Environment Partnership in Asia (WEPA)

1

Over the past 20 years since its launch, WEPA's 13 partner countries have undergone significant socio-economic and environmental transformations. While notable progress has been made in establishing legal frameworks, enforcing effluent standards, and enhancing the ambient water quality in public water bodies, water pollution persists as a critical challenge awaiting solutions. Moreover, emerging complexities such as the intensifying impacts of climate change and the degradation of vital ecosystem services call for more comprehensive and integrated approaches to water environmental management. The COVID-19 pandemic also underscored the fundamental importance of water for public health, while simultaneously highlighting the negative environmental externalities of human economic activity on water resources, thereby reinforcing the crucial role of robust water environmental management.

2

Across the region, partner countries are strengthening their freshwater environmental management frameworks. This includes a greater emphasis on the interconnectedness of riverine and marine environments, the implementation of comprehensive monitoring systems, the adoption of integrated water resource management principles, and the expansion of water quality monitoring parameters. These advancements are crucial for aligning national efforts with the United Nations Sustainable Development Goals (SDGs), particularly SDG target 6.3 focused on improving water quality.

3

The WEPA partner countries are still faced with a number of key water environment concerns and management challenges that necessitate continuous attention, as evidenced by earlier WEPA reports and surveys and this report. These challenges include:

a. The broad-based and ongoing challenge of ensuring consistent and effective enforcement of regulations. The WEPA partner countries are employing diverse approaches, ranging from punitive measures such as warnings, fines, and license suspensions, to incentivizing compliance through rewards, tax benefits, and performance ratings. Tailoring enforcement strategies to local contexts is crucial for effectively tackling water degradation.

b. Robust monitoring of the water environment, which is essential for informed decision-making and timely intervention. While most partner countries have established monitoring frameworks, the availability of adequate and accessible databases remains a limitation in some. Investing in human capacity, advanced equipment, and streamlined reporting mechanisms—both 'hard' and 'soft'—is vital for strengthening these systems.

c. The limitations of concentration-based effluent standards, which is becoming increasingly apparent in areas with high discharge volumes. Several partner countries are exploring or implementing load-based effluent control systems, such as Total Maximum Daily Loads (TMDLs), to address this issue. While implementation presents complexities requiring thorough research and multi-stakeholder consensus, the experiences of early adopters of these systems within the WEPA partner countries suggest this approach holds promise for improving the water quality in heavily impacted areas such as industrial districts.

d. Expanding sewerage coverage and treatment capacity. While progress has been made, significant variations persist across the WEPA countries. Decentralised sanitation systems and on-site (e.g., septic tank) sanitation systems continue to prevail in numerous countries. Developing clear operational guidelines and promoting awareness regarding the importance of proper operation and maintenance (O&M) are critical for the sustainability of both centralized and decentralized sanitation systems.

e. Tackling non-point source pollution from both urban and rural runoff remains a common and complex challenge. Alongside proper maintenance of septic tanks, comprehensive strategies encompassing responsible fertilizer use, livestock effluent management, safe pollutant disposal, and soil erosion prevention are necessary. Furthermore, integrated approaches are crucial for mitigating water degradation in enclosed water bodies, requiring concerted efforts to control both point and non-point sources.

4 Considering the triple planetary crisis—climate change, pollution, and biodiversity loss—and its nexus of linkages, humanity faces an unprecedented challenge in addressing these issues in a holistic manner. To effectively address these challenges, it is essential to have a clear vision and mission that fosters collaborative actions or efforts, dialogue, and knowledge sharing. Through these collaborative efforts, we can seek robust management solutions to sustain water resources and socio-economic vitality.

5 As highlighted in point 2, the WEPA partner countries should actively pursue achieving the 2030 Agenda for Sustainable Development by prioritizing improved water environment management. Furthermore, the regular evaluation of local indicators for SDG 6, particularly 6.3.1 (proportion of wastewater safely treated) and 6.3.2 (good ambient water quality), is crucial for monitoring progress and informing adaptive management strategies.

6 To effectively address the evolving challenges in water environmental management, there is a need to broaden the scope of knowledge exchange beyond wastewater management to encompass issues related to specific water bodies, specific pollutants, non-point sources, and urban wastewater. These areas have been consistently identified as critical challenges in the partner countries. Furthermore, the increasing volatility of climate patterns underscores the urgent need for climate-resilient water environmental management strategies and the sharing of best practices in this area.

Through collaborative efforts, knowledge sharing, capacity building, and open policy dialogue facilitated by WEPA, partner countries will be better equipped to address water environment challenges and achieve sustainable water management. It is believed that support through the WEPA platform will contribute to sustainable water environment management at the national level, as well as to the achievement of global agendas such as the SDGs.

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Abbreviations

ADB	Asian Development Bank
AI	Artificial Intelligence (Malaysia)
As	Arsenic
ASEAN	Association of South-East Asian Nations
ASM	Academy of Sciences Malaysia (Malaysia)
AWQS	Ambient Water Quality Standards (Sri Lanka)
B.E.	Buddhist Era (Thailand)
BAPPENAS	*Badan Perencanaan Pembangunan Nasional* (Ministry of National Development Planning) (Indonesia)
BFAR	Bureau of Fisheries and Aquatic Resources (Philippines)
BOD	Biochemical Oxygen Demand
BOI	Board of Investment (Sri Lanka)
Cd	Cadmium
CDOs	Cease and Desist Orders (Philippines)
CEA	Central Environmentl Authority (Sri Lanka)
CEPA	Communication, Education and Public Awareness (Malaysia)
Chi.a	*Chiorophyll a*
CMR	Compliance monitoring report (Philippines)
COD	Chemical Oxygen Demand
COD$_{MN}$	Chemical Oxygen Demand (potassium permanganate method)
Cr	Chromium
CSDGs	Cambodia's Sustainable Development Goals frameworks (Cambodia)
CSO	Civil Society Organization
CW	Constructed Wetland (Malaysia)
CWTP/CWTF	Centralized Wastewater Treatment Plants/ Facilities
DA	Department of Agriculture (Philippines)
DAO	DENR Administrative Order (Philippines)
DENR	Department of Environment and Natural Resources (Philippines)
DENR-NCR MBSCMO	Department of Environment and Natural Resources-National Capital Region Manila Bay Site Coordinating and Management Office (Philippines)
DEWATS	Decentralized Wastewater Treatment System
DGR	Department of Groundwater Resources (Thailand)
DHM	Department of Hydrology and Meteorology (Nepal)
DILG	Department of Inferior and Local Government (Philippines)
DIN	Dissolved Inorganic Nitrogen
DIP	Dissolved Inorganic Phosphorus
DISI	Directorate of Industrial Supervision Inspection (Myanmar)
DMH	Department of Meteorology and Hydrology (Myanmar)
DNREI	Department of Natural Resources and Environment (Laos)
DO	Dissolved Oxygen
DOE	Department of Environment (Malaysia)
DOH	Department of Health (Philippines)
DoNRE	Department of Natural Resources and Environment (Viet Nam)
DPCM	Department of Pollution Control and Monitoring (Laos)
DPWH	Department of Public Works and Highways (Philippines)
DWSSM	Department of Water Supply and Sewerage Management (Nepal)
EC	Electric Conductivity
ECC	Environmental Compliance Certificate (Laos)
ECD	Environmental Conservation Department (Myanmar)
EGAT	Electricity Generating Authority of Thailand (Thailand)
EIA	Environmental Impact Assessment (Myanmar)
EIA	Environmental Impact Assessments
EMB	Environmental Management Bureau (Philippines)
EMMP	Environmental Management and Monitoring Plan (Laos)
ENRC	Environment and Natural Resources Code of Cambodia (Cambodia)
EPL	Environmental Protection Law (Laos)
EPL	Environmental Protection license (Sri Lanka)
EQA	Environmental Quality Act (Malaysia)
EQS	Environmental Quality Standards (Japan)
ER	Environmental Recommendation (Sri Lanka)
ESG	Environmental, Social, and Governance (Malaysia)
ESIA	Environmental and Social Impact Assessment (Laos)
FAO	Food and Agriculture Organization
FCB	Faecal Coliform Bacteria
FMB	Forest Management Bureau (Philippines)
FY	Fiscal year (Japan)
GAP	Good Aquaculture Practice
GB	Mandatory Standards of Chinese National Standards (GuoBiao Standards) (China)
GB/T	Recommended Standards of Chinese National Standards (China)
GDP	Gross Domestic Product
GES	General Effluent Standards (Philippines)
GIS	Geografic Information System
GWQI	Groundwater quality index (Malaysia)
Hg	Mercury
HMs	Heavy Metal(s)
IEF	Initial Environmental Examination (Laos)
IETS	Industrial Effluent Treatment Systems (Malaysia)
IGES	Institute for Global Environmental Strategies
IMF	International Monetary Fund
IoT	Internet of Things (Malaysia)

IPL	Industrial Processing Law (Laos)
IR4.0	4th Industrial Revolution (Malaysia)
IRR	Implementing Rules and Regulations (Philippines)
IWK	*Indah Water Konsortium* (Malaysia)
IWMI	International Water Management Institute
IWRM	Integrated Water Resources Management
JICA	Japan International Cooperation Agency
KRA	Key Result Area (Philippines)
LFPS	Four leachate Final Processing (Indonesia)
LGUs	Local Government Units (Philippines)
LKR	Sri Lankan Rupee(s) (Sri Lanka)
LLDA	Laguna Lake Development Authority (Philippines)
LWUA	Local Water Utilities Administration (Philippines)
MAFF	Ministry of Agriculture, Forestry and Fisheries (Japan)
MAFRA	Ministry of Agriculture, Food and Rural Affairs (Korea)
MARD	Ministry of Agriculture and Rural Development (Viet Nam)
MEE	Ministry of Ecology and Environment (China)
MEPA	Marine Environment Protection Authority (Sri Lanka)
MHLW	Ministry of Health, Labour and Welfare (Japan)
MHLW	Ministry of Economy, Trade and Industry (Japan)
MIME	Ministry of Industry, Mine and Energy (Cambodia)
MLD	Million Liters Per Day
MLIT	Ministry of Land, Infrastructure, Transport and Tourism (Japan)
MLIT	Ministry of Land, Infrastructure, Transport (Korea)
MMDA	Metro Manila Development Autority (Philippines)
MMT	Multi-partite Monitoring (Philippines)
MMWQI	Malaysian Marine Water Quality Index (Malaysia)
MMWQS	Malaysian Marine Water Quality Standards (Malaysia)
MND	Ministry of National Defence (Korea)
MOAC	Ministry of Agriculture and Cooperatives (Thailand)
MOC	Ministry of Construction (Viet Nam)
MOE	Ministry of Environment (Korea)
MOE	Ministry of Environment (Sri Lanka)
MOEC	Ministry of Environment (Cambodia)
MOEF	Ministy of Environment and Forestry (Indonesia)
MOEF	Ministry of Forests and Environment (Nepal)
MoEJ	Ministry of the Environment, Japan (Japan)
MOEWRI	Ministry of Energy, Water Resources and Irrigation (Nepal)
MOF	Ministry of Finance (Viet Nam)
MOH	Ministry of Health (Viet Nam)
MOHA	Ministry of Home Affairs (Viet Nam)
MOIC	Ministry of Industrial and Commerce (Laos)
MOIS	Minsitry of the Interior and Safety (Korea)
MOIT	Ministry of Industry and Trade (Viet Nam)
MoNRE	Ministry of Natural Resources and Environment (Thailand)
MONRE	Ministry of Natural Resources and Environment (Laos)
MONRE	Ministry of Natural Resources and Environment (Viet Nam)
MONREC	Minisry of Natural Resourecs and Environmental Concervation (Myanmar)
MOPWH	Ministry of Public Works and Housing (Indonesia)
MOST	Ministry of Science and Technology (Viet Nam)
MOT	Ministry of Transport (Viet Nam)
MOTC	Ministry of Transport and Communications (Myanmar)
MoWRAM	Ministry of Water Resources and Meteorology (Cambodia)
MP	Malaysia Plans (Malaysia)
MPI	Ministry of Planning and Investment (Viet Nam)
MPWT	Ministry of Public Works and Transportation (Laos)
MRC	Mekong River Commission
MRD	Ministry of Rural Development (Cambodia)
MSDP	Myanmar Sustainable Development Plan (Myanmar)
MWS	Ministry of Water Supply (Nepal)
MWSS	Metropolitan Water Works and Sewerage System (Philippines)
NDC	Nationally Determined Contribution (Sri Lanka)
NDWQS	National Drinking Water Quality Standards (Nepal)
NEA	National Environmental Act (Sri Lanka)
NEAP	National Environment Action Plan (Sri Lanka)
NEB	National Environmental Board (Thailand)
NEDA	National Economic and Development Authority (Philippines)
NEP	New Emerging Pollutant (Malaysia)
NEQA	National Environmental Quality Act (Thailand)
NEQEG	National Environmental Quality (Emission) Guidelines (Myanmar)
NESAP	National Environment Strategy and Action Plan (Cambodia)
NGO	Non Governmental Organization
NH_3	Ammonia
NH_4^+	Ammonium
NIA	National Irrigation Administration (Philippines)
NIER	The National Institute for Rnvironmental Research (Korea)
NIWR	Norwegian Institute for Water Research
NLCDC	National Lake Conservation Development Committee (Nepal)
NO_3	Nitrate
NO_3-N	Nitrate Nitrogen
NOV	Notice of Violation (Philippines)
NPC	National Power Corporation (Philippines)
NRW	Non-revenue water (Malaysia)

NSWQS	National Surface Water Quality Standards (Myanmar)
NWP	Myanmar National Water Policy (Myanmar)
NWQS	National Water Quality Standards (Malaysia)
NWRB	National Water Resources Board (Philippines)
NWRC	National Water Resources Committee (Thailand)
NWRP	National Water Resources Policy (Malaysia)
NWSDB	National Water Supply and Drainage Board (Sri Lanka)
ONLIMO	Online Water Quality Monitoring System (Indonesia)
ONWR	Office of the National Water Resources (Thailand)
PAB	Pollution Adjudication Board (Philippines)
Pb	Lead
PC	City of Provincial People's Committee (Viet Nam)
PCA	Pollution Control Area (Thailand)
PCB	Polychlorinated Biphenyl
PCD	Pollution Control Department (Thailand)
PD	Presidential Decree (Philippines)
PEZA	Philippine Economic Zone Authority (Philippines)
pH	Potential of Hydrogen
PHP	Philippine Peso (Philippines)
PNSDW	Philippines National Standards for Drinking Water (Philippines)
PO_4	Phosphate
PoNRE	Provincial Department of Natural Resources and Environment (Laos)
PROPER	*Program Penilaian Peringkat Kinerja Perusahaan* (Program for Pollution Control Evaluation and Rating) (Indonesia)
RA	Republic Act (Philippines)
RPJMN	*Rencana Pembangunan Jangka Menengah Nasional* (National Medium-Term Development Plan) (Indonesia)
RPJPN	*Rencana Pembangunan Jangka Panjang Nasional* (National Long-Term Development Plan) (Indonesia)
SD	Secchi Disc
SDGs	Sustainable Development Goals
SIA	Social Impact Assessment (Myanmar)
SIA	Social Impact Assessments
SMEs	Small and Medium Enterprises
SMR	Self-Monitoring Report (Philippines)
SPAN	*Suruhanjaya Perkhidmatan Air Negara* (National Water Services Commission) (Malaysia)
SpTPs	Septage Treatment Plants
SS	Suspended Solids
SSD	Sewerage Service Department (Malaysia)
STIE	Science, Technologies, Innovation and Engineering (Malaysia)
STPs	Sewage Treatment Plants
SWML	Scheduled Waste Management License (Sri Lanka)
TCB	Total Coliform Bacteria
TDS	Total Dissolved Solids
THB	Thai Baht (Thailand)
TKN	Total Kjehldahl Nitrogen
TMDL	Total Maximum Daily Load System
TN/T-N	Total Nitrogen
TOC	Total Organic Carbon
TP/T-P	Total Phosphorus
TPLCS	Total Pollutant Load Control System (Japan)
TSA	Tonle Sap Authority (Cambodia)
TSL	Tonle Sap Lake (Cambodia)
TSM	Tariff Setting Mechanisms (Malaysia)
TSS	Total Suspended Solids
UNDP	United Nations Development Programme
UNEP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations Children's Fund
USD	United States Dollars
VEA	Viet Nam Environment Administration (Viet Nam)
VIPs	Ventilated Improved Pit Latrines
VOCs	Volatile Organic Compounds
WASH	Water, Sanitation and Hygiene (Nepal)
WECS	Water and Energy Commission Secretariat (Nepal)
WEPA	Water Environment Partnership in Asia (Japan)
WEPA	Water Environment Partnership in Asia
WHO	World Health Organisation
WQG	Water Quality Guidelines (Philippines)
WQI	Water Quality Index (Korea) (Malaysia) (Viet Nam)
WQMA	Water Quality Management Areas (Philippines)
WQMACA	Water Quality Management and Conservation Area (Philippines)
WST	Water Sector Transformation (Malaysia)
WWTPs	Wastewater Treatment plants
WWTS	Wastewater Treatment System
Zn	Zinc

Chapter 1

Outlook on Water Environmental Management in WEPA Countries

Outlook on Water Environmental Management in WEPA Countries

1 | Water Environmental Management Objectives

(1) Brief explanation of water environmental management

Freshwater, being a finite resource, is under tremendous pressure due to rapid environmental changes such as population growth, increased per capita consumption, industrialization, migration to cities, land use land cover change, and climate change and its induced extreme weather conditions. This results in unfavorable hydrological, ecological, and environmental changes in major river systems. Many communities are heavily affected due to a lack of adaptive capacity, as is well documented in contemporary literature. The focal point for the vulnerability of these peoples lies in the water resources (drinking water availability, meeting sectoral water demands, of the desired quality and quantity, excluding extreme weather conditions such as flooding, etc.) and the future interaction between human beings and water systems. To address this challenge, robust water environmental management systems are important, the critical components of which are efficient cooperation and coordination between relevant stakeholders, a participatory approach, up-to-date policies and ordinances, and well established institutions and governance. This section mainly highlights the status quo of policies and ordinances covering all WEPA partner countries and discusses the related gaps and challenges.

(2) Laws and ordinances related to the Basic Environment Law, water environment management, etc.

To address the complex, interconnected nature of water environmental issues, the WEPA countries have established basic environmental laws as umbrella laws, as well as acts, as a starting point. However, these laws and policies sometimes cannot address specific issues, in which case additional laws or customized polices are utilized to address challenges related to the water environment. Many of the WEPA countries have also established local ordinances to further strengthen national laws and policies. Table 1.1 lists the basic environmental laws, laws or acts specific to water environmental management, and subsidiary laws/regulations and local ordinances related thereto in WEPA countries. The major recent developments regarding policies, laws, and regulations relevant to the water environment in the WEPA partner countries are as follows:

- In the Kingdom of Cambodia (hereinafter referred to as Cambodia), the Sub-decree on Management of Sewage and Wastewater Treatment System was enacted in December 2017, mandating the management of sewage and wastewater treatment systems at the sub-national level. In 2023, a new Code on Environment and Natural Resources was approved. Additionally, a number of legal frameworks are in place to address water pollution and environmental quality, including the Sub-decree on Water Pollution Control (1999), the amended Sub-decree 103 on Water Pollution Control (2021), and the Law on Sewage System (2024).
- In the People's Republic of China (hereinafter referred to as China), the Environmental Protection Law was amended in 2014 and the Water Pollution Prevention and Control Law was amended in 2018. The scope of the latter was then expanded to include the prevention and control of water pollution and the protection of aquatic ecosystems. In addition, regarding marine resources and environmental protection, the Marine Environmental Protection Law was also amended in 2023.
- In the Republic of Indonesia (hereinafter referred to as Indonesia), Act No. 17 was enacted in 2019 focusing on holistic water resource management in line with the SDGs. New elements introduced through Act No. 17 include establishment of a water resource information system for more comprehensive monitoring, and licensing and empowerment for authorities engaged in water resource supervision and management. In terms of specific laws and policies on water resource management, Indonesia also has Government Regulation 22/2021, Presidential Decree 60/2021, and Regulation No.68/2016, Permen LHK No.16/2019.

- In Japan, several substances that come under environmental standards for water pollution under the Basic Environment Law, including dissolved oxygen concentration in bottom water (bottom layer DO), hexavalent chromium, and coliform bacteria, and several substances regulated under effluent standards under the Water Pollution Prevention Law, including boron, fluorine, nitrate nitrogen, zinc, cadmium, hexavalent chromium, and coliform bacteria, have been reviewed and revised to reflect and manage the current situation. A partial amendment to the *Johkasou* Law was issued in 2019. In 2024, a Sixth Basic Environment Plan based on the Basic Environmental Law and a new Basic Plan on Water Cycle was formulated based on the Basic Law on Water Cycle. To ensure effective implementation of national laws and policies, Japan also has several special laws targeting water bodies, such as the Law Concerning Special Measures for Conservation of the Seto Inland Sea (1973), and Law Concerning Special Measures for the Restoration of the Ariake and Yatsushiro Seas (2002).
- In the Republic of Korea (hereinafter referred to as Korea), the Framework Act on Water Management was established in 2018 to encompass the concept of integrated water resources management. The previous Water Quality and Ecosystem Conservation Act was expanded in 2018 to encompass the entire water environment, and was developed into the Water Environment Conservation Act. Since 2020, total organic carbon (TOC) has been used as a parameter to monitor organic substances in addition to COD_{Mn} due to the difficulty of monitoring non-degradable organic substances. TOC has been applied since 2020 for effluent standards, such as those for sewage treatment plants, and since 2021 for permissible discharge limits in wastewater and industrial treatment plants. Korea also has Acts for designated rivers, which came to the force in 2017.
- In the Lao People's Democratic Republic (hereinafter referred to as Laos), the environmental Protection Law was promulgated in 1999, revised in 2012, and recently further amended and enacted in 2024, which includes measures for the protection, pollution control, certification and pollution emission approval, mitigation and restoration of the environment as well as guidelines for environmental management and monitoring in business, investment projects, and special and specific economic zones. In 2022, to implement and expand the provisions of Article 21 of the Law on Environmental Protection, the Lao Government issued Environmental Impact Assessment Decree No. 389/GL, which covers the Environmental and Social Impact Assessment (ESIA) and Initial Environmental Examination (IEE) for all investment projects and activities. The law on water and water resources was adopted in 1996, and amended in 2017, 2020 and 2022. The national environmental standard was established in 2009 and amended in 2017.
- In Malaysia, the key environmental law is the Environmental Quality Act enacted in 1974 and revised in 2015. Other policies specific to water pollution and control are the Malaysia Groundwater Quality Standards and Index (2019) and the National Lake Water Quality Criteria and Standards (2015). Malaysia also has other acts, such as the Water Services Industry Act (WSIA) 2006 to regulate water supply services and sewerage services, and the Street, Drainage and Building Act 1974 to govern the development, upkeep, and management of streets, drainage systems, and buildings.
- In the Republic of the Union of Myanmar (hereinafter referred to as Myanmar), the National Environmental Policy was developed in 2019; also developed was the Myanmar Sustainable Development Plan (MSDP) 2018–2030. The National Surface Water Quality Standards (NSWQS) were approved on 1st December 2023 and officially published in 2024.
- In Nepal, following the enactment of a new Constitution in 2015, the Environment Protection Act was enacted in 2019. The National Environmental Policy and National Water Resources Policy were both put in place in 2019 and 2020, respectively. The Water Supply and Sanitation Act was enacted in 2022, and the integrated National Water Resources Act has been submitted to parliament.
- In the Republic of the Philippines (hereinafter referred to as the Philippines), DAO (DENR Administrative Order) 2021-19 provides updated Water Quality Guidelines and General Effluent Standards for selected parameters. Further, DAO 2021-23, 2021-24, 2021-44, and 2019-15 designate Water Quality Management Areas (WQMA) as well as the creation of its Governing Board for the Bolo River, Panglao Island, Bacuit-El Nido Bay, and Boracay Island.

- In the Democratic Socialist Republic of Sri Lanka (hereinafter referred to as Sri Lanka), the Ambient Water Quality Standards (AWQS) were established under the National Environmental (Ambient Water Quality) Regulations, No. 01 of 2019. A comprehensive river water quality monitoring and management program was initiated in 2020 with a special emphasis on the Kelani River, the main drinking water supply source for the Colombo Metropolitan area.
- In the Kingdom of Thailand (hereinafter referred to as Thailand), the 13th National Economic and Social Development Plan (2023–2027) came into effect in October 2022, which serves as a framework to achieve the National Strategy. The Pollution Control Department (PCD) developed a pollution management plan (2023–2027) to address sustainable development, the Bio-Circular-Green Economy (BCG Model), and the transition to a low-carbon society.
- In the Socialist Republic of Viet Nam (hereinafter referred to as Viet Nam), the 2023 Law on Water Resources builds on the 2020 Law to address water security, socialization, economic use, and resource protection. In addition, new National Technical Regulations were established in March 2023, which regulate the environment water quality of surface water, groundwater, and marine water.

Table 1.1 Basic environmental laws and laws or acts specific to pollution control in WEPA partner countries

Country	Basic Environmental Law	Law or Act specific to water environmental management	Subsidiary laws/regulations and local ordinances relevant to management
Cambodia	Constitutional law of Cambodia (1993) Law on Environmental Protection and Natural Resources Management (1996) Code on Environment and Natural Resources (2023)	• Law on Water Resource Management (2007) • Law on Sewage system (2024) • Sub Decree 27 on Water Pollution control (1999) • Amended Sub Decree No 103 on Water Pollution Control (2021) • Sub Decree on Environmental Impact Assessment Process • Sub Decree on Sewage system management and Sewage Treatment	• Circular strategic on environment (2023-2028) • Prakas No 445 on the implementation of self-monitoring and pollution reporting measures (2017) • Prakas No 263 on Water Quality Index (2021) • Prakas No 021 on Classification of EIA for development project • Guidebook on Water Pollution Loading Inventory in Tonle Sap Lake
China	Environmental Protection Law (2018 revised)	• Water Pollution Prevention and Control Law (2018 revised) • Marine Environmental Protection Law (2023 revised) • Action Plan for Prevention and Control of Water Pollution (2015) • Water Law of the People's Republic of China (2016 Revised) • Yangtze River Protection Law of the People's Republic of China (2020) • Yellow River Protection Law of the People's Republic of China (2022) • Interim Regulation on the Prevention and Control of Water Pollution in the Huaihe River Basin (2011Revision)	• Regulation on the Administration of the License for Water Drawing and the Levy of Water Resource Fees (revised 2017) • Regulation on Urban Drainage and Sewage Treatment • Regulation on Farmland Water Conservancy
Indonesia	Law concerning Environmental Protection and Management (Law No.32/2009)	• Government Regulation concerning the management of Water Quality and Control of Water Pollution (Government Regulation No.82/2001) • Law on Water Resources (Law No.17/2019) • Government Regulation (No.22/2021) • Presidential Decree (No.60/2021) • Ministry Decree (No.15/2014) • Ministry Regulation (No.68/2016) • Permen LHK (No.16/2019)	-

Country	Basic Environmental Law	Law or Act specific to water environmental management	Subsidiary laws/regulations and local ordinances relevant to management
Japan	Basic Environmental Law (1993)	• Water Pollution Control Law (1997) • Law Concerning Special Measures of Lake Water Quality (1984) • Law Concerning Special Measures for the Protection of Water Quality in Water Resources Areas for the Purpose of Preventing Specific Trouble (1994) • Law Concerning Special Measures for Conservation of the Seto Inland Sea (1973) • Law Concerning Special Measures for the Restoration of the Ariake and Yatsushiro Seas (2002)	–
Korea	Framework Act on Environmental Policy (1990)	• Framework Act on Water Management (2018) • Water Environment Conservation Act (2018) • Marine Environment Management Act (2019) • River Act (2017)	–
Laos	Environmental Protection Law (revised in 2024)	• Water and Water Resources Law (revised 2022) • Industrial Processing Law (2013)	–
Malaysia	Environmental Quality Act (Amended in 2024)	• Water Services Industry Act (WSIA) (2006) • Local Government Act 1976 • Street, Drainage and Building Act (1974) • State Water Resources Enactment • Environmental Quality Regulations (various)**	Local governments are involved in water resources planning, development and enforcement based on local authority by-laws
Myanmar	Environmental Conservation Law (2012)	• The Conservation of Water Resources and Rivers Law (2006)	–
Nepal	Environmental Protection Act (2019)	• Integrated National Water Resources Act (under development)	–
Philippines	Environmental Policy (1977) Environmental Code (1977)	• Clean Water Act (2004)	–
Sri Lanka	National Environmental Act No.47 (1980), as amended by Act No. 53 of 1998 and No. 53 in 2000	• Marine Pollution Prevention Act of No. 35 • Water Resources Board Act No. 2 of 1974 • Irrigation Ordinance—Law No. 32 of 1946 and its amendments • National Water Supply and Drainage Board Law of No. 02 of 1974	• Mahaweli Authority Act No. 23 of 1979 • Urban Development Authority Act No. 41 of 1978 as amended from time to time • Greater Colombo Economic Commission Law No. 4 of 1978 as amended by Act No. 43 of 1980 and No. 49 of 1992 • Coast Conservation Act No. 57 of 1984 as amended by Act No. 64 of 1988
Thailand	Enhancement and Conservation of National Environmental Quality Act (1992) (Amended in 2018)	• Water Resources Act (2018) • Groundwater Act (1997)	–
Viet Nam	Law on Environmental Protection	• Law on Water Resources	–

* Note: The contents of this table were compiled based on responses from FPs in WEPA partner countries.

** Environmental Quality Regulations encompass various regulations governing environmental management in Malaysia, including: Prescribed Premises Regulations for Crude Palm Oil (1977), Raw Natural Rubber (1978), Scheduled Wastes Regulations (2005), Sewage Regulations (2009), Control of Pollution from Solid Waste Transfer Station and Landfill Regulations (2009), Industrial Effluent Regulations (2009), and Prescribed Activities (Environmental Impact Assessment) Order (2015).

2 | Institutional Arrangement

Water resources management includes water quality management and water quantity management, both of which are important and are often managed under different government agencies. In many WEPA partner countries, this management is further divided into wastewater management, drinking water management, and agricultural water management, and other. Pollution control, a key aspect of water quality management, is often handled by a government agency in charge of environmental protection.

Agencies handling the protection of natural resources and the environment are responsible for setting national environmental goals and developing policies to control pollution, as necessary, and subnational governments are often responsible for implementing policies and monitoring the environment. Ministries or agencies responsible for infrastructure development and public works also play key roles, as they develop wastewater management facilities. Table 1.2 presents the ministries and agencies responsible for water resource management in the WEPA partner countries.

- In Cambodia, water resource management is mainly handled by three ministries (see Table 1.2). Water supply is managed by the Ministry of Industry Science Technology and Innovation (central water supply) and Ministry of Rural Development (rural water supply). In addition, the Tonle Sap Lake Authority is responsible for managing the water environment of the Tonle Sap Lake and its surrounding areas, which is one of Cambodia's key freshwater resources.
- In China, the Ministry of Ecology and Environment is the main central administrative agency for the supervision of ecological environmental protection. The Ministry of Housing and Urban-Rural Development is responsible for urban sewage management. The Ministry of Water Resources is responsible for water source protection and soil conservation, and the Ministry of Natural Resources is responsible for the management of water resources, including rational use, optimal allocation, conservation and protection. In addition, the Ministry of Agriculture and Rural Affairs is responsible for infrastructure development in rural areas.
- In Indonesia, the Ministry of Environment and Forests* and Ministry of Public Works and Housing are the main central administrative agencies for environmental protection and wastewater management, while the State Ministry of National Development and Planning is responsible for nationwide development.
- In Japan, the Ministry of the Environment is the central administrative agency for water environment conservation and wastewater regulations. The Ministry of Land, Infrastructure, Transport and Tourism is also an important administrative agency for water resource management and wastewater management.
- In Korea, the Ministry of Environment is responsible for both water quality and quantity, following the unification of water management functions separately handled by the Ministry of Environment and Ministry of Land, Infrastructure and Transport. The National Institute of Environmental Research has played a central role in providing scientific support for the development of environmental policy.
- In Malaysia, the Ministry of Health and Department of Health are responsible for drinking water quality. Additionally, the Ministry of Natural Resources and Environmental Sustainability (MNRES) oversees environmental protection, including water quality management, while the Ministry of Energy Transition and Water Transformation ensures water sustainability and security through policies and governance, and the National Water Commission manages water supply and sewerage services.
- In the Philippines, the Department of Health is responsible for the enforcement of drinking water quality standards. Other government agencies, such as the National Economic and Development Authority, Metro Manila Development Authority, Metropolitan Waterworks and Sewerage System, the Local Water Utilities Administration, and Laguna Lake Development Authority, are also key agencies in water resource management.
- In Nepal, the Ministry of Forests and Environment is responsible for Environmental protection and the Water and Energy Commission Secretariat is responsible for national policy and strategy formulation related to water and energy. Multiple agencies are involved in water related matters: the Ministry of Energy, Water Resources and Irrigation is responsible for monitoring river hydrology, sediment, water quality, limnology, snow hydrology, and glaciology, and the Groundwater Resources

Development Board is responsible for monitoring the quality of underground and surface water.

- In Thailand, the Pollution Control Department of the Ministry of Natural Resources and Environment is responsible for ambient and effluent water quality managements as well as formulating policies. The Office of the National Water Resources is responsible for overall water resources management, and multiple agencies are involved in water related matters, such as the Royal Irrigation Department and Department of Groundwater Resources.
- In Viet Nam, the Ministry of Natural Resources and Environment (MONRE) is the main ministry responsible for overall state management of water resources, but other ministries such as Ministry of Agriculture and Rural Development, Ministry of Industry and Trade, Ministry of Health, Ministry of Science and Technology, Ministry of Construction, Ministry of Transport, and Ministry of Finance, Ministry of Planning and Investment, and Ministry of Home Affairs are also relevant in water resource management.

* Note: In Indonesia, the Ministry of Environment and Forestry was reorganized in October 2024 into the Ministry of Environment and the Ministry of Forestry. This chapter was drafted based on information available as of September, 2024.

Table 1.2 Key institutions for environmental protection, surface water resources and wastewater management at the national level and roles of subnational governments in WEPA partner countries

Country	National level	Roles of subnational government
Cambodia	**Ministry of Environment (MOE):** Environmental impact assessments (EIA); inventory development; developing sub-degrees to prevent and reduce pollutions; monitoring/reporting/verification of water pollution, executing management and conservation plans **Ministry of Water Resources and Meteorology (MWRM):** Water management, conservation, and monitoring **Ministry of Public Work and Transport (MPWT):** Urban wastewater management	• One provincial department for each ministry is established and works as the secretariat and implementer on relevant duties under its authority. • In each province, there is one provincial department of environment responsible for implementing and coordination any tasks of national level. However, the national level (MOE) still engages in most activities.
China	**Ministry of Ecology and Environment (MEE):** Supervision and management of water ecological and environmental protection	• Local governments at various levels shall be responsible for the quality of the water environment in their respective administrative areas and shall take timely measures to prevent and control water pollution. • Ecological and environmental departments at all levels are responsible for supervising the quality of the ecological environment in their administrative areas, such as monitoring, enforcement and supervision.
Indonesia	**Ministry of Environment and Forestry (MoEF):** Water quality management, pollution control **Ministry of Public Works and Housing (MPWH):** Water resource management focusing on supply	Water quality management, and pollution control (Local area)
Japan	**Ministry of the Environment (MOE):** Water environment conservation, industrial wastewater regulation, water supply (quality and sanitation), and management of *Johkasou* **Ministry of Land, Infrastructure, Transport and Tourism (MLIT):** Water resource management, management of rivers, and management of water supply and sewerage systems	• Formulation of water quality monitoring plans • Monitoring of public waterbodies • Implementing policies • Maintenance, operation and management of water and sewage systems
Korea	**Ministry of Environment (ME):** Management of both water quality and water quantity	–
Laos	**Ministry of Natural Resources and Environment (MONRE):** Protection of natural resources, including water	Department of Natural Resources and Environment (DONRE, Province) is responsible for monitoring

Country	National level	Roles of subnational government
Malaysia	**Ministry of Natural Resources and Environmental Sustainability (NRES):** Environmental protection, including water quality management **Ministry of Energy Transition and Water Transformation (PETRA):** Water resource management, irrigation and drainage, sewerage service, and water supply **Ministry of Health: Regulation of drinking water quality** **National Water Services Commission:** Water supply and sewerage service	Local governments are involved in water resources planning, development and enforcement based on local authority by-laws
Myanmar	**Ministry of Natural Resources and Environmental Conservation (MONREC):** Formulation of water quality monitoring plan, monitoring public waterbodies, implementing policies; maintenance, operation and management of water and sewage systems	Implementing the environmental conservation policies and other related policies concerning water resources and other resources
Nepal	**Ministry of Forests and Environment (MoFE):** Environmental protection **The Water and Energy Commission Secretariat (WECS):** National policy and strategy formulation related to water and energy	Local units are responsible for local level planning and development in close coordination with the province.
Philippines	**Department of Environment and Natural Resources (DENR):** The primary government agency responsible for the conservation, management, development, and proper use of the country's environment and natural resources. **Department of Interior and Local Government (DILG):** Administers implementation of the country's National Water Supply and Sanitation Program; mandated to oversee attainment of the country's SDG goal on access to safe drinking water by all **Department of Public Works and Highways (DPWH):** Primary agency for implementing the country's national Sewerage and Septage Management	Local Government Units (LGUs) are required to provide water supply systems, communal irrigation facilities, and implement social forestry and local flood control projects under the supervision and control of DENR.
Sri Lanka	**Central Environmental Authority (CEA):** Performs law enforcement related to water quality protection and management and enhancement. Formulates water quality and effluent discharge standards and other necessary standards to protect the environment; performs EIAs and gazetting of environmental protected areas to preserve specific sensitive water bodies/areas.	N/A
Thailand	**Ministry of Natural Resources and Environment (MNRE):** Water pollution control and management; establishing water pollution control policy; formulating water quality standards and strategies; monitoring of water quality and water pollution; provision of water pollution advice (Water Quality Management Division in Pollution Control Department)	Environment and Pollution Control Offices 1–16 across the country are responsible for: • Water pollution control and management • Creating local environmental pollution management plans • Suggesting standards based on local sources • Monitoring and reporting on local water quality and environmental conditions • Providing advice on water pollution
Viet Nam	**Ministry of Natural Resources and Environment (MONRE):** Management of water resources	The Department of Natural Resources and Environment (DoNRE) under the city or provincial people's committee acts as the lead in promoting environmental conservation activities through implementing environmental regulations and providing guidance.

3 | Surface Water Quality Management

(1) Ambient water quality classification

Water quality standard classifications based on its sectoral use are in use around the world, as well as in WEPA partner countries. Table 1.3 summarizes classifications in partner countries, the details of which are shown in Table A-1 in the Appendix.

The table indicates the cleanest water quality, such as pristine condition, within this classification as required for protected areas. This category is followed by water quality suitable for drinking water, fish habitats, agriculture, industry and navigation.

Some countries, such as Japan, the Philippines, Thailand and Viet Nam, classify rivers according to their uses and monitor whether or not water quality standards are met, while others, such as China, Indonesia and Korea, measure the water quality of rivers and indicate the suitability of water uses for each river based on the measured water quality. Please see 4) Evaluation Methods, below, for more detailed information.

Some countries classify the water quality of public water bodies into several categories based on its suitability for drinking purpose, with each class requiring different treatment technologies to enable use as drinking water (see Table A-1 in the Annex). Korea and Viet Nam do not include "fish habitat" as a water use purpose in any of the classes, but do indicate classes suitable for specific species in the description. Cambodian water quality standards were established for the protection of public health and biodiversity conservation, and are set for closed and open waters. They do not use water use classification.

Table 1.3 Water use classification in partner countries (Rivers)

Country	Class	Protected area	Drinking water	Recreation (direct contact)	Fish habitat	Agriculture	Industry	Navigation/ Environmental-landscape conservation
Cambodia	Type 1*							
	Type 2*							
China	I	X						
	II		X		X			
	III		X	X	X			
	IV						X	
	V					X		X
Indonesia	One		X					
	Two			X				
	Three				X			
	Four					X		
Japan	AA	X	X					
	A		X	X	X			
	B		X		X			
	C				X	X		
	D					X	X	
	E						X	X
Korea	Ia	X	X					
	Ib		X					
	II		X	X				
	III		X				X	
	IV						X	
	V						X	
	VI							
Laos	1	X						
	2			X	X			
	3					X		
	4						X	
	5							X

Country	Class	Protected area	Drinking water	Recreation (direct contact)	Fish habitat	Agriculture	Industry	Navigation/ Environmental-landscape conservation
Malaysia	I	X	X		X			
	IIA		X		X			
	IIB			X				
	III		X		X			
	IV					X		
	V						X	X
Myanmar	I	X						
	II		X		X			
	III		X			X	X	
	IV					X	X	
	V							X
Philippines	AA	X	X					
	A		X					
	B			X				
	C				X	X		
	D							X
Sri Lanka	A		X					
	B			X				
	C				X			
	D**		X					
	E					X		
	F**							
Thailand	1	X						
	2		X	X	X			
	3		X			X		
	4		X				X	
	5							X
Viet Nam	A		X	X				
	B					X	X	
	C						X	
	D							X

*In Cambodia, standard Types 1 & 2 refer to the effluent standard and specific receiving water body (Sub-decree No. 103)
** In Sri Lanka, category D water is required to undergo a general treatment process for drinking, and category F is the minimum water quality.

(2) Parameters

Although several parameters to assess the state of the water environment are in use, the selection of parameters and their stringency regarding the ambient water quality depend on the required water quality summarized in 1) Ambient water quality classification above, considering various factors such as technology, economy, and capacity, tailored to the water environment conditions in each country.

From 2021 to 2024, the following updates were made in WEPA partner countries.

- Cambodia's ambient water quality standards for public water areas were revised through the amendment of Sub-decree 103 on Water Pollution Control in 2021. The revised standards introduced a comprehensive framework, including indicators for biodiversity conservation and public health protection. Specifically, the standards now incorporate 10 parameters for biodiversity conservation and 36 parameters for public health protection. This framework allows flexibility to adjust testing parameters as needed to address potential environmental concerns or suspicious activities.
- Myanmar established its national surface water quality standards in 2024, with 36 parameters for protecting aquatic ecosystems and human health.
- Viet Nam revised its surface water quality standards in 2023 to enhance environmental protection and public health. These updates reflect the country's efforts to address emerging challenges and support sustainable water resource management.

To provide an overview of indicators in WEPA partner countries, Table 1.4 summarizes water quality parameters for ambient surface water in each country. It does not include other standards such as groundwater or coastal water. Information on the standard referenced in preparing this table is provided in the Appendix. The parameters are broadly categorized into physical, chemical, biological, radiological, and other. For chemical parameters, we reviewed their uses through PubChem (https://pubchem.ncbi.nlm.nih.gov/) and classified them into pesticides, industrial use, heavy metals, and other ions.

- Among the WEPA partner countries, the table below indicates that Malaysia has the largest number of parameters, including a relatively large variety of chemical parameters such as physical parameters, ionic composition, and heavy metals.
- Cambodia, Japan, South Korea, the Philippines, and Viet Nam tend to specify relatively many chemical parameters associated with industrial activities.
- In Japan, the number of E. coli is used as a microbial indicator instead of the number of coliform bacteria.
- Indonesia, Laos, Malaysia, Thailand, and Viet Nam have also established indicators related to radioactive substances.

Table 1.4 Water quality parameters for surface water and human health protection in WEPA partner countries

Country	Physical parameter (P-##)	Chemical parameter (Basic and Ionic composition: C-##, Pesticide, insecticides and herbicides: CP-##, Industrial such as solvents, surfactants: CI-##, Heavy metals: CH-##)	Biological parameter (B-##), Radioactive radicals or substance (R-##),Other (O-##)
Cambodia	P-2	C-1, 2, 5, 6, 8, 11, 14, 17 CP-2, 3, 4, 6, 7, 9, 12 CI-1, 2, 3, 4, 7, 13, 15, 16, 31, 32 CH-4, 6, 8, 9, 11, 13, 16	B-1
China	P-1	C-1, 2, 4, 5, 6, 12, 14, 17, 24, 33 CI-23, 29, 32 CH-1, 4, 6, 9, 11, 13, 14, 16	B-3 O-5
Indonesia	P-1, 2, 4, 6, 8, 12	C-1, 2, 5, 6, 10, 11, 13, 14, 17, 19, 20, 23, 25, 33, 34 CP-4, 8, 10, 13, 16, 17, 22, 23, 26 CI-24, 27, 32 CH-1. 2, 3, 4, 5, 6, 9, 11,13, 14, 15, 16, 18	B-1, 3 R-2, 3 O-2
Japan	P-3	C-1, 2, 3, 5, 6, 10, 11, 14, 17, 33, 34 CP-2, 11, 27, 28, 29 CI-2, 6, 8, 9, 10, 11, 12, 13, 16, 29, 30, 31, 32 CH-1, 4, 6, 7, 9, 11, 13, 16	B-1, 4
Korea	P-3	C-1, 2, 5, 7, 14, 15, 17, 18 CP-2, 3, CI-2, 4, 5, 6, 7, 14, 16, 21, 22, 31, 32 CH-4, 6, 9, 11, 13, 17	B-1, 3
Laos	P-1, 2, 8, 9, 10, 11,	C-1, 2, 6, 11, 12, 13, 16 CP-4, 6, 8, 9, 14, 24, 33 CI-27, 32 CH-1, 2, 3, 4, 6, 9, 11, 13, 14,	B-1, 3 R-2, 3
Malaysia	P-1, 2, 4, 5, 7, 8, 9, 10, 11	C-1, 2, 5, 6, 8, 9, 10, 11, 12, 16, 19, 21, 22, 23, 25, 26, 27, 28, 29, 30, 31, 32, 34 CP-5, 10, 15, 18, 19, 20, 21, 22, 23, 25, 26 CI-27, 31, 32 CH-1, 2, 3, 4, 6, 9, 11, 12, 13, 14, 15, 16, 18, 19, 20	B-1, 3 R-2, 3, 4, 5 O-1, 3, 4
Myanmar	P-2	C-1, 2, 5, 6, 10, 11, 12, 33, 34 CI-16, 27, 31, 32 CH-2, 4, 6, 9, 11, 13, 14, 16,	B-4 O-2
Philippines	P-1, 2, 8	C-1, 2, 5, 11, 12, 16, 19, 25, 33, 34 CP-1, 4, 6, 8, 9, 13, 16, 17, 23, 26, 33 CI-13, 16, 17, 18, 19, 20, 22, 27, 31, 32 CH-1, 2, 3, 4, 6, 9, 11, 13, 14, 15, 16, 18	B-3 O-2

Country	Physical parameter (P-##)	Chemical parameter (Basic and Ionic composition: C-##, Pesticide, insecticides and herbicides: CP-##, Industrial such as solvents, surfactants: CI-##, Heavy metals: CH-##)	Biological parameter (B-##), Radioactive radicals or substance (R-##),Other (O-##)
Sri Lanka	P-2, 7, 8, 11	C-1, 2, 5, 6, 9, 11, 12, 16, 19, 22, 25, 32, 34 CP-30, 31 CI-22, 26, 32 CH-1, 2, 3, 4, 6, 9, 10, 13, 14, 16, 18	B-1, 3 O-2
Thailand	P-1, 8, 9, 10	C-1, 2, 5, 11, 12 CP-4, 6, 8, 9, 13, 14, 24 CI-27, 32 CH-1, 2, 3, 4, 6, 9, 11, 13, 14	B-1, 2, 3 R-2, 3
Viet Nam	P-2	C-1, 2,5, 6, 7, 10, 12, 14, 17, 18, 33 CP-2, 3, 5, 6, 9, 14, 23, 32 CI-2, 4, 5, 6, 10, 14, 16, 21, 22, 25, 31, 32 CH-1, 2, 3, 4, 6, 9, 11, 13, 14, 17, 18	B-1, 3, 4 R-2, 3 O-2

Note: Information on the standard referenced in preparing this table is provided in the Appendix (Table A-1).

(3) Monitoring framework for ambient water quality

Understanding the state of the water environment is fundamental to water environment management. Continuously monitoring changes in the water environment and implementing measures based on these observations is essential. Table 1.5 provides an overview of water environment monitoring in each country.

- Eleven WEPA partner countries conduct regular ambient water quality monitoring for public waters at least four times a year. In most cases, the ministries responsible for monitoring are at the central, subnational, or local government levels, overseeing water environment management.
- For example, In Japan, prefectures continuously monitor the pollution status of public water bodies and groundwater. Every year, based on measurement plans, local public bodies (including river administrators, etc.) conduct water quality measurements for public water bodies and groundwater. The prefectures then compile the results and report them to MOEJ.
- In Nepal, systematic ambient water quality monitoring is not yet conducted in public waters, although various ministries and agencies monitor water quality for different purposes. For example, the Bagmati River in Kathmandu Valley is monitored monthly by the High-Powered Committee for the Integrated Development of the Bagmati Civilization (HPCIDBC), and the Department of Hydrology and Meteorology under the Ministry of Energy, Water Resources, and Irrigation (MOEWRI) monitors the water quality of rivers and lakes.
- Regarding the number of monitoring stations, the responses from Korea, Thailand, and Viet Nam also mentioned the number of automatic monitoring stations. Korea reported it uses 70 automatic monitoring stations for surface waters, Thailand reported 160 automatic monitoring stations for surface waters, and Viet Nam reported 23 automatic monitoring stations at the central level and over 80 stations at the local level.

Table 1.5 Ambient water quality monitoring framework

Country	Responsibility for conducting water quality monitoring	Number of monitoring points	Frequency
Cambodia	MOE (public water bodies nationally) MoWRAM (under the Mekong River Commission WQ monitoring network program)	• Rivers: 11 • Streams: 14 • Lakes: 3 • Coastal: 8 • Sites for Mekong River	Monthly
China	National monitoring: MEE Local monitoring: local governments	Surface water: 3,641 • Rivers: 3,293 • Lakes and reservoirs: 348 Groundwater: 1,912	Monthly or seasonally
Indonesia	Local and central government	• Rivers: 510 • Lakes: 10	Twice/year
Japan	Prefectural and designated city governments and MLIT	Indicators for human health protection • Rivers: 3,837 • Lakes and reservoirs: 413 • Sea: 1,070 Indicators for the living environment • Rivers: 4,511 • Lakes and reservoirs: 480 • Sea: 2,012 Groundwater: 2,830 (As of FY2022)	Monthly
Korea*	• Environmental agencies • River environmental research centers • Local governments	• Rivers: 5,589 • Lakes: 368 • Estuaries: 668	Frequency of monitoring differs according to site: typically monthly for general purpose, weekly for important sites
Laos	Local DONRE	93 stations	Monthly
Malaysia*	Environmental Quality Monitoring Programme (EQMP) of Department of Environment (DOE)	• Rivers: 672 rivers with 1,353 manual river water quality and 55 upstream water intake monitoring stations • Coastal: 188 • Estuary: 85 • Island: 95 • Groundwater: 120 stations (wells)	6 times/year
Myanmar	State and regional environmental conservation departments (ECD)	• Rivers: 154 • Lakes: 78 • Groundwater: 30 (by ECD)	Seasonal (quarterly or twice a year), monthly, bimonthly (if required)
Philippines	Environmental Management Bureau (EMB) Regional Offices	Ambient stations: 2,406 • WQMA: 638 • Adopt an Estero: 298 • Primary/Other Freshwater bodies: 913 • Recreational: 587 (As of 2024)	Monthly or 4 times/ year
Sri Lanka	• CEA: Regular water quality monitoring in 18 rivers and 7 reservoirs • NWSDB: water quality monitoring at water intake points for drinking water purification • Sri Lanka Land Reclamation & Development Agency: canal water quality monitoring in the Colombo area	By CEA • Kelani river: 17 locations • Kalu river: 12 locations • Other rivers: 8, • 4 locations • Reservoirs: 6 locations By NWSDB • Monitoring of 141 intake points island-wide	Monthly
Thailand	Water Quality Management Division under the Pollution Control Department—MONRE	433 points • Rivers: 59 • Lakes: 6	4 times/year
Viet Nam	MONRE, relevant ministries, and DONREs	Surface water • MONRE: 300 stations • Line ministries: 100 stations	6 times/year

Note: The contents of this table were compiled based on responses from FPs in WEPA partner countries.
* Based on information from WEPA Outlook 2021.

(4) Evaluation Methods

The goals of establishing the water quality guidelines for different WEPA partner countries vary widely. In most cases, it is to protect the ambient environment in general, such as in Indonesia, Laos, Myanmar, Nepal, Sri Lanka, Thailand and Viet Nam. On the other hand, guidelines in Cambodia target protecting human health and biodiversity conservation, China targets preventing and controlling water pollution, and improving the ecological environment, Japan targets protecting human health, conservation of the living environment, and conservation of aquatic life, Korea targets protection of human health and the living environment, and Philippines targets meeting sectoral demand such as transportation, industry, fisheries, bathing and swimming, and water supply.

Each WEPA country evaluates the results of national ambient water quality monitoring for public water bodies. Table 1.6 provides a summary of the evaluation methods used, as well as the sources and policies related to disclosure of this monitored information in the public domain. The evaluation methods applied in these countries can be roughly divided into two types:

1. The first involves setting classes of water bodies in advance, such as in Japan, Korea, and the Philippines. In this method, based on the results of water quality monitoring, governments assess whether each water body satisfies the Environmental Quality Standard or not. Here, the standards serve as an indicator to evaluate the group of associated water bodies and assess whether a water body is suitable for its predetermined intended use or not.
2. The second type involves categorizing rivers based on the results of water quality monitoring and classification in the Environmental Quality Standard. For example, in China's environmental quality standards, the water use of rivers is categorized into six classes (I, II, III, IV, V and worse than V). Based on this evaluation, whether the water is suitable for the intended use is identified for each river. Unlike the first method, which focuses on pre-determining water body classes, this method determines classes based on actual water quality measurements.

- In Korea, Malaysia, Thailand, and Viet Nam, the same evaluation concept is applied, but they use the water quality index (WQI) instead of classifications based on their environmental quality standard. For these countries, the WQI is calculated by formulas developed by each country. The related governments also provide results of national water quality monitoring using this index on an annual basis.

The results of monitoring are evaluated annually in many WEPA partner countries and the information is disclosed in the public domain.

Such public disclosure mainly takes the form of publishing environmental quality reports on relevant ministerial websites, which provide comprehensive assessments of the water environment. Several WEPA countries have adopted this practice, such as China, Indonesia, Japan, Korea, Malaysia, Nepal, Philippines, Thailand, and Viet Nam, and to a limited extent in Sri Lanka.

Table 1.6 Ambient water quality monitoring and evaluation methods in WEPA partner countries

Country	Target of water quality guidelines	Evaluation method	Disclosure*
Cambodia	Protecting human health and biodiversity conservation	Achievement rate of WQI	Disclosed on MoE website
China	Prevention and control of water pollution; improvement of ecological environment	Based on six levels of environmental criteria	Disclosed online
Indonesia	Protection of ambient environment	Achievement rate of environmental standard for water in public water zones	Disclosed online
Japan	Protecting human health; conservation of living environment; conservation of aquatic life	Achievement rate of environmental standard for water in public water zones	Disclosed online
Korea	Human health and living environment	Achievement rate of WQ standards and WQI values	Disclosed online
Laos	Protection of ambient environment	Achievement rate of WQ standards	-
Malaysia	Protection of ambient environment	Classification of monitoring station based on monitoring results and WQI	-

Country	Target of water quality guidelines	Evaluation method	Disclosure*
Myanmar	Protection of ambient environment	Achievement rate of WQ standards	-
Nepal	Protection of ambient environment	Differs depend on monitoring agency	Water quality data for Bagmati River (Kathmandu Valley area), monitored by HPCIDBC, has generally been made public.
Philippines	To meet sectoral demand (transportation, industry, fisheries, bathing and swimming, water supply)	Compliance rate of WQ standards	Disclosed online*
Sri Lanka	Protection of ambient environment	Achievement rate of WQ standards	Dashboard to disclose water quality monitoring data in selected rivers (only for certain viewers)
Thailand	Protection of ambient environment	Based on achievement rate of WQI	Made public through online publications annually (*e.g., Thailand State of Pollution Report*).
Viet Nam	Protection of ambient environment	Based on the achievement rate of WQI	MONRE issues *National State of the Environment Report* annually, in which major data is made public; Several monitoring data are disclosed online.

Note: The "-" marks reflect the lack of response from FPs. In some countries, monitoring data is available online. The URLs for these data are compiled in the References section. Information referenced in preparing this table is provided in the Appendix.

4 | Industrial Wastewater Management

(1) Effluent water quality standard

Managing point sources of pollution irrespective of their scale is one of the main targets for water management systems. Since industrial effluent is one of the key point sources of water pollution, addressing this through establishing and revising effluent standards in a timely manner is one of the main objectives among WEPA partner countries. Table 1.7 shows industries subject to effluent standards, numbers of parameters, structures of the standards, and the potential for tightening the standards in each WEPA country. As shown, while all industries are subject to standards, parameters included in the standards vary. In general, effluent standards are set for sectors, but some countries set them in consideration of discharge points. Setting more stringent standards than national standards is permitted in several countries.

- In Cambodia, Indonesia, Laos and Philippines, all industries are subject to effluent standards, regardless of size or type, but in Malaysia and Japan, some standards are applied based on volumes of discharged wastewater. In Sri Lanka, specific industry types based on their pollution potential have been gazetted to comply with effluent standards.
- In countries with industrial effluent standards, general standards cover all types of industries or industries without specific standards. In some countries, standard values are categorized based on industry types and receiving bodies. For example, China has 63 specific standards based on industry types, and Indonesia has 44. Moreover, Indonesia, China, Japan and Korea have provincial standards that account for local water environment conditions. In Nepal, Philippines, and Sri Lanka, effluent standards are set for receiving bodies, in addition to industry types or activities.
- Some countries have revised standards to control different pollutants of concern, sometimes by adding new parameters or raising the stringency. In addition, setting tighter standards than national standards is legally possible in several countries, such as Cambodia, China, Indonesia, Japan, Korea, Malaysia, Sri Lanka, and Thailand.
- Cambodia is planning to establish separate effluent standards based on areas of concern, whether at the provincial, regional or local scale.
- Sri Lanka applies more stringent standards only after technical evaluation and consideration of the sensitivity of the water source.

Table 1.7 Industrial effluent standards and related regulating entities in WEPA countries

Country	Target industries and number of parameters	Structure of standards	Stringent standards
Cambodia	• All industries • 32 parameters	Standard values for three types of receiving body (Public water area 1, Public water area 2, and sewer pipelines)	MOEC can establish separate effluent standards for pollution source areas of concern.
China	• All industries • More than 150 parameters	65 separate standards (61 for industries, and livestock, WWTP, ship, and integrated standards for all other industries)	Provinces can set provincial standards
Indonesia	• All industries • 33 parameters (General industrial effluent standards)	General industrial effluent standards and specific quality standards for 42 industries, hospitality and health service facilities, slaughterhouses, and domestic (1. residential areas, area offices, commercial areas, and apartments; 2. restaurants with building areas of more than 1,000 m^2; and 3. dormitories for 100 persons or more)	Provincial governments can establish tighter wastewater quality standards.
Japan	• All industries (for hazardous pollutants) • Industries discharging effluent in excess of living environment item limits • 44 parameters	National uniform standard	Provincial governments can establish tighter wastewater quality standards.
Korea	• All industries (five categories, according to discharge volume) • Seven parameters in effluent standards and 53 parameters in permissible discharge limit, including 32 hazardous pollutants	Effluent standards and permissible discharge limit	Local governments can set different standards. In addition, TMDL approach is taken in Korea, enabling to assign different standards to certain sectors from national standards.
Laos	• All industries, regardless of size and type • 27 parameters (general factories)	Standards for water pollution control from general factories, buildings, resettlement villages, toilets, pig farms, and carwashes/ gas stations.	–
Malaysia	(1) Prescribed premises • Palm oil mills • Natural rubber processing • Scheduled waste disposal & treatment facilities (2) Non-prescribed premises • Manufacturing industries • Sewage treatment plants • Landfills	• Industrial effluent standards • Agro-industrial effluent standards (palm oil effluent discharge limits and raw natural rubber effluent discharge limits) • Domestic effluent standards	Besides the DOE standards, states can set tighter standards.
Myanmar	• National Environmental Quality (Emission) Guidelines (NEQEG) stipulate the industries • 28 parameters for wastewater, storm water runoff, effluent and sanitary discharges (general application) • Eight parameters for site runoff and wastewater discharge (construction phase)	71 industry-specific effluent levels	–
Nepal	Different parameters are set for 16 types of industries (3–27 parameters; Generic standards include 25 parameters)	• Tolerance limits for industrial effluent discharged into inland surface waters (generic) • Tolerance limits for specific industrial effluent discharged into inland surface waters • Tolerance limits for industrial effluent discharged into public sewers • Tolerance limits for wastewater discharged into inland surface waters from combined wastewater treatment plants (CWTPs)	–

Country	Target industries and number of parameters	Structure of standards	Stringent standards
Philippines	• All point sources of pollution • Significant effluent quality parameters are set for industries • Number of parameters differs by industry (DAO 2016-08)	Effluent standards set for industries, for receiving bodies, and for BOD of wastewater with observed high pollutant content	-
Sri Lanka	• All industries are required to obtain a license (gazette No.2264/18). • Seven standard limits specifying the standards for discharge location and one standard for specific component i.e., leachates from landfills • Parameter limits vary depending on discharge location (36 parameters in total, including colour and radioactivity, are mentioned in standards for discharging to inland surface water).	• Tolerance limits for the discharge to inland surface waters • Tolerance limits for discharges to coastal, marine waters, inland surface water, land for irrigation purpose, and sewer lines • Tolerance limits for discharges of leachates from landfills	CEA can apply more stringent standards after technical evaluation, considering the sensitivity of the water source.
Thailand	• All industries • 31 parameters (general effluent standards)	• General effluent standards • Type-specific effluent standards	Local governments (provincial and municipal) have the authority to set stricter wastewater discharge standards than national standards.
Viet Nam	• All industries • Parameters vary depending on sector	• National Technical Regulation on Industrial Wastewater (two standards for two receiving waters) • National Technical Regulations for specific industries	-

(2) Responsibility for conducting and supervising effluent water monitoring

Monitoring of effluent from industries is an important means of determining compliance with effluent standards in factories. In general, businesses operators are responsible for conducting water quality monitoring and regularly reporting the results to regulatory agencies.

- In Cambodia, under the Sub-decree on Water Pollution Control, all business operators are obliged to self-monitor treated/discharged effluent and submit periodic reports of results to the Ministry of Environment (MOEC). Additionally, 24 factories have installed automatic water quality analysis systems, and all effluent testing results are sent in real-time to MOEC, which also conducts regular on-site inspections to check compliance based on analysis of water samples and treated water.
- In China, local governments supervise enterprises according to emission permits issued based on the permit system for the discharge of pollutants.
- In Indonesia, all industries are required to send wastewater samples to registered laboratories once a month or more frequently depending on their activities; analysis reports are submitted every six months to local authorities and the MOEF. Local and national authorities have the right of access and sampling of effluent at any time.
- In Japan, any entity that discharges effluent or discharges water which permeates into the groundwater aquifer must monitor the level of contaminants and keep records for three years, as per Ministry of the Environment, Government of Japan (MOEJ) ordinance. Local and national authorities have the right of access of this information and sampling of effluent at any time.
- In Korea, every business operator or operators of pollution prevention facilities shall record and maintain the operating status of the relevant pollution discharging and prevention facilities, as prescribed by an Ordinance of the Ministry of Environment when operating discharging facilities and prevention facilities. The Minister of Environment or a mayor/provincial (or Do) governor may require operators to submit the necessary reports or materials to verify whether such facilities meet the standards for effluent water quality. Public officials appointed by the Minister of Environment have the right to conduct inspections.
- In Laos, according to the Regulation on Wastewater Discharge from Industrial Processing Factories issued in 2005 (by then Ministry of Industry and Handicrafts, now the Ministry of Industry and Commerce), all industrial factories are required to install wastewater treatment systems and the necessary facilities to monitor and analyze water

samples discharged. The monitoring report results are then submitted to the Director of the Industry or Department of the Ministry from the respective province. The industry department may dispatch factory environmental inspectors, who are permitted to enter all areas within factories to inspect, observe, measure, sample and monitor wastewater discharged into public water bodies.

- In Malaysia, monitoring of effluent, as well as recording and maintenance of the monitoring results are obligations that all premises are required to fulfill under the environmental regulations on sewage and industrial effluents. All premises are required to submit monthly effluent discharge reports to the Department of Environment (DOE), either by the online reporting system or hardcopy submission. Authorized DOE officials can carry out inspections of all premises, including surprise inspections, to ensure compliance with all provisions in the act, and non-compliance results in immediate penalties to polluters.
- In Myanmar, the monitoring of effluent water quality comes under the responsibility of the Environmental Conservation Department and they act based on the need.
- In Nepal, mechanisms and procedures are guided by the water quality monitoring framework, guidelines and responsibilities under relevant ministries or departments dealing with drinking water, industry, and agro-farms.
- In the Philippines, monitoring in industries is conducted at different levels, and can only be carried out by the subjects needing to comply with effluent standards themselves, in principle. The documents to be submitted include monitoring reports (self-monitoring), plans, required permits (discharge permits) or other proof of compliance or implementation. Field monitoring for verification involves actual plant inspection, effluent sampling and validation of submitted reports. The EMB Central Office and/or EMB-Regional Offices supervise the monitoring of wastewater.
- In Sri Lanka, in principle, effluent quality is monitored by the CEA laboratories (central and provincial), laboratories registered under the CEA, or self-monitored by the discharging industry concerned. Effluent quality reports are to be submitted as per the conditions in the license issued by the CEA. Based on the pollution potential, the conditions dictate the submission of effluent quality reports to quarterly, biannually or annually, as decided by the CEA. Industries also submit effluent quality reports from third party laboratories recognized by the CEA. CEA occasionally monitors and inspects effluents discharged from licensed industries as well as investigates suspected cases of noncompliance such as those based on complaints received from the public.
- In Thailand, under the Enhancement and Conservation of National Environmental Quality Act, the owner or processor of point source pollution is designated to monitor the quality of effluent and collect statistics and data, as well as submit notes and reports. The Ministry of Industry and MNRE have the right to conduct inspections of industries.
- In Viet Nam, investment projects, businesses, dedicated areas for production, business operation and service provision and industrial clusters that release waste into the environment must carry out monitoring as stipulated in the Law on Environmental Protection 2020 and under laws or legal documents, and in accordance with environmental technical regulations. They also need to report their results to MoNRE. MoNRE has the right to conduct inspections of industries at any time.

(3) Encouraging industry to comply with regulations (penalties and incentives)

Despite the existence of various laws and policies for water resource management, its effectiveness is poor in many countries due to the lack of robust enforcement mechanisms. Among the enforcement mechanisms, the most commonly used methods are penalty and incentive schemes. Penalty systems are sometimes ineffective in promoting compliance as they can be interpreted as being suppressive. Therefore, governments attempt to raise compliance through other measures, such as providing incentives for abiding to guidelines. Examples of WEPA partner country initiatives on penalties and incentives are listed below:

- Cambodia applies a penalty and incentive mechanism for factories or business owners who violate laws and regulations. Such penalties can take the form of administrative orders to correct minor infractions. However, penalties can be imposed for more serious violations. Cambodia's MoE is committed to combating environmental pollution by strictly enforcing existing laws and regulations. At the same time, MoE provides an incentive mechanism for factories or business owners who comply with environmental regulations, such as the issuance of certificates of compliance for factories for completely installed self-monitoring equipment and data management for wastewater discharged.

- In China, robust systems for both penalties and incentives exist. Penalties for legal violations include a warning period, order to cease production for rectification, and order to close down. For incentives, although every person or company in China has an obligation to protect the water environment, the government and its relevant competent departments commend and reward parties who have made outstanding contributions in the prevention and control of water pollution.
- Indonesia makes use of the PROPER program (Corporate Environmental Performance Rating Program), which encourages industries to comply with environmental regulations by publishing their environmental performance, including whether they meet designated effluent requirements.
- Japan has introduced provisional effluent standards of lighter punishments for specific types of industry that do not currently meet the original standards in order to encourage technical improvements over certain time periods. However, any entity in violation of orders pursuant to provisions is subject to imprisonment or a fine. For incentives, special tax breaks for investment in facilities or equipment are available for pollution control and prevention of public harm, such as reduced property tax rates for investment in wastewater treatment facilities. Loan programs also exist for small and medium-sized businesses to finance pollution prevention facilities, including those aimed at preventing water pollution.
- Korea employs a combination of strict regulatory enforcement, economic incentives and technical support. Non-compliance is addressed through penalties, including fines, temporary shutdowns, or revocation of operating licences. For economic incentives, industries that adopt advanced treatment technologies or achieve performance exceeding regulations are often rewarded with tax benefits, subsidies or reduced fees. The government also offers training programs and expert consultation to assist facilities in meeting compliance requirements.
- Malaysia also has rules to exempt the immediate need for compliance with effluent standards for treatment facilities under construction or undergoing upgrades. For incentives, both technical guidance and monetary benefits are provided to industries willing to adopt the Industrial Effluent Treatment System (IETS) for pollution control.
- In Myanmar, when violations of effluent standards are found, a written warning is sent to the industry concerned to correct current activities and comply with the relevant laws and effluent guidelines. If this fails to solve the pollution issue, an operation suspension notice is issued.
- The Philippines provides rewards to individuals, private organizations and other entities from the National Water Quality Management Fund for outstanding and innovative projects, technologies, processes and techniques, and activities.
- In Sri Lanka, the EPL (Environmental Protection Licensing) scheme, which started in 1990, is required for all entities in the country that discharge wastes into the environment, as prescribed by regulation published under the NEA, and licenses vary according to the pollution potential of the industry (Type A, B and C). Non-compliance or violation results in suspension or cancellation of licences and filing of cases, as well as minimum fines of 10,000 LKR, imprisonment, or both, as determined by the NEA. For incentives, loan programmes initiated by the Ministry of Industry are available for small and medium scale industries to encourage them to adopt effluent management system in their premises. Technical guidance for industries to control pollution is also another strategy introduced in order to induce industries to comply with regulations.

5 | Domestic Wastewater Management in Urban Areas

Water resources are polluted by untreated wastewater from human activities, and domestic wastewater is a particular concern in densely populated areas. Wastewater treatment is necessary to protect the water environment, and centralized and decentralized wastewater treatment technologies are used to treat domestic wastewater. In centralized systems, both greywater (wastewater discharged from kitchens, laundries, bathrooms) and blackwater (wastewater discharged from toilets including human waste) are treated. In decentralized systems, blackwater is treated, but greywater treatment depends on the type of system. For instance, septic tanks treat only blackwater while environmentally friendly waste treatment plants called Johkasou treat both greywater and blackwater. Moreover, even if septic tank or decentralized systems are installed, they will not perform as expected if not properly maintained. To address and prevent further water pollution in public waters, all types of domestic wastewater need to be properly treated.

Building centralized systems requires more time and capital than decentralized systems, particularly in built-up areas that have already been developed, owing to the extensive construction work required. Therefore, it may not always be an economically or environmentally feasible option for many of the partner countries. Table 1.8 shows the main wastewater treatment methods used in urban areas and nationwide sewerage coverage in the partner countries.

Rates of connection to centralized systems have increased over the past 20 years, but septic tanks are still the system in main use in some countries. All wastewater treatment systems require proper operation and maintenance (O&M) to enable the release of wastewater to public waters, but the responsibility of O&M is often not clearly specified for privately owned decentralized wastewater systems. If systems are not operated properly or de-sludging is not regularly carried out, their use does not contribute to maintaining the water quality. Developing rules and guidelines and obtaining the understanding and importance of O&M for all related parties is needed.

Table 1.8 Major wastewater treatment systems employed in urban areas and nationwide sewerage coverage

Country	Decentralized wastewater treatment system	Centralized wastewater treatment system (Sewerage connection)
Cambodia	–	NA
China	Septic tank	219,000 km (2004)* 914,000 km (2022)* 33% (2004)**
Indonesia	Septic tank Communal sewerage system	12% (2017)***
Japan	*Johkasou*	62% (2000)* 81% (2023)*
Korea	–	71% (2000)** 94% (2021)**
Laos	Septic tank *Johkasou* BORDA-DEWATS	–
Malaysia	Communal septic tank Individual septic tank Traditional system (soak pit)	60% (2007)** 83% (2019)**
Myanmar	Conventional treatment system MBBR system (Yangon and Mandalay)	–
Nepal	DEWATS system Septic tank	70% in Kathmandu Valley (2019)****
Philippines	Septic tank	27% (2023)*****
Sri Lanka	Septage treatment plants operated by local government On-site sewage treatment such as septic tanks Onsite sanitation coverage 83.2%	2.1% (2022)*
Thailand	Onsite treatment (most large buildings or at point sources) Onsite treatments (small to medium buildings or pollution point sources)	15% (2023)*
Viet Nam	Onsite systems (septic tanks are dominant in urban areas, and dry or other simple types of latrines/toilets are popular in rural areas). Decentralized wastewater treatment systems (peri-urban, small and medium buildings, etc.).	15% (2022) ******

*: Information from FP; **: UN data, n.d.; ***: Said, 2017; ****: JICA and Yachiyo Engineering, 2019; *****: MWSS, 2023, ****** Vietnamplus.vn

While it is challenging to obtain the understanding of owners of decentralized wastewater treatment systems of the importance of O&M and for performing it properly, centralized systems also involve issues related to maintaining system functionality sustainably. The chief unresolved problem is collecting and raising service fees—the costs for operating, maintaining, and upgrading the system need to be covered by the service users. However, when a system is newly developed in a country where sewerage systems are not the key wastewater treatment system, collecting service fees is challenging because residents are not used to paying the fee. Even in countries where sewerage systems are widely used, raising fees is not easy. Service fees are collected in a variety of ways, including ways that residents cannot refuse to pay. Table 1.9 shows methods of collecting the service fees in selected WEPA partner countries.

Table 1.9 Sewerage service fee system in selected countries

Country	Existence of service charges	Charging system
Cambodia	Yes	2.5–1,125 USD/month based on the building category is collected for centralized wastewater treatment facilities (implemented by the Department of Public Work and Transport).
China	Yes	Drainage entities and individuals shall pay the sewage treatment fee in accordance with the relevant provisions of the state. Drainage entities and individuals that discharge sewage into urban sewage treatment facilities and pay the sewage treatment fee shall no longer pay the sewage discharge fee.
Indonesia	Yes	Depending on WWTP: fees calculated based on m^3 of wastewater discharged, included as some portion of water bill, or monthly fixed fee**
Japan	Yes	Sewer service fees are often included in water bills, which users pay to local governments*
Korea	Yes	Local governments are responsible for collecting sewage fees, based on Article 61 and Article 65 of the Sewerage Act; fees vary between local governments and are calculated in accordance with Ministry of the Interior and Safety rules.***
Laos	No	Ongoing projects in Vientiane Capital and Pakse to introduce a system to collect fees for residential sewer connection in the near future
Malaysia	Yes	Tariff charges are based on the Water Services Industry Act 2006: Water Services Industry (Sewerage Services Charges) Regulations 2022. Domestic households are charged a minimal rate for sewerage services on a monthly basis. This act also integrates drinking water and sewerage services, providing a level of holistic management to water supply since supply can be cut for users who default on paying charges.****
Myanmar	Yes	(In Mandalay) The sewer service user pays the sewage truck rental fee, which is then collected by the local government.
Nepal	Yes	Sewer tariff is set at 50% of water consumption fee and is charged for customers with sewerage connection (Kathmandu Upatyaka Khanepani Limited)
Philippines	Yes	Fees to connect to a sewage treatment system vary by location, local government unit (LGU) policies, and specific requirements of properties. Costs generally include connection fees (often set by the local water district or utility provider), service fees (typically billed monthly or quarterly), and local ordinances (some LGUs may impose additional fees or taxes to cover the expenses of sewage treatment facilities).
Sri Lanka	Yes	Sewer system users pay a connection fee and monthly fee to National Water Supply & Drainage Board (NWSDB)
Thailand	Yes	Guidelines are established for collecting wastewater treatment fees for local administrative organizations; those with community wastewater treatment systems are encouraged to implement fee collection. The Pollution Control Department has developed a calculation program named WISE to determine rates for community wastewater treatment services, including the operational costs of wastewater treatment systems. (https://dowmat.pcd.go.th/wise/)
Viet Nam	Yes	Governmental Decree No. 53/2020/ND-CP regulates environmental protection fees for both domestic and industrial wastewater: domestic wastewater is 10% of the selling price of 1 m^3 of clean water, excluding value-added tax. If higher fees are called for, the People's Council of the province or centrally-run city decides on specific rates.*****

*: Information from FP; **: US AID, 2006; ***: Yoo and Park, 2022; ****: Indah Water Consortium, n.d. and SPAR, n.d.; ***** Government Electronic Information Portal, n.d.

6 | Pollution Load Control

Currently, several WEPA partner countries such as China, Indonesia, Japan, Korea, and Viet Nam actively implement pollution load control approaches such as TMDL (total maximum daily load) to manage their water quality, as shown in Table 1.10. Parameters introduced in these countries, such as biochemical oxygen demand (BOD), chemical oxygen demand (COD), total nitrogen (T-N), total phosphorus (T-P), total suspended solids (TSS), and ammoniacal nitrogen (NH_3-N), are critical for evaluating the overall health of water bodies and ensuring compliance with water quality standards.

- In China, a pollutant discharge permit system is implemented wherein local governments issue permits specifying allowable pollution amounts for enterprises, which is aimed at regulating the discharge of pollutants into the environment and ensuring compliance with national environmental standards. Local governments are responsible for supervising these enterprises based on the conditions outlined in the issued permits, which are typically valid for five years. During this time, enterprises are required to conduct self-monitoring and report their emissions to relevant local authorities to ensure adherence to the specified limits.
- In Japan, where achieving EWQS is a challenge, the Total Pollution Load Control System (TPLCS) sets target years and reduction goals for enclosed water bodies linked with high population and industry densities. MOEJ provides the Basic Policy for Total Emission Reduction, and prefectural governors establish reduction plans. Operators of facilities discharging 50 m^3/day or more, such as plants, wastewater treatment plants, and others, must report pollutant loads annually to the prefectural governments.
- Korea has been running a system called the Total Pollution Load Management System (TPLMS) since 2002, with local governments in charge of formulating pollution load reduction plans. Revisions of pollutant loads occur every eight-to-nine years for the Han River and every five years for the other three rivers.
- In Indonesia, MoEF has mandated assessments for the development of TMDL in 15 priority watersheds. However, only a small number of local governments have successfully carried them out, thus hindering the practical application of TMDL calculations. In addition, those that have completed TMDL calculations often do not utilize the results for the issuance of wastewater discharge permits. This lack of integration suggests that many local governments have not incorporated TMDL findings into their permit processes, which contributes to the ongoing decline in water quality nationally.
- In Viet Nam, MONRE is responsible for evaluating the carrying capacity (also known as the self-purification capacity) of surface water in major inter-provincial rivers and lakes to determine appropriate discharge quotas. Meanwhile, people's committees at the provincial level manage capacities and quotas for wastewater discharge within their respective jurisdictions. National monitoring of water quality and environmental compliance is overseen by MONRE, while provincial monitoring is conducted by provincial people's committees. Businesses and industrial projects are required to perform regular monitoring in accordance with the Law on Environmental Protection 2020 and Decree No. 08/2022/ND-CP, which outlines specific environmental management responsibilities and requirements for compliance. Assessments of pollutant loads and discharge quotas are reviewed every five years to ensure they remain relevant and effective in protecting water quality and managing pollution levels.
- In the Philippines, efforts are underway to implement TMDLs, particularly in areas with significant water quality issues. However, the process is complex and still in its early stages, and faces challenges such as limited technical capacity, funding constraints, and the need for comprehensive water quality and pollutant data coverage, and involves multiple stakeholders, including government agencies, local communities, and industries. The Department of Environment and Natural Resources (DENR) is leading initiatives to improve water quality through better management and stricter regulations.

Table 1.10 Targets and parameters of pollution load control system by country

Country	Target	Parameters
China	Surface water (rivers, lakes, reservoirs)	COD, TN, TP
Indonesia	Priority rivers and lakes: Citarum, Ciliwung, Cisadane	BOD, COD, TSS
Japan	Tokyo Bay Ise Bay Seto Inland Bay (including Osaka Bay)	COD, N, P
Korea	Four major rivers: Han River, Nakdong River, Geum River, Yeongsan Rive	BOD, TP
Viet Nam	Inter-provincial rivers and lakes Provincial rivers and lakes	COD, BOD, Ammonium, TP, TN

7 | Sustainable Development Goals (SDGs)

The 2030 Agenda for Sustainable Development was set after the Millennium Development Goals (MDGs), and the global community has set strategies to achieve the 17 Sustainable Development Goals (SDGs) by 2030. While the global community was making efforts to address the problems to meet the goals, the pandemic of COVID-19 effectively stalled such efforts. The advent of the pandemic, as well as the measures taken to combat it, extending over two years or more, did manage to reduce overall environmental impacts to some extent, but economies were severely impacted. Ignoring geopolitical factors, instability, and trade frictions in various regions, which each have their own ramifications, society globally could be considered to have returned to normal—a situation now referred to as the new normal—and actions aimed at achieving the SDG targets are gradually restarting. Unlike the MDGs, which mainly focused on basic human needs, the SDGs include targets for various social, economic, and environmental topics, with 17 related goals. Of the goals, SDG 6 aims to improve water quality through wastewater treatment, implement integrated water resources management, and protect and restore water-related ecosystems. It has six targets and 11 indicators.

WEPA was launched to improve the water environment in Asia by strengthening the related governance and public administration mechanisms through sharing knowledge and experiences, and SDG 6.3: 'By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally' overlaps with WEPA's main objective.

There are two indicators to assess progress, SDG 6.3.1 and 6.3.2, and each country has set local indicators to track their achievement, as shown in Table 1.11. The content in the table was composed from responses from the partner countries or data drawn from the SDG progress reports prepared by each country.

WEPA focuses on domestic and industrial wastewater, as they can both greatly deteriorate water quality, and provides a platform for discussing and sharing measures to address the problems as well as the monitoring frameworks in place or needed. As can be seen from the table, data on treated wastewater from industries is available in many WEPA partner countries, but the key aspect is safety, and it is a challenge to assess 6.3.1 in terms of the proportion of domestic wastewater treated safely. According to a UN report, 60% of water bodies monitored exhibited good surface water quality; however, it also reported that the lack of data is a key problem, and that efforts are needed to address agricultural and domestic wastewaters (UN 2023). Overall, the ambient water quality is deteriorating due to untreated domestic wastewater, as described for each country in Chapter 2. Although partner countries are working to address this problem, rates of treated domestic effluent are often not easy to grasp. In contrast, assessing 6.3.2, the proportion of water bodies with good ambient water quality, can be achieved in most WEPA countries owing to regular monitoring of surface water quality. Some partner countries use a water quality index while others use concentration-based water quality standards to determine conformity. In the former case, the proportion of water bodies falling in the 'good water quality' index is reported, as in Cambodia, China, Indonesia, and Korea.

Table 1.11 Local indicators to assess progress toward SDG target 6.3.

Country	6.3.1: Proportion of wastewater safely treated	6.3.2: Proportion of water bodies with good ambient water quality
Cambodia*	• Amount of wastewater safely treated of the total wastewater • Wastewater treatment coverage • Self-monitoring and data management equipment	Water Quality Index (WQI) is used to explain public water quality status
China*	Centralized sewage collection rate, sewage treatment rate	Grade I water quality index and Grade II water quality ratio
Indonesia	Percentage of industrial liquid waste processed safely	Surface water quality as raw water (water quality index)
Japan*	Proportion of safely treated domestic and industrial wastewater (%)	Achievement of human health-related and living environment-related standards (%)
Korea	Proportion of domestic and industrial wastewater flows safely treated	Proportion of bodies of water with good ambient water quality (number of water bodies classified as 'good quality' compared to number of assessed water bodies, expressed as a percentage)
Laos	Percent of population using water for drinking free from zero e-coli sources	Quality of water in the bodies of water
Malaysia	Proportion of safely treated domestic and industrial wastewater flows (%)	Proportion of water bodies with good ambient water quality (%)
Nepal	Proportion of untreated industrial wastewater; percentage reduction of untreated domestic wastewater	–
Philippines	Volume of wastewater treated	Proportion of monitored bodies of water with good ambient water quality (DO, BOD)
Sri Lanka*	Proportion of safely treated wastewater out of total wastewater generated from industrial processes as prescribed in EPL regulation	(a) 35 water bodies monitored by 2030 (b) Microbiological parameters such as total coliform and fecal coliforms. Implementation of heavy metal analysis for all selected 35 water bodies by 2030 is under consideration.
Viet Nam	Proportion of urban wastewater collected and treated meeting standards and technical regulations	Proportion of industrial parks and export processing zones with centralized wastewater treatment systems satisfying environmental requirements

* Responses from WEPA FP

As summarized in Chapter1, efforts have been made such as establishing a basic framework for water environment conservation and pollution prevention, and settling up water environmental quality standards at different administrative scales. However, challenges such as capacity building for government officers in charge of water environment management, sharing of up-to-date scientific information needed for tackling emerging environment pollutants, financing schemes for building required infrastructures to support diligent monitoring and evaluation, and development of robust policies to safeguard water environments and ecosystems in a sustainable manner still remain to be addressed, as evident from past WEPA outlooks and other publications. Addressing these challenges requires a holistic understanding of all key players in this complex system, as well as the socio-economic attributes, cultural and demographic signatures, and cooperation and coordination between institutions, all of which shape the evolution of the water environment. To this end, WEPA emphasizes the concept of adaptive management, which promotes an approach involving knowledge sharing and co-learning through implementation of customized versions of the best practices on the ground based on local conditions. The chapter aims to foster mutual understanding and learning among WEPA partner countries while providing information that can serve as a reference for addressing common challenges. In the next chapter, frameworks for water environment management in the 13 countries, focusing on the current state of water environments, legal systems, organizational structures, surface water, industrial wastewater, and urban sewage management, pollution load reduction measures, and recent trends and future challenges in water environment, are highlighted.

Chapter 2

Country Profiles of Water Environmental Management in WEPA Countries

2.1 Cambodia

1 | Country Information

Table 2.1.1 Basic indicators

Land area (km²)		181,035 (2024)*
Total population		17 million (2024)*
GDP (current USD)		31.77 billion (2023)**
Per capita GDP (current USD)		1875 (2023) **
Average annual rainfall (mm/year)		1,836 (1991-2020) ***
Total renewable water resources (km³)		488 (2021)****
Total annual freshwater withdrawals (billion m³)		2.184 (2021)****
Annual freshwater withdrawal by sector	Agriculture	94% (2021)****
	Industry	1.51% (2021)****
	Municipal (including domestic)	4.49% (2021)****

(Source: *World population Review Database, ** World Bank 2024a., ***World Bank 2024b, FAO Aquastat)

Figure 2.1.1 Tonle Sap Lake

2 | State of Water Resources

Cambodia is located in the middle reach of the Lower Mekong Basin and 86% of its land area, including Tonle Sap Lake (TSL), drains into the Mekong River (FAO 2020). The floodplains, TSL, and the Mekong Delta are the major sinks of sediments and nutrients, which are essential for aquatic ecosystems and agriculture. The Mekong-TSL is one of the world's unique aquatic ecosystems, in that high flow conditions of the Mekong River in the wet season induces reverse flow through the TSL River into the lake. Due to this reverse flow, as well as runoff from tributaries around the lake, the TSL transforms in size by six times on average, reaching approximately 13,000 km², with an average depth of 8–10 m (TSA 2015).

In the subsequent dry season, water draining out of the lake is critical for the overall flow condition in the downstream Mekong Delta. The Bassac River splits away from the mainstream Mekong River and then further splits into numerous channels, forming a wedge-shaped delta in Vietnam. The Mekong Delta is a major grain basket for both Cambodia and Vietnam. This distinctive hydrological cycle and associated sediment and nutrient regime is vital for aquatic biodiversity, including migrating fish, and Tonle Sap Lake forms the sole source of livelihood for about 40% of Cambodia's population (MRC 2010).

Cambodia has an ample supply of water, mainly from the Mekong River, Tonle Sap River, Bassac River and other tributaries, but most parts of the country encounter water shortages during the dry season, especially for domestic and irrigation uses. Water in Cambodia remains regulated only in part, resulting in an overabundance of water during the rainy season and deficiency in the dry season.

Groundwater availability is estimated at 17.6 billion m³ (MoWRAM 2012), which is primarily used for household water supply, irrigation and industry. In the Cambodia-Mekong River Delta Aquifer, groundwater storage is declining at a rate of approximately 0.68 cm per year, resulting in a total volume loss of 18.28 km³ over a 14-year period (2003–2016) (Upadhyay et al. 2024). For example, an average groundwater level decline of 14 cm per year was reported for wells in Prey Veng and Svay Rieng between 1996 and 2008 (Johnston et al. 2013).

3 | State of Ambient Water Quality

(1) Rivers

The water quality of rivers was assessed as good and water pollution is not considered to be a significant problem (MOEC 2020). However, in recent years water quality deterioration has been reported in river water bodies. Water quality monitoring conducted by the Department of Water Quality Management, Ministry of Environment of Cambodia (MOEC) at the Chroy Changva Station of the Mekong River revealed a rising trend in nutrient pollution in river water compared to 2011 (see Fig. 2.1.2). Although concentrations of total nitrogen (T-N) remained below the national standard value, they exceeded it in 2018 and 2019. Total phosphorus (T-P) concentrations exceeded the national water quality standard from 2012 to 2019. However, biological oxygen demand (BOD), and chemical oxygen demand (COD) values imply that organic pollution is low.

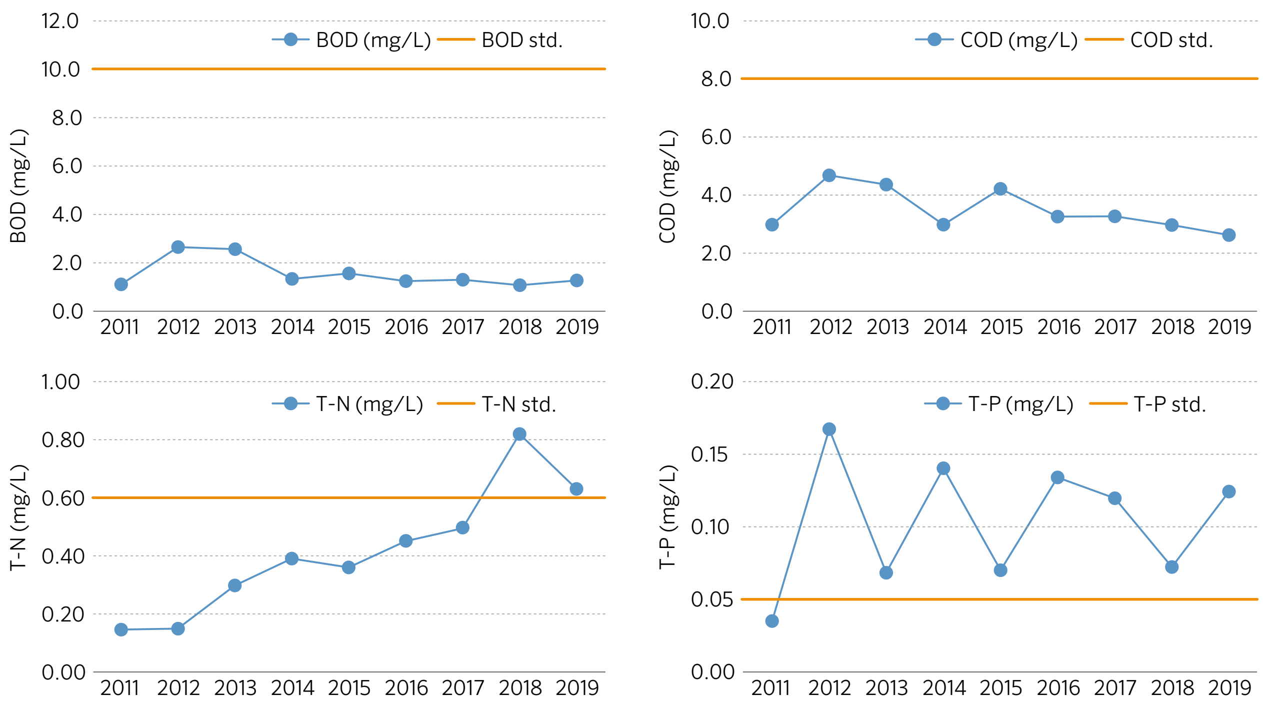


Figure 2.1.2 Water quality of Mekong River at Chroy Changva station (Source: MOEC 2020)

(2) Lakes and reservoirs

Tonle Sap Great Lake (TSL) is the largest freshwater lake and a unique 'flood-pulse' system in Southeast Asia. It covers an area of 13,000 km^2 during the rainy season and shrinks to 2,500 km^2 during the dry season. About 1.7 million people live in 1,037 fishing villages of TSL and surrounding floodplains and their livelihoods directly depend on TSL's resources (Shivakoti and Bao 2020). However, the livelihoods of millions of local residents are being affected by degradation of the TSL water environment due to the inflow of anthropogenic pollutants (Ung et al. 2019). The water quality of TSL was monitored by the Department of Water Quality Management, MOEC at the Chhnok Trou village from 2011 to 2019, which also revealed deterioration of water quality (see Fig. 2.1.3). However, according to the monitoring data, both BOD and COD values remained well within the national water quality standard for lakes, which implies organic pollution is not a major issue for water environment management of TSL.

In contrast to BOD and COD, concentrations of T-N and T-P exceeded the water quality standard for most of the monitoring period, which indicates TSL water could be highly polluted by agricultural sources, such as runoff of fertilizer and manure, as well as household products such as soap and detergent.

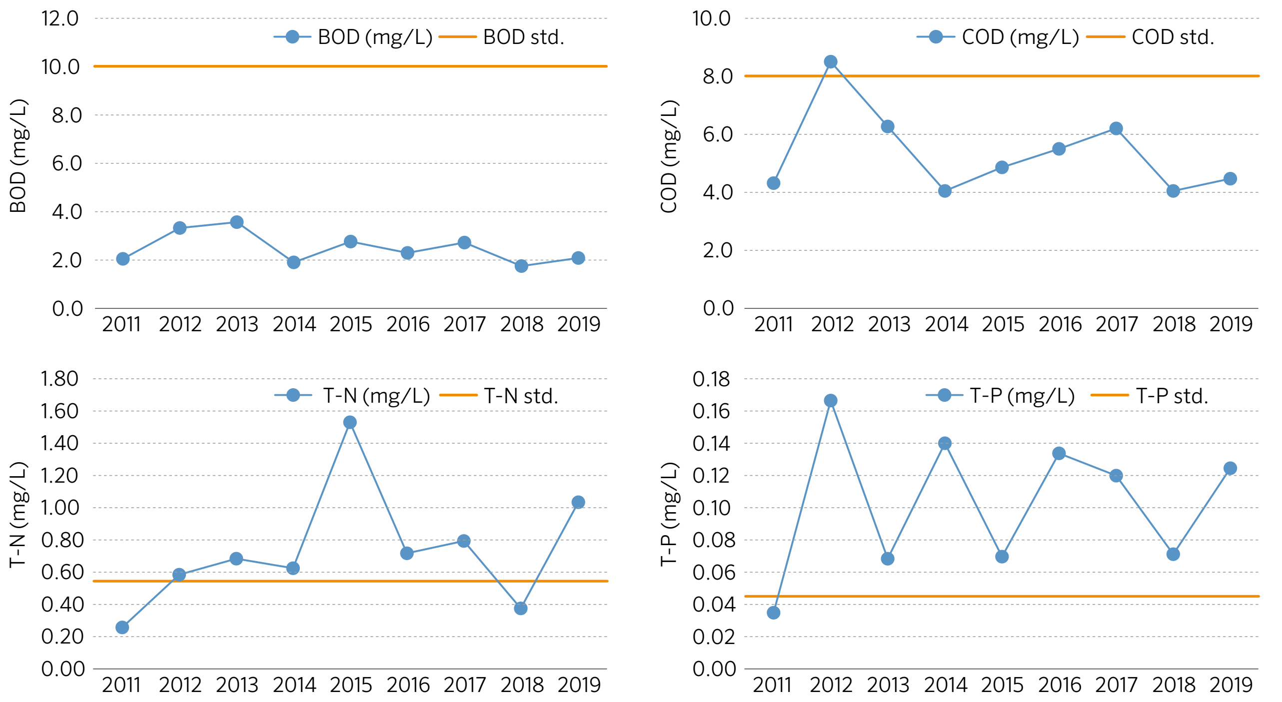


Figure 2.1.3 Water quality of Tonle Sap Lake at Chhnok Trou village, 2011–2019 (Source: MOEC 2020)

(3) 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, which has an area of 55,600km^2. The landward boundary of the coastal zone is currently not specifically defined, but is 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, the quality of coastal water is considered to be fairly good, but development activities such as in economic zones and seaports may degrade coastal water and coastal ecosystems if sound management of solid and liquid wastes generated from such activities is not properly implemented. According to the monitoring results for 2018, concentrations of T-N, T-P and oil and grease exceeded the national water quality standard for coastal water, which indicates anthropogenic activities are the main threats for the coastal water environment.

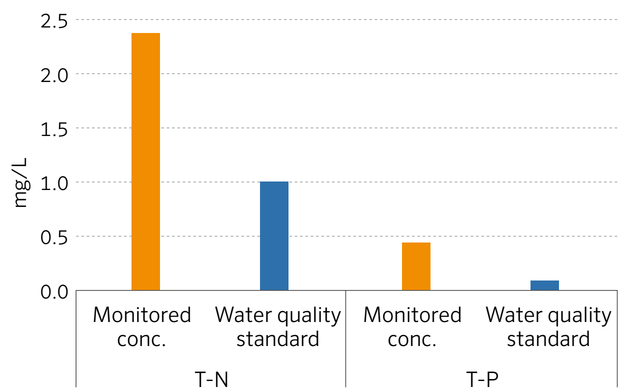


Figure 2.1.4 Coastal water quality in Kep Municipality, 2018
(Source: MOEC 2020)

(4) Groundwater

Groundwater in Cambodia is generally of good quality, and dependency on groundwater as a source of domestic water ranges from 62–100% (MoWRAM 2008). However, high levels of arsenic, iron, manganese, fluoride, and total dissolved solids (salinity) are observed in some areas (UNDP 2020). Arsenic concentrations in groundwater in many parts of Cambodia exceeded both the WHO standard of 10 mg/L and the Cambodia National Drinking Water Quality Standard of 50 mg/L. Many shallow wells are also contaminated by fecal coliform (IWMI 2013).

4 | State of Wastewater Treatment

Sewerage and sanitation in Cambodia are improving, and in most provinces the construction of wastewater treatment plants (WWTP) is being studied. In general, wastewater is primarily treated by septic tanks and discharged to the environment. As of 2019, only three centralized wastewater treatment plants (CWTPs) were in operation, located in Battambang City, Siem Reap City and Preah Sihanouk City (Rady 2020). Further, Phnom Penh has natural lagoons that receive wastewater from the drainage system. The current centralized WWTPs can treat only 5% of urban wastewater (Heng 2019). Monthly service fees are collected by the Department of Public Work and Transport for the centralized wastewater treatment facilities, such as in Preah Sihanouk City, where fees range from 2.5 to 1,125 USD per building based on building category. Cambodia has prioritized the development of sewerage systems and centralized wastewater treatment in several locations, and an urban wastewater management plan has selected priority towns for future centralized WWTPs (see Table 2.1.2). In addition to centralized systems, NGOs such as ESC-BORDA promote decentralized wastewater treatment solutions (DEWATS) in schools, communities, hospitals, and small and medium-sized enterprises. To date, ESC-BORDA has implemented 62 DEWATS across Cambodia (BORDA 2017).

Table 2.1.2 List of existing and future centralized wastewater treatment plants

Location of centralized WWTP	Approx. capacity (m^3/day)	Status
Battambang City	2,800	In operation
Siem Reap City	8,000	In operation
Preah Sihanouk City	60,000	In operation
Poipet City	3,000	Feasibility study
Srei Saophonae City	3,000	Feasibility study
Kampot City	6,000	Feasibility study
Kep City	3,000	Feasibility study
Phnom Penh	5,000	In operation
Takmao City	12,000	Feasibility study
Pursat City	6,000	Feasibility study
Kratei City	6,000	Feasibility study
Steung Sen City	3,500	In operation
Bavit City	3,000	Feasibility study

(Source: Heng 2019 and information from FPs)

5 | Frameworks for Water Environmental Management

(1) Legislation

Article 59 of the Constitution of the Kingdom of Cambodia covers the protection of the environment and the ownership of natural resources. The current legislative framework for water environment management in Cambodia is shown in Fig. 2.1.5. The stated objective for natural resource management is to protect and promote environmental quality and public health, including water (Article 1, Law on Environmental Protection and Natural Resource Management). The Law on Water Resources 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).

Details on water environmental conservation measures can be found in the Sub-decree on Water Pollution Control, established in 1999 under the Law on Environmental Protection and Natural Resources Management. This 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 this law, such as the Sub-decree on Solid Waste Management and the Sub-decree on Environmental Impact Assessment Process, also contain articles related to water environmental conservation.

The sub-decree on Water Pollution Control (6 April, 1999) has been amended by Sub-decree 103 on the amendment of Sub-decree 27 on Water Pollution Control (29 June, 2021) and Sub-decree 235 on Management of Sewage and Wastewater Treatment System (25 Dec, 2017). A new Environmental Code and Natural Resources has been endorsed (13 June, 2023) to reflect the current context and conditions in Cambodia.

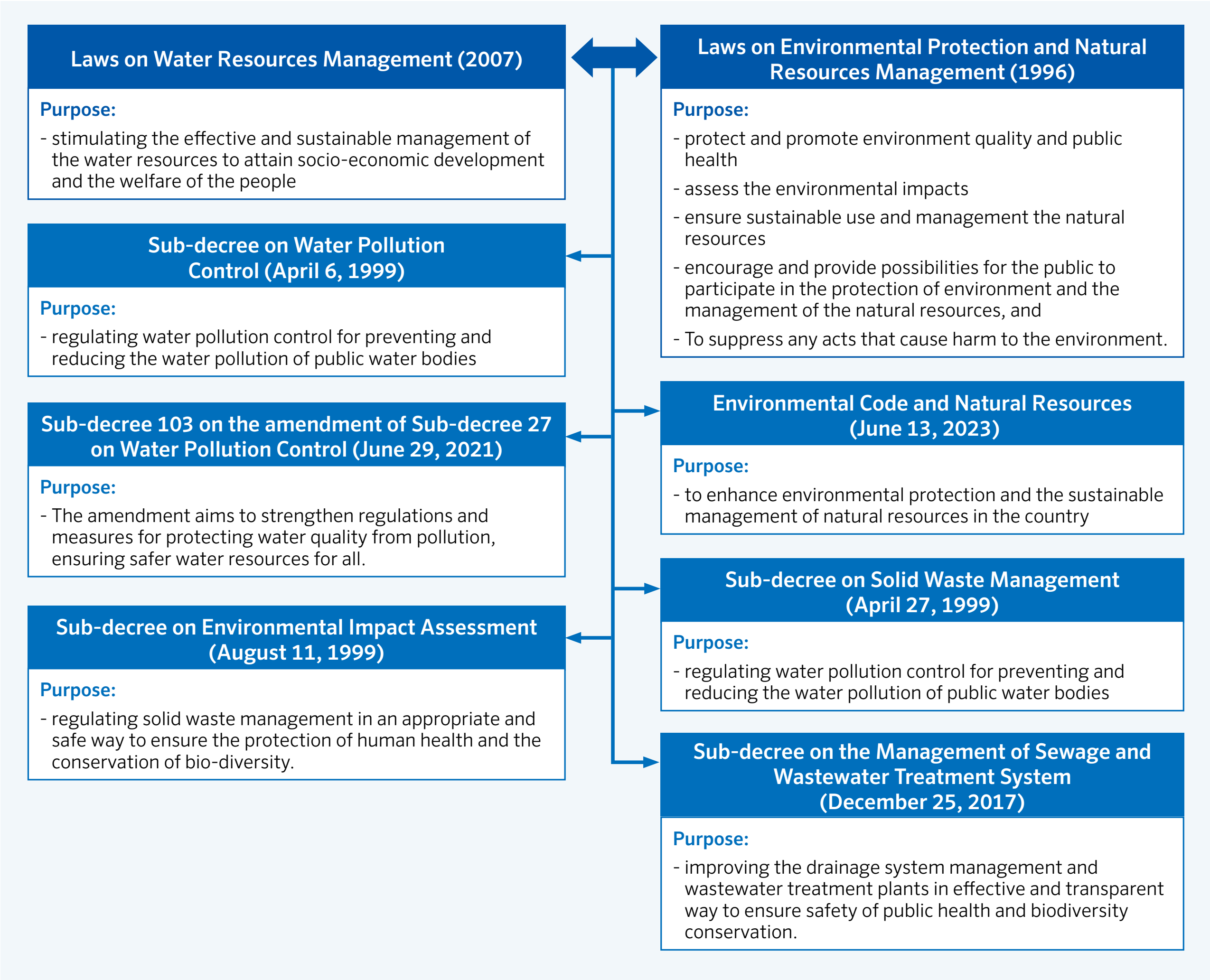


Figure 2.1.5 Legislative framework of water environment management in Cambodia

(Source: Prepared by WEPA Secretariat based on information from FPs)

(2) Institutional arrangement

In Cambodia, several ministries deal with water environment management (see Table 2.1.3). The Ministry of Environment of Cambodia (MOEC) is responsible for protection and management of the environment and natural resources in the country based on the Law on Environmental Protection and Natural Resource Management (Article 9), and local authorities such as provincial and municipal environmental departments are in charge of water environmental management, such as water quality monitoring. Sub-Decree 234, issued on November 17, 2021, outlines the organization and functioning of MOEC, which include policy formulation, regulatory oversight, monitoring and enforcement. The Ministry of Water Resources and Meteorology (MoWRAM) was established in 1999 as the lead water sector agency, and exercises overall responsibility for water management and conservation, including Integrated Water Resource Management (IWRM). The Ministry of Public Works and Transport (MPWT) is responsible for urban wastewater management. Other important agencies include the Ministry of Industry Science Technology and Innovation (MISTI), the Ministry of Rural Development (MRD), and the Tonle Sap Authority (TSA).

Table 2.1.3 Institutional arrangement of water environment management in Cambodia

Agency	Responsibilities
MOEC	The main strategic pillars of MOE include environmental protection, biodiversity conservation, conservation and sustainable use of natural resources and sustainable livelihood. Specific responsibilities of MOE are outlined below: • Assess the environmental impact (environmental impact assessment; EIA) of all existing and proposed projects/activities (Article 6) • 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 natural resources (Article 9) • Develop inventories of pollution sources (Article 12) • Develop sub-decrees 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 issue improvement order in cases of violations (Article 20)
MoWRAM	• Water management and conservation through Integrated Water Resource Management (IWRM)
MPWT	• Urban wastewater management
MISTI	• Drinking water supply for cities and towns
MRD	• Clean water supply for rural areas
TSA	• Coordinate the management, conservation, and development in Tonle Sap area and relevant areas

(Source: Prepared by WEPA Secretariat based on information from the relevant decrees)

(3) Ambient water quality standards

a. Ambient water quality standards

Ambient water quality standards for public water areas are set by the amendment: Sub-decree 103 on Water Pollution Control (2021). There are two kinds of standards: the first covers public water bodies for biodiversity conservation, which is designated for rivers (10 parameters), lakes and reservoirs (10 parameters), and coastal water (eight parameters); and the second covers public health, which designates standard values for 26 parameters related to harmful effects on human health. There is no groundwater quality standard, but water quality is assessed by standards designated for specific uses, such as national drinking water quality standards.

b. Water quality monitoring framework

Since the promulgation of the Sub-decree on Water Pollution Control in 1999, MOEC has been responsible for regular control and monitoring of water pollution in public water areas throughout Cambodia. MOEC monitors river water quality at 11 points, stream water quality at 14 points, lake water quality at three points, coastal water quality at eight points, groundwater quality at six points, and natural lagoon water quality at two points. Water quality is analyzed at MOEC laboratories. Further, under the Mekong River Commission Water Quality Monitoring Network Program, MoWRAM measures water quality monthly at designated stations in rivers and related tributaries. Details of the water quality monitoring framework are shown in Table 2.1.4.

Table 2.1.4 Water quality monitoring framework of MOEC and MoWRAM

Item	MOE	MoWRAM
Names of monitoring parameters	Surface water: pH, TSS, DO, BOD_5, COD_{Mn}, NO_3-N, TN, and TP Sea: pH, TSS, DO, COD_{Mn}, NO_3-N, TN, and TP	T °C, pH, EC, alkalinity/acidity, DO, COD, BOD, T-P, T-N, NO_3-N, NH_4-N, fecal coliform, TSS, Ca, Mg, Na, K, SO_4^{2-}, Cl.
Number of sampling points	42	19
Frequency of monitoring	Monthly	Monthly
Frequency of publishing monitoring report	Quarterly	-

(Source: Prepared by WEPA Secretariat based on information from the relevant decrees)

(4) Effluent standards

a. Effluent standards

The Sub-decree on Water Pollution Control has been updated to reflect the context of Cambodia. The current effluent standard is based on adoption of Sub-decree 103 on the amendment of sub-decree 27 on Water Pollution Control, which is aimed at managing effluents discharged from pollution sources. The Effluent Standard for Pollution Sources Discharging Wastewater to Public water bodies and Sewers thus established sets standard values for 32 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, MOEC can establish separate effluent standards for pollution sources in the relevant area (Article 5 of the sub-decree).

b. Effluent inspection procedure

Under the Sub-decree on Water Pollution Control, all business operators are obliged to self-monitor effluent and submit periodic reports of results to MOEC. However, as some do not, MOEC conducts regular on-site inspections to check for compliance, which involve taking and analyzing water samples of effluent as well as treated water. Two types of monitoring programs are in place at pollution sources: (i) regular effluent monitoring at normal factories and hotels, (ii), regular effluent monitoring at factories that use chemicals and/or chemical compounds for production.

c. Measures against non-compliance

When violations of effluent standards are found, MOEC issues written orders to industries to correct current activities in order to be in compliance 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 for failure to act on orders issued by MOEC.

(5) Major policies on water environmental management

The major means through which Cambodia has handled water environment management to date have been legislative, in the form of pollution related decrees and laws, creation of an institutional framework—especially under MOEC and MoWRAM—as well as introduction of monitoring and enforcement. One of such measures is the National Water Resource Policy for the Kingdom of Cambodia, developed by MoWRAM in 2014. Its main objectives are:

i. Protect, manage and use water resources in an effective, equitable and sustainable manner
ii. Solve water issues in collaboration with related institutions within public and private sectors
iii. Develop and carry out the national strategy and policy for water resource management
iv. Provide direction for stakeholders in developing, managing and utilizing water resources
v. Achieve the national policy objective on poverty reduction and sustainable national economy development

The National Environment Strategy and Action Plan (NESAP) 2016–2023 was created in accordance with Article 59 of the Constitution of the Kingdom of Cambodia. Additionally, NESAP 2016–2023 aligns with the 1996 Law on Environmental Protection and Natural Resource Management. NESAP guides the institutional, legal and policy development to improve integration of the environmental and natural resources sustainability into policies, strategies, action plans, programs and projects to promote effective and efficient cross-sector collaboration. A draft of the Strategic Plan on Environmental Protection is under development by the MoE.

6 | Recent Developments in Water Environmental Management

There are several developments in government policies that will have significant impacts on water environment management, as follows:

i. Sub-decree on Management of Sewerage and Wastewater Treatment System, enacted on 25 Dec. 2017, which provides a mandate for management of sewage systems and wastewater treatment systems to sub-national authorities.
ii. Environmental and Natural Resources Code, which was approved and declared for implementation in June 2024. The Prakas (official proclamation) on Self-monitoring has been established and is already in force, which aims to enhance monitoring of high risk pollution sources by installing real-time online monitoring equipment and regular reporting to MOEC.
iii. Sub-decree 103 on the amendment of sub-decree 27 on Water Pollution Control, which was approved and which revised effluents standards and the water quality standard.

7 | Challenges and Future Plans

Based on the current state of water quality management in Cambodia, several key management challenges have been identified, as follows:

i. Lack of specific water quality management policy and strategies
ii. Lack of sufficient inter-ministerial coordination for water environment management
iii. Improvement of human resources and institutional capacity, especially MOEC, in order to implement the Cambodian Sustainable Development Goals (CSDG) framework, the National Environment Strategy and Action Plan (NESAP) and the Environment and Natural Resources code (ENRC)
iv. Development of sewers and wastewater treatment to deal with drainage issues and pollution of water bodies; a master plan for sewerage and drainage sector for towns/country is also required
v. Barriers to appropriate management of water quality due to insufficient equipment for laboratory/field testing
vi. Shortage of expert technical officers at national and local levels to carry out adequate water quality management and enforcement
vii. Budget limitations of government, especially for improving capacities in laboratory and water quality monitoring activities in terms of facility infrastructure/equipment, human resources and research

In order to overcome these challenges, the following actions will need to be taken by the line ministries and agencies:

i. Initiation of development of the National Water Quality Management Strategies by MOEC
ii. Strengthening collaboration with other countries for capacity development on water quality monitoring and enforcement
iii. Enhancing cooperation with development partners to construct planned central sewage treatment plants in priority cities
iv. Establishment of inter-ministerial coordination mechanisms to enhance cooperation among line ministries such as Ministry of Environment, Ministry of Water Resources and Meteorology, Ministry of Agriculture, Forestry and Fisheries, Ministry of Mines and Energy, and Council for the Development of Cambodia towards sound management of Cambodia's water environment

2.2 China

1 | Country Information

Table 2.2.1 Basic indicators

Land area (km^2)		9.6 million (approx.) (2023)
Total population		1.4 billion (2023)
GDP (current USD*)		17,889 billion (2023)
Per capita GDP (current USD*)		12,681 (2023)
Average annual rainfall (mm/year)		642.8 (2023)
Total renewable water resources (km^3)		2,478.0 (2023)
Total annual freshwater withdrawals (billion m^3)		590.7 (2023)
Annual freshwater withdrawal by sector	Agriculture	62.2% (2023)
	Industry	16.4% (2023)
	Municipal (including domestic)	21.4% (2023)

(Source: National Bureau of Statistics of China 2024, Ministry of Water Resources the People's Republic of China (MWR) 2024; *RMB = 0.14191 USD in 2023)

Figure 2.2.1 Three Gorges reservoir area of Yangtze River (Wanzhou, Chongqing) (Photo by Li Zhang, 2023)

2 | State of Water Resources

China's total freshwater resources are the fourth largest in the world. However, due to its large population, water resources per capita are only about 1,757 m^3, which is only a quarter of the global average (Ministry of Ecology and Environment of the People's Republic of China, hereinafter MEE, 2021a). China's rivers and lakes are unevenly distributed, with both internal flows, or water systems with flows ending up in internal lakes or basins but not the sea, and external flows, which eventually flow into the sea and external water bodies. The boundary between the outflow and internal flow areas is the northern section along the Greater Khinganling-Yinshan-Helan Shan-Qilian Mountains (east) line, and the southern section along the 200 mm annual iso-precipitation line (Bayankala Mountain-Gangdise Mountain). The southeastern part of the boundary line is the outflow area, accounting for about 2/3 of the total area of the country, and over 95% of the total river water volume. Northwest of the boundary line is the inner flow area, accounting for about 1/3 of the country's total area but less than 5% of the country's total river water.

China has one of the most rivers in the world, and some of the longest, with deep histories. Over 1,500 have drainage areas of more than 1,000 km^2. There are seven major river systems, which from north to south are the Songhua River system, Liao River system, Haihe River system, Yellow River system, Huaihe River system, Yangtze River system and Pearl River system.

There are over 24,800 lakes, of which 2,759 are natural lakes with areas more than 1 km^2. In general, the eastern monsoon area, especially the middle and lower reaches of the Yangtze River, houses the largest freshwater lake group in China. The lakes in the western part of the Qinghai-Tibet Plateau are more concentrated and are mostly inland saltwater lakes.

Table 2.2.2 Overview of China's seven major rivers

Name of river	Drainage area (km²)	Length (km)	Flow (m³/s)	Annual flow (billion m³)
Songhua River	545,000	1,927	2,530	156.6
Liao River	164,104	1,430	302	53.4
Hai River	264,617	1,090	717	20.3
Yellow River	752,443	5,500	1,820	57.8
Huai River	185,700	1,000	1,110	61.5
Yangtze River	1,807,199	6,300	31,060	848.6
Pearl River	452,616	2,210	11,070	540.4

Table 2.2.3 Overview of China's major lakes

Name of lake	Location province	Area (km²)	Lake elevation (m)
Qinghai Lake	Qinghai	4,583	3,196
Poyang Lake	Jiangxi	3,583	21
Dongting Lake	Hunan	2,740	34
Taihu Lake	Jiangsu	2,425	3

(Source: MWR 2022, State Council of the People's Republic of China, hereinafter State Council, 2005)

3 | State of Ambient Water Quality

Water quality refers to the quality of surface water (rivers, lakes and reservoirs), groundwater and seawater.

Surface water quality is divided into five levels in accordance with the environmental function or protection objective (see Table 2.2.4).

According to Report on the State of the Ecology and Environment in China (MEE 2023a), the quality of surface water has continued to improve; the proportion of good quality water (Grade I to III) was 89.4%. The main pollutant indexes used to judge inferior grade river water quality are chemical oxygen demand, total phosphorus, and the permanganate index.

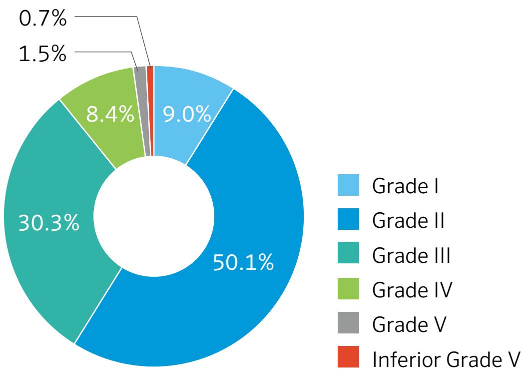


Figure 2.2.2 Quality of national surface water (2023)

Table 2.2.4 Classification of water quality standards for surface water (GB3838-2002)

Grade	Description
I	Mainly for headstreams and national nature preserves
II	Mainly for drinking water resources in first-class protected areas, protected areas for precious fish, and spawning areas for fish and shrimp
III	Mainly for drinking water resources in second-class protected areas, protected areas for fish, and swimming areas
IV	Mainly for industrial water resources and recreational use with no human contact with water
V	Mainly for agricultural water resources and water areas required for landscapes

(Source: MEE 2022a)

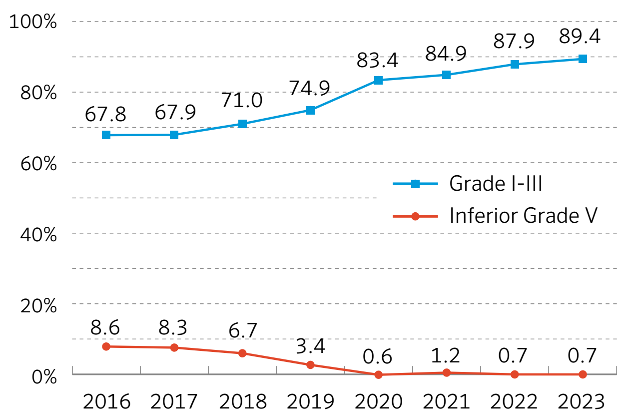


Figure 2.2.3 Interannual variation of surface water quality (2016–2023) (Source: MEE 2023a)

(1) Rivers

According to the national monitoring results for 2023, the overall water quality of 10 major water systems (Yangtze River, Yellow River, Pearl River, Songhua River, Huai River, Hai River, Liao River, rivers flowing through Zhejiang and Fujian provinces, and rivers in the northwest, and southwest) was between Grades I to III for 91.8%, an increase of 1.5 percentage points compared to 2022, and inferior to Grade V for 0.4%, the same as for 2022 (see Fig. 2.2.4).

The Yangtze River, Yellow River, Pearl River, Zhejiang and Fujian region rivers, and rivers in northwest and southwest China were of excellent quality. The water quality of the Huai River, Hai River and Liao River was judged to be fairly good. The Songhua River was slightly polluted (see Fig. 2.2.5).

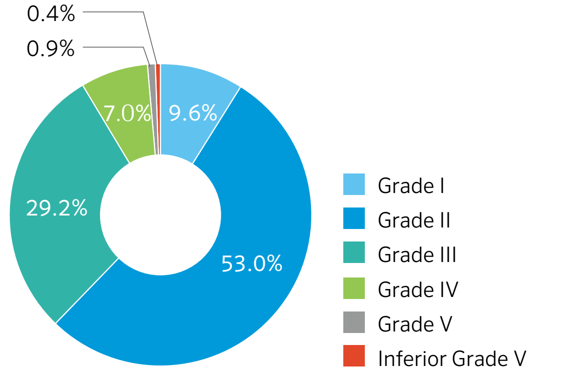


Figure 2.2.4 Water quality of major rivers (2023)
(Source: MEE 2023a)

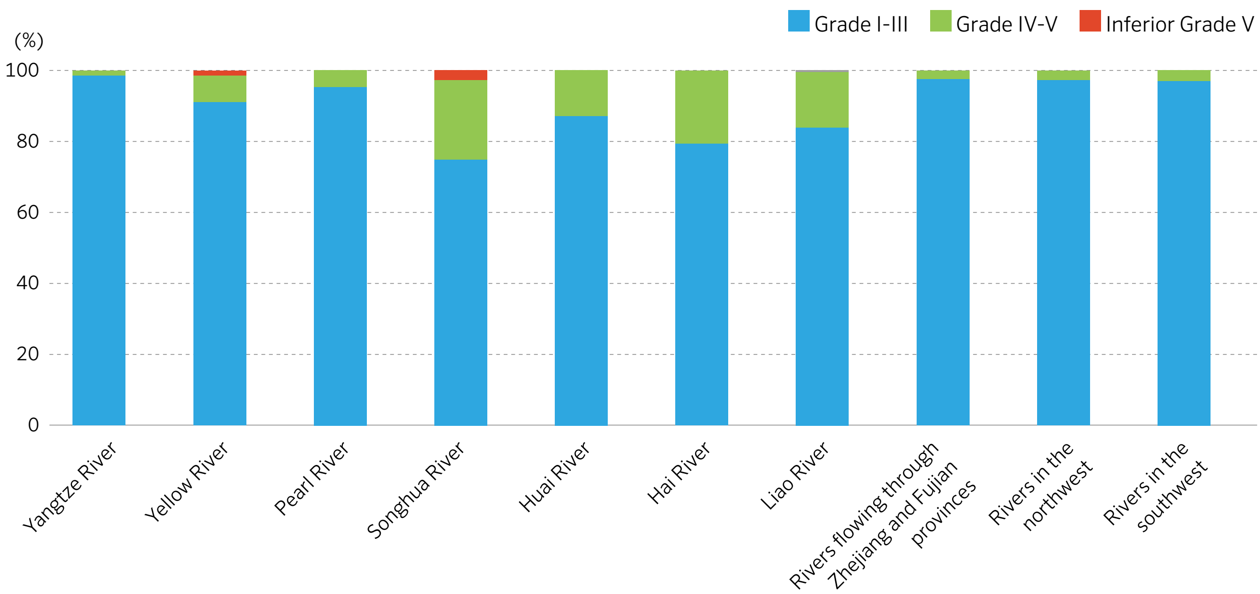


Figure 2.2.5 State of water quality of 10 major water systems in China (Source: MEE 2023a)

(2) Lakes and reservoirs

Results from a total of 209 water quality monitoring points set up in important lakes and reservoirs showed that in 2023, 74% were of Grade I to III, and 4.8% were found to be inferior to Grade V. The main indicators used to signify the existence of pollution were total phosphorus, COD (chemical oxygen demand), and the permanganate index.

Results from 205 monitoring points in important lakes and reservoirs measuring nutrients showed that 8.3% were of oligotrophic status, 64.4% were of mesotrophic status, 23.4% showed slight eutrophication and 3.9% showed intermediate eutrophication (MEE 2023a).

(3) Groundwater

Groundwater quality is divided into five categories. The standard is mainly based on the status quo of groundwater quality, human health benchmark value and groundwater quality protection objectives, and refers to the highest water quality requirements for drinking water, industrial and agricultural water (see Table 2.2.5).

Table 2.2.5 Classification of groundwater quality standards (GB/T 14848-2017)

Grade	Description
I	Reflects the low content of chemical components of groundwater; applicable to various purposes
II	Reflects the natural background content of groundwater chemical components; applicable to various purposes
III	Based on the baseline value of human health; primarily applicable to concentrative drinking water sources and industrial and agricultural use water
IV	Based on industrial and agricultural use water requirements; primarily applicable to agricultural water and partial industrial use water; applicable as drinking water, after being properly processed
V	Not applicable as drinking water; selection of such category of water depends on other purposes

(Source: MEE 2017)

According to the results of the 2023 groundwater quality monitoring, of the 1,888 monitoring sites, 77.8% were classified as of Grades I to IV, and 22.2% as Grade V. Major indicators exceeding the standard were iron, sulfate and chloride.

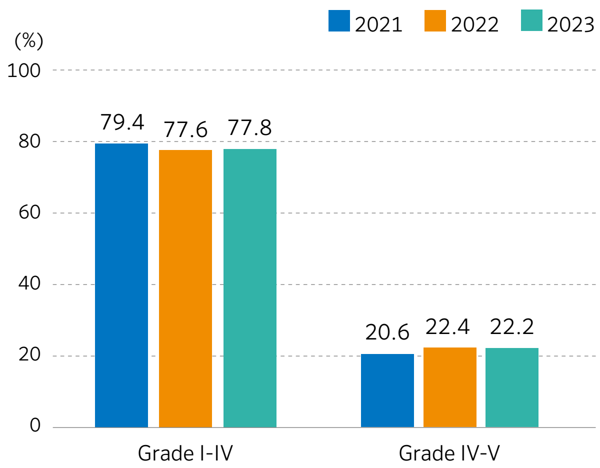


Figure 2.2.6 Groundwater quality, by percentage
(Source: MEE 2023a)

(4) Nearshore sea areas

Table 2.2.6 shows the classification of seawater quality standards. A total of 1,359 monitoring points have been set up across the country, including 1,172 in nearshore sea areas and 187 in offshore sea areas. The water quality of nearshore sea areas has steadily improved.

Table 2.2.6 Classification of seawater quality standards (GB-3097-1997)

Grade	Description
I	Suitable for marine fishing, marine nature preserves and protected areas for rare or endangered marine organisms
II	Suitable for marine cultivation, bathing, marine sports or recreation activities involving direct human contact with marine water, and for sources of industrial use of water related to human consumption
III	Suitable for water resources for general industrial use, coastal scenic tourism area
IV	Suitable only for harbors and ocean development activities

(Source: MEE 1997)

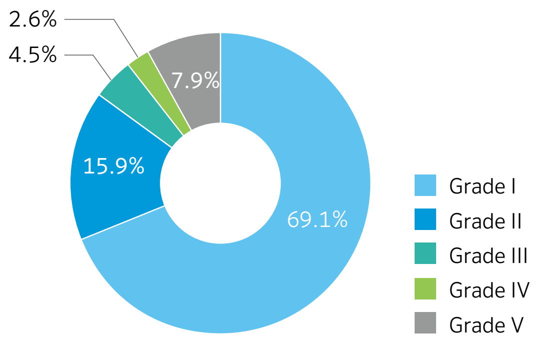


Figure 2.2.7 Water quality of nearshore sea areas, by percentage
(Source: MEE 2023a)

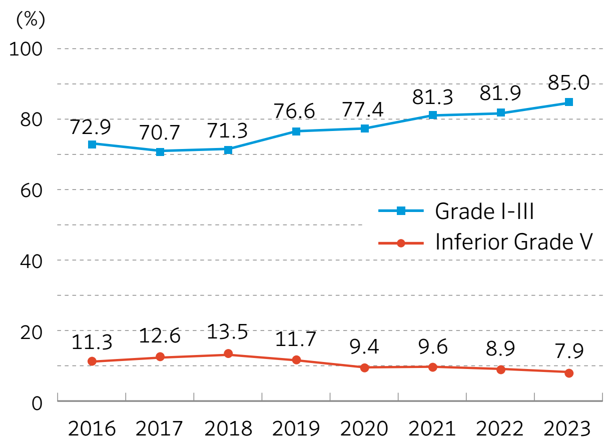


Figure 2.2.8 Interannual variation in water quality of nearshore sea areas (2016-2023)
(Source: MEE 2023a)

4 | State of Wastewater Treatment

The scope of statistical investigation of both COD-related and ammonia nitrogen-related discharges covers four types of discharge sources: industrial, agricultural, domestic and centralized pollution control facilities. The total COD discharge in 2022 was 25,959,000 tons, 29.7% of which resulted from household (domestic) discharge. The total of ammoniacal nitrogen discharge in 2022 was 820,000 tons, 64% of which resulted from household (domestic) discharge. In 2020, there were 2,618 urban domestic wastewater treatment facilities nationwide, with a capacity of 192.67 million m^3/day. The total volume of urban wastewater discharged was 57,136 million m^3, and the volume of annual urban domestic treated wastewater was 54,723 million m^3, with a treatment rate of 95.78% (MEE 2021a).

Table 2.2.7 COD and ammoniacal nitrogen discharge in 2022

	Total	Industrial sources	Agricultural sources	Domestic sources	Centralized pollution control facilities
COD					
Discharge (tons)	25,958,000	369,000	17,857,000	7,722,000	11,000
Percentage (%)	100	1.4	68.8	29.7	0.04
Ammoniacal nitrogen					
Discharge (tons)	820,000	14,000	281,000	525,000	1,000
Percentage (%)	100	1.7	34.2	64.0	0.1

(Source: MEE 2022a)

5 | Frameworks for Water Environmental Management

(1) Legislation

Environmental protection is a basic state policy of China, and was written into the Constitution upon its amendment in 1978. China has constantly improved its laws and regulations on water environmental management. There are two main types of basic laws and regulations for water ecological environment protection: the Environmental Protection Law (revised in 2014) and the Water Pollution Prevention and Control Law (revised in 2017). The former

Table 2.2.8 Water environmental management laws and regulations

Area of law	Document name	Date issued	Effective date
Constitution	Constitution of the People's Republic of China (2018 Amendment)	03-11-2018	03-11-2018
General Provisions on Environmental Protection	Environmental Protection Law of the People's Republic of China (2014 Revision)	04-24-2014	01-01-2015
Pollution Prevention	Water Pollution Prevention and Control Law of the People's Republic of China (2017 Revision)	06-27-2017	01-01-2018
Water Resources, General Provisions on Water Conservancy	Water Law of the People's Republic of China (2016 Amendment)	07-02-2016	07-02-2016
General Provisions on Environmental Protection	Yangtze River Protection Law of the People's Republic of China	12-26-2020	03-01-2021
Natural Conservation	Yellow River Protection Law of the People's Republic of China	10-30-2022	04-01-2023
General Provisions on Environmental Protection, Marine Resources	Marine Environmental Protection Law of the People's Republic of China (2023 Revision)	10-24-2023	01-01-2024
Water Resources	Regulation on Water Conservation	03-09-2024	05-01-2024
Water Resources	Regulation on Groundwater Management	12-01-2021	12-01-2021
Urban Planning, Development, and Construction	Regulation on Urban Water Supply (2020 Revision)	03-27-2020	03-27-2020
Water Resources	Regulation on the Administration of the License for Water Drawing and the Levy of Water Resource Fees (2017 Amendment)	03-01-2017	03-01-2017
Public Places and Environmental Sanitation	Regulation on Urban Drainage and Sewage Treatment	10-02-2013	01-01-2014
Agriculture Administration General Provisions on Water Conservancy	Regulation on Farmland Water Conservancy	05-17-2016	07-01-2016
Pollution Prevention	Interim Regulation on the Prevention and Control of Water Pollution in the Huaihe River Basin (2011 Revision)	01-08-2011	01-08-2011

(2014 revision) sets out clear definitions of the environmental protection responsibilities of local governments and established the strictest punishment and accountability precedents to date. The latter (2017) revision expands the legislative purpose as to "prevent and control water pollution, protect water ecology", etc.

(2) Discharge standards system

China has issued 65 standards covering water pollution discharge, which regulate and manage discharge sources, such as industrial, agricultural and domestic sources. These standards specify the requirements for water pollution discharge, such as discharge requirements, monitoring requirements and supervision and management requirements, and regulate the control of over 150 pollutants.

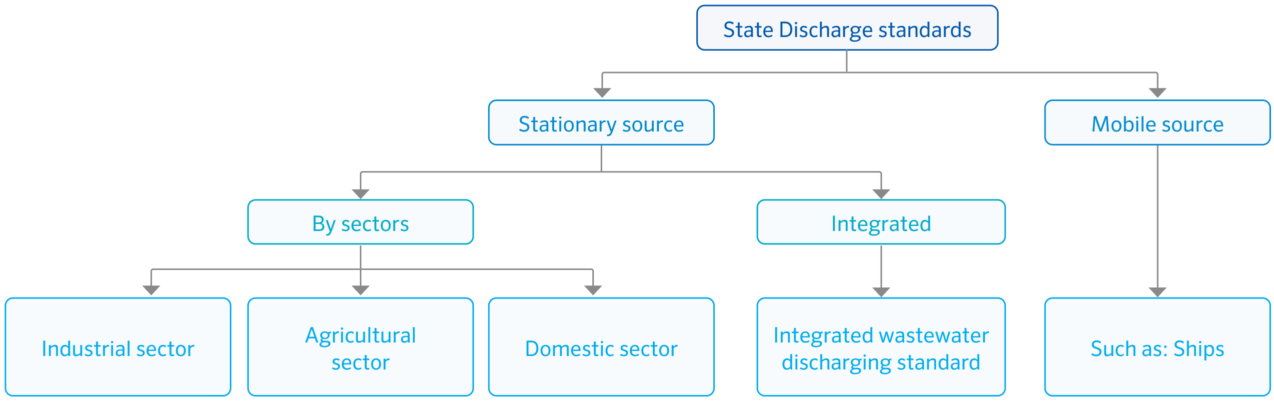


Figure 2.2.9 Structure of the water pollutant discharge standard system

(3) Supervisory responsibility system

The Ministry of Ecology and Environment (MEE) was established in 2018, and since then it has strengthened the function of ecological and environmental supervision and its responsibilities have grown. MEE is responsible for unified supervision and law enforcement covering ecological and urban and rural pollution discharges, and for implementing action plans for the prevention and control of air, water and soil pollution. It oversaw drastic reductions in the types and quantities of imported solid waste that led up to the final banning of foreign waste imports. MEE is also tasked with building an ecological and environmental governance system in which the government takes the lead, enterprises play the main role, and social organizations and the public participate. It also must implement the strictest ecological and environmental protection system, strictly observe the red lines governing ecological protection and the bottom line of environmental quality. MEE is also responsible for reducing pollution, ensuring national ecological security and 'building a beautiful China' (MEE).

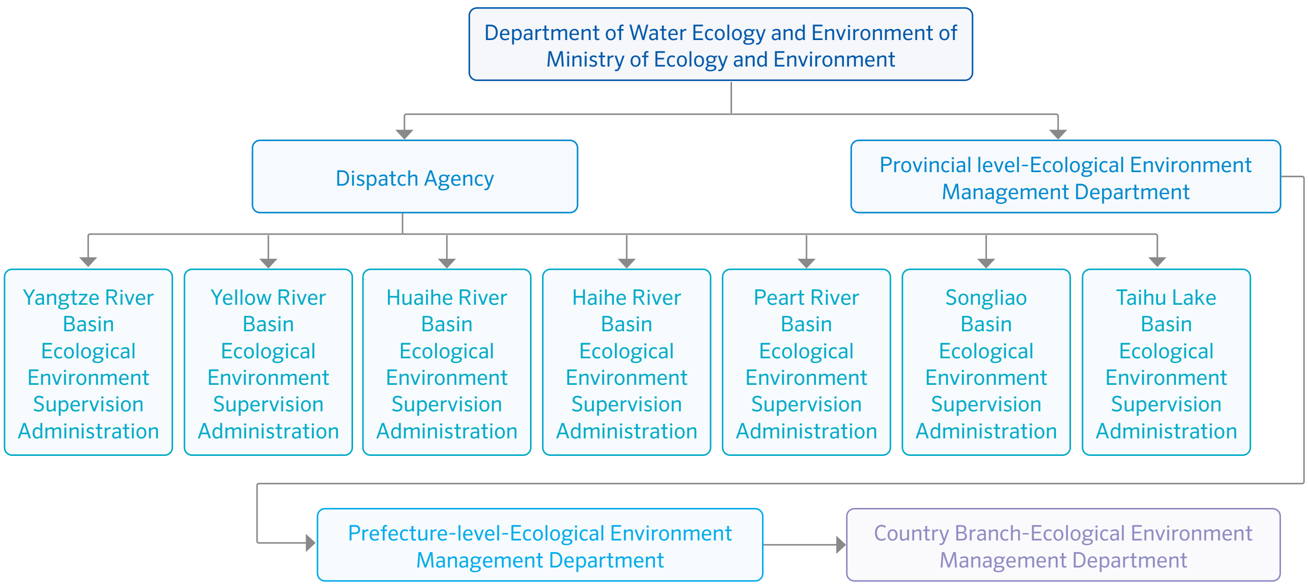


Figure 2.2.10 Structure of the ecological environment management system

(4) Major policies on water environmental management

Water Pollution Prevention Action Plan (Water Ten Articles) (2015)

The Water Ten Articles were released by China's State Council, and cover areas including:

i. Overall control of pollutant discharge
ii. Promotion of transformation and updating of economic structure
iii. A focus on water resources saving and conservation
iv. Strengthening of scientific and technological support
v. Giving full play to the function of market mechanisms
vi. Tightening of environmental law enforcement and supervision
vii. Effective strengthening of water environmental management
viii. Providing a full guarantee of water ecological environment safety
ix. Defining and fulfilling the responsibilities of each party
x. Strengthening of public participation and social supervision

The main indicators are: by 2020, attain a figure of over 70% for the proportion of good water quality (at or better than Grade III) for the seven major river basins of the Yangtze River, Yellow River, Pearl River, Songhua River, Huaihe River, Haihe River and Liaohe River; attain a figure of below 10% for the proportion of black and odorous water bodies in built-up areas of cities at prefecture level and above; attain a figure of over 93% for the proportion of concentrated drinking water sources at or above prefecture level; maintain a figure of about 15% for control over the proportion of very poor groundwater quality in the country, and a figure of about 50% for the proportion of coastal waters meeting water quality Grade I and II, i.e., good; by 2030, attain a figure of above 75% for the proportion of seven major river basins meeting the water quality level of excellent; eliminate all black and odorous water bodies in urban built-up areas; and attain a figure of about 95% for the proportion of centralized drinking water sources in urban areas reaching or exceeding Grade III water quality (MEE 2015). The proportion of water body sections in the Beijing-Tianjin-Hebei region that have lost their functional use (worse than Grade V) has decreased by about 15%, and the Yangtze River Delta and Pearl River Delta regions are striving to eliminate water bodies that have lost their functional use.

Opinions on Comprehensively Strengthening Ecological and Environmental Protection and Resolutely Fighting the Uphill Battle for the Prevention and Control of Pollution (2018)

These Opinions, issued by the CPC Central Committee and State Council, call for extending the utmost efforts possible to achieve a clean water environment, and include five key aspects expressing the importance of:

i. Protecting water sources
ii. Controlling black and odorous water bodies in cities
iii. Protecting and restoring the Yangtze River
iv. Comprehensive governance of the Bohai Sea
v. Controlling pollution in agriculture and rural areas

In order to achieve the above, key indicators have been set, which are: by 2020, attain a figure of over 70% for the proportion of Class I-III water bodies in China's surface water, and maintained within 5% for the proportion of poor, i.e., Grade V water bodies; attain a figure of 90% for the proportion of black and odorous water bodies eliminated in built-up areas at the prefecture level and above; and attain a figure of around 70% for the proportion of coastal waters meeting the water quality level of good, i.e., Grade I and II (MEE 2018).

Guideline on Further Prevention and Control of Pollution (2021)

This Guideline was issued by the CPC central committee and State Council jointly, and calls for in-depth, intense, and unremitting efforts to protect clean water (碧水保卫战), comprising:

i. Controlling black and odorous water bodies in cities
ii. Protecting and restoring the Yangtze River
iii. Ecological protection and governance of the Yellow River
iv. Improving the safety of drinking water
v. Comprehensively managing kea sea areas
vi. Strengthening coordinated pollution control on land and at sea

The main indicators related to these actions are: by 2025, achieve ongoing improvements in the ecological environment as well as lowered total discharges of major pollutants;

attain a figure of 85% for the proportion of surface water bodies rated Grade I-III, and 79% for the proportion of coastal waters with good water quality (Grade I and II); attain and maintain an overall water quality of excellent for the Yangtze River Basin and water quality of Grade II for the main stream; attain a water quality of Grade II for the upper and middle reaches of the main stream of the Yellow River (above Huayuan Estuary); and attain a figure of over 93% of centralized drinking water sources in cities at or above the county level meeting or exceeding Grade III (MEE 2021b).

Implementation Opinions on Strengthening the Supervision and Administration of Sewage Discharge Outlets into Rivers and Seas (2022)

This Opinions were issued by the General Office of the state Council. The related goals are: by the end of 2023, complete investigations into sewage discharge outlets in the main stream and important tributaries, key lakes and key bays of the Yangtze River, Yellow River, Huaihe River, Haihe River, Pearl River, Songliao River and Taihu Lake River basins (hereinafter referred to as the seven river basins); complete improvements to these outlets in the main streams and major tributaries of the Yangtze and Yellow rivers and in the Bohai Sea; by the end of 2025, complete inspections of and improvements in all sewage discharge outlets in these basins and coastal waters; and establish an efficient, scientific, technical sewage outlet supervision and management system that is at least partially based on related laws (MEE 2022b).

Water Ecological Environment Protection Plan for Key River Basins (2023)

This plan was issued by MEE and other departments. The goals of the Plan are: by 2025, to have continued reducing the total discharge of major water pollutants, to have improved the water ecological environment, to have made breakthroughs in non-point source pollution prevention and control, and to have refined the water ecological restoration and protection system. Additionally, systematic management and overall promotion of water resources, water environment, water ecology and other factors shall be well established. By 2035, the water ecological environment shall be fundamentally improved, the ecosystem shall function as a virtuous cycle, and the goal of creating a beautiful water ecological environment in China will basically have been achieved (Ministry of Ecology and Environment of the People's Republic of China, 2023b).

Opinions on Comprehensively Promoting the Building of a Beautiful China (2023)

These opinions were issued by the Central Committee and State Council. By 2027, attain a figure of approximately 90% for China's surface water and 83% of its coastal waters having excellent water quality, and attain a figure of about 40% for completion of beautification of rivers, lakes and bays. By 2035, the goal of creating 'harmony between humans and water' regarding rivers, lakes and bays shall be largely realized (MEE 2024).

6 | Recent Developments in Water Environmental Management

A total of 245,000 km of shorelines of rivers and lakes have been inspected, and over 250,000 sites have been rectified. More than 90% of the tasks of tracing sewage outlet in the Yangtze River and Bohai Sea have been completed, resolving over 20,000 sewage discharge problems. Additionally, sewage outlet in 30 cities and six provinces in the upper and middle reaches of the Yellow River and the Fenhe River basin have been investigated. More than 99,000 km of urban sewage networks and more than 2,100 centralized sewage treatment facilities were built. A total of 19,633 centralized drinking water source protection areas have been designated at the township level. Efforts to promote the reduction of total nitrogen in rivers entering the sea and to improve the water quality of coastal waters were taken, and the average concentration of total nitrogen in state-controlled rivers entering the sea decreased by 12.2% year on year. A total of 162 km of the Yangtze River shoreline was restored, 12.13 million m^2 of various shorelines was restored, and 76 outstanding cases of beautified rivers, lakes, and bays were published. Future plans include promoting assessments of water ecology in the Yangtze River basin and carrying out pilot monitoring for water ecology assessments. Further, comprehensive control of phosphorus pollution in the Yangtze River Basin (MEE) is aimed at being strengthened.

7 | Challenges and Future Plans

(1) Current challenges regarding China's water environment

Improvements in water environmental quality have taken place in an unbalanced and uncoordinated manner. Bottlenecks exist in the prevention and control of non-point source pollution in urban and rural areas. The environmental governance infrastructure is inadequate, with insufficient sewage collection and treatment capacity in some regions. Further, the treatment of domestic sewage and black and odorous water bodies in rural areas is inadequate.

Water ecology destruction is another issue; important ecological spaces, such as water conservation areas, rivers, lakes and their buffer zones are over-exploited, resulting in ecological function decline, biodiversity loss, and frequent cyanobacteria blooms in lakes.

Further, the ecological use of water in rivers and lakes is not fully guaranteed. China faces challenges due to its high population and limited water resources, leading to uneven distribution over time and space. The ecological flow in some rivers and lakes is difficult to maintain, resulting in problems such as disrupted river flows and lake shrinkage.

Risks affecting the water ecological environment remain high. Enterprises are often located around drinking water sources with production, storage, and transportation facilities distributed unevenly around them, which increases the level of potential risks. Problems related to tailing ponds and heavy metal accumulations in river and lake sediments are challenging to address, and capacities to manage new pollutants are insufficient (MEE 2023b).

(2) Water environmental management plan in the 14th Five-Year Plan for National Economic and Social Development and the Outline of Vision targets for 2035 of People's Republic of China

The Outline of the 14th Five-Year Plan for National Economic and Social Development and the Long-Range Objectives Through the Year 2035 was approved by the National People's Congress in March 2021. In the Plan, the following strategies to improve the water environment were formulated (State Council 2021):

- Improving the level of rural infrastructure and public services
  - Improve rural infrastructure, including water, electricity, roads, and gas[*1] (24-2)
  - Improve the living environment in rural areas, resolve black and odorous water bodies in rural areas, treat domestic sewage in rural areas, and comprehensively improve rural water systems (24-3)
  - Strengthen the ecological protection and improvement of major rivers (such as the Yangtze and Yellow rivers) and important lakes and wetlands, and strengthen the construction and protection of important ecological corridors (37-1)
  - Improve policies on land and sea use for ecological protection and restoration (37-2)
  - Promote the establishment of basin-wide ecological compensation measures for major river basins (37-3)

- Environmental improvement
  - Improve water pollution prevention measures, watershed management and coordination (38-1)
  - Strengthen the comprehensive management of major river basins, lakes, and urban and coastal waters (38-1)
  - Reduce COD and total ammonia nitrogen emissions by 8% each (38-1)
  - Eliminate inferior to Grade V water bodies in general (38-1)
  - Promote the relocation and renovation of heavily polluting industries present in major river basins (38-1)
  - Implement comprehensive prevention and management plans for water and soil environmental risks (38-1)
  - Strengthen the prevention and control of plastic pollution (38-1)
  - Promote full coverage of urban sewage pipe networks (38-2)
  - Upgrade sewage treatment (38-2)
  - Promote centralized sludge incineration and detoxification treatment (38-2)
  - Achieve a detoxification treatment rate of 90% for urban sludge (38-2)

*1 Numbers in parentheses indicate related sections in the 14th Five-Year Plan.

- Achieve use of recycled water at a rate of at least 25% in cities at and above the prefectural level facing water shortage (38-2)
- Establish an ecological environment management system that integrates above and below ground as well as land and sea (38-5)
- Realize the issuance of pollution discharge permits for point source polluters (38-5)
- Improve management and protection systems for rivers and lakes, and strengthen the system of river chiefs and lake chiefs (38-5)
- Improve the vertical management system of monitoring, supervision and law enforcement of ecological and environmental institutions under provinces (38-5)
- Promote comprehensive law enforcement reform for ecological environmental protection (38-5)
- Increase the disclosure of environmental protection information and strengthen the establishment of a corporate environmental governance system (38-5)
- Improve public supervision, and reporting and feedback mechanisms (38-5)
- Promote the participation of social organizations and the general public in environmental governance (38-5)

- In the near future to 2035, the water ecological environment is to have fundamentally improved, the ecosystem is to have achieved a virtuous cycle, and the goal of creating a beautified water ecological environment in China is to have basically been achieved.

Table 2.2.9 Water ecological environmental protection targets in China

Category	No.	Indicator	Target in 2025
Water environment	1	The proportion of surface water at or better than Class III (%)	85
	2	The proportion of surface water inferior Class V water bodies (%)	Basic elimination
	3	The proportion of centralized drinking water sources in cities at or above the county level reaching or better than Class III (%)	93
	4	The proportion of black and odorous water bodies brought under control in urban built-up areas (%)	Basic elimination
Water resources	5	The number of rivers and lakes that meet the ecological flow requirements (unit)	90 (National) 264 (Local)
	6	The number of watered rivers (unit)	53
Water ecology	7	Aquatic integrity index	Continuous improvement
	8	Length of restored river and lake ecological buffer zones (km)	Newly increased to 7,700
	9	Construction area for wetland water purification projects (km^2)	Newly increased to 213
	10	The number of bodies of water targeted for indigenous fish reproduction (unit)	107
	11	The number of bodies of water targeted for indigenous aquatic plant reproduction (unit)	20

(Source: State Council 2021)

2.3 Indonesia

1 | Country Information

Table 2.3.1 Basic indicators

Land area (km²)		1,900,000 (2013)*
Total population		275.8 million (2022)*
GDP (current USD*)		1,371 billion (2023)**
Per capita GDP (current USD)		4,940 (2023)**
Average annual rainfall (mm/year)		2,898 (2022)*
Total renewable rater resources (billion m³)		2,018 (2021)***
Total annual freshwater withdrawals (billion m³)		222.6 (2021)***
Annual freshwater withdrawal by sector	Agriculture	85.2% (2021)***
	Industry	4.1% (2021)***
	Municipal (including domestic)	10.7% (2021)***

(Source: *BPS-Statistics Indonesia 2023a, **World Bank 2024, ***FAO 2021)

Figure 2.3.1 Lake Toba, Sumatra, Indonesia

2 | State of Water Resources

Water resources in Indonesia account for about 4.7% of the world's water resources, or about 20% of the total water resources in the Asia-Pacific region. The total renewable internal freshwater resources in 2021 was estimated at 2,018.7 billion m³, whereas the total withdrawal was 222.63 billion m³ (FAO 2021). While water resources are abundant, their distribution is not even across the provinces, and rainfall amounts also vary (see Table 2.3.2).

Indonesia is the world's largest archipelagic state, with 17,504 islands and a freshwater availability that differs from region to region (BPS-Statistics Indonesia 2023a, 50). There are 3,137 watersheds in the National Strategic River Region and 304 watersheds in the Cross-Country River Region (BPS-Statistics Indonesia 2023a).

Water stress in the country's dry season is expected to increase by 2045 (World Bank 2021), and water storage per capita is 71 m³, which is relatively low compared to neighboring countries. According to the government, many areas of Java and Bali are classified as water scarce areas, and such area are estimated to increase from 6% in 2000 to nearly 9.6% by 2045 (Republic of Indonesia 2020). The government has made efforts to address the water shortage issue by increasing the storage capacity (World Bank 2021).

Table 2.3.2 Population, precipitation, and spatial distribution of surface water by Island

Island	Population (thousand) (2022)	Precipitation (mm/year) (2022)	Total water volume (million m³) of rivers with area over 100 km² (2021)	Total volume of lakes (million m³) (2023)	Total volume of dam(s) (million m³) (2023)
Java	154,282	17,384	51,271	440	406,483
Sumatra	59,977	32,036	28,519	29,888	2,127
Sulawesi	20,304	16,234	49,539	834	594
Kalimantan	17,052	14,417	-	480	71
Bali and Nusa Tenggara	15,355	7,667	899	1,060	31,482
Maluku	3,201	6,680	-	-	-
Papua	5,602	4,125	-	3,089	-

(Source: BPS-Statistics Indonesia 2023a and 2023b)

3 | State of Ambient Water Quality

(1) Rivers

The water quality of surface water in major cities has been affected by anthropogenic activities, and many rivers are polluted due to untreated effluent from industrial and residential areas. Changes in the status of surface water quality compliance compared to the national standards in selected rivers are shown in Fig. 2.3.2 From 2017 to 2020, rivers in most provinces were heavily polluted, and none met the ambient water quality standards. However, in 2021 and 2022, water quality significantly improved, and a few met the standards, which has been attributed to the dampened economic activities during the COVID-19 pandemic in 2020, which affected the water quality of rivers nationwide.

Province	River	2017	2018	2019	2020	2021	2022
Pollution level		Heavily polluted	Moderately-heavily polluted	Moderately polluted	Slightly-moderately polluted	Slightly polluted	Meet the standards
Aceh	Krueng Tamiang	Moderately polluted	Slightly-moderately polluted	Slightly-moderately polluted	Slightly polluted	Slightly polluted	Slightly polluted
Sumatera Utara	Batahan	Moderately polluted	Moderately polluted	Moderately polluted	Slightly polluted	Slightly polluted	Slightly polluted
Sumatera Barat	Batanghari	Heavily polluted	Heavily polluted	Heavily polluted		Slightly polluted	Slightly polluted
Riau	Siak	Heavily polluted	Moderately-heavily polluted	Heavily polluted	Moderately-heavily polluted	Slightly polluted	Slightly polluted
Jambi	Batanghari	Slightly polluted	Slightly polluted	Moderately polluted	Moderately polluted	Slightly polluted	Slightly polluted
Sumatera Selatan	Musi	Heavily polluted	Moderately-heavily polluted	Heavily polluted	Heavily polluted	Slightly polluted	Slightly-moderately polluted
Bengkulu	Musi	Slightly-moderately polluted	Slightly-moderately polluted	Slightly-moderately polluted	Slightly-moderately polluted	Slightly polluted	Slightly-moderately polluted
Lampung	Mesuji	Heavily polluted	Heavily polluted	Heavily polluted	Heavily polluted	Slightly polluted	Slightly polluted
Kepulauan Bangka Belitung	Baturusa	Moderately-heavily polluted	Moderately-heavily polluted	Moderately-heavily polluted	Slightly-moderately polluted	Slightly polluted	Meet the standards
Kepulauan Riau	Dam Duriangkang	Moderately-heavily polluted	Moderately-heavily polluted	Moderately polluted	Moderately polluted	Slightly polluted	Slightly polluted
DKI Jakarta	Ciliwung	Heavily polluted	Heavily polluted	Heavily polluted	Heavily polluted	Slightly polluted	Slightly-moderately polluted
Jawa Barat	Citarum	Heavily polluted	Heavily polluted	Heavily polluted	Heavily polluted	Moderately polluted	Moderately polluted
Jawa Tengah	Citanduy	Heavily polluted	Heavily polluted	Heavily polluted	Heavily polluted	Slightly-moderately polluted	Slightly polluted
DI Yogyakarta	Progo	Heavily polluted	Moderately-heavily polluted	Moderately polluted	Moderately polluted	Slightly-moderately polluted	Slightly polluted
Jawa Timur	Bengawan Solo	Heavily polluted	Heavily polluted	Heavily polluted	Heavily polluted	Slightly polluted	Slightly-moderately polluted
Banten	-	-	-	-	-	-	-
Bali	Tukad Ayung	Moderately polluted	Moderately polluted	Moderately polluted	Moderately polluted	Meet the standards	Slightly polluted
Nusa Tenggara Barat	Moyo	Moderately-heavily polluted	Moderately-heavily polluted	Heavily polluted	Heavily polluted	Slightly polluted	Slightly polluted
Nusa Tenggara Timur	Noelmina	Heavily polluted	Heavily polluted	Heavily polluted	Heavily polluted	Slightly polluted	Slightly polluted
Kalimantan Barat	Kapuas	Moderately-heavily polluted	Moderately-heavily polluted	Heavily polluted	Heavily polluted	Slightly polluted	Slightly polluted
Kalimantan Tengah	Barito	Moderately-heavily polluted	Moderately-heavily polluted	Moderately-heavily polluted	Moderately-heavily polluted	Slightly polluted	Slightly polluted
Kalimantan Selatan	Barito	Heavily polluted	Heavily polluted	Heavily polluted	Heavily polluted	Slightly polluted	Slightly polluted
Kalimantan Timur	Mahakam	Moderately-heavily polluted	Moderately-heavily polluted	Heavily polluted	Heavily polluted	Slightly polluted	Slightly polluted
Kalimantan Utara	Sesayap	-	-	Slightly polluted	Slightly polluted	Meet the standards	Slightly polluted
Sulawesi Utara	Talawan	Heavily polluted	Heavily polluted	Heavily polluted	Heavily polluted	Slightly polluted	Slightly polluted
Sulawesi Tengah	Lariang	-	-	Heavily polluted	Heavily polluted	Slightly polluted	Slightly polluted
Sulawesi Selatan	Jeneberang	Moderately-heavily polluted	Moderately-heavily polluted	Heavily polluted	Heavily polluted	Slightly polluted	Slightly polluted
Sulawesi Tenggara	Lalindu	Slightly-moderately polluted	Slightly-moderately polluted	Slightly-moderately polluted	Slightly-moderately polluted	Slightly polluted	Slightly polluted
Gorontalo	Randangan	Heavily polluted	Heavily polluted	Heavily polluted	Heavily polluted	Slightly polluted	Slightly polluted
Sulawesi Barat	Lariang	Heavily polluted	Moderately-heavily polluted	Moderately-heavily polluted	Moderately-heavily polluted	Slightly polluted	Slightly polluted
Maluku	Batu Gajah	Moderately-heavily polluted	Moderately-heavily polluted	Moderately-heavily polluted	Moderately-heavily polluted	Slightly polluted	Slightly polluted
Maluku Utara	Tabobo	Moderately-heavily polluted	Moderately-heavily polluted	Moderately polluted	Moderately polluted	Slightly polluted	Slightly polluted
Papua Barat	Remu	Moderately-heavily polluted	Moderately-heavily polluted	Slightly-moderately polluted	Slightly-moderately polluted	Slightly polluted	Slightly polluted
Papua	Bian	Slightly polluted	Slightly polluted	Slightly polluted	Slightly polluted	Slightly polluted	Slightly polluted

Figure 2.3.2 Status of water quality of selected rivers in Indonesia
(Source: BPS-Statistics Indonesia 2023a, Table 1.58 Status of river water quality, 2017–2022)

Figure 2.3.3 presents the annual average concentrations of dissolved oxygen (DO) and biochemical oxygen demand (BOD) of drinking source rivers in the provincial capitals. Data for Jawa Barat and Papua are missing. Of the 32 provinces, rivers in six provinces met the water quality standard for BOD. The water quality standards for fecal coliform and total coliform for raw drinking water are 100 MPN/ml and 1,000 MPN/mL, respectively. In 2022, 18 rivers did not meet the fecal coliform standard, and in 2022 the figure for average fecal coliform in the Ciliwung River in DKI Jakarta was 4,842,500 MPN/mL (BPS-Statistics Indonesia 2023a, Table 1.57).

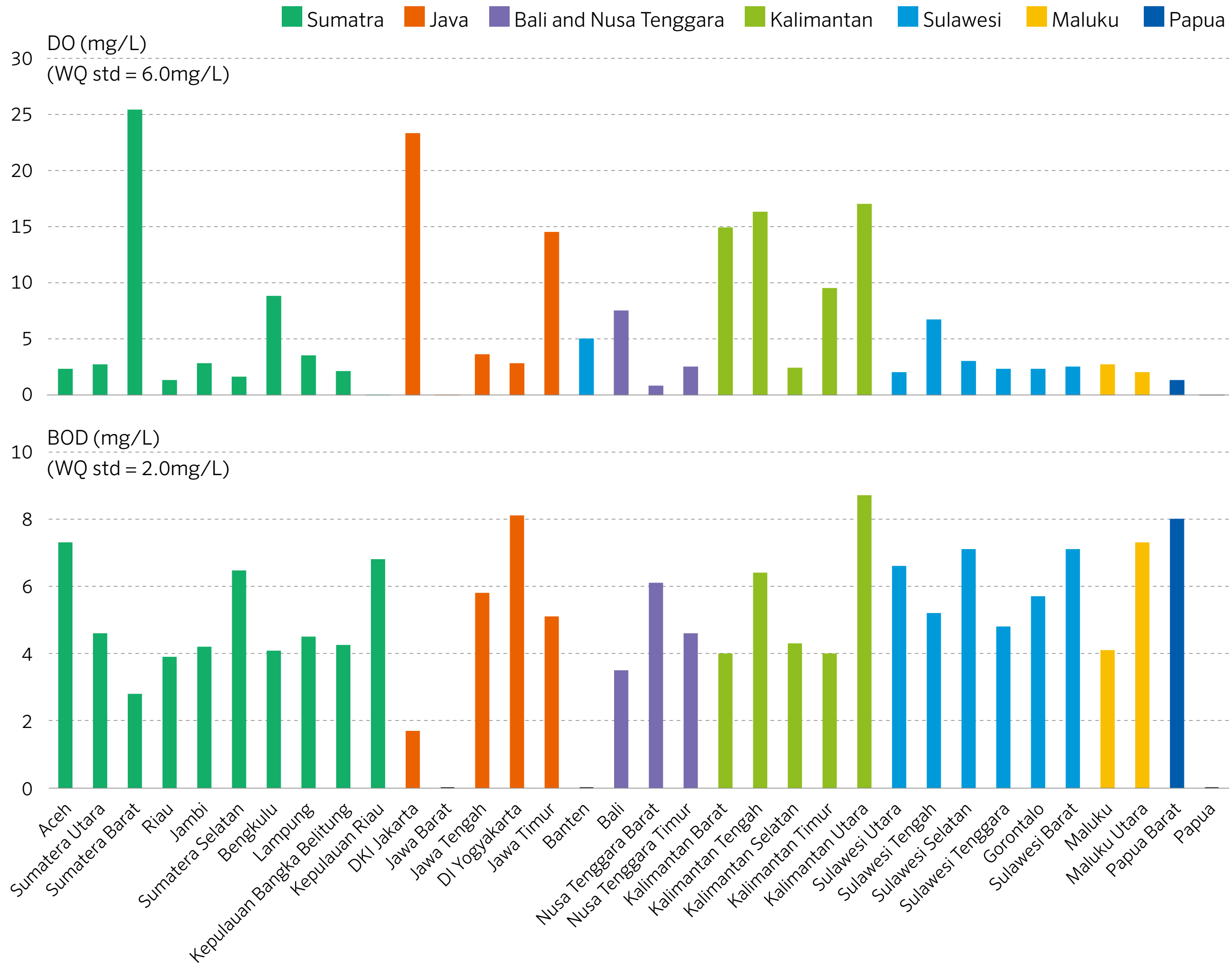


Figure 2.3.3 Water quality of drinking source rivers in provincial capitals in 2022

(Source: BPS-Statistics Indonesia 2023a, Table 1.57)

The Ministry of Environment and Forestry, Indonesia (MOEF) selected the following river basins as priority basins for restoration in the Medium-Term Development Plan (RPJMN) 2020–2024: 1. Asahan River and Toba Lake in North Sumatera, 2. Siak River in Riau, 3. Musi River in South Sumatera, 4. Citarum, Cisadane and Ciliwung Rivers in West Java and Jakarta, 5. Serayu and Bangawas Solo Rivers in Central Java, 6. Brantas River in East Java, 7. Kapuas River in West and Central Kalimantan, 8. Saddang River in West and Central Sulawesi, 9. Moyo River in West Nusa Tenggara, and 10. Limboto Lake dan Bone Bolango River in North Sulawesi (MOEF 2024).

(2) Lakes and reservoirs

Lakes are other waterbodies heavily affected by anthropogenic activities. MOEF designated the following 15 lakes as national priority lakes for restoration and conservation: Danau Toba, Danau Maninjau, Danau Singkarak, Danau Kerinci, Danau Rawa Danau, Danau Rawa Pening, Danau Batur, Danau Sentarum, Danau Kaskade Mahakam (Semayang-Melintang-Jeumpang), Danau Tondano, Danau Limboto, Danau Poso, Danau Tempe, Danau Matano, and Danau Sentani (Republic of Indonesia 2020, II.24).

(3) Coastal water

Indonesia is the largest archipelago on Earth, with more than 17,000 islands, about 290,000 km^2 of territorial sea waters, and 108,000 km of coastline (BPS-Statistics Indonesia 2023a, 50). The coastal water environment is thus of high importance for the nation, and conserving the coastal ecosystems is critical for sustainable economic growth and the population's well-being. Figure 2.3.4 presents the sea water quality index by province from 2019 to 2022. The index scores (I score) are classified as: very good (100 ≥ I score ≥ 90), good (90 > I score ≥ 80), good enough (80 > I score ≥ 70), medium (70 > I score ≥ 50), marginal (50 > I score ≥ 35), and bad (35 ≥ I score) (Damayanti et al. 2021). The water quality has been better than the water quality of drinking source rivers in provinces, and the score further improved in 2021.

WQ Criteria	Medium	Good enough	Good	Very good
Province	2019	2020	2021	2022
Aceh	Good enough	Medium	Good enough	Good
Sumatera Utara	Medium	Good enough	Good	Good
Sumatera Barat	Good enough	Good enough	Good	Good
Riau	Good enough	Good enough	Good enough	Good
Jambi	Good enough	Good enough	Good	Good
Sumatera Selatan	Good enough	Medium	Good enough	Good
Bengkulu	Good enough	Medium	Good	Good
Lampung	Good enough	Good enough	Good enough	Good
Kepulauan Bangka Belitung	Medium	Good enough	Good	Good
Kepulauan Riau	Good	Medium	Good enough	Good
DKI Jakarta	Medium	Medium	Good enough	Good
Jawa Barat	Medium	Medium	Good	Good
Jawa Tengah	Medium	Good enough	Good	Good
DI Yogyakarta	Medium	Good enough	Good	Good
Jawa Timur	Medium	Medium	Good	Good
Banten	Medium	Medium	Good	Good enough
Bali	Medium	Medium	Good	Good
Nusa Tenggara Barat	Good enough	Medium	Good	Good
Nusa Tenggara Timur	Medium	Good enough	Good	Good
Kalimantan Barat	Medium	Good enough	Good enough	Medium
Kalimantan Tengah	Good enough	Medium	Good enough	Good
Kalimantan Selatan	Good enough	Medium	Good enough	Good
Kalimantan Timur	Good enough	Good enough	Good	Good
Kalimantan Utara	Medium	Good enough	Good	Good
Sulawesi Utara	Good	Medium	Good	Good
Sulawesi Tengah	Good enough	Medium	Good	Good
Sulawesi Selatan	Good	Good enough	Good	Good
Sulawesi Tenggara	Good	Medium	Good	Good
Gorontalo	Good	Medium	Good	Good
Sulawesi Barat	Good	Good enough	Good	Good
Maluku	Good	Medium	Good	Good
Maluku Utara	Good	Medium	Good	Good
Papua Barat	Good	Good enough	Good	Good
Papua	Good	Good enough	Good enough	Good

Figure 2.3.4 Sea water quality index by province 2019-2022
(Source: BPS-Statistics Indonesia 2023a, Table 1.63)

(4) Groundwater

Groundwater has been a major source of domestic water as private wells meet about 46% of domestic water demand (World Bank 2021, 50), and the government faces challenges in managing this resource. In places where surface water is not the main source of water, over-extraction of groundwater is a common problem. While groundwater production is 457,400 million m³, the safe yield for extraction is 137,2000 million m³ (FAO 2024; USAID/Sustainable Water Partnership 2021). Figure 2.3.5 presents figures for existing wells providing domestic water. Groundwater is utilized on all islands, but more wells are seen on Java, Bali and Nusa Tenggara.

Thus, groundwater is an irreplaceable source of water. However, groundwater pollution is of serious environmental concern for the government as the quality does not meet the standards due to bacteria and chemical contamination (Republic of Indonesia 2020). The government reported that 45% of groundwater in Jakarta is contaminated by E. coli, with about 70% of groundwater pollution caused by leaking septic tanks and septage disposed of into waterways (World Bank 2021). Moreover, large-scale groundwater extraction may have contributed to land subsidence in the country (Republic of Indonesia 2020).

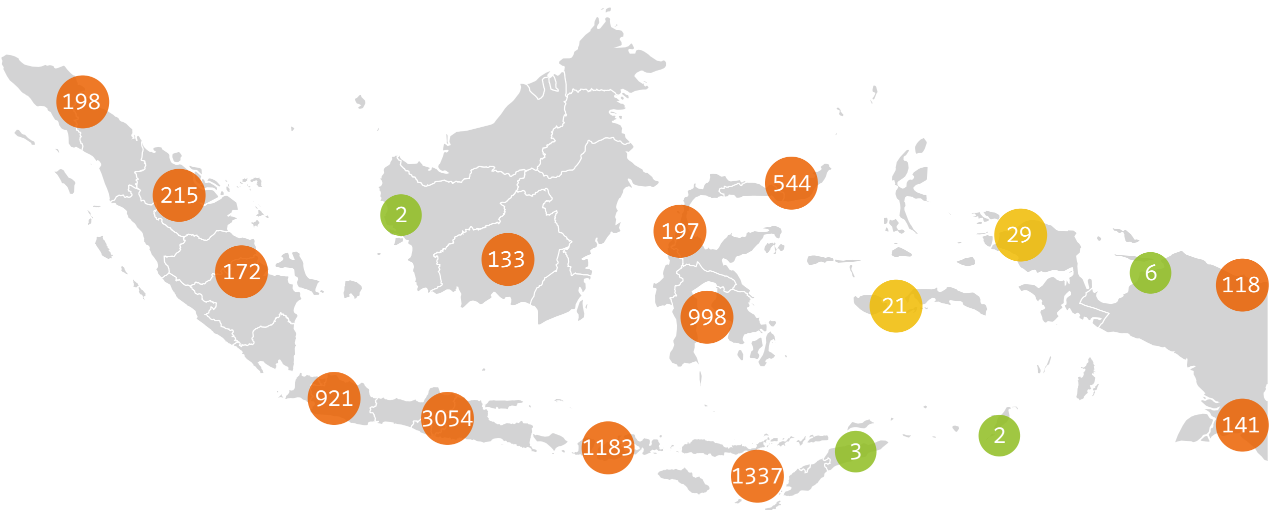


Figure 2.3.5 Distribution of groundwater from drilling wells (Source: Center for Data and Information Technology 2024)

4 | State of Wastewater Treatment

(1) Wastewater and major pollutants

In Indonesia, over 80% of households have a septic tank, but the waste is not properly managed. Furthermore, there are only about 139,000 households connected to centralized wastewater treatment systems. The main pollutant source of public waters is domestic waste (World Water Forum 2024). Further, in urban areas, 3.85% of households still practice open defecation, and 8.52% of households that have toilets do not have septic tanks (Republic of Indonesia 2020). Moreover, enforcing industry to comply with effluent standards is a challenge.

(2) Domestic wastewater

In 2021, while Indonesia's urban and rural populations were 153 million and 117 million, respectively, the country's municipal wastewater treatment capacity was only 0.3 km^3/year. Grey water is directly discharged into public water bodies without any treatment (Widyarani et al., 2022). Only 2% of wastewater in urban areas is correctly treated before being discharged to the water environment, and 92.6% of septage and wastewater is discharged in an unsafe manner (World Bank 2021).

(3) Industrial wastewater

Domestic wastewater is a major source of pollution in many rivers, but pollutants from industry are also a big concern. In the five major rivers, namely, Musi, Citarum, Ciliwung, Brantas, and Cisadane, the ratios of industrial wastewater to the total of pollution sources were 1%, 18%, 6%, 9%, and 20% respectively, indicating significant regional differences (MOEF 2021). Figure 2.3.6 presents the percentage of safely treated industrial effluent across the country, and shows that most industries treated wastewater and safely discharged it at a rate of 91% in 2020, which rate gradually dropped to 75-77% in 2021 and 2022.

The MOEF currently regulates wastewater discharged from industry based on Decree No. 5 of 2014, amended in 2018 and 2019. The following industries and facilities are regulated under the decree: a. metal coating and galvanizing industry; b. leather tanning industry; c. palm oil industry; d. rubber industry; e. tapioca industry; f. monosodium glutamate and inosine monophosphate industry; g. plywood industry; h. milk processing industry; i. soft drink industry; j. soap, detergent and vegetable oil industry; k. beer industry; l. lead acid battery industry; m. fruit and/or vegetable processing industry; n. fishery product processing industry; o. seaweed processing industry; p. coconut processing industry; q. meat processing industry; r. soybean processing industry; s. traditional medicine or herbal medicine processing industry; t. cattle and pig farming industries; u. cooking oil with wet and/or dry processes industry; v. sugar industry; w. cigarette and/or cigar industry; x. electronics industry; y. coffee processing industry; z. refined sugar industry; aa. upstream petrochemical industry; bb. rayon industry; cc. ceramic industry; dd. terephthalic acid industry; ee. polyethylene terephthalate industry; ff. basic oleochemical industry; gg. caustic soda/chlorine industry; hh. pulp and paper industry; ii. ethanol industry; jj. dry battery industry; kk. paint industry; ll. pharmaceutical industry; mm. pesticide industry; nn. fertilizer industry; oo. textile industry; pp. hospitality; qq. health service facilities; rr. slaughterhouses; and ss. domestic, which includes: 1. residential areas, area offices, commercial areas, and apartments; 2. restaurants with building areas of more than 1,000 m^2; and 3. dormitories for 100 (one hundred) persons or more (MOEF 2014, Article 3).

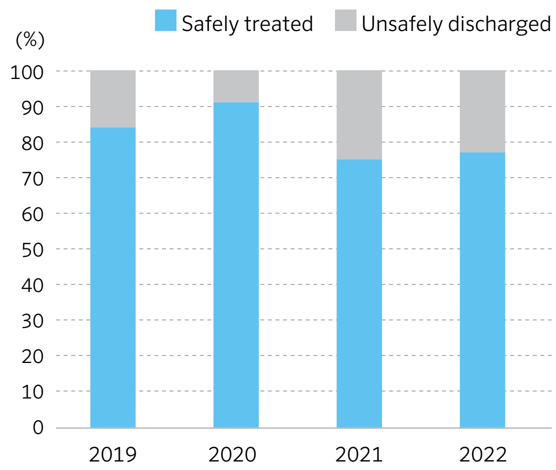


Figure 2.3.6 Percentage of industrial wastewater flows safely treated over 2019-2022

(Source: BPS-Statistics 2024)

5 | Frameworks for Water Environmental Management

(1) Legislation

In Indonesia, the basic environmental laws and regulations are Law No. 32 of 2009 on Environmental Protection and Management, Law No. 17 of 2019 on Water Resources, and Government Regulation No. 22 of 2021. Law No. 32 states that a good, healthy environment is a human right for all Indonesian citizens as mandated in Article 28H of the Constitution of the Republic of Indonesia, and Law No. 17 aims to establish sustainable water uses.

Ambient water quality standards were set in regulation No. 22 of 2021, and effluent standards were set in Ministry Decree No. 15 of 2014 and No. 68 of 2016 (MOEF 2024). Regulation No. 22 covers: 1) environmental approval; 2) water quality protection and management; 3) air quality protection and management; 4) sea water quality protection and management; 5) environmental damage control; 6) waste management; 7) guarantee fund for environmental function restoration; 8) environmental information system; 9) guidance and supervision; and 10) administrative sanctions and transitional provisions (MOEF 2024; Republic of Indonesia 2021).

Several other laws and regulations also cover water environment conservation, such as Government Guideline No. 06 of 2006 on water resources and No. 43 of 2008 on Groundwater, Presidential Regulation No. 12 of 2008 on Water Resources Council, and Regulation of the State Minister of Living Environment No. 1 of 2010 on the water pollution control system (USAID/Sustainable Water Partnership 2021, Table 2).

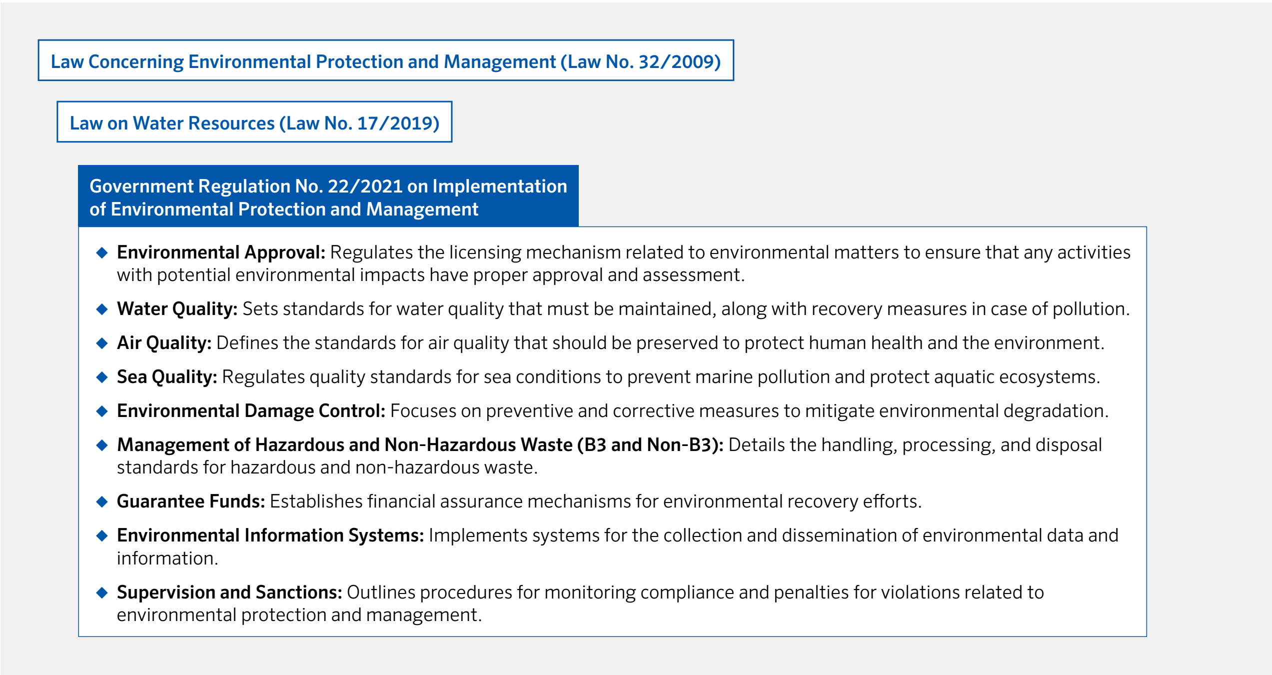
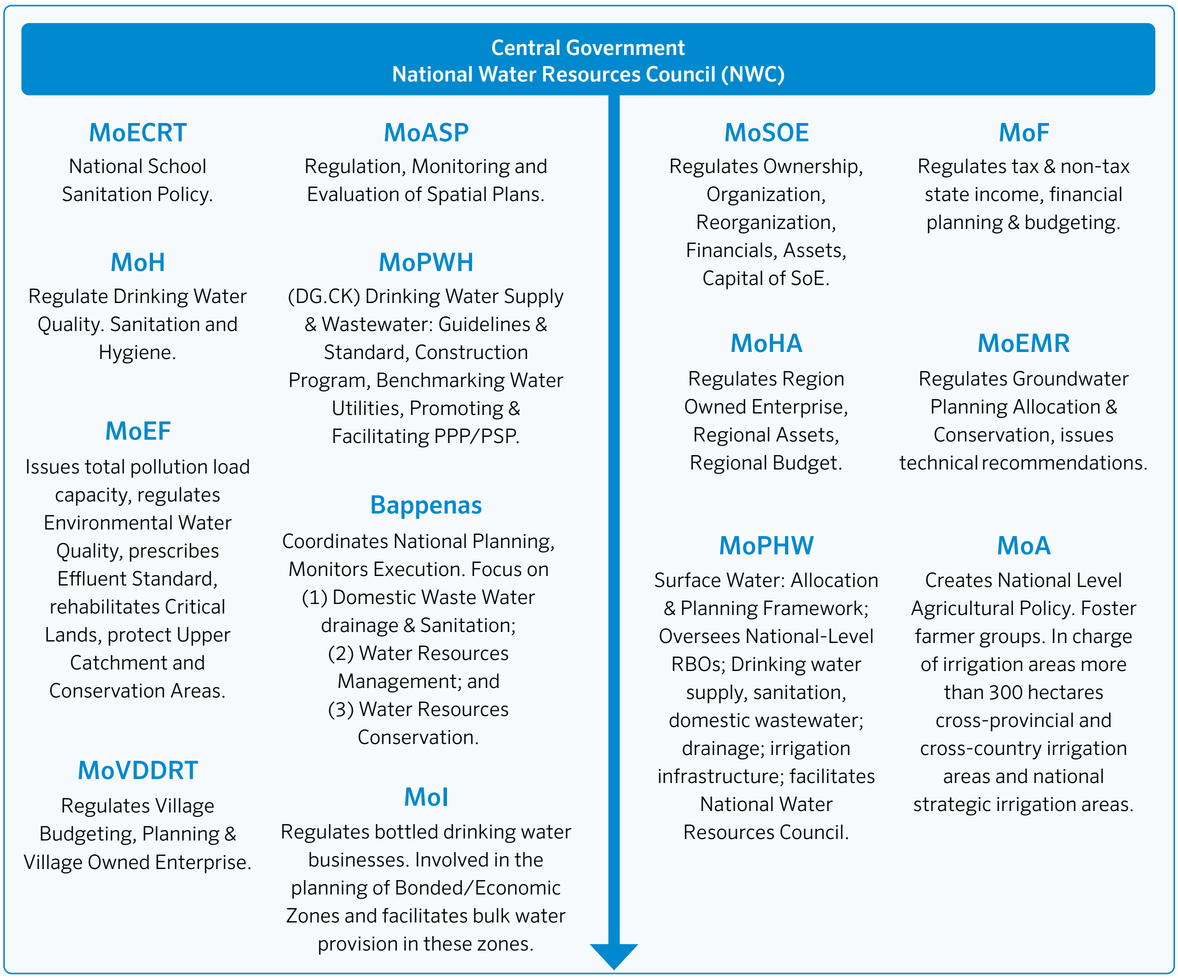


Figure 2.3.7 Basic legislative structure for water environment management

(2) Institutional arrangement

The Long-Term Development Plan 2005-2025 stipulates the role of government as facilitator, regulator, and development catalyzer to increase the effectiveness of public services (ADB 2016). In Indonesia, several ministries handle water management, including the Ministry of Environment and Forestry (MOEF), Ministry of Public Works and Housing (MOPWH) and State Ministry of National Development Planning (BAPPENAS). MOEF is responsible for water quality management and pollution, MOPWH handles water resource management with a focus on quantity and water uses, and BAPPENAS is responsible for the overall national development.



MoECRT: Ministry of Education, Culture, Research, and Technology
MoPWH: Ministry of Public Work and Housing (DG CK: Directorate General of Human Settlements)
MoVDDRT: Ministry of Village, Development of Disadvantaged Regions and Transmigration
MoASP: Ministry of Agrarian Affairs and Spatial Planning
MoEF: Ministry of Environment and Forestry
MoI: Ministry of Industry
MoH: Ministry of Health
Bappenas: National Development Planning
MoSOE: Ministry of State Owned Enterprises
MoEMR: Ministry of Energy and Mineral Resources
MoF: Ministry of Finance
MoHA: Ministry of Home Affairs
MoA: Ministry of Agriculture

Figure 2.3.8 Government agencies involved in water resources management (Source: Haneda Sri Mulyanto 2022)

(3) Ambient water quality standards

The ambient water quality standards for intended water use criteria are set in APPENDIX VI of Government Regulation No. 22, 2021. These are the minimum standards set by the national government and can be arbitrarily superseded by local governments if necessary, such as setting stricter standards or adding parameters in accordance with local settings.

To date, water quality standards are set for surface inland water bodies such as rivers and lakes (approved in 2001) and coastal waters (approved in 2004). Regarding groundwater, rather than setting a fixed standard, the Government has set water quality standards based on the water use, such as for drinking, hygiene and sanitation, swimming pools, spa, bathing, and recreation. Groundwater meeting the criteria can be used without processing (Regulation of the Minister of Health of the Republic of Indonesia No. 2 of 2023). Water use is further classified into one of four categories (see Table 2.3.3). However, as rivers have not been fully categorized into classes, the state of water quality in the country is evaluated based on the values for Class 2.

The government minister as well as provincial governors can set stricter standards for the purpose of restoring the water environment (Government Regulation No. 22 of 2021 Article 115).

Table 2.3.3 Water use criteria

Water use classification	Purpose
1	Drinking water and other purposes classified in 2-4
2	Water recreation, and other purposes classified in 3-4
3	Fish farming, livestock, irrigating plants and other purposes classified in 4
4	Irrigating crops

(Source: Government Regulation No.22 of 2021, APPENDIX VI)

Table 2.3.4 River and lake water quality standards

Parameter	Unit	Rivers				Lakes			
		Class 1	Class 2	Class 3	Class 4	Class 1	Class 2	Class 3	Class 4
Temperature	°C	3	3	3	3	3	3	3	3
Total dissolved solids	mg/L	1,000	1,000	1,000	2,000	1,000	1,000	1,000	1,000
Total suspended solid	mg/L	40	50	100	400	25	50	100	400
Transparency	M	-	-	-	-	10	4	2.5	-
Colour	Pt-Co	15	50	100	-	15	50	100	-
pH	–	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9
BOD	mg/L	2	3	6	12	2	3	6	12
COD	mg/L	10	25	40	80	10	25	40	80
DO	mg/L	6	4	3	1	6	4	3	1
Sulfate	mg/L	300	300	300	400	300	300	300	400
Chloride	mg/L	300	300	300	600	300	300	300	600
Nitrate	mg/L	10	10	20	20	-	-	-	-
Nitrite	mg/L	0.06	0.06	0.06	-	-	-	-	-
Ammonia	mg/L	0.10	0.20	0.50	-	-	-	-	-
Total nitrogen	mg/L	15	15	25	-	0.65	0.75	1.90	-
Total phosphorus	mg/L	0.20	0.20	1.00	-	0.01	0.03	0.10	-
Fluoride	mg/L	1.00	1.50	1.50	-	1.0	1.5	1.5	-
Sulfur	mg/L	0.002	0.002	0.002	-	0.002	0.002	0.002	-
Cyanide	mg/L	0.02	0.02	0.02	-	0.02	0.02	0.02	-
Free chlorine	mg/L	0.03	0.03	0.03	-	0.03	0.03	0.03	-
Dissolved barium	mg/L	1.00	-	-	-	1.00	-	-	-
Boron	mg/L	1.00	1.00	1.00	1.00	1.0	1.0	1.0	1.0
Mercury	mg/L	0.001	0.002	0.002	0.005	0.001	0.002	0.002	0.005
Arsenic	mg/L	0.05	0.05	0.05	0.10	0.05	0.05	0.05	0.10
Selenium	mg/L	0.01	0.05	0.05	0.05	0.01	0.05	0.05	0.05
Dissolved Iron	mg/L	0.30	-	-	-	0.3	-	-	-
Cadmium	mg/L	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Cobalt	mg/L	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Manganese	mg/L	0.1	-	-	-	0.4	0.4	0.5	1.0
Nickel	mg/L	0.05	0.05	0.05	0.1	0.05	0.05	0.05	0.1
Zinc	mg/L	0.05	0.05	0.05	2.00	0.05	0.05	0.05	2.00
Copper	mg/L	0.02	0.02	0.02	0.2	0.02	0.02	0.02	0.2
Lead	mg/L	0.03	0.03	0.5	0.5	0.03	0.03	0.5	0.5
Hexavalent chromium	mg/L	0.05	0.05	0.05	1.00	0.05	0.05	0.05	1.00
Oil and grease	mg/L	1	1	1	10	1	1	1	10
Total detergent	mg/L	0.2	0.2	0.2	-	0.2	0.2	0.2	-
Phenol	mg/L	0.002	0.005	0.01	0.02	0.002	0.005	0.01	0.02
Aldrin/dieldrin	μg/L	17	-	-	-	17	-	-	-
Benzene hexachloride	μg/L	210	210	210	-	210	210	210	-
Chlordane	μg/L	3	-	-	-	3	-	-	-
DDT	μg/L	2	2	2	2	2	2	2	2
Endrin	μg/L	1	4	4	-	1	4	4	-
Heptachlor	μg/L	18	-	-	-	18	-	-	-
Lindane	μg/L	56	-	-	-	56	-	-	-
Methoxychlor	μg/L	35	-	-	-	35	-	-	-
Toxapan	μg/L	5	-	-	-	5	-	-	-
Fecal coliform	MPN/100 mL	100	1,000	2,000	2,000	100	1,000	2,000	2,000
Total coliform	MPN/100 mL	1,000	5,000	10,000	10,000	1,000	5,000	10,000	10,000
Waste	–	nil	nil	nil	nil	nil	nil	nil	nil
Gross α radiation	Bq/L	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Gross β radiation	Bq/L	1	1	1	1	1	1	1	1

(Source: Government Regulation No. 22 of 2021, APPENDIX VI)

Regarding sea water, the decree on the Standard Quality of Sea Water (MOE Decree No. 51 of 2004) stipulates the water quality standards for ports and harbors, marine recreation, and marine ecosystems. Standards for marine ecosystems are set separately for coral, mangrove, and sea grass; see Table 2.3.5, below.

Table 2.3.5 Coastal water quality standards for marine ecosystems

Parameter	Unit	Ports and harbours	Marine recreation	Marine ecosystem (coral)	Marine ecosystem (mangrove)	Marine ecosystem (sea grass)
Colour	Pt-Co	-	30	-	-	-
Odour	-	Odourless	Odourless	Normal*	Normal*	Normal*
Clarity	M	>3	>6	>5	-	>3
Turbidity	NTU	-	5	<5	<5	<5
TSS	mg/L	80	20	20	80	20
Temperature	°C	Normal*	Normal*	28-30	28-32	28-30
Refuse	-	nil	nil	nil	nil	nil
Oil film	-	nil	nil	nil	nil	nil
pH	-	6.5-8.5	6.5-8.5	7-8.5	7-8.5	7-8.5
Salinity	‰	Normal	Normal	33-34	34	33-34
DO	mg/L	-	>5	>5	>5	>5
BOD	mg/L	-	20	20	20	20
Total ammonia	mg/L	-	0.3	0.3	0.3	0.3
Orthophosphate	mg/L	-	0.015	0.015	0.015	0.015
Nitrate nitrogen	mg/L	-	0.008	0.008	0.008	0.008
Cyanide	mg/L	-	0.5	0.5	0.5	0.5
Sulphides	mg/L	-	0.01	0.01	0.01	0.01
Phenols	mg/L	-	0.002	0.002	0.002	0.002
PAHs	mg/L	-	0.003	0.003	0.003	0.003
PCB	μg/L	-	0.01	0.01	0.01	0.01
Surfactants	mg/L	1	1	1	1	1
Oil and grease	mg/L	5	5	1	1	1
Tributyltin	μg/L	0.01	-	0.01	0.01	0.01
Pesticides	mg/L	-	-	0.01	0.01	0.01
Mercury	mg/L	0.003	0.002	0.001	0.001	0.001
Hexavalent chromium	mg/L	-	0.002	0.005	0.005	0.005
Arsenic	mg/L	-	0.025	0.012	0.012	0.012
Cadmium	mg/L	0.01	0.002	0.001	0.001	0.001
Copper	mg/L	0.05	0.05	0.008	0.008	0.008
Lead	mg/L	0.05	0.005	0.008	0.008	0.008
Zinc	mg/L	0.1	0.095	0.05	0.05	0.05
Nickel	mg/L	-	0.075	0.05	0.05	0.05
Fecal coliform	MPN/100 mL	-	200	-	-	-
Total coliform	MPN/100 mL	1,000	1,000	1,000	1,000	1,000
Pathogens	sel/100 mL	-	-	nil	nil	nil
Plankton	sel/100 mL	-	-	Not excessive	Not excessive	Not excessive
Substances of unknown composition (radioactive)	Bq/L	-	4	4	4	4

* Normal: normal condition of an environment, varying at all times (day, night and season)

(Source: Decree of the State Minister of the Environment No. 51 of 2004)

a. Water quality monitoring framework

Government Regulation No. 22 of 2021 Article 122 stipulates the monitoring framework, in which water quality monitoring is carried out by the MOEF, provincial government or municipal government through manual and/or automatic means. The results are integrated into the environmental information system, and are used for determining the water quality status (Republic of Indonesia 2021). There are 2,397 rivers in Indonesia, with a total length 84,678 km, the quality of which is monitored by MOEF at 15,065 points through collaboration with local governments. In 2023, the monitoring results from 812 points (MOEF) and 5,157 points (local governments) provided an overview of the water environment condition (Republic of Indonesia 2024).

In 2022, while the target water quality index was 55.3, the average index across 13,956 monitoring data from 6,442 monitoring points was 53.88. According to the annual WQI, Papua Barat was the province with the highest WQI while DI Yogyakarta had the lowest (MOEF 2022).

The MOEF established an automated, continuous and online water quality monitoring system (ONLIMO), and put into place related equipment at 127 points over 2015-2022 with the aim of acquiring accurate information for public disclosure (MOEF 2022 and 2024). The monitoring data is used to determine the water quality status and to help with water pollution control policy as well as an early warning system. By 2023, ONLIMO had been installed in 194 locations. While manual monitoring parameters are pH, DO, COD, TSS, NO_3-N, T-P, and fecal coliform in rivers and pH, DO BOD, COD, TSS, T-N, T-P, transparency, Chl-a, and fecal coliform in lakes, ONLIMO measures temperature, electrical conductivity, TDS, DO, pH, turbidity, depth, nitrate, ammonia, TSS, COD and BOD (MOEF 2024).

Figure 2.3.9 ONLIMO system for public disclosure

(Source: https://ppkl.menlhk.go.id/onlimo-2022/)

(4) Effluent standards

a. Effluent standards

National wastewater quality standards are specified by governmental regulation after due consideration of suggestions from related government agencies (Government Regulation No. 22 of 2021). Similarly with the water quality standards, provincial governments can specify similar or tighter wastewater quality standards than the national wastewater quality standard.

General industrial effluent standards were first established through Government Regulation No. 20/1990. Under the Decree of Ministry of Environment No. 3 of 1991, specific effluent standards were first identified for 14 industrial activities, which then increased to 21 by the Decree of Ministry of Environment No. 51/1995. These Decrees were subsequently merged into the Decree of Ministry of Environment and Forestry No. 5 of 2014. Currently, the quality-related aspects of effluent are applied to the industries and facilities specified in 4) (3). Local governments such as in DKI Jakarta, West Java and Jogjakarta have established tighter wastewater quality standards than the national government.

b. Effluent inspection procedure

All industries are required to submit wastewater samples to registered laboratories once a month or more frequently depending on their activities, and submit analysis reports every six months to local authorities and the MOEF. Local and national authorities have the right of access and sampling of effluent at any time.

Among 3,200 industries inspected in 2021–2022, 2,389 met the effluent standards, while 751 did not (see Fig. 2.3.10). The compliance rate was 76%.

Inspections at 36 domestic wastewater treatment plants (WWTP) and four leachate final processing (LFPS) sites were also carried out; the results are shown in Fig. 2.3.11. All plants met the effluent standards for oil and grease and TSS, but over 60% failed to meet the standards for ammonia and total coliform.

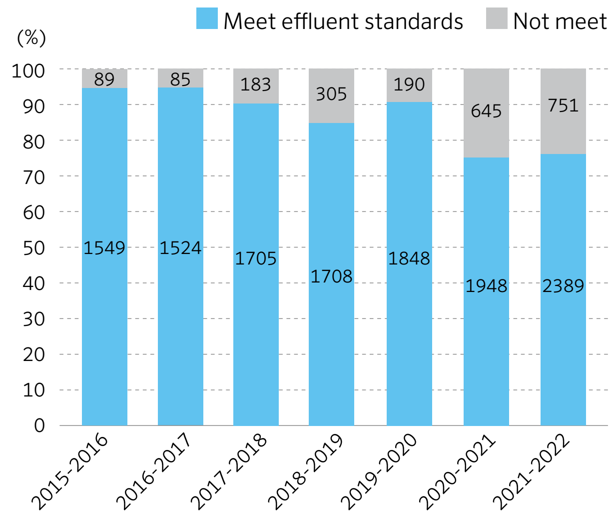


Figure 2.3.10 Results of effluent standard inspection (industries) (Source: MOEF 2022)

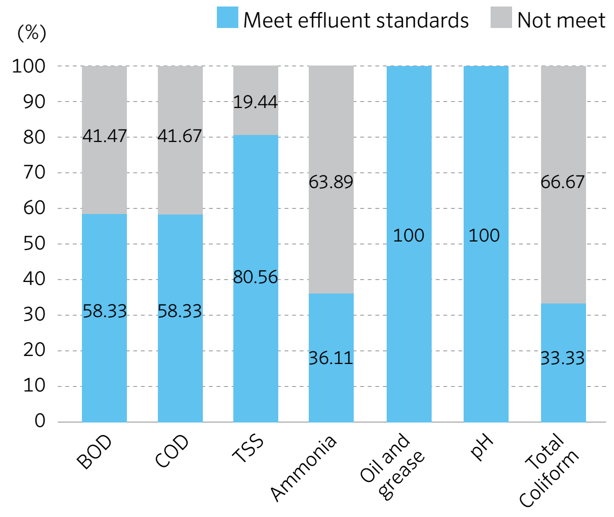


Figure 2.3.11 Results of effluent standard inspection (WWTP and LFPS) (Source: MOEF 2022)

c. Measures against non-compliance

In the absence of any economic tools or concrete plans for water quality management and enforcement of regulations, Indonesia has some judicial and non-judicial measures for managing non-compliance with effluent water quality standards. In order to enforce the water management guidelines, effluent standards for industrial and domestic sectors were approved in 2014 and 2016 respectively, for which either the Environment Agency of local and provincial government or MOEF manage inspections in accordance with permits issued.

While each industrial site has an obligation to monitor the quality of effluent once a month, rates of effluent discharge and pH are monitored daily. Reporting is done every three months, inspections for which involve a three-step process: a) on-site inspection, b) submittal of effluent quality report by the industry, and c) online report submission.

Based on Article 76 of Law No. 32 of 2009 on Environmental Protection and Management, the Minister, Governor, Regent, or Mayor can impose administrative sanctions on business actors in accordance with the degree of violation of environmental permits (e.g., effluent quality), which include:

i. Written warning
ii. Government order
iii. Freezing of environmental permit
iv. Revocation of environmental permit

Although an enforcement regulation previously existed, the Minister of Environment and Forestry introduced a new aspect of effluent quality monitoring that stipulates it be performed automatically, continuously and online, under Decree of the Minister of Environment and Forestry No. 93 of 2018.

d. Compliance management

To raise awareness of environmental management and increase compliance by the private sector, MOEF instigated an initiative named Program for Pollution Control, Evaluation, and Rating (PROPER) in 1996. PROPER is aimed at meeting the demands for transparency and public involvement in environmental management and creating incentives for the private sector to comply with regulations (PROPER, 2019).

PROPER primarily targets companies considered to have impacts on the environment (water, air, and waste). In addition to submitting self-monitoring data, participating companies are directly supervised by environmental monitoring officers. Based on the information gathered and other evaluation processes, the performance of companies is ranked and disclosed to the public (ibid). Participants are classified into the following five classes (PROPER 2024, 16):

- **Gold:** consistently demonstrates environmental excellence in production and service processes, and carries out ethical and responsible business for society
- **Green:** carries out environmental management beyond that required in regulations through implementing an environmental management system and utilizing resources efficiently and carries out social responsibilities well
- **Blue:** carries out environmental management efforts as required in accordance with applicable statutory provisions or regulations

- **Red:** carries out environmental management efforts but is not yet in compliance with the requirements as regulated under legislation
- **Black:** deliberately commits acts or negligence that results in environmental pollution or damage, as well as violates applicable laws and regulations and/or fails to carry out administrative sanctions

The numbers of participating companies increased from 1,895 in 2016 to 3,694 in 2023 (see Table 2.3.6).

Table 2.3.6 PROPER rating trends

Performance level	Number of companies in 2016	Number of companies in 2023
Gold	12 (1%)	79 (2%)
Green	172 (9%)	196 (5%)
Blue	1,422 (75%)	2,131 (58%)
Red	284 (15%)	1,077 (29%)
Black	5 (0%)	211 (6%)
Total participants	1,895	3,694

(5) Major policies on water environmental management

The Long-Term Development Plan 2005-2025 (RPJPN) presents the main policies and strategies, which in turn sets the direction for the National Medium-Term Development Plan (RPJMN) 2015-2019, which includes the following targets regarding conservation of the water environment:

- Rehabilitation of 5.5 million ha of Indonesian forest
- Increased community involvement in watershed management through community development
- Establishment of flood management schemes in 33 river basins
- Improved water quality in 15 lakes and five rivers
- Establishment of plantation forests, community forests, village forests; development of ecotourism and non-timber forest products; rehabilitation of 3 million ha and construction of 1 million ha of irrigation networks

Analyses of watershed status, water source protection and restoration are to be carried out in four priority watersheds (Ciliwung, Citarum, Kapuas and Siak), and vegetation management is to be conducted in 26 sub-priority watersheds. Presidential Decree No. 33/2011 lays out the national policy of water resource management from 2011 to 2030.

6 | Recent Developments in Water Environmental Management

Regarding the Sustainable Development Goals (SDGs), the Ministry of National Development Planning (BAPPENAS) is assigned to coordinate the entire process of planning, implementation, monitoring as well as evaluation and reporting by involving all stakeholders.

Indonesia maintains a working relationship based on mutual trust between all stakeholders, consisting of the government, civil society organizations, philanthropy, business, and academics. Active engagement of all stakeholders is encouraged and enhanced by their involvement and representation in the Implementing Team and Working Group within the SDGs National Coordinating Team. All stakeholders are not only involved in the implementation, but also in determining the direction of SDG implementation.

Indonesia's specific response to achieving its SDG targets on water quality (SDG targets 6.2, 6.3 and SDG target 6.A specifically) is described in Table 2.3.7.

Table 2.3.7 Country's response to achieve SDG 6 targets

Responses	Yes	No	If yes, please provide short description
Mapping of agencies for SDG targets 6.2 and 6.3	√		Ministry Public Work and Housing and Ministry of Environment and Forestry
Setup/ revision of country's indicator on SDG targets 6.2 and 6.3	√		By 2030, achieving access to improved sanitation and hygiene adequate and equitable for all, and ceasing the practice of defecation in open spaces, paying special attention to the needs of women and vulnerable groups of people.
Available datasets to measure progress of SDG targets 6.2 and 6.3	√		Central Bureau of Statistics (BPS): National Socio-Economic Survey (Susenas) health and housing modules. Ministry of Public Works and Settlements: Annual Report.

a. Major flagship program for improvement of water environment

After assessment by the MOEF, the following actions were determined as necessary: a. more intensive socialisation in regions; b. facilitation to coordinate relevant agencies; c. improvement of the action program strategy and implementation of water pollution control; d. construction of WWTP and domestic WWTP for small-scale businesses including EKORIPARIAN (see below); e. addition of monitoring points and frequency representing the upstream-downstream-middle of the administrative area; f. additional budget to conduct water quality monitoring and water pollution control; and g. community empowerment in order to improve the quality of river water (MOEF 2022).

The EKORIPARIAN program is a program aimed at improving water quality and restoring the ecological and socio-cultural functions of water bodies. Its goals are as follows:

i. Maintaining the quantities and continuity of water and preventing flooding
ii. Improving water quality and restoring aquatic ecosystems
iii. Revitalizing environmentally friendly river-based culture
iv. Empowering local communities in water protection and management
v. Implementing regulations that strengthen water quality management and control water pollution

Figure 2.3.12 shows the basic structure of EKORIPARIAN, and Figure. 2.3.13 shows the locations of WWTPs and EKORIPARIAN sites. Currently, there are 11 EKORIPARIAN programs in Java Barat and one in Sumber.

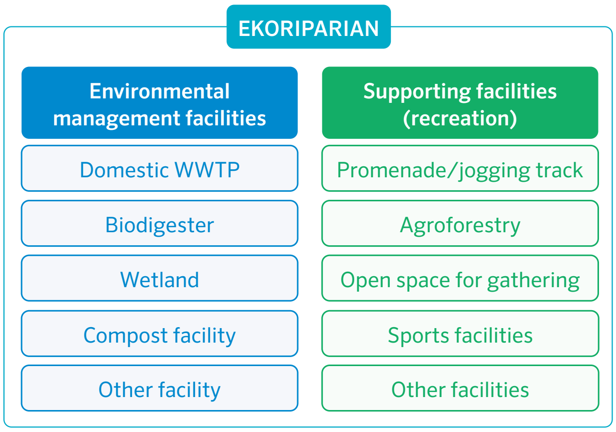


Figure 2.3.12 Structure of EKORIPARIAN

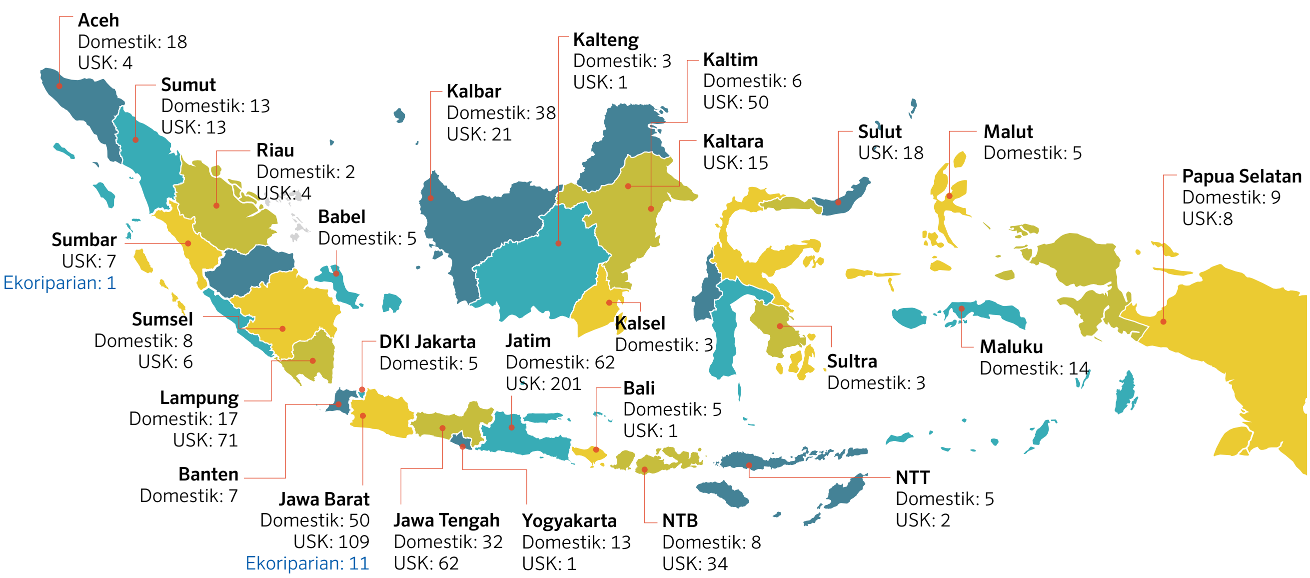


Figure 2.3.13 Locations of domestic WWTPs for domestic and small-scale businesses and EKORIPARIAN projects carried out between 2015 and 2023

7 | Challenges and Future Plans

Challenges: Key challenges are basically divided into the following four categories:

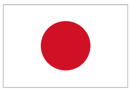
- Institutional challenges: Facilitation to coordinate with related agencies and outreach for local government are needed
- Enforcement challenges: More monitoring points are needed together with higher monitoring frequency, as well as improved action strategies and implementation of water pollution control
- Resource and financial challenges: Commitment to increase the budget for monitoring and controlling water pollution as well as resources at the community level for patrolling and cleaning rivers
- Technical challenges: The need to develop more WWTP (domestic and small-scale businesses)

Note: In Indonesia, the Ministry of Environment and Forestry was reorganized in October 2024 into the Ministry of Environment and the Ministry of Forestry. This chapter was drafted based on information available as of September, 2024.

Table 2.3.8 Necessary actions to address the above-mentioned challenges

Challenges	Actions necessary
Institutional challenges	i. Build an effective system in implementing joint programs and actions between related ministries and institutions and the community
Enforcement challenges	i. Increase the number of inspectors and training on inspection and enforcement of environmental law ii. Encourage policy makers at the local level to empower environmental inspectors
Resource and financial challenges	i. Increase the capacity of local governments with guidance and budgetary assistance ii. Implement an effective incentive and disincentive system for local government
Technical challenges	i. Increase collaboration between researchers and managers in the development and application of science and technology ii. Increase the technical capacity of staff and managers in industry and government agencies in water protection and management

2.4 Japan



1 | Country Information

Table 2.4.1 Basic indicators

Land area (km^2)		377,975 (2024)*1
Total population		124.1 million (2024)*2
GDP (current USD)		4,260.0 billion (2022)*3
GDP per capita (current USD)		34,064 (2022)*3
Average precipitation (mm/year)		1,691 (2013–2022)*4
Total renewable water resources (km^3)*5		430 (1992–2021)*4
Total annual freshwater withdrawals (billion m^3)		79.7 (2020)*4
Annual freshwater withdrawal by sector	Agriculture	66.8% (2020) *4
	Industry	16.3% (2020) *4
	Municipal (including domestic)	16.9% (2020) *4

Source:
*1 Geospatial Information Authority of Japan, MLIT, 2024
*2 Statistics Bureau of Japan, 2024
*3 Cabinet Office, Government of Japan, 2024
*4 Water and Disaster Management Bureau, MLIT, 2024

Note (*5): In Japan, the average renewable water resources is calculated as the 30-year average of the value obtained by subtracting the evaporation amount from the precipitation amount and then multiplying by the area of the region.

Figure 2.4.1 Lake Biwa in Otsu City, Shiga Prefecture

2 | State of Water Resources

Japan is located in the eastern monsoon region of Asia and noted for having one of the highest rainfalls in the world. The annual mean precipitation is 1,668 mm, about 1.4 times the global annual mean (inland area, 1,171 mm). On the other hand, on a per capita basis (annual mean precipitation × land area ÷ total population), this is about 5,000 m^3/person/year, about a quarter of the world average amount of approximately 20,000 m^3/person/year.

Compared with the world's renewable water resources, at around 3,400 m^3/person/year, the figure for Japan is less than half the world average of about 7,000m^3/person/year. Moreover, much of the available water is lost to the ocean unused due to the steep topography, very short streams, and heavy rainfall during the rainy and typhoon seasons (Water and Disaster Management Bureau, MLIT 2024).

3 | State of Ambient Water Quality

The main objectives of protecting the water environment in Japan are human health protection and environmental conservation. To achieve these, environmental quality standards (EQS) for ambient water were established under the Basic Environment Law as the acceptable levels of water quality to be maintained in public waters. As such, there are two types of EQS for water: one for human health, which sets uniform standards applicable nationwide for all public waters,, including groundwater; and another for conservation of the living environment, which differs according to the water use of the water body in question.

In most locations, EQS for human health protection were attained with a 99.1% compliance rate in fiscal year (FY) 2022. EQS for conservation of the living environment have been achieved, with an 87.8% rate of compliance for biochemical oxygen demand (BOD) and chemical oxygen demand (COD), the representative water quality indicators for organic contamination (Environmental Management Bureau, MOEJ 2024) (see Fig. 2.4.2).

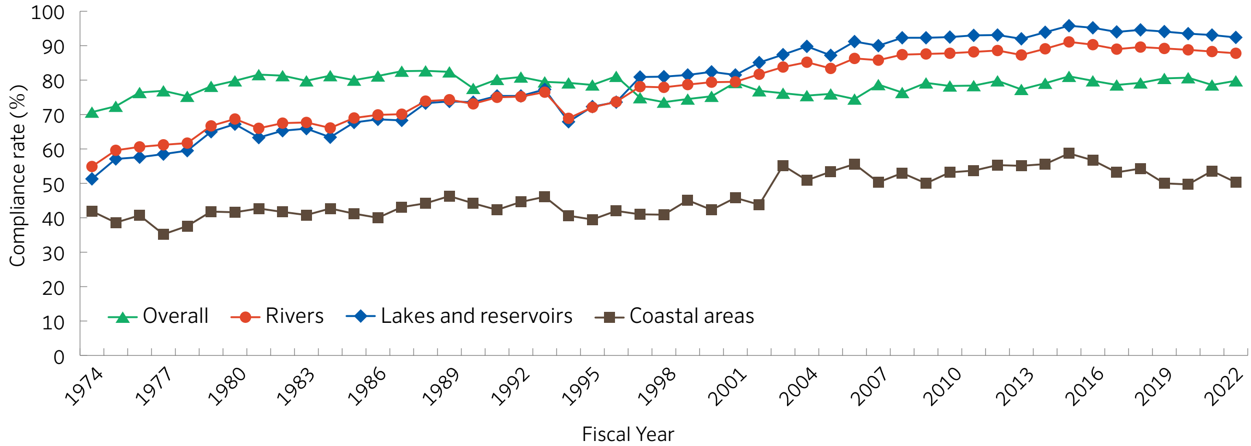


Figure 2.4.2 Trends in compliance rates for EQS (BOD and COD)

(1) Rivers

The compliance rate for BOD in rivers is 92.4% in the designated water bodies, and has been decreasing year by year.

(2) Lakes and reservoirs

The compliance rate for COD in lakes and reservoirs was 50.3% in the designated water bodies, and that for total nitrogen and phosphorus in lakes and reservoirs was 54.0%, indicating that further efforts are still needed for improvement.

(3) Coastal water

The compliance rate for COD in coastal areas was 79.8% in the designated water bodies, while the compliance rate for total nitrogen and total phosphorus was 90.1%.

(4) Groundwater

Of the 2,830 wells tested in 2022, 149 (or 5.3%) failed the standards in at least one parameter. In particular, values for nitrate-nitrogen and nitrite-nitrogen did not comply with the EQS (see Fig. 2.4.3). The main causes are assumed to be excessive fertilizer use, inappropriate management of livestock excreta and nitrogen loading from domestic wastewater (Environmental Management Bureau, MOEJ 2024).

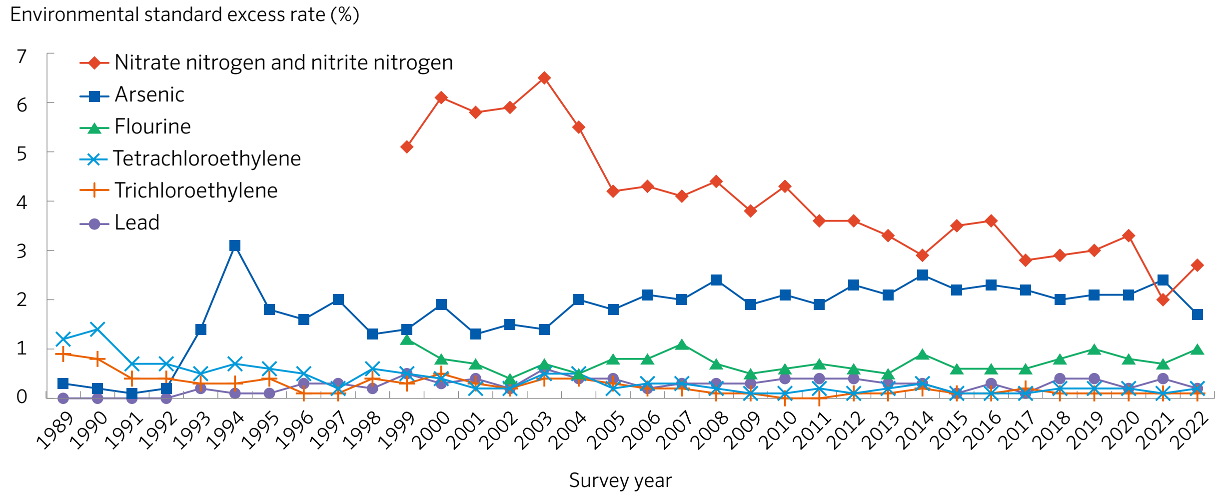


Figure 2.4.3 Trends in excess rates (failure of EQS compliance) for groundwater (key items)

Note 1: Wells measured in general survey differ by year.
Note 2: Environmental standards related to groundwater contamination were established in 1997. Actual evaluation criteria are based on standards established previously. In addition, the evaluation criterion for arsenic was revised from “under 0.05 mg/L” to “under 0.01 mg/L”, and for lead from “under 0.1 mg/L” to “under 0.01 mg/L” in 1993, and for trichloroethylene from “under 0.03 mg/L” to “less than 0.01 mg/L” in 2014.
Note 3: Nitrate nitrogen, nitrite nitrogen and fluorine were added to the environmental standard items in 1999.

4 | State of Wastewater Treatment

Access to domestic wastewater treatment facilities*1 in Japan stood at 93.3% for the population, as of the end of FY2023.

As shown in Fig. 2.4.4, municipalities with small populations tend to have lower rates of access to domestic wastewater treatment facilities. Additionally, *Johkasou**2, which is suitable for decentralized treatment on a household level, is more likely to be installed in these sparsely populated areas.

Wastewater treatment facilities are being developed continuously based on the plan titled Comprehensive Basin-Wide Plan of Sewerage Systems (known as *Todofuken Koso* in Japanese), which outlines development methods and schedules tailored to local conditions. The plan takes into account the characteristics and economics of sewers, rural sewerage systems, and *Johkasou*, and aims to eliminate areas without treatment facilities through the appropriate division of roles. In parallel with the above, implementing effective upgrades and operational and maintenance measures to ensure sustainable wastewater treatment also play an important role.

MOEJ supports upgrading from the older *Tandoku Johkasou* type of device*3 to the new *Gappei Johkasou* type through provision of a subsidy as part of domestic wastewater management measures. This subsidy is provided through the Circular Society Formation Promotion Grant, which covers the costs of conversion and related pipe installation, as well as the costs for removal and replacement of old systems.

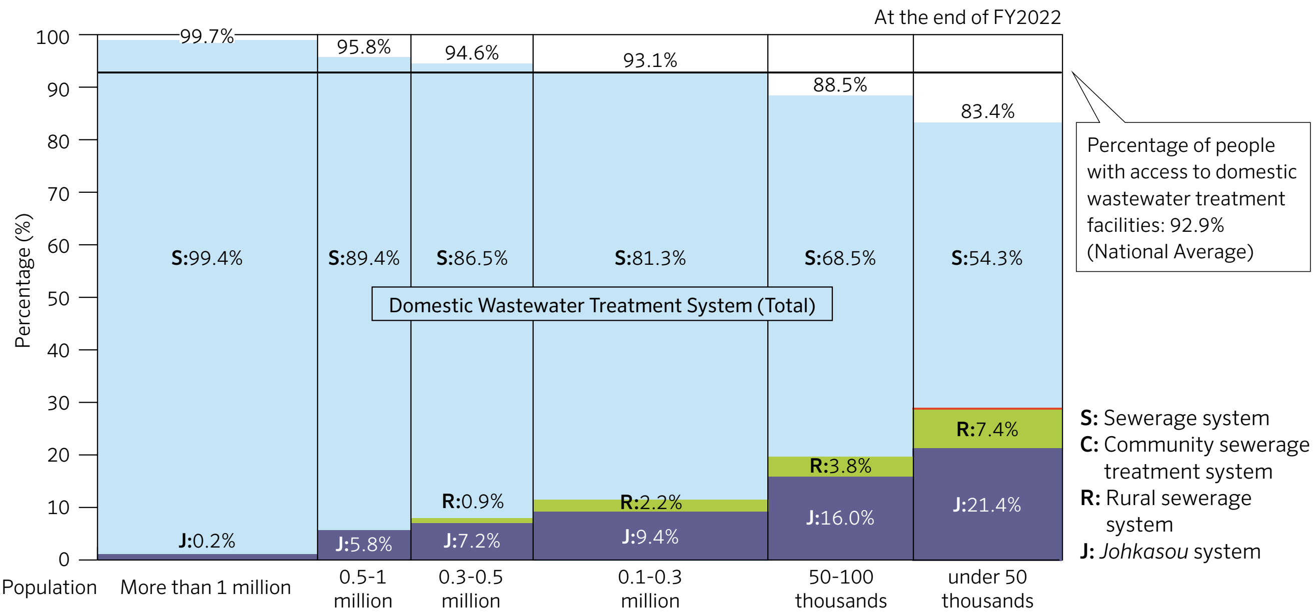


Figure 2.4.4 Percentage of people with access to domestic wastewater treatment facilities by size of municipality

(Source: MLIT 2024)

*1 The term 'domestic wastewater treatment facilities' here does not include facilities that treat only black water and discharge grey water into the environment without treatment.

*2 A decentralized domestic wastewater treatment system widely used in rural areas of Japan. It can treat both black and grey water and produce high quality effluent with aeration (BOD ≤ 20 mg/L according to the structural standard). Advanced types of *Johkasou* that can remove nitrogen or phosphorus are becoming increasingly prevalent recently. The *Johkasou* Law, modified in 2005, defines the effluent water quality standard for *Johkasou*.

*3 *Tandoku Johkasou* is an older-type *Johkasou* that treats only black water and not grey water, and has therefore low effluent removal rates and higher pollution loads (eight times) than the newer type (*Gappei Johkasou*). Under the *Johkasou* Act, the term *Johkasou* refers only to newer types that treat both black and grey water. The older type that does not treat grey water is, consequently, not regarded as *Johkasou*. New installations of the older type have been forbidden since 2000 owing to the existence of the newer type. More information is available at: https://www.env.go.jp/recycle/jokaso/en/pamph/wastewater_treatment_systems.html

5 | Frameworks for Water Environmental Management

(1) Legislation

The purpose of the Basic Environmental Law 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). The EQS for water were established by the Basic Environmental Law as the administrative targets for ambient water quality.

The Water Pollution Control Law, enacted in order to protect human health and preserve the living environment, sets provisions for water quality conservation such as effluent regulations from factories and business establishments, continuous monitoring of water quality and the total pollutant load control system. Other laws related to conservation of public waters are shown in Fig. 2.4.5.

As a measure related to domestic wastewater management, the Sewerage Act was enacted with the aim of constructing sewerage systems. In addition, the *Johkasou* Act for on-site packaged household wastewater treatment plants for areas without access to sewerage treatment was established, to define regulations relating to their manufacturing, installation, inspection, operation and maintenance and desludging.

(2) Institutional arrangement

Since water is involved in many aspects of human life, five ministries (Ministry of the Environment (MoEJ); Ministry of Land, Infrastructure, Transport and Tourism (MLIT); Ministry of Health, Labour and Welfare (MHLW); Ministry of Agriculture, Forestry and Fisheries (MAFF); and Ministry of Economy, Trade and Industry (METI)) have mainly been taking the lead and working together in water environment management in Japan (see Table 2.4.2).

In April 2024, the governance over drinking water was transferred from MHLW to MLIT and MoEJ.

The Basic Act on Water Cycle was enacted in 2014 to promote integrated and comprehensive measures related to the water cycle. According to this act, the headquarters for Water Cycle Policy, headed by the Prime Minister, was established in the Cabinet.

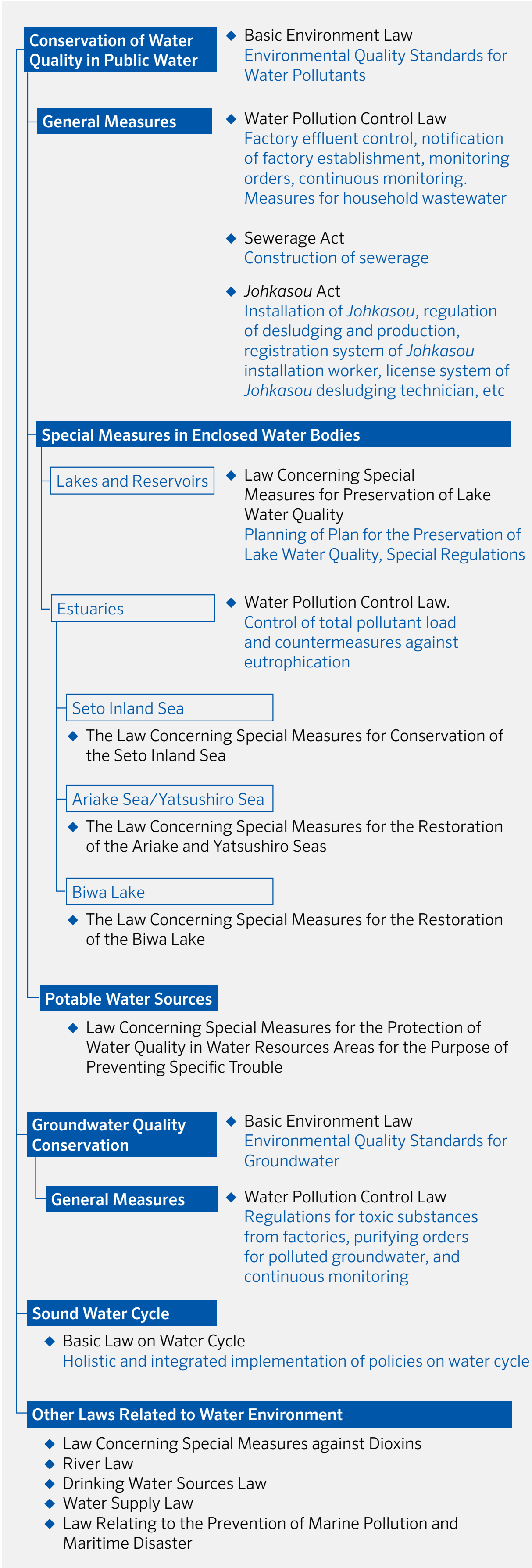


Figure 2.4.5 Structure of legal system for water environmental management in Japan (Source: MOEJ)

Table 2.4.2 Institutional arrangement for water environmental management

Ministry	Chief responsibilities
MoEJ	• Formulating and implementing a wide range of water environment management policies, such as formulation of ambient water quality standards, water quality monitoring of public waters and publication of the results, effluent standard, *Johkasou* maintenance, etc. • (From April 2024) Formulating and implementing policies related to water quality standards for drinking water, and assurance of drinking water quality.
MLIT	• Promoting sustainable river management through preparation of river-related development and management plans, disseminating sewerage policies and formulating and implementing policies related to the development and management of water resources. • (From April 2024) Formulating and implementing policies related to water supply system development and maintenance and security of drinking water quality.
MHLW	• (Until March 2024) Formulating and implementing policies related to water supply system development and maintenance, water quality standards for drinking water, and security of drinking water quality.
MAFF	• Formulating and implementing policies related to the conservation and management of agricultural land and water contributing to the conservation of the rural environment, and the development of sewage treatment facilities in rural areas.
METI	• Formulating and implementing policies such as for industrial water supply development and wastewater treatment in the mining industry through the implementation of mine pollution prevention projects.

(3) Ambient water quality standards

a. Ambient water quality standards

In 1971, the EQS for water were established, and nationwide uniform standard values were set for 27 items as the EQS for water related to protection of human health (health items). Meanwhile, the EQS for water related to conservation of the living environment (living environment items) include environmental standards for 13 items, such as BOD, COD, and DO, as well as total nitrogen and total phosphorus, for prevention of eutrophication in lakes and coastal waters.

As indicators of ambient water quality standards for the conservation of aquatic living resources, total zinc, nonylphenol and linear alkylbenzene sulfonic acid and its salts were registered in 2003, 2012 and 2013, respectively. In 2022, the indicator for total coliform count was revised to E. coli count.

b. Monitoring framework

According to the Water Pollution Control Law, prefectural governors are required to conduct regular monitoring of public water bodies and groundwater, and report to MoEJ as well as inform the public on the state of water pollution in public water bodies and groundwater. Prefectural governments also prepare monitoring plans and carry out regular water quality monitoring in cooperation with relevant national government organizations based on monitoring methods specified by MoEJ. Monitoring results from approximately 7,000 locations in public water bodies nationwide are publicly released on the MoEJ website (see Fig. 2.4.6).

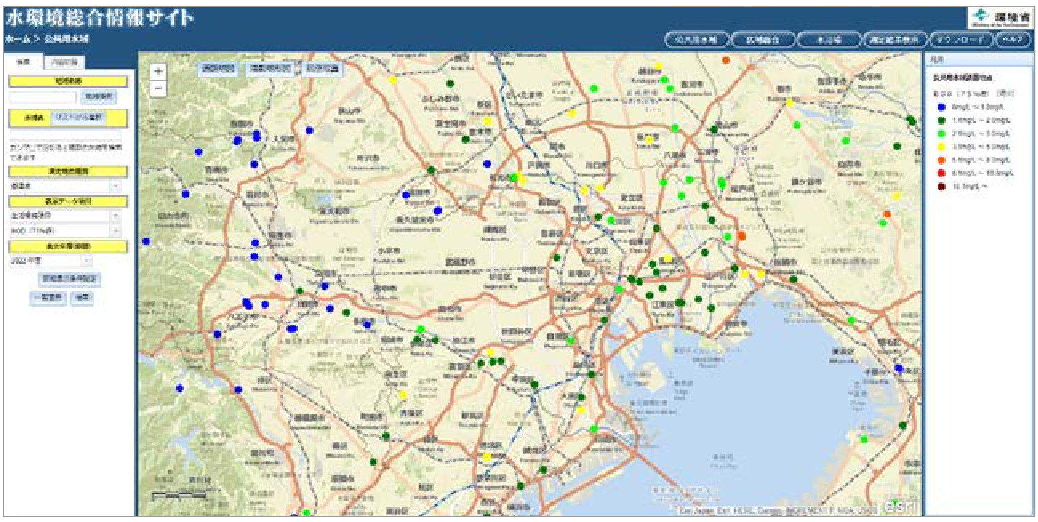


Figure 2.4.6 Comprehensive information site on the water environment (Source:MoEJ)

(4) Effluent standards

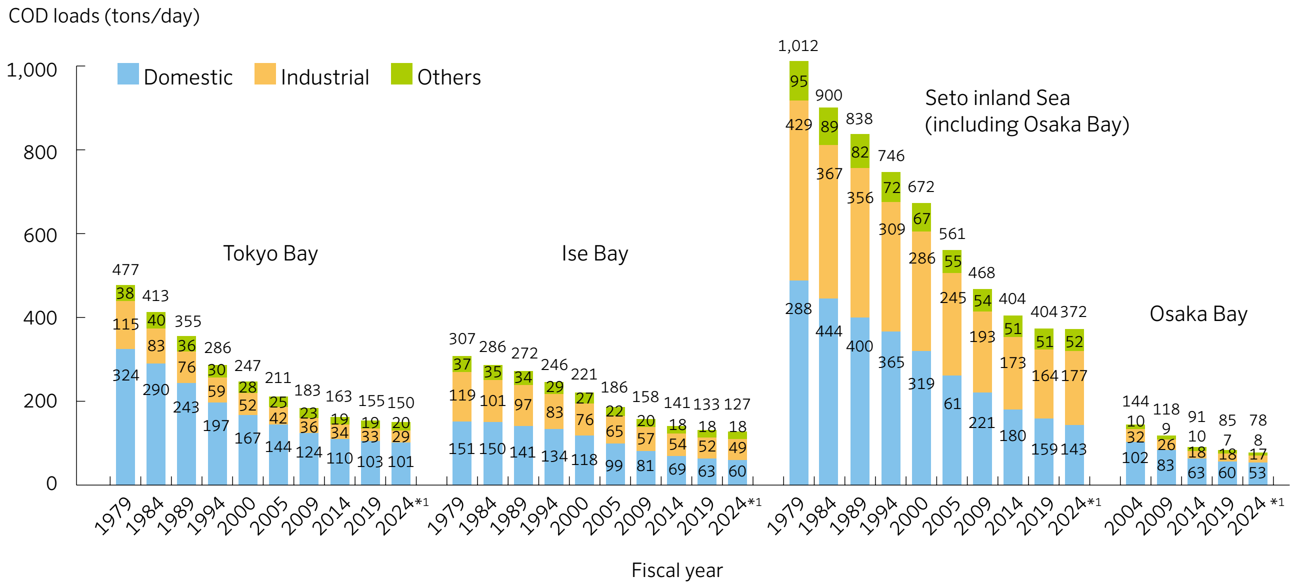
a. Effluent standards

Based on the Water Pollution Control Law, uniform effluent standards were established for 28 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 50 m³ 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 insufficient to achieve water quality targets.

b. Total pollutant load control system

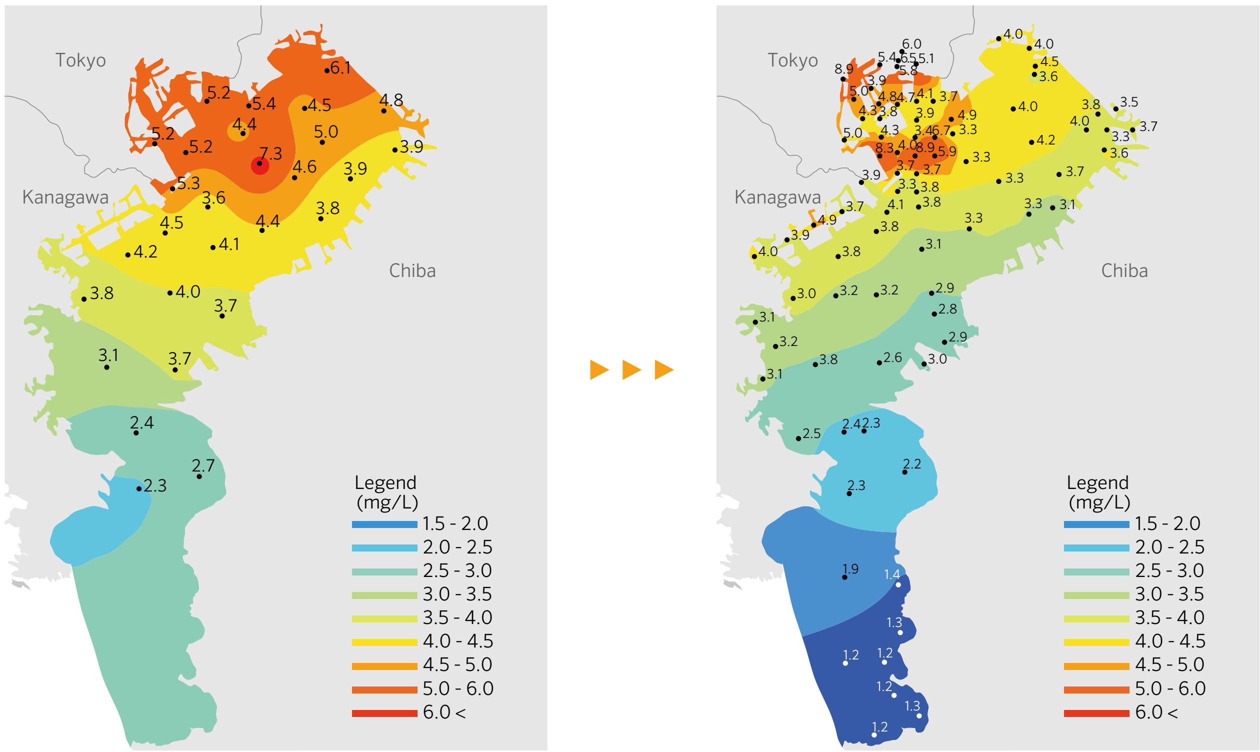
The total pollutant load control system (TPLCS) is an effluent control mechanism aimed at improving water quality by reducing the total load of pollutants flowing into certain enclosed coastal waters, namely Tokyo Bay, Ise Bay, and the Seto Inland Sea. Due to the presence of densely populated and industrialized areas, it is difficult to achieve EQS for these coastal waters by regulating effluent based only on concentrations of regulated substances. Under this system, the national government sets targets for pollutant loads and the years in which they are to be achieved, and the relevant prefectures specify detailed methods for achieving the targets.

To date, COD loads have been steadily reduced in target water bodies since 1979 (see Fig. 2.4.7). Figure 2.4.8 shows the improvement in COD concentrations in Tokyo Bay, for example. Nitrogen and phosphorus loads have also been reduced since they were added to designated items under the system in 2001. In January 2022, Japan set the Ninth Basic Policy for the TPLCS, with the target year of FY2024.



*1 The value up to for FY2019 represents the target, while the values for other fiscal years represent estimated results in the relevant prefectures.

Figure 2.4.7 Changes in pollution load and target value (COD) (Source: MOEJ 2022)



1982 – 1984 (average)

2016 – 2018 (average)

Figure 2.4.8 Improvement in COD concentrations in Tokyo Bay (Source: MoEJ)

c. Effluent inspection procedure

The Water Pollution Control Law stipulates monitoring and recording of the quality of effluent from factories and business establishments. Factories and business establishments located in total pollutant load control target areas 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, and are also authorized to take administrative measures in the event of violations, such as by issuing orders for improvements according to the outcomes of reports and inspections.

d. Measures against non-compliance

If it is judged that the water discharged from factories and business establishments is unlikely to meet the effluent standard (or will exceed the standard), administrative measures such as operational improvement orders and business suspension orders are implemented. Penalties such as imprisonment or fines are additionally applied in cases where effluent standards are not met (or are exceeded).

6 | Recent Developments in Water Environmental Management

Various revisions of the laws related to water environmental management have taken place according to the times and demands of society. Recent developments in water environmental management are summarized below.

a. Proactive measures to prevent groundwater pollution

In general, groundwater is widely used as a valuable freshwater resource in Japan owing to its good water quality and low variation in water temperature. However, groundwater pollution cases due to the leakage of harmful substances such as trichlorethylene from factories and business sites are continuously confirmed each year. Such groundwater pollution is caused by aging production facilities and storage facilities used in industry, as well as leakage of harmful substances due to operational errors during the use of production facilities.

Given these circumstances, in 2011, new regulations were introduced to effectively prevent groundwater contamination. These included the obligation to report the establishment of facilities that store hazardous substances, and the requirement for such facilities to comply with structural standards, as well as to monitor and keep records of periodic inspections (see Fig. 2.4.9).

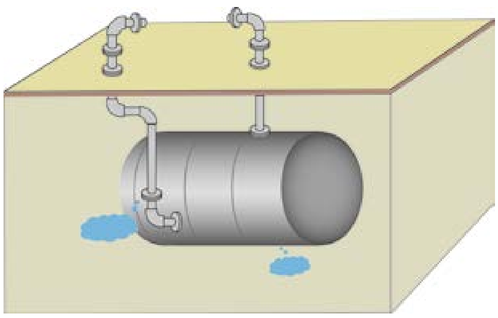


Figure 2.4.9 Underground infiltration of hazardous substances from production facilities (Source: MoEJ)

b. Monitoring of radioactive materials

Following the serious environmental pollution caused by the leakage of radioactive materials from the Fukushima Daiichi Nuclear Power Plant after the Great East Japan Earthquake in March, 2011, monitoring was instigated for radioactive materials in public water bodies and groundwater. The results of this monitoring are periodically evaluated and disclosed.

c. Ambient water quality standards

Ambient water quality standards consist of items for protection of human health (health items) and items for conservation of the living environment (living environment items). Regarding health items, 27 items are set for public waters, including heavy metals such as cadmium and lead, organochlorine compounds and agricultural chemicals, and 28 items are set for groundwater.

Standards for the living environment have been established for BOD, COD, total nitrogen, total phosphorus, total zinc, and other parameters. Based on these standards, each water body is classified according to its purpose of use. Regarding dissolved oxygen concentrations in bottom water (bottom-layer DO), which were added to the standards in March 2016, among water bodies the National Government is to designate classes for, classifications have already been designated for Lake Biwa, Tokyo Bay, Ise inland Bay, Osaka Bay (innermost part only) and Lake Kasumigaura. Further classifications for other water areas are subject to ongoing review.

In October 2021, the environmental standard for hexavalent chromium, a parameter for the protection of human health, was revised, and the indicator for fecal contamination was changed from coliform group to E. coli. The new standards went into effect in April 2022.

d. Regulation of the discharging of effluent (partial amendment of effluent standards)

Under the water pollution control law, nationwide uniform effluent standards are established for water discharged from specified facilities to preserve the quality of public water. Among the substances for which standards have been set, the provisional effluent standards for boron, fluorine, nitrate nitrogen, zinc, and cadmium were reviewed to account for the challenges related to achieving uniform effluent standards immediately.

As a result, as of July 2022, new provisional effluent standards are in effect for boron, fluorine, and nitrate nitrogen, and from December 2024, for zinc. For cadmium, all industries have transitioned to uniform effluent standards. Additionally, in response to the revision of environmental standards for hexavalent chromium and coliform bacteria, effluent standards were also revised. The new standards and provisional effluent standards for hexavalent chromium took effect in April 2024, while the revised standards for E. coli are scheduled to take effect from April 2025.

e. Partial amendment of *Johkasou* Act

In line with the development of sewage treatment facilities, the introduction of *Johkasou* is being promoted in each municipality through the use of national treasury subsidies, based on the Regional Plan for Establishing a Recycling-based Society. In particular, for the conversion from conventional *Tandoku*-type *Johkasou* to new *Gappei*-type *Johkasou*, the scope of subsidies has been expanded to include in-house plumbing work, and the subsidy rate has been increased for municipalities that promote the introduction of energy-efficient *Johkasou*. In further support of this initiative, a partial amendment to the *Johkasou* Act was enacted and promulgated in June 2019 and went into effect in April 2020.

f. Transference of drinking water governance

Prior to April 2024, the governance of water supply development and management was under the jurisdiction of the MHLW, which transferred to MLIT in April 2024 other than for water quality and sanitation-related matters, which are now handled by the MoEJ.

Cambodia
China
Indonesia
Japan
Korea
Laos
Malaysia
Myanmar
Nepal
Philippines
Sri Lanka
Thailand
Viet Nam

g. Enactment of the New Basic Plan on Water Cycle

To comprehensively and integrally promote policies related to the water cycle, the Basic Act on Water Cycle was enacted in 2014, followed by the formulation of the Basic Plan on Water Cycle in 2015 based on the act. The plan positions river basin management as one of the key directions for ensuring a healthy water cycle, emphasizing the need for collaboration among various stakeholders in each river basin towards this goal. The plan is to be reviewed approximately every five years taking into account changes in the situation related to the water cycle and evaluations of the effectiveness of policies. In light of recent developments, such as the transfer of water administration responsibilities and the Noto Peninsula earthquake in January 2024, a new Basic Plan on Water Cycle was formulated in August 2024.

The new Basic Plan focuses on four main priorities: (1) Securing a stable water supply with emphasis on substitutability and multiplicity, (2) Rebuilding sustainable and optimal water and sewage systems through facility consolidation and public-private partnerships, (3) Promoting measures against global warming in line with the goal of carbon neutrality by 2050, and (4) Expanding integrated basin-wide water management to ensure a sound water cycle. Item (4) comprises a comprehensive approach in which all stakeholders related to the basin collaborate on flood control, water use and environmental conservation, aiming to minimize damage from water-related disasters, maximize the benefits of water and ensure a rich environment connected by water. This approach is aimed at promoting river basin management to ensure a sound water cycle.

7 | Challenges and Future Plans

a. Community development through the conservation and use of the water environment

Although the measures taken to deal with the severe cases of pollution that occurred throughout the nation in the past have achieved some results, it can be said that issues such as water pollution in lakes and enclosed coastal areas, the maintenance and restoration of sound water and material cycles, and the revision of environmental standards still need to be addressed. There are also new issues, such as exploring ideal forms of environmental standards that can meet local needs as well as create a good environment. Based on the 'Future of Water and Air Quality Management' (offering an opinion) formulated in June 2023 and the Sixth Basic Environment Plan, which was approved by the Cabinet in May 2024, the Ministry of the Environment plans to promote initiatives to improve the well-being of local residents and revitalize local communities by preserving the natural environment and culture unique to each region, such as rich waterfronts, starry skies and soundscapes; promote initiatives to achieve comprehensive water environment management that contributes not only to water quality management but also to biodiversity conservation and regional development; and promote the creation of an integrated watershed management model that links regions from forests and rivers that provide water for tap water to the sea, based the use of other effective area-based conservation methods (OECM) to create a good environment. In addition, with regard to nitrogen, which also impacts on the eutrophication of water bodies and groundwater pollution, initiatives are to be promoted that contribute to society and local communities through sustainable nitrogen management, based on the 'Action Plan for Sustainable Nitrogen Management' formulated in line with the Sixth Basic Environment Plan, and through an integrated approach that combines the protection and management of the water environment with decarbonization, resource recycling and coexistence with nature.

b. Promotion of integrated risk management

Following the transfer of management of water quality and sanitation of water supply to the MoEJ in April 2024, integrated risk management from source to tap is to be promoted. Specifically, for substances such as PFOS (perfluorooctanesulfonic acid) and PFOA (perfluorooctanoic acid), which are of increasing domestic and international concern, the ministry will promote initiatives aimed at assuring safety, including reviewing water quality standards of water supply, strengthening environmental monitoring, and enhancing scientific knowledge. In addition, knowledge will be accumulated on pathogens such as protozoa and viruses that cause waterborne infectious diseases. Consideration will also be given to the effectiveness of E. coli counts as a hygiene indicator and to the potential use of alternative indicators. Given the lack of fundamental information regarding the presence of antimicrobial resistance (AMR) bacteria in aquatic environments and the potential health impacts thereof, efforts will be made to collect and analyze such data. Based on the latest scientific findings on chemical substances in the environment and research on chemical management, revisions to or establishment of additional environmental standards for the conservation of aquatic life and protection of human health will also be considered.

Furthermore, in managing the risks related to the contamination of water sources due to natural disasters or accidents, case studies and scientific evidence will be collected. Measures are to include the establishment of a rapid information-sharing system among stakeholders in environmental and water departments at national and local levels, as well as enhanced emergency preparedness, including consideration for optimal risk management frameworks.

c. Improvement of water quality of lakes

Although the water quality of lakes is gradually improving, the achievement rate of environmental standards is low at around 50%. Many issues have emerged, such as low oxygen levels at the lake bed, excessive growth of aquatic plants, reductions in native species and fish catches due to ecosystem changes, and weakened bonds between people and lakes due to reduced opportunities for people to interact with lakes. Moving forward, efforts will continue to include implementing various regulatory measures to improve water quality, comprehensively promoting the development of sewer systems and *Johkasou*, and addressing the impacts of climate change and ecological changes. These efforts are aimed at enhancing knowledge, exploring solutions, and achieving a balance between the conservation of aquatic resources and water quality preservation. Additionally, from the perspectives of preserving and restoring biodiversity and the functions of ecosystem services, ongoing efforts will be made to protect lakeshore environments, including the conservation of vegetation and aquatic life.

d. Restoring bountiful seas

Water quality is improved and preserved through human interventions in harmony with nature, resulting in seas that are clean and abundant in biodiversity and productivity—referred to as *satoumi* in Japanese. Promoting the creation of *satoumi* in coastal areas close to human settlements has been identified as a crucial task. In addition to conventional efforts to improve water quality and preserve natural coastlines, the MoEJ will promote policies that focus on meticulous nutrient management as well as the preservation, restoration, and creation of tidal flats and seaweed beds (based on the Opinion on Future Water and Air Environment Administration, issued in June 2023, and the Sixth Basic Environmental Plan, adopted by cabinet decision in May 2024). These efforts are aimed at creating a positive usage cycle of regional resources (MoEJ 2024).

e. Initiative on global water issues

Capitalizing on its experiences to date in overcoming serious instances of water pollution, Japan considers it a high priority to contribute to the preservation and improvement of the water environment in other countries, including developing countries. As such, Japan aims to utilize its technologies and knowledge to promote initiatives through international cooperation and partnerships, such as through institutional transfer and technology support. With the overarching ideal of creating a society focused on the global environment and public health, the advent of the Coronavirus pandemic in 2019 added impetus to achieving these aims.

Considering the above, the Japanese government attaches very high importance to conducting the Water Environment Partnership in Asia (WEPA) alongside public-private partnerships for the promotion of Japanese wastewater treatment technologies in other countries.

2.5 Korea

1 | Country Information

Table 2.5.1 Basic indicators

Land area (km²)		100,363 (2024)
Total population		52 million (2024)*
GDP (current USD)		3,058 billion (2024)**
Per capita GDP (current USD)		34,165 (2024)
Average annual rainfall (mm/year)		1,370 (2023)
Total renewable water resources (km³)		132.3 (2021)***
Total annual freshwater withdrawals (billion m³)		27 (2021)
Annual freshwater withdrawal by sector	Agriculture	59% (2021)
	Industry	15% (2021)
	Municipal (including domestic)	25% (2021)

(Source: * World Population Review, **World Economic Outlook Database (2024), ***FAO AQUASTAT

Figure 2.5.1 The Han River in Seoul, Republic of Korea

2 | State of Water Resources

Alongside exponential growth in GDP, per capita water use in the Republic of Korea also rose, until relatively recently. Per capita water use is currently 485 m³/year*1, whereas availability is 1,553 m³/year (Lee et al. 2019). Seasonal variation in water availability remains a challenge for the country's water management, especially in light of water-related disasters exacerbated by climate change. About two thirds of the annual precipitation falls in the monsoon season between June and September. There are four major river basins in Korea, namely the Han, Geum, Nakdong and Yeongsan-Seomjin.

3 | State of Ambient Water Quality

There are 1,936 sampling points for ambient water quality, which is measured against a composite water quality index divided into seven levels (Ia: very good, Ib: good, II: moderately good, III: moderate, IV: moderately bad, V: bad, VI: very bad). Water quality is assessed and publicly disclosed for key sampling points as shown in Fig. 2.5.2 (ME 2020, NIER MLIT 2020).

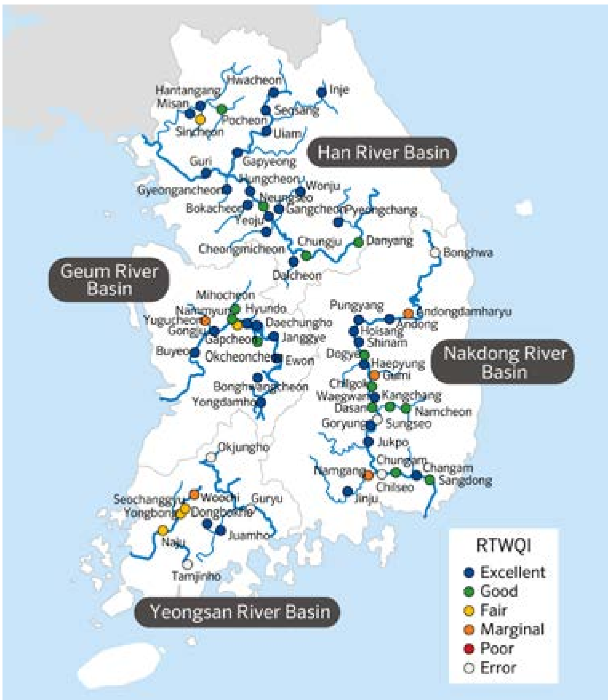


Figure 2.5.2 Water quality index of ambient water in Republic of Korea (Source: Park 2020)

*1 Calculated by dividing total water use (25.1 billion m³/year) by population (51.78 million) (Statistics Korea 2020).

(1) Rivers

All streams nationwide are classified into 115 sections and water quality targets have been established for each section. Water quality in the country has steadily improved overall since the late 1990s, due to increasing public interest. Figure 2.5.3 shows the trend in water quality in selected points in four major river systems in terms of BOD: Paldang (Han), Mulgeum (Nakdong), Daecheong (Geum) and Juam (Yeong-san-Seomjin). During 2020-2023, average concentrations of BOD of four rivers were 1.1, 2.1, 0.7 and 0.9 mg/L, respectively. Average COD values were 3.6, 6.1, 4.1 and 3.1 mg/L, respectively (see Fig. 2.5.4).

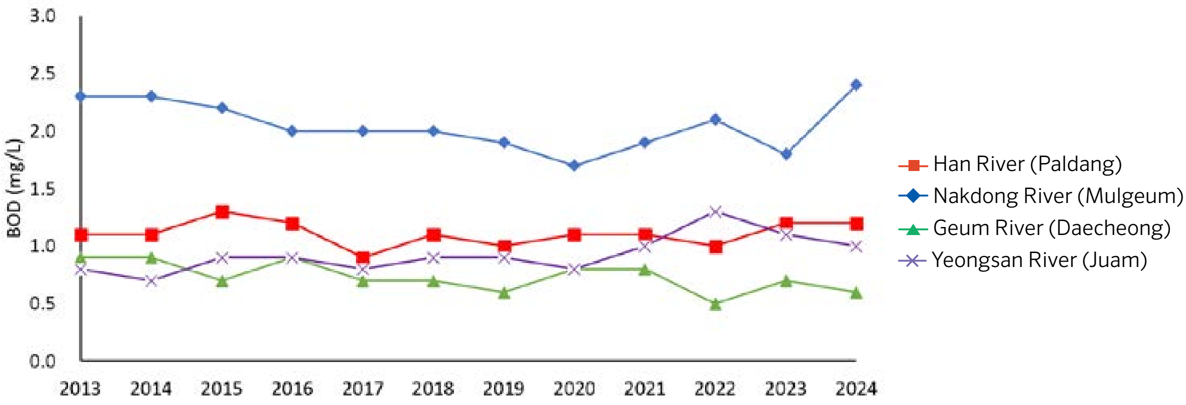


Figure 2.5.3 Changes in BOD values in four major rivers (2013-2024) (Source: ME)

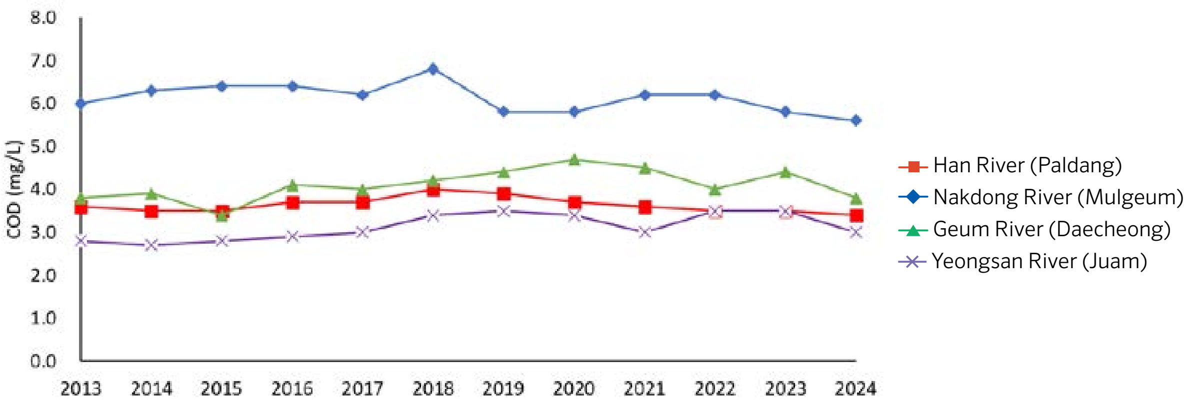


Figure 2.5.4 Changes in COD values in four major rivers (2013-2024) (Source: ME)

(2) Lakes and reservoirs

As with the quality of river water, that of lakes and reservoirs also shows a trend of improvement and stabilization in recent years. Table 2.5.2 shows recent water quality trends in selected reservoirs.

Table 2.5.2 Recent annual average water quality values for Lake Paldang, Andong, Daechong, and Juam

Year	BOD (mg/L)	COD (mg/L)	NO_3-N (mg/L)	PO_4-P (mg/L)	*E.coli* (CFU/ 100mL)
2020	1.1	3.3	1.284	0.007	219
2021	1.4	3.6	1.200	0.007	343
2022	1.5	3.6	1.234	0.006	677
2023	1.5	3.7	1.256	0.005	264

(3) Coastal water

The Korean marine environment monitoring network is composed of port, coastal/offshore, environmental management waters, and estuaries, and monitoring is carried out seasonally (February, May, August, and November) at 417 monitoring stations. Additionally, automatic continuous monitoring is conducted for Sihwa Lake, Masan Port, Ulsan Port, Yeosu New Harbor, and the coastal areas of Busan (MLIT 2020). Coastal water quality standards were introduced in 2018 (Ministry of Oceans and Fisheries, No.10/2018), and the Water Quality Index (WQI), comprising five levels, is calculated as described in Tables 2.5.3a to c.

Table 2.5.3a WQI calculation method for coastal water quality

Category	Water Quality Index*
I (very good)	≤ 23
II (good)	24-33
III (moderate)	34-46
IV (bad)	47-59
V (very bad)	≥ 60

(Source: Ministry of Oceans and Fisheries 2021)

$$^{*}WQI=10\times[DO]+6\times([Chl.a]+(\frac{[SD]}{2})+4\times([DIN]+\frac{[DIP]}{2})$$

Figures in square brackets [ ] represent scores based on Table 2.5.3 b. In the tables below, DO: Dissolved Oxygen, Chl.a: Chlorophyll a, SD: transparency (Secchi disc), DIN: dissolved inorganic nitrogen, and DIP: dissolved inorganic phosphorus.

Reference values vary according to sea area, as shown in Table 2.5.3c.

WQI trends of each sampling area are publicly disclosed on the NIER website. The example shown in Fig. 2.5.5 is for Incheon Port.

Table 2.5.3b Water Quality Index Scores for Each Parameter

Score	Parameter	
	Chl.a, DIN, DIP (μg/L)	DO (%), SD (m)
1	< reference value	> reference value
2	< 110% of reference value	> 90% of reference value
3	< 125% of reference value	> 75% of reference value
4	< 150% of reference value	> 50% of reference value
5	≥ 150% of reference value	≤ 50% of reference value

(Source: Ministry of Oceans and Fisheries 2021)

Table 2.5.3c Reference Values for Each Water Quality Index by Sea Area

Ecological zone	Parameter				
	Chl.a (μg/L)	DO (%)	DIN (μg/L)	DIP (μg/L)	SD (m)
East Sea	2.1		140	20	8.5
Korea Strait	6.3		220	35	2.5
Southwest sea	3.7	90	230	25	0.5
Central West Sea	2.2		425	30	1.0
Jeju Strait	1.6		165	15	8.0

(Source: Ministry of Oceans and Fisheries 2021)

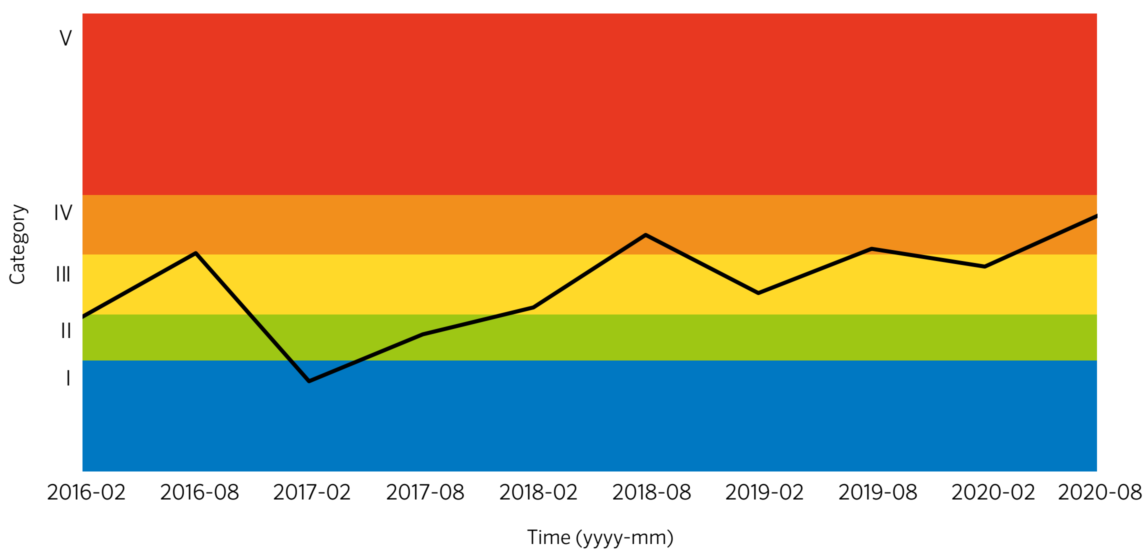


Figure 2.5.5 Trend of WQI in Incheon Port (2016-2020) (Source: NIER MLIT 2020)

(4) Groundwater

Prior to 2018, groundwater had been managed by various acts under the control of different ministries, namely, the Ministry of Environment (ME), Ministry of Land, Infrastructure and Transport (MLIT), Ministry of Agriculture, Food and Rural Affairs (MAFRA), Ministry of the Interior and Safety (MOIS), and Ministry of National Defense (MND) (Kang et al. 2020). In 2018, the government passed the landmark Framework Act on Water Management (No.15653/2018), which transferred all groundwater-related responsibilities to ME. According to Korea Environment Corporation (2021), 1,140 monitoring sites have been set up as of 2020, and a total of 3,725 sites are planned to be established by 2030. Kang et al. (2020) observe that strategic scaling up of groundwater use is essential in climate change adaptation, especially in light of the increasing frequency and intensification of droughts.

4 | State of Wastewater Treatment

In 2017, 2.16 million m^3/day of domestic wastewater and 4.01 million m^3/day of industrial wastewater was generated, and both were treated at a rate of 100%. Of domestic wastewater, 93.6% was treated centrally and 6.4% using decentralized treatment (ME 2018). The domestic wastewater tariff is staggered according to discharge volume; for example, in Incheon in 2016 the wastewater tariff was 0.31 USD/m^3 (for up to 15 m^3), 0.48 USD/m^3 (up to 50 m^3) and 0.83 USD/m^3 (up to 100 m^3) (IBNet 2020).

Public awareness regarding wastewater treatment is high. In 2017, a decision was made to construct the Seung-Gi Wastewater Treatment Plant of Incheon City underground to protect the breeding site of the blackfaced spoonbill (*Platalea minor*). Although numbers are gradually increasing, this bird is on the endangered list, with 3,941 birds observed as of January 2017 (Sung et al. 2017 and BirdLifeInternational 2021).

The number of industries is still climbing in the country; however, the volume of industrial effluent discharged is not rising as a result of water reuse and conservation efforts by industries and governments.

Framework Act on Environmental Policy (No. 10893/2011)

Framework Act on Water Management (No. 15653/2018)

- Water Environment Conservation Act (No. 15832/2018)
- Public Waters Management and Reclamation Act (No. 16501/2019)

Conservation of Water Quality in Inland Water

- Act on the Investigation, Planning, and Management of Water Resources (No. 16608/2019)

Rivers

- River Act (No. 14722/2017)
- Act on the Improvement of Water Quality and Support for Residents of the Han River Basin (No. 15104/2017)
- Act on Water Management and Residents Support in the Nakdong River Basin (No. 15095/2017)
- Act on Water Management and Residents Support in the Geum River Basin (No. 15094/2017)
- Act on Water Management and Residents Support in the Yeongsan and Seomjin River Basins (No. 15099/2017)
- Small River Maintenance Act (No. 16772/2019)

Conservation of Water Quality in Coastal Water

- Marine Environment Management Act (No. 16520/2019)
- Coast Management Act (No. 16285/2019)

Conservation of Water Quality in Groundwater

- Groundwater Act (No. 15624/2018)

Other Laws Related to Water Environment

- Environmental Impact Assessment Act (No. 15662/2018)
- Environmental Testing and Inspection Act (No. 15200/2017)
- Water Supply and Waterworks Installation Act (No. 16082/2018)
- Act on Promotion and Support of Water Reuse (No. 16080/2019)
- Ballast Water Management Act (No. 16150/2019)
- Special Act on the Utilization of Waterfronts (No. 15624/2018)
- Water-related Leisure Activities Safety Act (No. 15657/2019)
- Korea Water Resources Corporation Act (No. 15624/2018)
- Development and Management of Deep Sea Water Act (No. 16518/2019)

Figure 2.5.6 Legislative framework for water quality management

(Source: created by WEPA Secretariat based on KLRI 2020, ME 2020)

5 | Frameworks for Water Environmental Management

(1) Legislation

The basic law on which environmental management policy is based is the Framework Act on Environmental Policy, under which environment quality standards are established. Newly established in 2018 was the Framework Act on Water Management, which was designed to encompass the concept of integrated water resources management. This novel initiative streamlined previously fragmented water-related matters using a more holistic approach, and various amendments to other legislations were made accompanying this change.

In 2018 the previous Water Quality and Ecosystem Conservation Act was expanded to encompass the entire water environment, and was reformulated as the Water Environment Conservation Act. Figure 2.5.6 shows the legislative framework related to water environmental management in the country.

a. Basic policy direction of water environmental management

The Ministry of Environment has established five core strategies for the period of 2016-2025 under the framework of water environmental management, as below:

i. Establishing a harmonious water cycle
ii. Securing clean water through integrated basin management
iii. Improving the index for aquatic ecosystems
iv. Establishing a framework for a safe water environment
v. Creating economic and cultural value related to the water environment

The water quality monitoring framework was first established in 1967, with standards first set up in 1978.

(2) Institutional arrangement

In line with the approach of managing water from an integrated perspective, responsibilities which previously came under different ministries (for example, large rivers/streams were under MLIT, small streams/creeks were under the Ministry of Interior and Safety, lakes were under Ministry of Agriculture, Food and Rural Affairs, and sewerage was under the Ministry of Environment) were all restructured for management under the ME.

The National Institute for Environmental Research (NIER) conducts monitoring of environmental water quality.

The following local environmental agencies conduct monitoring and legal enforcement:

- Han River Basin Environmental Agency
- Geum River Basin Environmental Agency
- Nakdong River Basin Environmental Agency
- Yeongsan River Basin Environmental Agency
- Daegu Regional Environmental Agency
- Wonju Regional Environmental Agency
- Jeonbuk Regional Environmental Agency

These regional environmental agencies, together with the Water Environment Research Center, Research Institute of Public Health and Environment, K-Water, and the Korean Rural Community Corporation form a multistakeholder consortium that implements the water quality monitoring framework.

(3) Ambient water quality standards

There are two water quality standards for surface water. The first cover the protection of human health and apply to both rivers and lakes, for which there are currently 20 parameters, such as Cd, As, and PCB, with plans to increase parameters to 30 by 2025. The second, split into two, cover the living environment (residential environment criteria) and rivers and lakes/marshes, respectively. Standards for the living environment for rivers include pH, BOD, TOC, SS, DO, TP, total coliform, and fecal coliform; standards for lakes/marshes include pH, TOC, SS, DO, TP, TN, Chl.a, total coliform, and fecal coliform.

For groundwater, different standards are applied according to the purpose of water usage. Drinking water standards established under the Drinking Water Management Act are applied for drinking water use, with 51 parameters. For other purposes such as domestic, farming and fisheries and industrial uses, groundwater standards are used to evaluate groundwater quality, with 14 to 19 parameters, based on usage.

Special metropolitan cities, provinces 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).

a. Monitoring of water quality in public water bodies and groundwater

Water quality is monitored through a nationwide monitoring network in accordance with water category. There are 26 items for rivers, 30 for lakes and marshes, and 20 for groundwater. In particular, there are 70 automatic operating monitoring stations for surface waters. Water quality is monitored by measuring five common items, including DO, TOC, pH, and 17 optional items, including VOC. To raise inspection efficiency, monitoring spots are classified according to usage: river water, lake water, groundwater, coastal water, drinking water, irrigation water, industrial water and river water flowing through cities.

(4) Effluent standards

As of 2019, 58 water pollutants had been identified under the legal framework, of which seven parameters (BOD, COD/TOC, SS, TN, TP, total coliform, ecotoxicity) are used for effluent standards, and 32 parameters are monitored as hazardous pollutants under the permissible discharge limits.

Industrial facilities are categorized into the following five levels according to discharge volumes:

- Level I: ≥ 2,000 t/day
- Level II: 700 ≤ discharge < 2,000
- Level III: 200 ≤ discharge < 700
- Level IV: 50 ≤ discharge < 200
- Level V: others

In 2007, ecotoxicity was first included as a parameter under the permissible discharge limits under the Water Quality and Ecosystem Conservation Act, and in 2019, the ecotoxicity management system was expanded to cover 82 types of industrial facilities. Ecotoxicity is analyzed with water fleas (*Daphnia magna*).

TOC has definitively replaced COD and has been in use since 2021, due to the difficulty of monitoring non-degradable organic substances, which gives higher values for TOC than COD.

a. Effluent monitoring

The annual calendar for monitoring, together with demarcations, is as follows:

- By May: Industrial facilities analyze samples, and submit data with justifications
- By July: Regional Environmental Agencies review and verify reports, and take/analyze samples
- By December: National Institute of Environmental Research confirms the data and conducts metadata analysis
- By following March: Ministry of Environment discloses the data to the public

6 | Recent Developments in Water Environmental Management

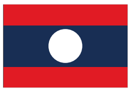
The inclusion of the concept of integrated water resource management as part of the governance of water management has had a large impact throughout all aspects of water management in the country. While it has allotted more responsibilities to ME, it has also resulted in a devolution of responsibilities for water environment management from central to local governments. Regarding the SDGs, achievement of indicator 6.3.2 (Proportion of water bodies with good ambient water quality) is reported at 93% as of 2020.

7 | Challenges and Future Plans

The inclusion of integrated water resource management together with devolution of responsibilities regarding water environmental management from central to local governments has added another dimension to the challenge of restructuring, as it necessitates a viable strategy and detailed plan to be rapidly formulated in order bring about institutional cooperation. A further challenge arising from the resulting increase in responsibilities and activities due to the restructure of the Ministry of Environment is how to prioritize projects related to water environment management.

Other technical challenges currently faced include distortion of the water cycle due to climate change and other environmental causes, increased non-degradable organic matter in effluent, the difficulty of managing nonpoint pollution sources, the need to add ecotoxicity standards based on other aquatic organisms and setting up a drinking water standard for PFAS. To combat these various challenges, a holistic and comprehensive review of projects is being carried out.

2.6 Laos



1 | Country Information

Table 2.6.1 Basic indicators

Land area (km²)		236,800 (2019)
Total population		7.12 million
GDP (current USD)		19.1 billion (2019)
Per capita GDP (current USD)		2,075 (2023)
Average annual rainfall (mm/year)		1,834 (2019)*
Total renewable water resources (km³)		333.55 (2011)**
Total annual freshwater withdrawals (billion m³)		7.32 (2017)**
Annual freshwater withdrawal by sector	Agriculture	95.9% (2017)**
	Industry	2.3% (2017)**
	Municipal (including domestic)	1.8% (2017)**

(Source: Department of statistics, Lao 2019, *Bank of the Laos 2020, **FAO 2021 (estimated))

Figure 2.6.1 Nam Song River in Vang Vieng, Laos

2 | State of Water Resources

Laos has rich water resources. The average annual rainfall at higher elevations in the southern part of the country is around 4,000 mm and in the northern valleys is around 1,300 mm. With a population of approximately 7.12 million, per capita annual water availability is around 55,000 m^3, the highest of the WEPA partner countries. Despite this, water supply capacity is limited due to the country's inadequately developed water infrastructure (MONRE 2019). Annual water consumption in Laos is 4.26 million m^3, which accounts for 1.3% of total renewable freshwater resources. Of the total water usage, industry consumes 4%, domestic 3.1% and agriculture 93%.

As with other Southeast Asian countries, seasonal distribution of water resources is uneven in Laos—about 80% of annual precipitation occurs during the rainy season (May to October) and 20% in the dry season (November to April). In the dry season, flows of the Se Bang Fai, Se Bang Hieng and Se Done Rivers that run through the central and southern parts of the country drop to 10–15% of the annual average.

There are 62 main river basins in Laos (MONRE 2019), a country with 90% of its territory within the Mekong River basin. The Mekong tributaries contribute the equivalent of 35% of the average annual flow and account for 25% of the catchment area of the basin (MRC 2005). In 2015, 71% of the population was using improved sanitation, while 76% had access to improved drinking water sources (WHO 2017).

3 | State of Ambient Water Quality

Surface water quality in Laos is considered good, although deterioration is observed in the rivers and tributaries in urban areas due to a rise in untreated or insufficiently treated wastewater and wastes. No urban center, including the capital Vientiane, has comprehensive piped sewerage systems nor wastewater collection, treatment or disposal systems. In the downstream part of the Mekong River from 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 and water runoff from agricultural activities are also potential sources of high nutrients and toxic chemicals originating from fertilizer and pesticide use (MRC 2010).

Inadequate management of solid waste in urban areas is another cause of concern for water quality, especially in the rainy season (MONRE 2012). Hazardous and infectious wastes are disposed of together with other wastes in the same locations, but landfill sites are not monitored for impacts of leachate on groundwater quality and runoff into surface water (rivers and lakes) during the rainy season.

To deal with the rising levels of domestic pollution, the Laos government is promoting decentralized wastewater treatment (DEWAT) systems. The country's DEWAT system capacity has increased significantly due to the transition to DEWAT system development. However, organic pollutant levels in public canals are quite high (BOD_5 19–32 mg/L, COD_{Cr} 38–101 mg/L), all exceeding the national surface water category four environmental requirements (Deevanhxay, 2022). A few DEWATS plants performed well and met effluent standards (Deevanhxay, 2022). Two DEWAT plants that were tested performed well and met the effluent standards (Deevanhxay, 2022), but they failed the standards for BOD_5 levels (35 and 120 mg/L) as well as the septic tank (45 mg/L).

(1) Rivers

As part of sustainable water resource management planning, the Provincial Department of Natural Resources and Environment (MONRE) frequently monitors the water quality—with special priority given for riverheads and watersheds. Water samples are collected at a frequency of every three months, which started in 2015. Both in-situ and laboratory analysis for key water quality parameters are performed, and water quality trends are assessed to evaluate their effects on ecosystems. The water quality of rivers in Laos is considered to be generally good. Water quality is assessed by the Mekong River Commission (MRC) based on the Water Quality Index (WQI), and the monitoring results show that except for a few monitoring stations, water quality is not appreciably affected by anthropogenic activities in the surroundings (see Table 2.6.2). This is a good sign that water resources can be managed sustainably, as long as management strategies are in place as and when needed.

As most of the country's land area is situated in the low-lying deltaic zone, excessive sediment load is the primary quality problem for the whole country, especially in the wet season.

Water quality monitoring of the Mekong River is conducted at five mainstream monitoring stations on a regular basis: Houa Khong, Luang Prabang, Vientiane, Savannakhet, and Pakse. Figure 2.6.2 shows the spatio-temporal analysis results for annual mean concentrations for the period 2020–2022. Although monitoring actually involves several parameters, chemical oxygen demand (COD) is shown in this figure as a representative indicator for water quality. As can be seen from the Luang Prabang results, the COD concentration ranged from 1.4 to 3.7 mg/L in 2020 and 2022 respectively. However, when this range is compared against the Laos surface water quality standards, all water samples fall under "Level 1 with COD concentration < 5mg/L," meaning that the water quality of this water resource is categorized as good, based on COD.

Table 2.6.2 Water quality based on WQI for the protection of human health and aquatic life 2019–2022 at the Mekong, Laos water quality monitoring stations

Monitoring site	WQI for the protection of human health				WQI for the protection of aquatic life			
	2019	2020	2021	2022	2019	2020	2021	2022
Houa Khong	A	A	A	B	A	A	A	A
Luang Prabang	A	A	A	A	A	A	A	A
Vientiane	A	B	A	B	A	A	A	A
Savannakhet	A	A	A	B	A	A	A	A
Pakse	A	B	A	A	A	A	A	A

Notes: Water quality criterion for the protection of human health (A: Excellent quality; B: Good quality; C: Moderate quality; D: Poor quality; E: Very poor quality); Water quality criterion for the protection of aquatic life (A: High quality; B: Good quality; C: Moderate quality; D: Poor quality)

(Source: MRC 2019, 2020, 2021, and 2022)

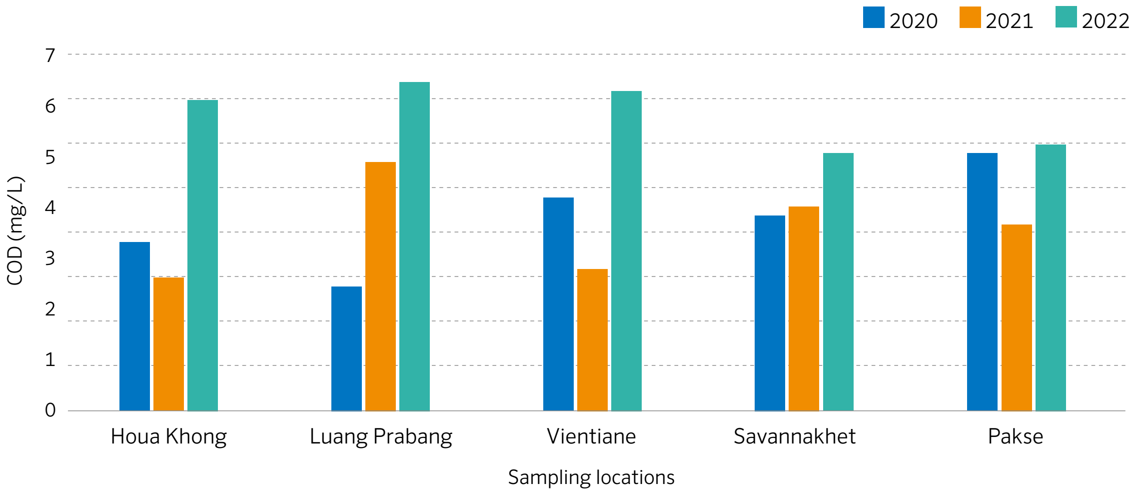


Figure 2.6.2 Spatio-temporal analysis of water quality at five mainstream monitoring stations along the Mekong River in Lao (MRC 2020, 2021, 2022) (Source: MONRE 2019)

Under a scheme supported by the World Bank, 11 major rivers around Laos were analyzed for water quality, the results of which are shown in Table 2.6.3. As the results suggest, river bodies around Vientiane, followed by Savannakhet, exhibited relatively high figures (compared to the national water quality standard) in certain water quality parameters, mainly chloride, sulphate, EC, and alkalinity, owing to the impact of higher anthropogenic activities, such as mining. Further, runoff from agricultural activities and improper sewage management are also responsible for water quality deterioration.

Table 2.6.3 Statistical summary of river water quality from 11 monitored river bodies around Laos

	Province								
	Vientiane CT	Vientiane PV	Savannakhet	Sekong		Champasak		Attapue	
River	Namguem	Namguem	Xe Champone	Xe Nam Noy	Houay Lam Phan	Xe Kham Por	Xe Nam Noy	Xekong	Xe su
Depth (m)	0.12	0.2	0.03	0.03	0.03	0.03	0.03	0.03	0.03
TEMP. (°C)	25.8	25.7	28.2	28.5	26.3	28.7	25.9	28.4	26
pH	7.67	7.7	7.12	7.73	7.5	6.89	7.25	7.3	7.68
TSS (mg/L)	12.83	1.5	0.88	2.56	4.66	1.8	3.75	14.83	65.66
TDS (mg/L)	116	109	157	76	25	44	25	55	78
EC (μS/cm)	115.8	109.1	156	75.2	24.8	44	25	54.7	78
Ca (mg/L)	30.02	29.36	8.12	10.02	2.3	6.16	12.88	7.21	8.4
Mg (mg/L)	2.82	4.22	1.74	1.15	1.42	1.9	0.18	1.58	1.69
Na (mg/L)	1.84	1.66	5.82	0.4	0.94	1.04	1.22	1.32	2.7
K (mg/L)	1.7	1.15	0.82	0.2	0.82	0.05	1.05	0.59	1.28
ALK (mg/L)	82	68	17.5	29	11	22	28	26	30.2
Cl (mg/L)	10.95	19.25	15.1	5.25	0.48	0.25	6.25	0.25	0.25
SO_4 (mg/L)	5.73	6.92	4.93	2.23	5.19	4.93	4.8	5.73	9.84
NO_3 (mg/L)	0.03	0.01	0.04	0.1	0.06	0.05	0.2	0.07	0.09
NH_4 (mg/L)	0.02	0.01	0.04	0.02	0.06	0.16	0.01	0.03	0.14
T-N (mg/L)	0.28	0.35	0.39	0.25	0.38	0.29	0.27	0.19	0.24
PO_4 (mg/L)	0.01	0.02	0.01	0.04	0.03	0.06	0.06	0.05	0.04
T-P (mg/L)	0.09	0.08	0.04	0.05	0.08	0.09	0.09	0.1	0.15
DO (mg/L)	7.36	7.27	7.18	7.77	8.24	6.85	8.31	7.62	8.02

(Source: MONRE 2019)

(2) Lakes and reservoirs

Perennial ponds, marshes and oxbow lakes are common in the lowland floodplains of Laos. Serving as habitats for many types of aquatic plants, mollusks, crustaceans, amphibians and reptiles, they vary greatly in size throughout the year and are usually of shallow depth. Currently, data on the water environment in lakes and reservoirs is available only on a project basis. 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 part of a hydropower development project, and the results of monitoring at nine monitoring stations (see Fig. 2.6.5) show a decreasing trend for dissolved oxygen (DO) levels in some stations compared with the national standard value of 6 mg/L (see Fig. 2.6.3). Total phosphorus levels in some stations in 2009 also highly exceeded the national standard (0.05 mg/L) (see Fig. 2.6.4). Fertilizers and detergents are assumed to be the chief sources of pollution (Komany 2011).

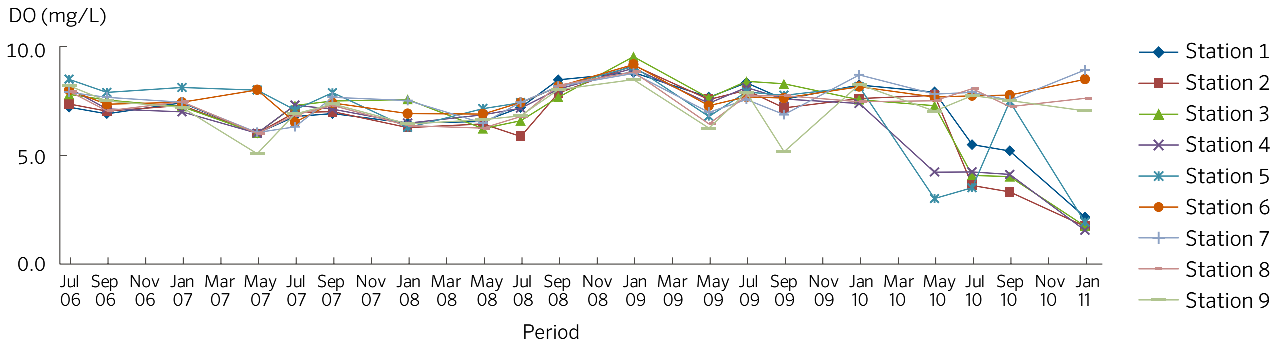


Figure 2.6.3 DO levels at monitoring stations at the Nam Ngum dams (Source: Komany 2011)

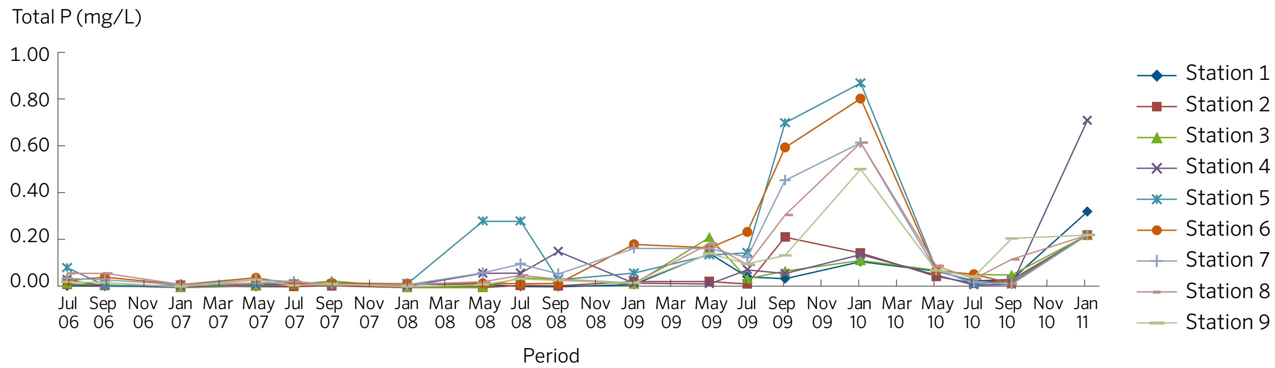


Figure 2.6.4 TP levels at monitoring stations at the Nam Ngum Dams (Source: Komany 2011)

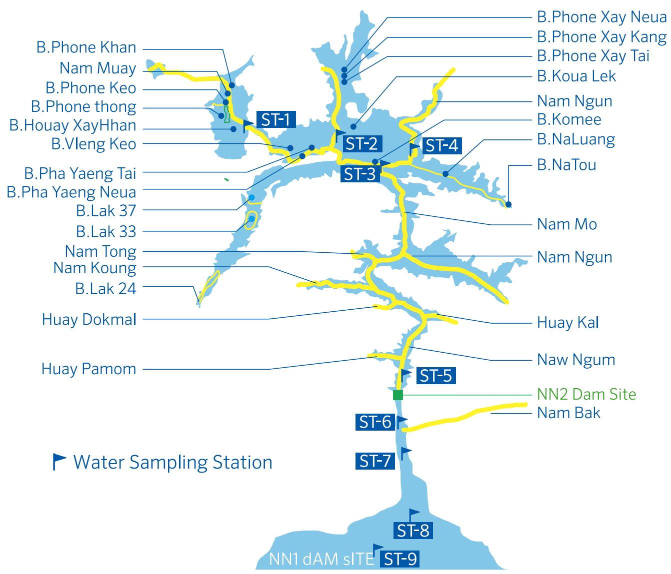


Figure 2.6.5 Monitoring stations of the Nam Ngum dams
(Source: Komany 2011)

(3) Groundwater

Information on groundwater uses and quality, including resource potential, 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). However, groundwater is an important source for domestic water, small-scale irrigation and small-scale industry. It is also used as a source for urban water supply, although it only covers around 5% of the total water production volume (if spring water is included in this definition, about 20% of the total water production is covered by subsurface water) (Chanthavong 2011). According to the Lao Social Indicator Survey (MoH and LSB 2012), around 32% of Lao households use ground-water or springs for drinking purposes. As for quality, arsenic contamination has been detected near the border with China (MRC 2010) and in Attapeu province.

4 | State of Wastewater Treatment

(1) Wastewater and major pollutants

Both domestic and industrial sectors release various pollutants. Domestic wastewater contains large amounts of COD, nutrients, and fecal coliform, and is the largest contributor to surface water pollution. Agricultural runoff primarily contains nutrients due to excessive use of fertilizers and pesticides, causing a diffused source of pollution. Industrial wastewater contains a wide variety of pollutants, depending on the nature of the raw materials used, processing units and final production outputs. It commonly contains various heavy metals, grease, oil, and such like.

(2) Domestic wastewater

In order to handle the increasing levels of domestic pollutants, the government of Laos is also promoting decentralized wastewater treatment (DEWAT) systems. Table 2.6.4 shows the transition to DEWAT system development around the country and indicates there is a significant increase in DEWAT system capacity in the country. As of 2022, the total capacity of DEWAT systems in place was 464.8 m^3/day (MONRE 2022).

Table 2.6.4 Status of domestic (decentralized) wastewater treatment system

No.	Project name	Project details	Capacity (m^3/day)	Location
1	NoUL Dormitory Residence, Faculty of Engineering	1 DEWATS for a dormitory	10	Vientiane Capital
2	Thongkhankahm Village, Units 11, 12, 13	1 DEWATS for a community	15	Vientiane Capital
3	Khualoung Primary School (SBS 1.0)	DEWATS for a school	26	Vientiane Capital
4	Northern Agricultural and Forestry College	DEWATS for a college	15	Luang Pra Bang Province
5	Operation camp of THPC	DEWATS for a dormitory	70	Khammoan Province
6	Expansion Camp of THXP	DEWATS for a dormitory	30	Khammoan Province
7	Khoualoung Temple school and Khoualoung village	DEWATS for a school/temple	30	Vientiane Capital
8	Hintid community, Hinheub district	DEWATS for a community	3	Vientiane Province
9	Nam Papa State Enterprise Attapeu (NPSE) Mixay Village, Sanxay district, Attapeu	DEWATS for a community	14	Attapeu Province
10	Nam Papa State Enterprise Attapeu (NPSE) Phouxay Village, Sanxay district, Attapeu	DEWATS for a community	14	Attapeu Province
11	National Academy for Politics and Public Administration (NAPPA)	DEWATS for an academy	80 x 2	Vientiane Capital
12	SK Engineering & Construction (SKEC); Xe-Pian Xe-Namnoy Hydroelectric Power Plant Project	DEWATS for SKEC and Xe Pian Xe Namnoy hydroelectric power plant	15	Champasak Province
13	Community-based sanitation in Navieng village (Xam Neua)	DEWATS for sanitation in Navieng village	10	Huaphan Province
14	Health and Science college at Luangphabang	DEWATS for health and science college	11	Luangphabang Province
15	SK II Engineering & Construction (SKEC); Xe-Pian Xe-Namnoy Hydroelectric Power Plant Project	DEWATS for construction/ engineering company and hydroelectric power plant project	8	Attapeu Province
16	Lao Disabled Woman's Development Center (LDWDC)	DEWATS for a disabled women's development center	6.4	Vientiane Capital
17	GIZ office (Lao-German House)	DEWATS for an office	1.5	Vientiane Capital
18	World Bank office Laos	DEWATS for a bank office	6.8	Vientiane Capital
19	Provincial hospital in Xekong province	DEWATS for a hospital	35	Xekong Province
20	Parkhao tai Primary School	DEWATS for a primary school	1	Bokeo
21	Luangphabang Night Market	DEWATS for a night market	2	Luangphabang
22	HouayTom Primary School	DEWATS for a primary school	1	Vientiane Capital
23	Angnoy Primary School	DEWATS for a primary school	1	Vientiane Capital
24	Kouy Primary School	DEWATS for a primary school	1	Vientiane Capital
25	DEWATS for Slaughterhouse in Xiengkhaung Province	DEWATS for a slaughterhouse in Xiengkhaung Province	19.8	-
26	DEWATS for five markets in northern Province	5 DEWATS for Phosy Market/LPB, Laung Namtha market and Sing district market/LNT, Sam Neua Market/Hauphan and Phonsavang Market/XiengKhaung	(5 plants) 150	-

No.	Project name	Project details	Capacity (m^3/day)	Location
27	Pakse Wastewater Management Project	4 DEWATS for 900 households in five villages and a market 1 fecal sludge treatment plant	DEWATS (4 plants) 400 FSTP 25	Champasak Province
	GMS 1 project	Wetland construction	–	–
28	Greater Mekong Subregion—GMS2	1 DEWAT for a community in Houyxay, Bokeo Province 1 DEWAT for a night market in LNT	75	Borkeo and Laung Namtha Province
	Greater Mekong Subregion—GMS2	1 FSTP each for LNT&HXY town	40	
	Greater Mekong Subregion—GMS2	Constructed wetland by FGF systems 1	1900	–
29	Greater Mekong Subregion—GMS4	• 8 DEWATS, including those for a hospital, community, market and school 1 FSPT in Paksan, Bolikhamxay Province • 7 DEWATS, including those for a hospital, community, market and school; 1 FSTP	1000	Bolikhamxay and Khammaun Provinces

(Source: Deevanhxay 2022)

(3) Industrial wastewater

Most industries and factories in Laos dispose of their industrial wastewater directly into surface water bodies such as ponds and rivers; however, such ponds lack the linings needed to prevent the leaching of various pollutants from untreated wastewater entering underground. Small factories in Laos have ponds for industrial effluent disposal, and some large-scale industries have their own wastewater treatment plants with both anaerobic and aerobic treatment units, such as Beer Lao company, Coca-Cola company and Sun Paper company, the mining sector and other industries (MONRE 2019).

5 | Frameworks for Water Environmental Management

(1) Legislation

The Environmental Protection Law (EPL) Amendment 2018 is the cornerstone to Laos's environmental legislation. Containing measures for the protection, mitigation and restoration of the environment as well as guidelines for environmental management and monitoring, it is specifically aimed at protecting nature, human health, the country's wealth of resources and facilitating the process of sustainable development. According to EPL, the Ministry of Natural Resources and Environment (MONRE) is responsible for coordinating different line agencies in establishing rules and regulations pertaining to the management of the environment, conducting research and development related to pollution control technologies and science, and for overall management and pollution control (EPL 2018).

EPL-2018 grants MONRE the monitoring and enforcement authority to inspect and issue administrative and civil actions regarding regulated point sources within its jurisdiction. In reality, however, EPL-2012 lacked the necessary efficacy in terms of granting enforcement powers to MONRE or its environmental and natural resources agencies, such as the Department of Pollution Control and Monitoring (DPCM), regarding industrial pollution sources (EPL 2018). Instead, the Industrial Processing Law (IPL) Amendment No. 026/NA, dated 27 December, 2013 authorized by the Ministry of Industrial and Commerce (MOIC), acts as the primary enforcement authority over most factories. Its remit includes imposing effluent and emission standards as part of certain operating permits, requiring self-monitoring reports from certain factories, conducting inspections, taking samples, shutting down factory operations, and issuing administrative, civil, and criminal actions or penalties (EPL 2018). As a result of overlapping and fragmented legislative bodies, however, no single ministry is responsible for overall environmental compliance and enforcement of pollution sources in Laos (EPL 2018).

The Law on Water and Water Resources, promulgated in 1996, stipulates the principles of management, utilization and development of water. Its purpose is to secure the quantities and quality of water needed by meeting the population's needs as well as ensuring environmental sustainability, but it lacked clarity on the issues of water supply and wastewater. In response to this, the new Water Supply Law was drafted by the Ministry of Public Works and Transportation (MPWT) with the assistance of the World Bank, and was approved by the National Assembly in November 2009. However, as most of its stipulations focused on water supply services only, it lacked provisions for sanitation and sewerage, which are planned to be added by decree. To reflect these changes, a revision of the Water and Water Resources Law proceeded with the assistance from the Asian Development Bank (ADB).

The Law on Water Resource Amendment was adopted by the National Assembly in 2017. This amendment aims to develop water resources in an environmentally sound and sustainable manner and in accordance with international best practices to ensure water resources and ecosystems are protected. New provisions have been added on water rights and use, including wastewater discharge permits, wetland and water resource protection, groundwater management, and reservoir management. Additionally, the Law expands on the terms and conditions of large, medium and small water users and includes an article on environmental flows of hydropower as well as a stipulation on irrigation use. The Law also grants greater responsibility to MONRE to develop and implement management plans for river basins throughout the country.

To implement and extend the provisions prescribed under Article 21 of the Law on Environmental Protection, the Lao government issued Environmental Impact Assessment Decree No. 389/GL on Environmental and Social Impact Assessment (ESIA) and Initial Environmental Examination (IEE) of Investment Projects (2022). This instruction is aimed at ensuring uniformity in the Initial Environmental Examination (IEE) conducted for any investment project or activity of public or private enterprises, both domestic and foreign, that operate businesses in Laos that cause or are likely to cause environmental and social impacts. To that effect, initial environmental examinations must be carried out efficiently and before investment projects and activities can proceed, in order to ensure sustainable socioeconomic development. The ESIA regulation assigns the Department of Environment and Social Impact Assessment (DESIA) responsibility for reviewing ESIA regulations, including recommendations for issuing environmental compliance certificates (ECC) and undertaking compliance monitoring, and assigns the Provincial Department of Natural Resources and Environment (PoNRE) responsibility for reviewing, issuing ECCs, and monitoring projects requiring an IEE. Ministerial Agreement No. 8056/MoNRE (Endorsement and Promulgation of List of Investment Projects and Activities Requiring Conducting the Initial Environmental Examination or Environmental and Social Impact Assessment (Vientiane Capital, 2013)) categorizes projects and activities into two groups: Group 1, requiring an IEE, and Group 2, requiring an ESIA. As all water-supply processing factories are in Group 1, an IEE is required. Municipal wastewater treatment plants with capacities capable of handling up to 5,000 people must prepare an IEE, whereas an ESIA is required for operations exceeding that capacity. An IEE is required for the construction of sewage drainage. Regardless of size, all industrial wastewater treatment plants need to prepare ESIAs. In 2019, the government issued a decree on environmental impact assessments, No. 21/GOL, which defines IEEs and comprehensive environmental impact assessments. The decree was amended in 2022 by decree 389/GOL dated 20 October 2022. Article 13, No. 6 states that the environmental management and monitoring plan (EMMP) must be prepared separately from the IEE report.

Another promising addition is the requirement to set minimum water flows as minimum thresholds for all water resources in order to satisfy the basic needs of those whose livelihoods rely on them, as well as the sustainability of the ecosystem within the affected area (Phonvisai 2017).

Other laws, such as the Forestry Law and Mining Law, are also related to water environmental management, as shown in Fig. 2.6.6.

(2) Institutional arrangement

The functions and responsibilities of the Ministry of Natural Resources and Environment (MONRE) were revised in accordance with Prime Minister's Decree No. 451/PM of 23 December 2019. MONRE has broad responsibilities, including protection of the nation's natural resources, such as land and water resources, and protection and restoration of the environment. Within it sits the Department of Natural Resources and Environment Inspection (DNREI), which is in charge of water pollution management policies and plans, pollution aspects of environmental quality management plans, action plans for the reduction and elimination of water pollution, and emergency response plans. It is involved with and coordinates work to control, resolve and remediate contaminated water bodies and assess environmental damage from water pollution by recommending and implementing standards, measures, criteria and methods for monitoring and management. Its responsibilities also include formulating the water pollution section of Laos's state of pollution report, and developing systems, criteria, codes of practice and methods for preventing water pollution.

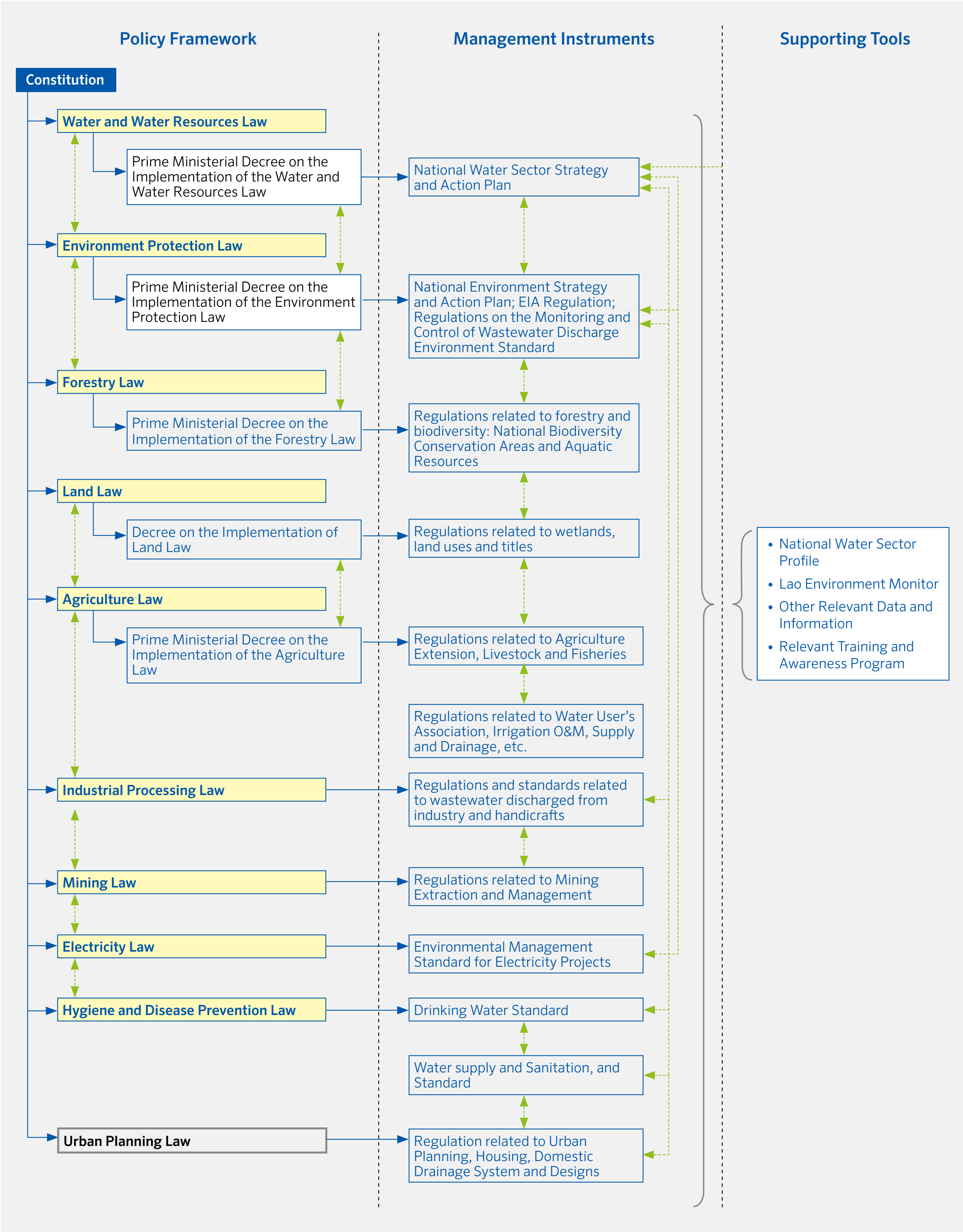


Figure 2.6.6 Legislation system for water environmental management in Laos (Source: MoEJ 2009)

(3) Ambient water quality standards

a. Ambient water quality standards

To improve certain parameters of the ambient water quality, DPCM revised the National Environmental Standards of 7 December 2009 (the new water supply law) through comparison of updated data on the country's environmental quality with the standards set by international organizations, as well as levels of economic development of certain other countries. This led to an amendment of the National Environmental Standard, which was adopted by Prime Minister Decree No. 81/PM on 21 February 2017, that enforced regulations on air, noise, soil and waste quality for assessing and managing contaminants released into air, water and soil to protect human health and the environment. The ambient water quality standards are comprised of groundwater (drinking) quality standards and surface water quality standards, as shown in Table 2.6.5 and Table 2.6.6, respectively.

(4) Effluent standards

a. Effluent standards

The following effluent standards are stipulated under the National Environmental Standards issued in February 2017, the data of which is assessed against the MRC Water Quality Guidelines for the Protection of Human Health and the Protection of Aquatic Life.

The average chemical oxygen demand (COD) concentration of around 1.4 mg/L at was recorded at Vientiane, compared to 2.7 mg/L at Champasack. The COD concentration at three stations (Mekong River, Nam Nguem, Nam Xebang Fai and Nam Xe Done) slightly exceeded the Mekong River Commission (MRC) Water Quality Guidelines for the Protection of Human Health of 5 mg/L. In terms of pH, other than a recorded pH of 9.9 for Luang Prabang, values for other areas along the Mekong River were within the water quality guideline for pH (values of 6 to 9 for both the protection of human health and the protection of aquatic life). The lowest pH measurement was observed at Vientiane monitoring station (pH = 6.2) while the highest pH measurement was observed at Luang Prabang monitoring station (pH = 9.9). Dissolved oxygen (DO) is one of the key water quality parameters monitored routinely by the MRC Water Quality Monitoring Network, and maintaining good water quality requires an adequate concentration of dissolved oxygen. In recognition of this, MRC member countries have jointly established target values for the protection of human health (≥ 6mg/L) and aquatic life (> 5 mg/L).

Table 2.6.5 Groundwater (drinking) quality standards

Indicator	Parameter	Standard	Unit
Colour	-	10	Platinum-Cobalt (Pt-Co)
Taste	-	-	-
Odor	-	-	-
Turbidity	-	15	NTU
Potential of Hydrogen	pH	6.5-8.5	-
Total Solid	TS	1000	-
Aluminum	Al	0.2	mg/L
Ammonia	NH_3	1.5	mg/L
Iron	Fe	1.0	mg/L
Manganese	Mn	0.5	mg/L
Sodium	Na	250	mg/L
Copper	Cu	1.5	mg/L
Zinc	Zn	15	mg/L
Calcium	Ca	150	mg/L
Magnesium	Mg	100	mg/L
Sulphate	SO_4^{2-}	250	mg/L
Hydrogen Sulfide	H_2S	0.1	mg/L
Sodium Chloride	NaCl	320	mg/L
Chloride	Cl^-	250	mg/L
Fluoride	F^-	1.0	mg/L
Nitrate	NO_3^-	45	mg/L
Alkylbenzenesulfonate	$C_{18}H_{29}NaO_3S$	1.0	mg/L
Phenol compound	C_6H_6O	0.002	mg/L
Mercury	Hg	0.001	mg/L
Lead	Pb	0.01	mg/L
Arsenic	As	0.01	mg/L
Selenium	Se	0.01	mg/L
Chromium Hexavalent	Cr^{+6}	0.05	mg/L
Cyanide	CN^-	0.07	mg/L
Cadmium	Cd	0.003	mg/L
Barium	Ba	1.0	mg/L
Resident Chlorine (Disinfection)	Cl_2	>0.2	mg/L
SPC Bacteria (Standard Plate Count Method)	-	500	Colonies/ cm^3
Coliform bacteria	-	-	MPN/ 100 cm^3
E.coli Bacteria	-	-	MPN/ 100 cm^3

Table 2.6.6 Surface water quality standard

Indicator	Parameter	Level of Water					Unit	Analysis
		1	2	3	4	5		
Colour, Odour and Taste	-	-	-	-	-	-	-	-
Temperature	t°C	-	-	-	-	-	°C	Thermometer
pH value	pH	6-8	6-8	5-9	5-9	-	-	Electrometric pH Meter
Dissolved Oxygen	DO	>7	6.0	4.0	2.0	<2	mg/L	Azide Modification
Electro-conductivity	Ec	<500	>1,000	>2,000	>4,000	>4,000	μS/cm	Ec meter
Chemical oxygen demand	COD	<5	5-7	7-10	10-12	>12	mg/L	Potassium Dichromate Digestion; Open Reflux or Closed Reflux
Total coliform bacteria	-	-	-	5,000	20,000	-	MPN/ 100 mL	Multiple Tube Fermentation Technique
Faecal coliform bacteria	-	-	-	1,000	4,000	-	MPN/ 100 mL	Multiple Tube Fermentation Technique
Total Suspended Solids	TSS	<10	>25	>40	>60	>60	mg/L	Glass Fiber Filter Disc
Phosphate	PO_4	<0.1	0.5	1	2	>2	mg/L	Ascorbic acid
Ammonium ion	NH_4^+	>0.5	>1.5	>3	>4	<4	mg/L	Kjeldahl
Nitrate-Nitrogen	NO_3^-	-		5.0		-	mg/L	Cadmium Reduction
Ammonia-Nitrogen	NH_3-N	-		0.5		-	mg/L	Distillation Nesslerization
Phenol	C_6H_5OH	-		0.005		-	mg/L	Distillation, 4-Amino antipyrene
Copper	Cu	-		1.5		-	mg/L	AA-Direct Aspiration
Nickel	Ni	-		0.1		-	mg/L	
Manganese	Mn	-		1.0		-	mg/L	
Zinc	Zn	-		1.0		-	mg/L	
Cadmium	Cd	-		0.003		-	mg/L	
Chromium Hexavalent	Cr^{6+}	-		0.05		-	mg/L	
Lead	Pb	-		0.01		-	mg/L	
Mercury	Hg	-		0.001		-	mg/L	AA-Cold Vapour Technique
Arsenic	As	-		0.01		-	mg/L	AA-Direct Aspiration, ICP
Cyanide	CN^-	-		0.07		-	mg/L	Pyridine-Barbituric Acid
Radioactive	Radioactive -α -β	-		0.1 1.0		-	Becquerel/L	GC
Organochlorine pesticide	-	-		0.05		-	mg/L	
Dichlorodiphenyltrichloroethane	DDT	-		1.0		-	μg/L	
Alpha-Benzen hexachloride	α-BHC ($C_6H_6Cl_6$)	-		0.02		-	μg/L	
Dieldrin	$C_{12}H_8Cl_2O$	-		0.1		-	μg/L	
Aldrin	$C_{12}H_8Cl_6$	-		0.1		-	μg/L	
Heptachlor and heptachlor epoxide	$C_{10}H_5Cl_7$ $C_{10}H_5Cl_7O$	-		0.2		-	μg/L	

Figure 2.6.7 Surface water quality monitoring network of Laos

In general, the water quality of rivers within the Laos is considered to be good; however, little information is available on groundwater quality despite its key significance in terms of water supply in rural areas. No systematic monitoring of the impacts of fluoride, pesticide, nitrate from fertilizer or other chemical pollutants is carried out.

Regarding standards of wastewater discharged 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 classified according to floor area. Regarding 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 National Environmental Standard is enforced by Article 27 and 32 of the Environment Protection Law, and covers:

i. Ground water quality
ii. Drinking water quality
iii. Effluent standards
   a. Effluent from general factories
   b. Effluent from community households
   c. Effluent from general toilets
   d. Effluent from public canals
   e. Effluent from pig farms
   f. Effluent from car washes and gas stations

b. Effluent inspection procedure

According to the Regulation on Wastewater Discharge from Industrial Processing Factories issued in 2005 (by the then Ministry of Industry and Handicrafts, now the Ministry of Industry and Commerce), all industrial factories are required to install wastewater treatment systems and the necessary facilities to monitor and analyze water samples. The monitoring report results are then submitted to the Director of the Industry Department of the Ministry or respective province. The industry department may dispatch factory environmental inspectors, who are permitted to enter all areas within factories to inspect, observe, measure, sample and monitor wastewater discharged into public water bodies.

c. Measures against non-compliance

Laos has several judicial and non-judicial measures at its disposal for cases of non-compliance in effluent water quality management. If violations are found by the industry department, certification for wastewater discharge is suspended and wastewater discharge is suspended or terminated until improvement and compliance is confirmed. Penalties for regulatory violations are as follows: (1) first stage: warning, suspension of import/export, suspension of production; (2) second stage: fine of five to 10 times the certification fee; (3) third stage: fine of 10–15 times the certification fee and penalty for non-compliance with other relevant regulations. Currently, DPCM is responsible for environmental quality monitoring, compliance enforcement, and preparation for Laos's state of pollution report, and provides data on air quality, noise levels, water quality, solid waste, hazardous substances and pollution issues throughout the country. Monitoring of environmental quality is intended to provide a grasp of the current ambient environment as well as to monitor the emissions and impacts of specific discharges.

6 | Recent Developments in Water Environmental Management

Regarding current challenges, decision makers have approved several policy-oriented changes of existing regulations and introduced several new policies on the ground, as below:

- Law on Water and Water Resources, 2017
- Decree on National Environmental Standard passed on 2017 Water and Water Resources Management, 2017
- Natural Resources and Environment Sector Vision towards 2030 and Ten-Year Strategy (2016–2025); Natural Resources and Environment Sector Five Year Action Plan (2016–2020), 22 September 2015
- Environment Impact Assessment Decree No. 112/PM, 2010
- Waste from Industry Processing Management Regulation 2012; and Industry Wastewater Discharge Regulation 2005
- National Strategy on Rural Water Supply, Sanitation and Hygiene 2019–2030 No. 0947/MoH (approved and issued in 2019)
- Natural Resources and Environment Sector Vision towards 2030 and Ten-Year Strategy (2016–2025); Natural Resources and Environment Sector Five Year Action Plan (2016–2020), 22 September 2015

7 | Challenges and Future Plans

Although the quality of water is generally considered to be good throughout the country, it has deteriorated in major urban areas in recent years. No urban centers, including Vientiane, have comprehensive piped sewerage systems, wastewater collection, treatment or disposal systems. The water quality of urban rivers may further deteriorate in the near future due to increasing inflows of untreated wastewater resulting from urban growth.

Current challenges facing water environment governance are as follows:

a. Policy and legislation:
- Lack of national planning policy framework, monitoring and enforcement
- Lack of strict regulations to implement laws in the field to control wastewater pollution
- Lack of criminal laws for pollution control

b. Institutional Framework:
- The absence of legal power leads to a serious lack of compliance and major pollution issues
- Lack of technical skills and adequate resources to support monitoring and enforcement
- Lack of cooperation and coordination of pollution control among the related central and local governments and agencies due to silo-based thinking

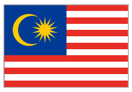
c. Financial support:
- Lack of fee/charge collection for pollutants released into the environment due to the lack of legally binding legislation
- Insufficient national government annual budget

Future plans to address the above challenges

The national government is currently considering potential solutions to address the above-mentioned challenges related to the water environment, some of which are listed below:

i. Human resources development, i.e., capacity building for technical officers in government, who will become key personnel for water environment monitoring and governance through collaborations with technically advanced countries
ii. Seeking financial/technological support from donor agencies to improve the water environment in Laos
iii. Conducting a pilot project/program on a wastewater treatment plant in Laos
iv. Developing technical guidelines/legislation on wastewater management as well as strict implementation thereof

2.7 Malaysia



1 | Country Information

Table 2.7.1 Basic indicators

Land area (km^2)		330,876.50 (2023)*
Total population		34.0 million (2024)**
GDP (current USD)		407.03 billion (2022)***
Per capita GDP (current USD)		11,993.19 (2022)****
Average annual rainfall (mm/year)		2,875 (2020)*****
Total renewable water resources (km^3)		580.0 (2020)*****
Total annual freshwater withdrawals (billion m^3)		7.25 (2023)*
Annual freshwater withdrawal by sector	Agriculture	45.65% (2020)*****
	Industry	29.90% (2020)*****
	Municipal (including domestic)	24.45% (2020)****

(Source: *DOSM 2023, **DOSM 2024, ***World Bank 2024a, ****World Bank 2024b, *****World Data Atlas 2024)

Figure 2.7.1 Ampang Hilir Lake in Kuala Lumpur, Malaysia

2 | State of Water Resources

Malaysia is a rich water resource country thanks to its high rainfall. In 2022, the highest annual rainfall recorded to date, 6,172.8 mm, was recorded at Mulu station, 807.0 mm higher than in 2021, and the lowest, 1,943.0 mm, was recorded at Sitiawan station (DOSM 2023). In terms of volume, Malaysia's annual rainfall equates to 972.8 billion m^3. Of this, 495.71 billion m^3 is surface runoff, 64 billion m^3 goes to groundwater and the remainder returns to the atmosphere through evapotranspiration (ASM 2014). Malaysia's weather is characterized by two monsoon regimes—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). Malaysia depends heavily on surface water—mainly rivers, lakes, wetlands and reservoirs—for water supply, which presently constitutes 98% of total water supply for domestic, industrial and agricultural use. The remaining 2% comes from groundwater. About 80% of the water withdrawn from river systems is used for irrigation. Percentages of water withdrawn from surface water sources for domestic and industrial uses are expected to rise in the future. Potable water supply extends mostly throughout the country except in a few isolated spots, where physical or geographical factors make it too challenging, for which wells or rural water supply scheme systems are provided.

According to ASM (2014), current water consumption is about 12.5 billion m^3/year, or less than 3% of the available runoff. This is expected to increase by about 5% annually, to around 30.4 billion m^3/year by 2020, 60.8 billion m^3/year by 2040, and 121.6 billion m^3/year by 2060 due to the rapidly rising population and industrial growth. Irrigation will continue to be the largest water user, but its share is expected to be outpaced by domestic and industrial consumption.

3 | State of Ambient Water Quality

(1) Rivers

There are 2,986 river basins in Malaysia, 189 of which are major river basins (exceeding 80 km^2). Of the major river basins, 144 are monitored for river water quality status (DOSM 2023). In 2022, 8,163 samplings were conducted by Department of Environment Malaysia (DOE) from 672 rivers, based on 1,353 manual and 55 upstream water intake water quality monitoring stations. Continuous river water quality monitoring was also conducted for 26 rivers based on 30 monitoring stations (DOE 2022). Regarding the five-year period from 2018 to 2022, results for river water quality are as shown in Fig. 2.7.2, whereas Figs. 2.7.3, 2.7.4 and 2.7.5 specifically show the trends of river water quality based on BOD, NH_3-N and SS sub-indexes.

From Fig. 2.7.2, it can be seen that clean rivers exhibited an improving trend from 56% in 2018 to 74% in 2022. Slightly polluted rivers decreased from 36% in 2018 to 22% in 2022. However, polluted rivers increased from 3% in 2021 to 4% in 2022, indicating the need for a stricter and more efficient approach to combating river water pollution. From Fig. 2.7.3, out of a total of 1,353 river stations, 1,060 (78.3%) indicated clean rivers in 2022—an increase of 11 compared to 2021 (1,049). Further, the number of stations indicating slightly polluted rivers also dropped, from 609 (45%) in 2018 to 149 (11%) in 2022, showing an improvement. For stations reporting polluted river water, while the number showed a large drop from 528 (39%) in 2018 to 122 (9%) in 2021, indicating a trend of improving river water quality, it then rebounded to 149 (11%) in 2022, indicating a worsening status, suggesting wastewater containing high organic matter (BOD) was being discharged into those rivers.

Figure 2.7.4 shows the trend of river water quality based on NH_3-N from 2018 to 2021 as indicated by stations. While the number of clean river indications from stations increased from 406 (30%) in 2018 to 685 (51%) in 2021, it then declined to 641 (47%) in 2022. On the other hand, the number of indications of polluted rivers decreased from 500 (37%) in 2018 to 389 (29%) in 2022. In terms of suspended solids (SS) (Fig. 2.7.5), the number of clean river indications from stations decreased from 1,037 (77%) in 2021 to 1,028 (76%) in 2022, and the number of polluted river indications from stations increased from 191 (14%) in 2021 to 207 (15%) in 2022. Most river water quality monitoring stations showed a significant deterioration in water quality in 2022 compared to 2021. Resumption of industrial activities since the rescindment of the Movement Control Order (MCO; imposed in 2021) is one of the contributing factors cited in increasing pollutant loads and thus deterioration in water quality at river stations located in areas close to industries (DOE 2022).

In 2022, the Department of Environment (DOE) analyzed 8,136 water quality samples from 1,353 manual river water quality stations to monitor heavy metal concentrations, including mercury (Hg), arsenic (As), cadmium (Cd), chromium (Cr), lead (Pb), and zinc (Zn). In terms of compliance with the National Water Quality Standards (NWQS), all river station results indicated standards were fully met for mercury and zinc. For arsenic, cadmium, chromium, and lead, compliance ranged from 99.2% to 100%, indicating that almost all samples were within acceptable limits (DOE 2022).

In 2022, the DOE assessed 55 upstream water intake stations based on the water quality index, 52 (94.5%) of which indicated clean water, while three (5.5%) indicated slightly polluted water. Based on the water quality index (WQI), 28 (50.9%) stations indicated Class I, 25 (45.5%) indicated Class II, and two (3.6%) indicated Class III (DOE 2022). For the BOD sub-index, 54 (98.2%) stations indicated Class II, and one (1.8%) indicated Class III. In terms of the NH_3-N sub-index, 43 (78.3%) stations indicated Class I, 11 (20.0%) indicated Class II, and one (1.8%) indicated Class III. Regarding the suspended solids (SS) sub-index, 36 (65.5%) stations indicated Class I, 13 (23.6%) indicated Class II, four (7.3%) indicated Class III, and two (3.6%) indicated Class IV (DOE 2022).

River pollution is still a major issue in Malaysia, despite substantial investment in and efforts taken to improve and maintain river quality. Both point-source and nonpoint-source pollution are significant contributors to water pollution, and levels of BOD, NH_3-N and SS in the monitoring samples were high. High BOD is attributed to inadequate treatment of sewage or effluent from agro-based and manufacturing industries. Meanwhile, the main sources of NH_3-N were assumed to be animal farming and domestic sewage, and sources of SS were attributed to improper earthworks and land clearing activities. Future scenario predictions indicate an even more challenging management environment for water pollution due to the presence of micro-pollutants and new emerging pollutants (NEPs) resulting from excessive use of pharmaceutical and personal care products, some of which are endocrine disruptors.

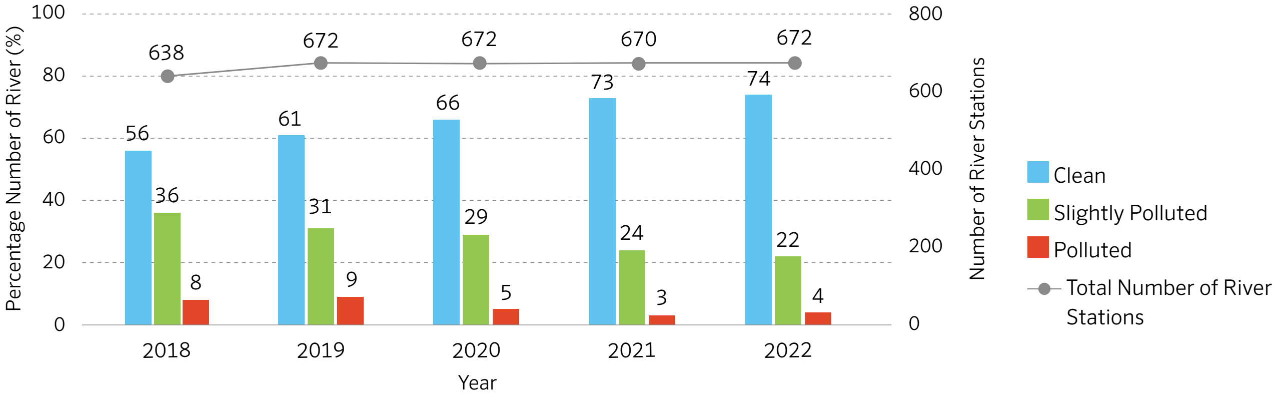


Figure 2.7.2 Trend in river water quality in Malaysia (2018-2022) (Source: DOE 2022)

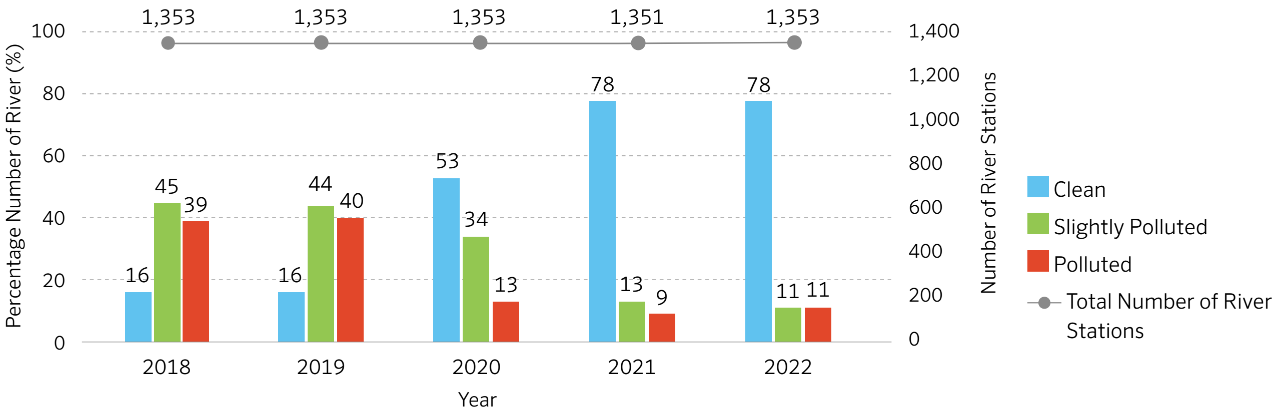


Figure 2.7.3 Trend in river water quality in Malaysia based on BOD sub-index (2018-2022) (Source: DOE 2022)

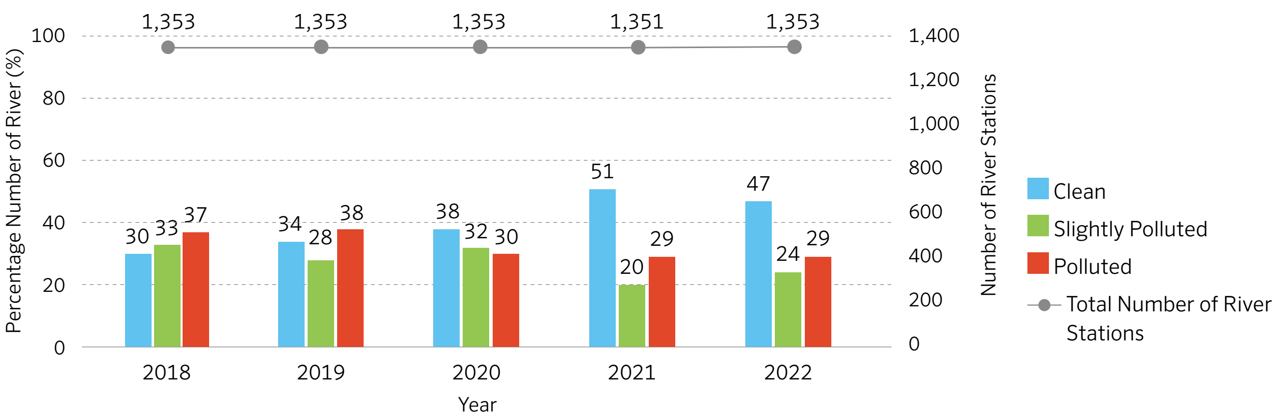


Figure 2.7.4 Trend in river water quality in Malaysia based on NH_3-N sub-index (2018-2022) (Source: DOE 2022)

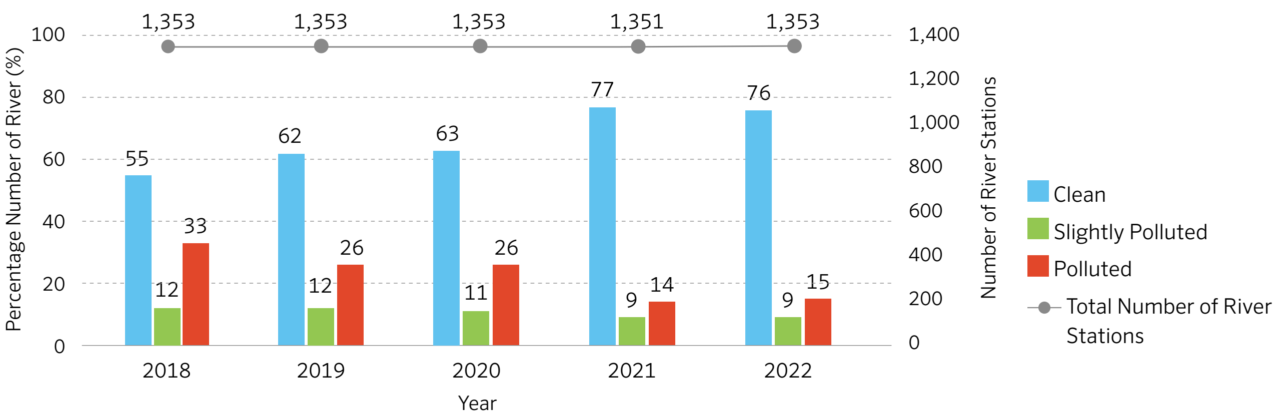


Figure 2.7.5 Trend in river water quality in Malaysia based on suspended solids (2018-2022) (Source: DOE 2022)

(2) Lakes and reservoirs

Lakes and reservoirs are managed by different authorities and owners and operators, which has meant comprehensive water quality monitoring has not been conducted by the DoE and no water quality inventories exist for either water bodies. However, a study by the Institute of Environment and Water Resource Management and Teknologi Malaysia shows 62% of water bodies comprised of lakes and reservoirs to be eutrophic (Sharifuddin 2011).

(3) Coastal water

In 2022, the DOE monitored 188 coastal stations, 85 estuary stations, and 95 island stations, each with a sampling frequency of six, producing 1,128 samples from coastal stations, 510 from estuary stations, and 570 from island stations. The samples were analyzed, and the results were summarized based on the MMWQI across the six samplings (DOE 2022).

Figure 2.7.6 illustrates the trend in marine water quality status of Malaysia's coastal areas based on the MMWQI and the number of monitoring stations. It shows that stations indicating Excellent water quality increased from 85 to 88 over 2021-2022. For Good water quality, however, the number of stations indicating it decreased from 40 to 39 over 2021-2022. Notably, no station indicated Poor in 2022 (DOE, 2022).

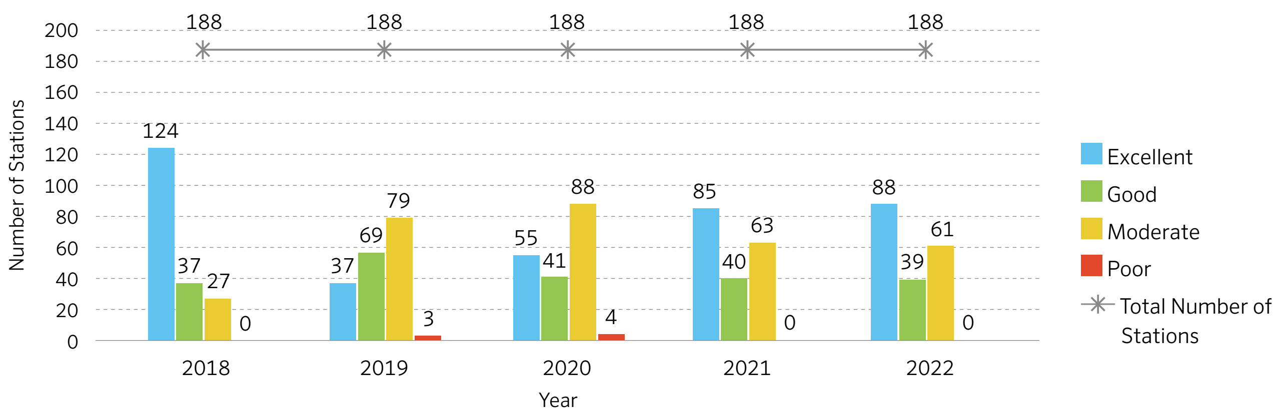


Figure 2.7.6 Trend in marine water status for coastal areas of Malaysia (2018-2022) (Source: DOE 2022)

(4) Groundwater

According to ASM (2014), the groundwater resource is currently still underused owing to relatively high exploration costs, and groundwater use mainly takes place in the State of Kelantan. In Sarawak, numerous villages, especially along the coast, obtain water from groundwater due to the low cost-efficacy of the pipework infrastructure installation necessary to connect these isolated areas. Groundwater is also an important source of water supply in many small islands and is used in conjunction with surface runoff and rainwater.

Groundwater quality monitoring in Malaysia was established in 1997, with sites selected based on specific land use. In 2022, a total of 406 groundwater samples were analyzed for various parameters, including volatile organic compounds (VOCs), pesticides, heavy metals, anions, bacteria (coliform), phenolic compounds, total hardness, total dissolved solids (TDS), pH, temperature, conductivity, and dissolved oxygen. Out of 120 nationwide groundwater quality monitoring stations (wells), sampling took place at 109; no sampling took place at the remainder due to factors such as the lack of groundwater discharge from development activities and rock cracking at monitoring sites (DOE 2022).

4 | State of Wastewater Treatment

(1) Wastewater and major pollutants

Regarding the different key pollutants (BOD, SS and NH_3-N) of water bodies, the sources can generally be divided into five main categories, as reported by DOE (2022): manufacturing industries, agriculture-based industries, wet markets, sewage treatment systems and pig farming. In 2022, the daily pollutant discharge load on the environment included an estimated biochemical oxygen demand (BOD) pollution load of 667.35 tons per day, as detailed in Table 2.7.2. The largest contributor to BOD load was sewage treatment systems, accounting for 343.45 tons per day (51.47%). This was followed by pig farming activities at 228.53 tons per day (34.24%), manufacturing industries with 61.92 tons per day (9.28%), agriculture-based industries at 27.45 tons per day (4.11%), and wet markets at 6.00 tons per day (0.90%). The overall estimation for SS load was 915.17 tons/day. Total pollution load from pig farming activities showed the highest load at 474.64 tons/day (51.86%), followed by the sewage treatment systems at 326.89 tons/day (35.72%). Manufacturing industries contributed 55.82 tons/day (6.10%), followed by agriculture-based industries 50.08 tons/day (4.11%) and wet markets 7.75 tons/day (0.85%). In 2022, the NH_3-N load was estimated to be 274.61 tons/day in which sewage treatment systems remained the largest contributor, with a total load of 174.15 tons/day (70.33%), followed by pig farming activities at 28.13 tons/day (11.36%), agriculture-based industries at 25.50 tons/day (10.30%), manufacturing industries at 19.50 tons/day (7.88%) and wet markets at 0.33 tons/day.

Table 2.7.2 Summary of pollutant load estimation based on water pollution source in 2022

Water pollution source	BOD load (tons/day)	SS load (tons/day)	NH_3-N load (tons/day)
Manufacturing industries	61.92	55.82	19.50
Agriculture-based industries	27.45	50.08	25.50
Wet markets	6.00	7.75	0.33
Sewage treatment systems	343.45	326.89	174.15
Pig farming	228.53	474.54	28.13

(Source: DOE 2022)

(2) Facilities and status of wastewater treatment

Originally, sewage treatment and desludging works were assigned to Indah Water Konsortium (IWK), a wholly-owned company of the Ministry of Finance Incorporated (IWK 2022). To improve operation and maintenance, IWK gradually took over sewerage systems of various scales and types — over 8,800 from 1994 to 2008, while over 3,000 private systems remained under direct management of the owners. On average, IWK assumed control over 300 treatment facilities and 1,000 km of sewer network every year. However, in areas without large-scale sewerage systems, private developers continued to construct small-scale sewerage systems.

Although IWK was not the owner of the public facilities, it had the right to collect sewerage fees as the operator. However, the tariff it introduced for individuals and enterprises was not popular, which led to three fee reductions (JSC 2011). This put IWK into the red as it could not cover the business expenses and fee collection proved difficult. To avoid insolvency, which would have affected sewerage services, IWK was placed under governmental control in 2000 and has since been managed as a semi-private company under the Ministry of Finance, which controls capital expenditure. The role of implementing agency managing sewerage construction was then transferred to the Sewage Service Department (SSD), supplementing its role as sewerage industry regulator.

In 2006, the Malaysian Parliament passed the Water Service Industry Act (WSIA), which replaced the Sewerage Service Act. Under the previous legal arrangement, IWK had no right to oblige users to pay desludging costs and sewerage fees or to impose fines. However, as the new Act also integrated drinking water and sewerage services, it enabled overall management of water supply and the ability to cut supply to users defaulting on payments. The new framework also reinforced SSD's roles and provided by law a new regulator, SPAN (*Suruhanjaya Perkhidmatan Air Negara* or National Water Services Commission).

SSD then became a project implementation agency, in charge of defining plans for new construction and upgrades of sewers and wastewater treatment plants. As was previously performed by IWK, SPAN thus handles monitoring and regulation of sewerage services. It also aims to improve the quality of new systems constructed by the private sector through providing conformity guidelines in order to ensure effluent quality requirements and standards are satisfied, as determined by the Department of Environment. Accordingly, developers are obliged to select only those systems approved by SPAN.

According to IWK, in 2022, the company's service area was 81,954 km^2, with a connected population equivalent (cPE) of 30.59 million. It operates and maintains 7,336 sewage treatment plants (STPs), 1,422 network pumping stations (NPS) and approximately 20,936 km of sewerage pipelines throughout Malaysia as of the end of December 2022. According to DOSM (2023) statistics provided by SPAN for 2022, there were 12,144 public and private sewage treatment plants, accounting for approximately 36 million cPE, as shown in Table 2.7.3. However, numbers of users of communal septic tanks, individual septic tanks and traditional systems increased from 2021 to 2022, and now stands at 13 million.

Table 2.7.3 Status of domestic wastewater treatment facilities (2019-2022)

Sewage Facilities	2019		2020		2021		2022	
	Quantity	Population Equivalent	Quantity	Population Equivalent	Quantity	Population Equivalent	Quantity	Population Equivalent
Public sewage treatment plant (a+b)	7,114	27,062,756	7,203	27,525,662	7,440	29,577,067	7,503	31,417,704
a. Multipoint Plant	7,012	18,045,882	7,101	18,321,827	7,336	19,881,838	7,395	20,186,013
b. Regional Plant	102	9,016,874	102	9,203,835	104	9,695,229	108	11,231,691
Private sewage treatment plant	4,119	4,302,350	4,215	4,512,796	4,464	4,882,300	4,641	4,957,337
communal septic tank	4,231	515,034	4,230	514,889	4,155	515,514	4,230	514,344
Individual septic tank	1,360,395	7,060,201	1,362,426	7,088,163	1,363,886	7,096,562	1,366,516	7,151,742
Traditional system	1,175,248	5,876,240	1,155,258	5,776,290	1,156,314	5,781,570	1,156,314	5,781,570
Network pumping station	1,272	n.a.	1,312	n.a.	1,375	n.a.	1,454	n.a.
Length of sewer network (km)	20,780	n.a.	21,216	n.a.	21,633	n.a.	21,964	n.a.

(Source: DOSM 2023)

5 | Frameworks for Water Environmental Management

(1) Legislation

The ultimate objective of Malaysia's environmental management (including water quality management) is to improve living standards and ensure a sustainable quality of life for its citizens. The National Policy on the Environment, approved in 2002, states that "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" (MoSTE 2002). In line with this policy, the national policy set eight principles to integrate the economy and environment: namely, stewardship of the environment; conservation of nature's vitality and diversity; continuous improvement in the quality of the environment; sustainable use of natural resources; integrated decision making; role of the private sector commitment and accountability; and active participation in the international community.

The Environmental Quality Act (EQA) 1974 (Amendments 2012) relates 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 specify maximum permissible loads dischargeable by any source into inland waters, with reference either generally or specifically to the body of water concerned.

Several amendments or additions have since been made to this Act, and some of the key subsidiary legislations related to water environment are as follows:

a. Environmental Quality (Prescribed Premises) (Crude Palm Oil) Regulations 1977
b. Environmental Quality (Prescribed Premises) (Raw Natural Rubber) Regulations 1978
c. Environmental Quality (Scheduled Wastes) Regulations 2005
d. Environmental Quality (Sewage) Regulations 2009
e. Environmental Quality (Control of Pollution from Solid Waste Transfer Station and Landfill)
f. Regulations 2009
g. Environmental Quality (Industrial Effluent) Regulations 2009
h. Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 2015

Other laws and regulations are also shown in Fig. 2.7.7.

Other important policies related to water Environmental Management also exist. One is the National Water Resources Policy (NWRP), launched in March 2012 for the period 2010-2050, which is aimed at determining the future direction of the water resources sector based on a review of national water resources. The NWRP for Malaysia provides clear directions and strategies in water resources management to ensure water security and sustainability for both humankind and nature.

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
- Sabah Water Resources Enactment (1998)
- National resources and Environment Ordinance Sarawak

Specific Sector

Peninsular Malaysia

1. **Agriculture**
   Irrigation Areas Act (1953)
   Drainage Works Acts (1954)
2. **Forestry**
   National Forestry Act (1984)
3. **Control of Rivers**
   Water Acts (1920), Reviewed (1989)
   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

Figure 2.7.7 Legislative chart on water quality management (Source: MOEJ 2009)

(2) Institutional arrangement

The Department of Environment (DOE) originally began as the Environment Division, established in 1975 under the Ministry of Local Government and Environment. It has since been reorganized several times due to realignments of government ministries and agencies and is now under the purview of the newly established Ministry of Natural Resources and Environmental Sustainability (NRES) as of December 2023. DOE is responsible for environmental protection, including water quality management. NRES's mission is to protect and manage the environment, drive climate action and promote green growth as well as preserve and conserve forests, biodiversity, geological heritage, and manage mineral resources in an optimum, sustainable and responsible way. As a result of a ministerial realignment in December 2023, the water sector is now under the responsibility of the newly established Ministry of Energy Transition and Water Transformation (PETRA). PETRA's mission is to ensure the sustainability and security of water through policy, strengthen governance and strategically manage and regulate the electricity supply industry by optimizing renewable energy and energy efficiency to guarantee reliable, affordable and sustainable services. The quality of drinking water is regulated by the Ministry of Health, and the National Water Commission regulates the entities involved in water supply and sewerage services under the Water Services Industry Act 2006 (Act 655), which came into effect in 2008. Local governments are involved in water resources planning, development and enforcement based on local authority bylaws.

(3) Ambient water quality standards

a. Water quality standards

Malaysia's National Water Quality Standards (NWQS), which apply to surface waters, set out standard values for 72 parameters in six water use classes (see Table 2.7.4), the goal of which 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 the water class one level higher.

Table 2.7.4 Water quality classes according to the national water quality standards

Grade	Description
I	Conservation of natural environment. Water Supply I— Practically no treatment necessary. Fishery I—Very sensitive aquatic species.
IIA	Water Supply II—Conventional treatment required. Fishery II—Sensitive aquatic species.
IIB	Recreational use with body contact.
III	Water Supply III—Extensive treatment required. Fishery III— Common, of economic value and tolerant species; livestock drinking.
IV	Irrigation
V	None of the above.

(Source: DOE 2022)

For marine water quality, the Malaysian Marine Water Quality Standards (MQWS) and the Malaysian Marine Water Quality Index (MWQI) were established. MQWS consists of six classes, covering 22 parameters whereas the MWQI consists of six sub-indexes: DO, fecal coliform, NH_3, NO_3, PO_4, and TSS (DOE 2022).

While groundwater quality standards have not been established, based on the assumption that groundwater can potentially be used as an alternative source of surface water, the National Guidelines for Drinking Water Quality act as the benchmark for evaluating groundwater quality monitoring results. Further, the Groundwater Quality Index (GWQI) is used as a benchmark to determine the groundwater quality status and category. Malaysia's GWQI was developed based on seven parameters with a quality scale ranging from 0 to 100, identifying the quality of the groundwater from the range of excellent to very poor (DOE 2022).

b. Water quality monitoring framework

The DOE's Environmental Quality Monitoring Programme (EQMP) monitors rivers, marine waters, and groundwater nationwide to assess environmental quality in the monitoring, prevention and control of pollution. EQMP serves as an early warning pollution detection system for cases such as oil spills, industrial disasters and illegal toxic waste dumping for mitigation and enforcement as well as to support planning and development efforts aimed at ensuring sustainable environmental management (DOE, 2019).

I. River water quality monitoring

River water quality monitoring in Malaysia comprises manual and continuous river water quality monitoring. The water quality index (WQI) is used to evaluate the status of river water quality and pollution levels, and thus the corresponding suitability in terms of water uses according to the national water quality standards for Malaysia (NWQS). The WQI for river water quality is calculated based on six parameters: DO, biochemical oxygen demand (BOD), chemical oxygen demand (COD), NH_3-N (Ammoniacal nitrogen), suspended solids (SS), and pH, and classified into three categories according to the index: clean, slightly polluted, and polluted (DOE 2022).

II. Coastal water quality monitoring

The DOE has been systematically monitoring marine water quality in Malaysia under the program since 1978 in Peninsular Malaysia, which was then later extended to Sabah and Sarawak in 1985. The program's primary goal is to evaluate the current condition of marine waters and identify pollution levels originating from both terrestrial and marine sources. This assessment is crucial as the detected pollution can significantly endanger the health and biodiversity of the marine ecosystem, threatening its sustainability. Monitoring stations established under the marine water quality monitoring program are classified into three categories: coastal stations, estuary stations and island stations (DOE 2022). Malaysia's marine water quality standards (MMWQS) and the Malaysian marine water quality index (MWQI) were also established. The MMWQI aggregates key marine water quality parameters to provide a comprehensive assessment of the marine water quality status of water bodies. The MMWQS consist of six classes covering 22 parameters, whereas the MMWQI consists of six parameters: DO, fecal coliform, NH_3, NO_3, PO_4, and TSS. The MMWQI aggregation is scaled from 0 to 100, with 0 indicating poor and 100 indicating excellent water quality (DOE 2022).

III. Groundwater monitoring

Monitoring of groundwater quality in Malaysia is carried out in accordance with the specific land use, categorized as one of agricultural area, used solid waste landfill, aquaculture, used gold mine, urban and suburban area, golf course, industrial site, water supply, rural area, resort and used animal burial site (DOE 2022). The Malaysia groundwater quality index (GWQI) serves as the benchmark to determine the status and category of groundwater quality, and was developed based on seven parameters: pH, Iron, total dissolved solids, nitrate, E. coli, phenol, and sulphate. The GWQI uses a scale from 0 to 100 to classify groundwater quality into categories of excellent, good, moderate, poor, and very poor (DOE 2022).

(4) Effluent standards

a. 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).

b. Effluent inspection procedure

Monitoring of effluent, as well as recording and maintenance of the monitoring results are obligations that all premises are required to fulfill under the 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 the DOE, either by the online reporting system or hardcopy submission. Authorized DOE officials can carry out inspections of any premises, including surprise inspections, to ensure compliance with all provisions in the act, and non-compliance results in immediate penalties to polluters. As a measure to improve effluent quality, industrial effluent treatment systems (IETS) were introduced with the aim of optimizing effluent treatment operations and maintenance by enabling preventive or corrective actions through the monitoring of treatment performance based on certain parameters. Through IETS, companies can benefit from the early identification of deficiencies, identification of proper dosages for chemicals (Keong 2008) and increased opportunities to identify preventive actions (How 2008). The DOE provides technical guidance to promote IETS, which recommends that within each industry a competent person certified by the director-general of the DOE be on duty to supervise IETS. The use of IETS is expected to encourage industry as a whole to be more proactively engaged in pollution control but without invoking the level of enforcement present in the public sector.

The government can be seen to have extended diligent efforts in its monitoring of effluents from both domestic and industrial sectors with the use of key indicators. Monitoring results for effluent quality in terms of compliance with national standards for both public sewage treatment plants and industrial sectors are shown in Table 2.7.5 and 2.7.6 respectively. Results show a compliance level of over 97% for public sewage treatment plants since 2010. In 2018, average rates of compliance of effluent monitoring sites for public sewage treatment plants and industrial sites with ambient guidelines were 97.8% and 99.6% respectively. For years 2018-2022, the compliance level for sewage treatment plants refers to STPs operated by IWK only, with a value of 97.4% in 2022, whereas the compliance level of industrial effluents for non-prescribed premises was 99.0% in 2022.

Table 2.7.5 Summary of public sewage treatment plants and status of compliance with sewage effluent standards for 2010-2022

Year	Description
2022	97.4*
2021	97.7*
2019-2020	97.1*
2018	97.8*
2017	98.9
2016	98.5
2015	98.3
2014	97.6
2013	97.1
2012	97.3
2011	97.6
2010	97.9

*Sewage Treatment Plants (STPs) operated by IWK only
(Source: *IWK 2018-2022; SPAN 2017)

Table 2.7.6 Summary of industrial wastewater management and status of compliance for non-prescribed premises based on the Environmental Quality (Industrial Effluents) Regulations 2009

Year	No. of inspections		Compliance (%)	
2022	3,642		99.0	
2021	3,930		98.0	
2020	5,772		99.6	
2019	5,203		95.3	
Year	**No. of desktop inspections**	**Compliance (%)**	**No. of field inspections**	**Compliance (%)**
2018	4,549	99.6%	5,663	99.6
2017	10,280	99.2%	5,518	99.2
Year	**No. of inspections**		**Compliance (%)**	
2016	14,995		99.0	
2015	11,372		99.0	
2014	11,410		99.0	
2013	7,201		99.0	
2012	6,597		98.1	

(Source: DOE Annual report 2012-2022)

c. Measures against non-compliance

Since 2009, DOE has designed different enforcement measures and tools for maintaining the water environment. A brief snapshot of these, including penalties for defaulters, is shown in Table 2.7.7 (DOE 2018b). Non-complying institutions or entities face penalties of up to 100,000 MYR or five-year jail terms.

Table 2.7.7 Summary of different enforcement instruments and economic tools for water environmental management

S.No	Regulations	Enforcement agency	Enforcement method/Reporting	Penalty
1	EQ (Industrial Effluent) Regulations 2009 - Industrial Effluent and Mixed Effluent	DOE	1. Self Regulatory Mechanism: a. Section 7: monitor COD and any parameter in Fifth Schedule b. Reporting: Monthly c. Section 9: Performance Monitoring of IETS —based on Guidance Document on Performance Monitoring of Industrial Effluent Treatment System d. Online Environmental Reporting (OER) 2. Site Inspection by DOE Officer	Section 32: Penalty—If convicted, maximum penalty of RM 100,000 and/or maximum 5 years jail and further fine of RM 1,000/ day for continued offence
2	EQ (sewage) Regulations 2009	DOE	1. Self Regulatory Mechanism: a. Section 10: Monitor concentration of the specified parameters in Second Schedule b. Reporting: Monthly c. Online Environmental Reporting (OER) 2. Site Inspection by DOE Officer	Section 26: Penalty—If convicted, maximum penalty of RM 100,000 and/or maximum 5 years jail and further fine of RM 1,000/ day for continued offence
3	EQ (Control of Pollution from Solid Waste Transfer Station and Landfill) Regulations 2009	DOE	Self Regulatory Mechanism: a. Section 8: Monitor concentration of ammoniacal nitrogen from landfill on a continuous basis using online instrumentation system linked to DOE b. Section 8: Monitor concentration of the specified parameters in Second Schedule (limits) c. Section 11: Conduct performance monitoring of leachate treatment system d. Online Environmental Reporting (OER)	Section 29: Penalty—If convicted, maximum penalty of RM 100,000 and/or maximum 5 years jail and further fine of RM 1,000/ day for continued offence

(5) Major policies on water environmental management

In order to manage the complex, interwoven issues of the water environment, the Malaysia government has introduced several legislations and guidelines in terms of new standards, as well as revised existing standards, as follows:

a. Malaysian Groundwater Quality Standards and Index (2019)—developed by DOE
b. National Standard for Natural Recreational Water Quality and Guidelines for Natural Recreational Water Quality Monitoring (Marine and Fresh Water) (2017)—developed by MOH
c. Guidelines for Green Industry Practice: Food sector for Slaughtering and Processing of Poultry (2017)—DOE, NRE (Malay version)
d. Guidelines on Land Disturbing Pollution Prevention and Mitigation Measures (2017)—DOE, NRE
e. Environmental Impact Assessment Guidelines for Development in Slope and Hill Areas (2017)—DOE, NRE
f. Environmental Impact Assessment Guidelines for Development in Coastal Areas and Marine Parks (2017)—DOE, NRE
g. Guidelines on the Effluent Treatment System for Pig Breeders (2016)—DOE, NRE (Malay version)
h. Guidelines of the Effluent Treatment System for Dairy Cattle, Beef Cattle and Buffalo Breeders (2016) —DOE, NRE (Malay version)
i. National Lake Water Quality Criteria and Standards (2015)—Developed by NAHRIM (Approved by National Water Resources Council in 2015)
j. Guidelines on the Disposal of Chemical Wastes from Laboratories (2015)—DOE, NRE
k. Guidelines for Packaging, Labelling and Storage of Scheduled Waste in Malaysia (2014)—DOE, NRE
l. Guidelines for Green Industry Practice: Juice Production Industry (2014)—DOE, NRE (Malay version)
m. Guidelines for Green Industry Practice: Printing Industry (2014)—DOE, NRE (Malay version)
n. National Standard for Drinking Water Quality (2000)—Developed by Ministry of Health (MOH)

6 | Recent Developments in Water Environmental Management

The Twelfth Malaysia Plan, 2021–2025 (Twelfth Plan), a medium-term plan with the objective of 'A Prosperous, Inclusive, Sustainable Malaysia', marks the start of a new phase in Malaysia's development: the Shared Prosperity Vision 2030 (WKB 2030). Policies under this Plan are structured to achieve sustainable economic growth, with a focus on equitable wealth distribution, the wellbeing of the people and environmental sustainability. The Twelfth Plan introduces a new transformative approach based on 'three themes, four catalytic policy enablers and 14 game changers'. The national development priorities of the Twelfth Plan will continue to be aligned with the Sustainable Development Goals (SDGs) of the 2030 Agenda for Sustainable Development (2030 Agenda). The adoption of a nationwide approach is essential for SDGs implementation. Water environment management falls under Theme 3, Advancing Sustainability, which focuses on advancing green growth as well as enhancing energy sustainability and transforming the water sector. The Plan also augments green growth to achieve sustainability and resilience (Ministry of Economy 2021).

For water environment management, Malaysia will implement the Water Sector Transformation (WST) 2040 plan, which is aimed at achieving water security and sustainability as well as positioning water as an economic opportunity. The transformation will be carried out through four phases under Malaysia Plans (MP) with a specific focus in each phase, as stated below (EPU 2021):

i. Phase 1: 12 MP (2021–2025)—Accelerating adoption of Integrated Water Resource Management (IWRM)
ii. Phase 2: 13 MP (2026–2030)—Developing indigenous technology to be on par with international standards
iii. Phase 3: 14 MP (2031–2035)—Achieving economies of scale
iv. Phase 4: 15 MP (2036–2040)—Becoming the regional water industry hub

The first phase of WST 2040 falls under 12 MP (2021–2025), with the focus of accelerating the adoption of IWRM. Some related strategies under the 12 MP for water environment management are stated below (EPU 2021):

i. Empowering people through the establishment of public consultation platforms, implementation of awareness-raising, advocacy and capacity-building (AACB) programs as well as expansion of community-driven conservation activities with the aim of instilling a sense of ownership among the people in protecting and conserving water resources.
ii. Strengthening governance at all levels (federal, state and district level) to ensure better integrated and more effective water management by harmonizing the water-related legislation and enhancing water pollution mitigation measures to streamline with IWRM. Several laws will be revised to regulate emerging pollutants and increase penalties based on the polluter pays principle. 10 Total maximum daily load (TMDL) studies will be carried out to determine the loading capacity of river segments.
iii. Enhancing capability in data-driven decision-making by strengthening the water research institute as a one-stop center for water-related data and R&D&C&I, and raising the capacity of water industry players and the scientific community to support the development of indigenous water technology.
iv. Strengthening the financial sustainability of water service providers by implementing the tariff setting mechanism (TSM) for sewerage services to achieve operating costs recovery and improve the financial capabilities of service providers as well as to explore alternative non-tariff revenues, particularly from water recycling and wastewater treatment by-products.
v. Developing sustainable infrastructure with cost-effective technology by adopting alternative systems in rural areas and islands to achieve 98% of sanitation coverage, reduction in non-revenue water (NRW) level to 25% as well as emphasizing nature-based approaches in addressing water pollution issues, such as the application of constructed wetlands (CWs) in treating wastewater and improving effluent quality before release into the river system.

On April 2024, the Parliament (*Dewan Negara*) of Malaysia passed the Environmental Quality (Amendment) Bill 2023, which is comprised of a series of amendments to the Environmental Quality Act 1974 (Act 127). This Amendment is aimed at further strengthening enforcement, preventing environmental pollution and dealing with ongoing environment-related criminal activities by increasing penalty rates and fines, as well as enabling decisive action to be taken against environmental offenders. The bill involves amendments to 28 sections of Act 127, including the enhancement of penalties with a minimum fine range of not less than RM 5,000, a maximum fine not exceeding RM 10 million, and mandatory imprisonment not exceeding five years for offences involving water pollution, oil waste pollution, and waste disposal in Malaysian waters, as well as illegal disposal of scheduled waste (NST 2024; The Star 2024).

7 | Challenges and Future Plans

It could be said that the Earth was in a better state, environmentally, during the CORONOVIRUS pandemic. A biodiversity movement gathered momentum as a result of the cleaner air, rivers and lakes. However, as socio-economic activities returned to normal, pollution of the environment resumed and its effects on public health. In Malaysia, the existence of the Environmental Quality Act 1974 ensured that environment monitoring continued through the control of point-source and nonpoint-source pollution as well as assessments of the water environment. Many challenges still remain, however, as in other countries. A new direction for water environmental management has been incorporated in the Twelfth Malaysian Plan (12th MP) through to the Environmental Act. In order to improve the nation's future water environment, all state government and selected ministries will need to take the following actions:

i. Sharing knowledge of science, technologies, innovation and engineering (STIEs) via Malaysia's federal platform, the National Water Council, chaired by the Prime Minister of Malaysia
ii. Developing action plans for improving river water quality via Malaysia's federal platform: the Special Committee to Address the Deterioration of National River Water Quality, chaired by Deputy Prime Minister of Malaysia
iii. Enhancing grey water pollution control by state regulation such as for market discharges and discharges from laundries and other businesses
iv. Introducing an innovation-based approach of mixed-industrial sewerage treatment systems
v. Use of the communication, education and public awareness (CEPA) approach at the community level by leaders at the state government level, and federal agency initiatives such as Friends of Rivers (FoR)
vi. Applying the latest conceptual approaches, such as the Sustainable Development Goals (SDGs), environmental, social, and governance (ESG), internet of things (IoT), 4th Industrial Revolution (IR4.0) and artificial intelligence (AI).

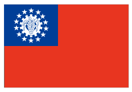
Some of the additional challenges are as follows:

i. Lack of sewerage coverage (limited to urban areas)
ii. Lack of lake water quality management
iii. Illegal discharge of wastewater to rivers disrupting public water supply
iv. Lack of regulations or standards for grey water monitoring
v. Assessing river carrying capacities via Malaysia's 12th Plan for series research of total daily maximum loading (TDML) of selected rivers by Department of Environment, Malaysia (DOE) and Department of Irrigation and Drainage, Malaysia (DID)
vi. Natural Disaster of 'In' (Stagnant/Inundation flood or locally meaning Dreamy Flood) at township, 'Banjir Puing' (Debris Flood) due to uncertainty and intense rainfall of climate change impacts
vii. Heatwave episodes that affect water resources for agriculture
viii. Sedimentation transport that reduces water surface volume and water level

For the way forward, the following key actions have been initiated:

i. Amendment of Environmental Quality (Sewage) Regulations 2009 of Environmental Quality Act 1974, since October 2023
ii. Amendment of National Wetland Policies (*Dasar Tanah Lembap Negara*);
iii. Amendment of National Policy on the Environment (2002);
iv. Restructuring for environment empowerment by establishing Ministry of Natural Resources and Environment and Ministry of Energy Transition and Water Transformation (PETRA).

2.8 Myanmar



1 | Country Information

Table 2.8.1 Basic indicators

Land area (km²)		676,552 (2022)*
Total population		54.82 million (2021)*
GDP (current USD)		64.81 billion (2023)**
Per capita GDP (current USD)		1,187 (2023)**
Average annual rainfall (mm/year)		2,225 (2021)*
Total renewable water resources (km³)		1,168 (2021)***
Total annual freshwater withdrawals (billion m³)		33.39 (2021)***
Annual freshwater withdrawal by sector	Agriculture	89% (2021)***
	Industry	1% (2021)***
	Municipal (including domestic)	10% (2021)***

(Source: *CSO 2022, **World Bank 2023, ***FAO 2021)

Figure 2.8.1 Inle Lake in Shan State, Myanmar

2 | State of Water Resources

Myanmar has an abundance of water resources, which are distributed unevenly spatially and temporally. The annual precipitation in the southeastern area (i.e., Kayin, Mon, and Taninthayi Regions) and western area (i.e., Rakhine Region) is over 4,000 mm, while that in inland areas (Sagaing, Mandalay, and Nay Pyi Taw Regions) is around 1,000 mm (CSO 2022). Around 78% of rainfall falls between June and September (CSO 2022). Myanmar has eight river basins: Ayeyarwady, Thanlwin, Mekong, Bago, Sittaung, Bilin, Tanintharyi, and Rakhine. The Ayeywarwady basin accounts for 55% of Myanmar's land area and Thanlwin for 19% (IFC 2020). Lakes and reservoirs are also important freshwater resources as approximately 91% of the total water withdrawal is from surface water (ADB 2017), while populations in the dry zone depend on groundwater (Dury and Aqua Rock Konsultants 2017). Inle Lake and Indawgyi Lake are the two largest natural lakes, with respective areas of 116 km² and 123 km² (Mjelde et al. 2023).

3 | State of Ambient Water Quality

(1) Rivers

Myanmar is well endowed with freshwater resources, and the main sources of domestic, agricultural and industrial waters are inland surface waters. While the water quality of Hlaing River in Yangon was relatively good in 2018, with an average BOD concentration of 3.0 mg/L, water degradation caused by human activities has been a concern (JICA 2018; Eriksen 2021). Monitoring data for the Bago River, Shwegyin River, and Sittaung River has revealed that the water environment in these three rivers was generally in a good in condition in 2023. Respective annual average TSS, BOD, and Nitrate concentrations (all in mg/L) were for the Bago River: 18, 1.45, 0.11; Shwegyin River: 69, 1.69, 0.1; and Sittaung River: 69, 1.98, 0.09 (FD 2023).

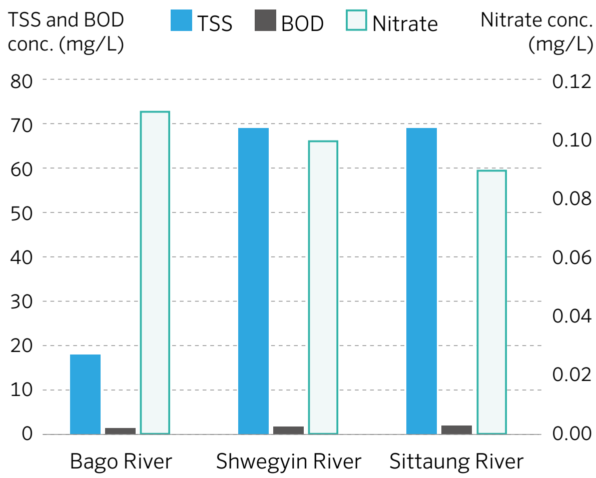


Figure 2.8.2 Water quality of selected rivers

(Source: FD 2023)

Table 2.8.2 River basins in Myanmar

Basin	Total basin area (km^2)	Basin area within Myanmar (%)	Country sharing the basin	Land area of Myanmar (%)	Total main river length (km)	State/region
Ayeyarwady	412,500	90.4	China and India	55.5	2,170	Ayeyarwady, Bago, Chin, Kachin, Magway, Mandalay, Nay Pyi Taw, Rakhine, Sagaing, Shan, Yangon
Thanlwin	283,335	45	China and Thailand	19	2,400	Mon, Bago, Kachin, Kayah, Kayin, Shan
Mekong	824,000	2.7	Cambodia, China, Laos, Thailand, Vietnam	3.3	3,469	Shan
Sittaung	34,913	100	-	5.2	450	Mon, Bago, Kayah, Kayin, Magway, Mandalay, Nay Pyi Taw, Shan
Bago	10,261	100	-	1.5	220	Mon, Bago, Yangon
Bilin	3,056	100	-	0.5	160	Bago, Kayin, Mon
Tanintharyi	44,876	100	-	6.7	400	Mon, Kayin, Tanintharyi
Rakhine	71,700	77	Bangladesh and India	8.2	280	Ayeyarwady, Bago, Chin, Kachin, Magway, Mandalay, Nay Pyi Taw, Rakhine, Sagaing, Shan, Yangon

(Source: IFC 2020)

(2) Lakes and reservoirs

Myanmar has numerous natural lakes and reservoirs, which are important freshwater sources for various purposes as well as for their biodiversity and scenery, making them popular tourist attractions. Similar to the situation of rivers, these lakes have faced water degradation in recent years, due to increasing wastewater inflow, deforestation, and illegal dumping of garbage.

Inle Lake is the country's second largest natural lake. With a surface area of 116 km^2 and a volume of 1,132 million m^3, it is one of the key freshwater sources in the lake basin and a tourist attraction with over 0.3 million annual visitors (NIWR 2017). According to the water quality monitoring data for 2023 for Inle lake, TSS, BOD, and nitrate concentrations (all in mg/L) were 69, 1.98, and 0.09, respectively (FD 2023). Table 2.8.2 shows selected water quality parameter data for Inle Lake and Indawgyi Lake for 2023 and 2024. The high turbidity indicates that the water in both lakes was visibly cloudy, but the DO concentration was good in Inle Lake and moderate in Indawgy Lake.

Table 2.8.2 Water quality of Inle and Indawgyi Lakes 2023–2024

No.	Parameter	Inle Lake (2023 rainy season)	Inle Lake (2024 rainy season)	Indawgyi Liake (2023 rainy season)	Indawgyi Lake (2024 rainy season)
1	Turbidity (NTU)	4.18	6.24	8.1	7.54
2	Dissolved Oxygen (mg/L)	8.36	9.77	6.6	5.37
3	Arsenic (mg/L)	<0.0001	<0.0001	0.00074	0.000238

(Source: FD 2023)

(3) Coastal water

Myanmar has three distinct regions and nearly 3,000 km of coastline: one bordering the Bay of Bengal, another bordering the Andaman Sea, and the Ayeyarwady region between these two (Oo and Win 2024). Hotel development and increasing numbers of visitors have affected the water quality, and marine plastic debris has been a concern as concentrations of microplastics in Ayeyarwady coastline waters can rise to 28,000 particles/km^2. Further, the Ayeyarwady River transports about 119 tons of plastic pollution daily into the ocean from deep inland (Oo and Win 2024).

(4) Groundwater

Groundwater is a vital source of freshwater, particularly in the Dry Zone. According to a household survey conducted in the Magway Region in November and December 2009, 4% had access to piped water from surface water sources (WFP 2011), and Census 2014 found that 75% of people still depended on groundwater for drinking and other domestic uses (Dury and Aqua Rock Konsultants 2017). Of the groundwater, about 50% is used for domestic water, including drinking, and about 22% is used by industry (Smedley 2020; Pavelic at al. 2015).

While groundwater is a vital resource for human consumption, its quality is a concern. Arsenic in the lower and middle Irrawady aquifer, salinity in the Pegu aquifer and delta and coastal areas, and microbiological contamination in dug wells are the major groundwater problems (Smedley 2020). Table 2.8.3 shows the analysis results of 132 samples from Kachin State.

Table 2.8.3 Arsenic concentration in groundwater of Kachin State

Region	Total samples	<0.05 mg/L
Kachin	16	0.000375

(Source: Baseline Data of ECD-2023-2024)

4 | State of Wastewater Treatment

In Myanmar, 35% of wastewater is not properly treated before being discharged into receiving waters, and Yangon, the largest city in Myanmar, has faced problems of wastewater management due to its increasing population and urbanization (Swan et al. 2023).

In Yangon, 7% of wastewater is managed by a centralized wastewater treatment system, 10% by decentralized wastewater treatment systems, 80% by septic tanks, and 3% by pit latrines (Swan et al. 2023). In Nay Pyi Taw, 1% of the population has access to improved sanitation, but this is lower in other main cities (Min 2018). Table 2.8.4 presents the domestic wastewater treatment capacity and existing systems in three major cities for 2023–2024.

The Government of Myanmar is also focusing on industrial wastewater with the aim of conserving the water environment. Currently, the following nine types of industry are selected as priority sectors targeted by the Environmental Management Plan: 1. alcohol, wine and beer production factories, 2. food and beverage processing facilities, 3. pesticide manufacturing, formulation and packaging, 4. cement and lime manufacturing, 5. textile and dying facilities, 6. foundries, 7. tanning and leather finishing, 8. pulp and paper mills, and 9. sugar manufacturing plants (ECD 2023).

Table 2.8.4 Domestic wastewater treatment practices in urban areas for 2023–2024

City name	Population (million)	Wastewater management practices
Yangon	6.2	• Centralized wastewater treatment ($14,775\ m^3$/day, designed value) • Decentralized wastewater treatment ($50\ m^3$/day) • Septic tank • Septic tank with upflow system • Aerobic biological system • Anaerobic biological system • Pit latrine
Nay Pyi Taw	0.37	• Centralized wastewater treatment ($1,600\ m^3$/day) • Septic tank • Pit latrine
Mandalay	1.7	• Decentralized wastewater (sewage) treatment ($227.30\ m^3$/day) • Domestic wastewater treatment ($3,363.63\ m^3$/day) • *Johkasou* system ($900\ m^3$) • Septic tank (about 164,438) • Pit latrine (about 102,716)

5 | Frameworks for Water Environmental Management

(1) Legislation

The current legislative framework for water environment management in Myanmar is shown in Fig. 2.8.3. Maintaining a healthy and clean environment and conservation of natural and cultural heritage for the benefit of present and future generations are the objectives of Environmental Conservation Law 2012. Article 7 stipulates that environmental impact assessments (EIA) and social impact assessments (SIA) must be carried out for projects that may cause significant impacts on the environment, the EIA process of which—according to EIA Procedure 2015—must start with submission of project proposals to the Environmental Conservation Department (ECD). The National Environmental Quality (Emission) Guidelines was approved in 2015, which provides the basis for regulation and control of noise and vibration, air emissions, and liquid discharges from various sources in order to prevent pollution for purposes of protection of human and ecosystem health, and includes industry-specific guidelines on air pollution, wastewater, noise and odour. The objectives of the Conservation of Water Resources and Rivers Law 2006 are to conserve and protect water resources and river systems for the benefit of public use, for smooth and safe navigation, and to contribute to the state economy through improving water resources and mitigating environmental impacts.

(2) Institutional arrangement

In Myanmar, several ministries are involved in water environment management. Table 2.8.5 is a list of agencies and their responsibilities for water environment conservation.

Disposal of wastewater from residences, office buildings and factories is controlled by the Ministry of Natural Resources and Environmental Conservation (MONREC). The Ministry of Industry is responsible for regulating industrial water use and wastewater discharge, and the City Development Committee is responsible for water supply and sanitation in respective cities.

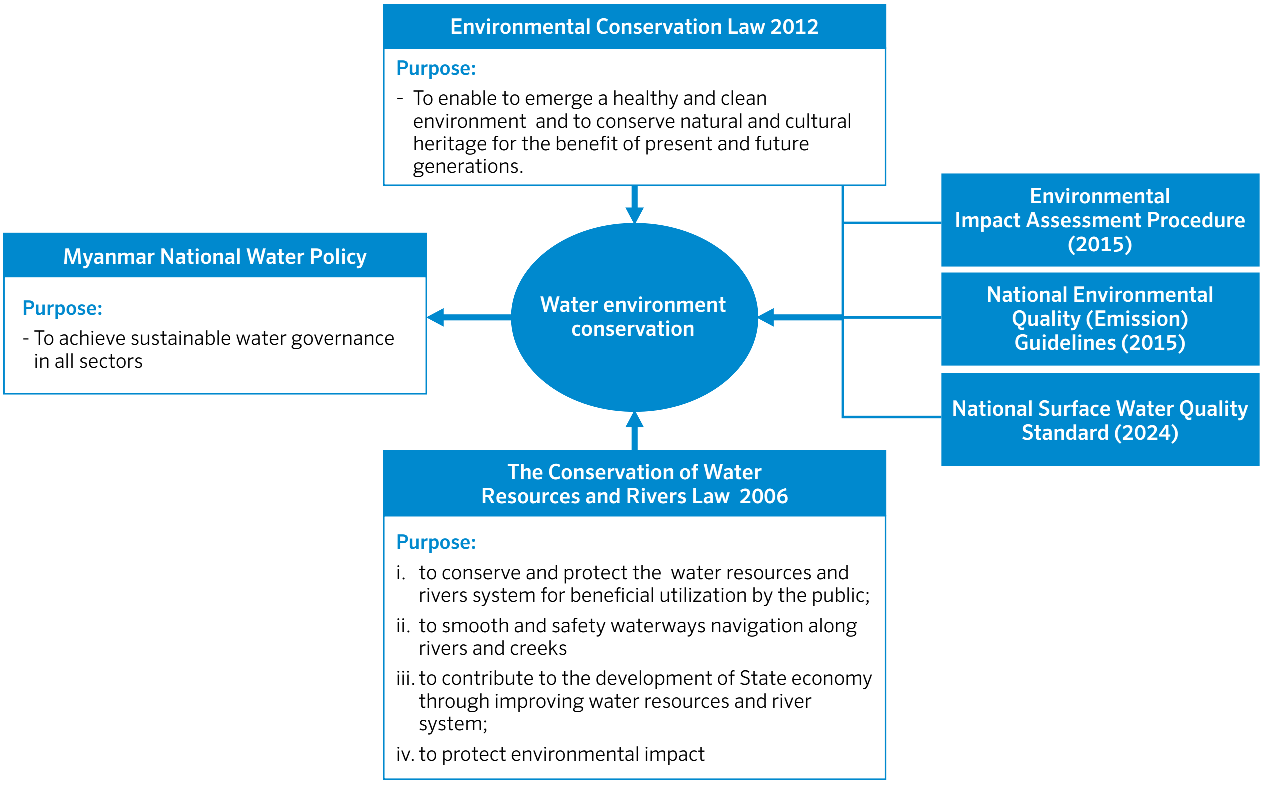


Figure 2.8.3 Legislative framework of water environment management in Myanmar

Table 2.8.5 Institutional arrangement for water environment management in Myanmar

Department	Ministry/organization	Responsibilities
Environmental Conservation Department	Ministry of Natural Resources and Environmental Conservation	Formulating national environmental quality standards including water quality standards, water quality monitoring, enforcement
Forest Department	Ministry of Natural Resources and Environmental Conservation	Reforestation and conservation of forests including watershed areas
Irrigation and Water Utilization Management Department	Ministry of Agriculture, Livestock and Irrigation	Supplying irrigation water and controlling floods
Water Resources Utilization Department	Ministry of Agriculture, Livestock and Irrigation	Irrigation and rural water supply
Department of Meteorology and Hydrology	Ministry of Transport and Communication	Flood early warning for major rivers
Directorate of Industrial Supervision and Inspection	Ministry of Industry	Regulating industrial water use and wastewater discharge
Department of Public Health	Ministry of Health	Drinking water quality assessments
Department of Rural Development	Ministry of Cooperatives and Rural Development	Rural water supply and sanitation
Department of Research and Innovation	Ministry of Science and Technology	Formulating national standards
Engineering Department (Water Supply and Sanitation)	City Development Committees (Yangon, Mandalay, Nay Pyi Taw)	Water supply and sanitation in city areas

(3) Ambient water quality standards

a. Ambient water quality standards

The ECD, in cooperation with other line ministries and international experts, made efforts to develop the National Surface Water Quality Standards (NSWQS), which were approved on 8 February, 2024. Standards were set for five classes of water use categories (Table 2.8.6), and include 36 parameters with threshold values for protecting aquatic ecosystems and human health (Tables 2.8.7 and 2.8.8).

Table 2.8.6 Water use classification

Water Class	Water use
Class I	(1) Conservation of the natural environment (2) Water supply Grade 1 (3) Water uses listed in Class II to V
Class II	(1) Water supply Grade 2 (2) Fisheries Grade 1 (3) Bathing & swimming (4) Water uses listed in Class III to V
Class III	(1) Water supply Grade 3 (2) Fisheries Grade 2 (3) Industrial water Grade 1 (4) Agricultural water Grade 1 (5) Water uses listed in Class IV to V
Class IV	(1) Industrial water Grade 2 (2) Agricultural water Grade 2 (3) Water uses listed in Class V
Class V	(1) Navigation/Transportation (2) Environmental Conservation

Note:
Water supply Grade 1: Applicable for water supply with sedimentation, filtration and other comparable means
Water supply Grade 2: Applicable for water supply with pre-treatment, sedimentation, filtration, and other comparable means
Water supply Grade 3: Applicable for water supply with pre-treatment and other advanced means
Fisheries Grade 1: Applicable for fisheries of oligotrophic species
Fisheries Grade 2: Applicable for fisheries of semi-eutrophic species
Industrial water Grade 1: Applicable for industrial use with sedimentation and other comparable means
Industrial water Grade 2: Applicable for industrial use with chemical additives and other advanced means
Agricultural water Grade 1: Applicable for agricultural use with ordinary means
Agricultural water Grade 2: Applicable for agricultural use with advanced means
Environmental conservation: Maintained to the extent of not causing discomfort to citizens

(Source: MMS 44:2024 National Surface Water Quality Standard, National Standard and Quality Department)

Table 2.8.7 National surface water quality standard (Standard values: Human health)

Parameter	Unit	Class I	Class II	Class III	Class IV	Class V
Chemical parameters						
Boron	mg/L	2.4				
Cyanide	mg/L	0.07				
Fluoride	mg/L	1.5				
Nitrate nitrogen	mg/L	10				
Nitrite nitrogen	mg/L	1				
Organics						
Benzene	mg/L	0.01				
Phenol	mg/L	0.05				
Polychlorinated biphenyls (PCB)	μg/L	0.5				
Heavy metals						
Arsenic	mg/L	0.05				
Cadmium	mg/L	0.003				
Chromium (hexavalent)	mg/L	0.05				
Lead	mg/L	0.01				
Mercury	mg/L	0.001				
Nickel	mg/L	0.07				
Selenium	mg/L	0.04				

* Standard values are expressed as annual average concentrations

(Source: MMS 44:2024 National Surface Water Quality Standard, National Standard and Quality Department)

Table 2.8.8 National surface water quality standard (Standard values: Environmental conservation)

Parameter	Unit	Class I	Class II	Class III	Class IV	Class V
Physical parameter						
Total Suspended Solids	mg/L	25	50	75	100	150
Chemical parameters						
BOD	mg/L	2	3	8	25	30
COD	mg/L	5	8	13	50	100
DO	mg/L	>6	>5	>4	>3	>2
pH	S.U.	6.5-8.5	6.5-8.5	6-9	5-9	-
Ammonium nitrogen	mg/L	0.2	0.3	0.5	0.8	0.9
Organics						
Oil & grease		Not detected				
Biological parameter						
Escherichia coli (E. coli)	MPN/ 100ml (or) CFU/ 100ml	20	300	1,000	1,000	-
Heavy metals						
Copper	0.1	0.3	0.5	-	-	-

* Standard values are expressed as annual average concentrations

(Source: MMS 44:2024 National Surface Water Quality Standard, National Standard and Quality Department)

b. Water quality monitoring framework

National surface water quality standards (NSWQS) were set in 2024, and ECD and the Forestry Department of MONREC are responsible for managing water quality monitoring. As such, ECD monitors river water quality at 154 sampling points, lake water quality at 78 monitoring points and groundwater quality at 30 monitoring points for 21 water quality parameters. The Department of Meteorology and Hydrology (DMH) under the Ministry of Transport and Communications (MOTC) monitors the quality of river water of four major rivers (Ayeyarwady, Chindwin, Thanlwin and Sittoung) for five water quality parameters, as appropriate. The Forestry Department monitors water quality for 30 parameters at 27 sampling points for rivers and nine monitoring points in dams.

Details of the water quality monitoring framework are shown in Table 2.8.9.

Table 2.8.9 Water quality monitoring framework of ECD and Forestry Department

Item	ECD	DMH	Forest Department
Monitoring parameters	On-site parameters: pH, temperature, dissolved oxygen, oxidation reduction potential, turbidity, salinity, total dissolved solids, electrical conductivity, water depth Laboratory parameters: mercury, arsenic, iron, nickel, boron, copper, aluminum, manganese, chromium, lead, biochemical oxygen demand	pH, electric conductivity, dissolved oxygen, temperature, turbidity	Turbidity, colour, conductivity, total suspended solids, pH, total alkalinity, bod, ortho-phosphate, total phosphorous, silicate, arsenic, lead, chromium, cadmium, mercury, copper, zinc, nickel
Number of sampling points	Rivers: 154 sampling points Lakes: 78 sampling points Groundwater: 30 sampling points	Rivers: 13 sampling points (Ayeyarwady: 9 points, Chindwin: 1 point, Thanlwin: 1 point, Sittoung: 2 points)	River: 27 points (Mekong and its tributaries) Dam: 9 points (Palaung, Sinthe, Ngalaik) Lake: 10 points (Inle)
Frequency of monitoring	Seasonal (quarterly or twice a year), monthly, bimonthly (if required)	As appropriate	Quarterly
Frequency of monitoring reports	Monthly	As appropriate (to National Water Resources Committee and Water Resources Research Group)	Quarterly

(4) Effluent standards

a. Effluent standards

The National Environmental Quality (Emission) Guidelines (NEQEG) were released on 29 December 2015. These guidelines provide the basis for regulation and control of noise and vibration, air emissions, and liquid discharges from various sources in order to prevent pollution and provide protection for human and ecosystem health. A total of 71 industry-specific effluent levels have been set out in the NEQEG. The guidelines for effluent levels cover thermal power, geothermal power, wind power, oil and gas, petroleum refining, natural gas processing, natural gas liquefaction, crude oil and petroleum product terminals, electric power transmission and distribution, gas distribution systems, petroleum-based organic chemicals manufacturing, plantation industrial/crop production, annual crop production, mammalian livestock production, poultry production, aquaculture, forest harvesting operations, meat processing, poultry processing, fish processing, food and beverage processing, dairy processing, vegetable oil production and processing, sugar manufacturing, breweries and distilleries, textiles manufacturing, tanning and leather finishing, sawmilling and manufactured wood products, board and particle-based products, pulp and/or paper mills, printing, large volume inorganic compounds manufacturing and coal tar distillation, petroleum-based polymers manufacturing, coal procession, nitrogen fertilizer manufacturing, phosphate fertilizer manufacturing, pesticide manufacturing, oleochemicals manufacturing, pharmaceuticals and biotechnology manufacturing, glass, and glass and mineral fiber manufacturing, ceramic tile and sanitary ware manufacturing, base metal smelting and refining, integrated steel mills, foundries, metal, plastic and rubber products manufacturing, semiconductors and other electronics manufacturing, solid waste management facilities, wastewater treatment facilities, health care facilities, and others (MONREC 2015).

b. Effluent inspection procedure

The Pollution Control Division of ECD, General Administration Department, Directorate of Industrial Supervision Inspection (DISI), and Directorate of Industrial Collaboration are responsible for inspections of effluent quality. Table 2.8.10 describes the responsibilities of each agency. DISI performs monitoring using an online monitoring system for wastewater discharged from alcohol factories. Local and regional offices of ECD are tasked with regular monitoring of effluent quality, and ECD headquarters is directly involved in effluent monitoring upon notification of major environment pollution issues.

Table 2.8.10 Effluent quality control agencies and their responsibilities

Agency	Responsibilities
Pollution Control Division of ECD	Regular monitoring of effluent quality
General Administration Department	Management and issuance of liquor licenses
Directorate of Industrial Supervision Inspection (DISI)	Promoting development of private industrial enterprises in accordance with the Industrial Enterprise Law
Directorate of Industrial Collaboration	Formulating policies and laws to develop and promote industries

c. Measures against non-compliance

When violations of effluent standards are found, a written warning is sent to the company at fault notifying of the need to rectify current practices for compliance with the relevant laws, effluent guidelines and standards. If this fails to solve the pollution issue, an operation suspension notice is issued.

(5) Major policies on water environmental management

The Myanmar Sustainable Development Plan (MSDP) 2018–2030 is a document laying out the country's vision on sustainable development. Its Goal 5 emphasizes sound management of natural resources and the environment for a more prosperous nation. The National Environmental policy of Myanmar (2019) sets a vision for a clean environment with a healthy and functioning ecosystem to ensure inclusive development and wellbeing for all people in Myanmar. Myanmar National Water Policy (NWP) sets its vision as, "in 2040 Myanmar will become a water efficient nation with well-developed and sustainable water resources based on a fully-functional integrated water resources management system". The objectives of the NWP are to establish an Apex body for strengthening inter-ministerial coordination for water management, investing in water sector infrastructures, institutions and capacity building, improving efficiency of the water supply and demand sides, and enhancing water information, knowledge, technology and cooperation.

6 | Recent Developments in Water Environmental Management

The following developments in government policies are expected to have impacts on the country's water environment management:

i. Approval of the national surface water quality standard on 8 February 2024
ii. Implementation of project on capacity development in enforcement and promotion of environmental compliance
iii. Implementation of project for establishing a national water quality monitoring system and building a national laboratory to improve the national capacity for water quality management in Myanmar

7 | Challenges and Future Plans

Based on the current state of water quality management in Myanmar, some key management challenges are identified as follows:

Table 2.8.11 Key Management Challenges and Actions

	Description	Actions to be taken
Institutional challenge	Monitoring and inspection of water and effluent quality	Organize monitoring and inspection teams at national, state, regional, city and township levels, including relevant departments.
Enforcement challenges	Lack of capacities in regional offices Lack of incentive policy	Arrange capacity-building training. Formulate incentive policy for enforcement of environmental pollution.
Resource and financial challenges	Lack of human resources Lack of financial capacity to establish laboratory and technical training	Recruit human resources Enhancing cooperation with development partners to establish laboratory and capacity development training program on water and effluent quality monitoring.

2.9 Nepal

1 | Country Information

Table 2.9.1 Basic indicators

Land area (km²)		147,181*
Total population		29.16 million (2021)**
GDP (current USD)		40.83 billion (2022/23)***
Per capita GDP (current USD)		1,399 (2022/23)***
Average annual rainfall (mm/year)		1,530 (2011)
Total renewable water resources (km³)		225.0 (2011)
Total annual freshwater withdrawals (billion m³)		15.0 (2011)
Annual freshwater withdrawal by sector	Agriculture	95.9 % (2011)
	Industry	0.3 % (2011)
	Municipal (including domestic)	3.8 % (2011)

(*Nepal Ministry of Foreign Affairs, websites, ** Nepal. National Statistics Office, National population and housing census 2021, *** Nepal. Ministry of Finance, Economic Survey 2022/2023. Others: Nepal. Water and Energy Commission Secretariat (WECS), Water Resources of Nepal in the Context of Climate Change 2011.)

Figure 2.9.1 Typical water environment in Nepal
(Source: https://nepalrivers.net/)

2 | State of Water Resources

Nepal has abundant water resources. Average annual precipitation is around 1,500 mm, ranging from over 6,000 mm along the southern slopes of the Annapurna Range in central Nepal to less than 250 mm in the northcentral portion near the Tibetan plateau. About 10% of total precipitation in Nepal falls as snow, mostly in the 23% of Nepal's total area that lies above the permanent snowline of 5,000 m. There are 3,252 glaciers, covering an area of 5,323 km² (or 3.6% of Nepal's total area), with an estimated ice reserve of 481 km³, and 2,323 glacial lakes, covering an area of 75 km² (WECS 2011). The snow-capped Himalayas is the main source of rivers in the country, especially during the dry season.

There are about 6,000 rivers in Nepal, with a total drainage area of 194,471 km², 76% of which lies in Nepal. Three categories of river systems predominate, based on their origin. The first comprises four main river systems from east to west, respectively: Koshi, Gandaki, Karnali, and Mahakali river systems, all of which originate from glaciers or snow-fed lakes in the Himalayas. River systems in the second category originate in the Mahabharat range in the mid-hills, and include Babai, West Rapti, Bagmati, Kamala, Kankai and Mechi river systems. River systems in the third category include streams or rivulets from the Chure hills bordering the Terai plain region in south Nepal, the streams and rivulets of which generally cause flash floods during monsoon rains and remain dry or with very low flow during the dry season.

Table 2.9.2 Distribution of lakes in seven provinces in Nepal

Province	Total lakes
Koshi Province	80
Madhesh Province	81
Bagamati Province	222
Gandaki Province	42
Lumbini Province	97
Karnali Province	7
Sudurpaschim Province	87
	616

Source: Nepal. National Lake Conservation Development Committee (NLCDC), Inventory of lakes in Nepal 2021.

An assessment has identified 5,358 wetlands in Nepal, including high altitude glacier lakes in the Himalayas, natural lakes as well as ponds, dams and other small wetlands (NLCDC 2009). Of these, 616 lakes (including ponds, small wetlands) up to 3,000 m elevation are roughly evenly distributed across seven provinces (Table 2.9.2) (NLCDC 2021).

The annual rechargeable groundwater reserve is 8.8 billion m^3, of which less than 2 billion m^3 is currently extracted, mostly for groundwater irrigation in the southern Terai region (WECS 2011). Usually, people living in the Terai (lowland), inner valleys in the hills and mountains extract groundwater for domestic as well as industrial uses.

3 | State of Ambient Water Quality

The water quality of public water bodies is generally considered good. However, urban areas, especially Kathmandu Valley and Pokhara, suffer from degradation due to direct disposal of huge volumes of untreated or insufficiently treated domestic and industrial wastewater. Solid waste dumped directly into rivers and lakes also negatively contributes to the state of the water environment.

Increased use of fertilizers and pesticides also impact the water quality of surface and groundwater, especially in peri-urban areas where commercial farming (such as vegetables) is extensive. During the rainy season there are increased incidences of waterborne diseases due to unsafe drinking water and sanitation, especially in rural areas.

Table 2.9.3 State of water quality in selected rivers across Nepal shown for upstream-downstream sections

	pH	DO (mg/L)	BOD (mg/L)	COD (mg/L)	TDS (mg/L)	EC (μS/cm)	NH_3–N (mg/L)	NO_3–N (mg/L)	NO_2–N (mg/L)	TOC (mg/L)	TH (mg/L)	Mg (mg/L)	Fe (mg/L)	TC (MPN/ 100mL)	*E-coli* (MPN/ 100mL)
Desired Value	6.5–8.5*	>5	<30	<250	<1000*	<1500*	<1.5*	<50*	-	-	<500*	<100*	<0.3*	0*	0*
Bagmati (Sundarijal – Khokana**)	6.6–7.4**	14.8–1.2	9.6–90.5	24.8–192	380–810	460–970	10–70	0.1–0.3	0.1–0.1	6.8–30	140–90	21.1–10.6	0.5–3.9	500–900	40–50
Bishnumati (Budhanilkantha – Teku Dovan)	7–7.5	12.5–0.9	15.4 – 167	36.7–178	120–920	187–1360	90–90	0.5–0.5	0.2–0.1	22.6–34.6	160–130	24.5–43.7	0.5–5.7	900–1600	110–170
Nakhu - Saibu	8–8.1	2.1–7.1	40.5 – 5.4	78–15.9	120–920	650–300	90–30	0.5–0.2	0.13–<0.1	12.1–3.6	100–120	12.3–24.7	4.2–2.8	1600-900	110–70
Hanumante (Sallaghari-Thimi)	8.5–7.3	1.8–15.1	33.0–48.9	120–90.7	1530-1290	1800-1600	160–180	2.4–2.7	0.2–0.1	45.6–26.7	80–120	9.8–10.2	6.4–6.5	1600-1600	120–90
Manahara (Pepsikola - Balkumari)	7.4–7.6	7.0–3.9	14.5–23.8	23.7–40.5	620–980	870–1450	60–60	2.3–2.0	0.2–0.2	4.5–12.8	60–80	7.8–11.8	4.9–6.1	1600-500	140–40
Seti Pokhara (Mardi – Dobila)	7.4–7.6	8.1–8.7	1.2–1.3	2.4–2.6	110–150	130–170	1.5–2.8	0.13–0.1	0.05–0.01	2.0–2.0	120–170	9.8–6.9	0.3–3.8	500–500	50–40
Narayani (Bridge – Devghat mixed)	7.3–7.1	11.2–9.7	0.88–1.5	2.5–3.5	170–160	200–180	2.0–1.1	3.5–3.9	0.1–0.1	2.0–5.0	340–180	25.6–22.9	0.2–0.3	900–900	60–70
Sirsiya (Parwanipur – Ghadiharwa Pokhara)	6.5–6.6	1.1–1.1	87.3–88.6	123.1–78	390–750	410–710	80.0–90.0	8.9–3.6	0.1–0.2	23.0–33.0	300–240	24.6–25.9	3.9–3.7	1600-900	170–110
Tinau (Jhumsa bridge – Radhakrishna Tole)	7.2–7.5	10.4–9.5	1.6–1.5	2.6–3.9	200–220	220–220	0.9–1.0	0.5–0.5	0.02–0.01	4.0–4.0	200–200	14.5–9.8	0.1–0.1	900–500	70–30

* NDWQS: National Drinking Water Quality Standard 2005
** Corresponds to upstream and downstream sections of the rivers shown in the table.

(Source: Nepal. Department of Hydrology and Meteorology, Water Quality Measurement and Hoarding Board Installation 2016)

(1) Rivers

Table 2.9.3 and 2.9.4 summarize the state of water quality in some key locations. Pollution of rivers in urban areas, soil erosion in rural areas, and mining of sand and rocks are the three main factors impacting river water quality. Sedimentation in rivers is prominent in the rainy season due to soil erosion and runoff. Development activities such as sand mining, encroachment of riverbanks and improper riverbank protection works have also caused serious sedimentation issues. Over the last decade increased mining of sand and stones by small and medium-sized crusher enterprises have resulted in increased sedimentation in the rivers, with serious turbidity and ecological impacts (such as changing courses of rivers and riverbank erosion).

(2) Lakes and reservoirs

Lake water in the country is generally good. However, some lakes are under pressure from economic development, tourism activities, and human impacts. Table 2.9.5 shows the state of water quality in two lakes, one in Kathmandu and the other in Pokhara. Phewa Lake, which is a major tourist attraction in Pokhara, has several hotels and residents established along its banks. Disposal of wastewater into the lake often causes eutrophication and algal bloom at several locations.

Table 2.9.4 State of water quality of selected river systems

Location/River	pH	TDS (mg/L)	DO (mg/L)	BOD (mg/L)
Mechi	8.3	30	8.9	1.8
Kankai	7.7	60	8.7	2
Arun	6.2	200	9.1	2.1
East Rapti at Sauraha	7.8	213	8.7	2.5
Seti at Ramghat	8.2	222	9.3	2
Bheri at Chatagaon	7.8	208	9.3	1.1
Karnali at Chisapani	7.8	264	10.5	1.5
Mahakali at Pancheswor	8.8	110	5	2

(Source: Department of Hydrology and Meteorology 2018)

Table 2.9.5 State of water quality in Phewa Lake (Pokhara) and Taudaha (Kathmandu)

	pH	DO (mg/L)	BOD (mg/L)	COD (mg/L)	TDS (mg/L)	EC (μS/cm)	NH_3-N (mg/L)	NO_3-N (mg/L)	NO_2-N (mg/L)	TOC (mg/L)	TH (mg/L)	Mg (mg/L)	Fe (mg/L)	TC (MPN/ 100mL)	*E-coli* (MPN/ 100mL)
Desired Value	6.5–8.5*	>5	<30	<250	<1000*	<1500*	<1.5*	<50*	-	-	<500*	<100*	<0.3*	0*	0*
Phewa Lake (Halanchowk - Dam site), Pokhara	7.5–7.6	7.9–8.0	2.5–2.1	5.7–5.7	50–50	50–60	1.6–1.6	0.11–0.16	0.07–0.07	5–4	120–120	6.7–11.1	0.1–0.1	900–900	70–70
Taudaha (Locations 1–3), Kathmandu	8.2–8.1	8.9–8.9	17.1–25.9	24.5–33.8	90–85	175–167	50–37.8	0.3–1.0	0.1–0.1	10.1–13.8	160–130	12.8–19.4	0.9–0.8	900–500	70–40

* NDWQS: National Drinking Water Quality Standard 2005

(Source: Nepal. Department of Hydrology and Meteorology, Water Quality Measurement and Hoarding Board Installation 2016)

Table 2.9.6 State of groundwater quality in selected locations

		Temp. (°C)	pH	EC (μS/cm)	Turbidity (NTU)	Hardness (mg/L)	Cl (mg/L)	Total Alkalinity (mg/L)	Fe (mg/L)	As (mg/L)	F (mg/L)
Desired Value		-	6.5–8.5*	<1500*	<5*	<500*	<500*	-	<0.3*	<0.05*	0.5–1.5*
Kathmandu Valley	Shallow Well	18.6	7.1	874.5	45.9	230.7	81.8	366.0	1.47	0.004	0.43
	Tube Well	17.9	7.0	576.8	54.8	218.8	61.1	258.0	1.90	0.003	0.27
	Deep Tube Well	20.3	7.0	704.2	33.2	251.2	59.0	302.7	1.80	0.009	0.74
East Terai (Jhapa, Morang and Sunsari) (2018)**	Groundwater	27	6.9	445	12.7	191.6	17	197.6	1.83	0.005	0.235
Far west Terai (Kailali) (2014)***	Groundwater	25.6	6.96	838.25	22.13	323	24.88	-	2.01	0.01	0.25

* NDWQS : National Drinking Water Quality Standard 2005

(Source: ** Mahato et al. 2018,*** Gurung et al. 2015.)

(3) Groundwater

Groundwater contamination in Nepal is caused by pathogenic bacteria, pesticides, nitrates and effluents from industrial and domestic sources. Unplanned urban development and insufficient waste management facilities are the main causes of groundwater pollution in rural areas. In Kathmandu Valley, long-term deterioration of groundwater quality is continuously being reported, such as nitrogen contamination in shallow wells (Shakya et al. 2019). Table 2.9.6 shows the groundwater quality at key locations.

4 | State of Wastewater Treatment

Discharge of untreated wastewaters and dumping of septic sludge from on-site sanitation systems into rivers is common due to lack of adequate facilities to treat wastewater. An estimated 876 million liters per day (MLD) of domestic wastewater is generated in Nepal, as shown in Figure 2.9.2 About 70% of this comes from on-site sanitation (faecal sludge) and only 30% of wastewater is collected through sewer networks. However, of the collected wastewater, only around 7% is treated while 93% (i.e., 268 MLD) is disposed of untreated. An estimated 20.1 MLD of wastewater is treated either in centralized WWTP or DEWATS systems.

Septic tanks and pit latrines in urban localities have posed the risk of ground water pollution. Rapid, unplanned urban growth and the lack of adequate investment are responsible for the current poor state of wastewater management in Nepal, especially in Kathmandu Valley. The extent of management of industrial wastewater is largely unknown due to the lack of data reporting, while the Department of Environment lacks the resources and capacity (human resources for monitoring/sampling and analysis labs) to enforce compliance with existing effluent standards. Industries, especially small and medium-sized enterprises, are unable to invest in costly treatment facilities as relevant acts and regulations on effluent discharge came into effect several years after these industries were established. The tariff for wastewater in Nepal is based on water consumption, which is either metered (block tariffs) or unmetered (flat rate) according to pipe size. The Kathmandu Upatyaka Khanepani Limited (KUKL) tariff for sewer connection (and wastewater treatment, if available) is 50% of the water consumption fee (KUKL 2021).

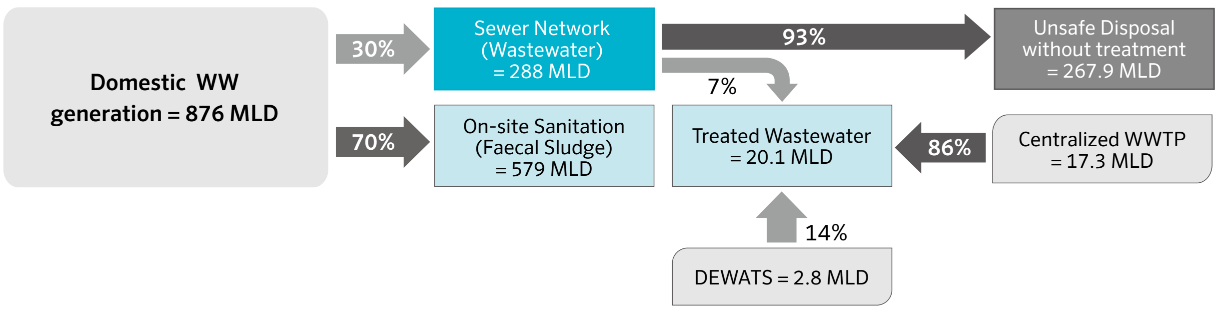


Figure 2.9.2 Domestic wastewater flows in urban areas in Nepal (Source: Shrestha et al. 2017)

5 | Frameworks for Water Environmental Management

(1) Legislation

Nepal has enacted various acts and regulations related to the environment and water since the 1980s, such as the Water Resource Act (1992), Drinking Water Rules (1998), Water Resource Strategy (2002), Drinking Water Quality Standards (2005). After Nepal become a federal republic comprising three layers of government (local, provincial and state), the new Constitution of Nepal 2015 (2072 BS) guaranteed the rights to a clean environment, healthcare and conservation, management and use of natural resources. The constitution also ensures the right of access to basic clean drinking water and sanitation services. Several articles of the constitution have provisions on water and the environment, while the government is either revising or in the process of finalizing new acts and regulations as part of legal or institutional reform under the new federal administration (Table 2.9.7). The Environment Protection Act (2019), National Environment Policy (2019), National Climate Change Policy (2019), and Integrated National Water Resources Policy (2020) are prominent acts/policies issued since adoption of the new constitution. The Integrated National Water Resources Act is in the final stage of drafting.

Table 2.9.7 Key provisions related to water environment in the new constitution and recent acts and policy documents

Name	Category	Year	Purpose/arrangements
Constitution of Nepal	Constitution	2015	Every citizen shall have the right to live in a clean and healthy environment; victim of environmental pollution shall be entitled the right to compensation from the polluter; the right to access to basic clean drinking water and sanitation services; conservation and multiple uses of water resources; Use of forests and waters and management of environment;
Environment Protection Act	Act	2019	The umbrella Act governing over all environmental protection of the country.
Forest Act	Act	2019	This Act governs all forest and related resources focusing on forest management, while contributing to the conservation of wildlife, environment, and water resources.
National Climate Change Policy, 2019	Policy	2019	Utilize the opportunities of financial, technical and other forms of assistance through the framework of conventions for the purpose of climate change management in line with the national priority and local needs while complying with international obligations.
National Environment Policy 2019	Policy	2019	Guide the implementation of environment related laws and other thematic laws, realize international commitment and enable collaboration between all concerned government agencies and non-government organizations on environmental management actions.
National Water Resources Policy	Policy	2020	The policy is aimed to cover all aspects of water resources development and management based on the Integrated Water Resources Management (IWRM) principle and newly restructured three tires of government.
Environment Protection Rules	Rule	2020	This Rule is based on the new Environment Protection Act 2019
Water Supply and Sanitation Act	Act	2022	This Act governs all water supply and sanitation protection of the country.
Water Resources Act (Draft)	Act	Under drafting	The draft Act will be the new water resources act for the execution of new policy which covers all aspects of water resources development and management
National Drinking Water, Sanitation and Hygiene Policy	Policy	2023	The policy aims to ensure all the issues of safe drinking water, sanitation and hygiene and control the water pollution and environmental sanitation.

(2) Institutional arrangement

The Ministry of Forests and Environment is responsible for environmental protection through managing and coordinating the country's environmental protection policies and measures. The Department of Hydrology and Meteorology (DHM) under the Ministry of Energy, Water Resources and Irrigation (MOEWRI) 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. The Groundwater Resources Development Board monitors the quality of underground as well as surface water. The Water and Energy Commission Secretariat (WECS) has assumed the role of 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. Various ministries and line agencies at the national level promote water and environmental management, which requires inter-ministerial coordination (Table 2.9.8).

Table 2.9.8 Key institutions and mandated areas related to the water environment

Name of the Institution	Level	Mandated Working Area
Ministry of Energy, Water Resources and Irrigation (MOEWRI)	Central	Over all Energy, Hydropower, Irrigation and Water Resources development of the country.
Department of Water Resources and Irrigation	Central	Department of Water Resources and Irrigation is responsible for planning, developing, implementing and monitoring of all sorts of central level surface and groundwater irrigation systems by utilizing the available surface and ground water resources.
Department of Hydrology and Meteorology (DHM)	Central	DHM is responsible to collect , process, publish and disseminate hydrological and meteorological data and monitors river hydrology, water quality, sediment, limnology, snow hydrology, glaciology, weather, climate, agro-meteorology, air quality and solar energy in the country.
Water and Energy Commission Secretariat (WECS)	Central	Policy and planning regarding energy and water resources development and management covering all sectors. Advisory role on critical issues related to large water resources projects.
Ministry of Water Supply (MWS)	Central	Water supply, sanitation and hygeine development and management of the country.
Department of Water Supply and Sewerage Management (DWSSM)	Central	The Department of Water Supply and Sewerage Management (DWSSM) is responsible for planning, implementing, operating and their maintenance of water supply and sanitation systems throughout the country.
Nepal Water Supply Corporation (NWSC)	National Corporation	NWSC is a public utility organization; an autonomous government body and provides drinking water supply services to the 20 cities within the country.
Ministry of Forest and Environment (MOFE)	Central	Forest resources and environmental development; management and enforcement environmental mandates.
Department of Environment	Central	Responsible for the implementation and the compliance of Environmental Protection Act, and Rule (EPR), and pollution control standard as promulgated by the Government of Nepal.
Ministry of Urban Development	Central	Over all urban planning, development and Management for the development of municipalities in the country.
Ministry of Physical Infrastructure Development	Provincial	Provincial level policy planning formulation and development of all sorts of physical infrastructures and their environmental management.
Ministry of Industry, Tourism, and Forests and Environment	Provincial	Provincial level policy planning formulation and development of all sorts of forest, environment, conservation of biodiversity, adaptation to climate change and science and technology related.
Kathmandu Upatyaka Khanepani Limited (KUKL)	Kathmandu Valley	KUKL is responsible for the operation and management of water and wastewater services in the Valley. The company will also take over the responsibility for infrastructure built by the Melamchi Water Supply Project.
High Powered Committee for Integrated Development of the Bagmati Civilization (HPCIDBC)	Kathmandu Valley	HPCIDBC is responsible to keep Bagmati River and its tributaries clean by preventing the direct discharge of solid and liquid wastes to the river and to conserve the river system within the Kathmandu Valley.
Local Units	Local	Local level planning and development in close coordination with province.

(3) Ambient water quality standards

a. Ambient water quality standards

Separate standards and guidelines exist for different uses (drinking water, irrigation, aquaculture, livestock, and recreation), in addition to Nepal Water Quality Guidelines for the Protection of Aquatic Ecosystem (2008).

b. Monitoring framework

Systematic ambient water quality monitoring is not yet conducted in public water bodies in the country, although water quality is monitored by different ministries and agencies for different purposes. For instance, regular monitoring of the water quality of the Bagmati River in the Kathmandu Valley area is conducted by the High Powered Committee for the Integrated Development of the Baghmati Civilization, which started publishing data for the general public in February, 2014. The Department of Hydrology and Meteorology, under the MOEWRI, monitors river and lake water quality. For drinking water, water supply providers are required to monitor different water quality parameters under the surveillance of concerned agencies under the Ministry of Population and Health (Table 2.9.9). Figure 2.9.3 shows the institutional framework for water quality surveillance.

Table 2.9.9 Drinking water quality parameters used in monitoring

No.	Category	Parameters	Monitoring Frequency	Monitoring Institution	Surveillance Agency
1	Physical	Turbidity, pH, Colour, Taste and Odor	Daily	Water Supply Providers	Ministry of Population and Health and its line agencies
2		EC	Monthly		
3		TDS	Quarterly		
4	Chemical	Residual Chlorine	Daily		
5		Ammonia, Chloride, Nitrate, Total Hardness, Calcium	Monthly		
6		Iron, Manganese, Sulphate, Arsenic, Cadmium, Copper, Fluoride, Cyanide, Lead, Chromium, Zinc, Mercury, Aluminum	Yearly		
7	Microbiological	*E. coli*, Total coliform	Monthly		

(Source: Nepal. Ministry of health and population, National Drinking Water Quality Standard 2005)

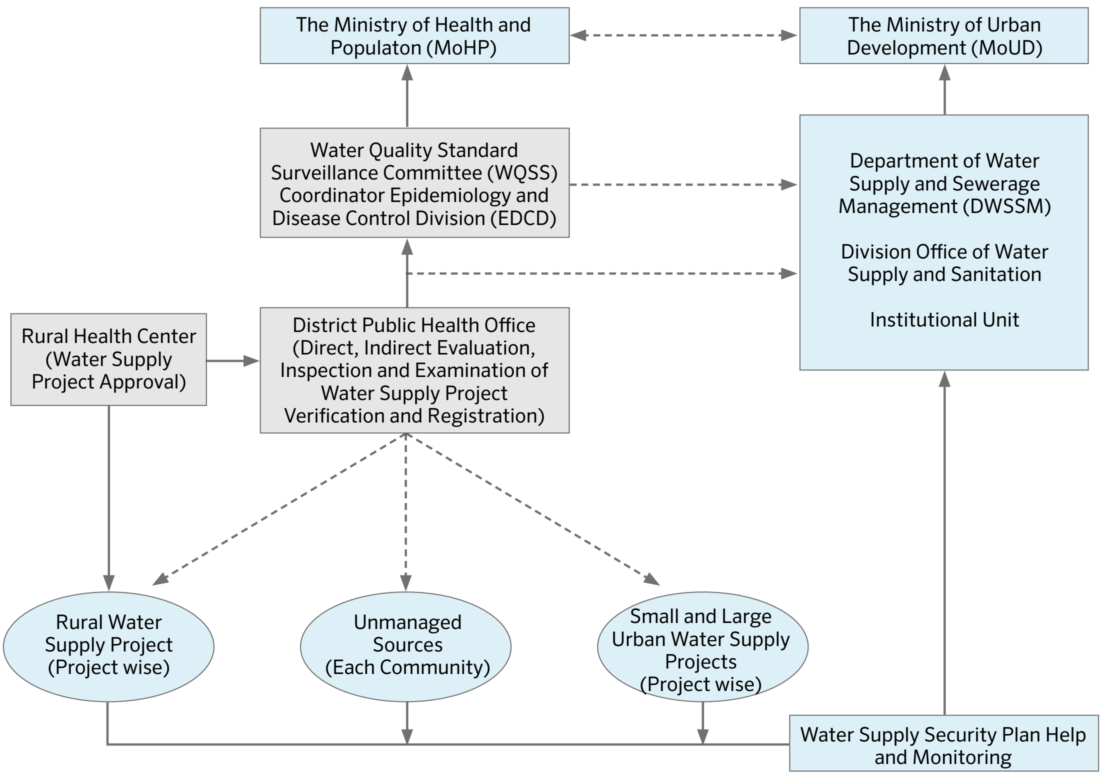


Figure 2.9.3 Institutional framework for national drinking water quality surveillance

(Source: Nepal. Department of Health Services, Water quality surveillance guidelines 2018)

(4) Effluent standards

a. Effluent standards

Effluent standards for different pollution sources are also set up under the 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 (tanning, wool processing, fermentation, vegetable ghee and oil, paper and pulp, dairy products, sugar milling, cotton textiles, non-alcoholic beverages, pharmaceuticals, soap, paints, etc.)
- Tolerance limits for industrial effluent discharged into public sewers
- Tolerance limits for wastewater discharged into inland surface waters from combined wastewater treatment plants

b. Effluent inspection procedure

Inspection mechanisms and procedures are guided by the water quality monitoring framework, guidelines and responsibilities under relevant line ministries or departments dealing with drinking water, industry, and agro-farms.

c. Measures against non-compliance

Penalties are imposed for non-compliance, although enforcement is sporadic due to gaps in monitoring capacity of the concerned agencies. Instances of enforcement have taken place, such as the MOFE decision in 2019 requesting penalties for non-complying medical institutes.

6 | Recent Developments in Water Environmental Management

The government has substantially strengthened environment-related legislations, acts, policies, and guidelines related to the water environment. Under its federal structure, the government is also revising or drafting acts and legislations and establishing new institutional structures at federal, provincial, and local levels. The establishment of Ministry of Water Supply reflects the government's national and international commitments and increasing prioritization of the water, sanitation and hygiene (WASH) sector together with relevant goals and targets, especially the Sustainable Development Goal on water and sanitation. Nepal has set its national indicators for WASH-related targets, such as ensuring access to piped water supply and improved sanitation by 2030 for 95% of the population.

7 | Challenges and Future Plans

A major challenge for water environment governance in Nepal is the actual implementation of acts, policies, and guidelines to ensure effective monitoring and enforcement at federal, provincial, and local levels. Coordination among line institutes such as water resources (MOEWRI), water supply (MWS), and environment (MOFE) at different levels is a big challenge due to overlapping mandates, resource constraints, multiple sector priorities, and the lack of technical expertise or capacity. Although the federal structure grants autonomy regarding power and decision making down to local levels, institutional establishment, allocation of trained staffs, and establishment of monitoring and assessment facilities are still in their infancy.

Nepal is aiming to rapidly develop and transition from Least Developed to Developed status such as through investments in industrialization, construction, tourism, and modernization of agriculture. For instance, rivers in Nepal are under pressure from mining industries (formal and informal), contributing to high levels of sedimentation due to high demand for construction materials. It is thus evident that the water environment will come under greater pressures going forward, meaning the level of water governance capacity of the concerned agencies as well as stakeholders needs to be substantially improved.

2.10 Philippines

1 | Country Information

Table 2.10.1 Basic indicators

Land area (km²)		300,000 (2024)
Total population		109.035 million (2020)*
GDP (current USD)		425 billion (2023)**
Per capita GDP (current USD)		3,905 (2023)**
Average annual rainfall (mm/year)		2,870 (2021)***
Total renewable water resources (km³)		479 (2017)****
Total annual freshwater withdrawals (billion m³)		91.0 (2022)****
Annual freshwater withdrawal by sector	Agriculture	76.2% (2021)*****
	Industry	13.4% (2022)*****
	Municipal (including domestic)	10.4% (2022)*****

*2020 Census of Population and Housing (2020 CPH), **World Bank (2023), ***PAGASA Weather Bureau, May 31, 2024 Report,****WORLDOMETER, 2024, ***** Philippine Statistics Authority (PSA), 2022

Figure 2.10.1 Marikina River at the Ortigas Bridge, Pasig city, Metro Manila

2 | State of Water Resources

The Philippines is an archipelagic country with a tropical and monsoon climate endowed with coastal bays, rivers, lakes, and groundwater. It has abundant water resources with water availability of 5,302 m³/year/capita, which varies according to topography and season. River basins are classified according to size by the National Water Resources Board (NWRB). Around 421 river basins have catchment areas of over 40 km². There are 18 with areas of over 1,400 km² (typologically classified as major river basins), which in occupy over a third (108,923 km²) of the total land area, as shown in Table 2.10.2. Owing to their significance for industry, agriculture and domestic uses and ecological stability, the government considers the protection and conservation of these rivers a high priority for overall socio-economic development and sustainability.

Table 2.10.2 Major river basins in the Philippines

Name of river basin	Catchment area (km²)	River length (km)
Cagayan	25,649	505
Mindanao	23,169	373
Agusan	10,921	350
Pampanga	9,759	260
Agno	5,952	206
Abra	5,125	178
Pasig-Laguna de Bay	4,678	78
Bicol	3,771	136
Abulug	3,372	175
Tagum-Libuganon	3,064	89
Ilog-Hilabangan	1,945	124
Panay	1,843	132
Agus	1,890	36
Tagoloan	1,704	106
Davao	1,623	150
Cagayan de Oro	1,521	90
Jalaur	1,503	123
Buayan-Malungon	1,434	60
Total	108,923	

(Source: National Water Resources Council, 1976, as cited in Integrated River Basin Management and Development Master Plan, 2006)

According to a report from the Bureau of Fisheries and Aquatic Resources (BFAR) of the Department of Agriculture (DA), there are 79 natural lakes in the Philippines, which are utilized for fish production. Ten of the lakes are considered as major hosts for aquaculture production, including Laguna Lake (Laguna de Bay), the largest inland freshwater body in the Philippines. Since there are numerous islands, the marine waters cover an area of about 266,000 km², with a coastline length of 36,289 km. Around 70% of municipalities are located in coastal areas. Surface water is the main water source for the country. Another important source of water for domestic supply, irrigation, and industrial uses is in the form of an extensive groundwater reservoir.

3 | State of Ambient Water Quality

The rapid increases in population, urbanization, and industrial development have led to water quality degradation and deterioration. Figure 2.10.2 shows the four key sources of water pollution. Water classification (or reclassification) based on the water quality criteria serves as the benchmark for maintaining or improving the state of water quality management in the Philippines. In 2019, the Environmental Management Bureau (EMB) completed its classification of 898 water bodies based on their use (such as public water supply, agricultural, aquacultural, commercial, industrial, navigational, recreational, wildlife conservation and aesthetic purposes) and water quality to be maintained (EMB 2019).

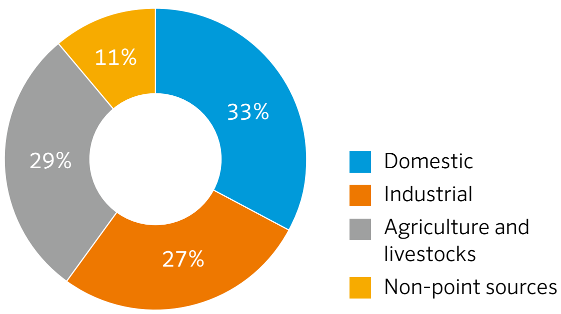


Figure 2.10.2 Major sources of water pollution in the Philippines based on BOD loading

(Source: National Water Quality Status Report, Environmental Management Bureau, 2019)

(1) Rivers

Monitoring takes place for 321 classified principal rivers with drainage areas of 40 km^2 or more, accounting for 76% of the country's 421 principal rivers identified by NWRB (EMB 2019). The objective of monitoring principal rivers is to improve their water quality and comply with the DENR Administrative Order No. 2016-08 (Water Quality Guidelines and General Effluent Standards of 2016). Of the 421 Principal Rivers, 180 were found to be polluted, mainly due to domestic (fecal coliform), industrial and agricultural wastes. Monthly water quality monitoring conducted in 46 Priority Rivers (rivers that are heavily polluted and subject to regular monitoring to track significant signs of improvement in compliance with DAO 2016-08 criteria using the monitoring results) during 2019, found that 34 were within the BOD criteria and 37 were within the DO criteria. An additional 180 rivers were monitored for DO, of which 82% were within the water quality guideline value.

To address the issue of floating garbage observed in various waterways and creeks, the country promoted the *Adopt-an-estero* (adopt a waterbody) program, which is a collaborative effort involving the Estero community, donor-partners, local government units (LGUs), other governmental agencies and DENR aimed at engaging both public and private entities to foster responsive and empowered communities.

The primary goal of the program is to remove waste, debris, and silt in *esteros* (waterbodies) and restore them to a pristine state. It also seeks to mobilize estero communities to actively participate in cleaning activities and develop plans to maintain a clean environment in the future. Measures undertaken include increased frequency of dredging and de-clogging, improved waste collection efficiency, expedited flooding abatement, implementation of complementary local policies and programs and employment opportunities for communities in proximity to adopted waterbodies.

Following extensive cleanup efforts of individuals from partner adopters, LGUs and communities connected with the adopted waterbodies, 2,065.3 tons of mixed solid waste were removed. Monitoring results from the program indicated significant improvements in biological oxygen demand (BOD) levels. Additionally, 351 rivers exhibited improved dissolved oxygen (DO) levels in terms of polluted esteros.

(2) Lakes and reservoirs

Deterioration of water quality is one of the core management issues regarding Laguna Lake (Laguna de Bay). Pollution of the lake derives from domestic (77%), agriculture (11%), industry (11%) and forestry (1%) sources. Table 2.10.3 summarizes the water quality from lakes and of tributaries feeding into the lake (Laguna de Bay). While there have been improvements in the water quality of the lake for several parameters, that of the tributaries is of Class D or Failed status.

Table 2.10.3 Observed water quality in Laguna Lake (Laguna de Bay) and its tributaries in 2018

Parameter		Class A	Class B	Class C	Class D	Fail
DO	mg/L	>5	>5	>5	2–5	<2
	% of monitoring points		100% (43%)		(19%)	(38%)
BOD	mg/L	<3	3–5	5–7	7–15	>15
	% of monitoring points	100% (24%)	(19%)	(11%)	(3%)	(43%)
Nitrate	mg/L	≤7	≤7	≤7	7–15	>15
	% of monitoring points		100% (100%)			
Phosphate	mg/L	≤0.5	≤0.5	≤0.5	0.5–5	>5
	% of monitoring points		100% (47%)		(50%)	(3%)
Fecal coliform	MPN/100 mL	<1.1	1.1–100	100–200	200–400	>400
	% of monitoring points	(N/A)	100% (N/A)	(N/A)	(N/A)	(N/A)

Note: There were nine monitoring points in the lake and 35 along the tributaries; Figures in parentheses refer to tributaries

(Source: Laguna Lake Development Authority 2018)

(3) Coastal water

In 2019, the EMB monitored 39 priority recreational waters (bathing beaches) for fecal coliform and found that 64% of beaches were within the water quality guideline value. Similarly, pH was monitored in 33 recreational waters, 97% of which had values within the criteria. In addition to priority bathing beaches, 174 bathing beaches were monitored for fecal coliform and 157 for pH, 97 of which passed the water quality criteria for Class SB waters* for fecal coliform, and 151 passed the water quality standard for pH. Table 2.10.4 shows the state of water quality for Manila Bay bathing beaches.

Table 2.10.4 Average dissolved oxygen (DO), phosphate (PO_4^{3-}), and nitrate (NO_3^-) in Manila Bay beaches (national capital region), 2018

Manila Bay bathing beaches monitoring station	DO	Phosphate (PO_4^{3-})	Nitrate (NO_3-N)
Navotas	2.59	0.2	0.33
Luneta	3.9	0.16	0.38
Cultural Center of the Philippines (CCP)	2.8	0.33	0.36
Mall of Asia (MOA)	0.9	0.51	0.33
PEATC	4.9	0.25	0.33
Water Quality Guidelines Class "SB" DAO 2016-08	6	0.5	10

(Source: EMB 2019)

(4) Groundwater

The status of groundwater quality is assessed through the Philippine National Standard for Drinking Water, under the Tap Watch Program of the EMB, which monitors 88 shallow wells in the country. The program revealed that nearly 58% of groundwater samples in selected sampling sites were contaminated with coliform, thus treatment is required. The increased level of salinity in groundwater is another concern, especially near coastal areas of major cities such as Metro Manila and Metro Cebu, the cause of which is assumed to be over-abstraction of groundwater.

4 | State of Wastewater Treatment

(1) Domestic wastewater

Only 10% of domestic wastewater is treated, and only 5% of the total population is connected to a sewer network. Those not connected rely on septic tanks, pit latrines, or practice open defecation, while the vast majority use flush toilets connected to septic tanks. In Metro Manila, 57 sewage treatment plants (STPs) and four septage treatment plants (SpTPs) serve over a million residents (around 20%) of the population. An average of 9.4 million kg of BOD is removed every year over the most recent four-year period. The highest pollution load reduction was attained in 2012, with 9.5 million kg of BOD removed. There are ongoing and planned wastewater treatment projects to treat domestic wastewater in major cities or under certain housing schemes (Maynilad & Manila Water Company, 2023).

*Class SB: Suitable for 1.Fishery Water Class II—Waters suitable for commercial propagation of shellfish and intended as spawning areas for milkfish (*Chanos chanos*) and similar species, 2.Tourist Zones—For ecotourism and recreational activities, and 3.Recreational Water Class I—Intended for primary contact recreation (bathing, swimming, skin diving, etc.)

(2) Industrial wastewater

As of October 2017, there were 379 operating special economic zones in the Philippines; 261 information technology parks, 74 manufacturing economic zones, 22 agro-industrial economic zones, 20 tourism economic zones and two medical tourism centers. Four zones are owned by the Philippine Economic Zone Authority (PEZA) while the remaining are privately owned. The majority of manufacturing industries in the Philippines are located in the National Capital Region (Metro Manila) (30%), Region 4A, Calabarzon (17%), and Region 3, Central Luzon (11%). Industries that are known to generate large amounts of wastewater are food and dairy manufacturing, pulp and paper, and textiles, though very little related data exists. Volumes generated by each industry depend mainly on the level of technical processing and production rates, as shown in Table 2.10.5.

Table 2.10.5 Estimated wastewater generation rates of selected industry types in the Philippines

Industry	Wastewater volume from industrial use ('process wastewater') (m^3/day)
Poultry processing plant	1,750
Meat and meat products	75–380
Mining	67,500
Pharmaceuticals manufacturing	50–200
Milk manufacturing	960
Ethanol manufacturing	3,100
Sugarcane milling	100,000
Beverage manufacturing	13,000
Packaging	60
Food processing	500
Pineapple processing	6,540

(Source: ARCOWA 2018)

Industrial wastewater generally contains high BOD loads and other kinds of pollutants, depending on the type of manufacturing process. Table 2.10.6 shows the indicative wastewater quality of selected industry types.

Individual companies are obligated to manage their wastewater either as stand-alone entities or as part of an industrial park. Ideally, process wastewater and other types of non-domestic wastewater are pre-treated by industrial entities before being discharged into sewerage systems of industrial parks. Many industrial parks operate their own; however, these must also comply with pre-treatment effluent standards established by the industrial park before being discharged into the centralized wastewater treatment facility (CWTF) of the park. The CWTF within the industrial park is obligated to further treat the effluent before discharging it into bodies of water, or, reuse it for landscaping, irrigation or other purposes. Recent regulations on nutrients have been cited as a challenge for CWTF operators in terms of compliance, as existing treatment systems in use are not designed to remove nutrients such as nitrates and phosphates to the levels required.

For industries not located within industrial parks, effluent must comply with the Philippine Effluent Standards, DAO 2016-08. However, some industries find managing wastewater challenging as they have to develop their own expertise to comply with effluent standards set either by the special economic zone or with general effluent standards.

Individual companies generally collect and report their wastewater volume data as required by the regulations, though there is no national database collating all these data. Individual industrial facilities outside of special economic zones need to acquire wastewater discharge permits and are responsible for the quality of their discharge to surface waters. From the monitoring conducted by the EMB, rivers of the regions had "unsatisfactory ratings" for their water quality criteria. In areas of regulation, in the Manila Bay Area alone, 5,228 out of 10,168 industries were served with notices of violation (NOV) for failure to acquire permits to discharge treated wastewater.

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. The concept behind this was to incentivize polluters to reduce their pollution loads, such as through improved production processes and investments in pollution control technologies. DENR also issues discharge permits for wastewater, which include the allowable values of both quantity and quality of effluents, compliance schedule and monitoring requirements.

Table 2.10.6 Indicative wastewater quality of selected industry types in the Philippines

Industry	BOD (mg/L)	COD (mg/L)	TSS (mg/L)	Temp (°C)	pH
Sugarcane milling	2,000–3,500	6,000	800–1,000	-	6.5–8.0
Manufacture of ethanol	60,000	110,000	6,000	48–50	4–4.5
Canning of fish products	30,000	45,000	10,700	25	6.5–7.5
Manufacture of beverages	900	1,500	250	25	11–12
Meat processing	1,000–1,500	2,000	250	-	7
Copper cathode	-	-	43	30.4	8.15
Swine farm	2,000–4,200	4,000–5,429	1,600–5,380	-	-
Bottling services	400	1,647.05	90	32.2	8.35
Manufacturing of desiccated coconut	6,000–10,000	17,000–20,000	2,000–4,000	-	5.0–6.3
Pineapple processing plant	10,200	20,000	585	40–50	4.5–6.5

(Source: ARCOWA 2018)

5 | Frameworks for Water Environmental Management

(1) Legislation

The Philippines has an extensive body of water-related legislation that provides the legal basis for policies and regulations concerning water resource management. The Philippine Clean Water Act of 2004 (Republic Act No. 9275 (RA 9275)) provides a comprehensive and Integrated strategy to prevent and minimize pollution through a multi-sectoral and participatory approach involving all stakeholders. The Act aims to protect the country's water bodies from pollution from land-based sources (industries and commercial establishments, agriculture, and community/household activities). The Act applies to water quality management in all water bodies, abatement and control of pollution from land-based sources, and enforcement of water quality standards, regulations and penalties.

Under Section 5 of the above Act, the Department of Environment and Natural Resources (DENR) in coordination with the National Water Resources Board (NWRB) designate Water Quality Management Areas (WQMA) using appropriate physiographic units such as watersheds, river basins or water resource regions. As such, WQMA have similar hydrological, hydrogeological, meteorological or geographic conditions which affect the physiochemical, biological and bacteriological reactions and diffusion of pollutants in the water bodies, or otherwise share common interests or follow similar development programs or have similar prospects or problems. Governing boards, composed of relevant stakeholders in each WQMA and chaired by DENR regional offices, are responsible for the development of strategies to coordinate policies, regulations/local legislation, and other measures necessary to effectively implement the Clean Water Act.

The Water Quality Guidelines and General Effluent Standards of 2016 (DAO 2016–08) provide guidelines for the classification of water bodies in the country, determination of time trends and the evaluation of stages of deterioration/enhancement in water quality, and evaluation of the need for taking action in preventing, controlling, or abating water pollution.

Other legislations related to water environmental conservation are the Philippines Environmental Policy (PD 1151) and the Solid Waste Management Act (RA 9003). EMB is the governmental agency responsible for water conservation and protection.

(2) Institutional arrangement

The lead agency for water resource management is the Department of Environment and Natural Resources (DENR). Its mandates are to formulate, integrate, coordinate, supervise, and implement all policies, plans, programs, projects and activities related to the prevention and control of pollution as well as management and enhancement of the environment. The responsibility for planning and managing water resources in the Philippines is shared among several government departments, bureaus and agencies (see Table 2.10.7). In addition, local government units (LGUs) are required to provide water supply systems and communal irrigation facilities, and implement social forestry and local flood control projects under the supervision and control of DENR (SEPO 2011). Several institutions and agencies are involved in overseeing water governance at all levels.

(3) Ambient water quality standards

a. Ambient water quality standards

Water quality standards in the Philippines are stated in Water Quality Guidelines and General Effluent Standards (GES) of 2016 (DENR Administrative Order No. 2016–08 (DAO 2016–08), which is an amendment of DAO 1990–35. DAO 2016–08 has a provision for the water classification of water bodies for the purpose of maintaining the quality of water based on beneficial usage (see Table 2.10.8).

Table 2.10.7 Key institutions involved in water governance in the Philippines

Name of the agency	Mandates of the agency
Department of Environment and Natural Resources (DENR)	The primary government agency responsible for the conservation, management, development, and proper use of the country's environment and natural resources.
National Water Resources Board (NWRB)	To administer/enforce the Water code and serves as the lead coordinator for water resources management programs.
Environmental Management Bureau (EMB)	To formulate, integrate, coordinate, supervise, and implement all policies, plans, programs, projects, and activities relative to the prevention and control of pollution as well as management and enhancement of environment
Forest Management Bureau (FMB)	To formulate/implement policies and programs for the protection, development, occupancy management, and conservation of forest lands and watershed areas.
Department of Agriculture	–
National Irrigation Administration (NIA)	To undertake water resource projects for agricultural irrigation and other purposes, such as flood control and drainage.
Bureau of Soil and Water Management (BSWM)	To formulate/implement policies and programs for the protection of existing and potential sources of soil and water for agricultural development.
Bureau of Fisheries and Aquatic Resources (BFAR)	To establish plans for the proper protection and management of the country's fisheries and aquatics resources.
Department of Health (DOH)	Administers compliance of the country's National Standard for Drinking Water Program.
Department of Interior and Local Government (DILG)	Administer the implementation of the country's National Water Supply and Sanitation Program and mandated to oversee the attainment of the country's SDG goal on access to safe drinking water by all.
Water Supply and Sanitation Unit	To provide capacity building programs for Local; Government Units (LGUs) in preparing local water supply and sanitation plans as well as providing information on available sector programs, and facilitating access to financing for water supply and sanitation projects.
Department of Public Works and Highways (DPWH)	Primary agency for implementing the country's national Sewerage and Septage Management.
National Economic and Development Authority (NEDA)	To coordinate the preparation of national/regional/sectorial development policies and investment programs, including those on sanitation.
National Power Corporation (NPC)	To develop and manage electric generation facilities including (but not limited to) hydroelectric dams and undertakes other activities related to watershed management.
Metro Manila Development Authority (MMDA)	Administers governance of MM area development such as infrastructure development, law enforcement of environmental laws—solid waste management, Clean Water Act, Water Code of the Philippines, Clean Air Act, etc.
Metropolitan Waterworks and Sewerage System (MWSS)	To regulate water concessionaires' rates and services standards in Metro Manila and maintains existing assets and infrastructures.
Pasig River Rehabilitation Commission (PRRC)	Coordinate and integrate, and monitor the implementation of all Government Agencies plans, and programs for the rehabilitation of Pasig river.
Laguna Lake Development Authority (LLDA)	To formulate, regulate and implement all policies, plans, programs, projects and activities relative to the prevention and control of pollution as well as management and enhancement of environment in Laguna Lake Region.
Local Water Utilities Administration (LWUA)	To promote, finance, and regulate the operation and construction of local water utilities outside Metro Manila.
Local Government Units (LGUs)	Administer/management of rivers within the jurisdiction of the LGUs and implement Ecological Solid Waste Management Act within its area of political and jurisdictional responsibility.

Table 2.10.8 Classification of water bodies according to intended beneficial use

Classification	Intended beneficial use
Class AA	Public Water Supply Class I—Intended primarily for waters having watersheds, which are uninhabited and otherwise protected, and which require only approved disinfection to meet the Philippine National Standards for Drinking Water (PNSDW)
Class A	Public Water Supply Class II—For sources of water supply requiring conventional treatment (coagulation, sedimentation, filtration and disinfection) to meet the latest PNSDW
Class B	Recreational Water Class I—intended for primary contact recreation (bathing, swimming, skin diving, etc.)
Class C	Fishery Water for the propagation and growth of fish and other aquatic resources. Recreational Water Class II (Boating, fishing or similar activities), and for agriculture, irrigation, and livestock watering
Class D	Navigation water

The water quality guidelines (WQG) are to be maintained for each water body classification, the parameters of which are categorized as primary or secondary. Primary parameters are the required minimum water quality parameters to be monitored for each water body. Secondary parameters are those used in baseline assessments as part of an environmental impact assessment or other water quality monitoring purposes.

b. Water quality monitoring framework

The EMB Regional Offices oversee a vast geographical area with diverse water sources, including rivers, lakes, and marine waters. This broad coverage enables monitoring of water quality in both urban and rural areas, addressing the needs of diverse communities and environments. As of 2024, a total of 2,406 ambient stations were monitored based on the parameters indicated in DAO 2016–08, which are broken down into the following: WQMA: 638; Adopt an estero: 298; Primary/Other freshwater bodies: 913; Recreational: 587 (EMB, 2024).

(4) Effluent standards

a. Effluent standards

DAO 2016–08 states that discharges from any point source shall at all times meet the effluent standards, and Section 7 of the same states that discharges from any point sources shall at all times meet the effluent standards set forth to maintain the required water quality per water body classification. The GES is to be used regardless of the industry category and volume of discharge. Effluent used for agricultural purposes shall conform to DAO 2007–26 and shall at all times meet the effluent standards.

b. Effluent inspection procedure

Monitoring of industries is conducted at different levels (Table 2.10.9), and can only be carried out by the subjects needing to comply with effluent standards themselves, in principle. The documents to be submitted include monitoring reports (self-monitoring), plans, required permits (discharge permits) or other proof of compliance or implementation. Field monitoring for verification involves actual plant inspection, effluent sampling and validation of submitted reports.

Table 2.10.9 Monitoring of industries

Level	Responsible person/office	Report requirement
Project proponent/ company	Pollution control officer	Self-monitoring report (SMR) and/ or Compliance monitoring report (CMR)
Multi-partite monitoring (MMT) or third-party monitoring	Team headed by the company composed of various stakeholders (LGU, non-government organizations (NGOs) and other sectors)	Audit report/CMR
Regulating body	EMB central office/ EMB-regional offices	Compliance evaluation report

c. Measures against non-compliance

The Clean Water Act requires owners or operators of facilities that discharge regulated effluents to obtain a discharge permit, which is a legal authorization granted by the DENR to discharge wastewater. The permit specifies items such as quantity and quality of effluent, compliance schedule and monitoring requirements, and can be suspended or revoked if business entities fall out of compliance with the rules and regulations and/or permit conditions.

Numerous industries and commercial establishments are still unable to comply with the effluent standards despite the availability of technology to treat wastewater. As shown in Table 2.10.10, about 54%, or 4,930 of the 9,060 monitored firms nationwide were found to have violated effluent standards in 2019. There are still micro-, small and medium-sized enterprises which do not invest in facilities to treat their wastewater prior to discharge to water bodies, resulting in the degradation of rivers, lakes and marine waters.

Table 2.10.10 Percentage of compliance of firms in 2018 and 2019

Details	2018	2019
Discharge permits issued	6,010	5,929
Monitored firms	9,554	9,060
Notices of violation issued	4,959	4,930
Compliance (percentage)	48%	46%

(Source: Environmental Management Bureau 2019)

Parties who violate the GES are referred to the Pollution Adjudication Board (PAB) for issuance of a Cease and Desist Order (CDO). Upon recommendation of the PAB, any entity that commits any of the prohibited acts or violates any of the provisions of this Act and its Implementing Rules and Regulations (IRR) may be fined not less than 10,000 PHP and not more than 200,000 PHP for every day of violation. Failure to undertake cleanup operations, willfully or through gross negligence, can lead to imprisonment of not less than two and not more than four years, in addition to a fine of not less than 50,000 PHP and not more than 100,000 PHP per day of violation. In cases where such failure or refusal to clean up results in serious injury or loss of life or irreversible water contamination, imprisonment of not less than six years (and not more than 12 years) and a fine of 500,000 PHP per day for each violation is applied.

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

6 | Recent Developments in Water Environmental Management

One noteworthy development is DAO 2019–15, which designates the Boracay Island Water Quality Management and Conservation Area (WQMACA) as well as creation of its Governing Board, the objectives of which are to protect and continuously improve water quality and sustain livelihood opportunities on the island. Under a cleanup initiative for Boracay beach areas, several notices of violation (NOVs) and cease and desist orders (CDOs) have been issued to various commercial establishments in Boracay Beach areas (prime tourist destination), Province of Aklan, regarding violations of the Clean Water Act. Various establishments were also demolished, due to violations of the easement rule under the Philippines' water code.

Another is DAO 2018–12, which has designated two water quality management areas and their governing boards, for the upper and lower Amburayan River system (UARS/LARS). This DAO aims to ensure the water quality of the UARS and its tributaries to make it a sustainable resource for the people of the municipalities of Atok, Bakun, Buguias, Kapangan, Kibungan and Tublay and their communities. In LARS, improvement in water quality is expected to contribute to enhancement as a source of water irrigation and other agricultural uses in the provinces of La Union and Ilocos Sur.

Regarding Manila Bay, an ongoing large-scale ground inspection/rehabilitation is underway, involving issuance of NOVs and CDOs to violating commercial establishments and hotels for failure to establish STPs or wastewater treatment plants. Part of the clean-up activities of the bay area and its tributaries undertaken by the DENR-NCR MBSCMO under KRA 2 include the installation of trash traps at Baseco Lagoon, fabrication of two trash collector rafts of 552 kg-load capacity, inspection of rivers and esteros, coordination meetings with concerned stakeholders, and launching of the Manila Bay Watch Bike Patrollers. Over 1.2 million kg of solid wastes had been collected and removed from Manila Bay area and its tributaries as of the time of this report.

Clean-up drives are also being implemented in other major beach areas of prime tourist destinations in the MIMAROPA region, namely Coron, El Nido and San Vicente, in Palawan; Puerto Galera in Oriental Mindoro; San Jose in Occidental Mindoro; and Panglao, Bohol and Siargao, and Agusan Del Norte. NOVs and CDOs have been issued to various commercial establishments in violation of the Clean Water Act, and various establishments were demolished in violation of the easement rule under the Philippines' water code.

7 | Challenges and Future Plans

With the foundation for sustainable water quality management already laid out, the main challenge now lies in the continuation of existing water quality management policies and programs to rehabilitate and preserve the quality of the country's water bodies, and ultimately, achieve and sustain quality of life for future generations. Weak water use regulations and fragmentation in the water agencies cause coordination issues and weak enforcement. Other challenges include maintaining water quality against drivers and stressors, such as high water demand and limited supply, indiscriminate land use and development, increasing volumes of solid wastes, pollutants, and hazardous wastes, and inadequate treatment facilities. Science-based data and information is needed for efficient and effective planning and decision making to improve water quality governance. For that, it is important to increase access to the new knowledge and technologies generated from international R&D standards.

The major responses planned or undertaken to overcome the challenges include:

- Meetings with concerned agencies to tackle issues and concerns as well as take appropriate action
- Review, reorganize, re-evaluate, and update legal and institutional frameworks for effective and proper handling of water management
- Study and implementation of participatory water governance model
- Improve planning and decision-making processes
- Create a cost-effective long-term plan/framework to help address issues in water management, especially in reducing long-term costs, potential increases in waste, and implications resulting from the lack of available clean water
- Conduct trainings and seminars to inform, educate and properly disseminate information regarding water management and water environment governance
- Conduct workshops on various technologies used in water resources management

2.11 Sri Lanka

1 | Country Information

Table 2.11.1 Basic indicators

Land area (km²)		65, 610 (2023)
Total population		22.3 million (2023)
GDP (current USD)		84 billion (2023)
Per capita GDP (current USD)		3,830 (2023)
Average annual rainfall (mm/year)		2,000 (2023)
Total renewable water resources (km³)		52.8 (2020)
Total annual freshwater withdrawals (billion m³)		13 (2005)
Annual freshwater withdrawal by sector	Agriculture	87.3% (2005)
	Industry	6.4% (2005)
	Municipal (including domestic)	6.2% (2005)

(Source: Central Bank report 2023)

Figure 2.11.1 Diyawanna Lake, Sri Jayewardenepura Kotte, Colombo, Sri Lanka

A popular urban water body, Diyawanna Lake is used for various domestic, industrial & recreational activities. However, studies have revealed that it is deteriorating due to discharges from domestic and industrial sources. To protect the water body and the beneficial uses of the general public, more stringent wastewater discharge standards were imposed under regulation No. 2264/17 of 27.01.2022.

2 | State of Water Resources

Sri Lanka is a tropical island country with an average annual rainfall of 900–5,000 mm (see Fig. 2.11.2), which provides 131,230 million m³ of freshwater annually. Zones in its southwest are the wettest, receiving over 2,000 mm/year, while northern (and some southeast) areas are considered dry zones with under 1,500 mm/year. There are 103 river basins; the largest river is the Mahaweli River, covering an area of 10,448 km² over its 335 km length (MENR and UNEP 2009). Rivers in the wet zones contribute over 50% of the runoff, despite covering only about one third of the land area. There are over 3,400 wetlands, which include ancient irrigation reservoirs, recently constructed multipurpose reservoirs, tanks and lakes.

Groundwater resources in the country are estimated at 7,253 million m³ and represent the main source of water, especially in rural areas, where around 72% of the rural population relies on them for domestic uses.

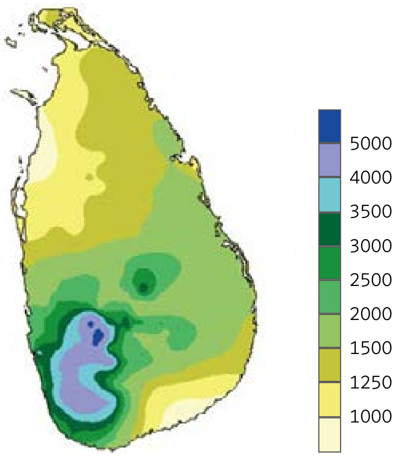


Figure 2.11.2 Annual precipitation distribution (in mm), Sri Lanka

3 | State of Ambient Water Quality

Pollution due to domestic and industrial wastewater as well as leachate from garbage continues to be a problem for surface water and groundwater resources in Sri Lanka. Central wastewater treatment facilities cover less than 5% of the population, and commonly comprise onsite septic tanks among urban dwellings. The heavy use of synthetic fertilizers on farms and the resultant runoff and leaching of nutrients is another cause of nutrient pollution in the surface and groundwater.

(1) Rivers

The water quality of main water courses is within the limits of the ambient water quality standard. However, untreated or insufficiently treated wastewater in urban areas is the main cause of river pollution. For instance, the Kelani River, the second largest river basin in Sri Lanka, is one of the most polluted due to the rapid growth of industry and high population density along the river.

Illegal dumping of solid wastes into waterways is also a serious concern. Expansion of sand mining activities also affects the river water quality, such as with increased turbidity, decreased water flow and accelerated saltwater intrusion. Table 2.11.2 shows the recent state of water quality for certain rivers.

Table 2.11.2 State of river water quality

River	Year	COD (mg/L)	BOD (mg/L)	NO_3^- (mg/L)	PO_4^{3-} (mg/L)
Kalani River	2022	6.95	2.5	2.4	0.02
	2023	14.1	2.2	0.9	0.026
Maa Oya	2022	1.5	3.7	1.2	0.023
	2023	1.5	5.1	1.2	0.015
Maragala Oya	2022	1.4	8.9	0.2	<0.1
Badulu Oya	2022	1.5	10	0.4	<0.1
	2023	1.78	10.085	0.5	<0.1
Menik River	2022	1.775	10.1	0.1	<0.1
	2023	10.75	1.95	0.1	<0.1
Nilwala River	2019	5.6	1	0.9	<0.012
Deduru Oya	2019	3.23	20.1	1.4	<0.013
	2020	26.06	2.95	9.9	<0.01
Attanagalu Oya	2019	16.83	3.71	<0.01	<0.01
Mahaweli River	2020	7.75	5	0.3	<0.01
Diyawanna Lake	2022	24.9	2.3	1.5	0.1
	2023	15.6	3.3	1.1	0.1
Malwathu Oya	2020	23.7	1.7	0.02	0.1

(Source: CEA 2023)

(2) Lakes and reservoirs

In general, the water quality of lakes and reservoirs is considered to be good. Table 2.11.3 summarizes the water quality status of selected reservoirs.

Table 2.11.3 Water quality of certain reservoirs

River	Year	BOD (mg/L)	COD (mg/L)	NO_3^- (mg/L)	PO_4^{3-} (mg/L)
Kurunagala Tank	2023	4.25	25.35	NA	<0.01
Wennaruwa Wewa	2023	2.76	18.98	NA	<0.01
Gregory Lake	2019	8.42	31	1.53	0.04
Nuwara Wewa	2019	2.53	28.27	NA	0.06
	2020	5.81	18.91	NA	0.03
Tissa Wewa	2019	3	35	NA	0.04
	2020	3.56	23.92	NA	0.02

(Source: CEA 2023)

(3) Coastal water

Water pollution in coastal water bodies has grown over the past few decades due to rapid development activities and human settlement both in and outside coastal areas, the establishment of new industries, and hotels and tourism. Over 60% of industrial establishments are located along Sri Lanka's coastal zone, such as the coastal districts of Colombo and Gampaha.

Aquaculture farms located in coastal areas have caused a considerable impact on mangrove ecosystems and the coastal water quality, where most of the coastal water bodies are deteriorating. At present, Sri Lanka has no established ambient water quality standards for coastal waters, which thus needs to be addressed urgently.

(4) Groundwater

A common groundwater quality problem in the country is microbial contamination and nutrients (such as nitrate) caused by leachate from on-site sanitation systems such as pit latrines (see Table 2.11.4). Excessive fertilizer use and untreated wastewater are other factors responsible for the high nitrate levels of the groundwater. In coastal areas, salinity is a prominent issue and is caused by a combination of factors such as excessive groundwater use and sea encroachment.

Table 2.11.4 Variation in groundwater quality across different areas (2014–2018)*

Sampling area	TDS (mg/L)	*E coli* (CFU /100 mL)	COD (mg/L)	TSS (mg/L)	PO_4^{3-} (mg/L)	NO_3^- (mg/L)
Farmland	160-172	22–40	10–13	140-155	0.3–0.6	0.3–0.5
Solid waste dumping site	270-296	10–790	1,220	13–93	0.2–0.5	3.1–7.4
City	80–105	4–608	16–20	6–58	0.2–0.4	0.3–7.4

*Based on research by the University of Peradeniya and National Water Supply and Drainage Board

(Source: CEA 2019)

Industry is another source of groundwater contamination in Sri Lanka. A study conducted under the WEPA Action Program (2017) found high levels of COD, nitrate, and electrical conductivity (EC) in groundwater samples collected near some industries in the Gampaha district.

4 | State of Wastewater Treatment

(1) Domestic wastewater

National sewerage coverage is limited to less than 3%, while the rest of the country relies on on-site sanitation such as septic tanks, ventilated improved pit latrines (VIPs), and unimproved sources (pit latrines and unknown types). There are ongoing and planned wastewater treatment projects to treat domestic wastewater in major cities or linked with certain housing schemes. Tables 2.11.5 and 2.11.6 show the state of existing wastewater treatment facilities.

Table 2.11.5 Existing wastewater treatment facilities in major cities

Scheme	Treatment capacity (m^3/day)	Beneficiaries
Colombo City	379,470	345,000
Dehiwala Mt. Lavinia	32,660	30,000
Kolonnawa	19,870	12,850
Moratuwa/Ratmalana	17,000	12,760
Ja Ela/Ekala	7,250	10,575
Kurunagala	4,500	9,275
Kandy	14,000	13,080
Kataragama sacred city	3,000	2,500
Hikkaduwa	970	527
Raddolugama housing scheme	3,000	9,450
Jayawadanagama housing scheme	1,000	5,454
Mattegoda housing scheme	1,000	5,360
Hantana housing scheme	360	421

(Source: Sanitation master plan 2021–2023)

Table 2.11.6 Wastewater treatment in major housing schemes

Scheme	Treatment capacity (m^3/day)	Beneficiaries
Mattegoda	600	4,850
Jayawadanagama	NA	2,810
Maddumagewatta	NA	1,320
Raddolugama	6,000	8,590
Kuruminiyawatta	NA	850
Royal Park	NA	1,045
Hantana	550	1,650

(Source: Sanitation master plan 2021–2023)

(2) Industrial wastewater

In Sri Lanka, industries are categorized into four groups, A, B, C and D as per the gazette notification No. 2264/18 of 27.01.2022 published under National Environment Act No. 47 of 1980. The Central Environmental Authority issues Environmental Protection Licenses (EPL) based on this categorization for Types A, B, and C industries (high and medium polluting), while local authorities issue EPL for Type D (low polluting) industries (see Table 2.11.7).

Table 2.11.7 Numbers of environmental protection licenses issued by industry category, 2023

Category	A	B	C	D
No. of Industries	1,044	15,556	12,267	23,439

(Source: CEA database 2024)

Most industrial zones have their own wastewater treatment systems for treating wastewater from factories operating within their boundaries. There is little or no data on the state of wastewater generation and treatment from small and medium-sized industries. Table 2.11.8 shows the state of wastewater treatment in several export processing zones.

Table 2.11.8 Wastewater treatment in certain export processing zones

Export processing zone	Treatment capacity (m^3/day)
Biyagama	21,000
Seetawaka	9,900
Koggala	1,000
Katunayaka	7,500
Mirigama	400
Wathupitiwala	600
Polgahawela	450
Mawathagama	500
Horana	1,000
Malwatta	450

(Source: Sanitation Master plan 2021–2030)

According to the National Water Supply and Drainage Board Law, No. 02 of 1974, different tariff structures apply for domestic and industrial sewer services based on total amounts of water consumption from all water supply sources for each billing month. The domestic sewer service provided for commercial purpose charges a flat rate of 40 LKR per cubic meter, while for residential purpose the tariff rate varies according to water consumption. For residential purpose, an additional service charge of 200 LKR also applies. For industrial purpose, a flat rate of 65 LKR per cubic meter applies.

5 | Frameworks for Water Environmental 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 such as rivers, streams and lakes are controlled by the government under the Crown Lands Ordinance and the Constitution.

The National Environment Action Plan 2021–2030 (NEAP) is a comprehensive action plan which is being executed to achieve the sustainable development goals. The plan identifies nine thematic areas, focusing on air quality management, biodiversity conservation and sustainable use, climate actions for sustainability, conservation and sustainable use of coastal and marine resources, sustainable land resources management, holistic waste management, integrated water resources management, environmental management in cities and human settlements and greening industries.

NEAP provides a holistic approach in environment management through its special focus on the water environment, which is a cross-cutting sector affecting almost all the identified thematic areas.

(1) Legislation

The National Environmental Act (NEA) No. 47 of 1980 (amended as Act No. 53 of 2000) is the only umbrella law aiming "for the protection, management and enhancement of the environment, for the regulation, maintenance and control of the quality of the environment; for the prevention, abatement and control of pollution". According to the act, discharges, deposits or emissions of waste into the environment cannot be carried out without a license and must comply with the standards and criteria prescribed. Other acts and ordinances related to water environmental management are illustrated in Fig. 2.11.3.

Environmental Conservation (Overall)

- Constitution of the Democratic Socialist Republic of Sri Lanka
- National Environment Act No.47 of 1980 as amended by No. 56 of 1988 and No. 53 of 2000
  - Effluents discharge standards Gazette No. 1534/18 and the prescribed activities for which a license is required in Gazette No. 1533/16
  - Prescribed projects in Gazette No. 772/22 which apply the EIA process
  - EPA—Environment Protection Areas declared under the sections 24C and 24D of the National Environmental Act No. 47 of 1980
- Local Authorities Act (for municipal and urban councils and Pradeshiya Sabah)

Management of specific areas

- Mahaweli Authority Act No. 23 of 1979
- North Western Provincial Environmental Statute No. 12 of 1990

Marine and coast water quality

- Marine Pollution Prevention Act of No. 35 of 2008
- Coast Conservation Act No.57 of 1984 as amended by Act No. 64 of 1988

Water resource development/management

- Irrigation Ordinance Chapter 453
- National Water Supply & Drainage Board Act No.2 of 1974
- Water Resources Board Act No. 29 of 1964

Other acts related to water environmental management

- Urban Development Authority Act No. 41 of 1978 as amended from time to time
- Greater Colombo Economic Commission Law No. 4 of 1978 as amended by Act No. 49 of 1992

Figure 2.11.3 Laws and regulations related to water environmental management

(Source: created based on information from CEA)

(2) Institutional arrangement

Different governmental agencies control different areas of water environment management in Sri Lanka, as summarized in Table 2.11.9. The Ministry of Environment, established in 2001, is the national authority for formulating policies and guidelines for conservation of the environment and natural resources. Under the ministry, the CEA is responsible for implementation of policies and regulations pertaining to environmental pollution control and management. The CEA was established in 1981 as the authority with regulatory powers to control, manage and enhance the environment.

The Marine Environment Protection Authority (MEPA) has regulatory power over the prevention of marine pollution. Other governmental organizations that are related to construction, engineering services, housing and common amenities, such as the Condominium Management Authority, National Housing Development Authority, and the Board of Investment (BOI) of Sri Lanka are indirectly related to the water environment as their activities significantly affect the condition of water quality. Local governments also play an important role in water environmental management through the regulation of low-impact industries and activities prescribed by orders issued under the NEA. Public health inspectors at the local level control on-site sanitation systems such as pit latrines and septic tanks.

Table 2.11.9 Key agencies involved in management of the water environment

Name of the agency	Mandates of the agency
Ministry of Environment (MOE)	Overall management of the environment and natural resources of the country. Formulating key policies, strategies, and guidelines for environmental management.
Central Environmental Authority (CEA)	Overall responsibility for protecting the environment, including water environment.
Water Resource Board	Scientific characterization, mapping and preparation of comprehensive and integrated plans for the conservation, utilization, control and development of groundwater resources.
National Water Supply & Drainage	Operational development and installation of public and private water supply schemes based on groundwater and coordinated sewerage systems.
Department of Irrigation	Regulation and control of inland waters.
Mahaweli Authority	Maintenance and management of Mahaweli River and its reservoirs for development of lands for agriculture.
Coast Conservation & Coastal Resources Management Department	Conservation of the coastal zone and management of its resources.
Marine Environment Protection Authority	Protection of the marine environment from ship and maritime-related activities.

(Source: created based on information from CEA)

(3) Ambient water quality standards

a. Ambient water quality standards

Table 2.11.10 shows the ambient water quality standards (AWQS) under the National Environmental (AmbientWater Quality) Regulations, No. 01 of 2019. Accordingto this standard, no person shall discharge, deposit or emit any pollutant into inland surface waters exceeding AWQS. There are six categories under AWQS, classified by suitability for different uses/purposes:

i. Category A: water sources requiring simple treatment for drinking
ii. Category B: water sources suitable for bathing and contact recreation
iii. Category C: water sources suitable for aquatic life
iv. Category D: water sources that require general treatment processes for drinking
v. Category E: water sources suitable for irrigationand agricultural activities
vi. Category F: water sources of minimum quality outside of categories A to E

Table 2.11.10 Ambient water quality standards in Sri Lanka (2019)

Group	No	Parameter	Unit	Category A	Category B	Category C	Category D	Category E	Category F
General	1	Colour	Pt mg/L, max	20	-	-	100	-	-
General	2	Electrical Conductivity	μS/cm, max	-	-	-	-	700	-
General	3	Turbidty	NTU, max	5	-	-	-	-	-
General	4	TSS	mg/L, max	25	-	40	1,500	2,100	-
General	5	Total Hardness (as $CaCO_3$)	mg/L	250 des 600 max	-	-	-	-	-
General	6	pH	-	6.0–8.5	6.0–9.0	6.0–8.5	6.0–9.0	6.0–8.5	5.5–9.0
General	7	DO at 250°C	mg/L, minimum	6	5	5	4	3	3
General	8	BOD_5 at 20°C	mg/L, max	3	4	4	5	12	15
General	9	COD	mg/L, max	10	10	15	30	-	40
Nutrient	10	NO_3^-	mg/L, max	10	10	10	10	-	10
Nutrient	11	NH_3-N, pH<7.5	mg/L, max	-	-	0.94	-	-	9.1
Nutrient	11	NH_3-N, 7.5 ≤ pH < 8.5	mg/L, max	-	-	0.59	-	-	4.9
Nutrient	11	NH_3-N, 8.5 ≤ pH	mg/L, max	-	-	0.22	-	-	1.6
Nutrient	12	PO_4^{3-}	mg/L, max	0.7	0.7	0.4	0.7	-	-
Other	13	Chloride (Cl)	mg/L, max	250	-	-	250	600	-
Other	14	CN	mg/L, max	0.05	0.05	0.05	0.05	0.05	0.05
Other	15	F	mg/L, max	1.5	-	-	1.5	-	-
Other	16	SO_4^{2-}	mg/L, max	250	-	-	250	1,000	-
Metal	17	Cd, total	μg/L, max	5	-	5	5	-	5
Metal	18	Cr, total	μg/L, max	50	-	20	50	-	50
Metal	19	Cu, total	μg/L, max	-	-	100	-	-	100
Metal	20	Fe, total	μg/L	300 des 1,000 max	-	-	2,000	-	-
Metal	21	Pb,total Hardness<120	μg/L, max	50	-	2	50	-	-
Metal	21	120<Hardness <180	μg/L, max	50	-	3	50	-	-
Metal	21	180<Hardness	μg/L, max	50	-	4	50	-	-
Metal	22	Mn, total	μg/L, max	1,000	1,000	1,000	1,000	1,000	1,000
Metal	23	Hg, total	μg/L, max	1	1	1	1	2	2
Metal	24	Ni, total	μg/L, max	70	100	100	100	200	100
Metal	25	Se, total	μg/L, max	10	10	5	10	-	-
Metal	26	Zn, total	μg/L, max	1,000	-	1,000	1,000	2,000	24,000
Metal	27	B, total	μg/L, max	-	-	-	-	500	-
Metal	28	As, total	μg/L, max	50	50	50	50	50	50
Metal	29	Al, total	μg/L, max	200	-	-	-	5,000	5,000
Organic Micro Pollutant	30	Phenolic compounds	μg/L, max	2	5	2	5	5	5
Organic Micro Pollutant	31	Oil/Grease	μg/L, max	100	-	100	100	-	300
Organic Micro Pollutant	32	Anionic surfactants as MBAS	μg/L, max	1,000	1,000	1,000	1,000	1,000	1,000
Organic Micro Pollutant	33	MCPA	μg/L, max	2	-	-	20	-	-
Organic Micro Pollutant	34	Pendimethalin	μg/L, max	2	-	-	20	-	-
Microbes	35	Total Coliform	MPN/100mL, max	10,000	10,000	-	10,000	-	-
Microbes	36	Fecal Coliform	MPN/100mL	500 des 1,000 max	500 des 1,000 max	-	-	-	-

Note: 'des' means desirable and 'max' means maximum.

(Source: Government of Sri Lanka, 2019)

b. Water quality monitoring framework

The CEA is authorized to conduct water quality monitoring, which is carried out by the environmental pollution control unit and water quality monitoring laboratory. The CEA possesses a main laboratory at the head office, and nine provincial and district laboratories as well as private laboratories are also registered once every two years to cater for the environmental monitoring needs. The National Water Supply and Drainage Board (NWSDB) conducts water quality monitoring at water intake points for drinking water purification, in total 340, including 70 groundwater intake points. The CEA conducts regular water quality monitoring in 12 main water bodies, with additional or random monitoring in other areas conducted on an as-needed basis. Ambient water quality monitoring projects are in place in different river basins, as shown in Table 2.11.11. The first water sampling took place in the Kelani River, which is a major source of water supply, in 2013. Online water quality monitoring commenced in 2017. In the same year, monitoring expanded to 16 water bodies (rivers, tanks, reservoirs), and in 2020 is now conducted on a comprehensive basis.

The Sri Lanka Land Reclamation & Development Agency carries out canal water quality monitoring in the Colombo area at 23 locations, while agencies such as the Water Resources Board and International Water Management Institute are also involved in groundwater monitoring.

Table 2.11.11 Water quality monitoring in major water bodies

Name of the water body	Monitoring Points	Frequency	Parameters
Kelani River	17	Once a month	pH, TSS, BOD, COD, Coliform, Phosphate, Nitrate, Heavy metals
Ma Oya	8		
Diyawanna Oya	8		
Bolgoda Oya	6		
Attanagalu Oya	6		
Gregory Lake	7		
Kandy Lake	5		
Mahaveli- upper stream	8		
Kantale Tank	5		
Mahaveli- down stream	8		
Nuwara Wewa	6		
Tissa Wewa	4		
Badulu Oya	7		
Kumbukkan Oya	3		
Menik Ganga	5		
Nilwala Ganga	8		
Kalu Ganga	12		
Kurunagala Tank	4		
Wennaruwa Tank	3		
Mee Oya	6		
Deduru Oya	8		
Kala Oya	4		

(Source: CEA 2023)

(4) Effluent standards

a. Effluent discharge standards

The standards for discharge of wastewater into the environment are published in Gazette Notification No. 2264/17, dated 27.01.2022, as amended National Environmental (Protection & Quality) Regulations No. 01 of 2008.

The standards are based on the point of discharge and the type of effluents identified. Tolerance limits and values for industrial and domestic wastewater as well as modes of discharge into coastal, marine sea outfalls (long and short) or nearshore waters, inland surface water, land for irrigation purpose, and sewer discharges exist. Further, specific tolerance limits and values are prescribed for discharges of leachates from landfill sites.

The regulation has a provision for imposing more stringent standards if necessary in accordance with the need to protect the water environment.

b. Effluent inspection procedure

In principle, effluent quality is self-monitored by the discharging industry concerned or laboratory assigned by the CEA. Effluent quality reports are submitted based on the pollution potential of respective industries on a quarterly basis or at least once a year, to the CEA.

Industries are also required to submit effluent quality reports from third-party laboratories recognized by the CEA. However, the CEA occasionally monitors/inspects effluent discharging industries and obtains samples, as well as investigates suspected cases of non-compliance such as those based on complaints received from the general public.

c. Measures against non-compliance

There are several enforcement instruments for the water environment, including environmental impact assessments (EIA), environmental protection licensing (EPL), scheduled waste management licenses (SWML), environmental protected areas, directives to local Government authorities on solid waste management, and environmental recommendations (ER).

The EPL scheme, which started in 1990, applies to all entities in the country that discharge wastes into the environment, as prescribed by a regulation published under the NEA, with licenses varying according to the pollution potential of the industry (from types A to D). Additional enforcement arrangements are made by other agencies, such as the Water Resource Board, which grants approval for groundwater withdrawals for commercial uses, MEPA, which requires discharge permits for discharging wastewater to the sea, and Mahweli Authority, which protects reservoirs under their purview.

Non-compliance or violation results in suspension or cancellation of the EPL license and filing of cases, as well as minimum fines of 10,000 LKR, imprisonment, or both, as determined by the NEA.

6 | Recent Developments in Water Environmental Management

In 2023, existing river water monitoring programs (implemented along 25 main rivers) were expanded by increasing the number of river monitoring points.

Urban waterbodies and related trends in pollution projections were highlighted during 2022 and 2023 due to the increase of domestic wastewater discharges into urban lakes in Colombo city. Thereafter, the CEA established continuous water quality monitoring in Diyawanna Lake, an urban water body. Monitoring points were selected covering the lake catchment area, and industries within the area were also monitored to check for non-compliance or operating without EPLs. Ultimately, the goal expressed is to control water pollution, restore and manage ecosystem functions and realize the maximum beneficial use from such waterbodies.

The proposed NEA amendments to be finalized in 2024 are to include new regulations on environmental damage compensation, introduction of 'the polluter pays' principle, legalization of environmental clearance, and control over groundwater pollution with the aim of protecting the country's water environment.

7 | Challenges and Future Plans

The lack of proper institutional coordination is a major challenge, as water sector management is divided into several sections under different ministries or agencies. Similarly, several disparate functions of water management are represented through various laws and regulations, meaning compliance monitoring and enforcement thereof remain an ongoing challenge.

There is also a need for considerable improvement as regards resources allocation from the national budget, such as for hiring staff for field monitoring and inspection and laboratory analysis. The lack of baseline data as well as limited sharing of available data are further barriers to improvements in water environmental governance. The lack of financial and technical resources often hampers regular monitoring as well as the establishment of new monitoring stations.

Failure to self-report by industries is another prominent challenge as some industries lack the resources and capacity to monitor and report their compliance. Industries, in particular SMEs, lack the financial resources such as for treating wastewater. Further, the high costs of constructing and operating centralized WWTP as well as public resentment and protests over WWTP establishment remain as challenges for wastewater treatment in cities.

The National Environmental Action Plan (2022–2030) has identified water environment management as a key sector, while the Nationally Determined Contributions (NDCs) implementation plan (2021–2023) has identified the water sector as an adaptation category. Each of the agencies related to the above needs to identify relevant sectors and categories and develop its own comprehensive action plans in line with its mandates and institutional framework. In this process the CEA plays a pivotal role and executes its strategies and actions according to the corporate plan for the years 2021 to 2025.

2.12 Thailand

1 | Country Information

Table 2.12.1 Basic indicators

Land area (km^2)		513,115*
Total population		65.05 million*
GDP (current USD)		495.34 billion**
Per capita GDP (current USD)		6,909.96**
Average annual rainfall (mm/year)		1,848.0***
Total renewable water resources (km^3)		1,780.0***
Total annual freshwater withdrawals (billion m^3)		57.31****
Annual freshwater withdrawal by sector (billion m)^3	Agriculture	51.79****
	Industry	2.78****
	Municipal (including domestic)	2.74****

(Source: *National Statistical Office, 2022, **World Bank, 2022, ***Thailandwater, 2022, **** World Data Atlas 2020)

Figure 2.12.1 Rin Beach, located at the southern tip of Phangan Island in southern Thailand

(Source: Data from FPs)

2 | State of Water Resources

Thailand is divided into 22 river basins, as defined in the Royal Decree on River Basin Boundaries, B.E. 2564 (2021). These river basins can be further divided into 353 sub-basins and include six island groups within the main river basins (ONWR 2022). In 2023, Thailand experienced an average annual rainfall of 1,408 mm, which was 95 mm or approximately 6% lower than normal. Most areas of the country experienced below-normal rainfall, although patches of above-normal rainfall were also observed, particularly in the lower south, from Nakhon Si Thammarat Province to the southern tip of the country. This rainfall pattern contrasted sharply with 2022, when all regions experienced above-normal rainfall. The significant reduction in rainfall in 2023 highlights the variability and challenges in water resource management that Thailand faces due to changing climatic conditions.

Less rainfall in 2023 resulted in less water flowing into the dams. All 35 large dams across the country experienced a total annual inflow of 40,980 million cubic meters (m^3), a drop of 13,074 million m^3 compared to the previous year and almost equivalent to the capacity of Bhumibol Dam. However, it still represented a relatively large annual inflow compared with historical data over the past 10 years. A total of 38,193 million m^3 was released, the fourth highest after 2018, 2022, and 2017. At year-end, the remaining water storage in the 35 dams was 54,621 million m^3, or 77% of total dam capacity. This was a moderate water level, slightly decreased from the previous year, with usable water amounting to 31,084 million m^3.

Compared with historical data over the past 10 years (2014–2023), 2023 witnessed the third highest amount of water remaining at the end of the year, following 2017 and 2022. Two dams overflowed, 15 dams had high water levels, 14 dams had moderate water levels, four dams had low water levels, and no dams had critically low water levels (National Hydroinformatics Data Center, 2023).

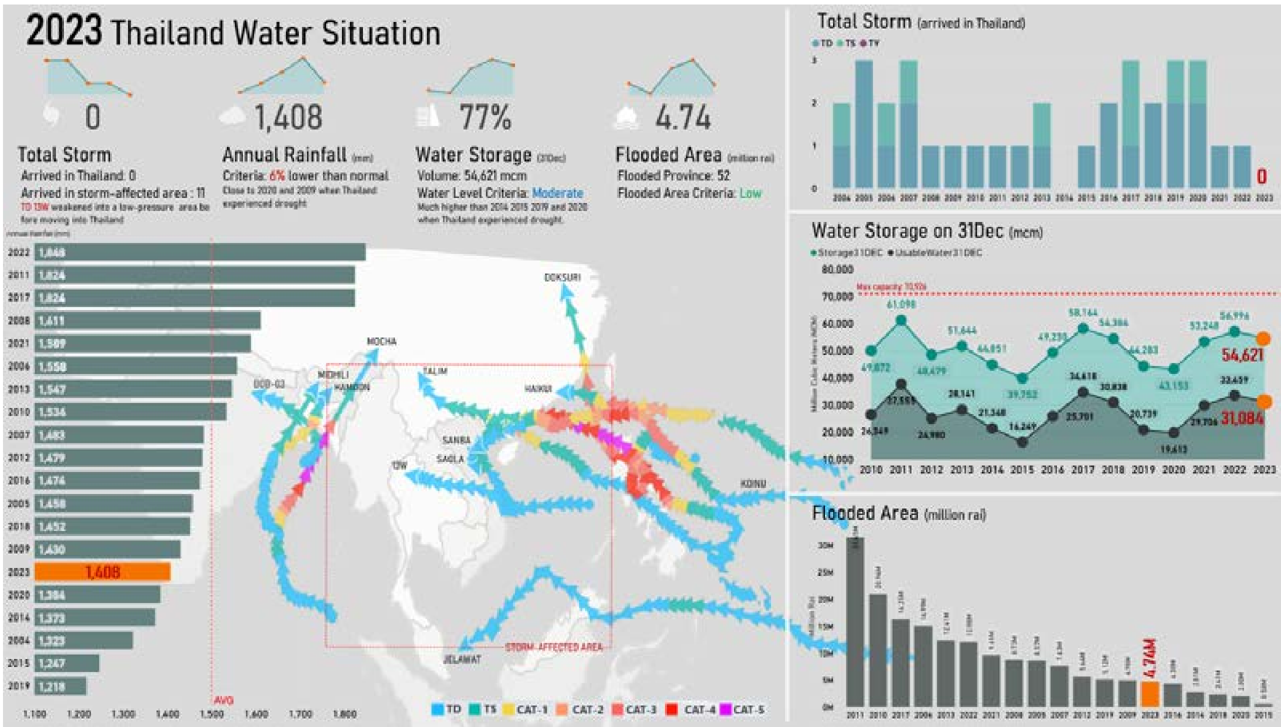


Figure 2.12.2 Overview of Thailand's water situation (Source: Data from FPs)

3 | State of Ambient Water Quality

(1) Surface water

Thailand's Pollution Control Department published results of water quality monitoring in 2022 covering 61 main water sources throughout the country. The water quality of Thailand's water sources is classified as very good, good, fair, deteriorated, or very deteriorated based on 13 types of use, with the proportions of each water quality calculated for each category. Compared with the previous year, the water quality of surface water in the northern, central, northeastern, and eastern regions was 23% worse than last year, and in the central region it was worse than in other sectors when compared based on the surface water classification criteria. Only three sources, accounting for 5% of the water sources, met the water quality criteria. Most water resources over the past decade (2013-2022) appear to be stable, at a moderate to good level (Chanan T. 2024).

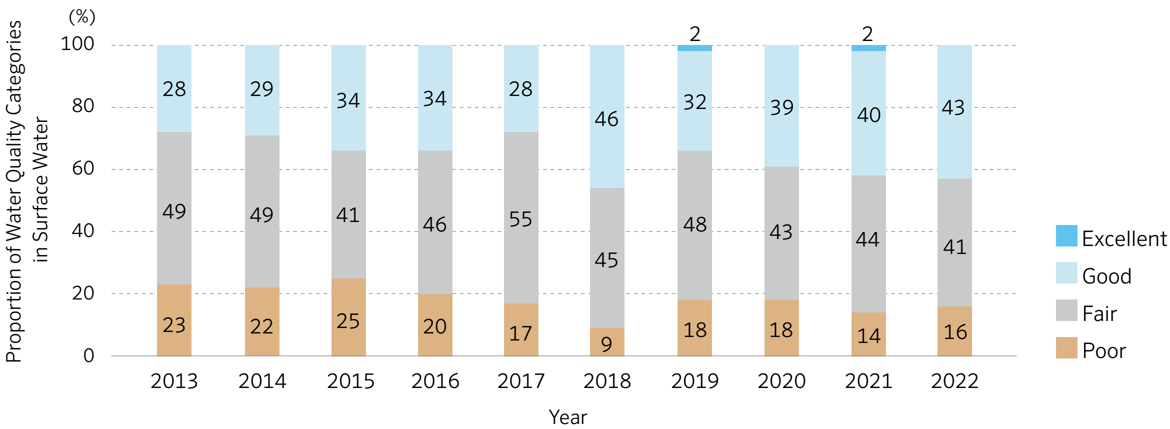


Figure 2.12.3 State of water quality of surface water sources nationwide, 2013-2022
(Source: Data from FPs)

Situation of surface water quality compared to water sources classification

In 2020, water quality data showed that important parameters like dissolved oxygen (DO), biochemical oxygen demand (BOD), total coliform bacteria (TCB), fecal coliform bacteria (FCB), ammonia-nitrogen (NH_3-N), and heavy metals (HMs) did not meet the required standards. Heavy metal levels were 0.2–1.5% higher than limits, while BOD and DO levels were worse by 19–36% and 19–31%, showing a slight worsening over time.

From 2013 to 2022, 18–34% of key parameters TCB, FCB, BOD, and DO continued to fail the standards (Fig. 2.12.5). BOD and DO showed a downward trend, while NH_3-N and HMs had a steady non-compliance rate of 10–18% (PCD 2022).

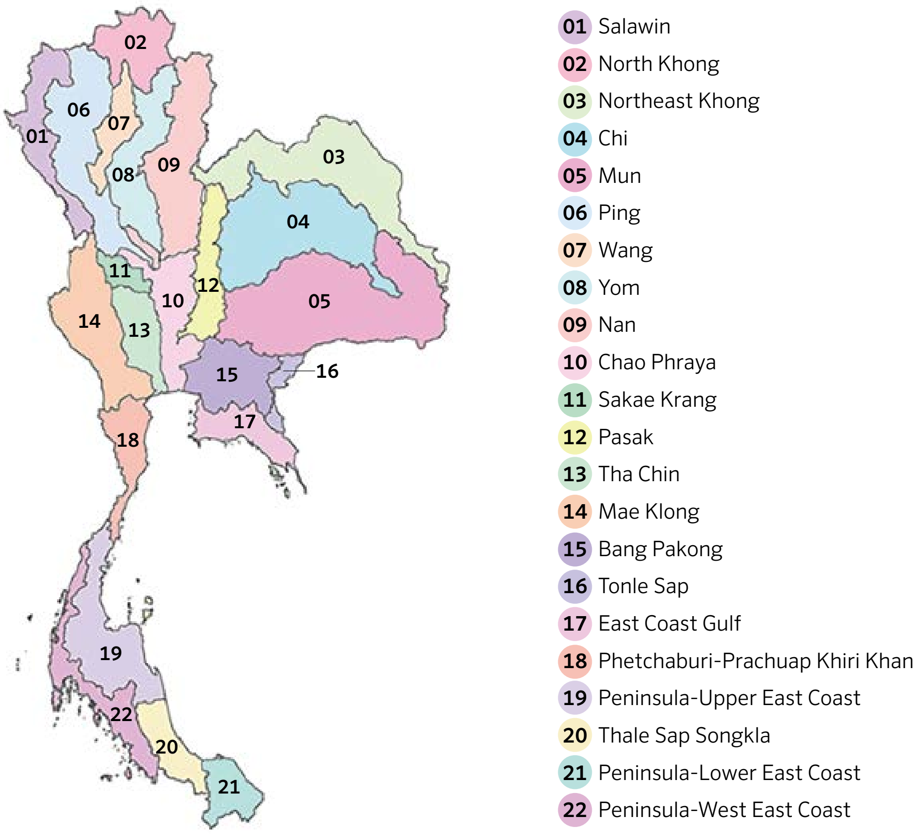


Figure 2.12.4 22 Main river basins in Thailand (Source: Data from FPs)

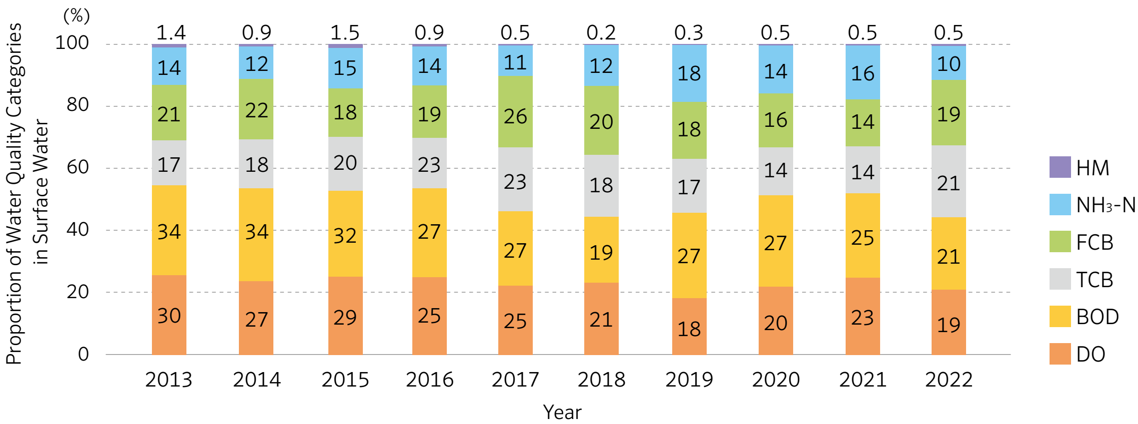


Figure 2.12.5 Percentages of parameters that failed to meet standards for water source classification determined for 2013-2022 (Source: Data from FPs)

(2) Coastal water

Thailand's Pollution Control Department (Ministry of Natural Resources and Environment) carried out monitoring of coastal seawater quality at 210 stations throughout the country, twice per year, covering areas of use according to six types of seawater quality standards: (1) quality of seawater for natural resource conservation; (2) quality of seawater for conservation of coral reefs (3); quality of seawater for aquaculture; (4) quality of seawater for recreation; (5) quality of seawater for industry and ports; and (6) quality of seawater for community areas.

State of pollution in 2023 regarding coastal water quality

In terms of the quality of coastal water, 55% of waters tested were found to be good, 39% were fair, 5% were poor, and 1% were very poor. The best five coastal areas in terms of water quality were (from best): 1. Lamai Beach (see Fig. 2.12.6), 2. Kai Bae Beach, 3. Chaweng Beach, 4. Rin Beach (tested at distance 500 meters from tideline), 5. Rin Beach (10 meters from tideline).

(3) Groundwater

In 2022, the groundwater quality was assessed based on the drinking water standards. Generally, groundwater quality remained stable or showed only minor change compared to previous values.

When evaluating groundwater quality based on total dissolved solids (TDS), it was found that levels were within the appropriate range set by the drinking water standards. The appropriate standard for TDS is not exceeding 600 mg/L, with the maximum permissible limit of 1,200 mg/L. These findings are based on analyses of groundwater quality from monitoring wells that were actively monitored in 2022.

The quality of groundwater is within the appropriate range of TDS in 64% of samples, but certain parameters exceeding the standard limits were found, as follows (see Fig. 2.17.8):

i. Concentrations of all parameters in the groundwater were within the appropriate limit in 20% of samples.
ii. Some parameters exceeded the suitable limit but did not surpass the maximum permissible limit in 14% of samples. These include dissolved iron, manganese, fluoride, conductivity, and zinc.
iii. Parameters exceeding the maximum permissible limit were found in 30% of samples, consisting of dissolved iron, manganese, fluoride, conductivity, and zinc.

Figure 2.12.6 Location of best coastal water quality area (Lamai Beach)

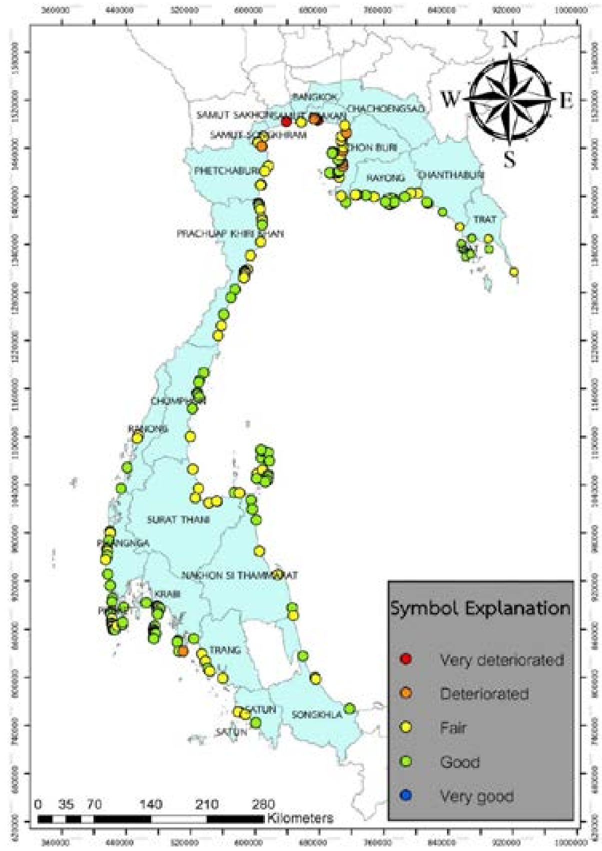


Figure 2.12.7 An overview of coastal water quality in Thailand (Source: Data from FPs)

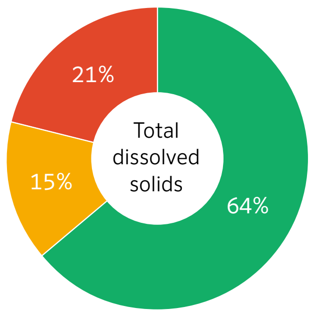
The groundwater quality exceeds the appropriate limit of TDS but does not surpass the maximum permissible limit in 15% of samples. The breakdown of parameters exceeding the standard limits is as follows:

i. Some parameters exceeded the suitable limit but not the maximum permissible limit in 8% of samples. These include dissolved ion, conductivity, chloride, fluoride, iron, manganese, zinc, and sulfate.
ii. Parameters in certain groundwater exceeded the maximum permissible limit in 7% of samples. These include dissolved iron, manganese, fluoride, conductivity, sulfate, and zinc.

The groundwater quality exceeds the maximum permissible limit of TDS in 21% of samples, with some parameters exceeding the standard limits. The breakdown is as follows:

i. Some parameters exceeded the suitable limit but not the maximum permissible limit in 3% of samples. These include dissolved zinc, conductivity, chloride, iron, manganese, fluoride, and sulfate.
ii. Parameters in certain groundwater exceeded the maximum permissible limit in 18% of samples. These include dissolved ion, conductivity, chloride, iron, manganese, sulfate, fluoride, and zinc.

Based on the above data, it can be said that the groundwater quality is generally good. Although some areas may exhibit high concentrations of dissolved minerals exceeding the maximum permissible limit, this is often due to specific geological conditions in such areas. Additionally, the intrusion of brackish groundwater into the upper freshwater aquifer layer may alter the quality of freshwater to brackish in certain areas, particularly in the northeastern region and along the coast of the Gulf of Thailand.



Groundwater Quality Standards for Drinking Purpose
Total Dissolved Solids (mg/L)

- Within acceptable standards (not more than 600)
- Exceeding the acceptable standards but not more than the Maximum Permitted Value (600-1,200)
- Exceeding the maximum permissible limit (more than 1,200)

***Based on the Groundwater Quality Standard for Drinking

Figure 2.12.8 Overview of groundwater standards for total dissolved solids in Thailand (Source: Data from FPs)

4 | State of Wastewater Treatment

Rapid population growth and insufficient collection, treatment, and management of household wastewater are major causes of the decline in water quality of surface and coastal waters. Although the population decreased from 66.41 million in 2018 to 65.05 million in 2022, the number of foreign tourists rose from 25.83 million in 2018 to 27 million in 2023. Wastewater from various sources including local businesses, factories, and agricultural activities is often released into water bodies that lack the capacity to handle it, especially in key watersheds, waterways, and tourist areas. Additionally, activities such as industry, port operations, tourism, and aquaculture are increasing each year, exacerbating the problem.

Although both surface and groundwater pollution derive from many sources, there are three main source categories: household wastewater, with a total volume of approximately 9.7 million m^3/day, industrial wastewater, with a total volume of 17.8 million m^3/day, and agricultural wastewater, with a total discharge volume of 4.45 million m^3/day (only for pig farms and aquaculture).

(1) Domestic wastewater

It is estimated that 11 million m^3 of domestic wastewater is generated across the country every day, which is managed by 119 centralized municipal wastewater treatment plants operated by local government agencies and wastewater management authorities. Currently, 97 treatment plants are in operation, with a treatment capacity of 2.7 million m^3 per day (24.5% of total wastewater volume). In big cities like Bangkok, ratios of treated wastewater are higher, estimated at 43%. The main reason for the low ratios of treated domestic wastewater across the country is the lack of budget to cover investment as well as operation and maintenance system expenditure at the local administrative organization level. The treatment technology used for wastewater mainly comprises stabilization ponds, aerated lagoons, and activated sludge systems.

Houses and all other buildings are required to install wastewater treatment systems for primary treatment to reduce the contamination of wastewater before it is discharged into water sources.

Large buildings such as hotels, condominiums, hospitals, department stores, markets, restaurants, schools, dormitories and office buildings are required to install wastewater treatment systems and treat wastewater according to standards. Monitoring and law enforcement are regularly implemented to manage wastewater treatment, especially in important river basin areas, major canals, and attractive beaches. Survey results revealed that 42.64% of large buildings are in compliance with the law (PCD 2022).

(2) Industrial wastewater

Industries discharge processed wastes including byproducts from industrial operations as wastewater. At present, many industries are located in areas of high population density or within residential areas in cities. Across the country there are about 107,959 industrial establishments of various sizes in 77 provinces, carrying out a wide range of activities, located within the Inner Gulf. Meanwhile, there are approximately 59,775 small or community factories in Thailand. Laws and regulations are being strictly enforced for small/community, medium-sized and large factories, industrial plants and industrial estates, which were all required to have wastewater systems complying with the effluent standards set by the Government of Thailand.

General standards for controlling effluent from industry, industrial parks, industrial zones and specific standards for producing fresh water from seawater reverse osmosis plants, leather mills, pulp and paper mills have been issued.

(3) Agricultural wastewater

There are three main sources of agricultural wastewater:

- From pig farms
- From aquaculture, including freshwater aquaculture, brackish aquaculture and coastal aquaculture
- From rice fields

According to statistics from the Agricultural Wastewater Source survey in 2022 assessing amounts of wastewater from source in the form of BOD loading, the total amount generated from agriculture was about 15.80 million m^3/day. Of this, an estimated 8.53 million m^3/day was discharged into the environment, of which the BOD loading in the form of dirt was 330,119.12 kg of BOD/day. The wastewater sources are detailed below.

Agricultural wastewater sources with a definite origin (point source). These include pig farms and aquaculture.

Pig farms: There were a total of 11,108,679 pigs, which contributed to approximately 0.31 million m^3/day of wastewater. Of this, around 0.12 million m^3/day (or 1.47%) contributed to the total wastewater discharge, with a BOD load of approximately 75,694.50 kg/day.

Aquaculture consists of freshwater aquaculture, brackish aquaculture, coastal aquaculture, summarized as follows:

Freshwater aquaculture: There were 408,260 sampling of freshwater aquaculture, representing approximately 7.8 million m^3/day of wastewater generated, approximately 4.6 million m^3/day of which is discharged into the environment, with a total daily BOD of 54,092.43 kg.

Brackish aquaculture: There were 5,417 cases of brackish aquaculture, representing approximately 0.3 million m^3 of wastewater generated per day, of which approximately 0.1 million m^3/day is discharged into the environment, with a total daily BOD of 3,071.29 kg projected to be discharged.

Coastal aquaculture: There were 26,047 coastal aquaculture cases, representing approximately 7.3 million m^3/day, of which approximately 3.7 million m^3/day is discharged into the environment, with a total daily BOD of 98,194.93 kg.

Pig farms and aquaculture are designated as pollution sources that are controlled for sewerage under the National Environmental Quality Promotion and Conservation Act B.E. 2535 (1992) as well as health hazards under the Public Health Act B.E. 2535 (1992). However, at present, monitoring cannot be implemented comprehensively, and there is no standard governing effluent discharges from other types of livestock.

5 | Frameworks for Water Environmental Management

(1) Legislation

Water Resources Act, B.E. 2561 (2018)

This Act is the first law on water resources of Thailand. It went into effect on 27 January 2019 and was promulgated as an important law defining the approach to overall water resources management of the country in an integrated way. It also decreases duplication of budget use and water-related action plans, enhances coordination and builds more clarity into the database system between government agencies to improve efficiency.

Master Plan for Water Resources Management 20 years (BE 2561–2580)

A vision for development has been established for 20 years, according to the Master Plan for Water Resources Management (BE 2561-2580) as follows: "Every village has clean and potable water, secure water for production, reduced damage from floods, water quality meeting standards, and sustainable water management under balanced development with the participation of all sectors."

Enhancement and Conservation of the National Environmental Quality Act (NEQA) of 1992

This Act is the basic law for environmental conservation in the country and defines the authorities and responsibilities regarding environmental protection. Some key features of NEQA are as follows:

- Establishment of the Environmental Fund, from which resources are drawn to solve environmental problems in priority areas.
- The environmental quality management plan for the years BE 2566–2570 places high significance on the involvement of relevant development sectors, as well as the empowerment of communities in the management of natural resources and the environment. The plan employs the Plan-Do-Check-Act (PDCA) cycle as the four critical steps to achieve its objectives, and includes a 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.

An overview of the legislation related to water environmental management in Thailand is shown in Fig. 2.12.9.

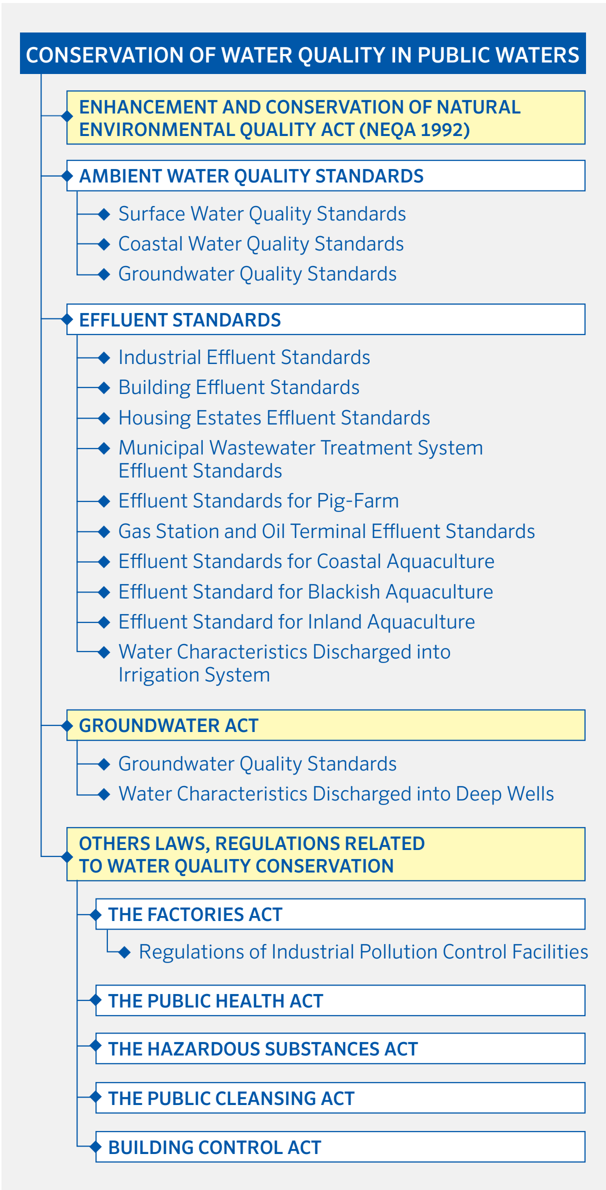


Figure 2.12.9 Legislative chart for water quality management
(Source: Prepared by WEPA Secretariat based on information from the FPs)

(2) Institutional arrangement

The institutional arrangement related to water management in Thailand operates under the Thai cabinet. The National Water Resources Committee (NWRC) was established, with the Office of the National Water Resources (ONWR) serving as the secretariat. There are subcommittees for each of the 22 river basins, and technical management together with implementation committees have been formed to address issues in specific areas.

As part of water quality management, the Ministry of Natural Resources and Environment (MoNRE) operates through the Pollution Control Department (PCD) and its Water Quality Management Division to propose policies addressing various issues, such as establishing effluent standards for pollution control from point sources to meet ambient environmental quality standards. These efforts are supported by regional offices, including the Environmental and Pollution Control Offices (EPO 1–16) throughout Thailand, which manage local-level problems. Additionally, other departments under MoNRE, such as the Department of Groundwater Resources (DGR), oversee both the quantity and quality of groundwater resources. The Department of Water Resources also plays a crucial role in managing flood and drought situations.

In addition to water management, various related ministries and their departments also play significant roles. These include the Department of Meteorology, the Department of Disaster Prevention, the Department of Public Works and Town and Country Planning, the Land Development Department, the Royal Irrigation Department, the Metropolitan Waterworks Authority, the Provincial Waterworks Authority, the Electricity Generating Authority of Thailand (EGAT), and other relevant organizations. These are shown in Fig. 2.12.10.

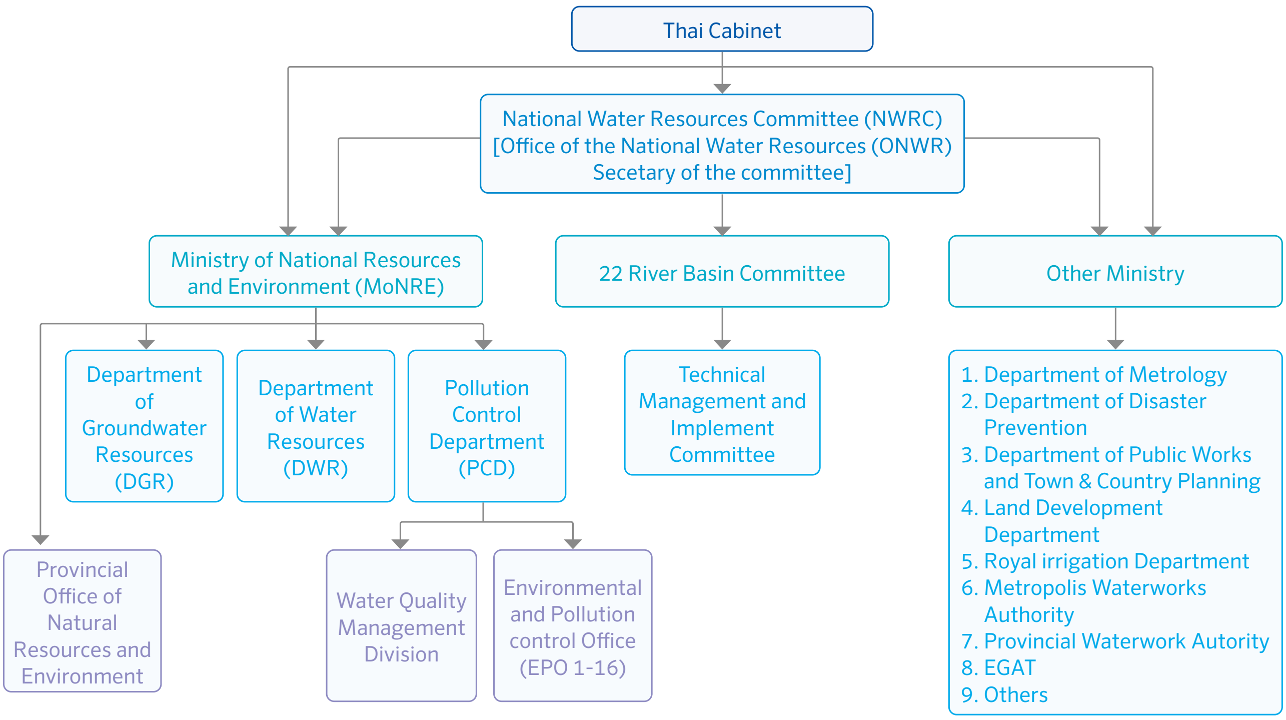


Figure 2.12.10 Institutional arrangement of water environment management in Thailand

(Source: Prepared by WEPA Secretariat based on information from the FPs)

Cambodia China Indonesia Japan Korea Laos Malaysia Myanmar Nepal Philippines Sri Lanka Thailand Viet Nam

(3) Ambient water quality standards

i. Surface water quality standards

The first standard for ambient water quality was established in 1994, and comprised 28 items under five categories of water bodies, designated according to water usage, as shown in Table 2.12.2 The General Water Quality Index was established as an indicator to promote an understanding of water quality, which is calculated with the values of five parameters (DO, BOD, NH_3-N ,TCB, FCB). These standards are the national minimum standards.

ii. Coastal water quality standards

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

iii. Groundwater quality standards

The parameters included in groundwater quality standards are divided into four groups: volatile organic compounds (15 parameters), heavy metals (10 parameters), pesticides (nine parameters) and others (four parameters).

iv. Water quality monitoring framework

Under the NEQA, the government conducts monitoring of the receiving water quality to maintain quality. The Water Quality Management Division under the Pollution Control Department—Ministry of Natural Resources and Environment (MONRE) is responsible for regular monitoring of both inland (surface and groundwater) and marine water. There are 433 general and 160 automatic monitoring stations across 61 main rivers and nine standing surface water resources (lakes) within the country. Water quality samples from general monitoring stations are taken four times a year during the wet and dry seasons in accordance with the Standard Method for the Examination of Water and Wastewater (1998). Monitoring results for ambient water quality are summarized and made available to the public through online publications annually (Thailand State of Pollution Report 2022).

(4) Effluent standards

Based on the NEQA (Section 32), a series of effluent standards have been set up, as follows:

i. 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). Standard values are designated for 15 parameters and 12 heavy metals. This standard, which has been in effect since 3 January, 1996, also provides some exemptions for certain industries such those as related to chemicals, starch, and animal foods. More recently, a new Decree on Industrial Effluent Control Standard B.E. 2559 (2016) was announced by the Ministry of Natural Resources and Environment of Thailand, on 6 June 2016, to take effect from 6 June 2017. Under the new standard, no exemptions are permitted. The standard is comprised of two parts—a general effluent standard (consisting of 15 parameters and 16 heavy metals), and type-specific effluent standards.

Regarding effluent quality control, the Regulations of Industrial Pollution Control Facilities (1982) oblige specific industrial plants to have supervisors and machine operators responsible for pollution prevention. Such industrial plants include those using heavy metals in production processes and discharging wastewater in quantities above 50 m^3/day containing designated quantities of heavy metals.

Table 2.12.2 Surface water quality standard classification

Class	Description/Condition	Beneficial Use
1	Natural water resources without wastewater from any activities	Water is safe for consumption, sanitized, and appropriate for propagation and ecosystem conservation.
2	Very clean fresh surface water resources	Water resources for conservation, fishery, swimming, water recreation and consumption (with basic treatment).
3	Medium clean fresh surface water resources	Water resources for agriculture and consumption (with general treatment).
4	Fairly clean fresh surface water resources	Water resources for industrial work and consumption (with special treatment).
5	Sources which are not classified into classes 1-4	Water resources for transportation.

(Source: PCD 2015)

ii. Domestic and commercial

Building effluent standards

Effluents from each type of building, namely apartments, hotels, hospitals, schools and academic buildings, public and private offices, department stores, fresh markets and restaurants, are regulated under these standards. Regulated parameters, depending on building size, include pH, BOD, SS, sulfide, TKN, and fat, oil, and grease.

Housing estate effluent standards

These standards regulate effluent from housing estates, which are classified into three types based on size: under 100 units, from 100 to 499 units, and 500 or more units. Regulated parameters include pH, BOD, SS, settleable solids, total dissolved solids, sulfide, TKN and fat, oil, and grease.

Municipal wastewater treatment system effluent standards

This standard was established in 2010, and has six parameters, namely pH, BOD, SS, TN, TP and fat, oil, and grease.

Gas station effluent standards and oil terminal effluent standards

There are four parameters in these standards, namely pH, COD, SS, and fat, oil, and grease.

iii. Agriculture

Effluent standards for pig farms

In consideration of the impact of pig farms on water pollution, such as in the Tha Chin River and Bang Pakong River, standards were established in 2021. Parameters designated by the standards include pH, BOD, COD, SS, TKN and TP, with values differing based on farm size: Type A (more than 600 livestock units), Type B (60–600 livestock units) and Type C (6–60 livestock units).

Effluent standards for aquaculture

Several effluent standards exist, categorized into those for:

- Freshwater aquaculture
- Brackish aquaculture
- Coastal aquaculture

iv. Other

Effluent standards for coastal aquaculture and other

There are several effluent standards for coastal aquaculture and other, as follows:

- Effluent standards for brackish aquaculture
- Effluent standards for Inland aquaculture
- Water characteristics of discharges into irrigation system
- Water characteristics of discharges into deep wells

(5) Major policies on water environmental management

The Government of Thailand has to date invested over 83 billion THB in constructing centralized wastewater treatment facilities. As per Section 23 and Section 24 of the Decentralization Act, 1999, provincial administrative organizations, municipalities, *tambon* (sub-district) administrative organizations and the City of Pattaya may receive income from fees collected from users for the public services provided in order to operate and maintain the facilities (Bao et al. 2020).

Similarly, under the National Environmental Quality Improvement and Conservation Act of 1992, local governments may collect fees from service areas in which centralized wastewater treatment facilities were built and operated as public works using government funds. On 4 December, 2006, the National Environmental Board (NEB) agreed to collect wastewater management fees based on the Polluter Pays Principle and the type of wastewater treatment system. According to a recent study, only around 17 local government agencies have adopted user fees for wastewater collection across the country (Bao et al. 2020). For various reasons, most local government agencies do not impose user fees or service charges for wastewater collection and treatment, which has resulted in insufficient funds to operate and maintain existing treatment plants.

Despite the many economic tools or instruments available, which have also been successfully applied in other countries, none have been successfully applied in Thailand. As a basic guiding rule, to effectively address the issues surrounding water pollution, the concept of the polluter pays principle should therefore be adopted nationwide. It should be noted that, based on the lessons learned from other ASEAN countries, economic instruments can be successfully implemented when combined with other measures, such as stricter environmental standards, guidelines on alternative technologies, and environmental awareness raising measures.

6 | Recent Developments in Water Environmental Management

(1) The 13th National Economic and Social Development Plan (2023-2027)

The 13th National Economic and Social Development Plan (2023-2027) is a second-level plan that acts as a key mechanism to translate the National Strategy into implementation. It also serves as a framework for the formulation of third-level plans so as to enable relevant development partners to function in support of achieving the targets of the National Strategy within the expected timeframe. The Plan contains 13 strategy milestones, two of which focus on natural resources and environmental sustainability:

Milestone 10: Thailand aims to have a circular economy and low-carbon society, aligned with four targets of the 13th Plan, namely:

- Target 1: Restructuring the manufacturing and service sectors towards an innovation-based economy by enhancing competitiveness through knowledge, creativity and innovation
- Target 3: Creating a society of opportunity and equity by creating opportunities and spreading income to communities
- Target 4: Ensuring the transition of production and consumption towards sustainability through efficient use of natural resources in manufacturing and consumption and within ecological limits
- Target 5: Enhancing Thailand's capability to cope with changes and risks under the new global context, in particular climate change

Milestone 11: Thailand aims to mitigate the risks and impacts of natural disasters and climate change, aligning with two targets of the 13th Plan, namely:

- Target 4: Ensuring the transition of production and consumption towards sustainability
- Target 5: Enhancing Thailand's capability to cope with changes and risks under the new global context

(2) Pollution Management Plan for 2023–2027 period

The Pollution Control Department under the Ministry of Natural Resources and Environment has prepared a pollution management plan, which is to serve as a framework and direction for managing pollution in Thailand. It is to be consistent with national development guidelines and allow for changing contexts at national and global levels, such as driving sustainable development, development of the bioeconomy - circular economy - green economy (Bio-Circular-Green Economy: BCG Model) and development towards a low carbon society, etc. It consists of three strategies:

- Strategy 1: Preventing and reducing pollution at the source.
- Strategy 2: Increasing efficiency in treating and eliminating waste and controlling pollution at the source.
- Strategy 3: Developing a pollution management system

(3) Strategy for Water Resource Management Act B.E. 2558–2569 (2015–2036)

MONRE, in cooperation with the Ministry of Agriculture and Cooperatives (MOAC) drafted the Strategy for Water Resource Management Act B.E. 2558–2569 (2015–2036), which was approved by the Cabinet on 7 May, 2015. The strategy set a policy framework for unified and integrated prevention of and solutions for water resource problems, including the scarcity of water, flooding and water quality issues. The strategy's vision states that "Every single village has clean water for household consumption as well as for stable production. Damage from flooding is mitigated. Water quality meets the standard. Water resources are sustainably managed with balanced development and participation of all sectors". This Strategy consists of six sub-strategies, each focusing on a different target area:

i. Strategy for water management for household consumption
ii. Strategy for creation of stable water supply in production sector (both agricultural and industrial sectors)
iii. Strategy for flood management
iv. Strategy for water quality management
v. Strategy for conservation and mitigation of impaired watershed forests and prevention of soil erosion
vi. Strategy for management

7 | Challenges and Future Plans

Some of the key challenges related to water quality in Thailand are as follows (Chanan, T. 2024):

a. Lack of standards for certain sources: The absence of standards for small factories and nonpoint sources necessitates clear standards and mitigation strategies to effectively manage water pollution.
b. Wastewater volume growth: Population growth and urban expansion contribute to increased wastewater volume, demanding sustainable management strategies to ensure the preservation of water quality.
c. Enhancing PPPP (public-private-people partnerships) collaboration: Encouraging collaboration among private, public, and community sectors is crucial for effective water quality management, fostering resource efficiency and innovative solutions.
d. Addressing regulatory conflicts: Resolving conflicts within regulatory frameworks is essential for a coordinated approach to water quality management, ensuring consistency and effectiveness in pollution control measures.

Based on the current challenges and above discussion, it is recommended that the following measures be considered to further improve water quality and more effectively control water pollution in Thailand in the coming years:

a. The impacts from climate change require the establishment of new standards and regulations to mitigate its effects.
b. Supporting initiatives that promote water conservation through the 3R approach (reuse, recycle, and reduce) is also critical for sustainable water resource management.
c. Addressing wastewater treatment fees for household services is essential to ensure equitable access to sanitation facilities.
d. Finally, updating parameter-specific standards is imperative to maintain water quality standards that meet evolving needs.

Addressing these challenges will necessitate proactive measures and collaboration among stakeholders to safeguard Thailand's water resources for future generations.

2.13 Viet Nam

1 | Country Information

Table 2.13.1 Basic indicators

Land area (km²)		331,344.8 (2023)*
Total population		100.31 million (2023)*
GDP (current USD)		430 billion (2023)*
Per capita GDP (current USD)		4,282 (2023)*
Average annual rainfall (mm/year)		1,990 (2022)**
Total renewable water resources (km³)		935 (2022)
Total annual freshwater withdrawals (billion m³)		117.03 (2022)
Annual freshwater withdrawal by sector	Agriculture	73.1% (2022)
	Industry	8.3% (2022)
	Services[1]	15.6% (2022)
	Municipal (including domestic)	3% (2022)

(Source: *Statistical Yearbook of Vietnam 2023, **VN national water resources planning 2022)

Figure 2.13.1 Han River in Da Nang, Viet Nam

2 | State of Water Resources

Viet Nam has a large river and canal network, including over 3,450 rivers and streams with lengths exceeding 10 km. There are 13 large rivers and 310 inter-provincial rivers belonging to eight large river basins, with an area of about 270,000 km² (accounting for 80% of the total area of the river basins). Of these, many rivers cross borders with other countries, such as the Mekong river systems (Mekong River), Red River, Bang Giang-Ky Cung River, Ma River, Ca River, and Dong Nai River. As a result, the country has an abundance of surface water resources. The total volume of the country's river basins is about 844 km³/year, but only about 340 km³ (40%) is within the country, while the remaining 60% is generated from neighboring countries (MONRE 2022).

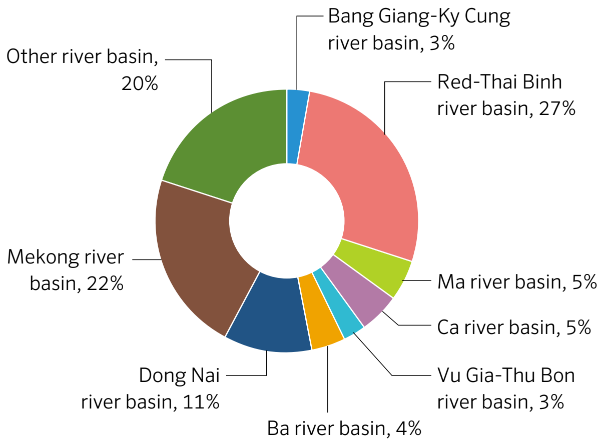


Figure 2.13.2 River basin area as percentage of total area
(Source: MONRE 2018)

Although Viet Nam enjoys abundant surface water resources in general, they are unevenly distributed across the country due partly to uneven rainfall distribution. The total volume of water exploited is about 117.03 billion m³ (approx. 12.5% of total national water volume), of which over 73% is used for agricultural purposes (about 78 billion m³/year). Water is also used for energy production, daily life, aquaculture and industrial production, tourism and services. There is a trend of rising water use in industry, fisheries, tourism, services and living. Water use for agricultural production is highest in the Mekong Delta and Red River Delta, accounting for 70% of water use. The catchment area with the highest industrial water use rate is Dong Nai, accounting for 68.3% of the total water use for Viet Nam's industry (MONRE 2022). The structure of water use is expected to change by 2030, with 66.4% going to agriculture, 9.9% to industry, 4.2% to domestic uses, and 19.5% to other purposes (MONRE 2022). In addition, rapid urbanization and the prolonged dry season due to the impacts of climate change are causing serious water shortages in many areas of the country, especially in areas around the Mekong river basin.

Note: Service water refers to water used for aquaculture. However, the current values are only estimated data. Vietnam is in the process of conducting a comprehensive water resources inventory, including an assessment of water use. Accurate and updated data on water resources and water use are expected to be available by the end of 2025.

Table 2.13.2 River basins in Viet Nam

Major river basin	Catchment area			Total annual flow			
	Whole area	Within Viet Nam		Total	Generated outside of Viet Nam	Generated inside of Viet Nam	
	km	km	%	10^6 m^3	10^6 m^3	10^6 m^3	%
Bang Giang-Ky Cung	10,847	10,847	100	8.610	-	8.610	100
Hong-Thai Binh	169,000	88,860	53	148.327	48.300	100.027	67
Ma	28,400	17,653	62	19.722	6.260	13.462	68
Ca	27,200	17,900	66	23.859	4.110	19.749	83
Huong	3,066	3,066	100	8.212	-	8.212	100
Vu Gia-Thu Bon	10,035	10,035	100	19.347	-	19.347	100
Tra Khuc	3,337	3,337	100	8.371	-	8.371	100
Kon-Ha Thanh	3,809	3,809	100	4.742	-	4.742	100
Ba	13,417	13,417	100	12.045	-	12.045	100
Se San	19,031	11,510	60	12.836	-	12.836	100
Srepok	30,841	18,230	59	18.396	-	18.396	100
Dong Nai	44,100	36,530	83	39.980	1.925	38.055	95
Cuu Long	795,000	39,945	5	474.144	443.840	30.304	6
Cai Ninh Hoa	916	916	100	0.766	-	0.766	100
Cai Nha Trang	1,732	1,732	100	3.192	-	3.192	100
Group of river basins in Quang Ninh	1,957	1,957	100	2.762	-	2.762	100
Group of river basins in Quang Binh	7,160	7,160	100	10.109	-	10.109	100
Group of river basins in Quang Tri	3,650	3,650	100	4.667	-	4.667	100
Group of river basins Southeast region	6,402	6,402	100	3.307	-	3.307	100
Group of coastal river basins	-	17.029	-	20,964	-	20,964	-

(Source: MONRE 2022)

It is predicted that Viet Nam will become one of the countries most vulnerable to climate change and is likely to face significant impacts, especially in its water resources—in particular surface water resources. Impacts from climate change will vary according to region, and in recent years the northern delta and central coastal regions have already been affected by longer dry periods and torrential rains, resulting in droughts and flooding, as well as rising sea levels, storms, flooding and coastal erosion. The southern region is relatively flat and geologically weak, and is prone to flooding and saltwater intrusion as a result of sea level rise, with about 45% of the region projected to be at risk by 2030 (MONRE 2018).

In addition to surface water, groundwater is also an important water supply source for domestic, industrial and agricultural activities. According to MONRE (2022), groundwater in Viet Nam is relatively plentiful due to the abundant rainfall, which is distributed widely across the country. Reserves are estimated at about 189.3 million m^3/day, mainly located in northern delta, southern delta and central highlands regions. The total volume of groundwater exploitation is about 10.5 million m^3/day, of which the northern and southern deltas are the two most exploited areas, with total capacities of about 5.87 million m^3/day, accounting for 55.7% of the country's exploitation. Recently, due to overexploitation of groundwater in areas such as Hanoi and the Mekong delta, problems of falling water tables associated land subsidence and salinity intrusion have been reported.

3 | State of Ambient Water Quality

Water pollution of river basins across the country results from different sources, but is mainly due to the discharge of untreated or partly treated domestic, industrial and agricultural wastewater, as well as wastewater from craft villages and hospitals.

(1) Surface water

Throughout the period of 2016-2021, the water quality of major river basins gradually improved, owing to the control and regulation of environmental pollution sources. However, the water quality as measured at many monitoring sites in the river basins of Hong-Thai Binh, Bang Giang-Ky Cung, Ma, Ca, Ba, Se San, Srepok, Dong Nai, Mekong and coastal rivers exceeded QCVN 08-MT: 2015/BTNMT (A2), mainly in the middle and lower river sections. Local pollution occurs in river sections flowing through densely populated areas, urban areas, industrial parks, and craft villages.

The results of calculating WQI values (based on average monitoring results) for the period 2016-2020 of nine major river basins show that the quality of the water environment in the river basins is mainly at the "average" to "good" level (see Fig. 2.13.3). Correspondingly, river water can be used for aquaculture, irrigation and domestic water supply purposes but requires appropriate treatment measures. The level corresponding to "pollution" was recorded mostly in river sections flowing through areas with developed socio-economic activities. The Water Quality Index (VN-WQI) is calculated according to Decision No. 1460/QD-TCMT (12/11/2019) of the Viet Nam Environment Administration, computed on a scale (WQI value range) corresponding to symbols and colors to evaluate water quality to fulfill consumption demands, as shown in Table 2.13.3.

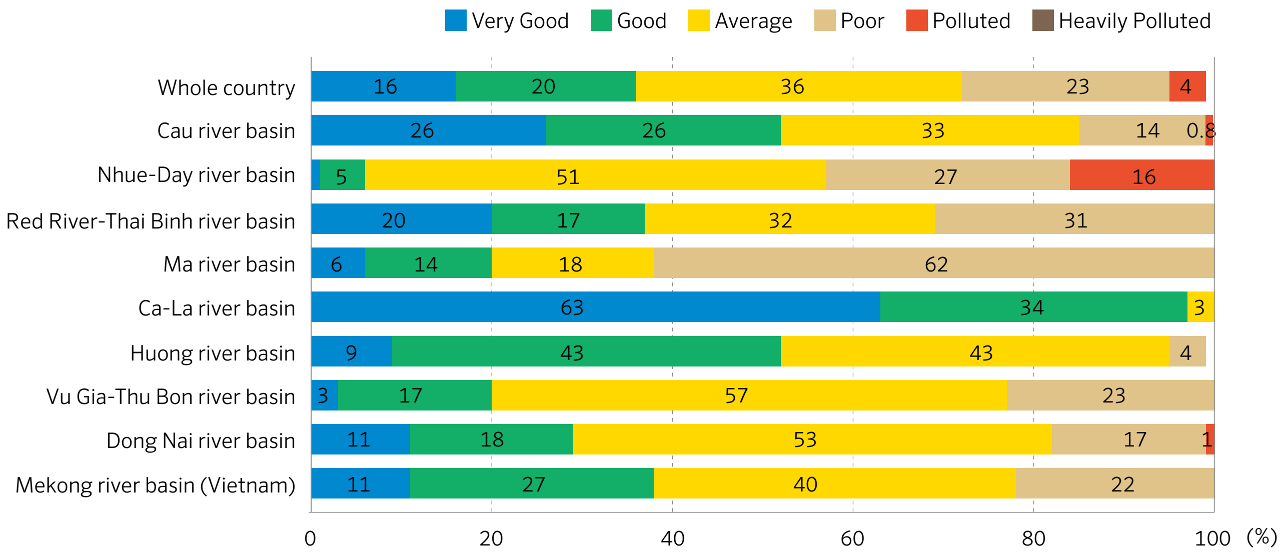


Figure 2.13.3 Proportions of WQI values at monitoring sites in major river basins for the period 2016-2020 (MONRE, 2021)

Table 2.13.3 Water quality index in Viet Nam

WQI range	Water quality	Suitability for the intended purpose	Color
91-100	Very good	Used for domestic water supply purpose	
76-90	Good	Used for domestic water supply purpose, but requires appropriate treatment measures	
51-75	Average	Used for irrigation and other similar purposes	
26-50	Poor	Used for navigation and other similar purposes	
10-25	Heavy pollution	Heavily polluted water source, requiring appropriate treatment measures in the future	
<10	Very heavy pollution	Toxic polluted water source, requiring treatment and recovery measures	

The majority of river basins in Viet Nam contain water of quite high TSS and turbidity levels, exceeding QCVN 08-MT: 2015/BTNMT, A2 in many regions and QCVN 08-MT: 2015/BTNMT, B1 in others, particularly during the flood season. Despite the distinguishing feature of the many rivers in Viet Nam, this has some implications for using river water for domestic purposes.

Hotspot areas of low-quality water environment in the river basins have not yet seen significant improvement. These include Hanoi's inner rivers (To Lich River, Kim Nguu River, Set River, etc.) in the Nhue river basin; Ngu Huyen Khe River in the Cau river basin; Bac Hung Hai River system in the Hong-Thai Binh river basin; Tan Hoa-Lo Gom canal, Tau Hu-Ben Nghe canal, Tham Luong-Ben Cat-Vam Thuat canal in the Dong Nai river basin, and others. The two primary types of environmental contamination in river basins are nutrient and organic pollution. Pesticide contamination has not been detected at most monitoring sites. Oil and heavy metal contamination has been detected locally in river segments affected by industrial, mining and navigation activities.

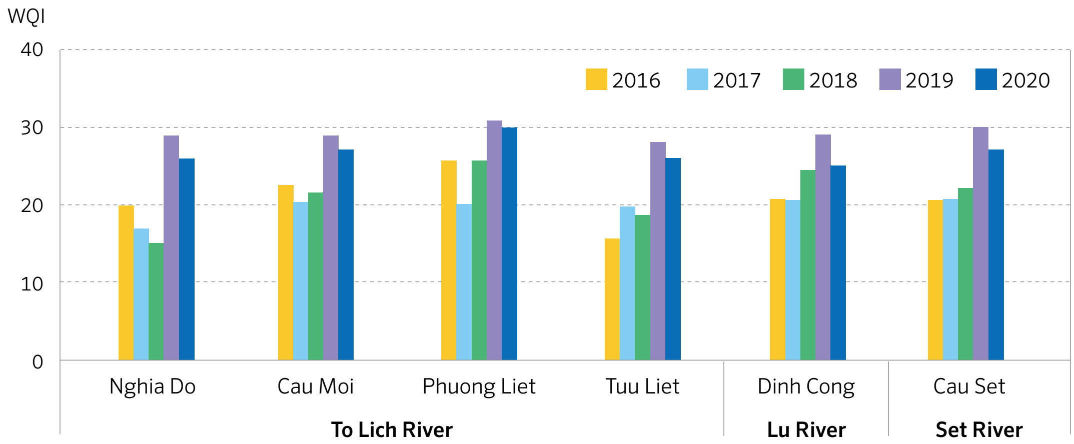


Figure 2.13.4 WQI values for Hanoi's inner rivers during 2016–2020 (Source: MONRE 2021)

The water quality of the Hong-Thai Binh is generally relatively good. In many sections, this water source can be suitable for domestic water supply purposes. However, one of the characteristics of the Red River is its high alluvial content. As a result, water monitoring results every year record high TSS. Additionally, TSS content has also increased due to mineral and sand mining activities in the area. The organic and nutrient pollution tends to increase in the downstream of the Red River. This is mainly caused by large discharges of domestic, industrial, and agricultural wastewater (see Fig. 2.13.5).

The worst hotspot of water pollution in the Red-Thai Binh river basin is the Bac Hung Hai river system, which is an irrigation system for Hanoi, Bac Ninh, Hung Yen and Hai Duong with a length of 200 km. According to water quality monitoring results of the Viet Nam Environment Administration for 2019, 90% of monitoring sites had parameters of organic pollution, nutrients, and microorganisms exceeding QCVN 08-MT: 2015/BTNMT, B1 (MONRE, 2021).

The water quality of the Mekong river basin is relatively good, with a fairly high WQI index, especially in the upstream sections. The basin's two largest rivers are the Hau River and Tien River. These provide abundant water resources, and consist of deep, wide river beds with high self-cleaning ability, contributing to reduced levels of pollution, especially organic and nutritional pollution. The biggest problems facing the Mekong River are reduced flow, saltwater intrusion and the risk of transboundary pollution. The water quality has also been significantly affected by municipal wastewater, aquaculture, seafood processing, and industrial effluents.

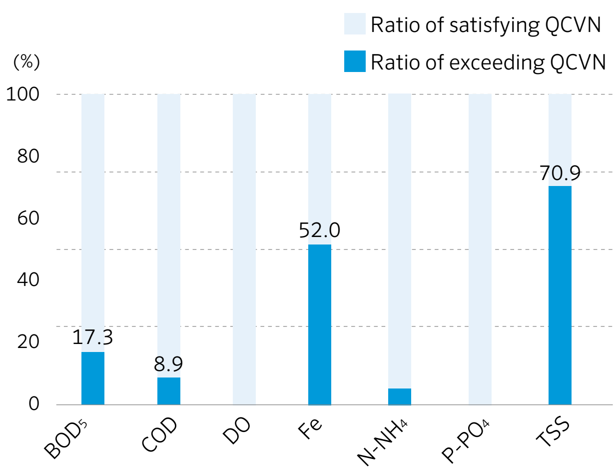


Figure 2.13.5 Proportion of water parameters exceeding QCVN 08-MT:2015/BTNMT (A2) in the Hong-Thai Binh river basin (Source: MONRE 2021)

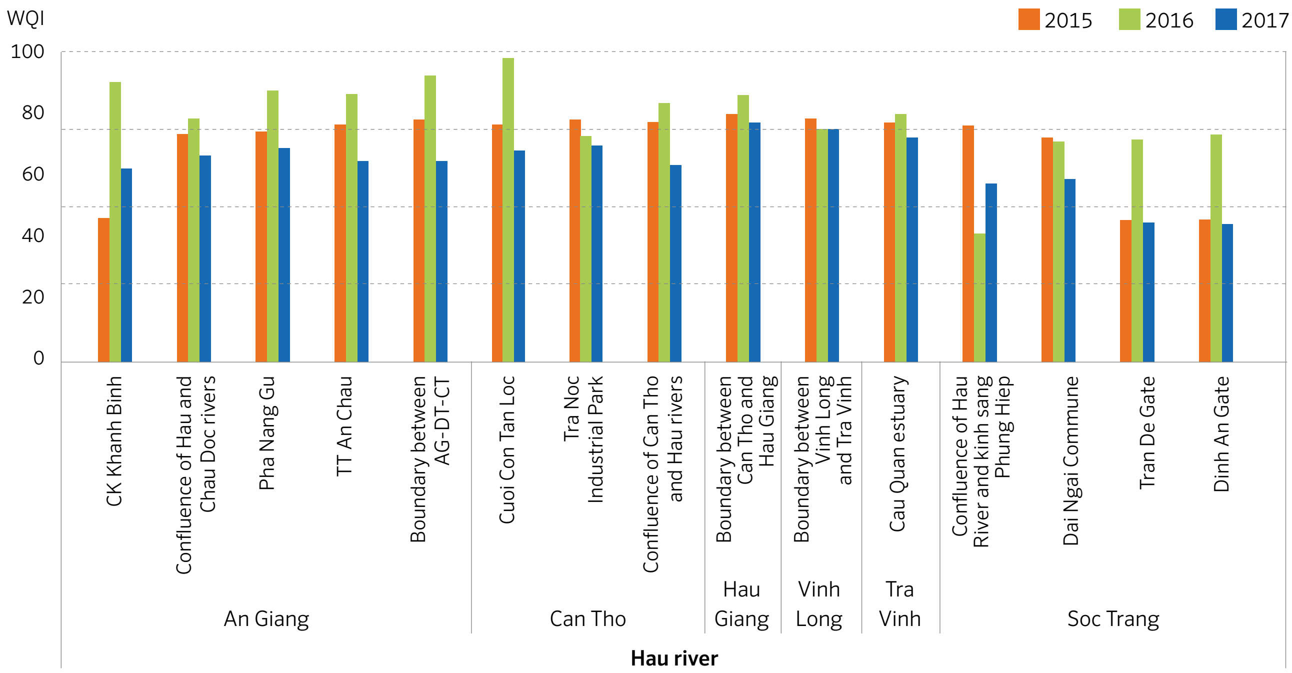


Figure 2.13.6 WQI values for the Hau River during 2016–2020 (Source: MONRE 2021)

Note: CK Khanh Binh = Khanh Binh border gate

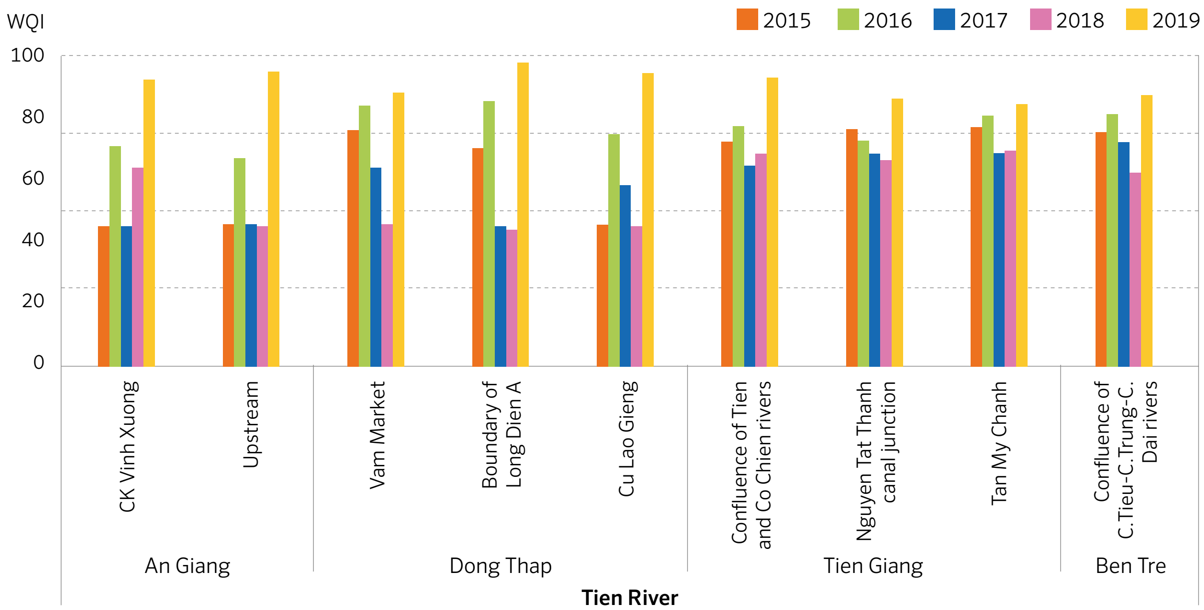


Figure 2.13.7 WQI values for the Tien River during 2016–2020 (Source: MONRE 2021)

(2) Coastal water

In the period 2016–2020, the quality of coastal seawater in Viet Nam was relatively good, with most parameter values within the limits set by National Technical Regulation on Coastal Water Quality QCVN 10-MT: 2015/BTNMT). The central area has the best coastal sea water environment, with 97.5% of the RQ index values less than 1, followed by the northern region (85.5%), then the southern region (75%), according to the results of the RQ index (Risk Quotient index) for the period of 2015–2019 (MONRE 2021).

The rainy season (May to October) sees higher pollution levels owing to the greater transfer of nutrients (ammonium, phosphate, nitrite, and nitrate) from land to sea. Furthermore, the northeast monsoon tends to drive marine contaminants into the coastal strip throughout the winter. In addition, socioeconomic activities in coastal regions, particularly in relation to seaport development, coastal aquaculture and seafood farming, and tourism development, have a significant impact on the quality of the seawater environment.

(3) Ground water

Although the water quality of groundwater may vary geographically throughout Viet Nam, it is generally considered relatively good. Normally, groundwater has pH values ranging from 6.0–8.0, which is termed as soft water (hardness <1.5 mg/L), and concentrations of organic compounds, microorganisms and heavy metals are often within permissible levels, i.e., as set by the National Technical Regulation on Groundwater Quality QCVN 09-MT:2015/BTNMT.

However, there has been evidence of heavy metal and ammonium pollution in groundwater in most areas of extensive groundwater exploitation, such as the northern region (Hanoi, Vinh Phuc, Ha Nam, Hai Phong, Hai Duong, Nam Dinh and Thai Binh), the central region (Thanh Hoa, Nghe An, Ha Tinh, Quang Binh and Thua Thien Hue), and a few locations in the southern region (Long An, Dong Nai, Binh Duong, Ho Chi Minh, Kien Giang, Ca Mau, and Soc Trang).

Arsenic contamination in groundwater mainly occurs in the northern delta region (see Fig. 2.13.8 and 2.13.9). According to groundwater quality results from 58 monitoring sites in the qh aquifer and 89 monitoring sites in the qp aquifer conducted from 2016 to 2020, Arsenic concentration in groundwater tends to grow in the qh aquifer and decrease in the qp aquifer.

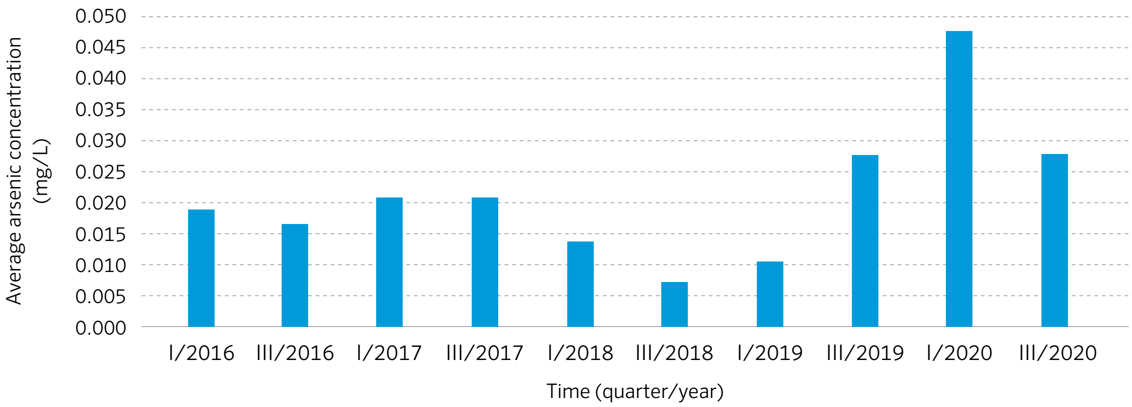


Figure 2.13.8 Average arsenic concentration in the qh aquifer in northern delta region (2016-2020) (MONRE, 2021)

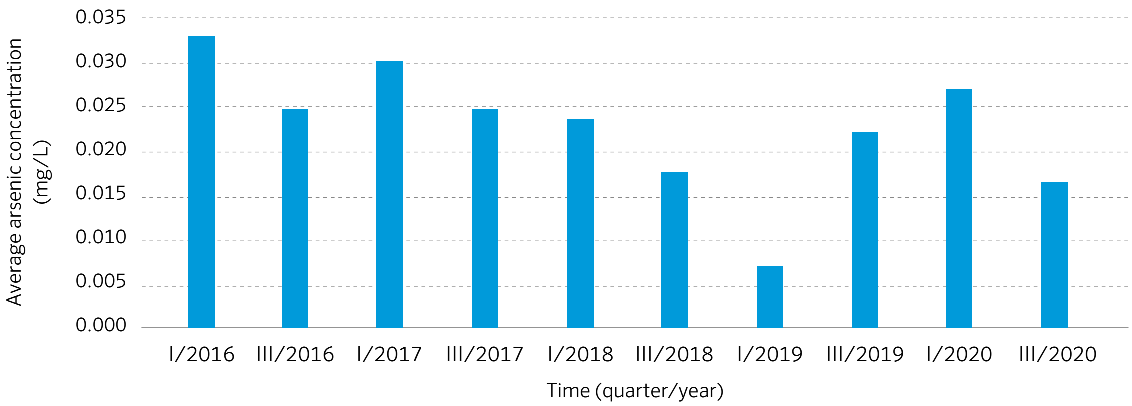


Figure 2.13.9 Average arsenic concentration in the qp aquifer in northern delta region (2016-2020) (MONRE, 2021)

4 | State of Wastewater Treatment

(1) Domestic wastewater

Domestic wastewater includes wastewater sources from household activities, businesses and service industries (restaurants, hotels, resorts, etc.). Although domestic wastewater accounts for more than 30% of the total amount of water directly discharged into the environment, the level of collection and treatment is still very low. One of the primary causes of the challenges facing centralized wastewater collection and treatment in metropolitan areas today is the system's primary usage for both rainfall and wastewater drainage. Although there are now more centralized urban wastewater treatment facilities than previously, the quantity is still highly insufficient in comparison to the true treatment needs. Untreated domestic wastewater released into the ecosystem is considered one of the main causes of water quality decline in rivers.

According to figures from the Viet Nam Environment Administration, around 7,680,000 m^3/day of domestic wastewater is generated from Class IV urban areas and higher, of which the rate of Class IV urban areas and higher with centralized wastewater treatment systems was 21.35%, which is considered low, with 49 centralized municipal wastewater treatment plants in operation. Nationwide, the average rate of municipal wastewater collection and treatment is estimated at 12.5% (MONRE 2021).

(2) Industrial wastewater

There are 280 industrial parks operating in the nation, with wastewater discharge volumes of approximately 510,000 m^3/day. Of these, 250 (89%) have centralized wastewater treatment systems that meet the environmental regulations. In areas with high concentrations of industrial parks, such Ho Chi Minh City, Hanoi, Binh Duong, Ba Ria-Vung Tau, Dong Nai, Long An, Quang Ninh, and Bac Ninh, the rate approaches 100%.

For the industrial parks without centralized wastewater treatment system, businesses and production facilities, such parks have invested in wastewater treatment systems that comply with approved environmental dossiers prior to discharge into the environment. Of the 250 industrial parks with centralized wastewater treatment systems, 219 (over 87.5%) have invested in automated wastewater monitoring equipment and send data to environmental control authorities on a regular basis. Industrial parks attach high importance to environmental incident prevention and response measures.

(3) Wastewater pollution from agricultural activities

Currently, agricultural wastewater is a matter of high concern as it represents one of the main factors influencing water resources in areas with thriving agricultural economies, such as the Mekong Delta and Red River Delta. Wastewater from agricultural activities often contains pesticides and fertilizers, which are toxic to the environment and human health. It is estimated that each year about 70,000 kg (solid form) and over 40,000 liters of pesticides (liquid form), as well as about 70,000 kg of untreated chemical bags enter the environment, increasing the levels of pollution of surface water and groundwater (World Bank 2017).

Regulations state that livestock facilities that produce less than 2 m^3/day of wastewater overall must provide sanitary wastewater collection, sedimentation, and composting systems; livestock facilities that produce over 2 m^3/day of wastewater but less than 5 m^3/day of wastewater must provide waste collection and treatment systems of sufficient capacity, such as biogas or appropriate biological bedding. However, the actual execution is still challenging and insufficient [Note: execution is vague as the subject is unclear. Suggestion: “However, the actual enforcement of such limits is still challenging and insufficient”].

5 | Frameworks for Water Environmental Management

(1) Legislation

Article 53 of the new Constitution 2013 states that “The land, water resources, mineral resources, wealth lying underground or coming from the sea and the air, other natural resources, and property invested and managed by the State are public properties, coming under ownership by the entire people represented and uniformly managed by the State.” The Constitution is the basis of environmental and water resources protection in the country.

On November 27, 2023, the National Assembly passed the Law on Water Resources No. 28/2023/QH15 (replacing the 2012 Law on Water Resources). To provide information on the implementation of the Law, on May 16, 2024, the Government issued Decree No. 53/2024/ND-CP detailing the implementation of certain articles of the Law on Water Resources, and Decree No. 54/2024/ND-CP regulating groundwater drilling practices, declaration, registration, licensing, water resource services, and water resource exploitation right fees. Simultaneously, on May 16, 2024, the Ministry of Natural Resources and Environment also issued three Circulars detailing the implementation of the Law (No. 03/2024/TT-BTNMT detailing the implementation of certain articles of the Law on Water Resources; No. 04/2024/TT-BTNMT regulating the inspection of legal compliance on water resources and the appraisal and acceptance of water resource basic investigation results; and No. 05/2024/TT-BTNMT regulating the relocation, change of location, and dissolution of groundwater monitoring stations). The above legal documents took effect concurrently with the effective date of the Law on Water Resources: July 1, 2024.

The 2023 Law on Water Resources represents a significant advancement in thinking and approach, shifting water resource governance “from an administrative management method to a combined administrative and economic instrument management method” in the context of Viet Nam’s water resources, which face numerous challenges. Management is carried out through four main policy groups reflected throughout the Law, including: (1) Ensuring water security; (2) Socializing the water sector; (3) Water resource economics; and (4) Water resource protection and prevention of water-related hazards.

Other relevant laws, such as the Mineral Law, Land Law and Biodiversity Law, and decrees, decisions, circulars and strategies on water resources management have also been promulgated to complete the national legislation related to water environmental management in Viet Nam.

(2) Institutional arrangement

State responsibilities for water resources management of the government, ministries and ministerial-level agencies, city and the provincial people's committee, district and commune people's committee are clearly stated in the Law on Water Resources 2012 and Law on Environmental Protection 2014, which has recently been replaced by a revised Law on Environmental Protection 2020 (No. 72/2020/QH14), which set out how the government is to perform uniform or overall state management of water resources.

The Ministry of Natural Resources and Environment (MONRE) is the main ministry responsible for the overall state management of water resources, including the planning for environmental protection, verification of reports on strategic environmental assessments, assisting the government in designing, implementing and providing guidelines for responses to climate change, providing instructions on environmental remediation and improvement, implementation of national environmental monitoring, promulgation of technical regulations, standards on water quality and obligation for water quality monitoring of public water bodies, and management of river basins nationwide (Figure 2.13.9).

Other ministries that may influence or affect water resources management include the Ministry of Agriculture and Rural Development, Ministry of Industry and Trade, Ministry of Health, Ministry of Science and Technology, Ministry of Construction, Ministry of Transport, and Ministry of Finance, Ministry of Planning and Investment, and Ministry of Home Affairs (see Table 2.13.4). In implementation, local governments play an important role in environmental management. The Department of Natural Resources and Environment (DoNRE) under the city or provincial people's committee takes a leading role in the promotion of environmental conservation activities through implementing environmental regulations and providing guidance.

Table 2.13.4 Responsibilities of other relevant ministries for water resources management

Relevant Ministries	Responsibilities
MARD	Responsible for agricultural water use and management; oversees irrigation system development and management; regulates agricultural water pricing and fee collection; and coordinates with MONRE on water resource planning and management for agricultural purposes
MOC	Responsible for urban water supply and drainage management; oversees urban water infrastructure development and management; regulates urban water pricing and fee collection; and coordinates with MONRE on water resource planning and management for urban areas
MOH	Responsible for water quality monitoring and health risk assessment; oversees waterborne disease prevention and control; and coordinates with MONRE on water quality management and health-related issues
MOST	Responsible for water-related scientific research and development; oversees water technology innovation and application; and coordinates with MONRE on water resource management and technology development
MPI	Responsible for national planning and investment in water resources; oversees water resource development and management in national plans and strategies; and coordinates with MONRE on water resource planning and management
MOF	Responsible for water resource-related budgeting and financial management; oversees water resource fee collection and management; and coordinates with MONRE on water resource financial management
MOIT	Responsible for industrial water use and management; oversees industrial water pricing and fee collection; and coordinates with MONRE on water resource planning and management for industrial purposes
MOT	Responsible for waterway transportation and management; oversees waterway infrastructure development and management; and coordinates with MONRE on water resource planning and management for transportation purposes
MOHA	Responsible for local government management and decentralization; oversees provincial and local water resource management; and coordinates with MONRE on water resource planning and management at local levels

(Source: Prepared by WEPA Secretariat based on information from the relevant decrees defining functions and responsibilities of each relevant ministry)

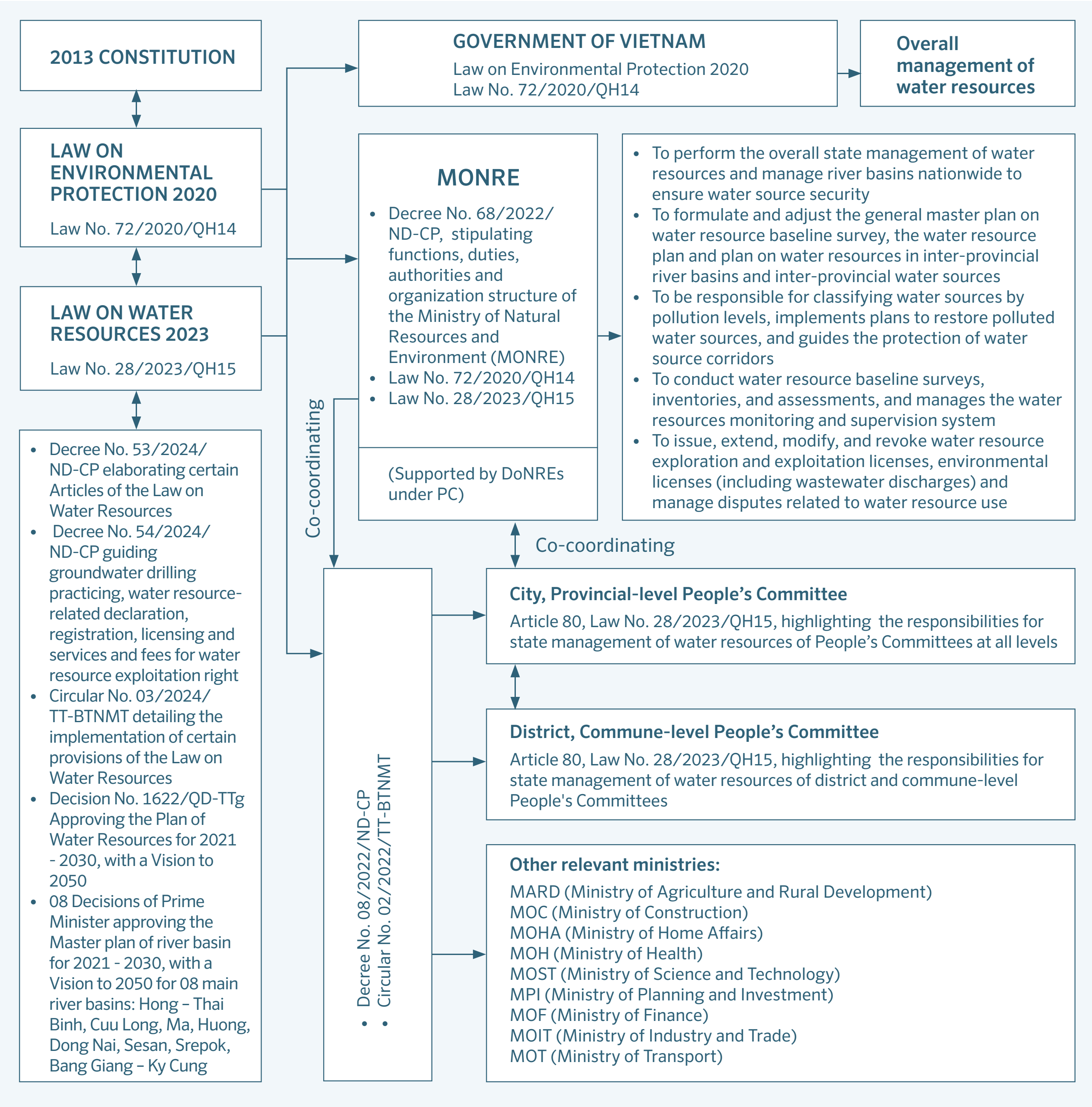


Figure 2.13.10 State responsibilities for water resources management in Viet Nam

(Source: Prepared by WEPA Secretariat based on information from the relevant decrees)

(3) Ambient water quality standards

a. Ambient water quality standards

Viet Nam has established a comprehensive system of ambient water quality standards to protect the environment and public health. These standards are developed based on scientific research and legal requirements and are regularly updated to meet the demands of sustainable development. Key ambient water quality standards in Viet Nam are regulated by MONRE and include the following:

- **National Technical Regulation on Surface Water Quality** (QCVN 08:2023/BTNMT): This regulation sets forth the maximum permissible limits for surface water quality parameters. It is used to manage, assess, and classify surface water quality, serving as a basis for the protection and utilization of water sources, as well as for the implementation of relevant environmental laws.

- **National Technical Regulation on Ground Water Quality** (QCVN 09:2023/BTNMT): This regulation specifies the limit values for groundwater quality parameters. It is applied in assessment and monitoring of the quality of groundwater sources, and provided guidance for various water use purposes.
- **National Technical Regulation on Marine Water Quality** (QCVN 10:2023/BTNMT): This regulation outlines the limit values for seawater quality parameters. It is used to assess and control the quality of seawater in marine areas, with the aim of protecting the environment, safeguarding human health, and fulfilling other objectives.

These regulations are applicable to state environmental management agencies, as well as all organizations, communities, households, and individuals whose activities impact surface water, groundwater and marine water quality within the territory of Viet Nam.

b. Water quality monitoring framework

Viet Nam has established a comprehensive water quality monitoring framework for surface water, groundwater and seawater. On March 7, 2024, the Prime Minister signed Decision 224/QD-TTg, approving the Overall Master Plan on National Environmental Monitoring for the 2021–2030 Period, with a Vision Toward 2050.

Currently, 260 points are operational, with 216 planned for implementation between 2021 and 2030, and 23 automatic monitoring stations are to be established post-2030. The monitoring frequency is set at a minimum of 10 times per year from 2023 to 2025, increasing to 12 times per year from 2026 to 2030. Key parameters for automatic stations include pH, COD (or TOC), TSS, and DO, with additional monitoring for total phosphorus (TP) and total nitrogen (TN) encouraged. Periodic monitoring will include pH, COD (or TOC), BOD_5, TSS, DO, NH_4^+, TP, TN, total coliform, and heat-resistant coliform, with chlorophyll a added for reservoir locations.

MONRE will also maintain and expand the estuarine water quality monitoring network to 76 points, comprised of 32 existing and 44 new points in river estuaries. The monitoring frequency is to be eight times per year at minimum from 2021 to 2025 and 12 times per year from 2026 to 2030, covering parameters such as pH, TOC, TSS, DO, NH_4^+, TP, TN, and total coliform.

For coastal seawater, the monitoring network is to expand to 70 points, maintaining 43 existing and adding 27 new points by 2030. The monitoring frequency is to be at least six times per year from 2021 to 2025 and eight times per year from 2026 to 2030, focusing on pH, DO, TSS, NH_4^+, PO_4^{3-}, and mineral grease.

Regulations stipulate a minimum monitoring frequency of 12 times per year for baseline surface water sites and quarterly for impact sites. Monitoring is conducted by environmental centers at various government levels.

(4) Effluent standards

a. Effluent standards

There are various effluent standards in Viet Nam, as shown in Fig. 2.13.12, including for domestic, industrial and medical wastewater. In general, industries are required to carry out environmental impact assessments (EIA) and to commit to self-monitoring four times a year, in accordance with a circular issued by the national government. Twice a year MONRE, VEA or/and DoNRE conduct inspections of compliance with industrial effluent standards, which are carried out based on prior announcement and not more than twice a year. If violations are suspected, so-called environmental police from the Ministry of Public Security are authorized to conduct compulsory investigations without prior notice, which increases opportunities to identify possible non-compliance.

As mentioned earlier, currently 219 out of 250 industrial parks are equipped with automated water quality monitoring equipment, accounting for 87.6%. In contrast, small-scale industrial clusters and craft communities typically lack automatic monitoring systems.

CONSERVATION OF WATER QUALITY

- **LAW ON ENVIRONMENTAL PROTECTION 2020**
- **LAW ON WATER RESOURCES 2023**
- **AMBIENT WATER QUALITY STANDARDS**
  - QCVN 08:2023/BTNMT – National Technical Regulation on Surface Water Quality
  - QCVN 09:2023/BTNMT – National Technical Regulation on Ground Water Quality
  - QCVN 10:2023/BTNMT – National Technical Regulation on Marine Water Quality
- **EFFLUENT STANDARDS**
  - **(a) Industrial Sectors**
    - QCVN 40: 2021/BTNMT – National Technical Regulation on Industrial Wastewater
    - QCVN 52: 2017/BTNMT – National Technical Regulation on Wastewater of Steel Industry
    - QCVN 60-MT: 2015/BTNMT – National Technical Regulation on the Effluent of Bioethanol Processing
    - QCVN 63: 2017/BTNMT – National Technical Regulation on Effluent Discharged from the Cassava Starch Processing Factory
    - QCVN 28: 2010/BTNMT – National Technical Regulation on Health Care Wastewater
    - QCVN 29:2010/BTNMT – National Technical Regulation on the Effluent of Petroleum Terminal and Stations
    - QCVN 35: 2024/BTNMT – National Technical Regulation on Discharged Produced Water for Offshore Oil and Gas Facilities
  - **(b) Agricultural, aquacultural and Livestock Sectors**
    - QCVN 62-MT: 2016/BTNMT – National Technical Regulation on the Effluent of Livestock
    - QCVN 11-MT:2015/BTNMT – National Technical Regulation on the Effluent of Aquatic Products Processing Industry
  - **(c) Textile and Dyeing Sector**
    - QCVN 13-MT: 2015/BTNMT – National Technical Regulation on the Effluent of Textile Industry
  - **(d) Paper and Pulp Sector**
    - QCVN 12-MT: 2015/BTNMT – National Technical Regulation on the Effluent of Pulp and Paper Mills
  - **(e) Rubber Sector**
    - QCVN 01-MT: 2015/BTNMT – National Technical Regulation on the Effluent of Natural Rubber Processing Industry
  - **(f) Domestic and Municipal Sectors**
    - QCVN 14: 2008/BTNMT – National Technical Regulation on Domestic Wastewater
    - QCVN 25: 2009/BTNMT – National Technical Regulation on Wastewater of Solid Waste Landfill Sites

Figure 2.13.12 Relevant laws and standards for conservation of water quality in Viet Nam
(Source: Prepared by WEPA Secretariat based on information from the relevant Laws, Standards, Decisions, Decrees, Circulars, etc.)

b. Effluent inspection procedure

Wastewater discharged from production, business, and industrial establishments is required to be periodically monitored as per the approved environmental impact assessment report and associated environmental protection plans. Industrial zones are obligated to install automatic continuous wastewater monitoring systems that transmit data to the local Department of Natural Resources and Environment.

According to Decision No. 1620/QD-BTNMT (July 21, 2016), organizations discharging 200 m^3/day or more of wastewater, which may pollute sea bodies or river basins, must be regularly inspected by central and local authorities.

As per Article 37 of Circular 25/2019/TT-BTNMT (December 31, 2019), project and facility owners are obligated to prepare annual environmental monitoring and protection reports, covering activities, measures, and waste management. These reports must be submitted to the Ministry of Natural Resources and Environment by January 31 of the following year. Facility owners must also maintain relevant documents for inspections.

In addition, the Ministry of Public Security issued Circular No. 71/2023/TT-BCA (December 18, 2023), which outlines detailed procedures for wastewater environmental inspections, with an emphasis on regular monitoring and compliance with effluent standards. This Circular takes effect in 2024, and is aimed at enhancing wastewater management at facilities.

(5) Major Policies on Water Environmental Management

In recent years, environmental management in Viet Nam has focused more on the use of economic tools, including taxes, environmental fees or other forms of sanctions or compensation as measures to complement other conventional standards-based approaches.

Tax policy related to the water environment

The Law on Environmental Protection 2020, which came into effect on January 1, 2022, introduces several economic instruments to enhance environmental protection, including:

i. Environmental protection taxes, which are introduced as a tool to mitigate pollution and encourage environmentally friendly practices. These taxes are levied on activities and products that have a significant impact on the environment, including water resources.
ii. The polluter pays principle, which mandates that those responsible for pollution bear the financial costs of managing it to prevent damage to human health or the environment. This principle is operationalized through taxes and fees that are proportionate to the level of pollution generated, encouraging polluters to reduce their environmental footprint.
iii. Tax incentives for sustainable practices, which allow entities that invest in environmentally friendly technologies and practices to benefit from tax incentives and reductions. This includes investments in wastewater treatment facilities and technologies that reduce water pollution. By offering these incentives, the government aims to promote the adoption of sustainable practices across various sectors, particularly those with significant environmental impacts.

It can be seen that the tax policy related to the water environment under the Law on Environmental Protection 2020 represents a strategic approach to integrating economic instruments into environmental governance. By leveraging taxes as a tool for environmental management, Viet Nam aims to reduce pollution, promote sustainable development, and enhance the protection of its water resources.

Environmental protection fee for wastewater

On May 5, 2020, the Government of Viet Nam passed Decree No. 53/2020/ND-CP, which governs environmental protection taxes for both residential and commercial wastewater. Organizations and individuals that release wastewater from their homes or businesses are subject to this directive. With value-added tax excluded, the environmental protection levy for household wastewater is 10% of the cost of one cubic meter (m^3) of clean water. Provincial or centrally-run city People's Councils determine the precise fee increases if required.

In the meanwhile, a fixed price based on wastewater volume is applied to industrial wastewater treatment plants with an average daily wastewater volume of less than 20 m^3/day. Facilities that discharge more than 20 m^3 per day are required to pay a fee that is determined by the formula: $F = f + C$, where F is the total fee, f is the fixed fee (VND 1,500,000/year until 2020, then VND 4,000,000/year starting in 2021), and C is the variable fee that is determined by the pollutant parameter content, collection rates, and total amount of wastewater discharged, as listed in the table presented in the Decree.

Sanctioning of administrative violations in the field of environmental protection and water resources

On July 7, 2022, the Government issued Decree No. 45/2022/ND-CP regulating sanctions for administrative violations in the field of environmental protection, effective from August 25, 2022, replacing Decree 155/2016/ND-CP and Decree 55/2021/ND-CP. The Decree comprises four chapters and 78 articles, and stipulates acts of administrative violations, sanction forms, sanction levels, remedial measures for acts of administrative violations, competencies required for administrative violation record keeping, and competencies required for sanctioning administrative violations in the field of environmental protection.

The Decree establishes a system of fines for different types of violations, with amounts set based on the severity and impact of violations. Fines range from a few million to several billion Viet Namese Dong, depending on the nature and extent of the violation.

In addition to fines, other sanctions may include suspension of operations, revocation of environmental permits, and mandatory corrective actions to address environmental damage.

6 | Recent Developments in Water Environmental Management

Implementation of the 2020 Law on Environmental Protection on the ground

Viet Nam has witnessed significant developments in water environmental management since the introduction of the revised Law on Environmental Protection in 2020 (hereinafter, '2020 Law'), driven by the need to address increasing levels of pollution and ensure sustainable water resources. The 2020 Law on Environmental Protection laid the groundwork for these advancements, introducing several crucial changes. Most notably, it established a river basin management approach, promoting integrated management across the entire river system, including upstream and downstream areas, and emphasizing biodiversity conservation and sustainable water use. This marked a shift from the previous focus primarily on downstream pollution control.

The 2020 Law also introduced stricter regulations on wastewater discharge, prioritizing environmental protection by restricting new projects that discharge into overloaded water bodies unless they employ advanced treatment or water recycling technologies. Furthermore, the 2020 Law mandated the development of surface water quality management plans, and specified carrying capacities, discharge limits, and pollution reduction targets. Responsibilities for these plans were divided between the Ministry of Natural Resources and Environment (MONRE) for inter-provincial rivers and lakes, and provincial People's Committees for intra-provincial bodies of water, promoting coordinated management efforts.

Law on Water Resources 2023

Further strengthening the legal framework, the 2023 Law on Water Resources (hereinafter, '2023 Law') built upon the foundation laid by the revised Law on Environmental Protection 2020. The 2023 Law highlights four important policy areas: ensuring water security; socializing the water sector; expanding water resource economics; and protecting water resources and minimizing water-related dangers.

The 2023 Law also introduces numerous specific provisions to achieve these goals, including: promoting water source restoration; requiring groundwater protection plans; linking water use plans to water resource scenarios published by MONRE; mandating registration for all surface and groundwater exploitation activities; establishing water resource protection corridors; integrating basic investigation results into a national water resource database system; formalizing water resource inspection procedures; regulating groundwater monitoring station operations; defining coordination requirements for reservoirs; listing and protecting key water infrastructure projects; allocating environmental protection budget for water quality and restoration investigations; promoting digital transformation of the water resource database system; institutionalizing water security measures based on Politburo Conclusion 36 on water security and dam safety; and implementing water resource accounting, a water security index, and artificial groundwater recharge programs.

The above advances constitute comprehensive efforts to modernize Viet Nam's water management system, including through integrated planning, stronger laws, economic instruments, and technical improvements to ensure the sustainable use and protection of the nation's essential water resources. While the full impact of these legal changes is still unfolding, they signal a clear commitment to addressing the pressing challenges facing Viet Nam's water environment.

7 | Challenges and Future Plans

Viet Nam's government has made extensive efforts to address water environmental challenges by focusing on regulatory improvements, strengthening enforcement mechanisms, securing resources, and adopting new technologies. Another important component of Viet Nam's approach to addressing these intricate water concerns is strengthening international cooperation.

Nevertheless, a number of issues still need to be resolved in spite of these efforts, especially:

1. Effective enforcement of new Law on Environmental Protection and Law on Water Resources 2020 to ensure the compliance and sufficient use of economic incentives, such as environmental taxes that contribute to reducing water pollution.

   - Proposed actions:
     - Increasing pollution control efforts, performing regular inspections, and promoting a shift to real-time monitoring technology are ways to improve pollution control in high-risk areas.
     - Applying cutting-edge scientific and technological solutions along with economic methods to protect water.

- The primary sources of water pollution should be further controlled with adequate funding allocation, particularly in areas that are contamination hotspots along major river basins.
- Encouraging community participation in environmental conservation projects.
- Further enhancing international and regional collaboration (ASEAN region), especially in the area of transboundary water management.

2. Inadequate funding allocated to implementing water protection initiatives. The government needs more financial support, particularly from private sector investments.

   - Proposed actions:
     - Promoting further international cooperation with development partners and partner countries to secure funding and resources.
     - Encouraging private sector investment in water environmental protection projects.

3. Adoption of low-carbon and eco-friendly or clean technologies presents technical obstacles. Water contamination, especially from the production process, is a result of outdated production methods and a lack of technical know-how for efficient water management.

   - Proposed actions:
     - Further promoting international collaboration, which may facilitate transfer of advanced and low-carbon technologies.
     - Minimizing reliance on antiquated technology, promoting environmentally sustainable production practices, and enforcing more stringent screening.

4. Weak institutional and human resources capacity, especially at the local government level, which hinders the country's efforts to manage water-related environmental challenges. These capacity limitations impact the effective implementation of policies, enforcement, and technical operations.

   - Proposed actions:
     - Establishing a central coordinating body that can ensure a unified approach to water management across sectors and regions.
     - Improving regulatory bodies' capabilities by offering focused training courses in resource management, data gathering, and policy enforcement.
     - Designing and implementing long-term capacity training programs, which could be focused on pollution monitoring, water quality assessment, and the effective application of advanced water and wastewater treatment technologies.Knowledge transfer and increased technical competence at the local level can be facilitated by international cooperation, especially with nations that have experience in managing water resources (such as Germany, Japan, etc.).
     - Training employees to operate and interpret digital monitoring tools is crucial to maximizing their efficacy upon their adoption by the government (e.g., Geographic Information Systems (GIS) and Internet of Things (IoT)-based sensors for real-time water quality tracking).
     - Developing a new generation of experts capable of addressing Viet Nam's water problems via cooperation with academic institutions to create water management and environmental engineering programs.

References/Appendix

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Chapter 1

3 | Surface water quality management

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Appendix

Table A-1 Classifications of surface water quality standard

Country	Classification	Details
Cambodia	Type 1	Public water Type 1 refers to the closed water sources, such as reservoirs, ponds, lakes, lowlands, as well as canals, streams, and creeks that do not flow during the dry season.
	Type 2	Public water Type 2 refers to open water sources, such as seas, rivers, estuaries, as well as canals, streams, and creeks that flow during the dry season.
China	I	Areas with high environmental importance/upstream areas
	II	Drinking water resources in first-class protected areas, protected areas for precious fish, and spawning areas for fish and shrimp
	III	Drinking water resources in second-class protected areas, protected areas for fish, and swimming areas
	IV	Industrial water resources and recreational use with no human contact with water
	V	Agricultural water resources and water areas required for landscapes
Indonesia	One	Drinking water, and/or water for other purposes that require the same water quality as the use
	Two	Water recreation infrastructure/facilities, freshwater fish farming, livestock, water for irrigating crops, and/or other purposes that require the same water quality as the use
	Three	Freshwater fish farming, livestock, water for irrigating crops, and/or other purposes that require the same water quality as the use
	Four	Crop irrigation and/or other purposes that require the same water quality as the use
Japan	AA	Water supply class 1, conservation of natural environment and A–E
	A	Water supply class 2, fishery class 1, bathing and B–E
	B	Water supply class 3, fishery class 2, and C–E
	C	Fishery class 3, industrial water class 1, and D–E
	D	Industrial water class 2, agricultural water, and E
	E	Industrial water class 3 and conservation of environment
	Aquatic life A	Water bodies inhabited by aquatic organisms such as salmon, and trout, and also their prey, which favour relatively low-temperature ranges
	Special aquatic life A	Water bodies categorized in “Aquatic life A” that need to be conserved in particular as breeding or nursery grounds for the aquatic life categorized in “Aquatic life A.”
	Aquatic life B	Water bodies inhabited by aquatic organisms such as carp and crucian, and also their prey, which favour relatively high-temperature ranges.
	Special aquatic life B	Water bodies categorized in “Aquatic life B” that need to be conserved in particular as breeding or nursery grounds for the aquatic life categorized in “Aquatic life B.”
Korea	Ia	The ecosystem is in a pristine state with abundant dissolved oxygen and absence of pollutants. Domestic water use is suitable after simple water treatment processes such as filtration and disinfection.
	Ib	The ecosystem is very near to a clean state with a high level of dissolved oxygen and minimal presence of pollutants. After common water treatment processes such as filtration, sedimentation, and disinfection, it can be used as domestic water for daily living.
	II	The ecosystem is in a relatively good state with a high level of dissolved oxygen, although there are slight traces of pollutants.
	III	After common water treatment processes such as filtration, sedimentation, and disinfection, it can be used as domestic water or recreational water for activities such as swimming.
	IV	Due to typical pollutants leading to the consumption of dissolved oxygen, this general ecosystem can be subjected to advanced water treatment processes such as filtration, sedimentation, activated carbon input, and disinfection.
	V	After high-level purification, the water can be utilized for domestic purposes or, following standard water treatment, for industrial purposes.
	VI	Due to a significant amount of pollutants leading to the consumption of dissolved oxygen, this general ecosystem can be subjected to advanced water treatment processes such as filtration, sedimentation, activated carbon input, and disinfection.

Country	Classification	Details
Laos	1	Natural water bodies with good quality water, that do not go through any production process or chemical additives and are free from wastewater from all kinds of activities.
	2	Water bodies that are used for consumption but must be disinfected. This type of water is suitable for the conservation of aquatic animals, fisheries, water sports, etc.
	3	Water bodies that are used for consumption, but must be disinfected. This type of water is suitable for agriculture, animal husbandry, etc.
	4	Water bodies that are used for consumption, but must be disinfected. This type of water is suitable for industry, as a place to receive and treat wastewater from the city or community, etc.
	5	Water bodies for transportation and for use as reservoir for treatment of wastewater from cities or communities, and so on.
Malaysia	I	Conservation of natural environment. Water Supply I—Practically no treatment necessary. Fishery I—Very sensitive aquatic species.
	IIA	Water Supply II—Conventional treatment required. Fishery II—Sensitive aquatic species.
	IIB	Recreational use with body contact.
	III	Water Supply III—Extensive treatment required. Fishery III—Common, of economic value and tolerant species; livestock drinking.
	IV	Irrigation
	V	None of the above
Myanmar	I	Conservation of the natural environment, Water supply Grade 1, Water uses listed in Class II–V
	II	Water supply Grade 2, fisheries Grade 1, bathing and swimming, water uses listed in Class III–V
	III	Water supply Grade 3, industrial water Grade 1, agricultural water Grade 1, water uses listed in Class IV–V
	IV	Industrial water Grade 2, agricultural water Grade 2, water uses listed in Class V
	V	Navigation/Transportation, environmental conservation
Philippines	AA	Public Water Supply Class I—Intended primarily for waters having watersheds, which are uninhabited and/or otherwise declared as protected areas, and which require only approved disinfection to meet the latest PNSDW
	A	Public Water Supply Class II—Intended as sources of water supply requiring conventional treatment (coagulation, sedimentation, filtration and disinfection) to meet the latest PNSDW
	B	Recreational Water Class I—Intended for primary contact recreation (bathing, swimming, etc.)
	C	1. Fishery Water for the propagation and growth of fish and other aquatic resources 2. Recreational Water Class II—For boating, fishing or similar activities 3. For agriculture, irrigation and livestock watering
	D	Navigable waters
Sri Lanka	A	Water that requires simple treatment for drinking
	B	Bathing and contact recreational water
	C	Water suitable for aquatic life
	D	Water source that requires general treatment process for drinking
	E	Water suitable for irrigation and agricultural activities
	F	Water of minimum quality but not falling into categories A to E
Thailand	1	Extra clean for conservation purposes
	2	Very clean; used for (1) consumption, which requires ordinary water treatment processes; (2) aquatic organism conservation; (3) fisheries; (4) recreation [e.g., DO > 6 mg/L, BOD > 1.5 mg/L, fecal bacteria < 1,000 MPN/100 mL)
	3	Medium-clean; used for (1) consumption, but only after passing through ordinary treatment process; (2) agriculture [e.g., DO > 4 mg/L, BOD < 2 mg/L, fecal bacteria < 4,000 MPN/100 mL)
	4	Fairly clean; used for (1) consumption, but requires special treatment process; (2) industry [e.g., DO > 2 mg/L, BOD < 4 mg/L)
	5	Water not classified in Class 1–4, which is no water quality requirement, and used for navigation
Viet Nam	A	Good water quality. The ecosystem in the aquatic environment has a high dissolved oxygen (DO) content. Water that can be used for domestic water supply, swimming, and water recreation purposes after applying appropriate treatment measures.
	B	Average water quality. The aquatic ecosystem consumes a lot of dissolved oxygen due to a large amount of pollutants. Water that can be used for industrial and agricultural production purposes after applying appropriate treatment measures.
	C	Poor water quality. The aquatic ecosystem has a sharp decrease in dissolved oxygen due to a large amount of pollutants. Water that does not cause unpleasant odours and can be used for industrial production purposes after applying appropriate treatment measures.
	D	Water quality is very poor; can cause high impact on fish and aquatic organisms due to low dissolved oxygen concentration; high concentration of pollutants. Water that can be used for waterway transportation and other purposes with low water quality requirements.

Table A-2 Reference table for parameter identifiers in Table 1.4

No.	Physical parameter	No.	Chemical parameter	No.	Chemical parameter
P1	Temperature	Basic		Ionic composition	
P2	Total suspended solids (TSS)	C1	pH	C32	Aluminium
P3	Suspended solids (SS)	C2	Dissolved oxygen (DO)	C33	Fluoride
P4	Total Dissolved Solids (TDS)	C3	Bottom dissolved oxygen	C34	Boron
P5	Floatables	C4	Permanganate index	Pesticide, insecticides, herbicides	
P6	Transparency	C5	Biochemicals oxygen demand (BOD)	CP1	Organophosphate as malathion
P7	Turbidity	C6	Chemical oxygen demand (COD)	CP2	Tetrachloromethane, Carbon tetrachloride
P8	Color	C7	Total organic carbon (TOC)	CP3	Hexachlorobenzene (HCB)
P9	Odour	C8	Salinity	CP4	Dichlorodiphenyltrichloroethane (DDT)
P10	Taste	C9	Hardness	CP5	t-DDT
P11	Electrical Conductivity	Ionic composition		CP6	Dieldrin
P12	Waste	C10	Nitrite nitrogen (NO_2-N)	CP7	Endrin aldehyde
No.	Biological parameter				
B1	Total Coliform	C12	Ammonium nitrogen (NH_3-N)	CP9	Aldrin
B2	Coliform Bacteria	C13	Ammonia	CP10	Aldrin/ Dieldrin
B3	Fecal coliform bacteria, thermotolerant coliforms	C14	Total nitrogen (TN)	CP11	1,3-Dichloropropene
B4	*Escherichia coli (E. coli)*	C15	Organic Phosphorus	CP12	Hexachlorocyclohexane
No.	Radioactive parameter				
R1	Uranium	C17	Total phosphorus (TP)	CP14	Heptachlor and Heptachlor Epoxide
R2	Related to radioactive-α	C18	Chlorophyll-a	CP15	Heptachlor/Epoxide
R3	Related to radioactive-β	C19	Chloride	CP16	Methoxychlor
R4	Radium-226	C20	Free Chlorine	CP17	Toxaphene
R5	Strontium-90	C21	Chlorine	CP18	2,4-dichlorophenoxyacetic acid (2,4-D)
No.	Other				
O1	CCE	C23	Sulfur	CP20	2- (2,4,5-trichlorophenoxy) propionic acid (2,4,5-TP, Fenoprop)
O2	Oils and grease	C24	Sulfide	CP21	Paraquat
O3	Oils and grease (Mineral)	C25	Sulfate	CP22	Benzene Hexachloride (BHC)
O4	Oils and grease (Emulsified Edible)	C26	Silica	CP23	Lindane
O5	Petroleum	C27	Carbon dioxide	CP24	α-Benzene Hexachloride (α-BHC)
		C28	Calcium	CP25	Endosulfan
		C29	Magnesium	CP26	Chlordane
		C30	Natrium	CP27	Thiram
		C31	Potassium	CP28	Simazine

Note: Parameters were primarily identified based on the parameter names or chemical formulas provided in the respective documents. However, in some cases, definitive identification was challenging. In such cases, the chemical formulas or translated names are listed as they appear.
The classification relies on the names of water quality standard parameters provided in the reference and does not account for variations in measurement methods.

No.	Chemical parameter	No	Chemical parameter
Pesticide, insecticides, herbicides		Industrial	
CP29	Thiobencarb	CI27	Phenol
CP30	MCPA	CI28	Nonylphenol
CP31	Pendimethalin	CI29	Volatile phenols
CP32	Organophosphorus pesticides	CI30	Linear alkylbenzene-sulfonate
CP33	Organochlorine pesticides	CI31	Polychlorinated Biphenyls (PCB)
Industrial (e.g. solvent, surfactants, materials)		CI32	Cyanide
CI1	$C_{10}H_{13}NO_3$	Heavy metals	
CI2	Tetrachloroethylene, PCE	CH1	Zinc
CI3	Hexachlorobutadiene	CH2	Nickel
CI4	Trichloromethane, Chloroform	CH3	Manganese
CI5	Formaldehyde	CH4	Cadmium
CI6	Methylene chloride, dichloromethane	CH5	Cobalt
CI7	1,2-Dichloroethene	CH6	Mercury
CI8	Cis 1.2-Dichloroethylene	CH7	Alkyl mercury
CI9	1,1-Dichloroethylene	CH8	Methylmercury
CI10	1,2 Dichloroethane	CH9	Lead
CI11	1,1,1- Trichloroethane	CH10	Chromium
CI12	1,1,2- Trichloroethane	CH11	Hexavalent chromium
CI13	Trichloroethylene	CH12	Chromium (III) oxide
CI14	1,4-Dioxane	CH13	Arsenic
CI15	1,2,3-Trichlorobenzene	CH14	Copper
CI16	Benzene	CH15	Barium
CI17	Benzo (a) pyrene	CH16	Selenium
CI18	Toluene	CH17	Antimony
CI19	Xylenes	CH18	Iron
CI20	Ethylbenzene	CH19	Silver
CI21	Bis (2-ethylHexyl) phthalate (DEHP)	CH20	Tin
CI22	Anionic surfactants (MBAS)		
CI23	Surfactant		
CI24	Total detergent		
CI25	Total Phenol		
CI26	Phenolic compounds		

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