2.6 Lao PDR

1 | Country Information

Table 2.6.1 Basic indicators

Land Area (km²)		236,800 (2019)
Total Population		7.12 million (2019)
GDP (current USD)		19.1 billion (2019)
GDP per capita (current USD)		2,670 (2019)
Average Precipitation (mm/year)		1,834 (2019)*
Total Renewable Water Resources (km³)		333.55 (2011)**
Total Annual Freshwater Withdrawals (billion m³)		7.32 (2017)**
Annual Freshwater Withdrawals 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 Lao PDR 2020, **FAO 2021 (estimated))

Figure 2.6.1 Mekong River in Luang Prabang, Lao PDR

2 | State of Water Resources

Lao PDR has rich water resources. 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).

As with other Southeast Asian countries, seasonal distribution of water resources is uneven in Lao PDR – 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 Lao PDR (MONRE 2019), a country where 90% of the territory lies within the Mekong River basin. Its 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 Lao PDR 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. On the part of the Mekong River downstream 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 run-off 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.

3.1 Rivers

For 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. River water quality in Lao PDR is generally considered to be good, although human impacts on the river water quality are increasing (Table 2.6.2). Result shows that except for a few monitoring stations, the water quality of most of the water sampling locations are not affected by anthropogenic activities in their surroundings. 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 area is located in the low-lying deltaic zone, excessive sediment load is the primary quality problem for the whole country, especially in the wet season.

Under different funding agencies, water quality monitoring was conducted from 2009 to 2015 in the mainstream of the Mak Hiao River and its major tributaries, the Hong Ke and Hong Xeng Rivers in Vientiane province. The results in terms of biochemical oxygen demand (BOD) are shown in Figure 2.6.2, which shows that BOD concentrations range from 2.1 mg/L to 29.2 mg/L (MONRE 2019). Water was found to be highly polluted especially in urban areas.

Table 2.6.2 Levels of human impacts on water quality and water quality class for the protection of aquatic life 2007–2011 at the Mekong, Lao PDR water quality monitoring stations

Monitoring sites	Human impacts on water quality					Water quality class for the protection of aquatic life							
	2007	2008	2009	2010	2011	2007	2008	2009	2010	2011	2012	2013	2014
Houa Khong	C	B	B	C	B	A	A	A	A	A	B	B	B
Luang Prabang	B	C	B	C	B	A	A	A	B	A	A	B	B
Vientiane	C	C	B	C	A	A	A	A	A	A	A	B	B
Savannakhet	C	C	C	B	C	A	A	A	A	A	A	B	B
Pakse	B	B	B	C	A	A	A	A	A	A	A	B	B

Notes: Impacts (A: No impact; B: Low impact; C: Medium impact; D: High impact/
Water quality for aquatic life (A: Excellent quality; B: Good quality; C: Moderate quality; D: Poor quality) (Source: Kongmeng and Larsen 2016)

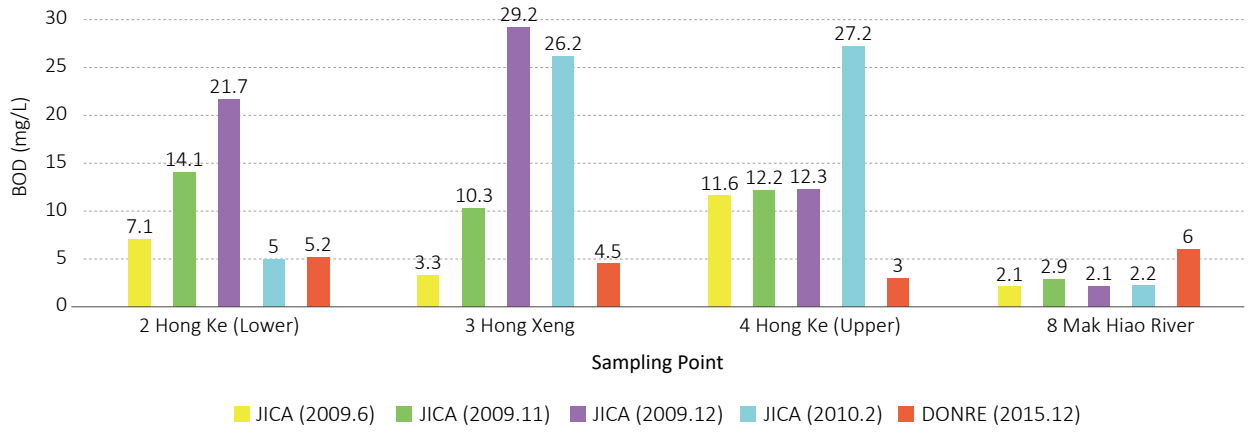

Figure 2.6.2 Comparative study of river water quality in terms of BOD for four major river bodies under five different works (Source: MONRE 2019)

Under a scheme supported by the World Bank, the water quality of 11 major rivers around Laos was analyzed, the results of which are shown in Table 2.6.3. As the results suggests, river bodies around Vientiane, followed by Savannakhet, show relatively high concentrations of water quality parameters compared to the national water quality standard, mainly chloride, sulphate, EC, and alkalinity, owing to the impact of higher anthropogenic activities like mining activities. 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 different monitored river bodies around Laos PDR

	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	0.12 m	0.2 m	0.03 m	0.03 m	0.03 m	0.03 m	0.03 m	0.03 m	0.03 m
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
TN (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
TP (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)

3.2 Lakes and Reservoirs

Perennial ponds, marshes and oxbow lakes are common in the lowland floodplains of Lao PDR, which are usually shallow and vary greatly in size during the year and serve as habitats for many types of aquatic plants, mollusks, crustaceans, amphibians and reptiles. 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 Ngum1) from 2006–2011 as part of a hydropower development project, and the results of monitoring at nine monitoring stations (see Figure 2.6.5) shows a decreasing trend for dissolved oxygen (DO) levels in some stations compared with national standard value of 6mg/L (Figure 2.6.3). Total phosphorus levels in some stations in 2009 also highly exceeded the national standard (0.05 mg/L) (Figure 2.6.4). Fertilizers and detergents are suspected as the potential sources of pollution (Komany 2011).

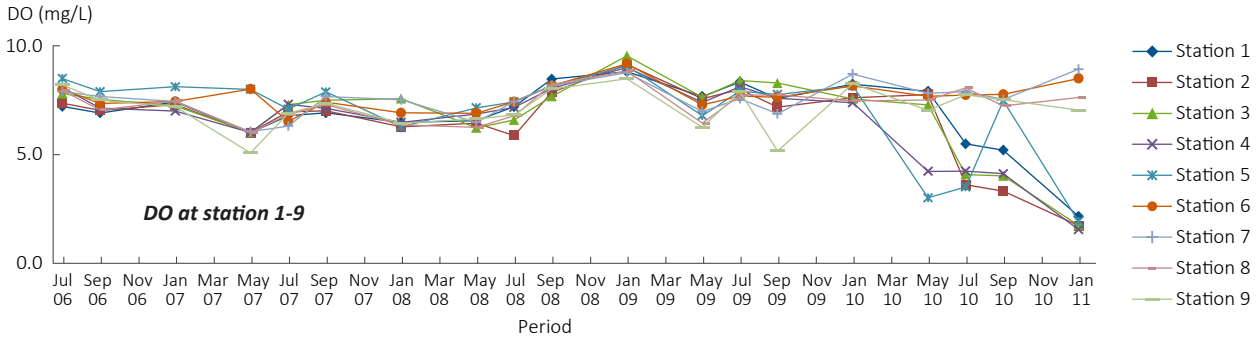

Figure 2.6.3 DO levels at monitoring stations at the Nam Ngum Dams (Source: Komany 2011)

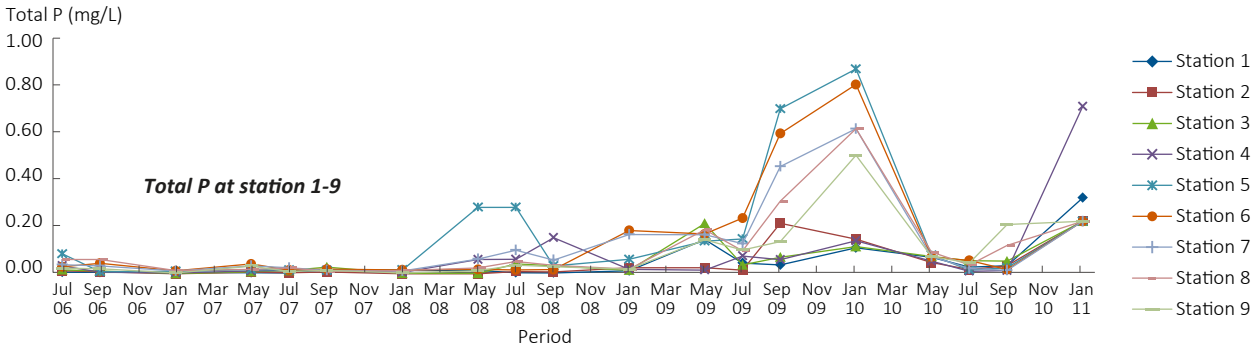

Figure 2.6.4 TP levels at monitoring stations at the Nam Ngum Dams (Source: Komany 2011)

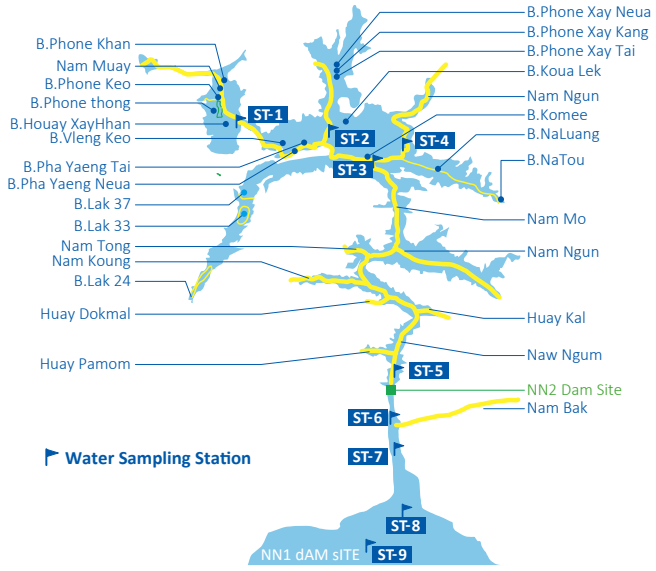

Figure 2.6.5 Monitoring stations of the Nam Ngum Dams (Source: Komany 2011)

3.3 Groundwater

Groundwater information, including resource potential, uses and quality is very limited in the country. Since surface water is abundant for supply, groundwater is regarded as a source only when and where surface water is not available (Chanthavong 2011). However, groundwater is an important source of domestic water, small-scale irrigation and small-scale industry. It is also used as a source for urban water supply, although covering only 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

Wastewater and major pollutants

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

Domestic wastewater

In order to handle these 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 it indicates there is a significant increase in capacity of DEWAT system in the country. As of 2017, a total capacity of 464.8 m^3/day DEWAT system is functional in the country (MONRE 2019).

Table 2.6.4 Status of domestic (decentralized) wastewater treatment system

No	Year	Location	Treatment capacity (m^3/day)	User
1	2009	Vientiane Capital	10	125
2	2010	Vientiane Capital	11.2	146
3	2010	Vientiane Capital	7	116
4	2011	Louanphabang Province	15	208
5	2011	Khammoan Provive	70	700
6	2011	Khammoan provive	30	300
7	2012	Vientiane Capital	26	455
8	2013	Vientiane Province	3	66
9	2014	Attapeu province	14	163
10	2014	Attapeu province	14	235
11	2014	Vientiane procince	160	1,600
12	2014	Champasak Province	15	300
13	2015	Champasak Province	8	150
14	2015	Vientiane Capital	6.4	80
15	2015	Vientiane Capital	1.5	50
16	2015	Houaphan province	14	161
17	2015	Louanphabang Province	10	500
18	2015	Vientiane Capital	10.2	-
19	2016	Xekong Province	35	50 bed
20	2016	Bokeo Province	1	220
21	2017	Louanphabang province	5	-
Total			**464.8 m^3/d**	

Industrial wastewater

Most industries and factories in Lao PDR dispose of their industrial waste water directly into surface water bodies such as ponds and rivers; however, such ponds lack the sheeting to prevent infiltration of various pollutants from untreated wastewater entering underground bodies. Small factories in Lao PDR have ponds for industrial effluent disposal, and some large-scale industries have their own wastewater treatment plants including 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

5.1 Legislation

The Environmental Protection Law (EPL) Amendment 2018 is the cornerstone to Lao PDR'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, richness of the country's 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 against regulated point sources within its jurisdiction. In reality, EPL-2012 lacked the necessary efficacy in terms of granting enforcement powers to MONRE or its environmental and natural resources agencies, such as DPCM, regarding industrial pollution sources (EPL 2018). Instead, the Industrial Processing Law (IPL) Amendment No. 026/NA, dated December 27, 2013 authorized by the Ministry of Industrial and Commerce (MOIC) acts as primary enforcement authority over most factories, including in 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, no single ministry is responsible for overall environmental compliance and enforcement of pollution sources in Lao PDR (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 quantity and quality of water by meeting the population's needs as well as ensuring environmental sustainability, but lacks clarity on the issue 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, which was approved by the National Assembly in November 2009. However, as most of its stipulations focused on water supply services, provisions for sanitation and sewerage, which it lacked, are planned to be added by decree. To reflect these changes, a revision of the Water and Water Resources Law was 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 the international best practices to ensure water resources and ecosystems are protected. New provisions have been added on water right 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 uses 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 of river basins throughout the country.

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

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

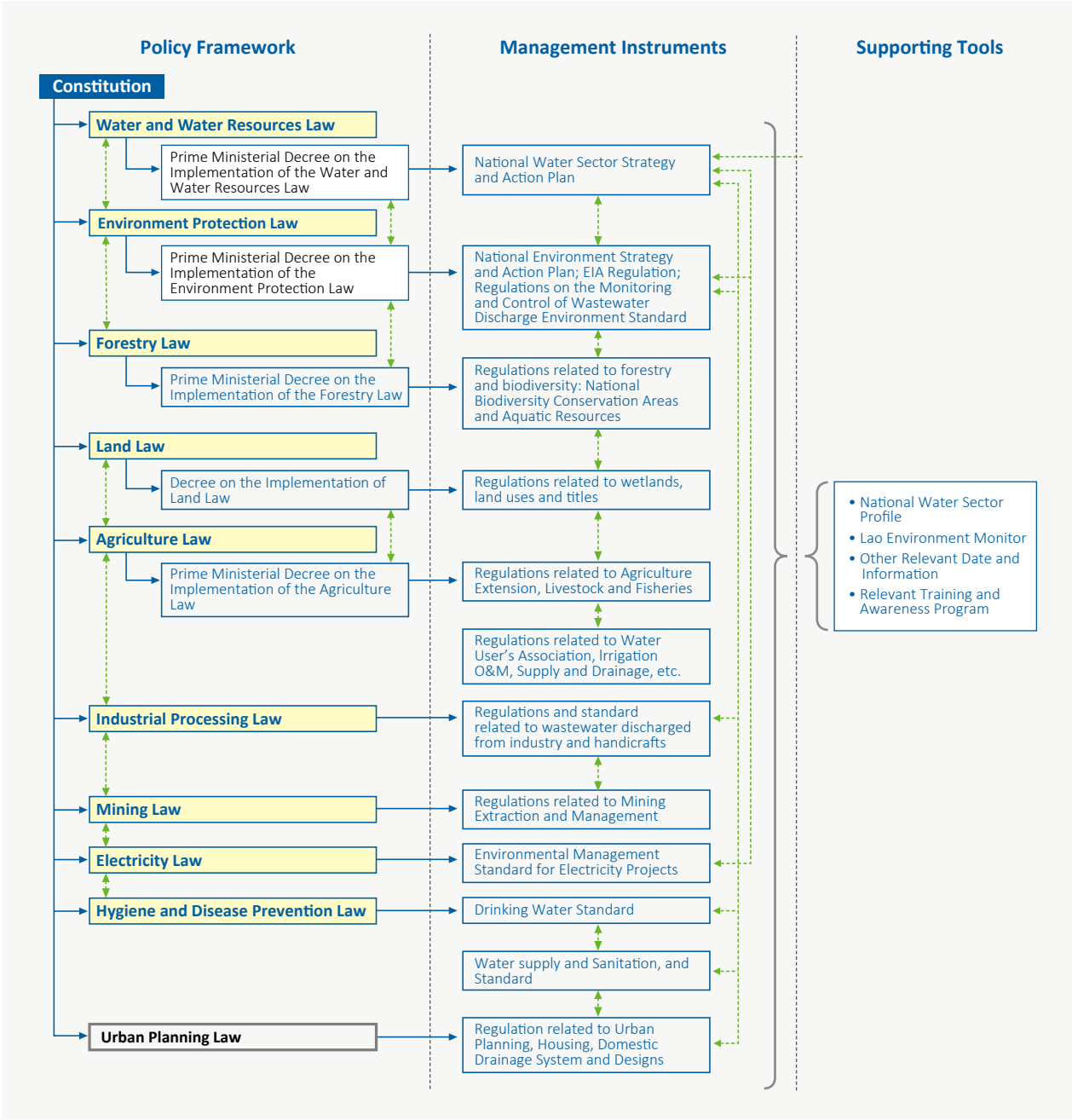

Figure 2.6.6 Legislation system of water environmental management in Lao PDR (Source: MoEJ 2009)

5.2 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 Pollution Control and Monitoring (DPCM), 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, developing systems, criteria, and codes of practice and methods for preventing water pollution.

5.3 Ambient Water Quality Standards

Ambient water quality standards

To improve ambient water quality on certain parameters, DPCM revised the National Environmental Standards of 7 December 2009 through comparison of updated data on the country's environmental quality with the standards set by international organizations as well as 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.

Water quality monitoring framework

In Lao PDR, surface water is the major water source for urban water supply, while groundwater is usually the main source for rural populations in lowland areas, particularly in the central and southern parts of the country where the groundwater table is sufficiently high and of sufficient quality. In upland areas, particularly the north and east of the country, water is usually supplied by gravity flow systems, mostly from streams (surface water), but also from springs (groundwater), although this access tends to be limited to remote communities. According to a Lao PDR MONRE Report (2012), water quality is considered good, although deterioration is observed in rivers and tributaries in urban areas due to increasing untreated or insufficiently treated wastewater and wastes. Mining activities and hydropower generation are the major sources of degradation, especially

Table 2.6.5 Drinking water quality standard

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	1,000	mg/L
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

sedimentation. Water runoff from agricultural activities could become a source of high nutrients and toxic chemicals due to fertilizer and pesticide use. Litter, dust and dirt, oil and grease, particles of rubber compounds from tires, particles of metal, glass and plastic from vehicles, and lead are the commonly found pollutants. Urban drains also act as secondary sewers carrying industrial discharges, septic tank seepage and overflows into the system.

A brief summary of the surface water quality network in Lao PDR is shown in Figure 2.6.7, which shows that 93 monitoring stations with facilities to analyze over 30 water quality parameter are active in 18 provinces of the country.

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-N	-		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
Asenic	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		-	Becqurel/L	GC
Organochlorine pesticide		-		0.05		-	mg/L	
Dichlorodiphenyltrichloroethane	DDT	-		1.0		-	µg/L	
alpha- Benzene hexachloride	α-BHC ($C_6H_6Cl_6$)	-		0.02		-	µg/L	
Dieldrin	$C_{12}H_8Cl_6O$	-		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	

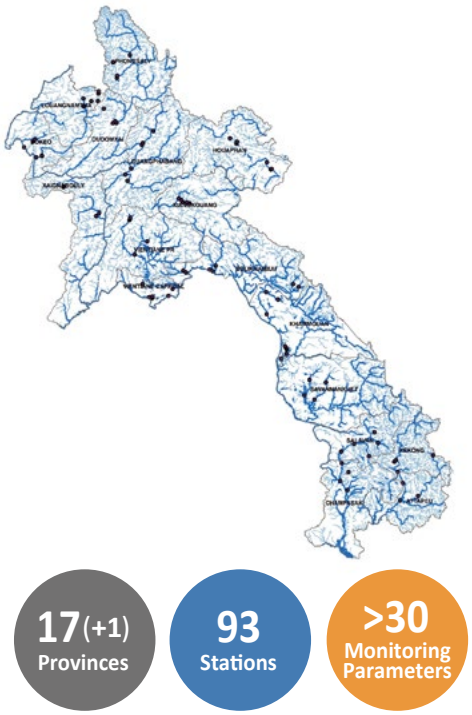

Figure 2.6.7 Network of surface water quality monitoring in Lao PDR

5.4 Effluent Standards

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 at Vientiane was recorded at around 1.4 mg/L, compared to 2.7 mg/L at Champasack. COD concentrations at three stations in the 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. Other than a recorded pH of 9.9 for Luang Prabang, pH values for other areas along the Mekong River were within the water quality guideline for pH (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 adequate concentrations 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).

In general, the water quality of rivers within the Lao PDR is considered to be good; however, little information is available on groundwater quality despite its use as chief source 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.

For 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 also classified according to floor area. For the wastewater treatment standards for public areas, classifications are in place for areas such as historical sites, public parks, water parks, and marshes and ponds.

The National Environmental Standard is enforced by Article 27 and 32 of the Environment Protection Law, and covers:

1. Ground water quality
2. Drinking water quality
3. 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

Effluent inspection procedure

According to the Regulation on Wastewater Discharge from Industrial Processing Factories issued in 2005 by the Ministry of Industry and Handicrafts (currently the Ministry of Industry and Commerce), all industrial factories are required to 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.

Measures against non-compliance

Lao PDR has some judicial or non-judicial measures 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 regulation 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, and (3) third stage: fine of 10–15 times the certification fee as well as penalties for non-compliance with other relevant regulations. Currently, DPCM is responsible for environmental quality monitoring and compliance enforcement and preparation for Lao PDR's state of pollution report, and provides data on air quality, noise levels, water quality, solid waste, hazardous substances and pollution problems 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

As regards current challenges, decision makers have approved several policy-oriented changes on existing regulations as well as introduced several new policies on the ground. Several of these are listed below:

- Law on Water and Water Resources, 2017
- Decree on National Environmental Standard passed on 2017Water and Water Resources Management, 2017
- Natural Resources and Environment Sector Vision towards 2030 and Ten-Year Strategy (2016–2025) and 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 was approved and issued in 2019
- Natural Resources and Environment Sector Vision towards 2030 and Ten-Year Strategy (2016–2025) and Natural Resources and Environment Sector Five year Action Plan (2016–2020), 22 September 2015

7 | Challenges and Future Plans

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

Overall, challenges for water environment governance can be summarized in the following categories:

a. Policy and legislation:

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

b. Institutional Framework:

- The absence of power leads to serious lack of compliance and major pollution issues
- Lack of technical skills and inadequate resources to support monitoring and enforcement
- Lack of cooperation and coordination of pollution control among the central and local governments and agencies concerned, due to silo-based thinking

c. Financial support:

- Lack of financial collection charges of pollutants released into the environment as no specific legislation is in force
- National government's annual budget is not sufficient

Future plans to address the above challenges

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

1. 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
2. Seeking financial/technological support from donor agencies for improving water environment in Lao PDR
3. Conducting the pilot project/program on wastewater treatment plant in Lao PDR
4. Developing technical guidelines/legislation on wastewater management and their strict implementation