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 m³, 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 m³, 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, $COD\text{-}^{Cr}$ 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)

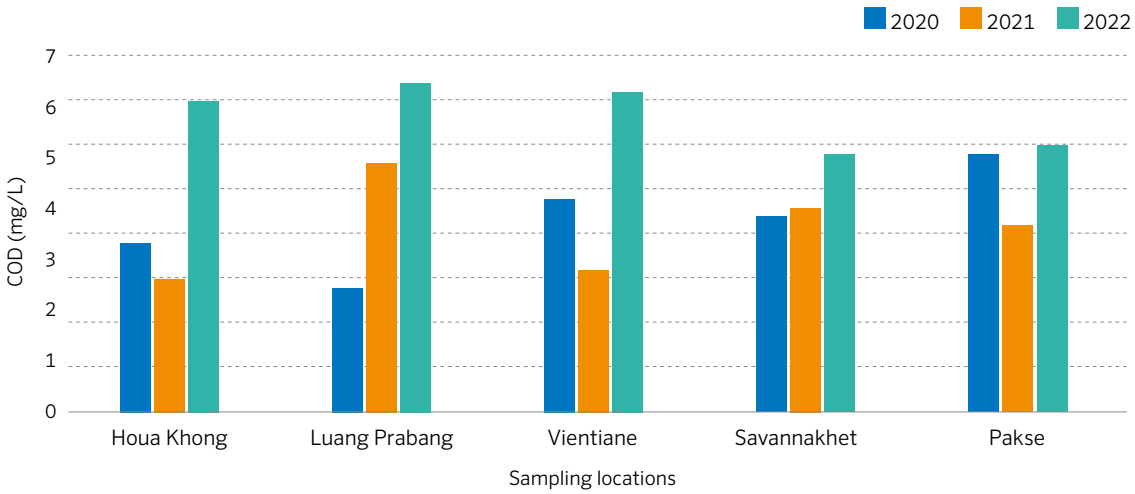

Figure 2.6.2 Spatio-temporal analysis of water quality at five mainstream monitoring stations along the Mekong River in Lao (MRC 2020, 2021, 2022) (Source: MONRE 2019)

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).

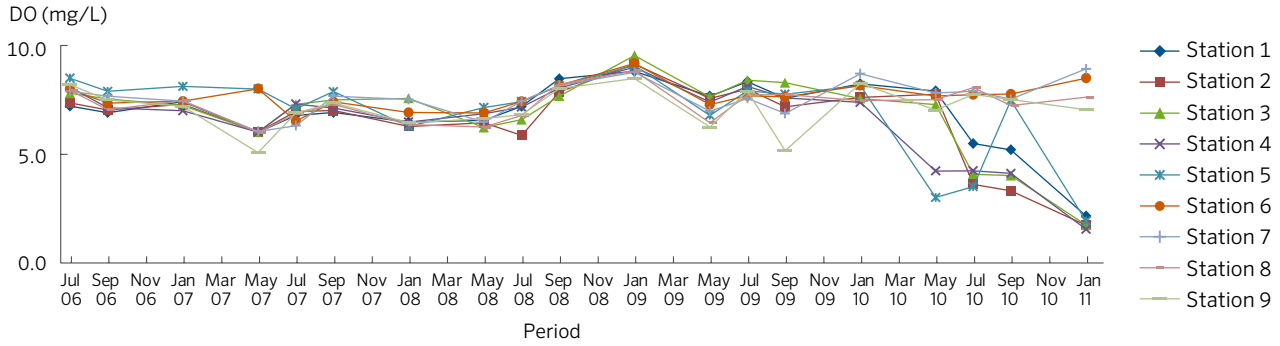

Figure 2.6.3 DO levels at monitoring stations at the Nam Ngum dams (Source: Komany 2011)

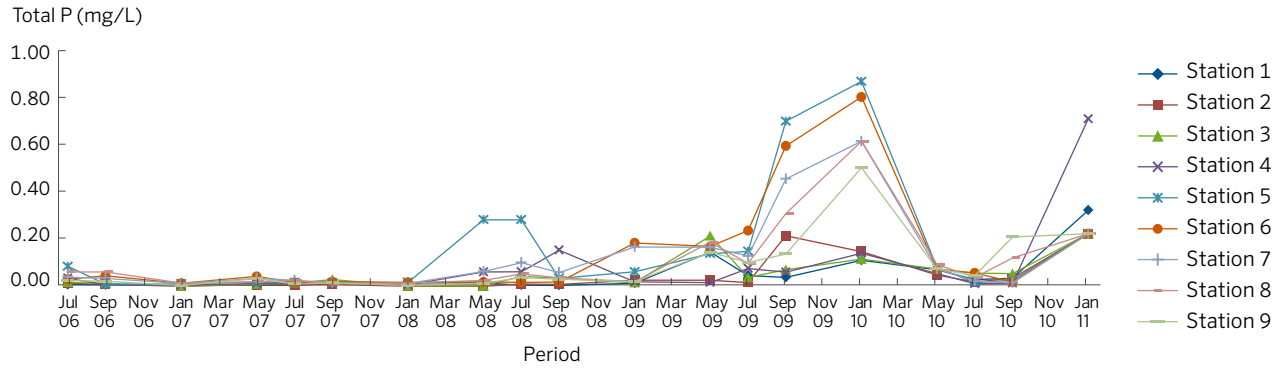

Figure 2.6.4 TP levels at monitoring stations at the Nam Ngum Dams (Source: Komany 2011)

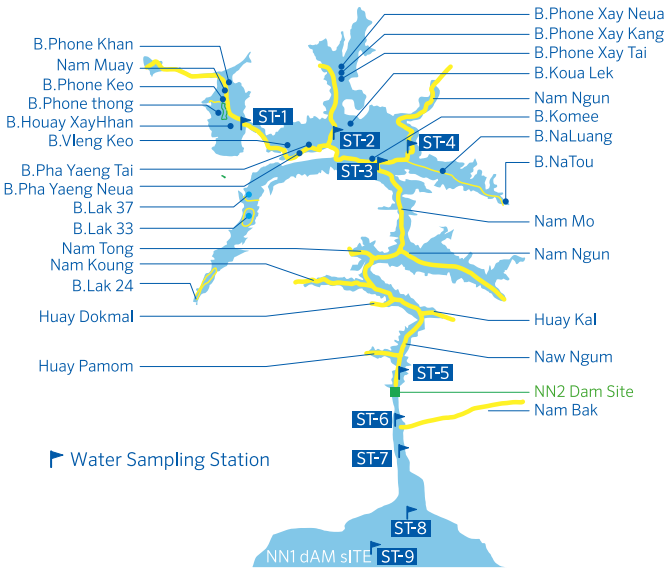

Figure 2.6.5 Monitoring stations of the Nam Ngum dams (Source: Komany 2011)

(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 groundwater 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.

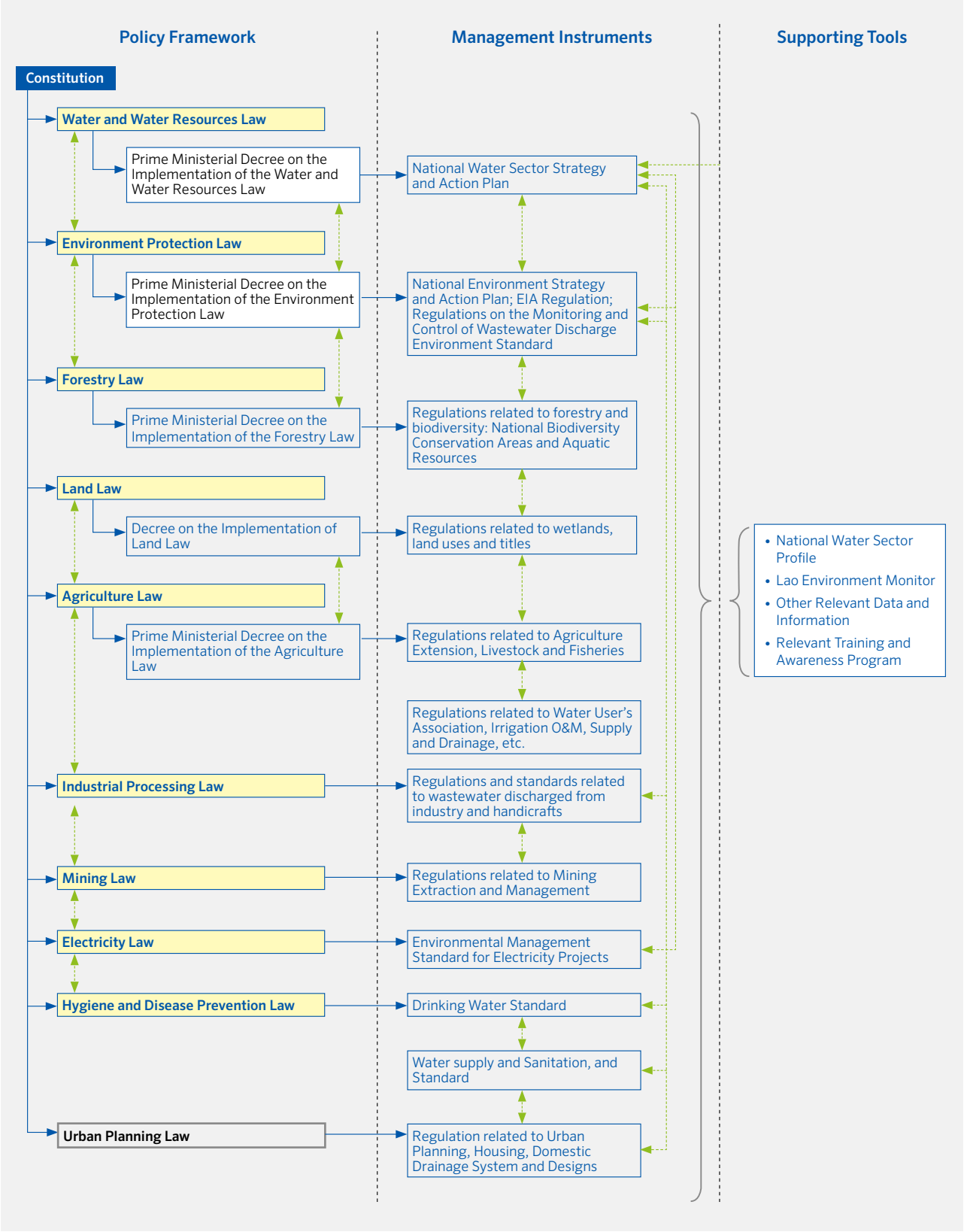

Figure 2.6.6 Legislation system for water environmental management in Laos (Source: MoEJ 2009)

(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