

Lao People's Democratic Republic



GEOGRAPHY, CLIMATE AND POPULATION

Geography

The Lao People's Democratic Republic is a landlocked country in the mainland Southeast Asia with a total area of 236 800 km². The country is bordered by China to the north, Viet Nam to the east, Cambodia to the south, Thailand to the west and Myanmar to the northwest. The country stretches more than 1 700 km along a north-south axis. Some 80 percent of the country's area is composed of hills and mountains. The highest point is the Phu Bia at 2 820 m above sea level. Administratively, the country is divided into 16 provinces (*khoueng*) which are: Attapu, Bokeo, Bolikhamxai, Champasak, Houaphan, Khammouan, Louangnamtha, Louangphrabang, Oudomxai, Phongsali, Salavan, Savannakhet, Vientiane (Viangchan) province, Xaignabouli, Xekong and Xiangkhoang and one capital city (*nakhon luang*) which is Vientiane (Viangchan).

The cultivable area is an estimated 2 million ha, composed of narrow valleys and the flood-prone plain of the Mekong river and its tributaries. In 2009 the total cultivated area accounted for 1 468 000 ha, around 6 percent of the total area of the country. Arable land was an estimated 1 360 000 ha and the area under permanent crops was 108 000 ha (Table 1).

Climate

The climate is typically tropical with a rainy season from mid-April to mid-October dominated by the humid southwest monsoon. The average annual rainfall is 1 834 mm but ranges from 1 300 mm in the northern valleys to over 3 700 mm at high elevations in the south (Table 2). About 75 percent of the rainfall occurs during the rainy season. The water level in the Mekong river may fluctuate by up to 20 m between wet and dry seasons.

Population

In 2009, the total population was an estimated 6.1 million inhabitants of whom around 68 percent lived in rural areas (Table 1). During the period 1999-2009 the average annual growth rate was 1.6 percent. The average population density is 26 inhabitants/km², which is amongst the lowest in the region. The lowest population density is in the southern provinces of Attapu and Xekong near the Vietnamese border and the highest in Savannakhet or Champasack provinces.

In 2008, access to improved drinking water sources reached 57 percent (72 and 51 percent for urban and rural population respectively) and 53 percent had sanitation coverage (86 and 38 percent for urban and rural population respectively).

ECONOMY, AGRICULTURE AND FOOD SECURITY

In 2009, the gross domestic product (GDP) was about US\$5 939 million, with a value added in agriculture in 2008 accounting for 35 percent of the GDP. In 2009, the total economically



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TABLE 1
Basic statistics and population

Physical areas			
Area of the country	2009	23 680 000	ha
Cultivated area (arable land and area under permanent crops)	2009	1 468 000	ha
• as % of the total area of the country	2009	6	%
• arable land (annual crops + temp fallow + temp meadows)	2009	1 360 000	ha
• area under permanent crops	2009	108 000	ha
Population			
Total population	2009	6 112 000	inhabitants
• of which rural	2009	68	%
Population density	2009	26	inhabitants/km ²
Economically active population	2009	3 077 000	inhabitants
• as % of total population	2009	50	%
• female	2009	50	%
• male	2009	50	%
Population economically active in agriculture	2009	2 311 000	inhabitants
• as % of total economically active population	2009	75	%
• female	2009	52	%
• male	2009	48	%
Economy and development			
Gross Domestic Product (GDP) (current US\$)	2009	5 939	million US\$/yr
• value added in agriculture (% of GDP)	2008	35	%
• GDP per capita	2009	972	US\$/yr
Human Development Index (highest = 1)	2010	0.497	
Access to improved drinking water sources			
Total population	2008	57	%
Urban population	2008	72	%
Rural population	2008	51	%

active population was almost 3.1 million, of which 50 percent were women. The population economically active in agriculture was around 2.3 million inhabitants, approximately 75 percent of the economically active population. Of the population economically active in agriculture, 52 percent are women.

Women are major contributors to agricultural production. They do most of the farm work (planting, weeding and harvesting crops), tend livestock, and spend long hours performing off-farm and household chores such as collecting firewood, preparing meals and caring for children. Traditionally, men plough, make bunds and prepare seedbeds. In some areas the traditional task division is changing because of the lack of male labour.

Women are often unpaid, but their contributions are crucial for household food security and the rural economy. Nevertheless, their activities are often excluded from economic accounts and their contributions remain invisible and therefore greatly undervalued as a result of lack of sex-disaggregated data. The Government has enacted conducive policies to promote gender equality. In the agricultural sector, gender concerns are being integrated into specific programmes and projects through a number of measures (FAO, 2010).

Food security still is and will be the highest priority strategy to stabilise economic development and sociopolitical security. As rice is the staple for the population, its production must be stabilised at a high level. Increased paddy production is to be achieved through intensified

TABLE 2

Water: sources and use

Renewable freshwater resources			
Precipitation (long-term average)	-	1 834	mm/yr
	-	434 290	million m ³ /yr
Internal renewable water resources (long-term average)	-	190 420	million m ³ /yr
Total actual renewable water resources	-	333 550	million m ³ /yr
Dependency ratio	-	42.9	%
Total actual renewable water resources per inhabitant	2009	54 565	m ³ /yr
Total dam capacity	2005	7 811	million m ³
Water withdrawal			
Total water withdrawal	2005	4 260	million m ³ /yr
- irrigation + livestock	2005	3 960	million m ³ /yr
- municipalities	2003	130	million m ³ /yr
- industry	2003	170	million m ³ /yr
• per inhabitant	2005	740	m ³ /yr
Surface water and groundwater withdrawal	2005	4 260	million m ³ /yr
• as % of total actual renewable water resources	2005	1.3	%
Non-conventional sources of water			
Produced wastewater	-	-	million m ³ /yr
Treated wastewater	-	-	million m ³ /yr
Reused treated wastewater	-	-	million m ³ /yr
Desalinated water produced	-	-	million m ³ /yr
Reused agricultural drainage water	-	-	million m ³ /yr

production in the six major plains and expansion of cultivated areas for paddy in mountain valleys with adequate water. Rice production reached 2.2 million tonnes in 2000 compared to 1.4 million tonnes in 1995. This remarkable increase was mainly the result of the rapid development of irrigation systems for dry season rice production since 1997.

Average production of rice per capita has increased from 310 kg in 1995 to 430 kg in 2000. During these five years the annual growth of rice production was 9.2 percent and other foodstuffs such as maize, roots and tuber crop, soybean, vegetables, eggs, poultry and meat products also increased. These annual growth rates exceeded the annual population growth rate of about 2.5 percent. However, production of food and foodstuffs is still insufficient and unevenly distributed. Foodstuff production is not very stable because of frequent natural events, such as calamitous floods and drought, and limited agricultural infrastructure. There is also a wide variation in food production between provinces. The main food producing areas are concentrated in the main plains along the Mekong river and account for 60-70 percent of food output. In the mountains, where over half the population lives, food output in 2002 was only 30-40 percent of total output (FAO, 2002).

WATER RESOURCES AND USE

Water resources

The Lao People's Democratic Republic has abundant water resources. The Mekong river is the main river and 90 percent of the country is located in the Mekong river basin. It forms the border with Thailand over a very large distance and almost every part is navigable. In the south, near Pakse, it enters the country with an estimated 280 km³/year at the confluence with the Chi/Mun river coming from Thailand. About 25 percent of the Mekong river basin is located in the Lao People's Democratic Republic, which contributes 35 percent of the Mekong's total flow. There are about 39 main tributaries in the Mekong river basin and the main ones that have their largest

catchment area in the Lao People's Democratic Republic are from north to south: Ou, Suang and Khan in the northern region; Ngum and Nhiep in the northern-central region; San, Theun-Kading and Bangfay in the central region, Banghiang in the Savannakhet plain in the central-southern region; Done in the southern region; and Kong in the southeastern region (Table 3). For planning purposes, the Lao part of the Mekong river basin is divided into 32 sub-basins.

Rivers that are not part of the Mekong river basin, such as the Tale, Ma, Mat and Xa rivers, drain from the Lao People's Democratic Republic towards Viet Nam, and the Luang and Mò rivers join in Viet Nam before reaching the sea.

A significant part of the water resources of the country (143.13 km³/year) comes from neighbouring countries: 73.63 km³/year enters from China (after first becoming the border between Myanmar and Lao People's Democratic Republic and then over a short distance the border between Thailand and Lao People's Democratic Republic before entering the country), 17.6 km³/year from Myanmar (contribution of Myanmar to the Mekong in the border reach), and 51.9 km³/year from Thailand (contribution of Thailand to Mekong in the border reach). The outflow from Lao People's Democratic Republic to other countries (333.55 km³/year) consists mainly of the Mekong river to Cambodia with 324.45 km³/year and small rivers, the Ca and Ma rivers, with 9.1 km³/year to Viet Nam.

The internal renewable surface water resources have been estimated as the difference between the outflow and the inflow to the country, which is 190.42 km³/year, while groundwater resources are an estimated 38 km³/year, all forming the base flow of the rivers, thus being considered the overlap between surface water and groundwater resources. The total renewable water resources are therefore an estimated 333.55 km³/year, which is equal to the total flow out of the country (Table 2).

Groundwater is emerging as a large and generally untapped resource. However, there is very little monitoring of groundwater quality in the country, even though it is the main source of rural water supply. A study made by the Interim Mekong Committee (1986) observed that the country is divided into two geological areas: the Annamian Strata occupying most of northern and eastern part and the Indosinian sediments mainly along the Mekong. There are three different aquifer systems:

- The Annamian aquifers, which occur randomly, discharge locally to the river or its tributaries. As such, they are not part of the regional flow system and will not carry pollution into the regional groundwater system. The water should be of reasonably good

TABLE 3
Major River Basin (tributaries of Mekong river) in Lao PDR (Source: WEPA, 2010)

	Name of River basin	Basin area (km ²)	Annual discharge (million m ³)	Length of main stream (km)
1	Ou	19 700	12 277	390
2	Suang	5 800	3 654	150
3	Khan	6 100	29 455	250
4	Ngum	16 500	23 021	1 403
5	Nhiep	4 270	5 885	156
6	San	2 230	4 271	120
7	Theun/Cading	3 370	7 027	138
8	Bangfay	8 560	13 624	190
9	Banghieng	19 400	15 673	370
10	Done	6 170	5 065	1 574
11	Kong	10 500	16 146	170

quality and for the most part potable but rich in iron. Yields up to 5 litres/s can generally be anticipated.

- The Indosinian aquifers, which have regional flows, include rock of the Indonesian Moyennes and Superieures and are relatively young. They are mostly freshwater sediments; although there are horizons of brackish water, and one major zone of saline water. Yields of 12-24 litres/s can be developed.
- The alluvial aquifers, which are associated with the sedimentary deposits of the Mekong river, are not highly rated as aquifers.

In 2009, total dam capacity was estimated at 7.811 km³. The country has great potential for hydropower development, estimated as 30 000 MW (WEPA, 2010). All existing and potential dams are on tributaries of the Mekong. The earliest major hydropower plant, Nam Ngum dam located north of Vientiane, has a storage capacity of 7.01 km³ and a total power generation capacity of 150 MW. Two other dams in the south, Xeset 1 and Selabam, have a total storage capacity of 0.3 km³ and can generate 50 MW. Since its commissioning in 1991, the 45 MW Xeset 1 dam has been generating electricity for domestic consumption and for export to Thailand. However, the Xeset 1 dam has a small reservoir, and low dry-season flow volumes of the Set river (Xeset) have resulted in correlated low volumes of electricity generation by Xeset 1.

Two more hydroelectric projects, the Xeset 2 and Xeset 3, are being proposed for construction in the Set river basin, which are also being promoted to increase rainy season water storage on the upper Set river to increase flow volumes for Xeset 1 (AKHA, 2006). In 1998, the 80 m high Houay-Ho dam was constructed in the south of the country, it produces 150 MW, which is exported to Thailand. In 2000, the Nam Leuk dam was constructed with a total power generation capacity of 60 MW, and in 2004, Nam Mang 3 was constructed producing 40 MW.

The Theun-Hinboun Power Company (THPC) developed the first independent power project in the country. The project, which was completed in 1998, is a trans-basin run-of-the-river project, located near the border of Bolikhamxay and Khammouan provinces. With a relatively small dam and reservoir, it transfers most of the Theun-Kading river to the neighbouring (and lower) Hinboun river to the west by tunnel. The generating capacity is 220 MW, of which 210 MW is used to export energy to Thailand and 10 MW to supply local power demands in the two provinces. THPC is now expanding the project to increase the total generating capacity to 500 MW. The capacity for export will rise to 440 MW and 60 MW will be available for Électricité du Laos (EdL). The expansion project will enable growth of the new Lao power transmission system by extending the 115 kV transmission grid to the area, increasing electricity supply to the grid, and improving reliability and quality of the EdL system (THPC, 2009).

Feasibility studies for 21 other hydropower projects throughout the country, all located on tributaries of the Mekong river, have been undertaken or are planned. Projects on the main stream of the Mekong have been planned for many years, more than 40 years in the case of the Pa Mong dam, but have not yet been implemented.

In 1999, it was estimated that 35 percent of liquid effluent disposal to inland surface waters from all sources was treated, while the quantity was unknown (WEPA, undated).

International water issues

The Mekong River Commission (MRC) came into existence on 5 April 1995 on agreement between the governments of Cambodia, Lao People's Democratic Republic, Thailand and Viet Nam. These four countries signed the "Agreement on the cooperation for the sustainable development of the Mekong River Basin" and agreed on joint management of their shared water resources and development of the economic potential of the river. The MRC has been built on a foundation of nearly 50 years of knowledge and experience in the region, starting in 1957 as the

United Nations-founded Mekong Committee. In 1996, China and Myanmar became Dialogue Partners of the MRC and the countries now work together within a cooperation framework.

The Asian Development Bank (ADB) and the World Bank have collaborated since 2004 on the preparation of the Mekong Water Resources Assistance Strategy (MWRAS), which was developed after analytical work and strategic workshops were carried out in 2004 and early 2005 with the national governments of the four countries. The MWRAS preparation work confirmed that there is a need for extensive capacity-building in all aspects of integrated water resources management (IWRM) in the region to support the further investments required in water management (ADB, 2007).

Water use

In 2005, total water withdrawal was an estimated 4.26 km³, which is only 1 percent of the total actual renewable water resources (Table 2). Water withdrawal for agriculture was approximately 3.96 km³, while for municipalities and industries it was an estimated 0.13 km³ and 0.17 km³ respectively (Figure 1).

IRRIGATION AND DRAINAGE DEVELOPMENT

Evolution of irrigation development

A rough estimate of the irrigation potential for Lao People's Democratic Republic is 600 000 ha (Table 4). The history of irrigation can be traced back several centuries in the northern mountains, where irrigation systems are based on primitive water intake made by logs, soil and/or stone, and have been managed well by communities. From the 1960s, 'modern' irrigation systems with concrete weirs and well-designed canals have been built with technical and financial assistance from foreign donors. Irrigation is classified by region into three types: (i) community-managed gravity irrigation in the northern mountains, with a range of service area from 1 ha to over 300 ha; (ii) pump irrigation in the Vientiane plain; (iii) recently introduced pump irrigation along the Mekong river where most of the plain is flood-prone (FAO, 2002).

In 2005, the total area equipped for irrigation was 310 000 ha (Pheddara, 2007). Irrigation by groundwater covers only 200 ha (Figure 2). In 1995, river diversion was the main source of water for irrigation schemes, particularly the smaller ones, accounting for 83 percent of the total equipped area. Pumping from rivers, which is concentrated in the southern region, accounted for 15 percent, and reservoirs 2 percent. All areas use surface irrigation techniques. In 2000 there were 19 170 irrigation schemes.

The actually irrigated area in the wet season has increased from 138 077 ha in 1995 to 270 742 ha

FIGURE 1
Water withdrawal by sector
Total 4.26 km³ in 2005

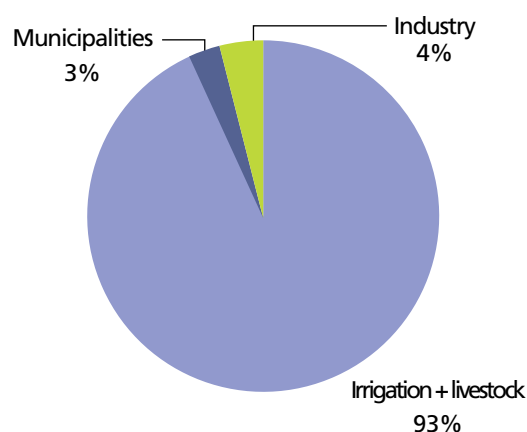


FIGURE 2
Source of irrigation water on area
equipped for full control irrigation
Total 310 000 ha in 2005

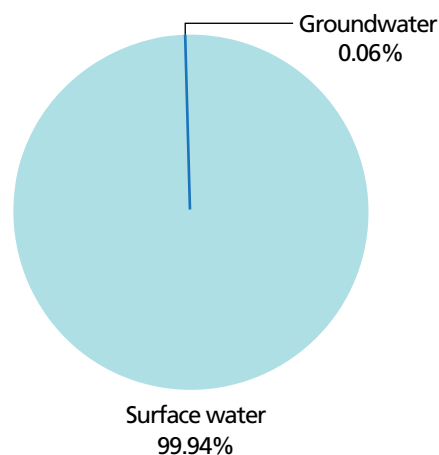


TABLE 4

Irrigation and drainage

Irrigation potential		600 000	ha
Irrigation			
1. Full control irrigation: equipped area	2005	310 000	ha
- surface irrigation	2005	310 000	ha
- sprinkler irrigation	2005	0	ha
- localized irrigation	2005	0	ha
• % of area irrigated from surface water	2005	99.94	%
• % of area irrigated from groundwater	2005	0.06	%
• % of area irrigated from mixed surface water and groundwater		-	%
• % of area irrigated from non-conventional sources of water		-	%
• area equipped for full control irrigation actually irrigated	2005	270 742	ha
- as % of full control area equipped	2005	87.3	%
2. Equipped lowlands (wetland, ivb, flood plains, mangroves)		-	ha
3. Spate irrigation		-	ha
Total area equipped for irrigation (1+2+3)	2005	310 000	ha
• as % of cultivated area	2005	27	%
• % of total area equipped for irrigation actually irrigated	2005	87	%
• average increase per year over the last 10 years	2000-2005	0.96	%
• power irrigated area as % of total area equipped	1995	15	%
4. Non-equipped cultivated wetlands and inland valley bottoms		-	ha
5. Non-equipped flood recession cropping area	1995	231 500	ha
Total water-managed area (1+2+3+4+5)	2005	541 500	ha
• as % of cultivated area	2005	48	%
Full control irrigation schemes:		Criteria:	
Small-scale schemes		< ha	- ha
Medium-scale schemes		> ha and < ha	- ha
Large-scale schemes		> ha	- ha
Total number of households in irrigation		-	-
Irrigated crops in full control irrigation schemes:			
Total irrigated grain production (wheat and barley)		-	metric tons
• as % of total grain production		-	%
Harvested crops:			
Total harvested irrigated cropped area	2005	371 676	ha
• Annual crops: total	2005	356 676	ha
- rice	2005	310 676	ha
- Vegetables	2005	33 000	ha
- Cotton	2005	8 000	ha
- Sugarcane	2005	5 000	ha
• Permanent crops: total	2005	15 000	ha
- Citrus	2005	15 000	ha
Irrigated cropping intensity (on actually irrigated area)	2005	137	%
Drainage - Environment:			
Total drained area		-	ha
- part of the area equipped for irrigation drained		-	ha
- other drained area (non-irrigated)		-	ha
• drained area as % of cultivated area		-	%
Flood-protected areas		-	ha
Area salinized by irrigation		-	ha
Population affected by water-related diseases		-	inhabitants

TABLE 5
Typology of irrigation schemes (1999)

Size	Type of water control	Description	Location	Population involved
Small schemes < 100 ha	Weir schemes	Traditional wet season supplementary irrigation systems. Most of them are < 50 ha	Mountainous provinces	1-2 villages, up to 50 households
	Pump schemes	Designed for dry and wet season irrigation	Along the Mekong and its tributaries	
Medium schemes 100-500 ha	Weir schemes	Wet season supplementary irrigation. Most built with external assistance	In the floodplains	Up to 8 villages, up to 500 households
	Pump schemes	Designed for dry and wet season irrigation	Near Vientiane and Pakse	
	Reservoir schemes	Gravity irrigation in dry and wet season. Built by provincial irrigation services on behalf of communities	Near Savannakhet	
Large schemes > 500 ha	Reservoir schemes	Gravity irrigation in dry and wet season	2 reservoirs: Nam Houm and Nam Souang near Vientiane	
	Pump schemes	Dry and wet season irrigation	Near Vientiane using water from the Mekong and Ngun rivers	

in 2005, while in the dry season the area has increased from 36 282 ha in 1995 to 100 934 ha in 2005 (FAO, 2008). While wet season irrigation is common throughout the country, dry season irrigation is mainly concentrated near major cities. It has been noted that after poor yields during rainy seasons, the irrigated area in the dry season are higher than the average to compensate for the low production of the previous season. In 1995, non-equipped flood recession cropping area was an estimated 231 500 ha.

A typology of irrigation schemes is presented in Table 5. The large-scale and several medium-scale schemes are generally underexploited and face operation and maintenance difficulties. Government policy is to transfer management responsibilities to users, but farmers lack management skills as they have never been involved in scheme and water management.

Another classification of irrigated schemes is by type of management. Some schemes are wholly managed by the farmers themselves, while others receive the assistance of irrigation department services. Pump schemes belong to the latter. More than 80 percent of the gravity irrigated schemes are managed by the farmers themselves.

A major irrigation scheme is the community-managed irrigation sector project (CMISP), funded by the ADB, which is to improve more than 40 existing irrigation schemes in the central and northern regions. The communities are responsible for managing the improved facilities by organizing water user associations (WUAs). Other similar schemes are the decentralized irrigation development and management sector project (DIDMP), funded by ADB and France, and the agricultural development project (ADP), funded by the World Bank. DIDMP is a pilot project exercising the irrigation management transfer process, focusing on pump irrigation schemes in six selected provinces. ADP, covering four southern provinces, is a rural development project including not only improvement of irrigation systems but also market oriented community development using village investment funds.

Role of irrigation in agricultural production, economy and society

In 2005, total harvested irrigated cropped area was an estimated 371 676 ha, of which 270 742 ha in the wet season and 100 934 ha in the dry season. The major irrigated crops are rice,

which account for 310 676 ha (245 676 ha in the wet season and 65 000 ha in the dry season), vegetables 33 000 ha, cotton 8 000 ha, citrus 15 000 ha and sugarcane 5 000 ha (Table 4 and Figure 3).

The country also has a large area of non-irrigated rice cultivation (estimated as 450 000 ha in 1994), of which about half is estimated to be upland rice (shifting cultivation), and the other half lowland flooded rice on the alluvial plains (Table 4).

In 1999, the average cost of small-scale weir scheme development was about US\$200-400/ha. Large schemes implemented by the government, sometimes with external aid, cost between US\$3 500 and 7 000/ha.

Status and evolution of drainage systems

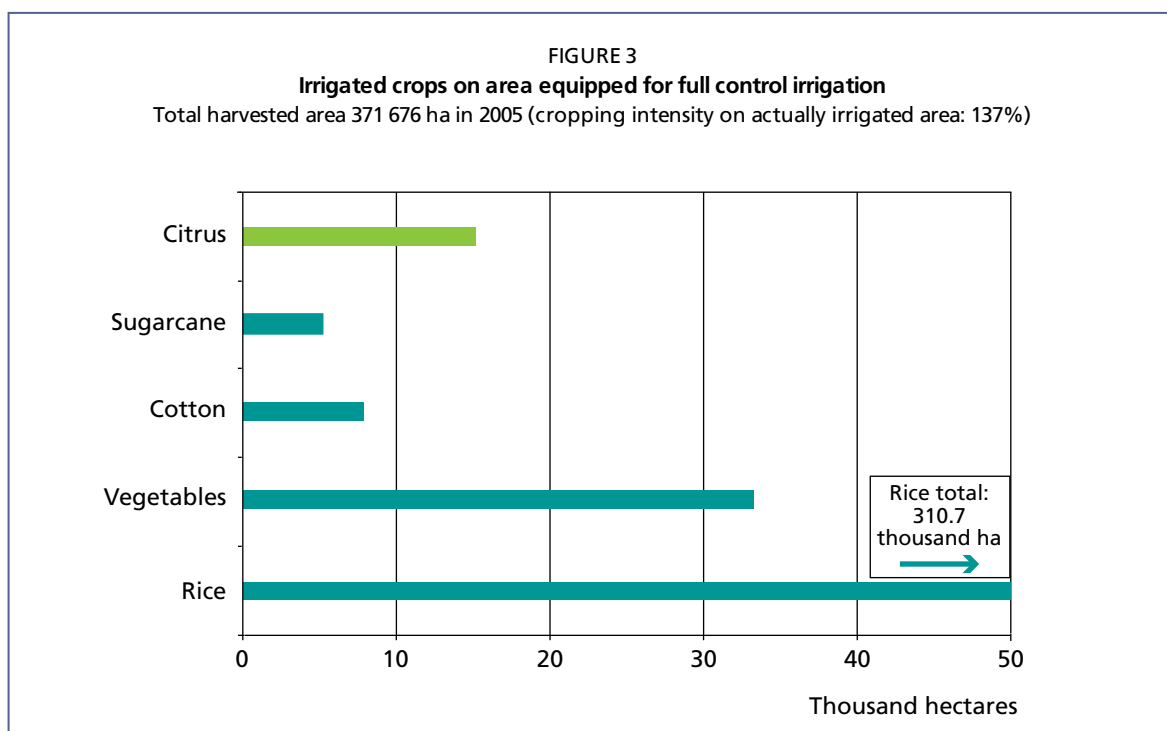
Drainage and flood protection structures have generally been considered in the irrigated schemes design plan but have often not been implemented because of budget restrictions.

WATER MANAGEMENT, POLICIES AND LEGISLATION RELATED TO AGRICULTURAL WATER USE

Institutions

The Prime Minister's Office is responsible for:

- The Water Resources Coordination Committee (WRCC), which provides advice to the government on matters related to water resources. It coordinates the planning, management, follow-up, inspection and protection of water resources for their sustainable development and utilization in line with the government policy of socio-economic development. It was established in 1997.
- The Lao National Mekong Committee (LNMC), which formulates policy, strategic plans, projects and programmes related to water resources development in the Mekong Basin to protect the environment, ecological balance, and to ensure community



participation and development, cooperation with other Mekong riparian countries, other countries and donors.

- The Science, Technology and Environment Agency (STEa), which monitors and inspects environmental parameters, such as: water, soil, air, radiation, noise, colour, etc. concerning development activities for adherence to environmental standards.

The Ministry of Agriculture and Forestry (MAF) is responsible for:

- The Integrated Watershed Management Unit (IWMU), which assists MAF in watershed management and rural development planning on a subwatershed (sub-basin) area.
- The Department of Irrigation (DoI), which carries out the testing and analyses of water quality based on MRC standard, and develops irrigated agriculture and drainage, flooding and drought prevention plans.

The Ministry of Industry and Handicraft is responsible for:

- The Industrial Environment Division (IED), which is responsible for industrial environment management, occupational health and safety, industrial waste, mineral resource management, hydropower and regulations to protect and control pollution from industrial factories (wastewater, smoke, odour, radiation, vibration, noise, etc.).

The Ministry of Communication, Transportation, Post and Construction is responsible for:

- The Waterway Administration Division (WAD), which is responsible for data collection (water quality sampling at some hydrological stations such as Luangphrabang, Savannakhet and Pakse), then forwarding it to Water Quality Laboratory, Irrigation Survey Design Center under Department of Irrigation, MAF.
- The Water Supply Authority (WASA), mainly develops regulations concerning urban water supply, and provides technical assistance to water supply operations for the whole country.

The Ministry of Public Health is responsible for:

- The National Center for Environment Health and Water Supply (NCEHWS), which regulates control of solid waste and waste water; defines disposal methods for solid and liquid waste, and supplies water and sanitation services to non-urban locations.
- The Food Management Division (FMD), which sets and monitors standards for drinking water supplies.

Water management

In 1984, about 23 percent of the cultivated area was managed by cooperatives. However, following the New Economic Mechanism implemented in 1986, the cooperatives were dissolved, and all the cultivated area is now privately managed.

The government's long-term objective for domestic water supply is to provide 80 percent coverage to the population by 2015. Although each province has benefited from an urban water supply programme financed by international aid (from Japan, Germany, ADB, WB and EU), rural water supply programmes have not been numerous.

The Water and Water Resources Law states that water and water resources are the property of the national community, which the State represents in managing as well as thoroughly and reasonably allocating its use to various parties. Individuals, juristic entities, or organizations shall have the right to control and use any natural water and water resource in any activity only

so long as they have received approval from relevant authorised agencies, except in the case of small-scale use as provided by this Law. The management instrument of the Water and Water Resources Law is the National Water Sector Strategy and Action Plan.

During the 1990s, the Government recognized the problems facing the country, and the strategy in the irrigation sector was redefined. The water law is based on:

- Improving the planning of new irrigation projects so that they are based on the needs of farmers and driven and managed by them. Water user groups (WUGs) are being set up, and the water law should provide a legal framework for these associations. The objectives of DoI are: (i) to develop irrigation for all lowland rice fields in the wet season as long as farmers are interested and group themselves into WUGs; (ii) to develop dry season irrigation.
- Making the existing schemes economically viable and self-sustaining, by: (i) helping farmers to establish WUGs; (ii) training farmers in irrigation management; (iii) encouraging farmers to introduce operation and maintenance cost recovery systems; (iv) developing marketing infrastructure.

Being a least-developed country rich in water resources, the most important challenges for WRCC in carrying out its coordinating role include: (1) strengthening of the legal framework for an effective and harmonious integration of water resources management, development and protection activities into the socio-economic development process, in particular to meet national priorities; (2) to enhance and consolidate the existing systems and foundation to operate, maintain and rehabilitate facilities safely, reliably and efficiently to protect the investment for public benefits; (3) to prioritize the capacity-building needs so as to enhance organizational capacity and effectiveness of the water resources coordination system (WEPA, 2010).

The objectives written in the Master Plan for integrated agricultural development are: to formulate an action plan and an implementation programme that contribute to more effective agricultural development promotion, based on the strategic vision framework in the agricultural development strategy and vision 2020; and to identify priority programmes and projects. 'Towards the Year 2020', an integrated agricultural development action plan, covers ten subsectors: land and water resources development, institution and organization, human resources development, field crop, livestock and fisheries, stabilising shifting cultivation, marketing and agro-processing, rural finance, rural development, and irrigation.

Finances

Under the New Economic Mechanism, formulated in the 1990s, policy for irrigated agriculture emphasizes the role of markets and prices as allocation mechanisms and a shift to cost recovery for services and facilities provided by government to farmers. Electricity and operating costs have been paid directly by farmers since 1992. Secondary and tertiary canals are the responsibility of farmers for all maintenance matters. Until 1994, the Irrigation Department was responsible for the operation and maintenance of weirs, dams, pumps and primary canals, after which it was supposed to be handed over to WUGs or WUAs. However, in many cases, operation and maintenance are still carried out by the Irrigation Department or its provincial services. A pragmatic approach has been adopted for a transitional period, where the establishment of WUGs is encouraged and farmers are trained in irrigation management, irrigation scheduling, and operation and maintenance. It is expected that, eventually, each WUG will be able to define the water charge needed to sustain the irrigation scheme.

Policies and legislation

In 1996, the Water and Water Resources Law was enacted and implemented. It determines necessary principles, rules, and measures relative to the administration, exploitation, use and

development of water and water resources to preserve sustainable water and water resources and to ensure volume and quality providing for people's living requirements, promoting agriculture, forestry, and industry, developing the national social-economy and ensuring that no damage is caused to the environment (WEPA, 2010).

In 2001, a Decree was enacted on the Implementation of the Water and Water Resources Law to implement the Law on Water and Water Resources and to establish the responsibilities of different ministries, agencies and local authorities regarding the management, exploitation, development and use of water and water resources. The Decree also ensures efficient development and use, conformity with the socio-economic development planning, an increase in production, an improvement of the living conditions of the people and sustainable use of water resources.

ENVIRONMENT AND HEALTH

In general, the water quality of rivers within the country and the Mekong is considered to be good, based on international standards. The level of oxygen is high and the nutrient concentration is low. Sediment is the primary pollutant source affecting rivers. Sedimentation loads in tributaries vary considerably, from 41 to 345 tonnes/km² per year. Tributaries and river reaches with high sedimentation are the Banghiang, Done, Ou, and the upper and lower stretches of the Mekong.

With the pressure of rapid demographic growth, socio-economic development and urbanization, however, the water quality is increasingly exposed to deterioration. Currently there are some problems related to waste and polluted water in major urban areas from varied community use (residential density, hotels, hospitals and entertainment centres). In addition there is water pollution from agricultural and industrial sectors, including mineral exploitation. This is not yet a major problem, but it could become one (WEPA, 2010).

A study on wastewater management and building in Vientiane (2004) reported that, with a rapidly growing population in the urban area of Vientiane Capital City, sewerage is becoming a serious problem because of the lack of a sufficient drainage system and lack of sewerage systems, while on-site sewerage disposal or septic tanks are often poorly designed. Further contributing to the problem in urban area is stagnant untreated wastewater from households and some small industries with open road-side drains, flowing directly into marsh or natural channels. This mixing of sewerage in the storm drainage system will continue to have a detrimental impact on public health (WEPA, 2010).

PROSPECTS FOR AGRICULTURAL WATER MANAGEMENT

Management of the Mekong will increasingly require riparian countries to address cross-border issues, which in turn will demand strong national capacities to deal with complex water use and resource protection issues. The future may require tradeoffs that have been avoided so far as a result of the relatively limited development of water resources in the basin. The projected challenges highlight the need for each country in the basin to have appropriate policies and capacities for water resource management (ADB, 2007).

In 2006, the ADB and World Bank undertook further studies to define the scope of an IWRM strengthening programme in the country. The study identified ten major groups of activities necessary for the effective facilitation of IWRM, which would take about 5 years to implement, at a cost of about US\$9 million (ADB, 2007).

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