

VALUING LAO LANDSCAPES: A PROVINCE, DISTRICT, AND HOUSEHOLD LEVEL ANALYSIS OF NATURAL CAPITAL IN KHAMMOUANE PROVINCE



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Lao PDR Green Growth Advisory Program

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Acronyms and abbreviations

ASEAN	Association of Southeast Asian Nations
BOL	Bank of Lao PDR
CDR	Center for Development Policy Research
CPI	Consumer Price Index
CFA	Conservation Forest Area
DOA	Department of Agriculture
DOF	Department of Forestry
EDL	<i>Électricité du Laos</i>
ESIA	Environmental and Social Impact Assessment
FAO	Food and Agriculture Organization of the United Nations
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GEF	Global Environment Facility
GOL	Government of Lao People's Democratic Republic
GPS	Global Program on Sustainability
GWh	Gigawatt-hours (10^9 watt-hours)
Ha	Hectare
IDA	International Development Association
IPP	Independent Power Producer
IREP	Institute of Renewable Energy Promotion
IRR	Internal Rate of Return
IUCN	International Union for Conservation of Nature
Kg	Kilogram
kWh	Kilowatt-hours (10^3 watt-hours)
LAK	Lao Kip
LECS	Lao Expenditure and Consumption Survey
LEV	Land Expectation Value
LHSE	Lao Holding State Enterprise
LPG	Liquid Petroleum Gas
LSB	Lao Statistics Bureau
LSIS	Lao Social Indicator Survey
masl	Meters Above Sea Level
MAF	Ministry of Agriculture and Forestry
MJ	Megajoule (10^6 Joules)
MEM	Ministry of Energy and Mines
MOH	Ministry of Health
MOICT	Ministry of Information, Communication and Tourism
MONRE	Ministry of Environment and Natural Resources
MPI	Ministry of Planning and Investment
NAFRI	National Agriculture and Forestry Research Institute
NCA	Natural Capital Accounting
NCV	Natural Capital Value
NPA	National Protected Area
NSEDP	National Socio-economic Development Plan

NTFP	Non-timber Forest Product
NUOL	National University of Laos
PES	Payment for Ecosystem Service
PFA	Production Forest Area
PPA	Power Purchase Agreement
SDG	Sustainable Development Goal
SEA	Strategic Environmental Assessment
SEEA	System of Environmental Economic Accounting
SFM	Sustainable Forest Management
SNA	System of National Accounts
SPP	Small Power Producer
TCS	Traditional Cookstove
UNDP	United Nations Development Programme
UNSD	United Nations Statistical Commission
UXO	Unexploded Ordnance
WAVES	Wealth Accounting and the Valuation of Ecosystem Services
WTP	Willingness to Pay

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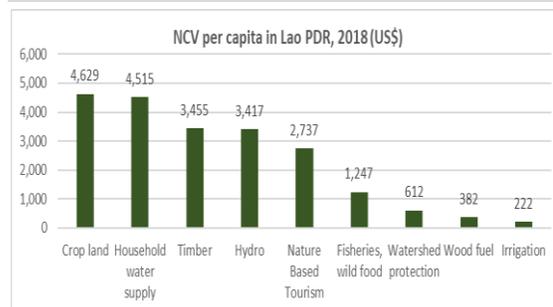
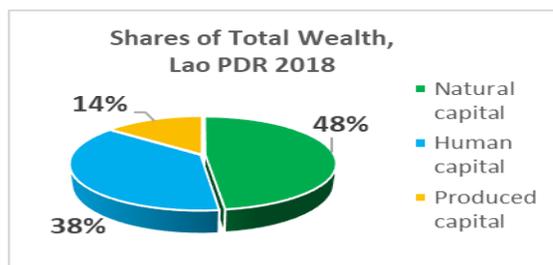
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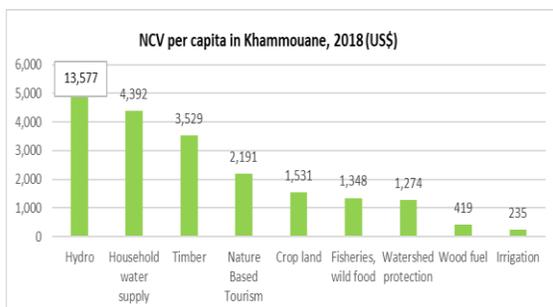
1. **Natural capital is the largest form of wealth in the Lao People’s Democratic Republic.** The country’s landscapes—a mosaic of forests, water, fish, biodiversity, minerals, and land—play a crucial role in the country’s economic development prospects and resilience. Protecting and sustainably enhancing the value or productivity of this capital is of utmost importance. Yet, natural capital is being depleted, posing a significant challenge to achieving poverty reduction and sustainable development objectives. The World Bank has long promoted natural capital accounting (NCA) and regularly provides estimates of the value of natural capital in terms of a nation’s wealth, with wealth being the total value of human, produced, and natural capital.

2. **A major limitation of gross domestic product (GDP) is the underrepresentation of natural capital.** The widely used System of National Accounts (SNA) is used to measure economic activity, such as GDP. According to the SNA, Lao PDR’s natural-resource-based sectors contributed one-third of GDP in 2018, and forestry and food production provide over 65 percent of total employment. The SNA, however, severely understates the contribution of natural resources to the economy. Furthermore, many non-market services provided by natural resources are either wrongly attributed to other sectors (for example, the value of natural sites and attractions are attributed to the tourism industry) or omitted entirely (for example, biodiversity protection). NCA seeks to address the shortcoming in the SNA by following a standard methodology, the System of Environmental Economic Accounting (SEEA), adopted by the United Nations Statistical Commission (UNSD) in 2012.

3. **Nearly half of Lao PDR’s total 2018 wealth is in its natural capital, demonstrating the importance of sustainably managing renewable natural resources and enhancing their productivity for economic growth and livelihoods.** The natural capital value (NCV) of renewable natural resources in Lao PDR in 2018 was estimated at US\$149 billion or over US\$21,000 per capita. The largest NCVs are cropland, household water supply, timber, hydropower, nature-based tourism, and fisheries and wild forest food. The actual value of forested watershed protection is much higher than calculated, as data are insufficient to estimate its true value. The low value for irrigation is due to its limited development, but it has a high value per hectare



4. **In Khammouane Province, natural capital is even more important, with significant total value from the forest landscape for timber, nature-based tourism, food, fuel, and watershed protection services.** The NCV in Khammouane Province in 2018 is estimated at US\$12 billion or over US\$28,000 per capita. The per capita value is 30 percent higher than nationally, mainly due to the high value of the Nam Theun 2 hydropower plant. For natural assets other than hydropower, the NCV per capita is US\$17,800 nationally and US\$14,900 in Khammouane. The lower value in Khammouane is mainly due to the lower NCV of cropland associated with



limited cultivation of high-value crop and limited nature-based tourism presently. However, the NCVs do not capture the substantial existence values, such as biodiversity, of the globally significant protected areas that cover over 40 percent of the territory of Khammouane

5. **In this report, Khammouane Province was selected as the case study for natural capital valuation due to its diverse and significant natural assets.** Important assets include forest areas with high global biodiversity value including two National Parks, limited but growing nature-based tourism (until the Coronavirus pandemic), hydropower, irrigated crops, and potential for increased productive forestry. Particularly promising is the potential for enhancing the NCV in the province for poverty reduction and economic growth through sustainable forest plantation development of various forms, further development of nature-based tourism, regeneration of severely depleted production forest, and exploration of the potential for groundwater-based irrigation of high-value crops.

6. **A large amount of data was analyzed at the district and provincial levels to estimate the NCV in Khammouane and prepare natural capital profiles for each district.** The data include 32 natural capital indicators at the district level from the Population and Housing Census, the Agricultural Census, Statistical Yearbooks, publications from the Department of Agriculture (DOA) and Department of Forestry, small area estimation of poverty, and unexploded ordnance (UXO) survey data. A total of 24 natural capital indicators were also analyzed using Stata statistical software from household data of two national surveys representative of the provincial level. The two surveys were the fifth Lao Expenditure and Consumption Survey (LECS-5) and Lao Social Indicator Survey (LSIS). Data from publications by partners and published research were also used. Yet, there were some significant data gaps that would need to be filled in for future assessments.

7. **Data limitations prevented meaningful estimation of NCV at the district level.** Despite the large amount of data analyzed, there were in particular two data shortcomings: (a) the LECS-5 and LSIS national household surveys are not representative at the district level and (b) timber production (consumption and export) data, along with data on forest stock and growth rates, are severely limited. These shortcomings prevent quantification of the large spatial differences in natural capital across districts in the Khammouane landscape.

8. **Valuing the contribution of natural capital to the country's development puts decision-makers, planners, and their partners in a better position to take advantage of green growth opportunities and understand the repercussions and trade-offs of policy and investment choices.** NCA provides statistics for better management of the portfolio of natural assets in the landscape that contribute to drive economic growth and boost resilience. This assessment of the value of Lao PDR's landscapes was initiated to support the country's ongoing transformation toward economic growth that is sustainable, clean, green, resilient, and inclusive. NCA is an instrument for the country's ambitious green transformation. This assessment of NCVs supports the 2019–2030 National Green Growth Strategy and National Socio-economic Development Plans (NSDPs) for 2016–2020 and 2021–2025.

Key Recommendations

Overall

9. **Environmentally sustainable investments are likely to contribute to natural wealth.** No-regret opportunities for investment are found in sustainable uses of the landscape. For example, sustainable forest production, conservation, nature-based tourism, and local livelihoods are complementary and generate green jobs, local income, and livelihoods as well as multiplier effects. Poverty is substantially higher in districts with more abundant forest land, important for scaling up sustainable forestry models for villages and firms, and nature-based tourism. Yet, competition for land and other resources can lead

to unsustainable depletion if the trade-offs are not well managed. NCVs are a tool to help manage these trade-offs, identify mutual opportunities (that is, win-wins), and promote resilience and sustainability.

10. **Examples of ‘win-win’ opportunities for natural capital and wealth accumulation in the landscape include** (a) implementing small-scale irrigation (and household agricultural production) plus sustainable forest management (SFM) and protection in the command area to provide steady water flow; (b) maintaining healthy forest in the watershed of hydropower reservoirs to reduce sedimentation, thus enhancing the long-term financial sustainability of the investment; (c) conserving biodiversity and forest landscapes to enable competitive tourism, which can create green jobs from private sector investment and government revenues; (d) empowering villages to collaborate on forest and protected area management to generate timber and non-timber revenues and ecosystem services; and (e) de-risking industrial forest plantation investments, and generating government revenues and local benefits, by ensuring that these investments contribute to environmental and social sustainability. These examples of ‘natural solutions’ relevant to Lao PDR illustrate the mutual opportunities that can be secured from managing the interconnectivity of natural assets in the landscape.

11. **Use of Strategic Environmental Assessments (SEAs) at the program and policy levels and Environmental and Social Impact Assessments (ESIAs) at the individual project level** will help strengthen multisector dialogue and identify win-win opportunities and sectoral trade-offs among investment and policy options. These instruments are especially important in relation to land use, especially industrial forestry and agricultural plantations, and infrastructure development. The new Government of Lao PDR (GOL) policies enacted in 2019 provide detailed regulations and prime minister-level authority for using these tools, including public consultations and disclosure, which are recognized global good practices.

12. **Establishing and maintaining a Government-led ‘Landscape Investment Platform’,** would provide a space for agencies to share information, make decisions, and monitor progress concerning programs, projects, and policies covering multiple sectors and themes. Nationally, this platform could be jointly led by the Ministry of Planning and Investment (MPI) and Ministry of Agriculture and Forestry (MAF). At the provincial level, one option is for the Governor’s Office to chair such a platform.

Building wealth through forestry

13. **Further assessment of opportunities for smallholder and sustainable industrial forestry plantations.** Four southern districts in Khammouane have production forest areas (PFAs) totaling over 250,000 ha where forestry plantations may be suitable. There are also over 470,000 ha of land that are not classified as forest land nor cultivated with crops, some of which may be suitable for sustainable plantations. Khammouane is part of the GOL’s ongoing effort nationally to identify over 400,000 ha of degraded PFAs for possible private investment. Social and environmental sustainability processes and measures are needed at all stages from identification to implementation.

14. **Sustainable village- and smallholder-based native forest plantations in PFAs** could be a promising approach, combined with nature-based tourism, to enhance the value of forest capital for poverty reduction in several districts in Khammouane. This will require a technical and managerial support system that ensures adequate plantation yields for financial viability.

15. **Protection forest areas, often in great need of reforestation to enhance their intended watershed protection value, have potential for smallholder and village forest plantations.** Bualapha District, for example, has about 50,000 ha that may benefit from reforestation by villages and smallholders. This option will also require a technical and managerial support system.

16. **Large-scale industrial forest plantations must be balanced with continued local access to resources,** such as wild food and non-timber forest products (NTFPs) that matter greatly in the daily life

of most rural communities. Up to 86 percent of households in Khammouane use the forests surrounding their villages for these and other purposes.

17. **Successful forestry plantations require skills development.** This includes skills for plantation management, harvesting, and haulage and processing.

Building wealth through conservation

18. **Continue to invest in protected areas.** The Prime Minister's Decree on Protected Areas could be enhanced to reflect the strengthened commitment of the GOL to the emerging national park agenda and the adoption of the internationally recognized protected area categories of the International Union for Conservation of Nature (IUCN). Staffing levels need to expand to meet the commitment, as well as continued investment in the livelihoods and capacity of enclave and buffer villages that are involved in collaborative management of the protected areas.

Building wealth through nature-based tourism

19. **Promotion of nature-based tourism in the Khammouane landscape is a great opportunity to create greener economic growth and good jobs,** given the rich protected areas and wildlife, unique and dramatic karst landscapes, and a large and fast-growing regional market demand for experiences with nature. This is especially important in districts with attractive natural assets and limited alternative income opportunities. Regulations and procedures for tourism concessions in protected areas and the broader landscape would benefit from clear steps and incentives for businesses to invest in nature-based tourism.

20. **Identify ways for the Government to capture natural resource rents from tourism.** Several instruments are potentially available to extract more of tourists' consumer surplus from nature-based tourism. One attractive instrument is a special tax on hotel stays, levied as a percentage of the hotel bill. A second instrument is a tax on tourist transportation. A third instrument is a tax on restaurant meals. Such a tax would, however, also affect the population of Lao PDR unless it could be carefully targeted. These tools could also help manage the sites to avoid overcrowding and deterioration of assets that draw tourists.

Building wealth through water resources

21. **Assessment of potential for groundwater-based dry season crop irrigation in select districts in Khammouane.** Irrigation is now confined by surface water availability with uneven irrigation development across districts. Pilot groundwater irrigation shows promising results in the Vientiane plain.

22. **Provision of improved and safely managed household water supply in the poorest districts of Khammouane.** This is particularly needed in Bualapha and Nakai.

Build natural capital and human capital together

23. **Expand clean cooking technologies and behaviors to combat the serious health effects from the high usage of wood fuels¹ in the province.** Household air pollution from wood fuels for cooking and other household purposes is the most serious environmental health risk nationally and in Khammouane, causing over 4,000 deaths annually in Lao PDR. The annual cost of these health effects is estimated at about US\$950 million equivalent to 5.7 percent of GDP in 2017 (World Bank 2020b). This is over nine times the value of the annual resource rent of wood fuels.

24. **Expand use of alternative drinking water filtration systems.** Poor households use wood to boil drinking water to avoid potential exposure to microbial contamination, but using wood increases

¹ Wood fuels refer to charcoal or wood (which is also known as fuel wood).

household air pollution with even larger health effects. Other methods of treating drinking water, such as ceramic filtering or solar disinfection, are alternatives for which health benefits by far outweigh the cost of treatment (World Bank 2020b).

Improve decision-making through information modernization

25. **Consider expanding the LECS and the LSIS to be representative at the district level.** These two surveys, if representative at the district level, have the potential to fill significant gaps in natural resource data. One option is to start with this in select provinces.

26. **Establish a forest data bank that contains vital data on forest activities, production rates, forest densities, stocks and growth rates, and other parameters.** Such data are largely unavailable and are much needed for improved forest resource management, planning and investment. Where data exist, data are fragmented among divisions or are inaccessible.

27. **Include additional dimensions of natural capital to have a more complete picture of wealth, expanding beyond the NCA approaches.** This report is the first effort to measure natural capital in Lao PDR. Future valuations should include other assets and provinces that were not considered due to data, funding and time constraints.

28. **Continue to build NCA in the national statistics.** This report is a first attempt to value natural assets in a selected landscape. Policy makers can consider scaling up this process in other provinces and at the national level by integrating key dimensions of natural capital in questionnaires for the next census and other key surveys.

29. **Continue to invest in the Lao Statistics Bureau (LSB) in the MPI, line ministries, provincial agencies, and universities to produce, analyze, manage, and use environmental data.** The ability to develop natural capital accounts will improve investment planning and evaluation. This capacity support should be a long-term engagement, and the World Bank is well placed to provide, in coordination with other partners, substantial support for natural resource management and green growth in Lao PDR. For future research by development partners or government bodies, the LSB is well positioned to play a more prominent coordination role to obtain, update, and manage all data on natural capital from the concerned line ministries. This will help quickly respond to new policy priorities and provide the tools for swift evidence-based analysis.

30. **Maintain and strengthen the interministerial working group on natural capital.** The working group, led initially by the LSB, formed under this advisory service has become an important platform to discuss priorities and challenges that intersect among line ministries' usual business. The valuation of natural assets, and their inherent interconnection, including potential trade-offs, require a more sophisticated planning process endowed with sector-specific knowledge and an overall vision of landscape development. Other countries in the region and globally are involved in similar NCA efforts and together with the Lao PDR's interministerial working group can be a network of champions that can reinforce one another's efforts.

1. Overview

1.1 Natural resources in the economy of Lao PDR

31. **The Lao People’s Democratic Republic is endowed with vast natural resources.** With a territory of 236,800 km² and population of 7.0 million in 2018, the country had a low population density of 30 people per km². As much as 58 percent of the country was forested in 2015, down from 61 percent in 2000 (World Bank 2019a). Tributaries to the Mekong River run through mountainous terrain providing significant hydropower potential. The population remains 65 percent rural, and agriculture, forestry, and fishing provide over 65 percent of total employment (World Bank 2020a). Tourism development and foreign direct investment (FDI) in hydropower, mining, and agroforestry have been instrumental to economic growth. Gross domestic product (GDP) grew at an annual rate of 6.9 percent from 1990 to 2018, transforming the country from a low-income to a lower-middle-income country, while the national poverty rate fell from 47 percent in 1992/93 to 23 percent in 2012/13 (World Bank 2020a).

32. **Natural-resource-based sectors contributed one-third of GDP in Lao PDR in 2018.** Agriculture, forestry, and fishing contributed the largest share, followed by electricity production and mining and quarrying (Figure 1.1). The value added per worker is many times higher in electricity production, mining, and quarrying than in agriculture, forestry, and fishing, but the latter form the basis of the livelihoods of the vast majority of the poor (World Bank 2020a).

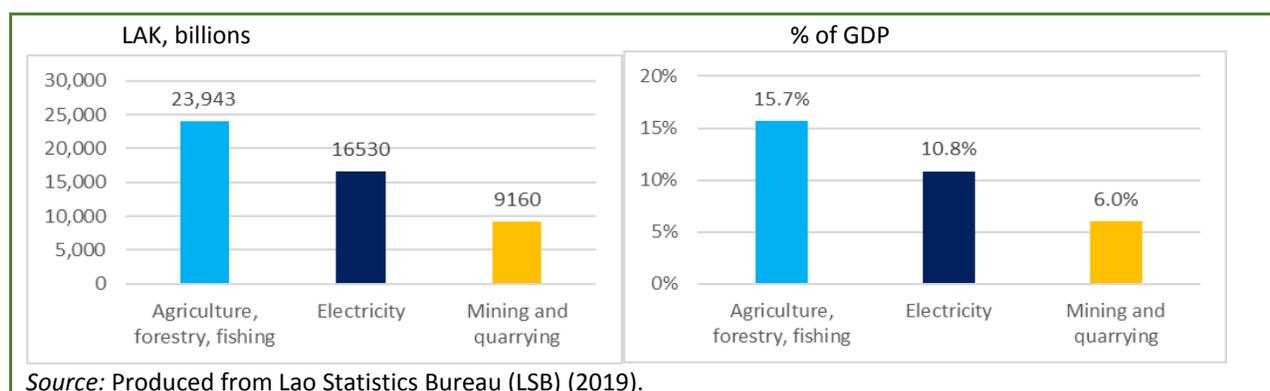


Figure 1.1: Natural-resource-based sectors contribution to GDP in 2018

33. **The natural-resource-based sectors, such as hydropower, have contributed not only to economic growth but also to improvements in human welfare.** With availability of relatively inexpensive hydropower electricity, national electrification grew from 15 percent of households in 1995 to 94 percent in 2018 (EDL 2019), a “remarkable success story in rapid national electrification” (World Bank 2012a).

34. **The contribution of natural-resource-based sectors does not, however, provide the full picture of the contribution of natural resources to GDP and household income and consumption.** Natural resources, such as non-timber forest products (NTFPs) and fish, are important sources of household self-collected energy, food, and nutrition that may not be adequately reflected in GDP. Natural resources are also important for foreign tourism to Lao PDR as well as for domestic tourism and recreation now and in the future. There are nearly 1,200 natural sites for tourism and 4.2 million foreign tourists visited Lao PDR in 2018. Tourist revenues were US\$811 million for the year, an amount equivalent to 4.5 percent of GDP (MOICT 2019).

35. **Natural resources also contribute to GDP indirectly.** Forests provide regulation services that reduce flash floods, flooding, landslides, and droughts, thus reducing damages to productive assets and prolonging their useful life (for example, reduced sedimentation of reservoirs). The value of these regulation services is not reflected in the GDP.

1.2 Natural capital accounting

36. **The World Bank has long promoted natural capital accounting (NCA)** and regularly provides estimates of the value of natural capital in terms of a nation's wealth, which is defined as the total value of human, produced, and natural capital.

37. **NCA fills a gap in existing national accounts.** The widely used System of National Accounts (SNA) is used to measure economic activity, such as GDP. The SNA was formalized in the 1950s and has since then undergone several updates and revisions. However, the SNA does not capture the full value of natural resources to society nor does it adequately measure the sustainability of economic growth in terms of the quantity and quality of natural resources.

38. **A shortcoming of the national accounts is that they do not account for**

- a) Depletion of natural capital such as fisheries, NTFPs, and forests;
- b) Degradation of the environment and natural resources; and
- c) Non-market goods (which are not included in GDP).

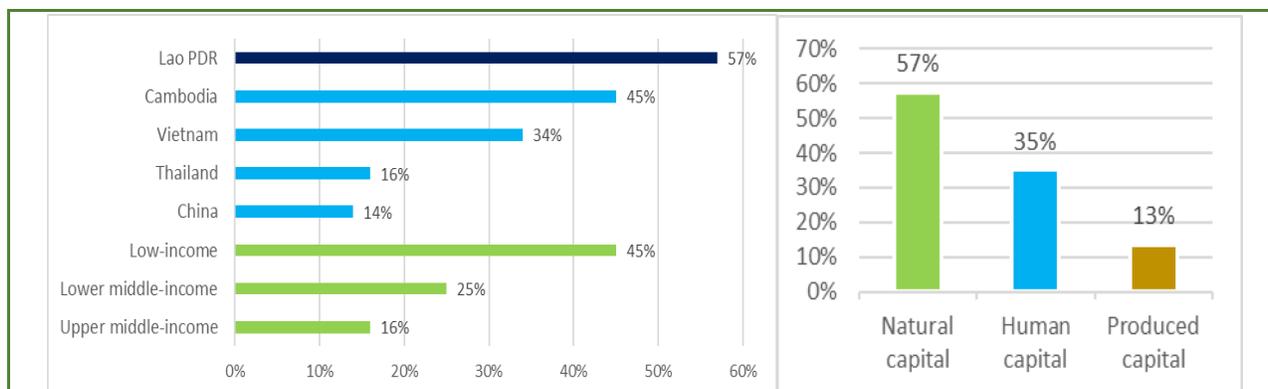
39. **Furthermore, many non-market services provided by natural resources are either wrongly attributed to other sectors.** For example, the value of natural attractions is attributed to the tourism sector or omitted entirely, which is often the case with biodiversity protection and carbon storage (Pagiola 2019).

40. **The System of Environmental Economic Accounting (SEEA) was developed to address the shortcomings of the SNA, and is being further revised.** The SEEA provides for (a) measuring environmental assets and individual resources and the manner in which the economy uses them, and (b) measuring ecosystems and the services that they provide to economic and human activity. The SEEA Central Framework was adopted as an international statistical standard by the United Nations Statistical Commission (UNSD) in 2012. A revision of the SEEA Experimental Ecosystem Accounting was launched in March 2018, to be finalized by March 2021 (Alfieri 2019).

41. **The SEEA is the internationally agreed methodology for NCA.** The SEEA allows for compiling physical and monetary accounts for a range of natural resources, such as minerals, timber, and fisheries, and linking these to the SNA (Ruijs and Vardon 2018).

42. **The natural capital share of total wealth in Lao PDR was 57 percent in 2014, according to the World Bank's flagship report, The Changing Wealth of Nations 2018.** This report presents natural capital estimates for 141 countries, including Lao PDR (World Bank 2018). The natural capital share in Lao PDR is higher than the share in its neighboring countries and more than double the share in other lower-middle-income countries (Figure 1.2).²

² The report does not provide estimates for Myanmar.



Source: World Bank 2018.

Figure 1.2: Natural capital share of total wealth in 2014

43. **NCA focuses on the part of total wealth that comes from land, water, mineral, energy, soil, forests, and timber, and ecosystem assets.** According to Pagiola (2019), NCA has been most useful as

- a) Indicators for monitoring sustainable development;
- b) Water accounting for managing a scarce resource;
- c) Energy and air pollution for cleaner, more efficient production;
- d) Stocks of minerals and energy for managing resource rents for long-term growth; and
- e) Land and ecosystems for balancing the needs of tourism, agriculture, and other uses.

44. **To operationalize NCA, the World Bank has been leading a global partnership called WAVES, or 'Wealth Accounting and the Valuation of Ecosystem Services'.** The WAVES partnership and the UNSD promote sustainable development by mainstreaming NCA in development planning and national accounting systems. WAVES and UNSD use the SEEA to produce NCAs in countries as an important tool to inform economic decision-making on natural resources (Ruijs and Vardon 2018). WAVES is now part of a broader World Bank initiative, the Global Program on Sustainability (GPS).³

45. According to Pagiola (2019), WAVES seeks to, specifically,

- a) Help countries adopt and implement NCAs that are relevant for policies and compile a body of experience;
- b) Develop ecosystem accounting methodologies;
- c) Establish a global platform for training and knowledge sharing; and
- d) Build international consensus around NCA.

1.3 Advisory services for Lao PDR

46. **This report on the natural capital of Lao PDR landscapes, in particular Khammouane Province, was produced as part of advisory services initiated to support Lao PDR's ongoing transformation toward economic growth that is sustainable, clean, green, resilient, and inclusive.** The advisory services aim to

³ <https://www.worldbank.org/en/programs/global-program-on-sustainability>.

- a) Support implementation of the country’s 2019–2030 National Green Growth Strategy, the eighth National Socio-economic Development Plan (NSEDP), implementation and development of sector strategy and policies, and preparation of the ninth NSEDP;
- b) Inform the preparation of new investments such as the Lao Landscapes and Livelihoods Project now under preparation for financing by the International Development Association (IDA) and Global Environment Facility (GEF), and associated support under consideration by the International Finance Corporation on forestry and nature-based tourism;
- c) Support new and stronger investment decision-making tools that are in place (that is, Strategic Environmental Assessment [SEA], Environmental and Social Impact Assessment [ESIA]); and
- d) Build interest and capacity of key counterparts in working with and eventually generating natural capital accounts for evidence-based decision-making. The advisory services are designed as a first step, which could continue in later years if financial support can be maintained.

1.4 Natural capital valuation in Lao PDR

47. **This assessment is based on a strong engagement with the Government of Lao PDR (GOL).** An initiating workshop was held at the World Bank on June 13, 2019. It was followed by a second workshop on December 9, 2019, to present initial findings from the analysis. The engagement highlighted the contribution that NCA can provide to the GOL’s green growth agenda, ongoing environmental statistics development, and academic research on Payment for Ecosystem Services (PESs). Participants attended the workshop from several institutions. These included the Ministry of Planning and Investment (MPI), (including Center for Development Policy Research [CDR] and LSB); Ministry of Agriculture and Forestry (MAF) (including National Agriculture and Forestry Research Institute [NAFRI]); Ministry of Environment and Natural Resources (MONRE); Ministry of Energy and Mines (MEM); and Ministry of Information, Communication; and Tourism (MOICT), National University of Laos (NUOL); and Luxembourg Development Cooperation (LuxDev). The GOL established an interministerial NCA Working Group to support and deepen the current engagement.

1.5 General methodology for natural capital valuation

48. **The methodology for valuation of natural capital in this report generally follows the steps outlined in the report, The Changing Wealth of Nations (World Bank 2018).** The methodology in this report also includes additional approaches for valuing natural assets.

49. **The first step in the natural capital valuation is to calculate the annual economic rent (resource rent) from a natural asset or natural resource.** The economic rent is a surplus value. It is

Value of an output created from a natural asset
 Less: all costs (other than of the natural asset)
 Less: normal profits
 = Economic rent

50. **The natural capital value (NCV) is then the discounted or present value of the future stream of annual rents.** It is important to note that the NCV is an asset value: it measures the value of the streams of benefits that natural capital will provide, in present value terms. As such, it is not directly comparable to GDP, which measures the annual flow of economic activity. It is, however, comparable to the value of produced capital as measured in the SNA.

51. **For some assets (for example, cropland and hydropower), the economic rent from the natural asset (land, water) is included in GDP, and the natural capital valuation brings out the contribution and value of the natural asset.** For other assets, the rent is attributed to other sectors (for example, tourism and transport) while in reality, it arises from natural assets. And yet for others, the rent is inadequately reflected or absent in GDP (for example, watershed protection services, household water supply, NTFPs, and household fishing).

52. **The main forms of natural capital in Lao PDR and Khammouane, and the goods, services, and functions they provide, are presented in Table 1.1, classified in three broad categories: land, forest, and water resources.** The focus is on sustainable use of renewable resources. Nonrenewable subsoil assets, such as minerals and energy (coal), are therefore not included in the study, even though minerals have/are playing an important role in the national economy and coal mining is increasingly being developed (not in Khammouane) for use in power generation.

53. **The NCVs of a majority of these categories are estimated in this report.** Exceptions are livestock, most of the watershed protection services, and biodiversity and climate change protection. This is largely due to data constraints. The forest value of carbon storage is not assessed as this is not a rent (although it could be in the future with competitive carbon markets) and the NCV largely does not accrue to Lao PDR, and is rather a global benefit. Sun and wind resources are included in the table but are not assessed in the report as solar and wind power in Lao PDR are still minimally developed in contrast to the rapid development in its neighboring countries such as China, Thailand, and Vietnam.

Table 1.1: Main forms of natural capital in Lao PDR and Khammouane Province

<i>Natural capital</i>	<i>Goods, services, functions</i>	<i>Main subgroups</i>
Agricultural land	Agricultural products	Crops and livestock
Forest resources	Timber	Natural forest and plantation timber
	Wood fuel	Fuelwood and charcoal
	Wild food	Meat and vegetables, tubers
	Tourism services	Foreign and domestic tourism
	Watershed protection	Flood and drought protection, regulation services, reservoir sedimentation protection, soil erosion protection, and protection of municipal water supply
	Biodiversity protection	Habitat, medicinal
	Climate change protection	Carbon storage, watershed protection services
Water resources	Household water supply	Surface water and groundwater
	Hydropower	Domestic supply, exports
	Fisheries	Capture fisheries, culture fisheries
	Irrigation	Surface water and groundwater
	Biodiversity protection	Aquatic life
Sun and wind	Energy production	Solar power, wind power

1.6 Estimates of natural capital values in Lao PDR

54. **The NCV of renewable natural assets in Lao PDR quantified in this study is US\$149 billion in 2018, or over US\$21,000 per capita.** Some of the annual rent from natural capital is captured by foreigners. This includes some of the value of nature-based tourism that accrue to foreign visitors and some of the annual rent from hydroelectricity that is exported at a price less than the cost of alternatives in the importing country. Nevertheless, Lao PDR captures at least 84 percent of the present value of the annual flow of rent from its natural capital, equivalent to an NCV of US\$125 billion of the total of US\$149 billion. This is shown in Table 1.2 as ‘total NCV’ and ‘NCV captured by Lao PDR’.

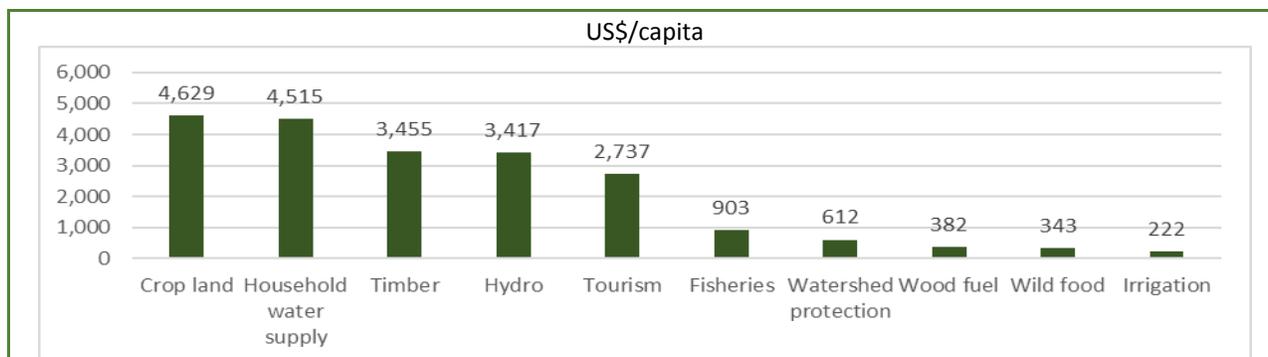
55. The three most valuable NCVs are agricultural cropland, household water supply, and timber (although timber sales have been banned by the Prime Minister and enforcement has been strengthened effectively since 2015). These are followed by hydropower and tourism. Each of these NCVs is in the range of US\$2,700 to US\$4,600 per capita (Figure 1.3). The value of fish and wild forest food amounts to over US\$1,240 per capita, and wood fuel amounts to nearly US\$400 per capita. The value of forest in terms of its watershed protection services is estimated at over US\$600 per capita. This is, however, a gross underestimate of the true value of watershed protection services as values, such as reduced reservoir sedimentation and protection of municipal water supply, are not estimated due to data constraints. The NCV of water resources in terms of irrigation is smallest at US\$222 per capita due to relatively limited irrigated area in Lao PDR. The value is, however, over US\$10,000 per ha, reflecting the high value of dry season irrigation in terms of agricultural crop productivity.

Table 1.2: NCVs in Lao PDR, 2018

	<i>Annual rent (US\$, millions)</i>	<i>Total NCV (US\$, millions)</i>	<i>NCV captured by Lao PDR (US\$, millions)</i>	<i>Total NCV (US\$ per capita)</i>	<i>NCV captured by Lao PDR (US\$ per capita)</i>
Agriculture					
Agricultural cropland	1,249	32,461	32,461	4,629	4,629
Forest					
Timber	932	24,229	24,229	3,455	3,455
Wood fuel	103	2,677	2,677	382	382
Wild food	93	2,406	2,406	343	343
Foreign tourism	595	15,463	ND	2,205	ND
Domestic tourism	180	3,729	3,729	532	532
Watershed protection	165	4,290	4,290	612	612
Water resources					
Household water supply	1,218	31,666	31,666	4,515	4,515
Hydropower	744	23,967	15,310	3,417	2,183
Fisheries	244	6,336	6,336	903	903
Irrigation	60	1,559	1,559	222	222
Total	5,582	148,783	124,663	21,215	17,776

Source: Estimates by the author.

Note: Annual discount rate is 4 percent. ND = not determined.



Source: Estimates by the author.

Figure 1.3: NCVs in Lao PDR (US\$ per capita), 2018

56. **The value of the same portfolio of renewable natural assets in Khammouane Province was US\$12 billion in 2018, or over US\$28,000 per capita.** This is 30 percent higher than the national NCV per capita and is mainly due to the high value of the Nam Theun 2 hydropower plant. For natural assets other than hydropower, the NCV per capita is US\$17,800 nationally and US\$14,900 in Khammouane. The lower value in Khammouane is primarily due to the lower value of agricultural cropland and foreign tourism. Some of the annual rent from natural capital in Khammouane also accrues to foreigners as in the national case, that is, foreign tourism and hydroelectricity. Nevertheless, Khammouane captures at least 77 percent of the present value of the annual flow of rent from its natural capital. This is shown in Table 1.3 as ‘total NCV’ and ‘NCV captured by Lao PDR’.

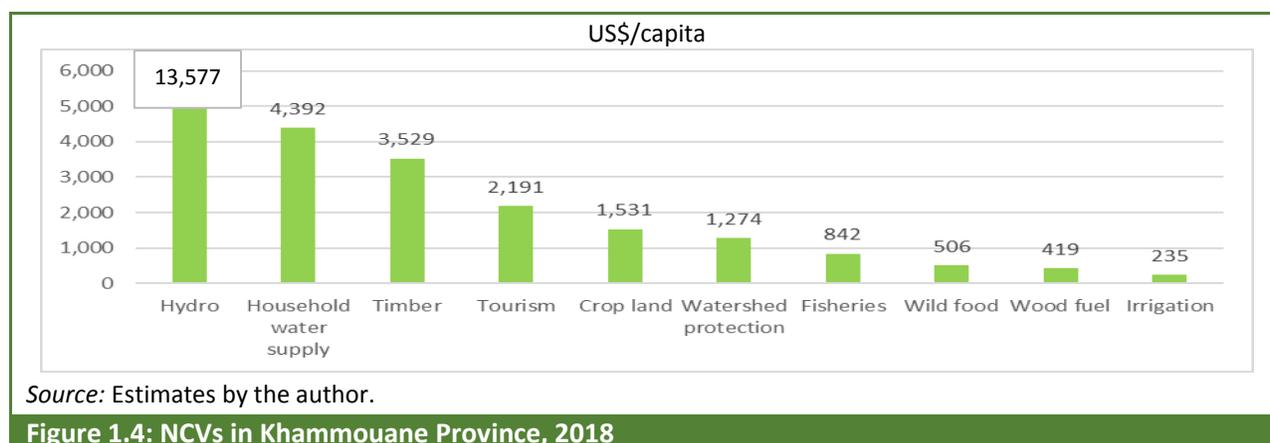
57. **The most valuable natural capital in Khammouane is water resources in terms of hydropower, accounting for 47 percent of total NCV in the province.** Hydropower is followed by household water supply, timber production, and tourism (now starting to grow from a low base). A distant fifth is agricultural cropland at one-third of the national per capita value, due in part to limited cultivation of high-value crops. The value of fish and wild forest food amounts to about US\$1,350 per capita, somewhat higher than nationally, and nearly as high as the value of cropland in Khammouane. The value of wood fuel amounts to over US\$400 per capita, while the value of forest in terms of its watershed protection services is nearly US\$1,300 per capita. This is, however, as in the national case, a gross underestimate of the true value of watershed protection services in Khammouane as values, such as reduced reservoir sedimentation and protection of municipal water supply, are not estimated due to data constraints. The NCV of water resources in terms of irrigation is smallest at US\$235 per capita due to relatively limited irrigated area in Khammouane (Figure 1.4). The value is, however, over US\$10,000 per ha, reflecting the high value of dry season irrigation in terms of agricultural crop productivity.

Table 1.3: NCVs in Khammouane Province, 2018

	<i>Annual rent (US\$, millions)</i>	<i>Total NCV (US\$, millions)</i>	<i>NCV captured by Khammouane (and Lao PDR) (US\$, millions)</i>	<i>Total NCV / US\$ per capita)</i>	<i>NCV captured by Khammouane (and Lao PDR) (US\$ per capita)</i>
Agriculture					
Agricultural cropland	25	645	645	1,531	1,531
Forest					
Timber	57	1,486	1,486	3,529	3,529
Wood fuel	6.8	177	177	419	419
Wild food	8.2	213	213	506	506
Foreign tourism	26	688	ND	1,635	ND
Domestic tourism	9	234	234	556	556
Watershed protection	21	536	536	1,274	1,274
Water resources					
Household water supply	71	1,849	1,849	4,392	4,392
Hydropower	172	5,716	3,603	13,577	8,558
Fisheries	14	355	355	842	842
Irrigation	4	99	99	235	235
Total	413	11,998	9,197	28,497	21,843

Source: Estimates by the author.

Note: Annual discount rate is 4 percent. ND = not determined.



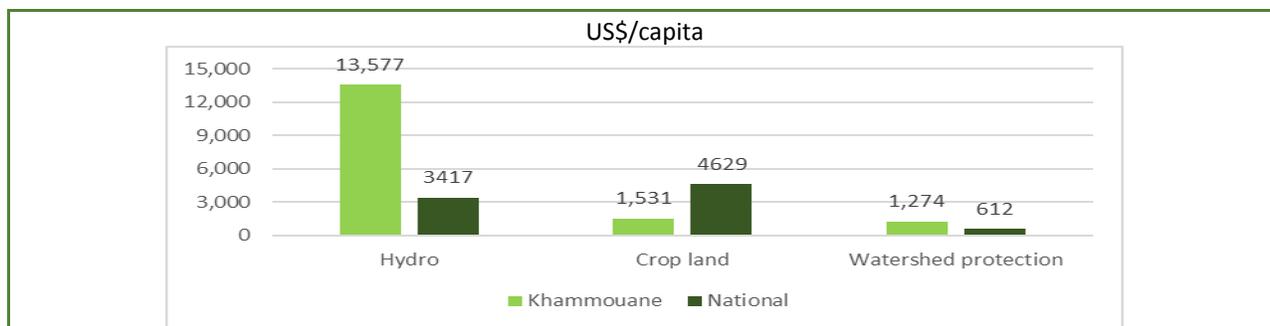
Source: Estimates by the author.

Figure 1.4: NCVs in Khammouane Province, 2018

58. **The main differences between Khammouane and Lao PDR nationally are the NCV of hydropower, cropland, and watershed protection (Figure 1.5).** The value of hydropower and watershed protection services in Khammouane is four and two times higher than the national average, respectively, while the value of cropland is one-third the national average. The difference for hydropower is Nam Theun 2 (1,070 MW), which accounted for 20 percent of installed hydropower capacity (5,200 MW) in the country in 2018.⁴ The difference for cropland is due to the substantially lower value of cropland in Khammouane, as self-reported by farmers.⁵ This is reflected in the low share of high-value crops cultivated in Khammouane. The difference for watershed protection services is the high propensity for flooding along the Xebangfay River in Khammouane, one of the eight major flood-prone river basins in the country, and thus the high value of protection (eWater 2018; UNDP 2010).

⁴ In 2018, the total installed power generating capacity was 7,080, of which 1,878 MW was coal-fired.

⁵ From the analysis of household data from the fifth Lao Expenditure and Consumption Survey (LECS-5) (2012–13) provided by the LSB. LECS is administered every five years and is representative at the provincial level.



Source: Estimates by the author.

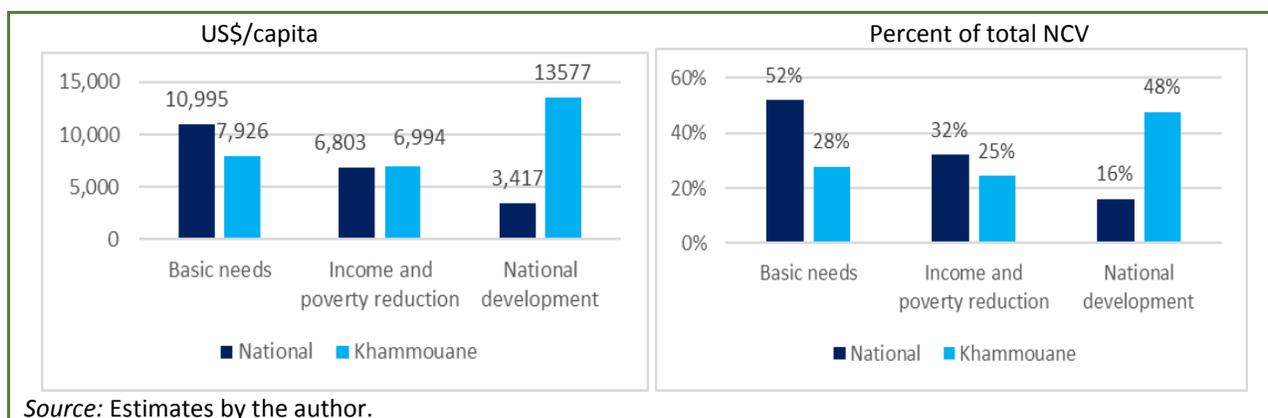
Figure 1.5: Differences in NCVs, 2018

59. **The natural capital, or natural-resource-based activities and services, can be categorized in terms of how they can serve sustainable socioeconomic development and human welfare.** The categories are ‘basic needs’, ‘income generation and poverty reduction’, and broader ‘national development’. The ‘basic needs’ category contains natural assets providing food and water and assets that support the production of food and water. The ‘income generation and poverty reduction’ category contains natural asset-related activities and services that can contribute to income and mitigate natural disaster risk. The ‘national development’ category centers on hydropower (Table 1.4).

Table 1.4: Categorization of natural assets by socioeconomic classification

Categories	Natural assets
Basic needs	Cropland, wild food, fish, household water supply, wood fuel, and irrigation
Income generation and poverty reduction	Timber (natural forest and plantations); foreign and domestic (nature-based) tourism; and watershed protection (that is, flood mitigation)
National development	Hydropower

60. **The natural resource activities and services for ‘the basic needs’ and ‘income generation and poverty reduction’ categories are important for most rural, and even a large share of urban, households, especially in smaller cities and towns.** The NCV for ‘basic needs’ is the largest category nationally, followed by ‘income generation and poverty reduction’. The NCV for ‘basic needs’ is lower in Khammouane largely because of the lower NCV of cropland. The NCV of the two categories constitutes as much as US\$17,800 per capita nationally and US\$14,900 per capita in Khammouane (Figure 1.6).



Source: Estimates by the author.

Figure 1.6: NCVs and shares in Lao PDR and Khammouane Province, 2018

61. **The large differences in some of the NCVs between Khammouane and the national average point to the usefulness of conducting province-level analysis to improve planning decisions for local development.** The differences in natural resource endowments, and thus rents and NCVs, are also visible across districts within Khammouane Province, as seen in the report, and are often larger than across provinces. The implication on policy and investment is to seek multisectoral solutions across the broader landscape of the province based on securing a sustainable flow of ecosystem services.

62. **The substantial spatial heterogeneity found in the report has important implications for future valuation efforts as optimal policies may differ across provinces and the landscape within each province.** Moreover, a province-by-province (or district-by-district) approach may not be optimal. Focusing on watersheds might be better but poses new challenges to data availability for some natural assets.

1.7 Rent capture and distribution

63. **The annual rent from many of the assets for which the NCVs are calculated in this report is widely distributed among the Lao population,** such as the rent from agricultural cropland, wood fuels, wild food, household water supply, and fisheries.

64. **For other assets, such as water used for crop irrigation, the rent is captured by the beneficiaries of irrigation** unless water is priced by the GOL for the Government to capture the rent.

65. **In the case of watershed protection values of the forest, the rent or benefit accrues to those downstream of the forest** in terms of flood and sedimentation mitigation. The downstream beneficiaries may elect to pay the upstream communities to protect the forest, or so-called Payment for Ecosystem Services (PESs).

66. **For other assets, such as hydropower and timber production, the GOL can tax hydropower and forestry plantation developers and logging companies** so that the GOL captures the resource rent and the developers and companies receive normal returns on investment. The GOL then distributes the rent to the population through its expenditures on infrastructure, education, health services, poverty reduction programs, and other priorities.

67. **Rent associated with tourism largely accrues to the tourists.** Therefore, most of the rent associated with foreign tourists is not captured by Lao PDR. Some of the rent, however, may be captured by the GOL through visa fees, airport taxes, user and entrance fees to tourist sites, and taxes on tourist accommodation.

68. **In some cases, the GOL may share some of the rent with neighboring countries.** This is the case for the rent from hydropower. The estimated share of rent from hydropower that is captured by the GOL is around two-thirds.

69. **In other cases, the rent goes uncaptured by the broader population and the GOL.** This is the case with illegal logging and illegal wildlife trade, where the rent benefits only a limited number of people.

1.8 Synergies and trade-offs

70. **The natural capital, or natural-resource-based activities and services, discussed earlier are often interlinked.** In some cases, synergies prevail, in others they involve potential conflict and trade-offs, and in others they may be largely unrelated. Table 1.5 shows the potential synergies and trade-offs for natural-resource-based activities and services, for most of which the NCVs are estimated in this report.

- a) **Land use.** Land has many potential uses. This includes land for agricultural cultivation, forestry plantations, natural forest, and hydropower. Agricultural cropland has been expanding at an annual rate of 4 percent per year in Khammouane over the last decade, reflecting population growth and an increase in farm household land holdings. Cropland expansion is the leading cause of deforestation in Lao PDR and often involves a trade-off with watershed protection services that forests provide. Cropland expansion may also involve trade-offs with other goods and services that forests provide, such as wood fuels, wild food, and other NTFPs.
- b) **Watershed protection services.** Most forms of forest management provide strong synergies with watershed protection services, such as natural forest protection, forestry plantations, and reforestation. Watershed protection services are of utmost importance in Lao PDR and Khammouane for flood protection, hydropower reservoir sedimentation control, agricultural soil erosion control, and mitigating effects of climate change.
- c) **Sustainable timber production in natural forest** also has the potential for substantial synergies. This is particularly the case for the supply of wild food, wood fuels, and other NTFPs that the large majority of the population in Khammouane relies on. Natural forests also provide synergies for nature-based tourism, a sector with substantial potential in Khammouane, for income generation and poverty reduction.
- d) **Forestry plantations** for timber production have strong synergies with watershed protection, especially if developed on scarcely forested land, and can provide local income and poverty reduction. But forestry plantation can involve trade-offs with availability of wild food, wood fuels, and other NTFPs. Around 86 percent of households in Khammouane rely on forests surrounding their villages for wild food and other NTFPs.
- e) **Nature-based tourism** has good potential for local income generation and poverty reduction and has synergies with forest/watershed protection, water resources, and sustainable natural forest timber production but may result in potential conflict with availability of wild food (wild animals may withdraw), timber plantation development, and quality of water (pollution) for household water supply. Khammouane has great potential for water-based tourism, including fishing in the Nam Theun 2 reservoir.
- f) **Hydropower development** has been and continues to be important for national socioeconomic development by providing domestic electricity supply, export earnings, and government revenues. Hydropower reservoirs can be positive for seasonal continuity of water resources for household water supply and irrigation; may help reduce seasonal flooding; and can provide opportunities for water-based tourism, fish culture, and fishing tourism. However, as reservoirs

may inundate large land areas, hydropower most often involves trade-offs with many natural-resource-based activities and services, as seen in Table 1.5. In the case of Khammouane, Nam Theun 2 generates PESs to finance Nakai Nam Theun National Park through the concession agreement to 2034 between the Nam Theun 2 Power Company and the GOL.

Table 1.5: Natural capital matrix – synergies and trade-offs

		Land		Forest						Water				
		Cropland	Wild food	Watershed protection	Wood fuel	Other NTFPs	Timber, plantation	Timber, natural forest	Tourism, forest based	Household water supply	Fisheries	Irrigation	Tourism, water based	Hydropower
Land	Cropland			T			T	T						T
	Wild food			S			T		T					T
Forest	Watershed protection	T	S		S	S	S	S	S	S				S
	Wood fuel		S	S			T	S						T
	Other NTFPs			S			T	S						T
	Timber, plantation	T	T	S	T	T		T	T					T
	Timber, natural forest	T	S	S	S	S	T		S					T
	Tourism, forest based		T	S			T	S						T
	Household water supply			S								S	T	S
Water	Fisheries										T/S			T/S
	Irrigation								S	T/S				S
	Tourism, water based								T					S
	Hydropower	T	T	S	T	T	T	T	T	S	T/S	S	S	

Note: S = Synergies; T = Potential trade-offs.

1.9 The value of land for alternative uses

71. **Estimating the NCV per hectare of land for various use options emerges from the above discussion as a potentially important input into land use decisions.** Accurately estimating the values is, however, no trivial task. Only broad averages can be provided based on the available data.

72. **In Khammouane, the NCV per hectare of land used for hydropower is the highest, at about US\$80,000 in Khammouane.** This is for Nam Theun 2 with an inundated area for the reservoir of about 450 km² or 45,000 ha. Nationally, the average NCV per hectare for hydropower on other tributaries of the Mekong River is about US\$92,000. The estimates are based on the natural resource rent and share of the NCV that accrues to Lao PDR. The values do not include unmitigated environmental and social costs of hydropower.

73. **The NCV per hectare from dry season irrigation is the second highest, at about US\$10,000.** Combined with the NCV of land, the NCV of dry season irrigated agriculture is over US\$16,000 per ha. The estimate for dry season irrigation is for rice cultivation and is likely to be substantially higher for high-value crops.

74. **The NCV per hectare in rainfed agriculture in Khammouane seems to be similar to the high-end values for forestry plantations.** The NCV per hectare for rainfed crop cultivation is US\$6,200. Values for industrial forestry plantations and sustainable native forest management plantations are in the range of US\$600–US\$6,300 depending on achievable yields. However, these values do not include watershed protection services, which in Khammouane are estimated at roughly US\$600 per ha of forest.

75. **The NCV per hectare of natural forest as it is today in Khammouane may be higher than most forms of forestry plantations.** The NCV per hectare of natural forest is estimated at US\$6,300. This includes timber for domestic consumption and export, wild food, wood fuel, current domestic nature-based tourism, and watershed protection services. It does not include natural resource rent and the NCV of nature-based foreign tourism in Khammouane as little of this rent is captured by Lao PDR.⁶ Neither does it include other values of natural forests, such as biodiversity, habitat, existence, and spiritual and cultural values. And the NCV per hectare may be enhanced by further development of the nature-based tourism potential in Khammouane.

76. **These calculations of the NCVs per hectare of land use are orders of magnitude but do provide some guidance for land use decisions.** They indicate that hydropower development on the tributaries of the Mekong River provides benefits that are substantially higher than alternative uses of land, as long as environmental and social impacts are properly mitigated and compensated. They also indicate that expansion of agricultural cropland is an economically efficient decision as long as land productivity is sufficiently high, cultivation is sustainable and not on sloped marginal land subject to excess erosion and nutrient losses, and does not infringe on natural forest areas of high value.

77. **The calculations also indicate that expanding dry season irrigation is a priority,** exploring the opportunity for use of groundwater resources to make irrigation more widely available and not limited to areas close to surface water sources.

78. **Moreover, the calculations indicate that industrial forestry plantations are warranted on unforested land or severely degraded forest land that have limited alternative uses** and that do not unduly affect local communities' access to forest resources such as wild food, wood fuel, and other NTFPs.

1.10 Trends, threats, and opportunities

79. **The NCVs presented in the previous sections represent a snapshot in time of the stock and flow of rent from renewable natural assets in Lao PDR and the Khammouane landscape.** Some of the assets, and goods and services associated with the assets have increased over time. This includes agricultural cropland, tourism, household water supply services, and hydropower development. Some have been fairly constant over time, such as household use of wood fuel although the trend has been an increased use of charcoal and decline in use of fuel wood. Forests, however, have experienced severe degradation mainly due to unsustainable timber production, and forest cover has declined. Watershed protection services have declined in tandem with deforestation and forest degradation. For other assets, such as fish and wild food, further analysis is required to assess trends in consumption and availability. New

⁶ Nature-based foreign tourism in Khammouane does, however, provide normal economic benefits that are not included in the calculations of NCV.

opportunities are, however, available. They include forestry plantations, development of nature-based tourism, and expansion of dry season irrigation (Table 1.6).

Table 1.6: Trends, threats, and opportunities

<i>Agriculture and forestry</i>	
Agricultural cropland	Agricultural cropland expansion is the main driver of deforestation in Lao PDR. Expansion has been 4 percent per year in Khammouane during the last decade. Increased dry season irrigation and increased cultivation of higher-value crops may help slow the need for expansion.
Forest	From 2005 to 2015, forest cover declined by 3 percentage points of national territory, and forests have become severely degraded in many areas of the country.
Timber	National timber production from natural forests increased at an unsustainable rate up until 2014, with high rates of valuable exports. Production has since declined by 50 percent, of which exports have declined by as much as 85 percent. Reliable timber production and export data for Khammouane are not available. Forestry plantations provide an attractive alternative with a large potential for degraded forest land and for land with limited or no forest cover.
Wood fuel	As much as 97 percent of the population in Khammouane relies on wood fuels for cooking. The trend has, however, been a pronounced substitution of fuel wood with charcoal.
Wild food	Wild meat, tubers, and vegetables from the forests constitute a substantial share of total food consumption in Khammouane according to analysis of household survey data from 2012–13. Further analysis of prior survey data and the most recent survey in 2019 can shed light on trends in consumption as well as availability.
Foreign tourism	Foreign tourist arrivals to Lao PDR increased at an annual rate of 9 percent over the last decade, making tourism the third largest export sector after minerals and electricity. Surveys have consistently found that the natural assets of the country are a major attraction for two-thirds of international tourists. Statistics indicate that 8 percent of foreign tourists visit Khammouane. The province has a significant unexploited nature-based tourism potential that can contribute to local community incomes and poverty alleviation, including in the poorest districts of the province.
Domestic tourism	Domestic tourism has increased at an annual rate of 8 percent in recent years and can be expected to continue its rise with per capita income growth.
Watershed protection	Watershed protection has continued to be compromised with loss in forest cover, forest degradation, and loss in forest density. This ecosystem service is, however, vital for Lao PDR and Khammouane with large flood- and drought-prone areas and many hydropower reservoirs. Forestry plantations and reforestation efforts can help turn the trend.
<i>Water resources</i>	
Household water supply	Access to improved household water supply has continued to increase nationally and in Khammouane. From 2012 to 2017, the share of households with piped water supply doubled in Khammouane, while households having unprotected dug wells and springs declined by 50 percent. Yet 13 percent have no built water source and use unprotected surface water from rivers, ponds, and lakes.
Hydropower	Electricity production from hydropower increased seven-fold from 2008 to 2018. Most of the electricity is exported to neighboring countries. Only about one-fourth of hydropower potential was developed in 2018 as new plants on the Mekong tributaries and on the Mekong River are coming into operation and are being developed.

Fisheries	Fish consumption stands at about 3 kg per household per week in Khammouane, compared to 2 kg of meat, and is thus a major source of protein and nutrition, according to analysis of household survey data from 2012/13. Further analysis of prior survey data and the most recent survey in 2019 can shed light on trends in consumption as well as availability.
Irrigation	28 percent of total planted area in Khammouane is irrigated, of which 18 percent is wet season irrigation and 10 percent is dry season irrigation. This is slightly above the national average. Irrigation remains inadequate and solely relies on surface water. A recent pilot project with groundwater irrigation suggests a promising alternative that needs to be further explored.

80. **The remainder of the report is organized as follows:**

- **Section 2** presents an overview of the data used in the report, ranging from household survey data to district and provincial statistics. These data provided the basis for the creation of 32 district-level indicators and an additional 24 province-level indicators presented in the report (Khammouane Province has 10 districts). These 56 indicators were used for estimation of the NCVs in Khammouane and for the creation of district national capital landscape profiles presented Annexes 3 and 4.
- **Section 3** presents demographics and poverty indicators of Khammouane and its districts. This provides a basis for understanding the socioeconomic differences across the Khammouane landscape and the manner in which these differences are associated with the spatial natural resource endowment across the landscape.
- **Section 4** presents an overview of the unexploded ordnance (UXO) contamination in Khammouane from the second Indochina War 1964–1973. The UXO contamination continues to hamper utilization and investment in natural assets, infrastructure development, and poverty reduction.
- **Sections 5 and 6** present an overview of forest and water resources as these resources constitute nearly 80 percent of the estimated NCV of renewables nationally and 85 percent of the NCV of renewables in Khammouane. The overview discusses forest land, National Protected Areas (NPAs) and biodiversity, forest plantation development, nature-based tourism, river basins, and seasonal flooding. Annex 1 provides further details on forest and water resources as well as agricultural cropland.
- **Section 7** presents the estimation of natural resource rent and NCVs, both nationally and in the Khammouane landscape for various goods and services that agricultural land and forest and water resources provide.
- **Section 8** concludes the report with a set of recommendations for protecting and enhancing the value of natural capital in Khammouane.

2. Data and analysis

81. **Khammouane Province was selected for NCV for its large and significant national protected areas (NPAs), covering 39 percent of its territory, and its substantial agricultural and water resources, including the country's largest hydropower plant.**

82. **The report focuses on what are considered the most important forms of natural capital for the population and local communities of Khammouane** and provides a provincial-, district-, and household-level analysis of natural capital in the Khammouane landscape.

83. **The analysis is summarized in district natural capital profiles.** The profiles form the basis for identifying tentative natural capital enhancement priorities in each district presented toward the end of the report. District-level poverty incidence is also provided, so that it can be seen in the context of the natural capital profiles and priorities for poverty alleviation and reduction in the large poverty incidence disparities can be tailored across the districts.

84. **The report also touches on the cross-cutting subject of the widespread UXO contamination** left from the second Indochina War (1964–1973), whose clearance is often essential for development and poverty reduction.

85. **The assessment of natural capital in the landscape of Khammouane Province starts with an overview of demographics and poverty in the province.** This is followed by assessments of three main forms of natural capital that have important interactions among them:

- a) Forest resources (for conservation, protection and production)
- b) Agricultural land (irrigated and non-irrigated, often at the forests' margin in traditional rotational forest/crop systems)
- c) Water resources (for multiple uses).

86. **Khammouane exhibits considerable spatial diversity in terms of initial endowment of the various forms of natural capital,** their current use, the quality and quantity of these forms of capital, and the potential for enhancement of their values.

87. **A spatial assessment of the landscape is therefore needed to capture some of this diversity.** The spatial unit of assessment in this report follows administrative divisions to the extent data are available, that is, an analysis of each of the 10 districts in the province. A total of 32 indicators are provided at this spatial level of assessment (Table 2.1). District natural capital profiles are provided in Annex 4 for each of the 10 districts.

Table 2.1: Indicators of district natural capital		
<i>Indicators</i>	<i>Number of indicators</i>	<i>Main data</i>
Population and geography	5	Lao Population and Housing Census 2015 (LSB); Lao Statistics Yearbook 2018 (LSB)
Poverty	2	Data based on (LECS-5) 2012–13 and the Lao Population and Housing Census 2015 (LSB)
UXO density and village impacts	4	Data based on the national UXO 1997 survey (UXO Lao)
Forest resources		
Forest area	10	Data on forest land categories (Department of Forestry [DOF])
NPAs	2	Data from NPA fact sheets (DOF)
Plantation potential	1	Based on forest land areas from DOF
Nature-based tourism potential	1	Based on nature-based tourist attractions
Agricultural land		
Agricultural land	3	Lao Crop Statistics Yearbook 2017 (Department of Agriculture [DOA])
Water resources		
Dry season irrigation	3	Lao Crop Statistics Yearbook 2016–17 Dry Season (DOA)
Seasonal flood risk	1	National Risk Profile of Lao PDR 2010 (United Nations Development Programme [UNDP]) and satellite imagery 1984–2018, European Union
Total indicators	32	

88. **In addition, the assessment also includes analysis of various aspects of the main forms of natural capital at the province level, with a total of 24 indicators bringing total indicators to 56.** This involved Stata analysis of the Khammouane household data from two national surveys by the LSB: LECS-5 (2012–13), and the Lao Social Indicator Survey (LSIS II) 2017. These surveys are representative at the province but not the district level.

89. **The LECS is administered nationally every five years and is used for calculation of consumption-based poverty incidence in Lao PDR.** The survey also contains valuable information on

- a) The contribution of natural capital to household livelihoods;
- b) Household activities in exploiting the natural capital; and
- c) Household use, consumption, and sale of goods and services from the natural capital.

90. **This includes natural capitals related to agricultural land; forest resources such as wild meat/hunting, fuel wood and charcoal, and wood used in housing; and water resources in terms of fishing, fish consumption, and irrigation.** A total of 15 indicators were analyzed using Stata (Table 2.2).

Table 2.2: Indicators of natural capital in LECS-5

Agriculture	Agricultural land
	Agricultural productivity
	Agricultural land values
	Dry season cultivation (irrigation)
Food consumption	Wild meat
	Wild vegetables
Household activities	Fish
	Fishing
	Hunting
	Fuel wood collection
	Forest exploitation
Wood consumption	Wood used in housing
	Fuel wood
	Charcoal
Total indicators	15

Source: Produced from the LECS-5 household questionnaire.

91. **The LSIS is also administered nationally every five years.** The survey contains valuable information on household water supply and use of wood fuel for cooking (wood and charcoal). A total of nine indicators were analyzed using Stata software.

92. **Despite the large amount of data used in this report, NCVs are not calculated for subareas (districts) of the larger Khammouane landscape due to lack of data.** District-level data are insufficient to allow detailed NCV estimates at that level. The lack of representative district-level data in important national household surveys in Lao PDR, such as LECS and LSIS, is a major shortcoming for understanding and addressing the spatial distribution of natural capital in Khammouane and other provinces. Differences in spatial distribution are often larger across districts within a province than across provinces. Provincial averages mask these differences. The Poverty-Environment Nexus study in the Mekong subregion of Lao PDR, Cambodia, and Vietnam 15 years ago recognized the need for district-level data to meaningfully understand the poor's reliance on and degree of access to natural resources and how the poor are affected by environmental and natural resource degradation (World Bank 2006, 2012a). This problem has been addressed for poverty analysis and targeting of poverty reduction programs by combining Population and Housing Census and LECS data to estimate small-area poverty. This, however, is not available for natural resources and especially the economic dimensions of natural resources. Thus, old studies of the countrywide or subnational population's economic reliance on natural resources, such as NTFPs, continue to be cited, such as Foppes and Samontry (2010). While this study was an important contribution at the time, it relies mainly on previous studies published between 1997 and 2006, with data in these studies of even older origin. This highlights the need for timely and periodic natural resource data on meaningful spatial aggregations, such as district level, or at several watershed scales.

3. Demographics and poverty

93. **Khammouane Province in the central region of Lao PDR is characterized by both flat lowlands and hilly and mountainous regions.** The lowlands are along the Mekong River in the west and in much of the southern and central regions of the province. The northeast and southeast regions are mostly hilly and mountainous, reaching altitudes of over 2,000 meters above sea level (masl).

94. **In 2018, the province had a population of 421,000 with a population density of 26 persons per km², slightly lower than the national average.** Nearly 78 percent of the population resided in rural areas, compared to 67 percent nationally. The vast majority of the population is located in the lowlands, consisting mainly of Lao-Tai populations. Smaller parcels of populations reside in the southeast and northeast, consisting mainly of Mon Khmer populations. Population density in the 10 districts of the province ranged from well over 100 per km² in the southwest lowlands to less than 10 per km² in most of the southeast and northeast.

95. **Consumption-based poverty incidence in Lao PDR** declined from 46 percent in 1993 to 23 percent in 2013. Poverty incidence in Khammouane Province has been close to the national average over this period and stood at 26 percent in 2013.

96. **The GOL has identified 47 first priority and 25 second priority districts for poverty reduction across the country (GOL 2003).** Nationally, poverty incidence has declined faster in the first priority districts since 2003, reaching the same levels as in the second priority districts in 2013. However, poverty incidence in the priority districts remained twice as high as in the non-priority districts, pointing to the need for continued efforts for inclusive and equitable economic growth and development.

97. **Khammouane has two first priority districts (Nakai and Bualapha) and three second priority districts (Mahaxay, Nhommalath, and Xaybuathong).** In 2015, poverty incidence in these five districts was almost twice as high as in the non-priority districts and was highest in the two first priority districts of Bualapha and Nakai.⁷

⁷ District poverty incidence is estimated by combining LECS (2012–13) and the Lao Population and Housing Census 2015 data (LSB 2016b).

4. UXO contamination

98. **UXO from the second Indochina War (1964–1973) continues to be an obstacle to development in Lao PDR.** Nationally, over 25 percent of all villages and close to 25 percent of the total population in Lao PDR are affected by UXO. UXO contamination affects agricultural land development; forest resources; and implementation of development projects (for example, irrigation, household water supply, and hydropower development) and adds to the cost of private investment. It increases the cost of development, restricts movements between villages, slows transportation and communication work, undermines social and economic development, and has resulted in thousands of casualties since 1975 (World Bank 2012b).

99. **A decade ago, the Poverty-Environment Nexus Study in Lao PDR found that poverty incidence and UXO contamination are highly correlated.** Districts with a higher share of villages affected by UXO had substantially higher poverty incidence, less cultivated land per capita, higher rate of rice insufficiency, spent more time on fuelwood and water collection, and had less access to improved water supply and sanitation (World Bank 2006, 2012b). The correlation between poverty incidence and UXOs was just as pronounced in 2015. Despite increased efforts and funding for UXO clearance, poverty reduction has been no faster from 2005 to 2015 in districts affected by UXO than in other districts.⁸ This suggests that further targeting of UXO clearance toward the poorest and most contaminated districts may be possible, along with complementary poverty reduction policies, programs, and projects.

100. **Khammouane is among the six provinces with the most severe UXO problem.** The share of villages affected by UXO is particularly high in the districts of Mahaxay, Xaybuathong, Bualapha, Nhommalath, and Xebangfay, with Bualapha having the highest share of severely affected villages.

101. **All types of investments on land require UXO clearance in many parts of the country, including parts of Khammouane Province.** The three most important national parks and protected areas in Khammouane have, however, significantly less UXO contamination than other parts of the province, which could help support the province’s continued nature-based tourism development around ‘The Loop’ that circles a large part of the province.

102. **UXO contamination is, however, likely to greatly influence the areas in Khammouane in which forestry plantations will be economically viable due to high UXO clearance cost.** The cost of clearance for plantations may be approximately US\$700 per ha (IFC 2018) but may be as high as US\$2,000–US\$3,000 per ha in areas severely affected by UXO.

⁸ The analysis used 2015 district poverty incidence data from the LSB (2016b).

5. Forest resources

103. **Forests provide many benefits in Lao PDR, of which only some are reflected in standard national accounts and GDP.** The most obvious of these benefits are timber production and processed wood products. A substantial share of the population's food consumption, most of the energy for cooking and other household purposes, and NTFPs also come from the forests. These benefits are only reflected in GDP to the extent that they are recorded or adequately estimated. Forests, along with their aquatic environments, also provide nature-based tourism and recreational benefits. These benefits are rarely fully reflected in GDP and are most often misattributed to other sectors rather than to their natural resource base. Forests also provide important ecosystem services that are typically not traded in markets, including regulation services, soil erosion reduction; and mitigation of natural hazards such as flash floods, seasonal flooding, landslides, and droughts. Reduction of soil erosion and natural hazards help protect water quality (for example, reduced turbidity); protect infrastructure and productive assets; and prolong their useful life (for example, reduced sedimentation of reservoirs). The value of these services is not reflected in GDP. The forests in Lao PDR also have important biodiversity values of global significance and carbon storage values for mitigation of climate change. They also have important, intangible cultural and religious values for many people, as well as existence value.

104. **All these forest ecosystem values, most of which are not reflected in national accounting and measures of GDP, point to underestimation of the true economic and social value of the forests in national accounts.** This leads to overexploitation of the type of services that provide immediate financial gains and/or that can be captured through rent-seeking behavior, such as overextraction of timber, wildlife, and NTFPs and conversion of forest to other uses.

Box 5.1. Ecosystem Services

Ecosystem services have typically been categorized in four main types:

- Provisioning services are the products obtained from ecosystems such as food, fresh water, wood, fiber, genetic resources, and medicines.
- Regulating services are defined as the benefits obtained from the regulation of ecosystem processes such as climate regulation, natural hazard regulation, water purification and waste management, pollination, or pest control.
- Habitat services highlight the importance of ecosystems to provide habitat for migratory species and maintain the viability of gene pools.
- Cultural services include nonmaterial benefits that people obtain from ecosystems such as spiritual enrichment, intellectual development, recreation and aesthetic values.

Source: Biodiversity Information System for Europe: <https://biodiversity.europa.eu/topics/ecosystem-services>.

5.1 Forest land

105. **About 70 percent of the land area in Lao PDR is classified as forest land and is designated into three forest categories:**

- a) **Production Forest Areas (PFAs)** are managed primarily for production of wood, fiber, fuel, and NTFPs. These areas total 14 percent of the territory of Lao PDR, or over 3.1 million ha, of which 71 percent is forested.

- b) **Protection Forest Areas** are managed primarily for soil, water, and natural disaster protection, such as strategic reservoirs. Protection forest areas cover 35 percent of the total land area in Lao PDR, or 8 million ha, of which 60 percent is forested.
- c) **Conservation Forest Areas (CFAs)**, also known generally as protected areas, are managed primarily for biodiversity conservation. There are three national parks (of which two are in Khammouane), 21 NPAs, and 66 provincial and 143 district protected areas, covering 21 percent of the total land area in Lao PDR, or 4.8 million ha, of which 73 percent is forested (World Bank 2019a).

106. **Importantly, by another designation, village use forests may overlap all of these categories and can also be found outside them** and there are nearly 0.5 million ha of plantation forests, spread over each forest category (World Bank 2019a). In addition, there are 3.2 million ha of forests (13.5 percent of national territory) outside of these three forest area categories. The 2019 Forestry Law seeks to devolve forest management responsibilities to villages and could allow timber production in village use forests.

107. **The actual forest cover is less than the forest land area (which is an administrative definition) and has declined over the last decade.** According to the latest definitions and classifications from satellite imagery, the forest cover in Lao PDR declined from 61 percent of the total territory in 2000 to 58 percent in 2015 (MAF 2018; World Bank 2019a).

108. **Forest degradation has been severe over the last decades.** While forested PFAs amount to over 2 million ha, harvestable forest in sufficiently good condition to sustain production was reported to have been only 0.6 million ha in 2012 (DOF/SUFORD 2013) and currently as little as 0.2 million ha (SUFORD 2019). The remaining forested areas are heavily degraded and may need 20 years and investment to regenerate. High and unsustainable levels of logging is the cause of this situation.

109. **In Khammouane, around 63 percent of the provincial territory is designated as the three forest categories, including provincial and district conservation and protection forest areas.** The share of territory designated as PFA (15 percent) in Khammouane is about the same as nationally, while the area under CFA (41 percent) is substantially larger and that in protection forest areas (4 percent), substantially smaller than nationally.

110. **Large areas of Khammouane are classified as forest land, and large areas are still covered by forest.** Most of the forest cover is located at the higher elevations (300+ masl), while the lowlands (150–200 masl) are populated and devoted to agriculture. The large majority of the forest cover is in the three NPAs—Nakai Namtheun in Nakai District in the northeast, Hin Nam No in Bualapha District in the southeast, and Phou Hin Poun in the northwest.



Source: DOF.

Note: White dots are population settlements. Dark green is forest (left and right map) and light green is NPAs (right map).

Figure 5.1: Population distribution, forest cover, and protected areas in Khammouane, 2015

111. **Forest land areas in Khammouane with the densest forest covers are in Nakai and Bualapha Districts with status of NPAs or National Parks all of which possess high global biodiversity value.** The two districts, as previously discussed, are characterized by higher elevations, low population density, Mon-Khmer populations, and the highest poverty incidence in Khammouane. PFAs extend through much of the southern areas of Khammouane in the districts of Xaibuathong, Xebangfay, southern Mahaxay, and Bualapha. The largest protection forest area is in Bualapha.

112. **Forest land area as a share of the total territory is strongly correlated with poverty in Khammouane.** The larger the district's forest land area as a share of total land, the higher is the poverty incidence. Enhancing the value of and community income from forest resources has the potential to form an integral part of poverty reduction efforts. Two potential directions in this regard are development of forest plantations and nature-based tourism, which are discussed at the end of this section.

5.2 National Protected Areas and biodiversity

113. **Protected areas, or CFAs, cover well over 40 percent of the territory of Khammouane.** There are three NPAs in the province covering 39 percent of the province's area, two of which now have National Park status (Nakai Nam Theun and Hin Nam No). Khoun Xe–Nongma in Bualapha District, a Provincial Protected Area with national and global significance, is in the process of becoming an NPA (DOF 2020).

114. **In 2015, 25 percent of Khammouane's population lived in or adjacent to the three NPAs.** As much as 98 percent of the population of Nakai and a third to two-thirds of the populations of Hinboon, Nhommalath, and Kounkham live in villages located in or adjacent to an NPA. Only three districts have no population living in or adjacent to an NPA.

Phou Hin Poun

115. **The Phou Hin Poun NPA is located in northwest Khammouane.** Its predominant physical feature is limestone karst ranges with steep slopes, cliffs and bluffs, and caves. A little over half of the NPA's area is limestone. Much of the remaining area is covered by various forms of forest and shrubland. Data indicate that cultivated crop area inside the NPA may be about 7.5 percent of the total area of the NPA. This is three to four times more than an estimate from 1997, pointing to the potentially large increase in human activity and footprints inside the NPA over the last 20 years (see Annex 1).

116. **A total of 81 species of reptile, 47 species of amphibians and 145 fish species have been recorded within the NPA (DOF 2018).** The NPA also provides catchment protection for parts of several rivers and has cultural value, including numerous temples and shrines in limestone caves, a number of sacred forests, and archaeological remains (Annex 5).

Hin Nam No

117. **Hin Nam No NPA in Bualapha District in southeast Khammouane was designated a National Park in 2019.** Forest covers as much as 87 percent of the NPA. The variety of habitat and forest types in the NPA supports a high diversity of animals and plants. Most of the habitats and associated wildlife are considered to be in pristine condition and with little forest loss over the decade and half (Annex 5).

Nakai Nam Theun

118. **Nakai Nam Theun NPA, mainly located in Nakai District in northeast Khammouane, was designated a National Park in 2019.** Its main forest types and wildlife are discussed in Annex 5. A total of 59 villages are located inside or adjacent to the NPA and use its resources. The NPA is facing several threats, including hunting and illegal logging of luxury timber (DOF 2018).

5.3 Forest plantation development

119. **There were almost 500,000 ha of forest plantations in Lao PDR in 2015, mostly rubber plantations (54 percent of plantation area), with smaller areas of eucalyptus and acacia (13 percent), teak (10 percent), agarwood (3 percent), and other species (9 percent)** (Smith et al. 2017; World Bank 2019a). Plantation arrangements include smallholder plantations, contract farming, and land concessions to domestic and/or foreign investors. There are several large-scale concessions of 20,000 ha–50,000 ha, which are partially located in Khammouane. Most of the concession plantation forests in Khammouane is located north of Hinboon district capital on land not classified as forest land area.

120. **Four districts in Khammouane have substantial PFAs totaling over 250,000 ha, and Bualapha has about 50,000 ha of protection forest areas.** Many of these areas may be suitable for plantations. Poverty incidence in two of these districts, Bualapha (44 percent) and Xaybuathong (39 percent), is substantially higher than the province average. There are also over 470,000 ha of land that are not classified as forest land nor cultivated with agricultural crops, some of which may be suitable for some kinds of plantations.

121. **A recent report assessed the financial and economic merits of four plantation regimes in Lao PDR (World Bank 2019a).** All four regimes have the potential for relatively high internal rates of return (IRR) on investment, including sustainable forest management (SFM) of native/natural mixed hardwood forest, subject to good management and timber growth rates. Land expectation values (LEVs) have the potential to reach thousands of dollars per hectare (Table 5.1). The LEV is the value of the land's contribution to the rate of return on plantation investment, and thus is the value of the natural resource (that is, land) that enters into the production of plantation timber. However, the outgrower eucalyptus plantation regime requires relatively good timber growth rate to achieve a positive LEV and viable rates of return on investment. Subject to good management and timber growth rates, plantations have the potential to provide income generation, employment, and poverty reduction in many districts in Khammouane. This must, however, be carefully designed and balanced in relation to community use of forest for wild food and other NTFPs, as 86 percent of households in Khammouane use forests surrounding their villages for these purposes.

Table 5.1: Estimated economic returns to forest plantations in Lao PDR

	<i>Eucalyptus industrial plantation</i>	<i>Outgrower eucalyptus plantation^a</i>	<i>Smallholder teak plantation</i>	<i>Sustainable management of native forest^b</i>
Timber growth rate (m ³ /ha/year)	26–33	14–18	9–14	3.2
LEV (US\$)	2,500 to 6,300	–560 to +3,000	2,400–5000	600–3,600
IRR (%)	15–22	6–23	13–18	14–24

Source: Cabbage et al. 2018; World Bank 2019a.

Note: Discount rate of 8 percent is applied for calculating LEV.

a. Low-end LEV and IRR reflect low growth (14 m³), value of own labor, and cost of planting. High-end LEV reflects base growth (18 m³), value of own labor, but not cost of planting provided by the industrial investor.

b. High LEV and IRR reflect higher stumpage prices.

122. Plantations and plantation-based industries offer opportunities for profitable and environmentally and socially responsible land use. Expansion of native forest logging and processing and/or export of high-value native hardwood is unlikely as the resource base will remain limited for the foreseeable future due to past degradation and non-wood values of the forests (for tourism, watershed protection, other ecosystem services) are being appreciated more.

123. This acknowledgement of opportunities for plantations and plantation-based industries could be strengthened through a stronger dialogue around the processing needs and market opportunities for plantation-grown wood:

- a) In the neighboring Savannakhet Province, the Sun Paper mill at Sepone imports some 700,000 tons of plantation-grown eucalyptus wood from Thailand, worth over US\$80 million annually. Similarly, 600,000 tons of plantation-grown acacia wood are imported from Vietnam annually. This suggests significant market potential for plantation development in Lao PDR.
- b) Emerging demand for eucalyptus wood from industries in Thailand, facilitated by the Mekong bridge at Thakhek, also points to the potential for plantation development in Lao PDR.
- c) Additional market potentials are
 - Veneer logs to Thai plywood mills;
 - Pulp logs to the Thai Paper mill in Khon Kaen, Thailand;
 - Sun Paper’s need for non-plantation fuelwood for its production of chemicals (estimated at 80,000 tons per year);
 - The proposed establishment of a veneer mill by Mekong Timber Plantations (150,000 tons input of plantation grown acacia and eucalyptus annually);
 - Mekong Timber Plantations, also selling plantation wood to Sun Paper. Prices are confidential but may be in the order of US\$55 per green metric ton delivered to mill gate; and
 - Agricultural companies seeking sources of plantation-based green energy for dry agricultural commodities.

124. Plantation forestry brings important growth and jobs opportunities to Lao PDR. If properly accounted for, including costs for environmental social, environmental, and governance standards of the value chain, the plantation industry could compete with other agricultural cash crops or land uses, providing additional ecosystem services, such as carbon sequestration, steep slope stabilization, and erosion control, and contribute to the national and local economies.

125. **Successful forestry plantations require skills development.** This includes skills for plantation management, harvesting, and haulage and processing that must be developed.

126. **Large-scale industrial forest plantations must be balanced with continued local access to resources,** such as wild food and NTFPs that matter greatly in the daily life of most rural communities. Nearly 86 percent of households in Khammouane use the forests surrounding their villages for these and other purposes.

5.4 Nature-based tourism development

127. **The 2019 World Bank report, ‘Developing Nature-based Tourism as a Strategic Sector for Green Growth in Lao PDR’, identifies the tourism sector, and especially nature-based tourism as a great opportunity to create greener economic growth and good jobs, given the country’s rich and abundant natural capital, protected areas, and a large and fast-growing regional tourism market** (World Bank 2019b). The report further states that tourism has the potential to become the largest foreign exchange earner and nature-based tourism the biggest rural employer. Tourism revenues amounted to US\$811 million in 2018 (MOICT 2019), equivalent to 4.5 percent of GDP. The COVID-19 crisis offers an opportunity to reboot the sector to respond to increasing demand for nature-based tourism in Lao PDR, especially in Khammouane which has been promoting ‘The Loop’ through half of its districts in recent years which connects various natural attractions inside and outside protected areas. Khammouane offers bountiful potential for development of nature-based tourism with its NPAs, mountain caves, rivers and waterfalls, and forests and rich biodiversity.

128. **The districts that perhaps offer the best potential for nature-based tourism are Kounkham, Nakai, and Bualapha, followed by Hinboon and Thakhek, Nhommalath, and Mahaxay.** Nature-based tourism opportunities in the three national protected areas are presented in the following paragraphs (also see Annex 6).

129. **Phou Hin Poun.** The Phou Hin Poun NPA has high potential for development of nature-based tourism that can provide alternative sources of income for the local communities for growth and poverty reduction. The NPA already has a significant number of visitors each year. The NPA is located on the popular tourist ‘Loop’ around Khammouane and Bolikhamxay Provinces which links many of the area’s attractions.

130. **Hin Nam No.** Village-based tourism services exist in 4 of the 19 villages adjacent to Hin Nam No National Park. The services include guesthouses, homestays, boat trips, visit to caves, trekking, history guides, waterfalls, and swimming. The authorities in Hin Nam No NPA have developed a strategy for supporting these cooperative groups where the income they earn from tourism acts as an incentive for nature conservation. Furthermore, a ticketing system has been established that allows benefit sharing with local communities and provides a source of sustainable funding for the NPA (DOF 2018; TRC Tourism 2015).⁹

131. **Nakai Nam Theun.** Nakai Nam Theun National Park offers important tourist attractions. Tourists traveling ‘The Loop’ typically start and end in Thakhek and visit Khammouane’s major attractions. Most visitors stop at the northwestern side of the Nam Theun 2 reservoir just across from the National Park. Nakai’s unique location offers an amazing opportunity to tap Khammouane’s tourism market (Annex 6).

⁹ Further information is available at: <https://hinnamno.org/library/>.

6. Water resources

132. **The water resources in Khammouane provide numerous benefits.** The resources include household water supply, hydropower, fisheries, and crop irrigation. Most of these benefits are enjoyed by the local population while government revenues from the hydropower development serve national development, including in Khammouane. While the benefits of hydropower and crop irrigation are reflected in the GDP, households' own consumption of fish from their fishing activities may be understated in the GDP, and most of the household benefits of water supply are not reflected in the GDP.

133. **Water resources also have indirect benefits.** Water sustains forests and rainfed agriculture and serves as an important ingredient for nature-based tourism. But water also causes damages through seasonal flooding in Khammouane, with forests providing mitigating effects.

6.1 River basins

134. **Khammouane receives around 2,500 mm of rainfall per year on average, the second highest of all provinces in 2017 and third highest in 2018.** As much as 90 percent of rainfall is received from May to September, peaking in July and August.

135. **Khammouane Province includes several river basins.** The Xebangfay river basin spans the southern part of Khammouane and the northern section of Savannakhet Province. The Nam Theun-Kading river basin spans the northeastern part of Khammouane and the southern part of Bolikhamxay Province. The Nam Hinboon river basin spans the northwestern part of Khammouane. Interbasin transfers from Nam Theun-Kading to Xebangfay and Nam Hinboon are substantial due to the Nam Theun 2 and Theun-Hinboon hydropower plants. The Xebangfay River, with a length of approximately 350 km, is the sixth longest tributary to the Mekong River in Lao PDR. The river runs through Khammouane from east to west and into Savannakhet before flowing into the Mekong. Nam Hinboon is a shorter river, with a length of 89 km. The Nam Theun River serves the Nam Theun 2 hydropower plant from which water is diverted through a channel to the Xebangfay River.

136. **Khammouane also has unquantified volumes of renewable groundwater resources.** Groundwater in Khammouane is mainly used for municipal and household water supply but may also have substantial potential for dry season agricultural crop irrigation.

6.2 Seasonal flooding

137. **Natural capital is not only associated with positive economic and social benefits.** This is the case with seasonal flooding that arises from the everchanging influence of water resources and now amplified by climate variability and change.

138. **The largest seasonal flood risk in Khammouane arises from the Xebangfay River, with its tributaries.** Nongbok, Xebangfay, and Mahaxay districts are most affected by seasonal flooding from the river. Flooding also takes place along the Nam Hai and Nam Hinboon Rivers in the north, exacerbated by the diversion of water by the Theun Hinboon hydropower project. Flood risk has also occurred from the Mekong River as the water rises to critical levels in some years.

7. Natural capital values in the Khammouane landscape

139. **This section provides estimates of the values of the main forms of natural capital in the Khammouane Province landscape.** The focus is on renewable natural resources, or natural capital, categorized as agricultural land resources, forest resources, and water resources. These resources provide many goods, services, and functions. While the resources often cannot be valued directly, they can be valued indirectly by the goods, services, and functions they provide. As the production of these goods, services, and functions often involves multiple inputs and production factors, of which natural capital is one, the cost of these other inputs and production factors must be deducted to arrive at the value of the natural capital.

140. **Economists employ various techniques and concepts to value natural capital.** These techniques involve the use of market prices and revealed preferences and contingent valuation for goods, services, and functions not traded in the market and concepts such as opportunity cost and substitutes.

141. **The section presents aggregate NCVs for the Khammouane Province landscape as a whole based on valuation of the good, services, and functions that the natural resources in the landscape provide and for which sufficient data are available to provide any meaningful estimates.** The NCVs are also provided at the national level, in absolute values and per capita, for comparison to values in Khammouane.¹⁰

142. **Table 7.1 provides an overview of main categories of natural capitals and the goods, services, and functions they provide in Lao PDR and Khammouane Province.** The NCVs of a majority of these categories are estimated in this section. Sun and wind resources are included in the table but are not assessed in the report as solar and wind power in Lao PDR is still minimally developed in contrast to the rapid development in its neighboring countries such as China, Thailand, and Vietnam.

Table 7.1: Main forms of natural capital in Khammouane Province

<i>Natural capital</i>	<i>Goods, services, functions</i>	<i>Main subgroups</i>
Agricultural land	Agricultural products	Crops and livestock
Forest resources	Timber	Natural forest and plantation timber
	Wood fuels	Fuel wood and charcoal
	Wild food	Meat and vegetables, tubers
	Tourism services	Foreign and domestic tourism
	Watershed protection	Flood and drought protection, regulation services, reservoir sedimentation protection, soil erosion protection, protection of municipal water supply
	Biodiversity protection	Habitat, medicinal
	Climate change protection	Carbon storage, watershed protection services
Water resources	Household water supply	Surface water and groundwater
	Hydropower	Domestic supply, exports
	Fisheries	Capture fisheries, culture fisheries
	Irrigation	Surface water and groundwater
	Biodiversity protection	Aquatic life
Sun and wind	Energy production	Solar power, wind power

¹⁰ The value per capita is calculated as total value divided by the national population and the population of Khammouane so that all per capita estimates are consistent and can be compared.

143. **The NCVs are estimated for most of the goods, services, and functions using so-called exchange values, that is, price x quantity exchanged, as is standard in the national accounts.** Welfare values were, however, used for tourism and household water supply. Welfare values are based on how much consumers are willing to pay, which, for some consumers, can be substantially higher than the price they are actually paying. The two measures of value are therefore not comparable.

7.1 Agricultural cropland

144. **Agricultural cropland is one of the most valuable natural assets of the rural population in Lao PDR.** The planted area is 7.6 percent of the national territory, or 0.26 ha per capita. The planted area in Khammouane is somewhat lower at 6.4 percent of the province's area, or 0.25 ha per capita.¹¹

145. **Crop cultivation in Khammouane is dominated by rice,** accounting for 86 percent of the total planted area, compared to 55 percent nationally. The area under rice cultivation increased at an annual rate of 4 percent from 2008 to 2018, or by a total of nearly 50 percent. Flooding had severe impacts on the area harvested in 2011 and 2018.

146. **Almost all rural households in Khammouane report having agricultural land (94 percent), as well as nearly half of urban households (47 percent) according to LECS-5 (2012–13).** The average land holding per household is 1.8 ha and is similar among urban and rural households. The reported average yield is 1.8 tons per ha of harvested land for wet season rice and 2.0 tons per ha for dry season rice.

147. **The yields reported by households in LECS-5 are in stark contrast to the yields for 2012 presented by the MAF for Khammouane in the Lao Statistics Yearbook 2012:** 3.4 tons and 4.8 tons per ha harvested for wet and dry season irrigated rice, respectively.

148. **Crop cultivation in Khammouane differs substantially across districts.** Cultivated land in Thakhek and Nongbok Districts constitutes over a third of the province's cultivated land, while cultivation in Bualapha and Nakai Districts constitutes only 10 percent. Cultivated land as a share of the total land area is highly correlated with district population density.¹² Half of Nongbok's land area is cultivated, while only 1–2 percent of land is cultivated in Nakai and Bualapha. Districts with small shares of their land cultivated also have smaller areas of cultivated land per capita. Less cultivated land per capita is also associated with a somewhat higher poverty incidence. This relationship is further explored in the section on irrigation.

149. **The LECS provides data on the value of agricultural cropland as self-reported by farmers (Figure 7.1).** The value per hectare in Khammouane is substantially lower than the national average, reflecting the low share of high-value crops cultivated in the province.

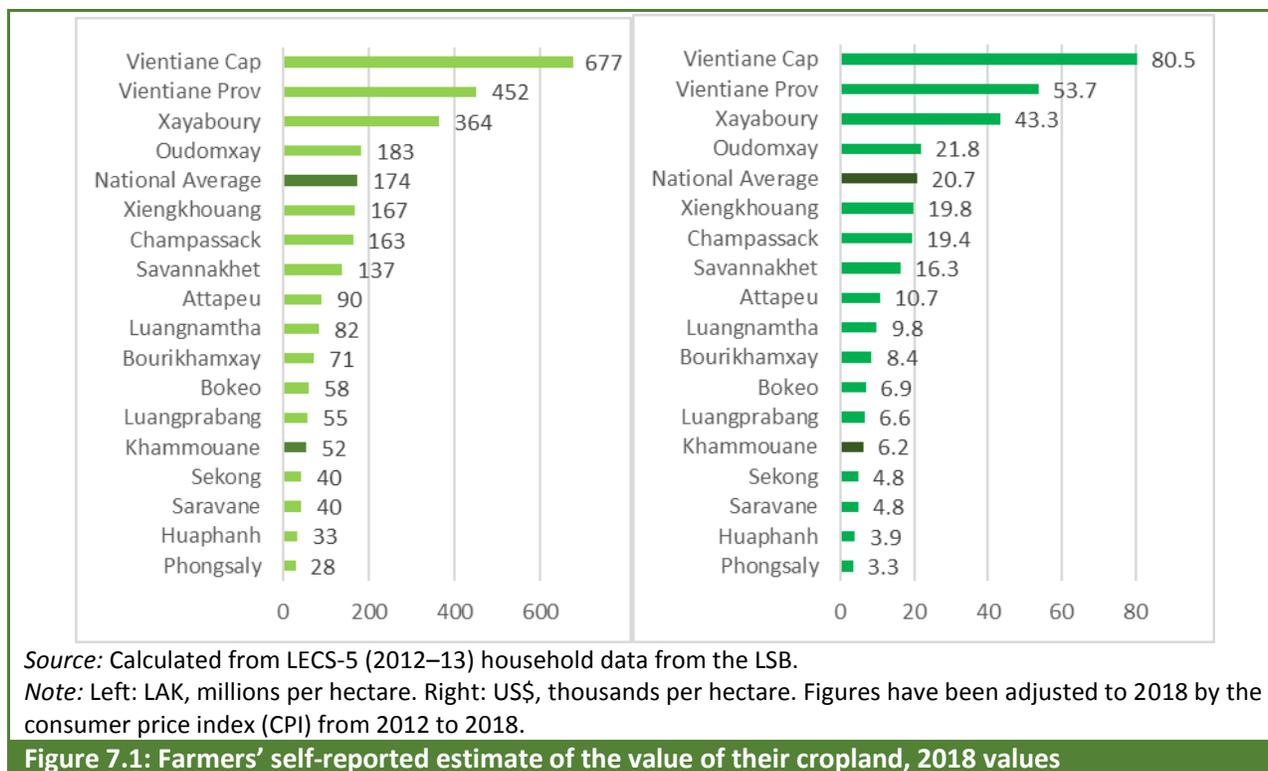
150. **Provincial average values range from LAK 28 million per ha (US\$33,000) in Phongsaly to as high as LAK 677 million per ha (US\$80,500) in Vientiane Capital, with a national average value of LAK 174 million (US\$20,700).** The value in Khammouane is LAK 52 million per ha (US\$6,200), which is less than one-third of the national average, and the fifth lowest in the country.

151. **Agricultural land values should reflect the type of crops for which the land is suitable and the productivity of these crops.** As few high-value crops are cultivated in Khammouane, land values are relatively low. The national average value without Vientiane Capital¹³ is LAK 139 million per ha (US\$19,400), three times higher than in Khammouane.

¹¹ These statistics are calculated from DOA (2018) and LSB (2018, 2019).

¹² The correlation coefficient is 0.95.

¹³ The high values in Vientiane Capital reflect the opportunities for higher value nonagricultural uses of the land near urban areas.



152. **The adjusted national value of US\$19,400 and the value of US\$6,200 in Khammouane are used to estimate the NCV of agricultural cropland.** Applying these values to the area of cropland gives an NCV of US\$32.5 billion nationally and US\$645 million in Khammouane in 2018, or US\$4,629 and US\$1,531 per capita, respectively (Table 7.2).

	Units	National	Khammouane
Cropland	Thousands, ha	1,670	103
Value of cropland	US\$/ha	19,438	6,209
Total value (NCV)	US\$, millions	32,461	645
NCV per capita	US\$	4,629	1,531
Imputed annual rent	US\$, millions	1,249	25

Source: Estimates by the author.

7.2 Forest resources

153. **Forest resources provide many valuable goods, services, and functions** in terms of meeting the basic needs of the population, generating income and reducing poverty, regulating hydrological flows, protecting against natural disaster risks and climate change, and preserving biodiversity, among others. Sufficient data are available to estimate some of these values. For other goods, services, and functions, only an indication of their value can be provided, and for others no value can readily be estimated (Table 7.3).

154. **As much as 70 percent of land in Lao PDR is classified as forest land and 58 percent of land is forested.** However, the quality of the remaining forest resources varies and large areas of forests have

been lost over the last decades. Deforestation and forest degradation have greatly impaired the NCV of forests in Lao PDR. The main drivers of deforestation, or loss of forested areas, are changes in land use, with forests being converted to agriculture; hydropower; mining; and plantations. Logging and pioneering shifting cultivation are considered the two main drivers of forest degradation (Koch 2017). There is little pioneering shifting cultivation in Khammouane.

155. **The total forest land area in Khammouane is also close to 70 percent.** CFAs—including the NPAs and National Parks—constitute the largest share of forest land area, or over 40 percent of the total land area. The NPAs and National Parks are of significant national and international importance. Some of the goods, services, and functions provided by these natural assets can be valued—notably wood fuels, wild food, tourism, and some watershed protection functions in terms of their contribution to household water supplies, fisheries, and irrigation of local communities inside or on the periphery of the NPAs and National Park, and hydropower production—albeit sometimes only approximately (Table 7.3). However, much of the immense biodiversity and climate change protection functions are difficult to value because of both conceptual issues and data constraints.

Table 7.3: NCV estimation of forest resources in Khammouane

<i>Goods, services, functions</i>		<i>NCV estimated</i>
Timber	Yes	
Wood fuels	Yes	
Wild food	Yes	
Tourism services	Yes	
Watershed protection	Indication of value of flood protection, protection of household piped water quality from surface water sources, and reservoir sedimentation protection	
Biodiversity protection	No	
Climate change protection	No	

7.2.1 Timber

156. **The LECS-5 (2012–13) household survey provides some perspectives on wood consumption.** About 16 percent of households in Khammouane reported owning forests. One-third of these households exploited their forests for timber, 99 percent for fuelwood, and 57 percent for bamboo.

157. **Forests surrounding villages are particularly important to the population of Khammouane.** Almost 86 percent of households exploited these forests, of which 40 percent for timber, 97 percent for fuelwood, and 78 percent for bamboo. These local forests are also important for food with 80 percent of households in the province collecting tubers and 80 percent collecting vegetables from the forests.

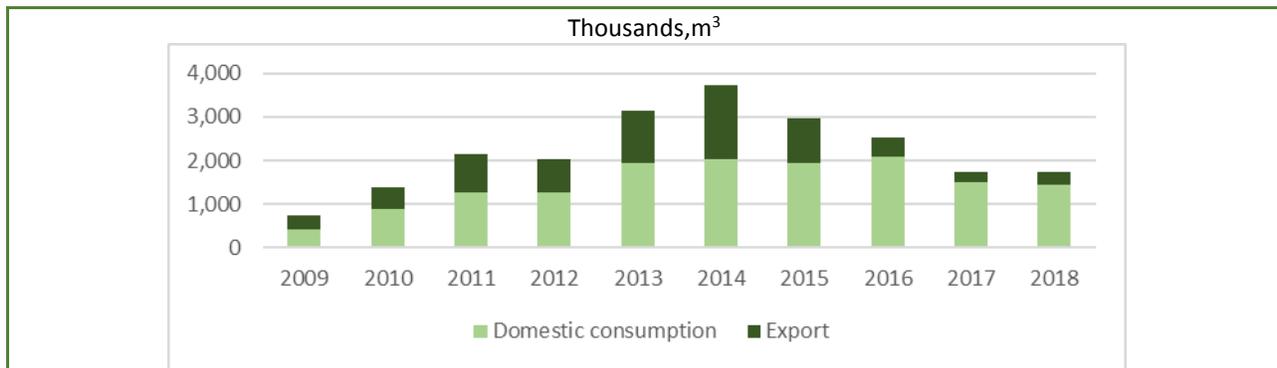
158. **Housing requires major use of wood.** About 29 percent of houses in Khammouane, less than six years of age, have wood walls, and nearly two-thirds have wooden floors.

159. **Data on production and domestic consumption of timber or industrial roundwood¹⁴ are severely inadequate and mostly nonexistent.** This is also the case for data on standing stock of forest and forest growth rates, even after 40 years of projects and institutional capacity building. No data on production and consumption of timber were provided for this study, which thus had to rely on national estimates by the Food and Agriculture Organization (FAO).

160. **According to the FAO estimates, timber production in Lao PDR increased fivefold from 2009 to 2014, reflecting a large increase in exports and a domestic construction boom.** Exports increased 5.3

¹⁴ All roundwood except wood fuel (FAO 2019).

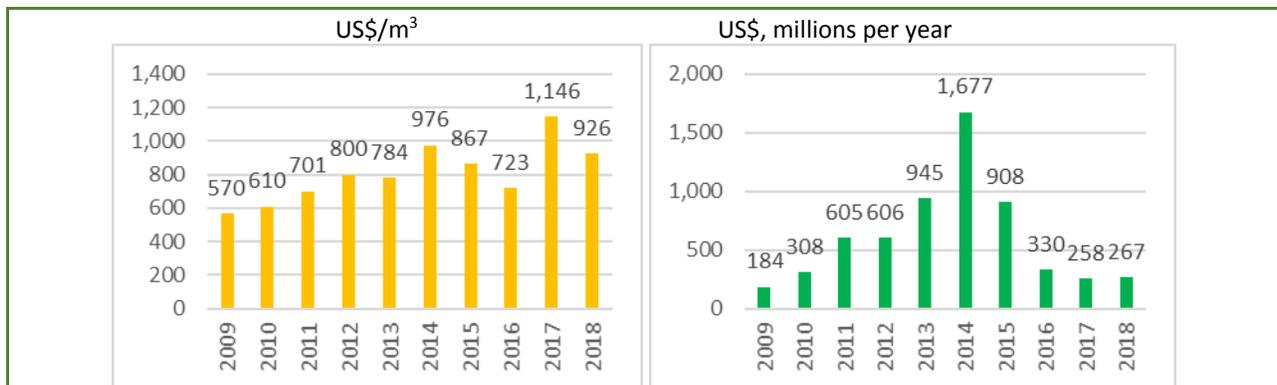
times and domestic consumption increased 4.8 times (WWF 2015). Domestic consumption has since fallen by nearly 30 percent, while exports have declined by over 80 percent in the aftermath of the ban on exports of unprocessed wood (logs and sawn wood) (Forest Trends 2017). Figure 7.2 shows these trends.



Source: Produced from FAO data at <http://www.fao.org/faostat/en/#data/FO>.

Figure 7.2: Domestic consumption and export of timber, Lao PDR

161. **Exported timber from Lao PDR is of high value, ranging from US\$570 per m³ in 2009 to US\$1,146 per m³ in 2017.** The total value of timber export rose from US\$184 million in 2009 to US\$1,677 million in 2014, and declined to around US\$260 million in 2017 and 2018 (Figure 7.3).



Source: Produced from FAO data at <http://www.fao.org/faostat/en/#data/FO>.

Figure 7.3: Value of timber exports from Lao PDR

162. **Data on domestic consumption of timber or industrial roundwood are scarce, especially rural consumption.** Data from the FAO indicate that per capita consumption increased rapidly to 0.3 m³ per capita in 2014, then declined to 0.21 m³ in 2018. Consumption in most neighboring countries was in the range of 0.19 m³ to 0.29 m³ in 2018 (Figure 7.4).

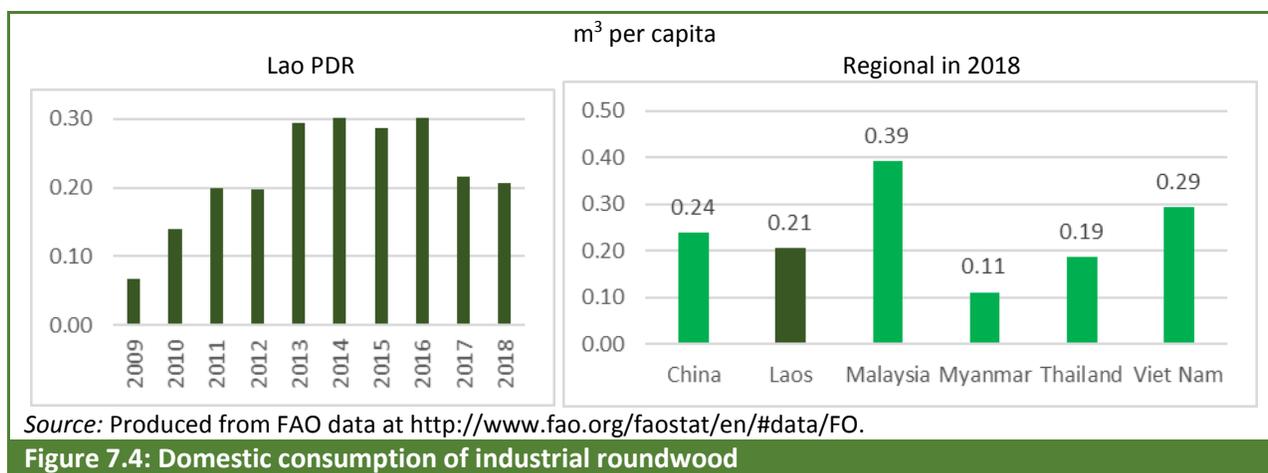


Figure 7.4: Domestic consumption of industrial roundwood

163. **There are no data or estimates of domestic consumption and export of timber from Khammouane.** Consumption is therefore approximated in proportion to the population by using the national estimate of per capita consumption, while exports are approximated in proportion to forest land area. This suggests that annual production (domestic consumption and export) of industrial roundwood in Khammouane averaged about 105,000 m³ in 2017–18. This would include wood from both natural forests and plantations in the province.

164. **While the FAO reports export values per cubic meter, no estimate of values is available for wood consumed domestically.** Applied Geosolutions (2015) reports the timber prices for key timber producing countries worldwide. Data from four East Asia and Pacific countries (Australia, China, Indonesia, and Malaysia) suggest a ratio of domestic to international prices of non-coniferous timber logs of 0.4. This ratio is applied to estimate the price of timber used domestically in Lao PDR. The ratio is, however, uncertain and efforts to estimate the average prices of domestically consumed timber need to be undertaken to improve the price estimates.

165. **The annual resource rent from timber production is simply the production value less the harvesting cost.** A harvesting cost of US\$10 per m³ is applied here, based on the harvesting cost in several Asian countries reported in Applied Geosolutions (2015). The annual resource rent is calculated based on annual averages for 2017–18 as timber production can vary substantially from year to year.

166. **The NCV is calculated from the annual resource rent by assuming that timber production is now at sustainable levels after the large decline since 2014.** An infinite production horizon is therefore applied with constant resource rent and an annual discount rate of 4 percent.¹⁵ This gives an NCV of forest resources from timber production of US\$24 billion nationally and of US\$1.5 billion in Khammouane. The NCV per capita in Khammouane and nationally is similar at about US\$3,500 (Table 6.4).

Table 7.4: NCV of forest resources for timber, 2018

	Units	National	Khammouane
Domestic consumption	Thousands, m ³	1,476	88
Unit price	US\$/m ³	466	466
Value of domestic consumption	US\$, millions	687	41
Exports	Thousands, m ³	257	17
Unit price	US\$/m ³	1,022	1,022
Value of exports	US\$, millions	262	17

¹⁵ As in World Bank (2018): $NCV = R + R / 0.04$, where R is the annual resource rent.

	Units	National	Khammouane
Total production	Thousands m ³	1,732	105
Total value of production	US\$, millions	949	58
- Harvesting cost	US\$, millions	-17	-1
Annual resource rent	US\$, millions	932	57
NCV	US\$, millions	24,229	1,486
NCV per capita	US\$	3,455	3,529

Source: Estimates by the author.

167. **The resource rent from exported timber was as much as US\$6 billion from 2009 to 2018** (taking into account the high export levels up to 2014). It is unclear how much of this resource rent was captured by the GOL. Published data seem to show that timber royalties have only been a small fraction of resource rent, totaling US\$209 million from 2009 to 2018 (Figure 7.5). The difference, that is, US\$5.8 billion, is lost income for the GOL, amounting to 60 percent of Lao PDR's total foreign debt of US\$9.76 billion in 2018 reported by the Bank of the Lao PDR (BOL 2019).

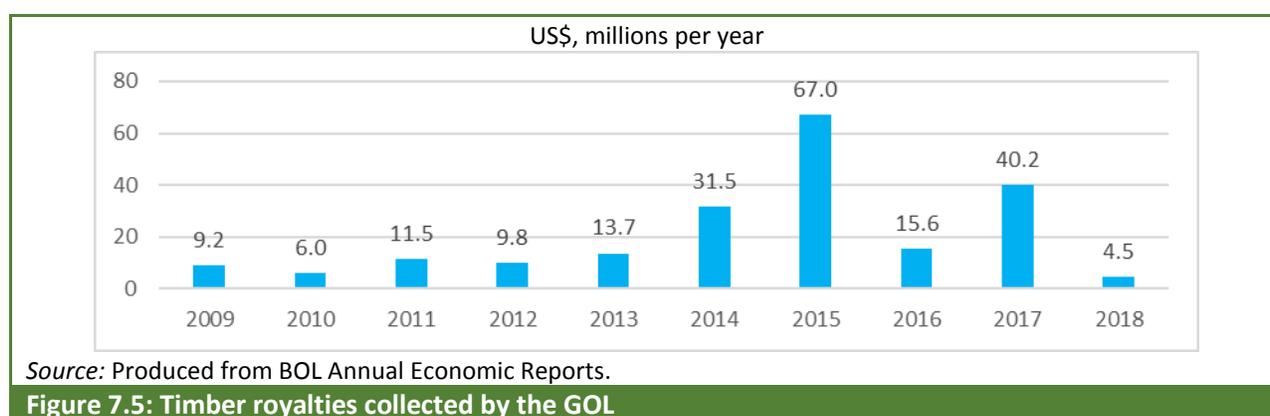


Figure 7.5: Timber royalties collected by the GOL

7.2.2 Wood fuel

168. **Almost 97 percent of households in Khammouane, and 93 percent nationwide, used wood fuels as the primary cooking fuel in 2017** (LSB 2018b). This is by far the highest reliance among the countries of the Association of Southeast Asian Nations (ASEAN). At Lao PDR's income level, 33–50 percent of the population would be expected to use clean energies, such as liquid petroleum gas (LPG) and electricity (World Bank 2020b).

169. **Use of charcoal has been on the rise in Khammouane, reaching 35 percent of households in 2017, a doubling since 2012.** Charcoal was the primary cooking fuel for over 74 percent of people in urban areas and 22 percent of people in rural areas. In Nakai and Bualapha, nearly 96 percent used wood as their primary cooking fuel, while less than 5 percent used charcoal (LSB 2018b; MoH/LSB 2012).

170. **Differences in primary cooking fuel are even more distinctive across household living standards.** Over 99 percent of the poorest quintile of the population in Khammouane used wood as their primary fuel in 2017, while 85 percent of the richest quintile used charcoal. Clean energies were used almost exclusively by the richest quintile of the population.

171. **Estimates of household fuel wood and charcoal consumption are presented in Table 7.5.** The starting point for the estimates is that LPG consumption by households that exclusively use LPG for cooking is 30 kg per person per year, in line with estimates for several countries in Asia, Africa, and South America (Kojima et al. 2011). This LPG consumption is then converted to fuel wood and charcoal consumption based on the energy content of the fuels (MEM 2018), the efficiency of traditional

cookstoves (TCS) generally used in Lao PDR, and adjusting for differences in cooking time (World Bank 2013).

Table 7.5: Estimated per person consumption of cooking fuels in Lao PDR

	<i>LPG</i>	<i>Fuel wood (TCS)</i>	<i>Charcoal (TCS)</i>
Energy content (MJ/kg)	49.3	16.0	28.9
Stove efficiency (%)	55	12	15
Effective energy (MJ/kg)	27.11	1.92	4.34
Incremental cooking time (%)	—	13	13
Consumption (kg/person/year)	30	477	211

Source: Estimates by the author.

172. **The total annual wood fuel consumption is estimated at 4.2 million tons nationally and 280,000 tons in Khammouane (Table 7.6).** This is estimated based on the per person consumption estimated above and the percentage of households nationally and in Khammouane that use fuelwood and charcoal for cooking. This estimate is conservative, as households in many parts of the country also use fuel wood for heating in the cold season and making livestock feed. Nearly 18 percent of households in Khammouane report using fuel wood for heating according to analysis of the LSIS 2017 data. It may also be noted that because about 6 m³ of wood is needed to produce 1 ton of charcoal, wood consumption would have been 76,000 tons less if households had used fuelwood instead of charcoal (even though charcoal’s energy content is about 80 percent higher than fuelwood) (MEM 2018). Burning charcoal, however, causes fewer health effects from smoke inhalation than burning wood.

Table 7.6: Estimated residential wood fuel consumption for cooking in Lao PDR and Khammouane, 2018

	<i>Units</i>	<i>Lao PDR</i>	<i>Khammouane</i>	<i>Source</i>
Population 2018		7,013,000	421,000	LSB (2019)
Fuel wood per person	kg/year	477	477	Calculated in previous table
Charcoal per person	kg/year	211	211	Calculated in previous table
Household size, average		4.70	4.44	LSIS II 2017 (LSB 2018b)
Household size, charcoal users		4.48	4.21	LSIS II 2017 (LSB 2018b)
Household size, fuel wood users		4.88	4.64	LSIS II 2017 (LSB 2018b)
Charcoal per household	kg	946	889	Calculated here
Fuel wood per household	kg	2,326	2,212	Calculated here
Charcoal, % of households	%	28	35	LSIS II 2017 (LSB 2018b)
Wood, % of households	%	65	62	LSIS II 2017 (LSB 2018b)
Wood per kg of charcoal	kg	5	5	FAO
Total consumption				
Charcoal	tons/year	414,530	31,106	Calculated here
Wood	tons/year	2,172,698	124,410	Calculated here
Total primary wood consumption	tons/year	4,245,349	279,940	Calculated here

173. **Estimating the value of wood fuel consumption and the cost of production are the next steps in calculating the natural resource rent and NCV.** This is first undertaken for fuel wood. If wood fuels (wood and charcoal) were not available, the most common alternative is LPG. The value of LPG in Lao PDR is about LAK 9,000 per kg, or about US\$1 per kg, depending on world prices, transportation, and retailing costs. Adjusting this value for differences in energy content, stove efficiencies, and cooking time between LPG and fuel wood gives a value of LAK 566 per kg of fuelwood. Most fuel wood is self-collected by households and the main production cost is time spent on collection. Analysis of the LECS (2012–13) data finds that average household collection time is 43 minutes or 0.72 hours per day. This collection time can be valued using rural agricultural wage rates from the Lao PDR Labor Force Survey 2017 (LSB 2018c). Females rates are applied, as much of the fuel wood collection is undertaken by the women in the

household, and at a 50 percent fraction of the full wage rate to reflect the opportunity cost of time spent on household activities, which often is less than the full wage rate (Wittington and Cook 2019). This gives a production cost of LAK 362 per kg of fuel wood. The natural resource rent for fuel wood is then LAK 204 per kg, that is, the difference between its value and production cost. The natural resource rent for charcoal may be approximated as the same as for fuel wood, given that wood is collected and transformed to charcoal.

174. **The NCV is then calculated from annual resource rent by applying an infinite production horizon with constant resource rent and an annual discount rate of 4 percent as in World Bank (2018).**¹⁶ This gives an NCV of forest resources from wood fuels of US\$2.7 billion nationally and US\$177 million in Khammouane. The NCV per capita in Khammouane and nationally is similar at about US\$400 (Table 7.7).

Table 7.7: NCV of forest resources for wood fuel, 2018

	<i>Units</i>	<i>Lao PDR</i>	<i>Khammouane</i>
Population 2018	Thousands	7,013	421
Wood fuel consumption	ton	4,245,349	279,940
Value	LAK/kg	566	566
Cost	LAK/kg	362	362
Unit resource rent	LAK/kg	204	204
Annual resource rent	LAK billion	866	57
Annual resource rent	US\$, millions	103	6.8
NCV	US\$, millions	2,677	177
NCV per capita	US\$	382	419

Source: Estimates by the author.

175. **It should be noted that household air pollution from the use of wood fuels causes over 4,000 deaths annually in Lao PDR and is the largest identified environmental health risk in the country.** The annual cost of these health effects is estimated at about US\$950 million equivalent to 5.7 percent of GDP in 2017 (World Bank 2020b), This is over nine times the value of the annual resource rent.

176. **Several interventions are available to mitigate the health effects of household biomass combustion,** including improved biomass cookstoves and clean cooking energies such as LPG or electricity. A recent benefit-cost analysis estimated that the benefits of improved wood and charcoal cookstoves in Lao PDR would be two to four times higher than their cost (World Bank 2020b). These interventions reduce smoke exposure levels, but rarely to safe levels. To reap larger health benefits, clean cooking energies are needed. The same analysis estimates that benefits of using LPG and electricity are 2.7 times larger than their costs, although the costs are much higher than the cost of improved biomass stoves due to the high cost of LPG fuel and electricity consumption. The more recently developed gasifier stoves—which provide clean burning of biomass—were also estimated to provide large net benefits with benefits at four times the costs.

7.2.3 Wild food

177. **According to LECS-5, food accounted for as much as 70 percent of household consumption expenditure in Lao PDR in 2012–13, and over 80 percent among the poor.** A distinction can be made between food that originates from the farm and food from the wild. Food from the wild includes fish, wild meat, and many vegetables and fruits growing naturally. This food depends on the quantity and quality of water and forest resources as well as the sustainable use of these natural assets.

¹⁶ $NCV = R + R / 0.04$ where R is the annual resource rent.

178. **According to LECS-5, the average household in Khammouane spends about 1.6 hours per week on hunting throughout the year.** In 2012–13, wild meat from hunting and trapping constituted as much as 30 percent of the total meat consumption among rural households, 13 percent among urban households, and 25 percent among all households.

179. **In the past 12 months, around 80 percent of households in Khammouane collected wild tubers and 73 percent collected (other) vegetables grown naturally in the forest.** Collection constituted as much as 46 percent of the total vegetable consumption. The share reached over half among rural households and nearly a third among urban households.

180. **The value of wild meat, tubers, and vegetables consumption is estimated at LAK 138 billion in 2018.**¹⁷ Resource rent is estimated by assuming a linear cost or supply curve from zero to reported unit values of wild food.¹⁸ The cost is mainly the value of household time spent on hunting and collection of vegetables and tubers. The resource rent gives an NCV of US\$213 million or US\$506 per capita by applying an infinite horizon with constant resource rent and an annual discount rate of 4 percent as in World Bank (2018) (Table 7.8).¹⁹ Based on the same survey data, the national NCV of wild food was estimated at US\$2.4 billion (US\$343 per capita) in 2018.

181. **Valuing the time spent on hunting at 50 percent of male agricultural wage rates gives a total cost of hunting of LAK 38 billion and thus a resource rent of LAK 34 billion.**²⁰ This is almost identical to the rent in Table 7.8. The survey does not provide any information on time use for collection of wild vegetables and tubers.

182. **Along with fish, wild food consumption constituted as much as 31 percent of the total food consumption among rural households in Khammouane and 23 percent among urban households.** This demonstrates the continued importance of forest and water for household food supply and nutrition. The NCV of fish is estimated in a separate section.

Table 7.8: NCV of forest resources for wild food in Khammouane, 2018

		<i>Meat</i>	<i>Vegetables and tubers</i>	<i>Total</i>
Value	LAK, billions	72.00	65.00	138.00
Annual resource rent	LAK, billions	36.00	33.00	69.00
NCV	LAK, billions	942.00	851.00	1,793.00
Annual resource rent	US\$, millions	4.31	3.90	8.20
NCV	US\$, millions	112.00	101.00	213.00
NCV per capita	US\$	265.00	241.00	506.00

Source: Estimates by the author.

7.2.4 Tourism services

183. **Tourism development is one of the GOL's eight priority programs for socioeconomic development (MOICT 2019).** Tourism is included here under forest resources, although water resources are also major tourist attractions.

184. **Foreign tourist arrivals in Lao PDR reached 4.2 million in 2018.** Arrivals increased at an annual rate of 9.0 percent from 2007 to 2018. Revenues from foreign tourists increased at an annual rate of 12 percent from 2007 to 2018 (MOICT 2019), reaching US\$811 million in 2018, making tourism the third largest export sector after minerals (US\$1,439 million) and electricity (US\$1,408 million).

¹⁷ The LECS reports the value of consumption per household. Figures are adjusted to 2018 by the CPI.

¹⁸ Rent is $R = V / 2$ where V is the total value of wild food.

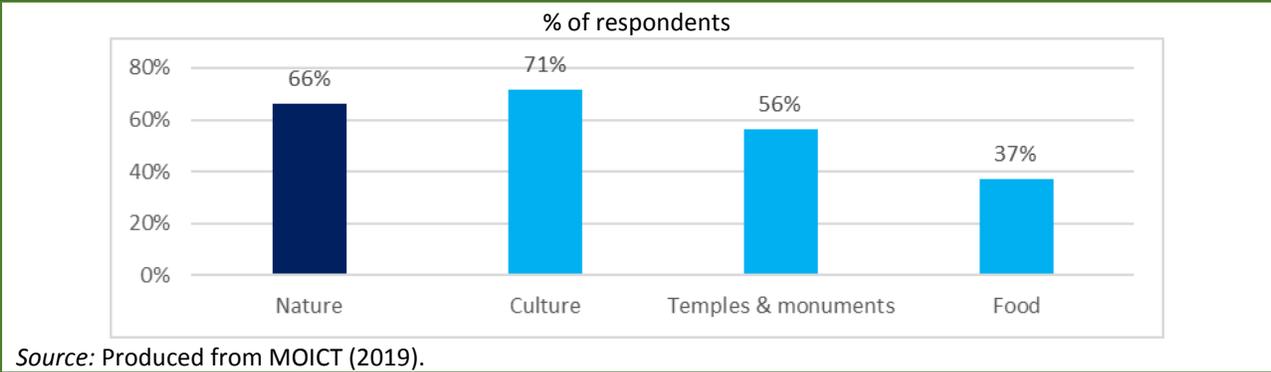
¹⁹ $NCV = R + R / 0.04$ where R is the annual resource rent.

²⁰ See section on wood fuels for a similar calculation and explanation of methodology.

185. **Forests and other natural assets have a substantial tourism value.** However, estimating the NCV of these assets in terms of tourism is not straightforward. The tourism value of a natural site may be estimated based on visitor numbers, the travel cost incurred by tourists to visit the site, entrance and user fees, and contingent valuation studies of tourists’ willingness-to-pay (WTP) to enter or use the site. The market price of tourist accommodation in excess of the normal cost could also be applied to estimate the NCV of its surroundings or nearby sites.

186. **While these approaches are commonly applied for single sites, they cannot readily be applied for the whole country or a whole province.** An alternative is to estimate the total consumer surplus of foreign and domestic tourists in Lao PDR. The consumer surplus is the value that tourists place on their tourism experience, less the cost of acquiring this experience. A share of the consumer surplus is due to the natural assets of Lao PDR and can be equated to a natural resource rent. This is a welfare measure of resource rent, while for instance the resource rent of agricultural land, timber, wood fuels, wild food, and fish is based on exchange values. The two measures, therefore, are not directly comparable and cannot be added together.

187. **Annual tourism surveys show that the country’s natural assets and attractions are the main interest for two-thirds of international tourists arriving in Lao PDR (Figure 7.6).** If there were no forests, rivers, mountains, or other sites of natural attraction or if these natural assets were severely degraded, many of the international tourists would not come to Lao PDR or would shorten their stays. Domestic tourism would likewise be affected. It is assumed here that one-third of the annual tourist days would be lost without the country’s natural assets.



Source: Produced from MOICT (2019).

Figure 7.6: Main interests of international tourists in Lao PDR, 2013–2018

188. **The resource rent, or difference in consumer surplus with and without natural assets is calculated separately for foreign and domestic tourists, nationally and in Khammouane Province, based on data from MOICT (2019) on number of tourists, length of stay, and expenditure per tourist day.** An inverse demand function for tourist days with a constant price elasticity of demand of -1.45 is applied to estimate the difference in consumer surplus.²¹ Foreign tourists tend to stay longer than domestic tourists. However, foreign tourists in Khammouane are mainly short-stay visitors from Thailand and Vietnam, who tend to stay for shorter periods and spend less per day than other foreign tourists in Lao PDR. Domestic tourists are assumed to spend the same as tourists from Thailand and Vietnam (Table 7.9).

189. **The difference in consumer surplus, or annual natural resource rent, is presented in Table 7.9, assuming that the absence of natural attractions would cause a one-third reduction in tourist days.** The total NCV for both foreign and domestic tourism is US\$19 billion nationally and US\$0.9 billion in

²¹ Peng et al. (2015) conducted a meta-analysis of 195 studies of international tourism demand elasticities from around the world. The analysis found a price elasticity of demand of -1.45 for tourism in Asia.

Khammouane. NCV per capita from foreign tourists is estimated to be lower in Khammouane than nationally due to the lower daily expenditure in Khammouane.

Table 7.9: NCV for foreign and domestic tourism, 2018

	<i>Lao PDR</i>		<i>Khammouane</i>	
	<i>Foreign</i>	<i>Domestic</i>	<i>Foreign</i>	<i>Domestic</i>
Number of tourists (million)	4.186	2.237	0.325	0.140
Length of stay (days)	3.27	2.00	2.54	2.00
Tourist days (million)	13.70	4.47	0.83	0.28
Expenditure per tourist day (US\$)	59	44	44	44
Difference in consumer surplus (US\$ million)	595	143	26	9
NCV (US\$, millions)	15,463	3,729	688	234
NCV per capita (US\$)	2,205	532	1,635	556

Source: Estimates by the author.

190. **It is important to note that the estimates of rent generated from natural assets from tourism take the form of welfare increases to foreign tourists.** Only a portion of this annual value accrues to Lao PDR. The annual revenue of US\$811 million in 2018 largely reflects the cost of providing services for tourists (such as hotel, food, transportation, and entertainment) plus a normal rate of return on capital investment. In addition, some of the value generated by natural assets are captured through price premiums at hotels and restaurants at locations with attractive natural assets and fees to enter nature sites. However, the aggregate value of these premiums is relatively small compared to the consumer surplus of the tourists.

191. **Several instruments are potentially available for Lao PDR to extract more of this consumer surplus.** One attractive instrument is a special tax on hotel stays, levied as a percentage of the hotel bill. Such a tax is more proportional to tourists' WTP to visit Lao PDR than a flat rate per tourist would be. It also has the advantage of capturing some of the consumer surplus of all tourists staying at least one night. A second instrument is a tax on tourist transportation. A third instrument is a tax on restaurant meals. Such a tax would, however, also affect the population of Lao PDR unless it could be carefully targeted.

192. **Special taxes may also be implemented in locations of particular tourist interest and attraction to capture more of the tourists' consumer surplus.** These tools could also help manage the sites to avoid overcrowding and deterioration of the assets that draw the tourists to these locations. These locations may include, for instance, Luang Prabang, Vang Vieng, and special natural attractions in, for instance, Khammouane, such as the NPAs.

7.2.5 Watershed protection

193. **The NCV of forest resources in terms of watershed protection includes the value of flood risk mitigation; reduced soil erosion and sedimentation of reservoirs and rivers; protection of surface water quality (that is, turbidity); and regulation of groundwater recharge.** The values of these services and functions are often difficult to estimate. Services such as timber and NTFP production would be lost entirely in the absence of forests, and so current output levels provide an indication of likely losses. Hydrological services, on the other hand, would not be lost entirely but would be modified if forests were lost. Water would become dirtier, flows would become more irregular, and flood risks would increase, but the magnitude of these effects is hard to estimate without careful hydrological modeling. Time and resource constraints precluded preparing such a model for this study. Some indications of three of these values is, however, provided in the following paragraphs.

194. **Flooding.** Parts of Lao PDR are subject to severe seasonal flooding. The annual cost of these events has been estimated at US\$165 million (World Bank 2020b). Based on this estimate and assuming that the

national cost of flooding would double in the absence of forests, the NCV of the flood protection function of forests is estimated to be about US\$3.4 billion, or US\$612 per capita. The Xebangfay River in Khammouane is one of the eight major flood-prone river basins in the country (eWater 2018; UNDP 2010). Given this high propensity for flooding, the value of watershed protection in Khammouane may be proportionately higher, with an NCV per capita of US\$1,274 and a total NCV of US\$536 million. This is simply calculated as one-eighth of the national value to illustrate the potentially high value of forests in terms of watershed protection.

195. **Municipal water supply.** Another important value of forests is protecting surface water quality (for example, controlling turbidity by reducing erosion), which increases the value of municipal water supplies sourced from rivers. The provincial capital, Thakhek, receives its piped water supply mainly from the Mekong River, whose water quality is largely beyond the influence of Khammouane. However, the district towns of Mahaxay, Nongbok, and Xebangfay Districts have piped water supply from the Xebangfay River and the town of Nakai receives water from the Nam Theun, all of which are affected by the upstream watershed conditions in Khammouane. The piped water supply to these towns covers one-third of the urban population in Khammouane outside of Thakhek (conditions in Khammouane). Alternative groundwater supplies for this population would require investments of millions of U.S. dollars.

196. **Reservoir sedimentation.** By controlling erosion, forests in Khammouane also reduce sedimentation downstream, a role that is particularly important in the case of the Nam Theun 2 reservoir. Without upstream forest vegetation, the useful life of the reservoir would be substantially shortened. Each year lost in useful life would entail a loss of over US\$400 million per year.²² This value alone is over half the value of the natural capital component of hydropower nationally in 2018.

7.3 Water resources

197. **Water resources provide many valuable goods, services, and functions in terms of meeting basic needs of the population, generating income, reducing poverty, contributing to socioeconomic development, and preserving biodiversity among others.** Sufficient data are available to estimate many of these values (Table 7.10).

Table 7.10: NCV estimation of water resources in Khammouane

<i>Goods, services, functions</i>	<i>NCV estimated</i>
Household water supply	Yes
Hydropower	Yes
Fisheries	Yes
Irrigation	Yes
Biodiversity protection	No

7.3.1 Household water supply

198. **Household water supply is an important component of the NCV of water resources.** The main household uses of water are drinking, food preparation, handwashing, food hygiene, bathing, laundry, and cleaning.

199. **A hierarchy of water service levels, with incremental water quantities and water uses are presented in Table 7.11.** Service levels range from no access with the point of collection more than 1,000 m from home to optimal access with piped water into the home with multiple taps. The quantity of

²² Calculated: Annual electricity production (approximately 6,000 GWh per year) multiplied by the cost of alternative sources of electricity production (coal at US\$0.07 per kWh).

consumption is generally less than 5 liters per capita per day for households with no access to over 100 l per capita per day for households with optimal access.

200. **Households place a high value on the first few liters of water per capita per day** with a corresponding high WTP. These initial liters are for survival, that is, for drinking and food preparation. Households' WTP for additional units of water generally declines with increasing quantities of consumption.

Table 7.11: Water service levels, quantities, and household uses

<i>Service level</i>	<i>Point of collection</i>	<i>Quantity</i> (liters per capita per day)	<i>Water uses</i>
No access	> 1,000 m	Often < 5	Drinking and food. Hygiene not assured
Basic access	100–1,000 m	Up to 20	Not all requirements met. Bathing and laundry may occur at water source with additional volumes of water
Intermediate access	On premises with single tap	Around 50	Most basic hygiene and consumption needs met. Bathing and laundry possible on premises.
Optimal access	Piped into home with multiple taps	> 100	All uses can be met.

Source: Adapted from Howard and Bartram 2003.

201. **In 2017, over half of the urban population in Khammouane had piped water supply to their dwelling or yard.**²³ The sources of piped water supply are treated surface water (for example, from the Mekong River for Thakhek) and groundwater wells. The district towns of Mahaxay, Nongbok, and Xebangfay have piped water supply from the Xebangfay River and the town of Nakai from the Nam Theun. Upstream watershed protection in Khammouane is therefore important for the quality (for example, turbidity) and seasonal availability of these household water supply sources. The piped water supply to these towns covers one-third the urban population in Khammouane outside of Thakhek.

202. **Another third of the urban population obtained water from protected groundwater sources,** and about 10 percent relied on unprotected wells and springs and open, unprotected surface water (that is, rivers, streams, ponds, and lakes).

203. **Among the rural population, the most common water types were protected wells and springs and tube wells/boreholes.** Over a third of the rural population, however, continued to rely on unprotected wells/springs and surface water.

204. **Almost 40 percent of the population in Nakai and Bualapha Districts source their water from open, unprotected surface water.** The large majority of the population in these districts are Mon-Khmer and non-Buddhists.

205. **The type of household water supply varies greatly with households' living standard.** Nearly two-thirds of the poorest quintile of the population relied on unprotected wells/springs and surface water, while nearly two-thirds of the richest quintile of the population had piped water supply to their dwelling or yard.²⁴

²³ Information on household water supply is available in LSIS II 2017. Analysis of the survey's household data using Stata is presented in this section. The survey contains 1,460 households in Khammouane Province. The dataset (Multiple Indicator Cluster Survey 6 Lao PDR) is publicly available at <https://mics.unicef.org/surveys>.

²⁴ LSIS II classifies households by a wealth index into five quintiles ranging from poorest to richest. The wealth index is based on household durable goods and housing characteristics.

206. **Many households do not rely on their water supply for drinking, but rather purchase bottled water.** In 2017, almost 40 percent of the population in Khammouane used bottled water for drinking. Bottled water use ranged from less than 1 percent among the poorest quintile to 90 percent among the richest quintile of households.

207. **Piped water supply in urban areas in Khammouane increased from 44 percent in 2011–12 to 54 percent in 2017, while the use of dug wells declined by the same percentage points.** In rural areas, the use of dug wells declined by as much as 17 percentage points from 2011–12 to 2017 while the use of public taps/standpipes, tube wells/boreholes, and piped water supply increased by 14 percentage points. However, the use of open, unprotected surface water increased by 9 percentage points. It appears from these data that many households switched from unprotected dug wells to open, unprotected surface water sources, although the reason for this is not clear. The use of bottled water for drinking was relatively unchanged from 2011–12 to 2017 in urban areas (73 percent) but increased from 15 percent to 29 percent in rural areas.

208. **The resource rent of household water supply is calculated as the value that households derive from water minus the cost of supply, where cost includes normal profit or return on capital.** The welfare approach to estimating the resource rent is applied here. This is undertaken by estimating the consumer surplus from the households' water demand function using a constant price elasticity of demand for water of -0.6 .²⁵

209. **The population of Khammouane is distributed into four groups by location and type of water supply for the purpose of estimating the resource rent and NCV.** Water consumption is highest among the urban population with piped municipal water supply, that is, in Thakhek and four district towns. Consumption in this group averages about 150 liters per capita per day based on reported production levels minus an estimate of losses. Data on the consumption level among other households are not available and is set here at 70 liters among other urban households and 50 liters among the rural households with a built water source. The population relying on unprotected, open surface water from rivers, streams, dams, and ponds are also included as this water still has value even though the quality may be compromised.

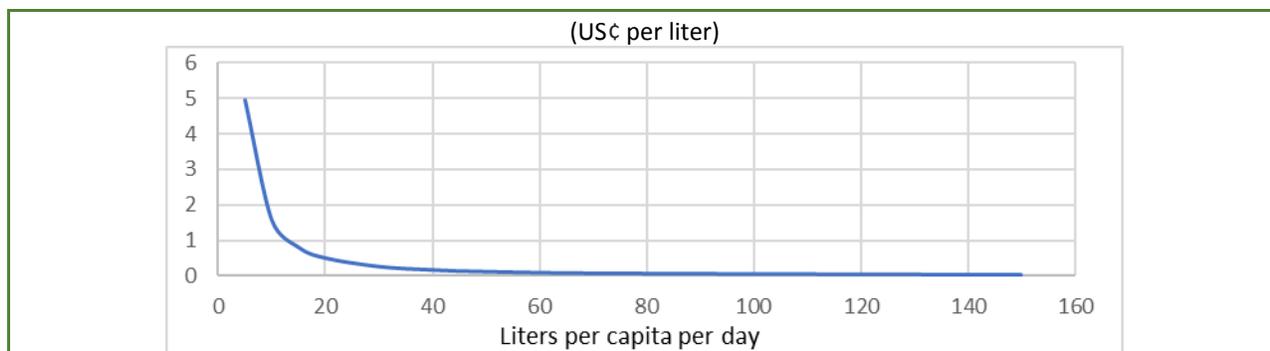
210. **The consumer surplus, or resource rent, is estimated from the household demand function,²⁶ the water consumption level of each of the four groups of households, and an assumed WTP of US\$0.17 per m³ for water at a consumption level of 150 liters per capita per day among the urban population with piped water supply.** This is the tariff rate in Vientiane Capital and is likely to be the lower bound for the WTP.²⁷ The WTP for water among the other groups is then estimated based on their water consumption levels. This is depicted in Figure 7.7. The largest consumer surplus or resource rent is for the first 20 liters per capita per day consumption. The WTP for the first 5 l per capita per day is assumed to not exceed US\$0.05 per liter. This is the same as the WTP for the fifth liter. A water supply cost of US\$0.20 per m³ is applied.²⁸

²⁵ Nauges and Whittington (2010) found the price elasticity of water demand to be in the range of -0.3 to -0.6 in a survey of studies in low- and middle-income countries. The smaller the elasticity, the larger is the consumer surplus. Thus, using an elasticity of -0.6 gives the most conservative estimate of the resource rent and the NCV of household water supply.

²⁶ The household demand function is assumed to be identical for all households.

²⁷ Aylward et al. (2010) find a WTP of US\$0.235 per m³ from contingent valuation studies in Asia. Water consumption level is, however, not reported.

²⁸ The resource rent is insensitive to a cost within a plausible range. This is because most of the rent is for the first 20 liters per capita per day, with a WTP of nearly US\$5 per m³.



Source: The author.

Figure 7.7: Household WTP for water

211. The estimated annual consumer surplus or resource rent in Khammouane is presented in Table 7.12. The NCV is US\$1.8 billion with a per capita value of US\$4,392. The national NCV is US\$31.7 billion with a per capita value of US\$4,515. These values using the welfare approach are large and not directly comparable to the NCVs estimated using the exchange value approach.²⁹

Table 7.12: NCV of household water supply in Khammouane, 2018

	Units	Urban		Rural		Total
		Piped water	Other water	Built water sources	Surface water	
Population	%	12	10	65	13	100
Water consumption per capita	Liters/day	150	70	50	10	—
Consumer surplus per capita	US\$/day	0.50	0.49	0.48	0.33	—
	US\$/year	182	179	174	121	—
Consumer surplus, total per year	US\$, millions	9.3	7.4	47.9	6.6	71.1
NCV	US\$, millions	241	191	1,244	173	1,849
NCV per capita	US\$	4,740	4,650	4,536	3,155	4,392

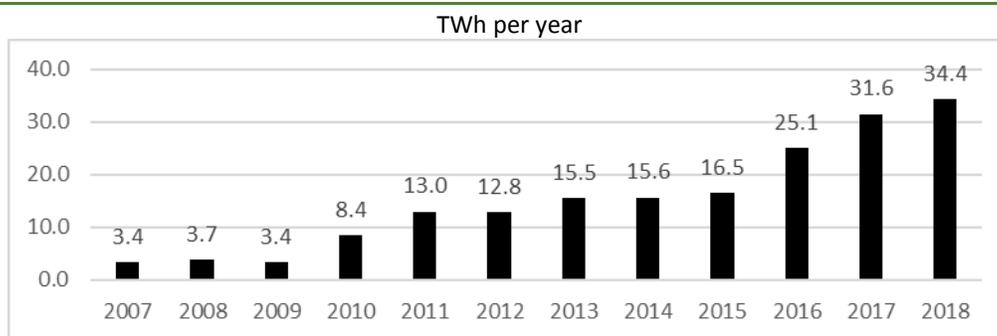
Source: Estimates by the author.

7.3.2 Hydropower

212. Electricity production in Lao PDR increased tenfold from 2007 to 2018 (Figure 7.8). Installed generating capacity increased from 680 MW to 7,080 MW, of which nearly 5,200 was hydropower (EDL 2019).³⁰ Potential capacity by 2030 is around 23,000 MW of hydropower (IREP 2018). About 80 percent of electricity production was exported in 2018.

²⁹ It may be noted that using exchange values (price times quantities) with the marginal WTP for water as the price may lead to counterintuitive results. With an inelastic demand function, as in the case of household water, when the exchange value gets larger, water consumption gets lesser. So, unless the water supply cost function is (very) steeply downward sloping, the annual resource rent gets larger and larger and the quantity of water consumption gets lesser.

³⁰ Another 1,878 MW was in a large thermal coal-fired power plant, Hongsa.



Source: MEM (2016) and LSB (2019).

Figure 7.8: Electricity production

213. **Electricity production from hydropower in Lao PDR is less expensive than from alternative generation, both domestically in Lao PDR and in the country's export markets.** The difference in cost is the resource rent from hydropower, that is, a resource rent of water and the ecosystems that contribute to supplying that water.

214. **Boungnong and Phonekeo (2012) use the software 'EVALS' developed by Lahmeyer International to evaluate the cost of a large number of hydropower projects in Lao PDR.** The authors find that the cost of electricity is on average around US\$0.04 per kWh for projects greater than 100 MW and US\$0.05–US\$0.06 per kWh for projects smaller than 100 MW. This includes all capital costs, operations and maintenance costs, normal profit, and social and environmental expenditure of the project. The cost, does not, however, include residual social and environmental impacts nor does it include potential benefits of downstream irrigation and flood control.

215. **The authors estimate that the resource rent is US\$0.046 per kWh for projects supplying the domestic market and about US\$0.03 per kWh for export projects, being the difference between the cost of hydropower and alternative power generation.** The high resource rent for projects supplying the domestic market relates to the assumed high cost (> US\$0.1 per kWh) of alternatives to hydropower (for example, small-scale coal-fired thermal plants),³¹ while the cost of alternatives to hydropower in the export markets of Thailand and Vietnam is around US\$0.07–US\$0.075 per kWh (that is, large-scale coal-fired thermal plants), not including the undetermined costs of environmental impacts (Payakkamas et al. 2017; Wood Mackenzie 2017).

216. **Domestic market.** Hydropower for the domestic market is purchased by *Électricité du Laos* (EDL) from domestic independent power producers (IPPs), domestic small power producers (SPPs), its subsidiary (EDL-Generation), and export-oriented IPPs (5–10 percent of their production). EDL's hydropower purchases also include some imports.

217. **In 2018, the cost of purchases from domestic producers was US\$0.059 per kWh.** It is assumed that this price reflects normal profits and therefore is the economic cost of production. With the cost of alternatives at US\$0.1 per kWh, the resource rent was US\$0.041 per kWh and a total annual resource rent of US\$253 million (Table 7.13).

³¹ The large Hongsa thermal power plant has a much lower generation cost than US\$0.1 per kWh. This plant would, however, not be a viable alternative to hydropower for domestic consumption due to the substantially higher transmission cost this would entail, both in terms of increased cost of transmission infrastructure and transmission losses.

218. **The estimated annual resource rent accrues to Lao PDR through EDL.** The resource rent is distributed by EDL to consumers through lower electricity tariffs than would have prevailed if hydropower generation were not available and Lao PDR would have to rely on more expensive alternatives.

Table 7.13: Annual resource rent of hydropower for domestic market

	2016	2017	2018	Unit
EDL purchases of hydropower for domestic market	5,274	5,916	6,214	GWh
Cost of purchases	5.5	5.8	5.9	US¢ per kWh
Cost of alternatives	10	10	10	US¢ per kWh
Unit rent	4.5	4.2	4.1	US¢ per kWh
Annual resource rent	235	250	253	US\$, millions

Source: Estimates by author based on data from EDL and MEM.

219. **Exports.** Hydropower is exported mainly by large IPPs. Unit rent is US\$0.03 per kWh, based on cost of US\$0.04 per kWh for large hydropower projects as estimated by Bounngong and Phonekeo (2012). This results in an annual resource rent of US\$491 million in 2018 (Table 7.14).

Table 7.14: Annual resource rent of exported hydropower

	2016	2017	2018	Unit
Hydropower exports	11,343	14,825	16,362	GWh
Cost of hydropower	4.0	4.0	4.0	US¢ per kWh
Cost of alternatives	7.0	7.0	7.0	US¢ per kWh
Unit rent	3.0	3.0	3.0	US¢ per kWh
Annual resource rent	340	445	491	US\$, millions

Source: Estimates by author based on data from EDL and MEM.

220. **Natural capital value.** The NCV of the existing stock of hydropower resources in 2018 is calculated as the present value of annual rent over the remaining lifetime of the stock. The original concession period was 25 years, and the existing hydropower plants in 2018 have been in operation for 7 years on average. It is assumed that the original useful life of the power plants is 50 years. The NCV of the existing hydropower resources in Lao PDR in 2018 is estimated at US\$24 billion, based on a 4 percent annual discount rate (Table 7.15).

221. **This estimate is based on an annual rent calculated as follows:**

- a) Annual rent during years 1–18 (remaining period of concessions) is calculated as the difference between cost of production and cost of alternative generation (see above)
- b) Annual rent during years 19–43 is equal to the cost of alternative generation (US\$0.1 per kWh for domestic consumption and US\$0.07 per kWh for export) with zero cost of production.

222. **Year 19 is the year that the power plant is transferred to the GOL and the only cost to the GOL is operations and maintenance, which is relatively minor and ignored in this report.** All capital costs are amortized during the concession period up to year 18. The annual rent from year 19 is therefore more than double the rent during the first years.

Table 7.15: NCV of hydropower water resources in Lao PDR, 2018

	US\$, millions
Annual rent (Years 1–18)	744
Annual rent (Years 19–43) after concession period	1,767
NCV	23,967
NCV per capita (US\$)	3,417

Source: Estimates by the author.

223. **Lao PDR employs a variety of instruments to capture hydropower resource rent.** The instruments are

- a) Hydropower royalties;
- b) Profit taxes (24 percent) on any ‘excess profits’ of hydropower developers;
- c) Dividend tax (10 percent) on distribution of any “excess profits”;
- d) Dividends (less cost of funds) from the GOL equity participation (10–20 percent) in hydro projects;
- e) EDL purchases of electricity at a rate below the cost of alternative generation (coal); and
- f) The transfer of hydropower plants to the GOL at the end of 25–30 years concession period.

224. **The annual extraction of resource rent of hydropower exports by Lao PDR is through the first four instruments.** The fifth instrument pertains to hydropower for the domestic market and the six instruments will occur in the future as hydropower concessions expire and power plants are transferred to the GOL.

225. **Although Lao PDR appears to capture a minor share of the annual resource rent of hydropower exports during the concession period, the share of the NCV is US\$15.3 billion, or 64 percent of the total NCV.** Lao PDR is capturing such a large share mainly due to the transfer of the power plants to the GOL at the end of the concession periods.

226. **Two large hydropower plants are located in or near Khammouane:** Nam Theun 2, located in Nakai District with interbasin water transfer from Nam Theun to the Xebangfay River, and Theun Hinboon, located in Bolikhamxay Province with interbasin water transfer from the Nam Theun/Nam Ngouang Rivers to Nam Hai/Nam Hinboon in Khammouane.

227. **Nam Theun 2 is the largest hydropower plant on the tributaries of the Mekong River in Lao PDR.** At the end of 2018, its installed capacity of 1,070 MW represented 20 percent of hydropower capacity in the country. About 95 percent of electricity production is exported to Thailand. The project is expected to generate US\$2 billion in government revenue over the concession period of 25 years.³² The GOL owns 25 percent of Nam Theun 2 through its state-owned company, Lao Holding State Enterprise (LHSE).

228. **Nam Theun 2 is located in Nakai District in the northeast of Khammouane.** Its reservoir covers 450 km² at full supply level with a capacity of 3.9 billion m³, inundating 40 percent of the Nakai Plateau. The catchment area covers 4,039 km², or nearly a quarter of Khammouane’s area. The reservoir receives water from the Nam Theun River with an annual average flow of 7.5 billion m³ per year.

229. **The water from the powerhouse flows through a 27 km channel to the Xebangfay River.** The discharge from Nam Theun 2 to the Xebangfay constitutes as much as 45–50 percent of the natural runoff from rain in the Xebangfay basin. While the share of water from Nam Theun 2 in the lower sections of the Xebangfay River is moderate during the wet season, it amounts to several times the natural flow during the dry season (eWater 2018), providing opportunities for dry season irrigation.

230. **Theun-Hinboon hydropower plant with 520 MW of installed capacity is located in Bolikhamxay but diverts water to the Nam Hai River and subsequently to the Nam Hinboon River in Khammouane Province which drains into the Mekong River.** The power plant started operations in 1998 and during 1998–2018 has contributed over US\$608 million to the GOL's finances through dividends, royalties, profit taxes, and equity returns.³³ As much as 60 percent of Theun Hinboon was owned by the state-owned EDL,

³² www.namtheun2.com.

³³ <http://www.thpclaos.com>.

which transferred its holding to its subsidiary, EDL-Generation, in 2012. The production cost at Theun Hinboon has been less than US¢2 per kWh.

231. **Theun Hinboon has caused larger-than-anticipated downstream flooding during the wet season along Nam Hai and Nam Hinboon Rivers.** Some villages have had to relocate, and dry season irrigation systems have been constructed to compensate for income losses from the flooding.

232. **In this report, the NCV of hydropower electricity in Khammouane is estimated for Nam Theun 2.** The NCV of Theun Hinboon is not included as the plant is located outside the province.

233. **Electricity of around 5,600–5,700 GWh is exported to Thailand, and EDL purchases 300–400 GWh per year from Nam Theun 2.** The sales price to Thailand was US\$0.045 kWh in 2018, while the cost of purchases by EDL was US\$0.0437. The Power Purchase Agreement (PPA) with Thailand has a three-tiered structure with over 75 percent of the electricity sold at US\$0.051 per kWh in 2018, declining to US\$0.0175 per kWh for the last 5 percent of projected annual production. The electricity price increases at 1.4 percent per year during the concession period of 25 years. The concession expires in 2034, at which time it is transferred to the GOL. It is assumed that the life of the plant is to 2060.

234. **The cost of production, including normal profit, is approximated as sales price minus royalties collected by the GOL.** The levelized cost from 2018 to 2034 is then estimated at US\$0.045 per kWh at a 4 percent annual discount rate, and with zero cost from 2035. This gives an NCV of US\$5.7 billion, or US\$13,577 per capita in Khammouane (Table 7.16). The NCV per MW is US\$5.3 million, compared to US\$4.6 million nationally.

Table 7.16: NCV of Nam Theun 2 in 2018

	2018–2034	2035–2060	Unit
Hydropower sales	6,000	6,000	GWh per year
Cost of hydropower	4.5	0	US¢ per kWh
Cost of alternatives	7.0	7.0	US¢ per kWh
Unit rent	2.5	7.0	US¢ per kWh
Annual resource rent	161	431	US\$, millions
NCV		5,716	US\$, millions
NCV per capita (Khammouane)		13,577	US\$

Source: Estimates by the author.

235. **Lao PDR captures US\$3.6 billion of the NCV, or 63 percent.** During the remaining period of the concession from 2018 to 2034, the resource rent to Lao PDR is royalties amounting to US\$576 million, with a present value of US\$380 million, and the capturing of rent associated with the domestic purchases by EDL, amounting to about US\$20 million per year, with a present value of US\$238 million. As much as US\$3 billion are in the years after the concession period. This points to the importance of watershed protection and management to control sedimentation of reservoirs.

236. **The total area of hydropower reservoirs in Lao PDR, or area inundated, was about 1,650–1,700 km² in 2018, or 165,000–170,000 ha.** This implies an NCV of about US\$144,000 per ha, or US\$92,000 per ha for the share of the NCV that accrues to Lao PDR. In contrast, the NCV of agricultural cropland is estimated at US\$20,000 per ha nationally, US\$6,200 per ha in Khammouane, and up to about US\$6,300 per ha for forest plantation land.³⁴ While the difference is large, it does not, however, reflect the NCV of many products and services of the forest that are often lost to hydropower development. These values would, however, also be lost if the land were to be used as cropland or industrial plantations.

³⁴ See section on forest plantation development and Cabbage et al. 2018; World Bank (2019a) with estimates of LEVs up to US\$6,300 per ha.

237. **An emerging energy sector opportunity in Lao PDR is solar and, to some, extent wind power.** The cost of these electricity generation technologies is now at par with or below the cost of coal-fired power plants. Exclusively using the cost of coal as the alternative to hydropower is therefore not entirely correct, meaning that the resource rent and NCV of hydropower is declining and will continue to decline as the cost of solar and wind power, as well as battery storage, continue to fall.

7.3.3 Fisheries

238. **Nearly 86 percent of households—including almost all rural households—reported that they engage in fishing in Khammouane.** Fishing mainly takes place in the rivers, lakes, reservoirs, and swamps of the province. Fishing in seasonal flood plains and rice fields is also prominent. The average household spends nine hours per week on fishing throughout the year according to data from LECS-5 (2012–13).

239. **The population of Khammouane consumes 600 grams of fish per person per week.** This is more than the total of wild and raised meat and underscores the importance of this natural asset in household consumption, protein intake, and overall nutrition. Almost all consumption is captured fish with little cultured fish.

240. **In 2018, the value of this consumption is estimated at LAK 229 billion.**³⁵ Resource rent is estimated by assuming a linear cost or supply curve from zero to reported unit values of fish.³⁶ The cost curve is mainly the value of household time spent on fishing. The resource rent gives an NCV of US\$355 million or US\$842 per capita by applying an infinite horizon with a constant resource rent and an annual discount rate of 4 percent as in World Bank (2018) (Table 7.17).³⁷ Nationally, based on the same survey data, the NCV is estimated at US\$6.3 billion and US\$903 per capita in 2018.

Table 7.17: NCV of water resources for fisheries in Khammouane, 2018

Value	LAK, billions	229
Annual resource rent	LAK, billions	115
NCV	LAK, billions	2,980
Annual resource rent	US\$, millions	13.6
NCV	US\$, millions	355
NCV per capita	US\$	842

Source: Estimates by the author.

7.3.4 Irrigation

241. **Of the total planted area in Khammouane, 28 percent is irrigated, of which 18 percent is wet season irrigation and a little over 10 percent is dry season irrigation.** This is slightly above the national average according to data from DOA (2018).

242. **Dry season irrigation varies greatly across districts, ranging from 15 ha per 1,000 rural people in Bualapha and Xaybuathong to 120 ha in Xebangfay.** The share of dry season irrigated cultivation in total planted area is also low in Bualapha and Xaybuathong. Notably, the highest share is in Nakai District, albeit at a relatively low hectareage of 38 per 1,000 rural population.

³⁵ The LECS survey reports value of consumption per household. Figures are adjusted to year 2018 by the CPI.

³⁶ Rent is $R = V / 2$ where V is total value of fish.

³⁷ $NCV = R + R / 0.04$ where R is the annual resource rent.

243. **Dry season irrigation is associated with lower poverty incidence at the district level.**³⁸ The association between poverty incidence and dry season irrigation is much stronger than for total non-irrigated and irrigated planted area per 1,000 rural population.

244. **A recent analysis of LECS 3–5 (2003–2013) found a long-term productivity increase of 2.4 tons per ha of irrigated rice in Lao PDR** (Sengsourivong and Ichihashi 2019). The gross value of this productivity increase was LAK 6.7 million (US\$803) per ha (at the 2013 farmgate price adjusted to 2018 using the CPI). Evenson and Fuglie (2010) provide production cost shares for several countries in Asia with labor, capital, and inputs amounting to 52 percent of the gross value. This gives a net value, or natural resource rent from irrigation, of 48 percent, or LAK 3.2 million (US\$385) per ha. This is the difference in resource rent between irrigated and non-irrigated land. The total annual resource rent from irrigation in Khammouane is then LAK 32 billion (US\$3.8 million), by applying the rent per hectare to land with dry season irrigation. The NCV is LAK 831 billion or US\$99 million (Table 7.18). While this is a relatively small value (due to the limited area under dry season irrigation), the NCV of irrigation is US\$10,020 per ha. This is far more than the NCV of US\$6,200 per ha for agricultural cropland in Khammouane, most of which is non-irrigated. Thus, dry season irrigation has the potential to more than double the NCV in agricultural crop production.

245. **Furthermore, the NCV of irrigation estimated here is for rice.** While rice accounts for as much as 86 percent of the planted area in Khammouane, vegetables and other higher-value crops account for over 40 percent of dry season irrigated land in the province. The NCV of irrigation for these crops is likely to be substantially higher than calculated here for rice. A recent pilot community-managed dry season irrigation project in the Vientiane plain, during two consecutive dry seasons, found substantially higher rates of return to high-value cash crops than to rice (Clement et al. 2018). A review of studies of the economic value of water found that the value of irrigation water in Asia was over three times higher for high-value crops such as vegetables (US\$1.1 per m³) than for rice (US\$0.3 per m³) (Aylward et al. 2010). Nationally, with over 155,000 ha of dry season irrigated area, the NCV is US\$1.56 billion, or US\$222 per capita.

246. **Almost all irrigation in Lao PDR relies on surface water, which has restricted irrigation to areas near waterways and reservoirs.** An alternative is the use of groundwater. A recent pilot community-managed dry season irrigation project in the Vientiane plain, during two consecutive dry seasons, demonstrated the viability of dry season irrigation with groundwater for cash crops. The irrigation system investment costs, including boreholes, pumps, water pipes, and irrigation system (sprinklers and drip), was US\$2,200 per ha. With full utilization of the irrigation system and reasonably successful cultivation of cash crops the estimated IRR on project investment was as high as 45 percent (Clement et al. 2018).

Table 7.18: NCV of water resources in irrigation in Khammouane, 2018

	<i>Unit</i>	<i>Khammouane</i>
Irrigated area (dry season), 2017	Ha	9,860
Productivity increase	Kg/ha	2,446
Farm gate price per kg	LAK	2,760
Gross value per Ha	LAK, millions	6.7
	US\$	803
(Price-cost)/price*		0.48
Annual rent per hectare	LAK, millions	3.2
	US\$	385
Total annual rent	LAK, billions	32
	US\$, millions	3.8
NCV	LAK billion	831
	US\$, millions	99

³⁸ The correlation coefficient across the 10 districts is –0.55.

NCV per capita	LAK, millions	1.97
	US\$	235
NCV per hectare	US\$	10,020

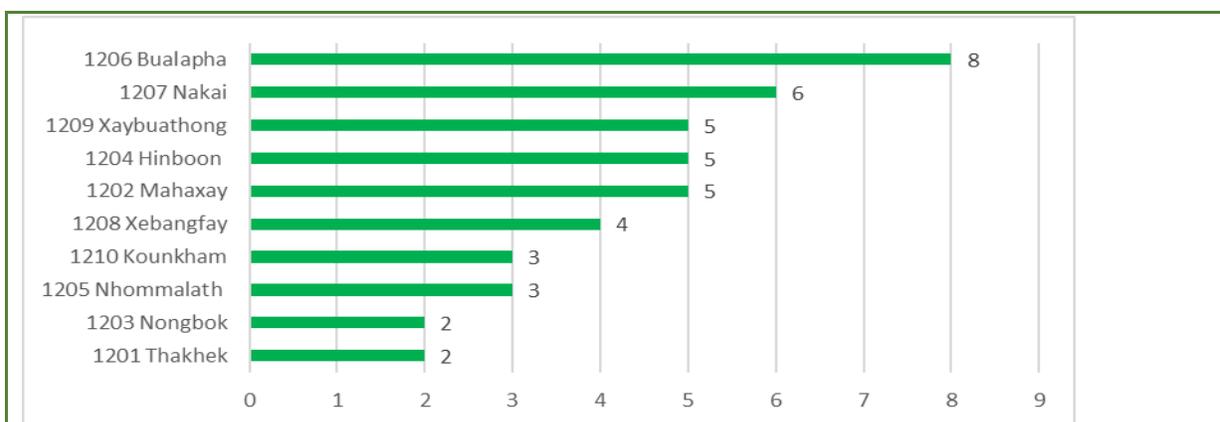
Source: Estimates by the author.

Note: * From Evenson and Fuglie (2010).

7.4 District natural capital profiles

247. **Natural capital profiles are presented in Annex 4 for each of the 10 districts in Khammouane.** The profiles provide an overview of the districts' natural capital endowment, current use, and indications of potential for enhancement. These profiles provide a tentative indication of the natural capital priorities in each of the districts.

248. **These natural capital priorities are summarized in Tables 7.19 and 7.20.** The number of priority areas are the highest in Bualapha (8) and Nakai (6), followed by Mahaxay (5), Hinboon (5), and Xaybuathong (5).



Source: The author.

Figure 7.9: Number of natural capital priorities in the districts of Khammouane

Table 7.19: District natural capital priorities										
District code	1201	1202	1203	1204	1205	1206	1207	1208	1209	1210
District name	Thakhek	Mahaxay	Nongbok	Hinboon	Nhommalath	Bualapha	Nakai	Xebangfay	Xaybuathong	Kounkham
UXO										
UXO clearance priority		Yes			Yes	Yes			Yes	
FOREST AND BIODIVERSITY										
Sustainable forest resource management (high priority)		Yes		Yes	Yes	Yes	Yes	Yes	Yes	Yes
Need for improved biomass cookstoves and clean energies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plantation potential (High)		Yes				Yes		Yes	Yes	
Nature-based tourism potential (High)	Yes			Yes		Yes	Yes			Yes
AGRICULTURAL LAND										
Access to land for agricultural cultivation				Yes		Yes	Yes			
WATER RESOURCES										
Increased dry season irrigation priority						Yes	Yes		Yes	
Need for improved water supply close to dwelling						Yes	Yes			
Flood risk management		Yes	Yes	Yes					Yes	
Number of priority areas	2	5	2	5	3	8	6	4	5	3

Source: The author.

Key Recommendations

Overall

249. **Environmentally sustainable investments are likely to contribute to natural wealth.** No-regret opportunities for investment are found in sustainable uses of the landscape. For example, sustainable forest production, conservation, nature-based tourism, and local livelihoods are complementary and generate green jobs, local income, and livelihoods as well as multiplier effects. Poverty is substantially higher in districts with more abundant forest land, important for scaling up sustainable forestry models for villages and firms, and nature-based tourism. Yet, competition for land and other resources can lead to unsustainable depletion if the trade-offs are not well managed. NCVs are a tool to help manage these trade-offs; identify mutual opportunities (that is, win-wins); and promote sustainability.

250. **Examples of ‘win-win’ opportunities for natural capital and wealth accumulation in the landscape include** (a) implementing small-scale irrigation (and household agricultural production) plus SFM and protection in the command area to provide steady water flow; (b) maintaining healthy forest in the watershed of hydropower reservoirs to reduce sedimentation, thus enhancing the long-term financial sustainability of the investment; (c) conserving biodiversity and forest landscapes to enable competitive tourism, which can create green jobs from private sector investment and government revenues; (d) empowering villages to collaborate on forest and protected area management to generate timber and non-timber revenues and ecosystem services; and (e) de-risking industrial forest plantation investments, and generating government revenues and local benefits, by ensuring that these investments contribute to environmental and social sustainability. These examples of ‘natural solutions’ relevant to Lao PDR illustrate the mutual opportunities that can be secured from managing the interconnectivity of natural assets in the landscape.

251. **Use of SEAs at the program and policy levels and ESAs at the individual project level** will help strengthen multisector dialogue and identify win-win opportunities and sectoral trade-offs among investment and policy options. These instruments are especially important in relation to land use, especially industrial forestry and agricultural plantations, and infrastructure development. The new GOL policies enacted in 2019 provide detailed regulations and prime minister level authority for using these tools, including public consultations and disclosure, which are recognized global good practices.

252. **Establishing and maintaining a Government-led ‘Landscape Investment Platform’,** would provide a space for agencies to share information; make decisions; and monitor progress concerning programs, projects, and policies covering multiple sectors and themes. Nationally, this platform could be jointly led by the MPI and MAF. At the provincial level, one option is for the Governor’s Office to chair such a platform.

Building wealth through forestry

253. **Further assessment of opportunities for smallholder and sustainable industrial forestry plantations.** Four southern districts in Khammouane have PFAs totaling over 250,000 ha, where forestry plantations may be suitable. There are also over 470,000 ha of land that are not classified as forest land nor cultivated with crops, some of which may be suitable for sustainable plantations. Khammouane is part of the GOL’s ongoing effort nationally to identify over 400,000 ha of degraded PFAs for possible private investment. Social and environmental sustainability processes and measures are needed at all stages from identification to implementation.

254. **Sustainable village- and smallholder-based native forest plantations in PFAs** could be a promising approach, combined with nature-based tourism, to enhance the value of forest capital for poverty reduction in several districts in Khammouane. This will require a technical and managerial support system that ensures adequate plantation yields for financial viability.

255. **Protection forest areas, often in great need of reforestation to enhance their intended watershed protection value, have potential for smallholder and village forest plantations.** Bualapha District, for example, has about 50,000 ha that may benefit from reforestation by villages and smallholders. This option will also require a technical and managerial support system.

256. **Large-scale industrial forest plantations must be balanced with continued local access to resources,** such as wild food and NTFPs that matter greatly in the daily life of most rural communities. Almost 86 percent of households in Khammouane use the forests surrounding their villages for these and other purposes.

257. **Successful forestry plantations require skills development.** This includes skills for plantation management, harvesting, and haulage and processing.

Building wealth through conservation

258. **Continue to invest in protected areas.** The Prime Minister's Decree on Protected Areas could be enhanced to reflect the strengthened commitment of the GOL to the emerging national park agenda and the adoption of the internationally recognized protected area categories of the International Union for Conservation of Nature (IUCN). Staffing levels need to expand to meet the commitment, as well as continued investment in the livelihoods and capacity of enclave and buffer villages that are involved in collaborative management of the protected areas.

Building wealth through nature-based tourism

259. **Promotion of nature-based tourism in the Khammouane landscape is a great opportunity to create greener economic growth and good jobs,** given the rich protected areas and wildlife, unique and dramatic karst landscapes, and a large and fast-growing regional market demand for experiences with nature. This is especially important in districts with attractive natural assets and limited alternative income opportunities. Regulations and procedures for tourism concessions in protected areas and the broader landscape would benefit from clear steps and incentives for businesses to invest in nature-based tourism.

260. **Identify ways for the Government to capture natural resource rents from tourism.** Several instruments are potentially available to extract more of tourists' consumer surplus from nature-based tourism. One attractive instrument is a special tax on hotel stays, levied as a percentage of the hotel bill. A second instrument is a tax on tourist transportation. A third instrument is a tax on restaurant meals. Such a tax would, however, also affect the population of Lao PDR unless it could be carefully targeted. These tools could also help manage the sites to avoid overcrowding and deterioration of assets that draw tourists.

Building wealth through water resources

261. **Assessment of potential for groundwater-based dry season crop irrigation in select districts in Khammouane.** Irrigation is now confined by surface water availability with uneven irrigation development across districts. Pilot groundwater irrigation has shown promising results in the Vientiane plain.

262. **Provision of improved and safely managed household water supply in the poorest districts of Khammouane.** This is particularly needed in Bualapha and Nakai.

Build natural capital and human capital together

263. **Expand clean cooking technologies and behaviors to combat the serious health effects from the high usage of wood fuels in the province.** Household air pollution from household use of wood fuels for cooking and other household purposes is the most serious environmental health risk in Lao PDR and Khammouane, causing over 4,000 deaths annually in Lao PDR. The annual cost of these health effects is estimated at about US\$950 million equivalent to 5.7 percent of GDP in 2017 (World Bank 2020b). This is over nine times the value of the annual resource rent of wood fuels.

264. **Furthermore, poor households use wood to boil drinking water to avoid potential exposure to microbial contamination, but using wood increases household air pollution with even larger health effects.** Alternative methods of treating drinking water, such as ceramic filtering or solar disinfection, are interventions for which health benefits by far outweigh the cost of treatment (World Bank 2020b).

Improve decision-making through information modernization

265. **Consider expanding the LECS and the LSIS to be representative at the district level.** These two surveys, if representative at the district level, have the potential to fill significant gaps in natural resource data. One option is to start with this in select provinces.

266. **Establish a forest data bank that contains vital data on forest activities, production rates, forest densities, stocks and growth rates, and other parameters.** Such data are largely unavailable and are much needed for improved forest resource management, planning and investment. Where data exist, data are fragmented among divisions or are inaccessible.

267. **Include other dimensions of natural capital to have a more complete picture of wealth, expanding beyond the NCA approaches.** This report is the first attempt to measure natural capital in Lao PDR. Future valuations should include other assets and provinces that were not considered because of data and time constraints.

268. **Continue to build up NCA in the national statistics.** This report is a first attempt to value natural assets in a selected landscape. Policy makers can consider scaling up this process in other provinces and at the national level by integrating key dimensions of natural capital in questionnaires for the next census and other key surveys.

269. **Continue to invest in the LSB in the MPI, line ministries, provincial agencies, and universities to produce, analyze, manage, and use environmental data.** Building up the ability to develop natural capital accounts will improve investment planning and evaluation. This capacity support should be a long-term engagement, and the World Bank is well placed to provide, in coordination with other substantial support for natural resource management and green growth in Lao PDR. For future research by development partners or government bodies, the LSB is well positioned to play a more prominent coordination role to obtain, update, and manage all data on natural capital from the concerned line ministries. This will help quickly respond to new policy priorities and provide the tools for swift evidence-based analysis.

270. **Maintain and strengthen the interministerial working group on natural capital.** The working group, led initially by the LSB, formed under this advisory service has become an important platform to discuss priorities and challenges that intersect among line ministries' usual business. The valuation of natural assets, and their inherent inter-connection, including potential trade-offs, require a more sophisticated planning process endowed with sector-specific knowledge and an overall vision of landscape development. Other countries in the region and globally are involved in similar NCA efforts and together with the Lao PDR's interministerial working group can be a network of champions that can reinforce one another's efforts.

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Annex 1. An analysis of Khammouane

A1.1. Demographics

1. **Khammouane Province is located in the central region of Lao PDR. The province borders Bolikhamxay Province in the north, Savannakhet Province in the south, Thailand in the west, and Vietnam in the east.** Khammouane Province consists of 10 districts. The capital, Thakhek, is located in Thakhek district (Figure A1.1).
2. **Khammouane’s population of 421,000—or 79,521 households—lives in 574 villages across an area of 16,315 km². Average population density is 26 persons per km² (Table A1.1).** The province has a slightly larger area, population, and number of villages and households than the average province in Lao PDR, while average household size is slightly smaller than the national average.



Table A1.1: Population of Khammouane Province, 2018

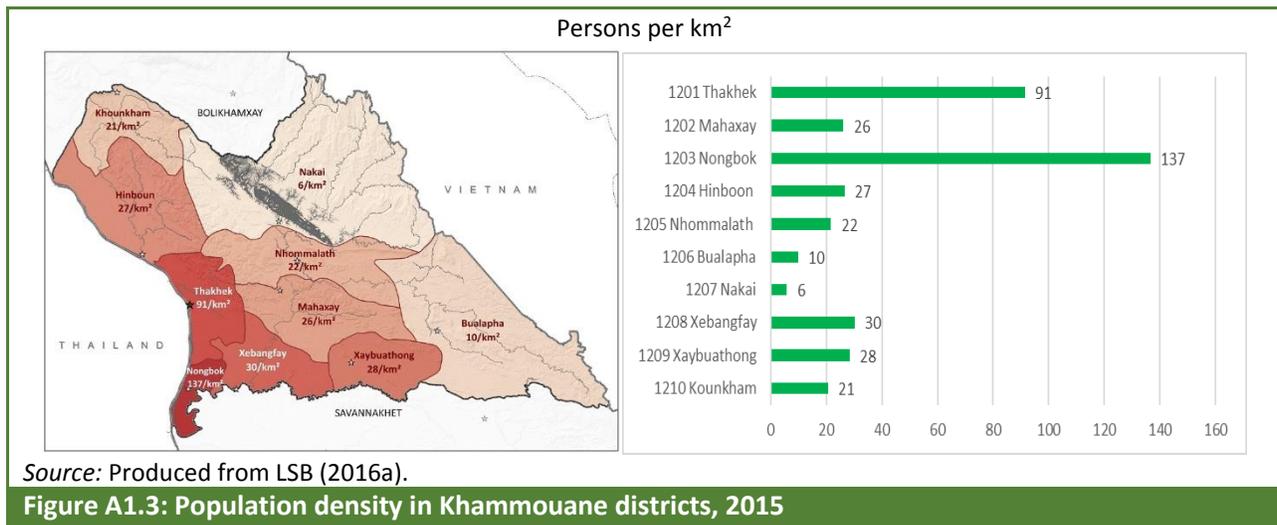
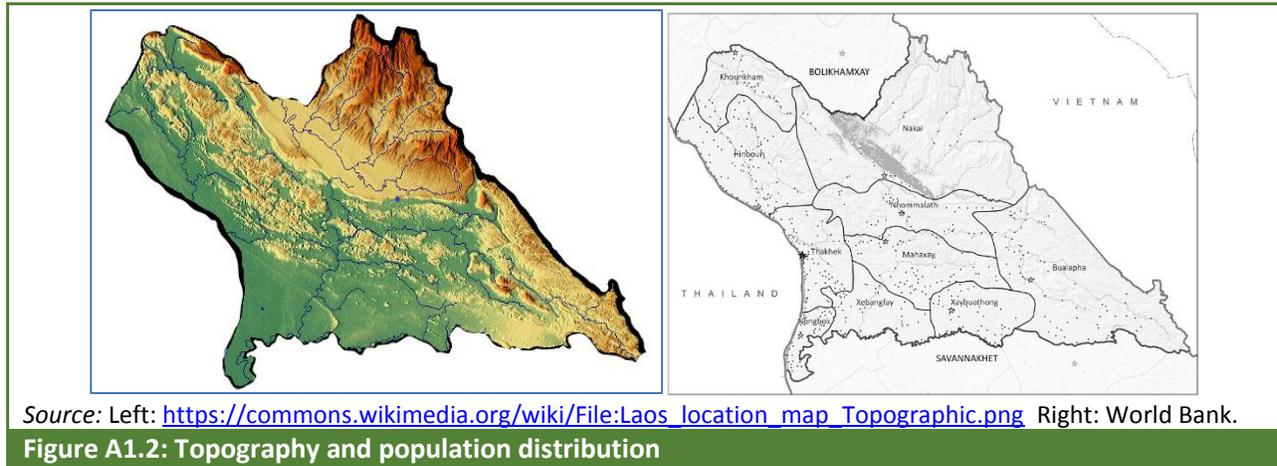
	Khammouane	National
Area (km ²)	16,315	236,800
Population (000)	421	7,013
Population density (per km ²)	26	30
Villages	574	8,447
Households	79,521	1,276,771
Population per village	733	830
Households per village	139	151
Average household size	5.3	5.5

Source: LSB 2019.

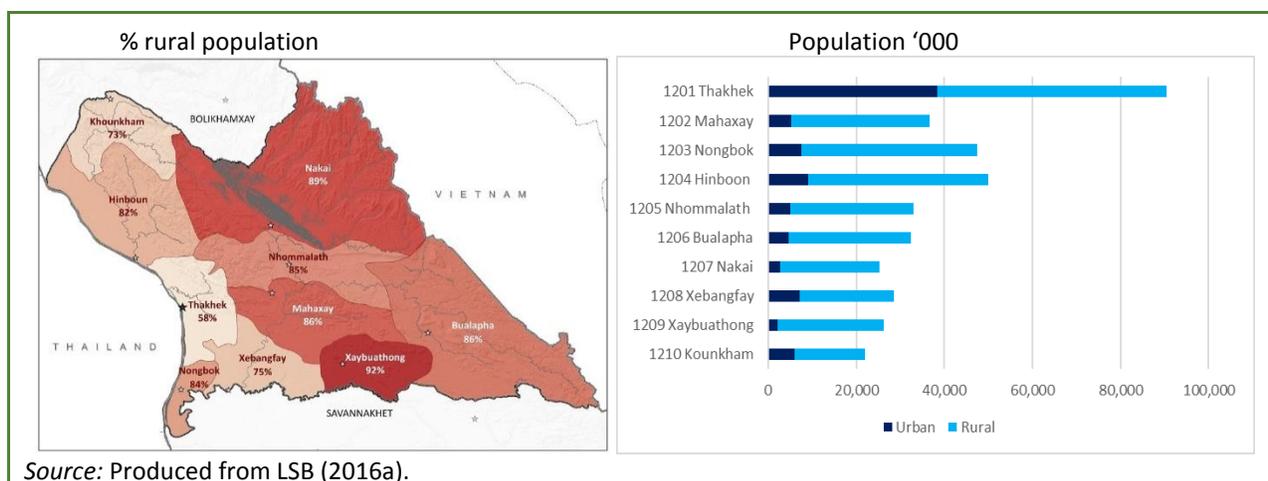
3. **The province is characterized by relatively flat lowlands along the Mekong River from north to south in the west and in much of the southern and central region of the province (Figure A1.2).** The northeast (Nakai District) and southeast (Bualapha district) regions of the province are mostly hilly and mountainous, reaching altitudes of over 2,000 masl in the northeast.

4. The vast majority of the population is located in the lowlands at altitudes of 150-200 masl, consisting mainly of Lao-Tai populations. Smaller parcels of populations reside at 300-600 masl in the southeast corner of the province in Bualapha district and at 500-650 masl in the north east in Nakai District, consisting mainly of Mon Khmer populations.

5. District population density in 2015 ranged from less than 10 per km² in most of Nakai and Bualapha Districts to 91 per km² in Thakhek district and 137 per km² in Nongbok District in the southwest lowlands along the Mekong River (Figure A1.3).

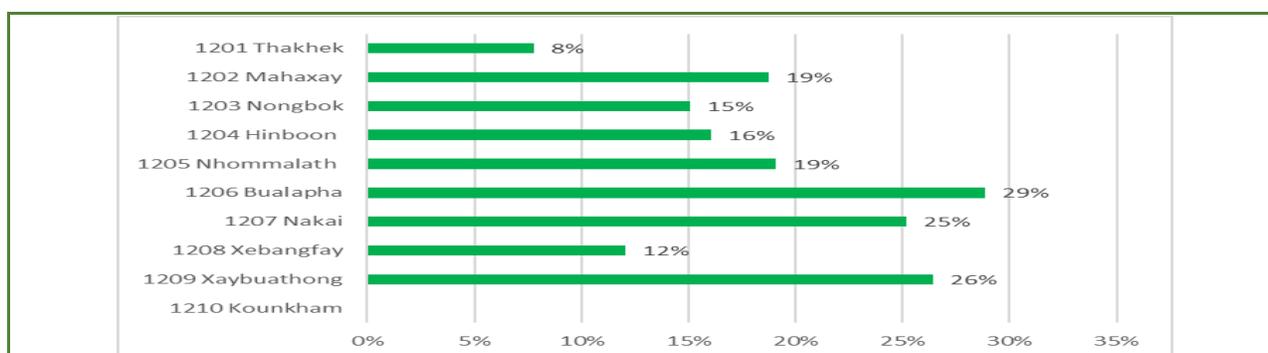


6. As many as 78 percent of the population in Khammouane Province resided in rural areas in 2015, according to the Lao Population and Housing Census 2015, compared to 67 percent nationally. The rural population share was 82-92 percent in most districts, except for Thakhek district (58 percent). The population ranged from 25,000 to 50,000 in 9 districts, with the population in Thakhek reaching over 90,000 (Figure A1.4). Population growth in the last decade has been particularly rapid in Bualapha, Nakai, and Xaybuathong Districts (Figure A1.5).



Source: Produced from LSB (2016a).

Figure A1.4: District population in Khammouane Province, 2015



Source: LSB (2016a).

Note: 1210 Kounkham District was established after 2005. It was previously part of 1204 Hinboon district. Population growth in Hinboon District is based on Hinboon plus Kounkham District.

Figure A1.5: Population growth in Khammouane districts, 2005-2015

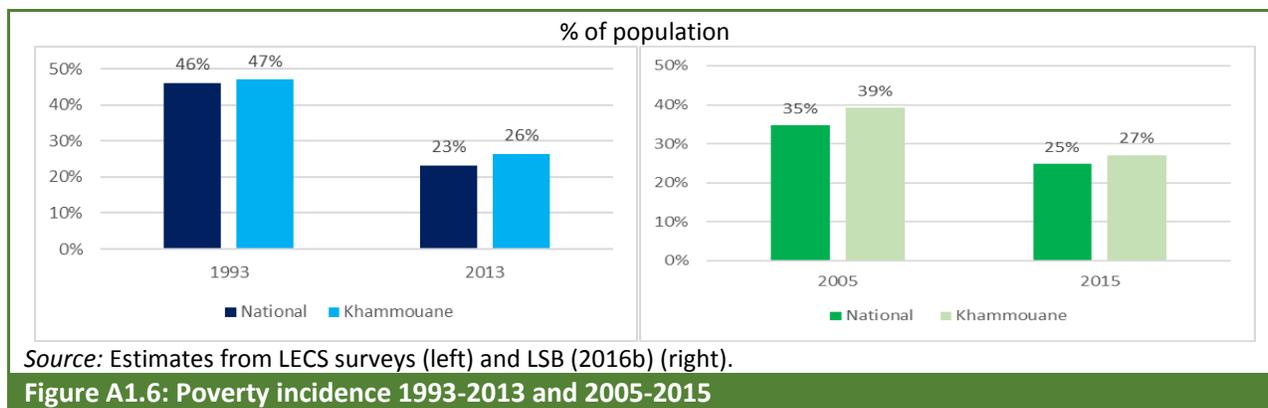
A1.2. Poverty

A1.2.1 Provincial level

7. **Poverty alleviation is a high priority for GOL. Consumption-based poverty incidence in Lao PDR has been estimated since 1992/93 from the LECS, which is administered every five years.** LECS estimates of poverty incidence are representative at the national, regional, and provincial levels. The most recent poverty estimates are for 2012–13 (LECS-5).³⁹ National poverty incidence declined from 46 percent in 1993 to 23 percent in 2013. Poverty incidence in Khammouane Province has been close to the national average over this period and stood at 26 percent in 2013 (Figure A1.6).

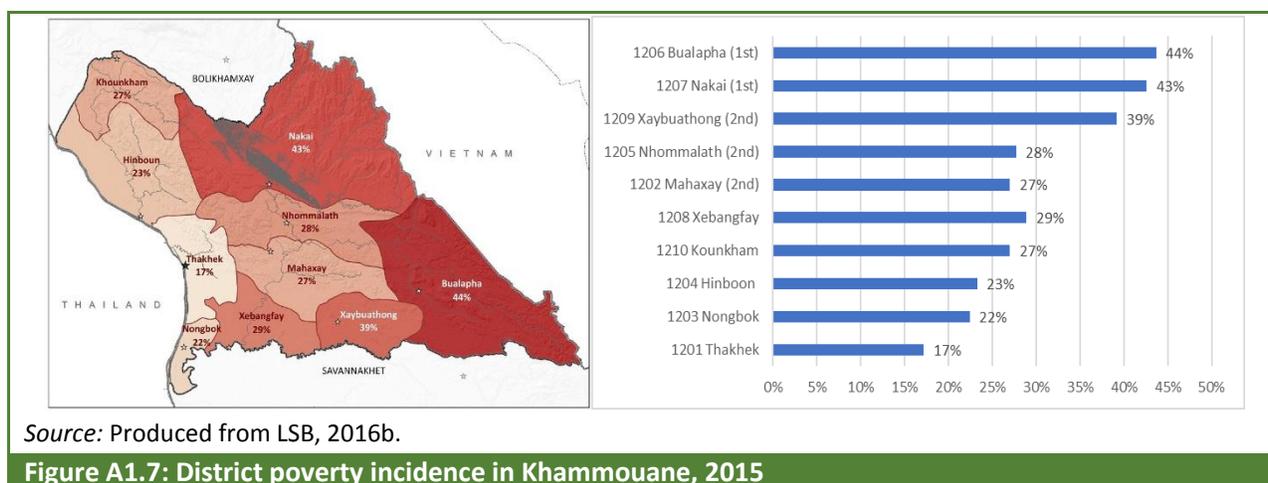
8. **Poverty incidence has also been estimated for 2005 and 2015 by combining the LECS2002–03 and 2012–13 and the Lao Population and Housing Census 2005 and 2015 data (LSB 2016b).** This has allowed estimates of poverty incidence at the national, regional, and provincial levels as well as at district and village levels, and are used in the district analysis in sections below. Poverty incidence according to these estimates are similar albeit slightly higher at the national level and in Khammouane Province than the estimates from LECS for 2003 and 2013 (Figure A1.6).

³⁹ Poverty incidence from the LECS 6 (2017/18) was not yet available at the time of preparing this report.



A1.2.2 District level

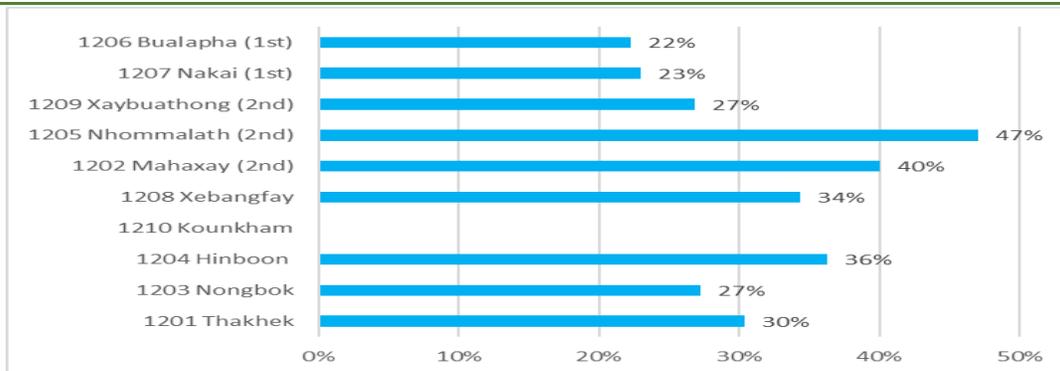
9. **GOL has identified 47 first priority and 25 second priority districts for poverty reduction across the country (GOL, 2003).** Nationally, poverty incidence has declined faster in first priority districts since 2003, reaching the same levels as in second priority districts in 2013, that is, about 35 percent. However, poverty incidence in first and second priority districts remained twice as high as in non-priority districts in 2013, pointing to the need for continued efforts for inclusive and equitable economic growth and development.



10. **Khammouane has two first priority districts (Nakai and Bualapha) and three second priority districts (Mahaxay, Nhommalath, and Xaybuathong).** These five districts had the highest poverty incidence in 2005, ranging from 45 percent to 56 percent. By 2015 poverty incidence in these districts had declined to 27-44 percent. Poverty incidence in the non-priority districts was 17-29 percent in 2015. Poverty incidence in 2015 was highest in the two first priority districts of Bualapha and Nakai (43-44 percent) and in the second priority district of Xaybuathong (39 percent) (Figure A1.7).

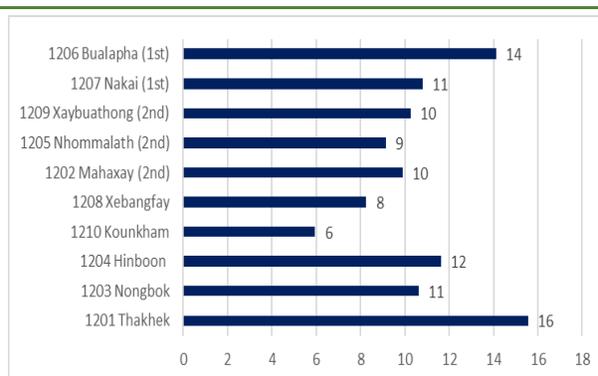
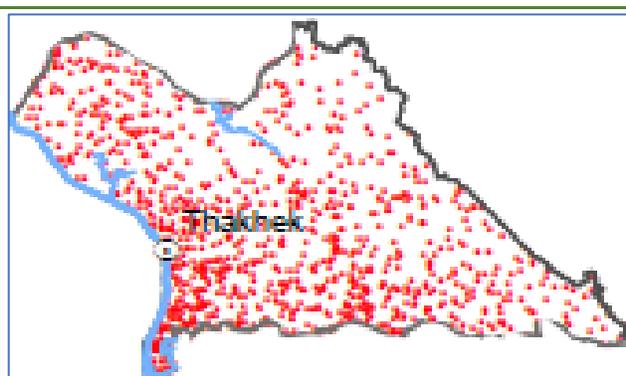
11. **Poverty incidence in Khammouane declined, in relative terms,⁴⁰ by over 30 percent between 2005 and 2015.** Poverty reduction was smallest in the two first priority districts, where poverty incidence was the highest, and was largest in two of the second priority districts (Figure A1.8). Each district has a similar number of poor people, as the less populated districts have high poverty incidence (Figure A1.9).

⁴⁰ $1 - \frac{P_{2005}}{P_{2015}}$ where P is poverty incidence rate.



Source: Produced from LSB, 2016b.

Figure A1.8: Poverty incidence reduction from 2005 to 2015



Note: Poverty density is 100 poor per red dot. Source: LSB (2016b).

Figure A1.9: Poverty density and number of poor per district ('000), 2015

A1.3 UXO contamination

12. **The Lao PDR is the world's most heavily bombed country per capita. More than 2 million tons of ordnance was dropped on the country during the second Indochina War (1964-1973), with 30 percent of 270 million cluster munitions remaining unexploded.** This UXO continues to be an obstacle to development and Lao PDR has included a Sustainable Development Goal (SDG) 18 on reducing UXO obstacles to development. UXO affects 14 of Lao PDR's 17 provinces and more than 25 percent of the total land area. Nationally, over 25 percent of all villages and close to 25 percent of the total population in Lao PDR are affected by UXO. About 14 percent of villages are classified as having a severe UXO contamination problem. UXO contamination affects agricultural land development, forest resources, and implementation of development projects (for example, irrigation, household water supply, hydropower development), and adds to the cost of private investment. It increases the cost of development, restricts movements between villages, slows transportation and communication work, undermines social and economic development, and has resulted in thousands of casualties since 1975 (World Bank, 2012).

13. **A decade ago, the Poverty-Environment Nexus Study in Lao PDR found that poverty incidence and UXO contamination is highly correlated.** Districts with a higher share of villages affected by UXO had substantially higher poverty incidence, less cultivated land per capita, higher rate of rice insufficiency, spent more time on fuelwood and water collection, and had less access to improved water supply and sanitation (World Bank 2006, 2012b). The correlation between poverty incidence and UXOs was just as pronounced in 2015. Despite increased efforts and funding for UXO clearance, poverty reduction has been

no faster from 2005 to 2015 in districts affected by UXO than in other districts.⁴¹ This suggests that further targeting of UXO clearance toward the poorest and most contaminated districts may be possible, along with complementary poverty reduction policies, programs and projects.

14. **Khammouane is among the six provinces with the most severe UXO problem, in terms of the percentage of villages severely affected.** The share of villages affected by UXO is particularly high in the districts of Mahaxay, Xaybuathong, Bualapha, Nhommalath, and Xebangfay, with Bualapha having the highest share of severely affected villages (Figure A1.10). The three most important national parks and protected areas have significantly less UXO contamination, which could help support the province’s ongoing nature-based tourism development around ‘The Loop’ that circles a large part of the province.

15. **The correlation across districts between the share of villages severely affected by UXO and poverty incidence in 2015 is particularly high (0.64, increasing to 0.86 if Nakai District is omitted).**

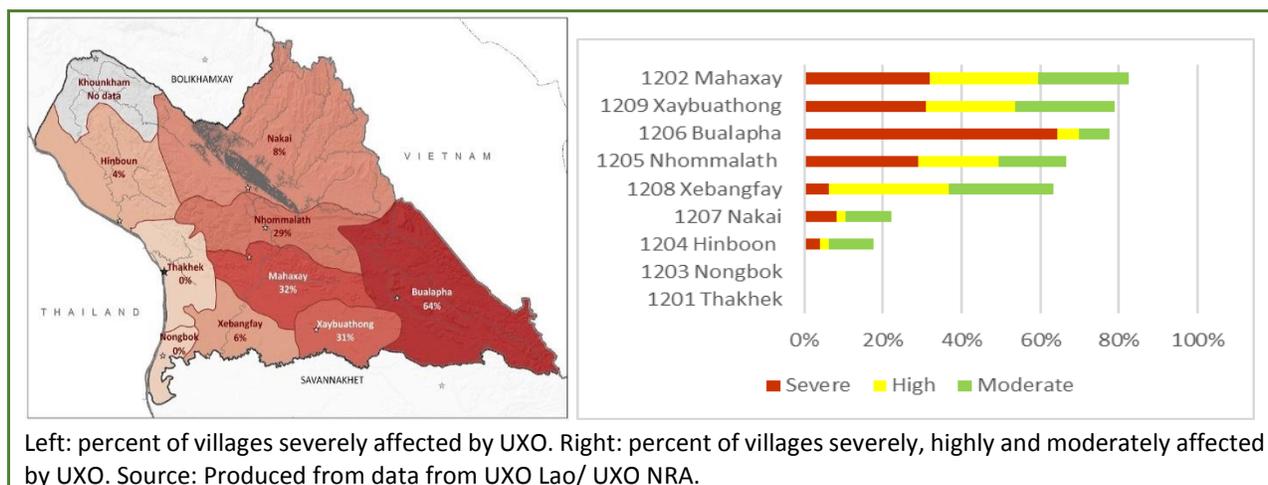


Figure A1.10: Districts affected by UXO in Khammouane

A1.4 Agriculture

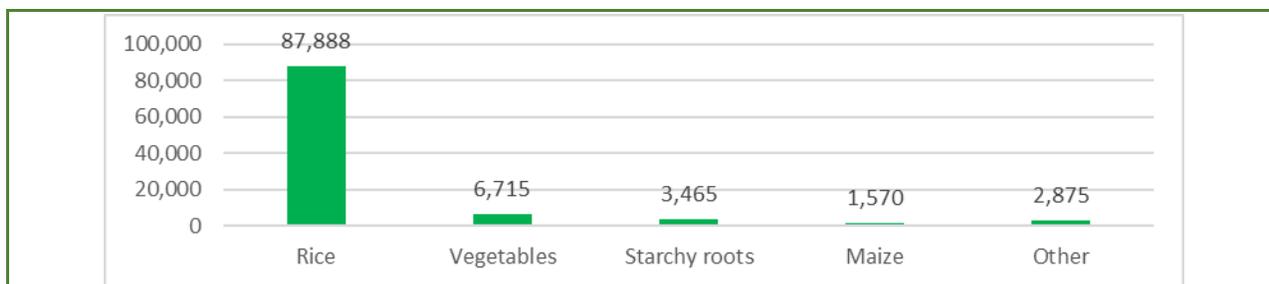
A14.1 Provincial level

16. **Planted area of agricultural crops in Khammouane was about 103,000 ha in 2017–18, This is nearly 6.4 percent of territory, or somewhat less than the national average of 7.6 percent.** Planted area per capita was 0.25 ha, compared to the national of 0.26 ha.⁴²

17. **Agriculture in Khammouane is dominated by rice cultivation, accounting for about 88,000 ha, or 86 percent of total planted area, compared to 55 percent nationally (Figures A1.11 and A1.12).** Of rice cultivation, 81,000 ha are lowland rainfed paddy rice while 7,000 ha are dry season irrigated paddy rice. There is little traditional upland rice cultivation. Vegetables, starchy roots, and maize account for only 11 percent of planted area, compared to 26 percent nationally.

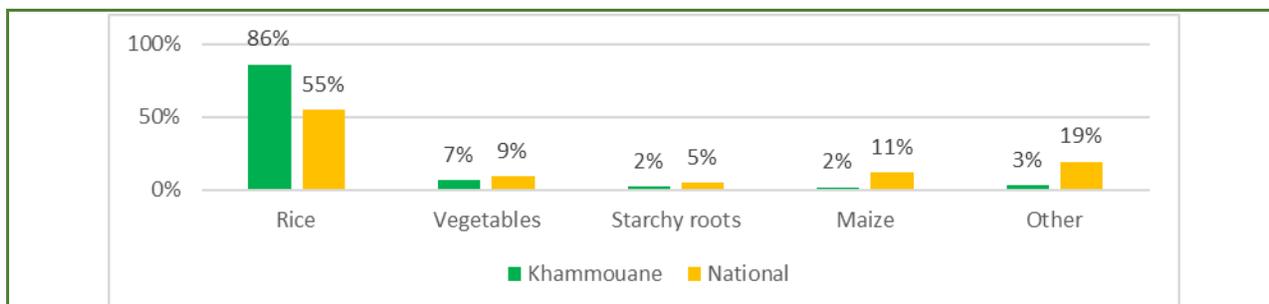
⁴¹ The analysis used 2015 district poverty incidence data from LSB (2016b).

⁴² These statistics are calculated from DOA (2018) and LSB (2018; 2019).



Source: LSB 2019.

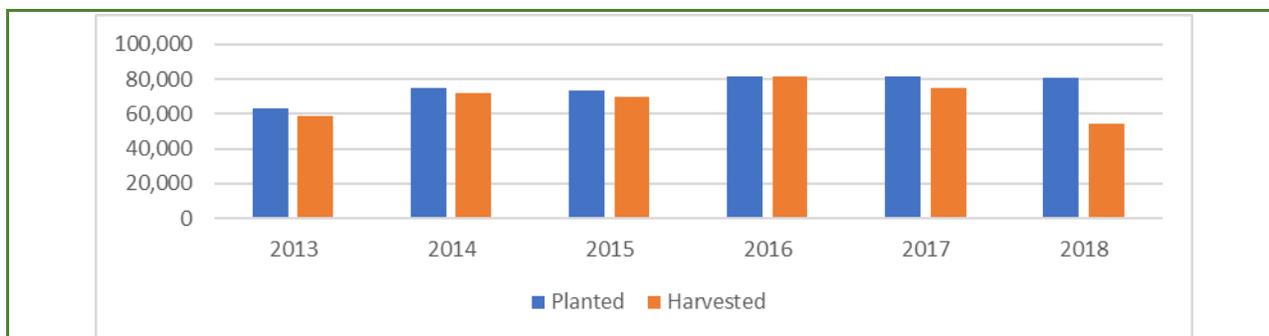
Figure A1.11: Planted area of agricultural crops in Khammouane (ha), 2018



Source: LSB (2018a) and DOA (2018).

Figure A1.12: Crop shares in total planted area, 2017

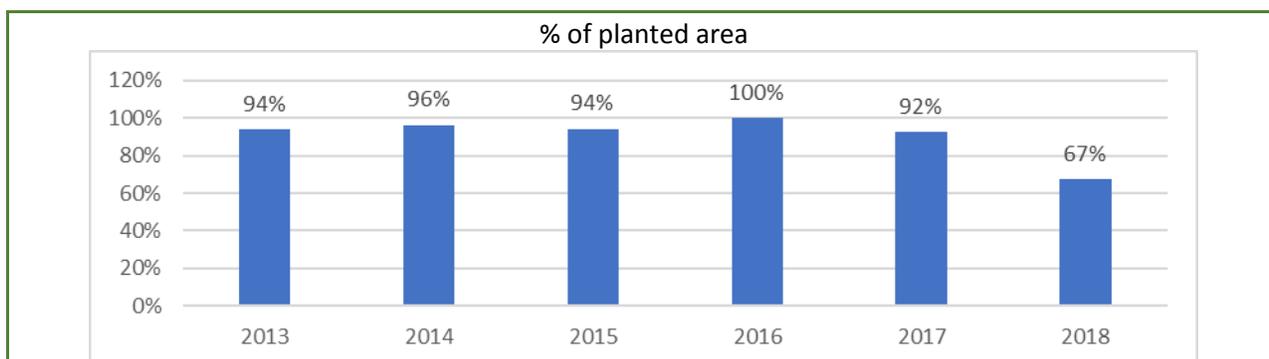
18. **The area planted to lowland rainfed paddy rice increased from 63,000 ha in 2013 to 81,000 ha in 2016 to 2018.** The harvested area was somewhat lower in most years, ranging from 92 percent to 100 percent of planted area during 2013 to 2017. Harvested area was, however, only 67 percent of planted area in 2018 mainly due to flooding (Figures A1.13 and A1.14).



Source: LSB (2019) and previous editions.

Note: ha.

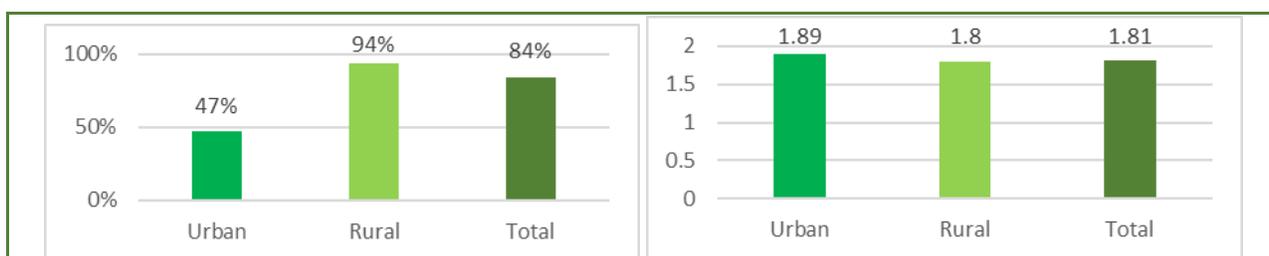
Figure A1.13: Lowland rainfed paddy rice cultivation in Khammouane (ha)



Source: LSB (2019) and previous editions.

Figure A1.14: Harvested area of lowland rainfed paddy rice in Khammouane

19. According to the household data from LECS-5 (2012–13), almost all rural households in Khammouane Province report that they have agricultural land (94 percent), as well as nearly half of urban households (47 percent). Average land holding per household reporting agricultural land is 1.8 ha and is similar among urban and rural households (Figure A1.15).

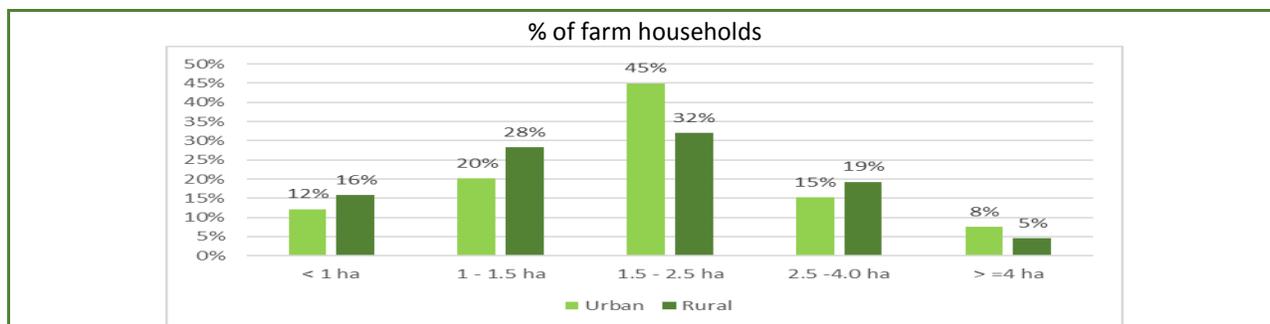


Source: LECS-5 data from LSB.

Note: Left: Percent of households. Right: Average land holding per household (ha).

Figure A1.15: Khammouane households with agricultural land, 2012–13

20. The distribution of agricultural land holding sizes in Khammouane is similar among urban and rural households. About 80 percent of urban households and 79 percent of rural households have between 1 and 4 ha of land. But as many as 16 percent of rural households reported to have less than 1 ha, in contrast to 12 percent of urban households (Figure A1.16).

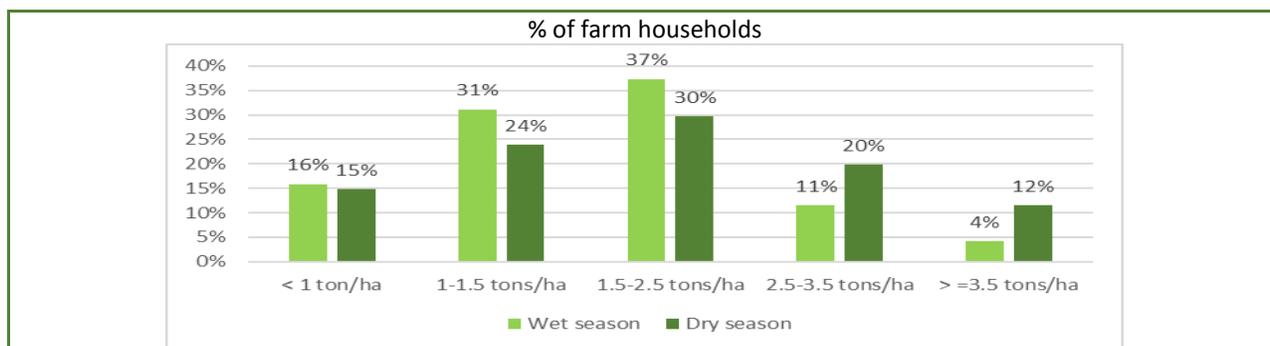


Source: LECS-5 data from LSB.

Note: Size distribution among households that reported to have agricultural land.

Figure A1.16: Size of agricultural land holdings among households in Khammouane 2012–13

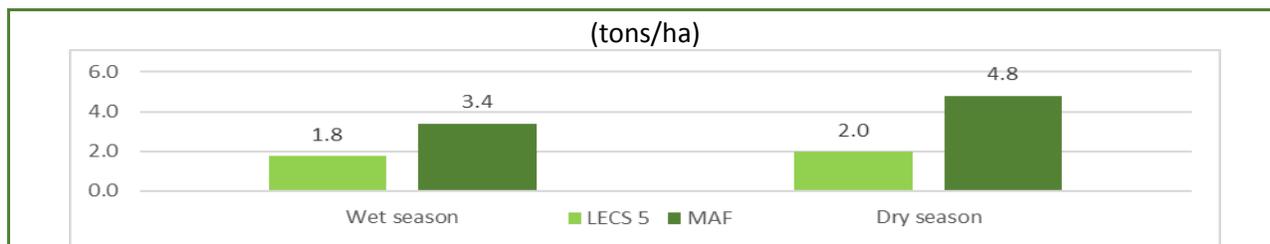
21. Households also reported average yields of 1.8 tons/ha of harvested land for wet season rice and 2.0 tons/ha for dry season rice. About 80 percent and 73 percent of households reported a yield of 1-3.5 tons/ha for wet and dry season rice, respectively (Figure A1.17).



Source: LECS-5 data from LSB.

Figure A1.17: Yield of wet season and dry season rice among households in Khammouane, 2012–13

22. The yields reported by households in LECS-5 are in stark contrast to the yields presented by MAF for Khammouane in the Lao Statistics Yearbook 2012 for 2012: 3.4 tons and 4.8 tons per ha harvested for wet and dry season irrigated rice, respectively (Figure A1.18).



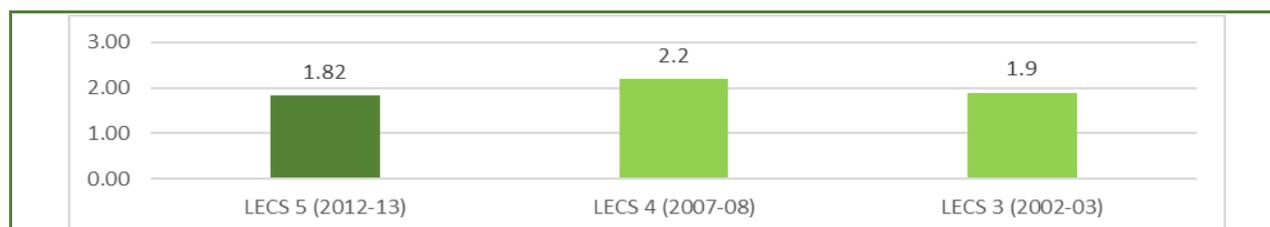
Source: LECS-5 data from LSB and Lao Statistics Yearbook 2012 (LSB).

Figure A1.18: Wet and dry season rice yields in Khammouane, 2012

23. Mean rice yields found in LECS-5 (2012–13) in Khammouane are quite similar to those found in LECS 4 (2007-08) and LECS 3 (2002-03) in the Central region of Lao PDR, including Khammouane, in an analysis by the World Bank 10 years ago (Figure A1.19).⁴³ The yields in the Central region in LECS 3–4 were found to be somewhat higher than in Khammouane in LECS-5. Such variation may be due to

⁴³ The analysis did not report on Khammouane Province separately.

differences between Khammouane and the other provinces in the region, or year specific factors such as flood damages.



Source: LECS data from LSB.

Note: Yields are weighted average wet and dry season yields. LECS-5 is for Khammouane. LECS 3-4 are for the Central Region of Lao PDR.

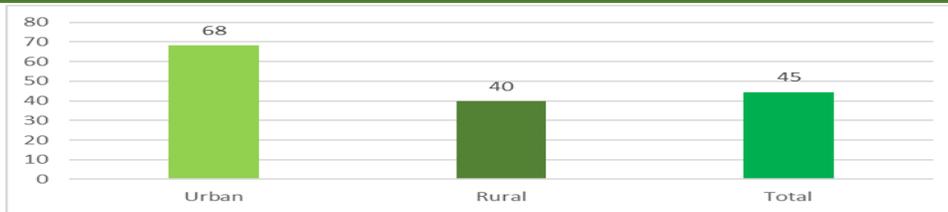
Figure A1.19: Rice yields reported in LECS surveys, 2002–03 to 2012–13 (tons/ha)

24. **Households in LECS-5 also report their own estimate of the market value of their agricultural land.** The mean value reported among households in Khammouane is LAK 45 million (US\$5,700) per ha. The value is substantially higher among urban households (Figure A1.19). This may be due to their agricultural land being closer to urban areas, where land prices are higher.

A1.4.2 District level

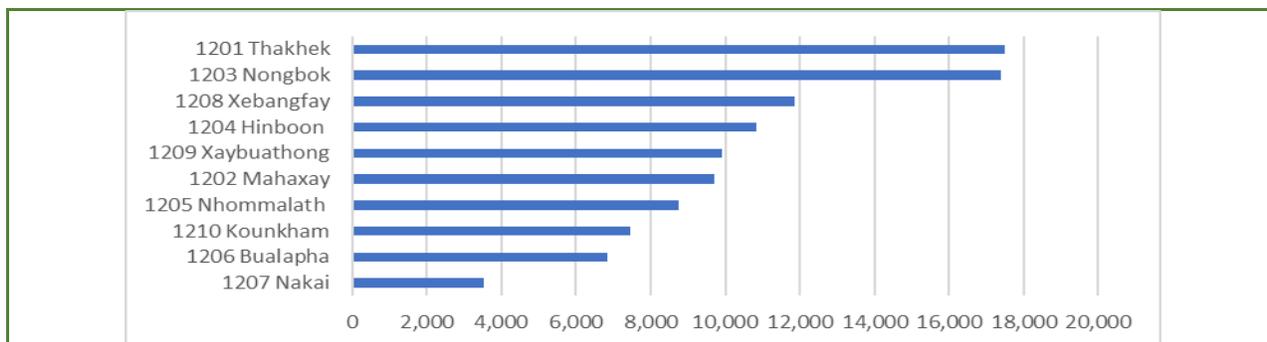
25. **Thakhek and Nongbok districts have the most cultivated land, jointly accounting for over a third of the province’s cultivated land, while Bualapha and Nakai Districts have the least, jointly with only 10 percent of cultivated provincial land (Figure A1.20).** Half of Nongbok district’s land area is cultivated, the highest share in the province. In contrast, only 1-2 percent of land in Nakai and Bualapha Districts is cultivated. The share of cultivated land is highly correlated with district population density ranging from 6-10 per km² in Nakai and Bualapha to 137 km² in Nongbok,⁴⁴ except for Thakhek with its large urban, non-farm population (Figure A1.22). Districts with small shares of their land cultivated also have smaller areas of cultivated land per capita. Less cultivated land per capita is also associated with a somewhat higher poverty incidence (Figure A1.23). This relationship is further explored in the section on irrigation.

⁴⁴ The correlation coefficient is 0.95.



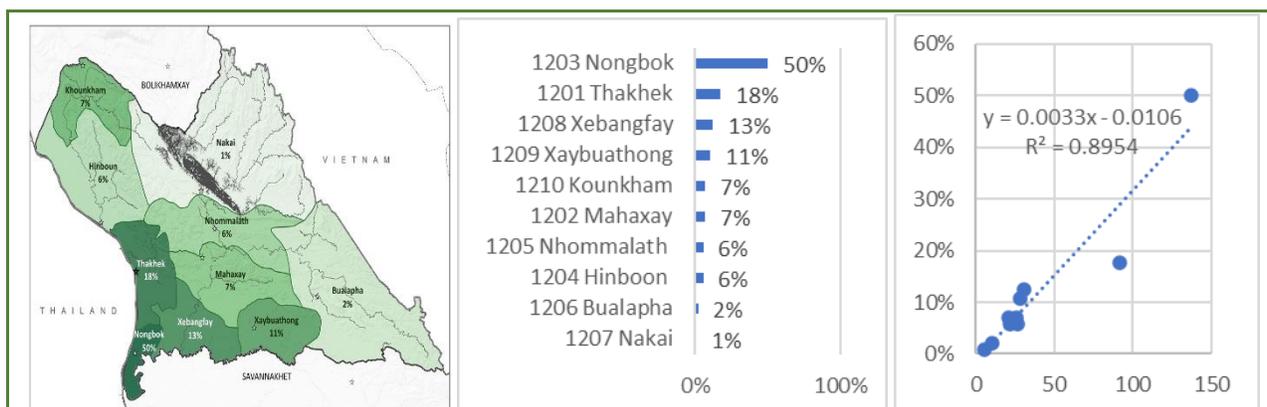
Source: LECS-5 data from LSB.

Figure A1.20: Market value of agricultural land in Khammouane, 2012–13 (million Kip/ha)



Source: Produced from data in DOA (2018).

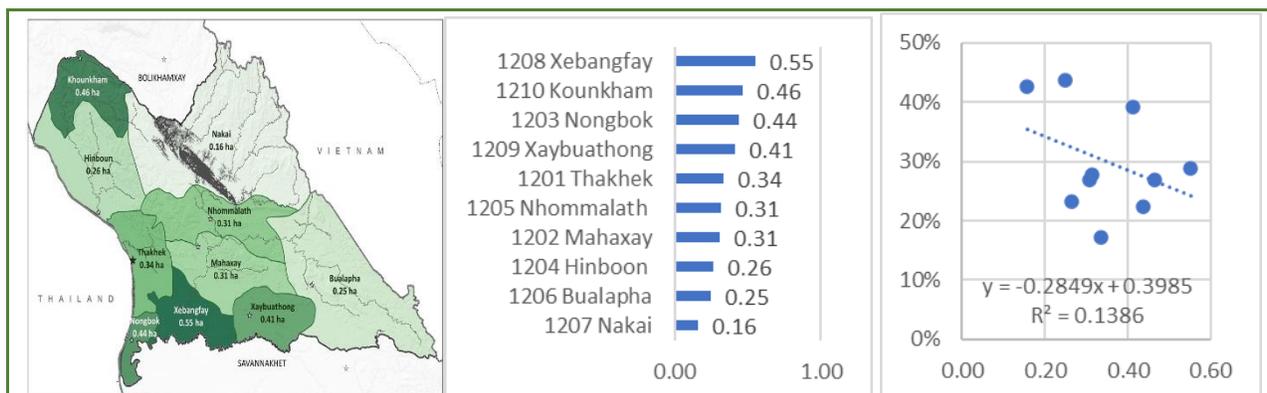
Figure A1.21: Agricultural cultivated land by district in Khammouane in 2017 (ha)



Source: Produced from data in DOA (2018) and LSB (2016a).

Note: Cultivated land is from 2017. Population density is from 2015.

Figure A1.22: District cultivated share of total land (left) and its relation to population density (right)



Source: Produced from data in DOA (2018) and LSB (2016b).

Note: Cultivated land is from 2017. Poverty incidence is from 2015.

Figure A1.23: Cultivated land per rural capita, Ha (left) and its correlation with district poverty incidence

A1.5 Forest resources

26. **Forests provide many benefits in Lao PDR.** Some of the benefits, such as timber production and processed wood products, and nature-based tourism are reflected in GDP. However, many other benefits are either not reflected in GDP, or mis-attributed to other sectors. Forests provide a substantial share of the population's food consumption, energy for cooking and other purposes, and other NTFPs—benefits that are imperfectly reflected in GDP. Forests also provide other important ecosystem services that are typically not traded in markets, including recreational values, regulation services, soil erosion reduction, and mitigation of natural hazards such as flash floods, seasonal flooding, landslides, and droughts. Reduction of soil erosion and natural hazards help protect water quality (for example, reduced turbidity), protect infrastructure and productive assets, and prolong their useful life (for example, reduced sedimentation of reservoirs). The value of these services is not reflected in GDP. The forests in Lao PDR also have important biodiversity values of global significance and carbon storage values for mitigation of climate change. They also have important, intangible cultural and religious values for many people, as well as existence value.

27. **All these forest ecosystem values, most of which are not reflected in national accounting and measures of GDP, point to under-estimation of the true economic and social value of the forests in national accounts.** This leads to overexploitation of the type of services that provide immediate financial gains and/or that can be captured through rent-seeking behavior, such as overextraction of timber, wildlife, and NTFPs and conversion of forest to other uses.

28. **The following subsections look at forest land areas in Khammouane, household wild forest food consumption, wood consumption, national protected areas and biodiversity, as well as provide an indication of forest plantation and nature-based tourism potential in the province.** Data are unfortunately insufficient to provide perspectives on the value of forests in Khammouane in terms of other ecosystem services such as watershed protection and regulation services.

Box A1.1. Ecosystem Services

Ecosystem services have typically been categorized in four main types:

- Provisioning services are the products obtained from ecosystems such as food, fresh water, wood, fiber, genetic resources, and medicines.
- Regulating services are defined as the benefits obtained from the regulation of ecosystem processes such as climate regulation, natural hazard regulation, water purification and waste management, pollination, or pest control.
- Habitat services highlight the importance of ecosystems to provide habitat for migratory species and maintain the viability of gene-pools.
- Cultural services include nonmaterial benefits that people obtain from ecosystems such as spiritual enrichment, intellectual development, recreation and aesthetic values.

Source: Biodiversity Information System for Europe: <https://biodiversity.europa.eu/topics/ecosystem-services>

A1.5.1 Forest land

A1.5.1.1 Provincial

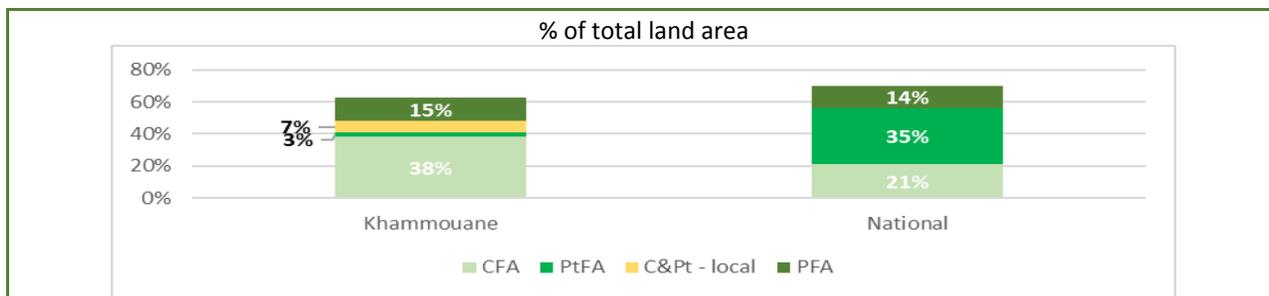
29. **About 70 percent of the land area in Lao PDR is classified as forest land and are designated into three forest categories:**

- a) **PFA**s are managed primarily for production of wood, fiber, fuel, and NTFPs. There are 51 national PFA (105 forest management areas in 17 provinces) that total over 3.1 million ha, of which 2.2 million ha (70.8 percent) are forested. However, harvestable forest in sufficiently good condition to sustain production was reported to have been only about 0.6 million ha in 2012 (DOF/SUFORD 2013) and currently as little as 0.2 million ha (SUFORD 2019). The remaining forested areas are heavily degraded and may need 20 years and investment to regenerate. Forty of 51 PFA have been formally delineated.
- b) **Protection Forest Areas** are managed primarily for soil, water and natural disaster protection, such as for strategic reservoirs. Protection forest areas cover 8 million ha at national, provincial and district levels, of which 4.8 million ha (59.8 percent), are forested. Most have not been formally delineated.
- c) **CFAs**, also known generally as protected areas, are managed primarily for biodiversity conservation. There are three national parks (of which two are in Khammouane), 21 NPAs, 66 provincial and 143 district protected areas, with a total area of 4.8 million ha, of which 3.5 million ha (73.4 percent) are forested. Many have not been formally delineated (World Bank 2019a).

30. **Another designation, village use forests, may overlap all of these categories and can also be found outside them.** There are also nearly 0.5 million ha of plantation forest, spread over each forest category (World Bank 2019a). In addition, there are 3.2 million ha of forest (13.5 percent of national territory) outside of these three forest area categories. The 2019 Forestry Law seeks to devolve forest management responsibilities to villages and could allow timber production in village use forests.

31. **Actual forest cover is less than the given forestland area (which is an administrative definition).** According to the latest definitions and classifications from satellite imagery the forest cover in Lao PDR was 58 percent in 2015 down from 61 percent in 2000 (World Bank 2019a). Deforestation was 1.3 percent of territory from 2005 to 2010 and 1.4 percent from 2010 to 2015 for major types of forest cover (MAF 2018).

32. **In Khammouane around 63 percent of the provincial territory is designated as these three forest categories, including provincial and district conservation and protection forest areas.** While the share of territory designated as PFA in Khammouane is about the same as nationally, the area under CFA is substantially larger and that in protection forest area substantially smaller than nationally (Figure A1.24).



Source: Khammouane is based on data from DOF. National is from World Bank (2019a).

Figure A1.24: Forest land area

A1.5.1.2 District level

33. **Large areas of Khammouane are classified as forest land, and large areas are still covered by forest. Most of the forest cover is located at the higher elevations (300+ masl) while the lowlands (150-200 masl) are populated and devoted to agriculture.** The large majority of the forest cover is in the three NPAs – Nakai Namtheun (3,552 km²) in Nakai District in the northeast; Hin Nam No (872 km²) in Bualapha district in the southeast; and Phou Hin Poun (2,380 km²) in the northwest in several districts (Figure A1.25).



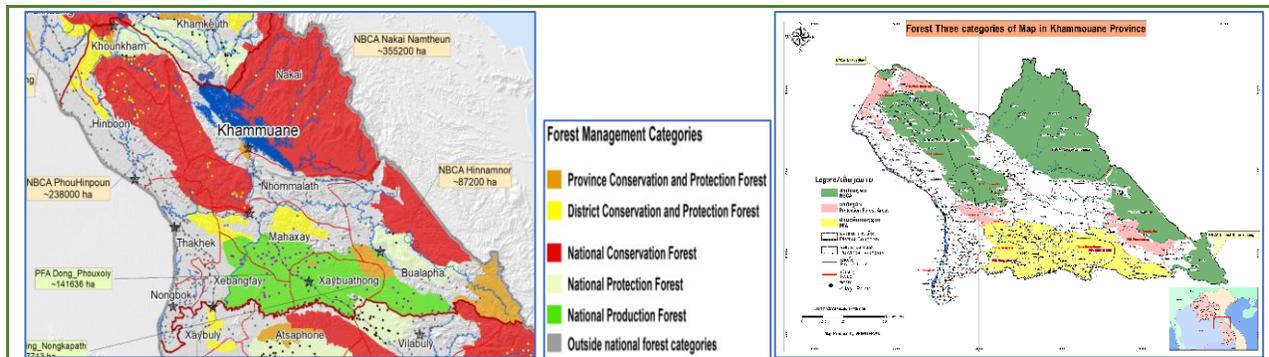
Source: DOF.

Note: White dots are population settlements. Dark green is forest (left and right map). Light green is NPAs (right map).

Figure A1.25: Population distribution, forest cover and protected areas in Khammouane, 2015

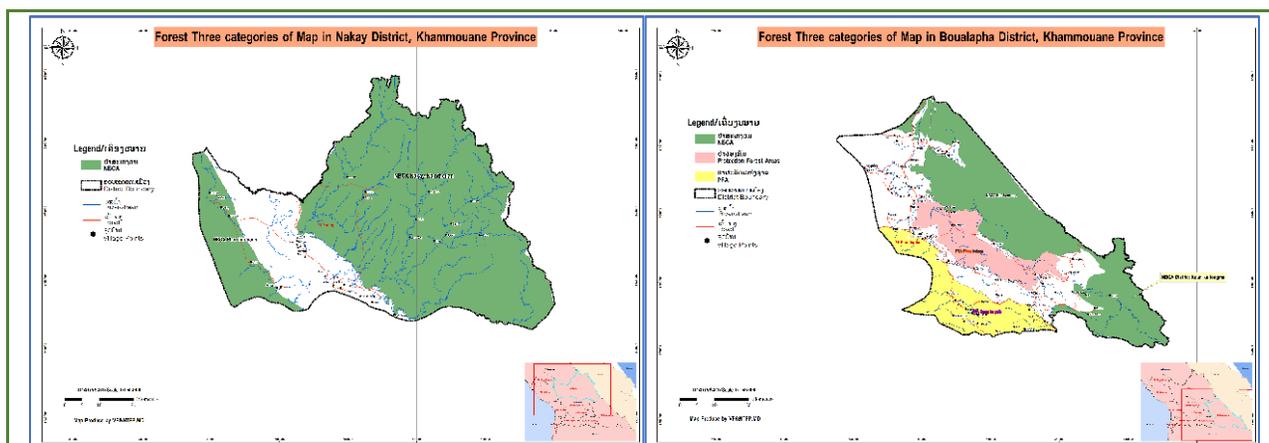
34. **Forest land areas in Khammouane are presented by categories in Figure A1.26.** The forest land areas with the densest forest covers are in Nakai and Bualapha Districts (Figure A1.27) with status of NPAs or National Parks all of which possess high global biodiversity value. The two districts, as previously discussed, are characterized by higher elevations, low population density, Mon-Khmer populations and the highest poverty incidence in Khammouane.

35. **A third NPA (Phou Hin Poun), with less dense forest cover naturally due to its dramatic limestone landscape, is located in the northwest in the districts of Hinboon, Kounkham, and Nakai.** The three NPAs occupy as much as 39 percent of Khammouane, while NPAs nationwide occupy about 16 percent of territory.



Source: DOF.

Figure A1.26: Forest land by categories in Khammouane



Source: DOF.

Figure A1.27: Forest land by categories in Nakai and Bualapha Districts

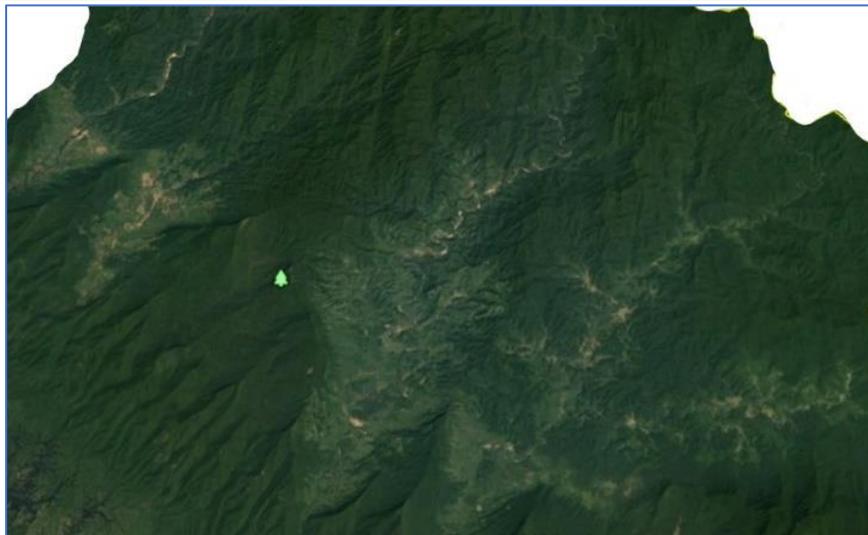
36. PFAs extend through much of the southern areas of Khammouane in the districts of Xaibuathong, Xebangfay, southern Mahaxay, and Bualapha. The largest protection forest area is in Bualapha.

37. Satellite imagery collated by Google Earth can give a sense of land use and vegetation cover in Khammouane (Figure A1.28). Forest cover is dark green, while lighter colors are areas with no vegetation or agricultural fields (dry season imagery). The image for Nakai Nam Theun National Park shows the enclave village clusters and their agricultural areas in each of the riverways (Figure A1.29).



Source: Satellite Imagery from Google Earth.

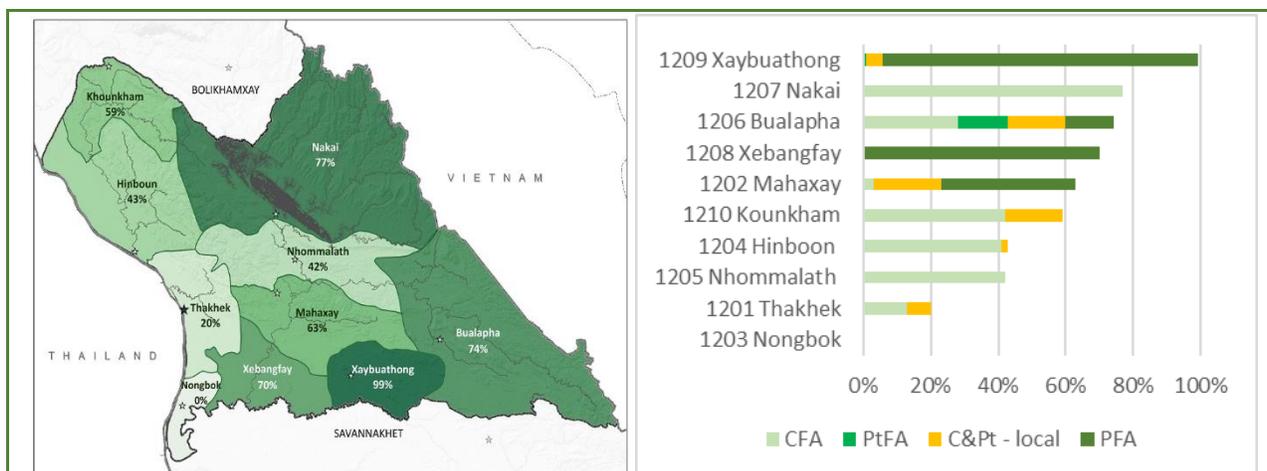
Figure A1.28: Land use and vegetation cover in Khammouane



Source: Satellite Imagery from Google Earth.

Figure A1.29: Land use and vegetation cover in Nakai-Namtheun NPA

38. **District forest land area as a share of total district territory are presented in Figure 5.7.** Forest land area in Xaybuathong is well over 90 percent, and above the provincial average in Nakai (77 percent), Bualapha (74 percent), and Xebangfay (70 percent). Forest land areas are only 20 percent in Thakhek and zero in Nongbok, as these are predominantly agricultural districts. CFAs (that is, protected areas) dominate in Nakai, Kounkham, Hinboon, and Nhommalath as a percent of the districts' forest area. PFAs dominate in Xaybuathong, Xebangfay and Mahaxay, while Bualapha has relatively even shares of conservation, protection and PFAs.



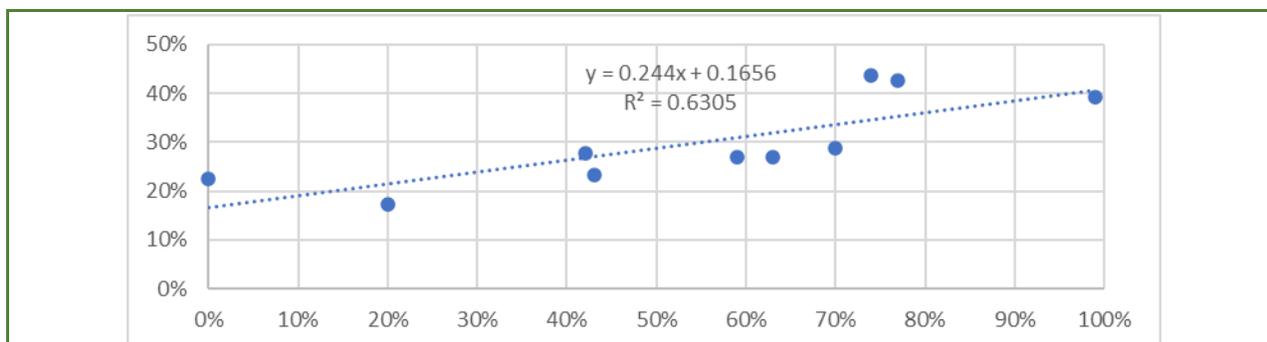
Source: Produced from data from DOF.

Note: Forest land area as percent of total district land area.

Figure A1.30: Forest land area by district in Khammouane

A1.5.1.3 Forest land and poverty

39. **Forest land area as a share of total territory is strongly correlated with poverty in Khammouane.** The larger the district's forest land area, the higher is the poverty incidence (Figure A1.31). Enhancing the value of and community income from forest resources have the potential to form an integral part of poverty reduction efforts. Two potential directions in this regard are development of forest plantations and nature-based tourism, which are discussed at the end of this section.



Source: Produced from data from LSB (district poverty incidence (vertical) and forest land area (horizontal) (DOF).

Figure A1.31: Correlation between forest area and poverty incidence in Khammouane, 2015

A1.5.2 Wild food

40. **Food accounts for as much as 70 percent of household consumption expenditure in Lao PDR in 2012–13, and over 80 percent among the poor, according to LECS-5.** A distinction can be made between food that originates from the farm and food from the wild. Food from the wild includes fish, wild meat, and many vegetables and fruits growing naturally. This food depends on the quantity and quality of water and forest resources as well as the sustainable use of these natural assets.

41. **Households in Khammouane report that they eat nearly 2 kg of meat, over 3 kg of fish, over 3 kg of vegetables and nearly 2 kg of fruit per week.** Consumption of meat, fish and vegetables is similar in urban and rural areas while consumption of fruit is much higher in urban than in rural areas (Figure A1.32).

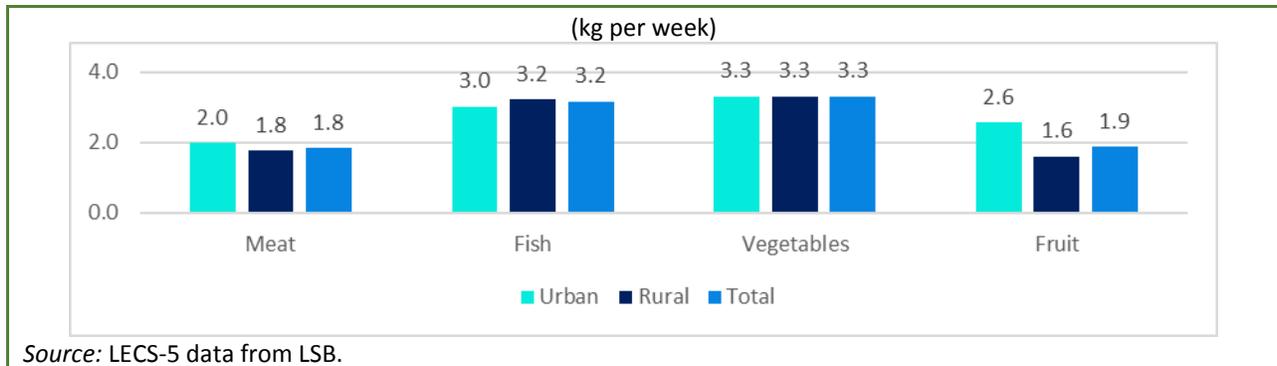
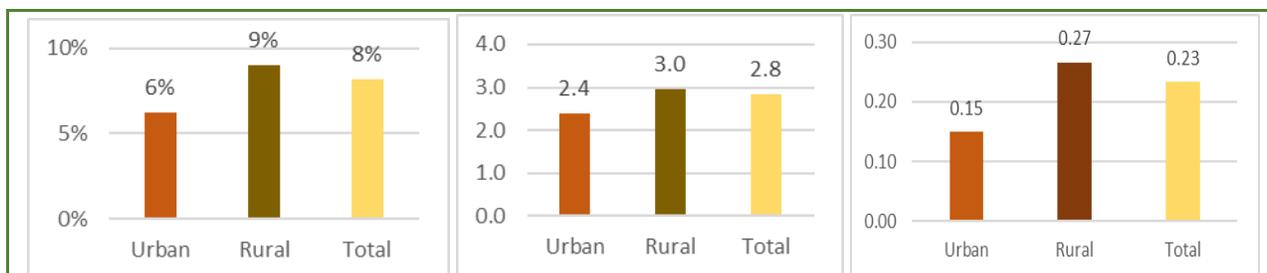


Figure A1.32: Household food consumption in Khammouane, 2012–13

A1.5.2.1 Meat

42. **About 8 percent of households in Khammouane reported they engaged in hunting in the 24 hours prior to the survey interview, spending 2.8 hours on average.** If these results reflect the annual activity patterns, each household spends about 0.23 hours per day or 1.6 hours per week on hunting throughout the year (Figure A1.33).

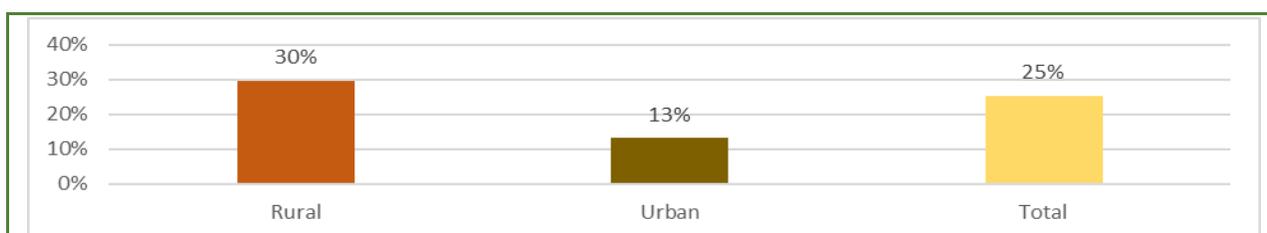
43. **Wild meat from hunting and trapping constituted as much as 30 percent of total meat consumption** among rural households in Khammouane in 2012–13, 13 percent among urban households, and 25 percent among all households (Figure A1.34).



Source: Calculated from LECS-5 data from LSB.

Note: Left: Percent of households engaged in hunting in the past 24 hours. Middle: Hours spent on hunting in the last 24 hours among households hunting in the past 24 hours. Right: Hours spent per household per day on hunting throughout the year.

Figure A1.33: Household frequency and time spent on hunting in Khammouane, 2012–13



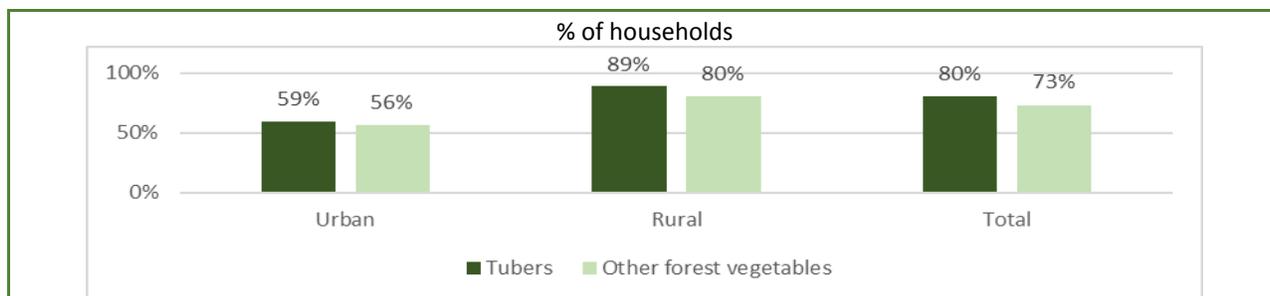
Source: LECS-5 data from LSB.

Figure A1.34: Share of wild meat in total meat consumption among households in Khammouane, 2012–13

A1.5.2.2 Vegetables

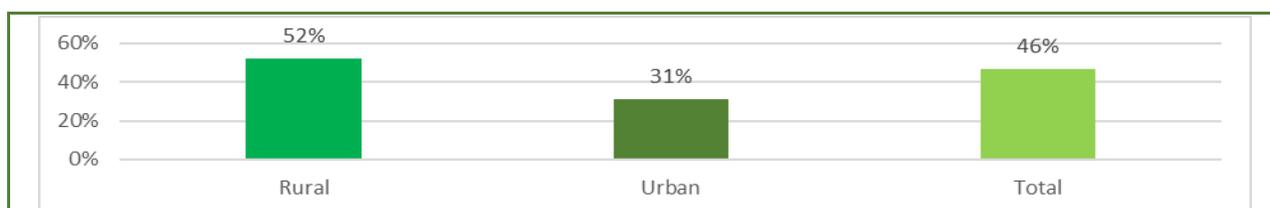
44. **As many as 80 percent of households in Khammouane collected wild tubers and 73 percent collected (other) vegetables grown naturally in the forest in the past twelve months.** Even in urban areas more than half of households engaged in this activity (Figure A1.35).

45. **Collection of wild vegetables grown naturally constituted as much as 46 percent of total vegetable consumption among households in Khammouane in 2012–13.** The share reached over half among rural households and nearly a third among urban households (Figure A1.36).



Source: LECS-5 data from LSB.

Figure A1.35: Households collecting tubers and vegetables in Khammouane, 2012–13



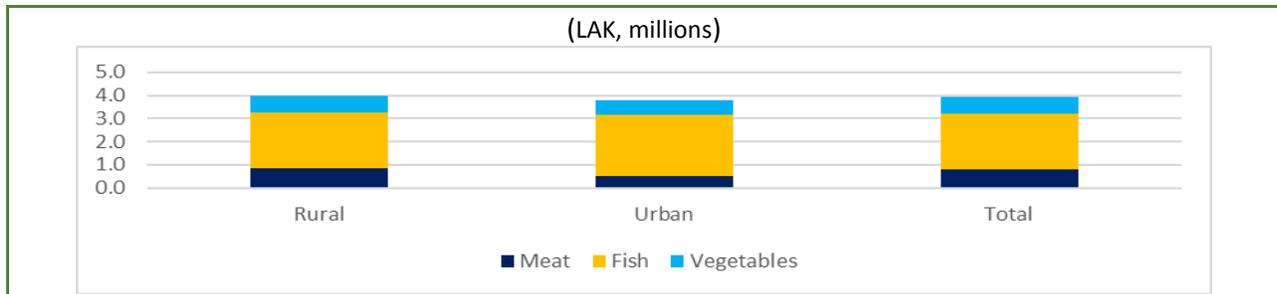
Source: LECS-5 data from LSB.

Figure A1.36: Share of wild vegetables in total vegetable consumption among households in Khammouane, 2012–13

A1.5.2.3 Total wild food

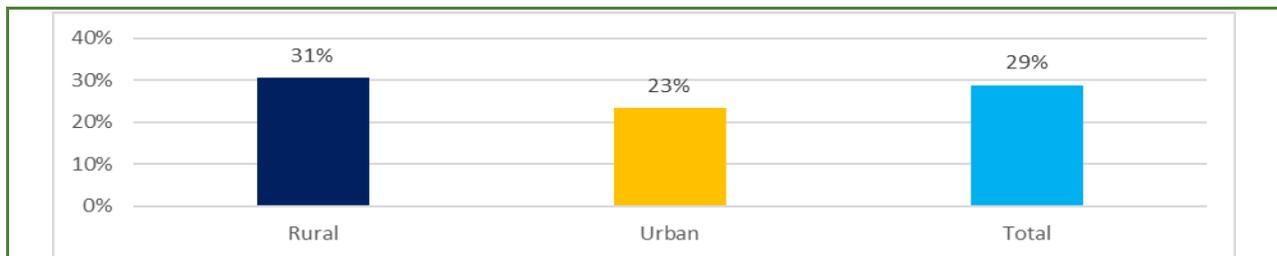
46. **The value of total annual wild food consumption reached nearly LAK 4 million per household with little variation across rural (LAK 4.0 million) and urban (LAK 3.8 million) households.** Fish constitutes approximately two thirds of these values (Figure A1.37).

47. **Wild food consumption constituted as much as 31 percent of total food consumption among rural households in Khammouane and 23 percent among urban households (Figure A1.38).** This demonstrates the continued importance of forest and water for household food supply and nutrition.



Source: LECS-5 data from LSB.

Figure A1.37: Wild food consumption value per household per year in Khammouane



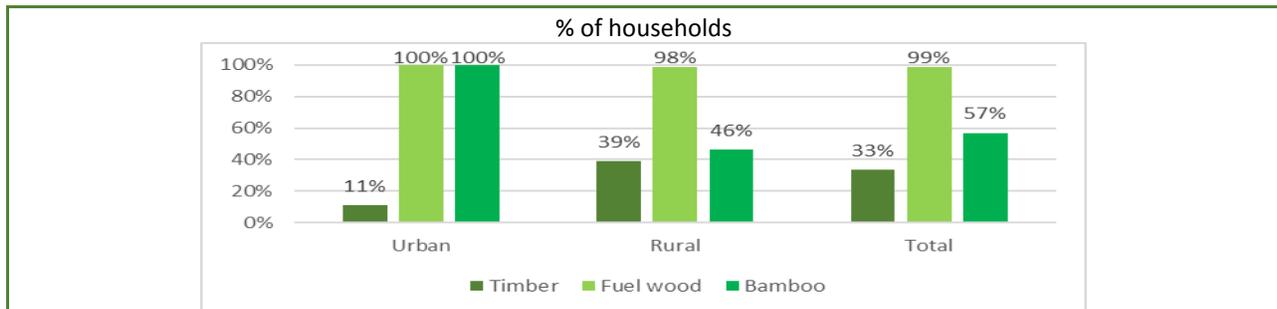
Source: LECS-5 data from LSB.

Figure A1.38: Wild food consumption share in total food consumption in Khammouane

A1.5.3 Wood consumption

A1.5.3.1 Household forest exploitation

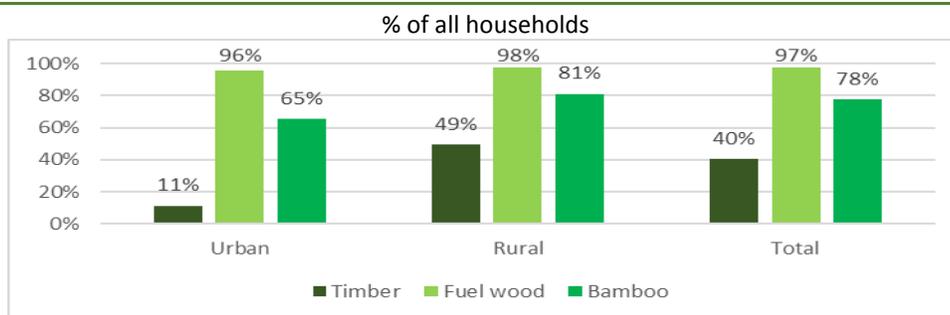
48. **About 16 percent of households in Khammouane reported owning forest, according to the LECS 2012–13.** One-third of these households exploited their forest for timber, 99 percent for fuelwood, and 57 percent for bamboo (Figure A1.39).



Source: LECS-5 data from LSB.

Figure A1.39: Households in Khammouane exploiting own forest

49. **Forests surrounding villages are particularly important to the population of Khammouane.** As many as 86 percent of households exploited these forests, of which 40 percent for timber, 97 percent for fuelwood, and 78 percent for bamboo. These local forests are also important for food with 80 percent of households in the province collecting tubers and 80 percent collecting vegetables (Figure A1.40).

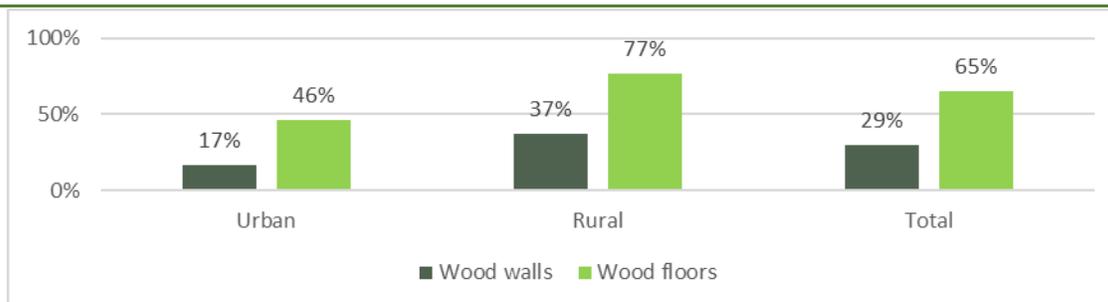


Source: LECS-5 data from LSB.

Figure A1.40: Household in Khammouane exploiting forest surrounding their village

A1.5.3.2 Housing

50. **Housing is a major use of wood. About 29 percent of houses in Khammouane less than six years of age have wood walls, and nearly two thirds have wood floors according to LECS 2012–13. The use of wood is higher among rural than among urban households (Figure A1.41).**



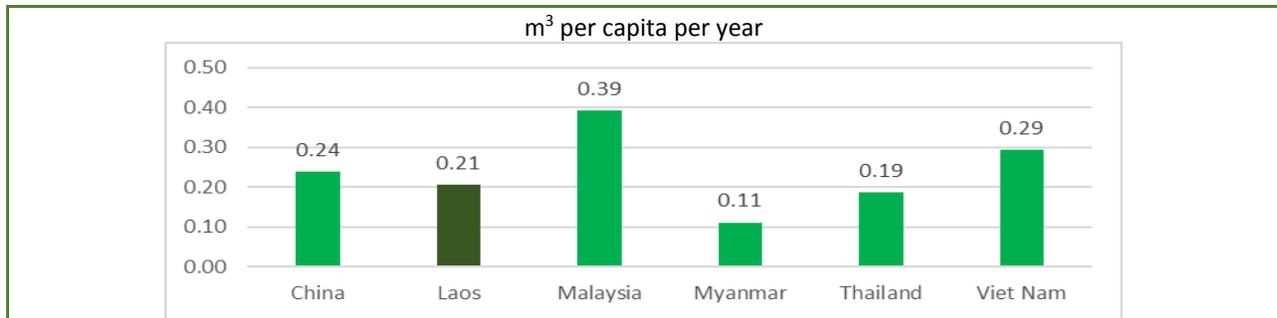
Source: LECS-5 data from LSB.

Note: Among houses of less than six years of age.

Figure A1.41 Share of houses with wood walls and floors in Khammouane, 2012–13

A1.5.3.3 Roundwood consumption

51. **Data on domestic wood consumption in Lao PDR are scarce.** FAO reports annual domestic consumption of roundwood (net of wood fuel) at 0.21 m³ per capita per year in Lao PDR in 2018. For comparison, industrial roundwood consumption averaged 0.24 m³ in five regional countries, ranging from 0.11 m³ in Myanmar to 0.39 m³ in Malaysia (Figure A1.42). If consumption in Khammouane is the same as the national level in Lao PDR reported by FAO, then total roundwood consumption (net of wood fuel) in Khammouane would have been about 88,000 m³ in 2018.



Source: FAO (2020): <http://www.fao.org/faostat/en/#data/FO>

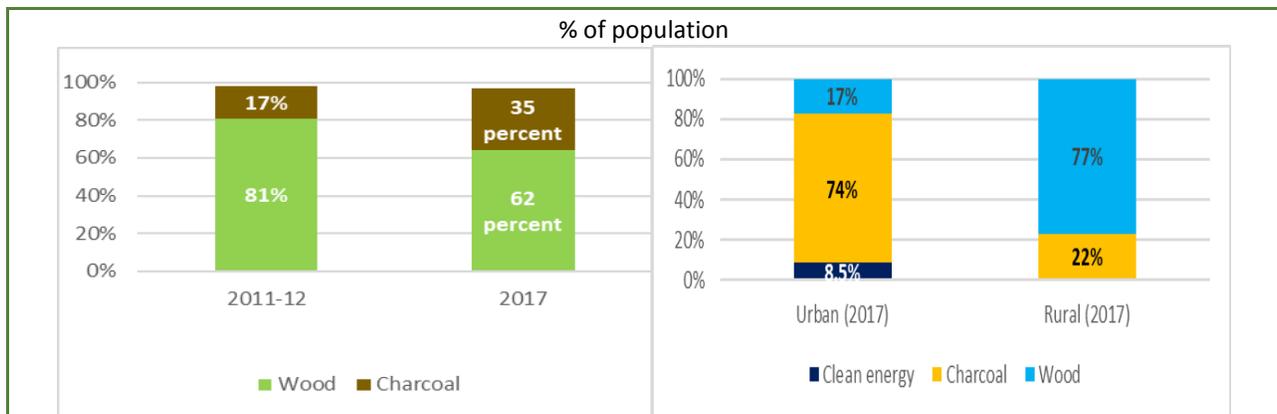
Note: Net of wood fuel.

Figure A1.42: Roundwood consumption per capita in Khammouane in 2018

A1.5.3.4 Wood fuel

52. **As much as 97 percent of Khammouane’s population used wood fuels as their primary cooking fuel, whereas only 3 percent used clean cooking energies such as electricity and LPG (LSB 2018b).** 35 percent used charcoal as their main cooking fuel in 2017, up from 17 percent in 2011–12 (MoH/LSB 2012), and 62 percent used wood as the main cooking fuel in 2017, down from 81 percent in 2011–12 (Figure A1.43).

53. **Charcoal was the primary cooking fuel for over 74 percent of people in urban areas and of nearly 22 percent of people in rural areas.** Clean energies were used by over 8 percent of people in urban areas but only by 1 percent in rural areas (Figure A1.44). In Nakai and Bualapha, nearly 96 percent used wood as their primary cooking fuel while less than 5 percent used charcoal.⁴⁵

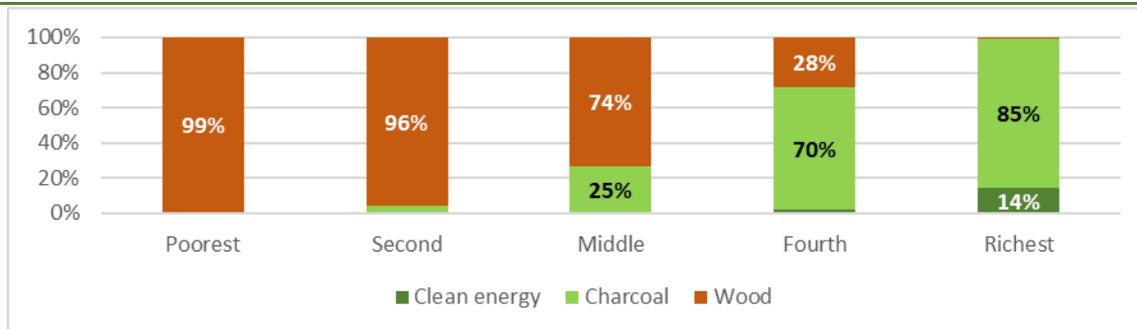


Source: MoH/LSB (2012) and LSIS II 2017 household data from LSB (2018b).

Figure A1.43: Primary cooking fuel in Khammouane

54. **Differences in primary cooking fuel were even more distinctive across household living standards.** Over 99 percent of the poorest quintile of the population in Khammouane used wood as their primary fuel in 2017 while 85 percent of the richest quintile used charcoal. Clean energies were used almost exclusively by the richest quintile of the population (Figure A1.44).

⁴⁵ Calculated based on the ethnicity and religion of the household heads.



Source: Produced from the LSIS II 2017 household data from LSB (2018b).

Note: Percent of population.

Figure A1.44: Primary cooking fuel in Khammouane by household living standard, 2017

55. **In addition, nearly 20 percent of Khammouane’s population used solid fuels (mainly fuelwood) for space heating when needed during the cold season in 2017.**

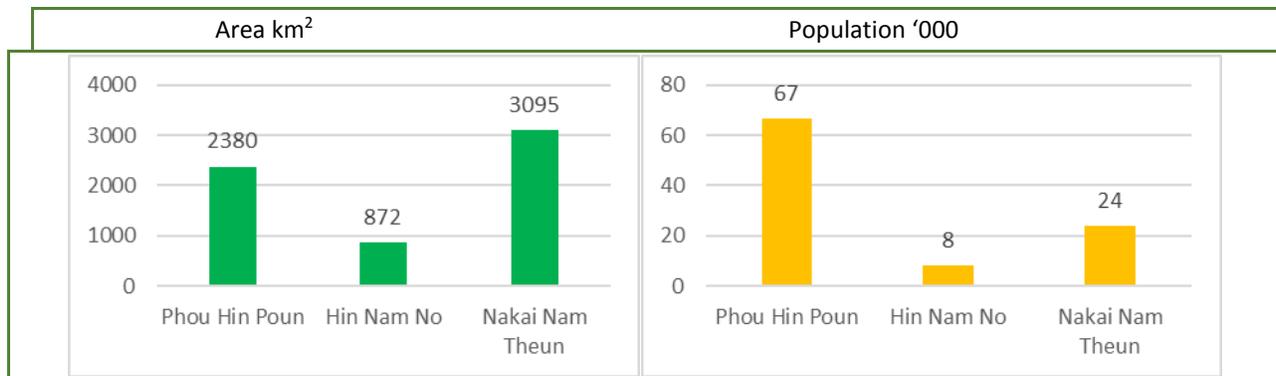
56. **Consumption of fuel wood and charcoal for cooking and other domestic purposes translates to over 280,000 tons of wood consumption per year in Khammouane.** Because about 6 m³ of wood are needed to produce 1 ton of charcoal, consumption would have been 76,000 tons less if households had used fuel wood instead of charcoal (even though charcoal’s energy content is about 80 percent higher than fuel wood) (MEM 2018). Burning charcoal, however, causes fewer health effects from smoke inhalation than burning wood. Nevertheless, the use of biomass fuels causes over 4,000 deaths annually in Lao PDR, imposing costs equivalent to 5.7 percent of GDP in 2017; their use is the country’s largest identified environmental health risk (World Bank 2020b forthcoming).

57. **While wood represents a valuable natural asset in terms of household energy, its use causes substantial health damages.** Several interventions are available to mitigate the health effects of household biomass combustion, including improved biomass cookstoves and clean cooking energies such as LPG or electricity. A recent benefit-cost analysis estimated that the benefits of improved wood and charcoal cookstoves in Lao PDR would be 2-4 times higher than their cost (World Bank 2020b forthcoming). These interventions reduce smoke exposure levels, but rarely to safe levels. To reap larger health benefits, clean cooking energies are needed. The same analysis estimates that benefits of using LPG and electricity are 2.7 times larger than their costs, although the costs are much higher than the cost of improved biomass stoves due to the high cost of LPG fuel and electricity consumption. The more recently developed gasifier stoves—which provide clean burning of biomass—were also estimated to provide large net benefits with benefits at four times the costs.

A1.5.4 National Protected Areas and biodiversity

58. **Protected areas, or CFAs, cover well over 40 percent of the territory of Khammouane.** There are three NPAs in the province covering about 6,350 km² or 39 percent of province’s area, two of which now have National Park status (Nakai Nam Theun and Hin Nam No). Khoun Xe–Nongma in Bualapha district, a Provincial Protected Area with national and global significance, is in the process to become an NPA (DOF 2020).

59. **About 100,000 people, or 25 percent of the province’s population in 2015, live in or adjacent to the three NPAs.** The largest NPA is the Nakai Nam Theun in the north-east of Khammouane followed by Phou Hin Poun in the north-west and Hin Nam No in Bualapha district in the south-east. As many as 67,000 people lives in or adjacent to Phou Hin Poun (Figure A1.45).



Source: Data from DOF and NPA Fact Sheets (DOF 2018).

Figure A1.45: NPAs in Khammouane

60. As much as 98 percent of the population of Nakai and a third to two thirds of the populations of Hinboon, Nhommalath, and Kounkham live in villages located in or adjacent to an NPA. Only three districts have no population living in or adjacent to an NPA (Figure A1.46).



Source: Calculated from data from NPA Factsheets (DOF 2018).

Note: Percent of district population.

Figure A1.46: District population living in a village in or adjacent to an NPA

A1.5.4.1 Phou Hin Poun

61. Phou Hin Poun was designated an NPA in 1993. Its area of nearly 2,380 km² spans part of six districts. 93 percent of its area is in Kounkham, Hinboon, Nakai, and Nhommalath districts and 7 percent in Thakhek and Mahaxay. The NPA occupies as much as 41 percent of Hinboon, 42 percent of Kounkham district, and 33 percent of Nhommalath (Table A1.2).

62. According to the recent Phou Hin Poun Fact Sheet (DOF 2018): The predominant physical feature of the NPA is “limestone karst ranges with steep slopes, cliffs and bluffs and caves in many areas. Valleys range in size from a few hundred ha to 40 km². Rivers include the Nam Hinboon, Nam Pathen, Nam Pakan, and Nam Don. Many of these rivers flow through underground caves, the largest of which is between Kong Lor and Natan on the Nam Hinboon and is navigable by boats.

<i>Code</i>	<i>District</i>	<i>Area of NPA (ha)</i>	<i>% of district area</i>
1205	Nhommalath	50,162	33
1204	Hinboon	77,568	41
1210	Kounkham	44,677	42
1202	Mahaxay	4,666	3
1207	Nakai	47,872	11
1201	Thakhek	13,037	13
	Total	237,982	

Source: Calculated based on area of Phou Hin Poun from IUCN.

63. **A little over half of the NPA's area is limestone.** Evergreen wood and shrubland covers nearly one third of its area, continuous cover of evergreen/mixed of medium density covers nearly 11 percent, continuous cover of deciduous and evergreen/mixed (high density) covers a little over 3 percent, and agricultural land 2 percent. Various mosaics and drywood and shrubland cover the remaining 1.3 percent. These calculations are derived from satellite imagery dating from 1997.⁴⁶ Vegetation cover today may be somewhat different.

64. **Several biodiversity surveys of the NPA were undertaken in 1997 and 1998. A total of 81 species of reptile, 47 species of amphibians and 145 fish species have been recorded within the NPA (DOF 2018) (Annex 5).** The NPA also provides catchment protection for parts of several rivers and has cultural value, including numerous temples and shrines in limestone caves, a number of sacred forests, and archaeological remains.

65. **48 villages are located inside the NPA (Type I), 42 are located outside it, and use agricultural land and other resources inside the NPA (Type II), and 7 villages are outside the NPA and use resources other than agricultural land inside the NPA (Type III) (Table A1.3).** The total population in these villages was nearly 67,000 in 2018, constituting 33-36 percent of the population in Nhommalath and Hinboon (40-43 percent of the rural population), and as much as 63 percent of the population in Kounkham (87 percent of the rural population). Even in Nakai, which only has 11 percent of its area in the NPA, 29 percent of the population (33 percent of the rural population) lives in villages in or adjacent to the NPA.

66. **These village classifications and population data allow the area of cultivated cropland within the NPA to be estimated.** If households located inside the NPA (Type I) cultivate the same area as average rural households in Khammouane, their cultivated area is about 4.2 percent of the total area of the NPA. Similarly, households who live adjacent to the NPA cultivate land about 3.3 percent of its area. Total cultivated area is then as much as 7.5 percent of the NPA. This is 3-4 times more than the estimate from 1997 based on the Landsat satellite imagery discussed above. This points to the potentially large increase in human activity and footprints inside the NPA over the last twenty years.

⁴⁶ These calculations are from the Forest Cover Monitoring Project (FCMP) MRZ/GTZ, based on interpretation of 1996/97 Landsat TM.

Table A1.3: Villages and population in or adjacent to the Phou Hin Poun in 2018

<i>District</i>	<i>No. of Villages</i>	<i>No. of Villages by type</i>			<i>Population</i>
		<i>I</i>	<i>II</i>	<i>III</i>	
Nhommalath	16	5	11	0	12,733
Hinboon	32	22	7	3	17,267
Kounkham	19	17	2	0	14,681
Mahaxay	11	0	11	0	7,540
Nakai	8	0	7	1	7,827
Thakhek	11	4	4	3	6,795
Total	97	48	42	7	66,843

Source: Phou Hin Poun Fact Sheet (DOF 2018).

67. The DOF identifies several main threats to the NPA (DOF 2018):

- a) Logging of remaining mature forest areas adjacent to the protected area.
- b) Limestone quarrying; copper, gold and tin mining in Hinboon.
- c) Forest clearance, and expansion of agricultural lands.
- d) Impacts from hydroelectricity development on Nam Hinboon River and on elephant migration routes.
- e) New road proposals in Nakai District.
- f) Increased village populations and resource use.
- g) Hunting and wildlife trade.
- h) Fires.

A1.5.4.2 Hin Nam No

68. Hin Nam No was designated an NPA in 1993 and National Park in 2019. Its area of about 870 km² spans a little over a quarter of Bualapha district. The NPA is located in the eastern part of the district bordering to Vietnam. Forest covers as much as 87 percent of the NPA (Table A1.4). The variety of habitat and forest types in the NPA supports a high diversity of animals and plants (Annex 4).

Table A1.4: Forest cover in the Hin Nam No NPA, 2015

<i>Vegetation type</i>	<i>Area (ha)</i>	<i>percent of total area</i>
Karst forest	28,833	32.6
Dry karst forest	7,321	8.3
Evergreen forest	11,886	13.4
Semi evergreen forest	16,828	19.0
Mixed deciduous forest	8,399	9.5
Bamboo forest	4,094	4.6
Fallow / disturbed forest	2350	2.7
Karst	2,486	2.8
River	81	0.1
Unidentifiable / Hill shade	4308	4.9
Burned Hill	1702	1.9
Fields (paddy)	21	0.0
Village/roads	177	0.2
Total	88,487	100.0

Source: Hin Nam No Fact Sheet (DOF 2018).

69. **There are no villages located inside the Hin Nam No, but nineteen villages with a population of about 8,000 in 2014 (26 percent of Bualapha’s population) are located adjacent to the NPA.**

70. **The DOF lists several main threats to the NPA (DOF 2018):**

- a) Commercial and community hunting and logging.
- b) Commercial overharvesting of NTFPs.
- c) Community harvesting of NTFPs.

71. **Floods and fires are also listed as threats, although of lesser importance.** Nevertheless, most of the habitats and associated wildlife within Hin Nam No National Park are considered to be in pristine condition, and with little forest loss over the decade and half.

A1.5.4.3 Nakai Nam Theun

72. **Nakai Nam Theun was designated an NPA in 1993 and National Park in 2019.** It covers 3,532 km², or 4,395 km² including the northern corridor (739 km²), the southern corridor (33 km²) and special conservation areas (107 km²). It is located mostly within Nakai, with portions in Nhommalath and Bualapha and in Khamkeuth in Bolikhamxay Province (Table A1.5). Its main forest types and wildlife are discussed in Annex 5.

Table A1.5: Area of Nakai Nam Theun National Park (ha)

Code	District	Area of NPA (ha)	Total district	% of district area
1105	Khamkeuth	38,752	262,400	15
1206	Bualapha	3,272	325,100	1
1205	Nhommalath	13,879	152,500	9
1207	Nakai	292,382	440,400	66

Source: Nakai Nam Theun Fact Sheet (DOF 2018).

73. **A total of 59 villages are located inside or adjacent to the NPA and use its resources (Table A1.6).** These villages had a total population of nearly 44,000 in 2015, of which 24,000 lived in Khammouane. 67 percent of Nakai’s population lives in or near the NPA, as does 12 percent of Nhommalath’s population and 9 percent of Bualapha’s population.

Table A1.6: Villages and population in or adjacent to the Nakai Nam Theun National Park

District	No. of villages	Number of villages by type			Population
		I	II	III	
Khamkeut*	21	0	21	0	19,877
Nakai	29	13	0	16	17,048
Nhommalath	7	0	0	7	3,903
Bualapha	2	0	0	2	3,009
Total	59	13	21	25	43,837

Note: * In Bolikhamxay Province. Source: Nakai Nam Theun Fact Sheet (DOF 2018).

74. **The DOF (2018) identifies several main threats to the NPA, including:**

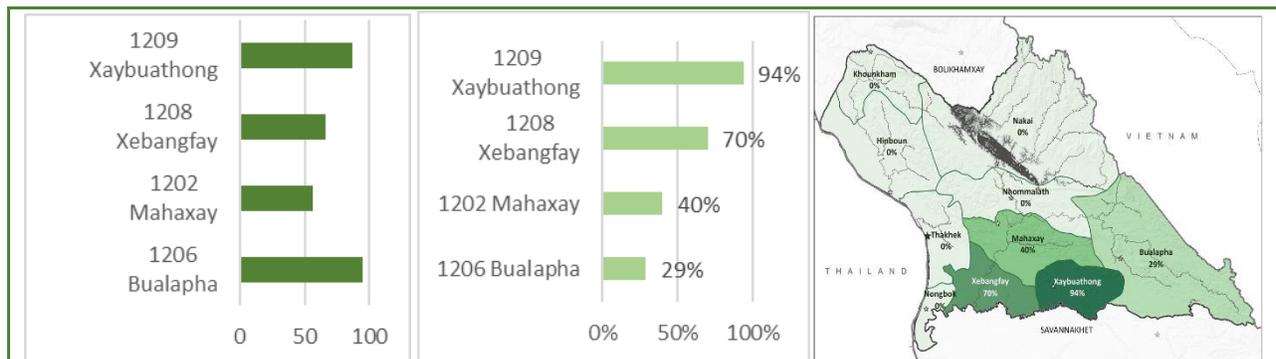
- a) Increasing illegal hunting by Vietnamese nationals crossing the international border.
- b) Increasing illegal hunting by Lao nationals coming from surrounding areas outside the NPA.
- c) Unsustainable and/or illegal hunting by community members within the NPA.
- d) Presence of middlemen in village within the NPA incentivizing unsustainable/illegal hunting.
- e) Persistence/availability of hunting tool, that is, snares, home-made guns, etc.

- f) Continued illegal extraction of luxury timber to supply national, but probably predominately international, timber trading networks.
- g) Increasing encroachment of outsiders seeking land.

A1.5.5 Forest plantation development

75. There are almost 500,000 ha of forest plantations in Lao PDR in 2015, mostly in rubber plantations (54 percent of plantation area), with smaller areas of eucalyptus and acacia (13 percent), teak (10 percent), agarwood (3 percent), and other species (9 percent) (Smith et al. 2017; World Bank 2019a). Plantation arrangements include smallholder plantations, contract farming, and land concessions to domestic and/or foreign investors. Concessions include 50,000 ha in Khammouane and Savannakhet by Birla Lao Pulp and Plantation, 24,000 ha in Khammouane and Bolikhamxay by Mekong Timber Plantations (formerly Oji Lao Plantation Forest Company), 36,000 of ha in Savannakhet and the southern provinces, and 2,000 ha in Vientiane Province (Smith et al. 2017).⁴⁷ Much of the concession plantation forest in Khammouane is located north of Hinboon district capital on land not classified as forest land area.

76. Four districts in Khammouane have substantial PFAs totaling over 250,000 ha, and Bualapha has about 50,000 ha of protection forest areas (Figure A1.48). Many of these areas may be suitable for plantations. Poverty incidence in two of these, Bualapha (44 percent) and Xaybuathong (39 percent), is substantially higher than the province average of 27 percent in 2015. There are also over 470,000 ha of land that are not classified as forest land nor cultivated with agricultural crops, some of which may be suitable for some kinds of plantations.



Source: Produced from DOF forest land maps.

Note: Left: Thousand ha; Middle and Right: Percent of district land area.

Figure A1.47: Production and protection forest areas in Khammouane districts

77. A recent report assessed the financial and economic merits of four plantation regimes in Lao PDR (World Bank 2019a). All four regimes have the potential for relatively high IRRs on investment, including SFM of native/natural mixed hardwood forest, subject to good management and timber growth rates. LEVs have the potential to reach thousands of dollars per hectare (Table A1.7). The LEV is the value of the land's contribution to the rate of return on plantation investment, and thus is the value of the natural resource (that is, land) that enters into the production of plantation timber. However, the outgrower eucalyptus plantation regime requires relatively good timber growth rate to achieve a positive LEV and viable rates of return on investment. Subject to good management and timber growth rates, plantations have the potential to provide income generation, employment and poverty reduction in many

⁴⁷ See also: <http://www.mekongtimberplantations.com/>

districts in Khammouane. This must, however, be carefully designed and balanced in relation to community use of forest for wild food and other NTFPs.

Table A1.7: Estimated economic returns to forest plantations in Lao PDR

	<i>Eucalyptus industrial plantation</i>	<i>Outgrower eucalyptus plantation^a</i>	<i>Smallholder teak plantation</i>	<i>Sustainable management of native forest^b</i>
Timber growth rate (m ³ /ha/year)	26–33	14–18	9–14	3.2
LEV (US\$)	2,500 to 6,300	–560 to +3,000	2,400–5000	600–3,600
IRR (%)	15–22	6–23	13–18	14–24

Source: Cabbage et al. 2018; World Bank 2019a.

Note: Discount rate of 8 percent is applied for calculating LEV.

a. Low-end LEV and IRR reflect low growth (14 m³), value of own labor, and cost of planting. High-end LEV reflects base growth (18 m³), value of own labor, but not cost of planting provided by the industrial investor.

b. High LEV and IRR reflect higher stumpage prices.

A1.5.6 Nature-based tourism development

78. **The 2019 World Bank report, “Developing Nature-based Tourism as a Strategic Sector for Green Growth in Lao PDR,” identifies the tourism sector, and especially nature-based tourism as a great opportunity to create greener economic growth and good jobs, given the country’s rich and abundant natural capital, protected areas, and a large and fast growing regional tourism market (World Bank 2019b).** The report states further that tourism has the potential to become the largest foreign exchange earner and nature-based tourism the biggest rural employer. Tourism revenues amounted to US\$811 million in 2018 (MOICT 2019), equivalent to 4.5 percent of GDP, and tourist arrivals increased by 9 percent from 4.19 million in 2018 to 4.58 million in 2019. The COVID-19 crisis offers an opportunity to reboot the sector to respond to increasing demand for nature-based tourism in Lao PDR especially in Khammouane which has been promoting ‘The Loop’ (see below) in recent years which connects various natural attractions inside and outside protected areas. Khammouane offers bountiful potential for development of nature-based tourism with its NPAs, mountain caves, rivers and waterfalls, and forests and rich biodiversity (Box A1.2).

Box A1.2: The Khammouane Province Tourism Development Management Plan

According to the Khammouane Province Tourism Destination Management Plan 2016–2018:

“Khammouane Province is home to towering limestone mountains, deep cavernous mountain caves and beautiful meandering rivers. Its history dates back as early as the 6th to 8th centuries when the region was part of the Sikhottabong Kingdom. Remnants of the ancient civilization include the Great Wall (Kampeng Nyak), Meuang Phone Stupa, and Sikhottabong Stupa which is one of the holiest pilgrimage sites in Laos.”

“The vision for Khammouane Province is be a top of mind tourism destination that connects visitors with local communities through sustainable eco-adventure tourism contributing to conservation and livelihoods.”

Source: Swiss Contact (2016).

79. **One of the most popular tourist attractions is the “Loop” that traverses through half of the districts of Khammouane, as well as the southern reaches of Bolikhamxay province.** The “Loop” takes visitors to a variety of attractions, and can also serve as an entry point to further exploration of the Nakai Nam Theun and Phou Hin Poun NPAs (Figure A1.49) as well as other natural attractions outside the protected areas. The region has become internationally recognized as a hotspot for rock climbing in the past few years.

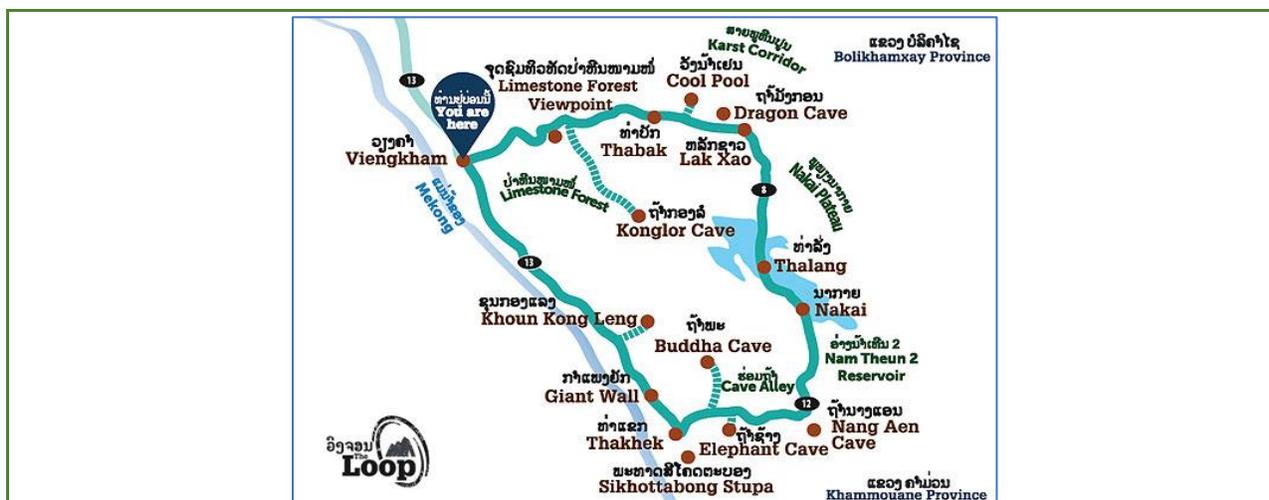
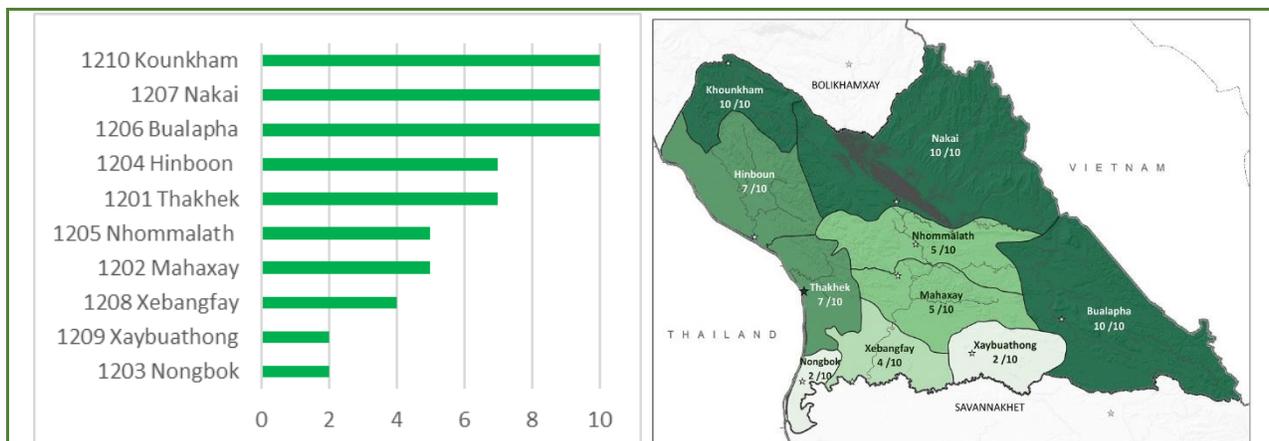


Figure A1.48: The 'Loop'

80. The districts that perhaps offer the best potential for nature-based tourism are Kounkham, Nakai, and Bualapha, followed by Hinboon and Thakhek, Nhommalath and Mahaxay (Figure A1.50). Nature-based tourism opportunities in the three NPAs are presented below.



Source: Expert opinions.

Note: Ranking 1 (low) to 10 (high).

Figure A1.49: Nature-based Tourism potential in the districts of Khammouane

81. **Phou Hin Poun.** The Phou Hin Poun NPA has high potential for development of nature-based tourism that can provide alternative sources of income for the local communities for growth and poverty reduction. The NPA already has a significant number of visitors each year. The main attraction is currently the Kong Lor Cave (see below). Also, the NPA is located on a popular tourist loop around Khammouane and Bolikhamxay provinces which links many of the area's attractions. The Phou Hin Poun Fact Sheet (DOF 2018) summarizes several of the main tourist attractions in Phou Hin Poun (Annex 6).

82. **Hin Nam No.** Village based tourism services exist in four of the nineteen villages adjacent to the Hin Nam No National Park: Nong Ping, Nongbua, Nongsaeng and Thongxam villages. The services include guesthouses, homestays, boat trips, visit to caves, trekking, history guides, waterfalls and swimming (Box 7.6.3). According to the Hin Nam No Factsheet: "The authorities in Hin Nam No NPA have developed a strategy for supporting these cooperative groups where the income they earn from tourism acts as an

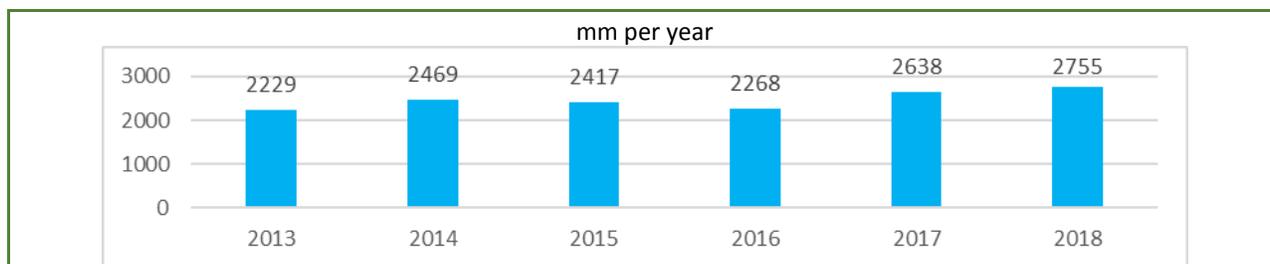
incentive for nature conservation. Furthermore, a ticketing system has been established that allows benefit sharing with local communities and provides a source of sustainable funding for the National Protected Area.” One of the main attractions in Hin Nam No is the Xebangfay Cave, being one of the longest river caves in the world, nearly 7km long. Other main attractions are Tham Nam & Tham Long caves used as bomb shelters by villagers during the second Indochina War; and trekking in Thongxam Village Area; and the Ho Chi Minh Trail (DOF 2018; TRC Tourism 2015).⁴⁸

83. **Nakai Nam Theun.** Nakai Nam Theun National Park also offers important tourist attractions. Tourists traveling ‘The Loop’ typically start and end in Thakhek and visit Khammouane’s major attractions including Kong Lor Cave, Lak Xao, and Buddha Cave. Most visitors stop in Thalang for one night, located on the north-western side of the Nam Theun 2 reservoir just across from the protected area. Nakai’s unique location offers an amazing opportunity to tap Khammouane’s tourism market (Annex 6).

A1.6 Water resources

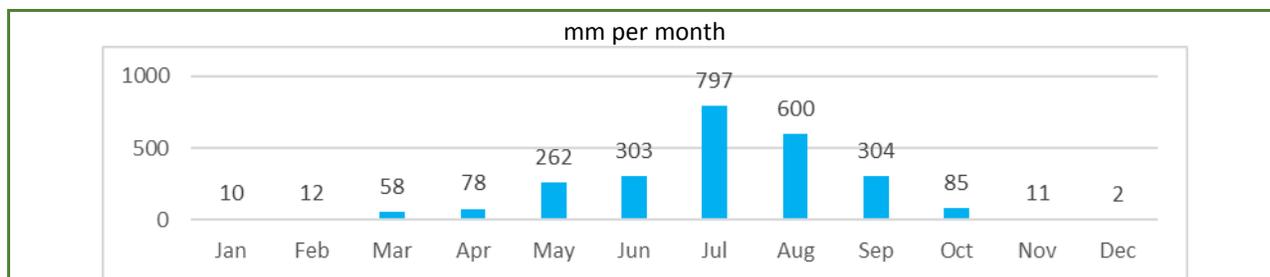
A1.6.1 Rainfall

84. **Khammouane receives around 2,500 mm of rainfall per year on average (Figure A1.51), the second highest of all provinces in 2017 and third highest in 2018.** As much as 90 percent of rainfall is received from May to September, peaking in July and August (Figure A1.52).



Source: LSB (2019) and previous editions.

Figure A1.50: Annual rainfall in Khammouane



Source: LSB (2019) and previous editions.

Figure A1.51: Monthly average rainfall in Khammouane, 2015-18

A1.6.2 River basins

85. **Khammouane Province includes several river basins.** The Xebangfay river basin spans the southern part of Khammouane as well as the northern section of Savannakhet Province. The Nam Theun-Kading river basin spans the northeastern part of Khammouane and the southern part of Bolikhamxay Province. The Nam Hinboon river basin spans the northwestern part of Khammouane. Interbasin transfers

⁴⁸ Further information is available at: <https://hinnamno.org/library/>.

from Nam Theun-Kading to Xebangfay and Nam Hinboon are substantial due to the Nam Theun 2 and Theun-Hinboon hydropower plants.



Source: Ward et al. 2013.

Figure A1.52: River basins and major rivers in Khammouane

86. **The Xebangfay River, with a length of approximately 350 km, is the sixth longest tributary to the Mekong River in Lao PDR.** It runs through Khammouane and into Savannakhet before flowing into the Mekong. The river has a catchment area of 9,708 km². The Nam Ou La and Se Noy are two major tributaries of the Xebangfay. Most of the catchment area is in Khammouane, with the Se Noy forming the border between Khammouane and Savannakhet (Figure A1.53). The mean annual run-off in the Xebangfay river basin is 14.7 billion m³ per year, of which 2.9 billion m³ is in the sub-basin of Se Noy in Savannakhet. There are two stream gauges along the Xebangfay River. The first gauge is in Mahaxay, between the inflow point from Nam Theun 2 and the Nam Ou La tributary. The second gauge is by the Xebangfay bridge just downstream of the inflow point of Se Noy tributary. Monthly mean flows peak at around 900 m³ per second in the gauge in Mahaxay and 2000 m³ per second at the gauge by the bridge (eWater 2018).

87. **Nam Hinboon is a shorter river, with a length of 89 km and a catchment area of 2,529 km² (Sioudom 2013).** The Nam Theun River in the Khammouane portion of the Nam Theun-Kading basin carries 7.5 billion m³ of water annually to the reservoir of the Nam Theun 2 hydropower plant from a catchment area of 4,039 km².

A1.6.3 Hydropower

88. **Two large hydropower plants are located in or near Khammouane:** Nam Theun 2, located in Nakai District with interbasin water transfer from Nam Theun to the Xebangfay River; and Theun Hinboon, located in Bolikhamxay province with interbasin water transfer from the Nam Theun/Nam Ngouang Rivers to Nam Hai/Nam Hinboon in Khammouane (Figure A1.53).

A1.6.3.1 Nam Theun 2

89. **Nam Theun 2 is the largest hydropower plant on the tributaries of the Mekong River in Lao PDR.** Its installed capacity of 1,070 MW represented 20 percent of hydropower capacity in the country at the end of 2018. The plant started operations in 2010, with a 25-year concession period. About 95 percent of electricity production is exported to Thailand. The project is expected to generate US\$2 billion in

government revenue over the concession period.⁴⁹ The Lao government owns 25 percent of Nam Theun 2 through its state-owned company, LHSE.

90. **Nam Theun 2 is located in Nakai District in the northeast of Khammouane.** Its reservoir covers 450 km² at full supply level with a capacity of 3.9 billion m³, inundating 40 percent of the Nakai Plateau. The catchment area covers 4,039 km², or nearly a quarter of Khammouane's area.

91. **The reservoir receives water from the Nam Theun River with an annual average flow of 7.5 billion m³/year.** About 200-240 m³/s is released for electric power production on average, amounting to 6.3-7.5 billion m³/year.

92. **The powerhouse is located at the south-western side of the reservoir. The water flows from the powerhouse through a 27 km channel to the Xebangfay River.** The discharge from Nam Theun 2 to the Xebangfay constitutes as much as 45-50 percent of the natural run-off from rain in the basin. While the share of water from Nam Theun 2 in the lower sections of the Xebangfay River is moderate during the wet season, it amounts to several times the natural flow during the dry season (eWater 2018), providing opportunities for dry season irrigation.

A1.6.3.2 Theun Hinboon

93. **Theun-Hinboon is located in Bolikhamxay but diverts water to the Nam Hai River and subsequently to the Nam Hinboon River in Khammouane Province which drains into the Mekong River.** The installed capacity of the original power plant was 240 MW following upgrades in 2016-17. Theun-Hinboon has since its origin expanded to a total of 520 MW by the building of a storage reservoir on the Nam Gnouang River, a tributary of the Nam Theun River, with a 60 MW powerhouse and an expansion of the original powerhouse by 220 MW. The expansion has been in operation since 2013.

94. **The power plant started operations in 1998 and has during 1998-2018 contributed over US\$608 million to the Lao government's finances through dividends, royalties, profit taxes and equity return.**⁵⁰ As much as 60 percent of Theun Hinboon was owned by the state-owned EDL, which transferred its holding to its subsidiary, EDL-Generation, in 2012. The production cost at Theun Hinboon has been less than US¢2 per kWh.

95. **Theun Hinboon has caused larger-than-anticipated downstream flooding during the wet season along Nam Hai and Nam Hinboon Rivers.** Some villages have had to relocate, and dry season irrigation systems have been constructed to compensate for income losses from the flooding.

A1.6.4 Fisheries

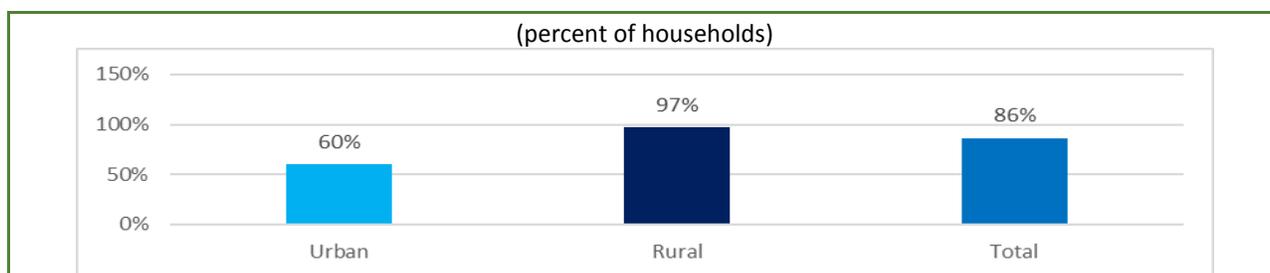
96. **As many as 86 percent of households—including almost all rural households—reported they practice fish culture and/or engage in fishing (Figure A1.54).** Only 5 percent of households reported they have fish culture, of which fishponds are the most common form. In contrast, 86 percent reported they engage in fishing. About 70 percent of all households, and as many as 80 percent of rural households, fish in rivers, lakes, reservoirs, and swamps. Fishing in seasonal flood plains and rice fields is also prominent, especially among rural households (Figure A1.55).

97. **As many as 37 percent of households in Khammouane reported they engaged in fishing in the 24 hours prior to the survey interview.** Each of these households spent on average 3.5 hours on this activity. If these results reflect annual activity patterns, then each household spends about 1.3 hours per day or 9 hours per week on fishing throughout the year (Figure A1.56).⁵¹

⁴⁹ www.namtheun2.com.

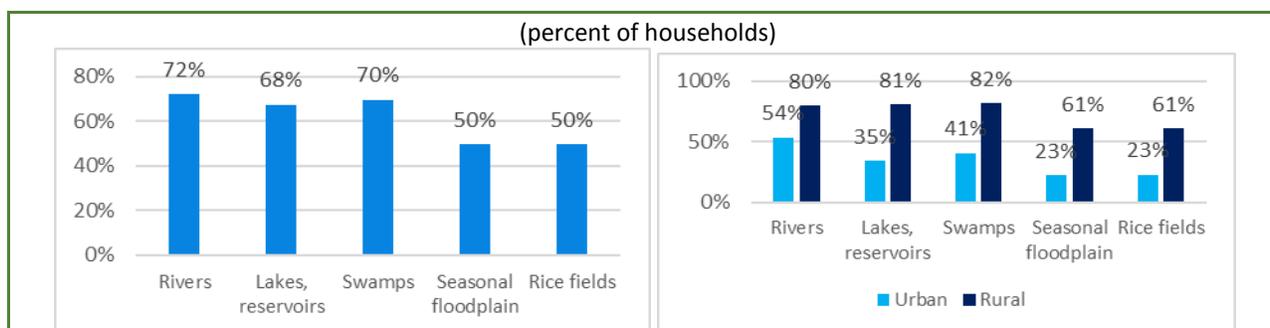
⁵⁰ <http://www.thpclaos.com>.

⁵¹ 37% x 3.5 hours = 1.3 hours



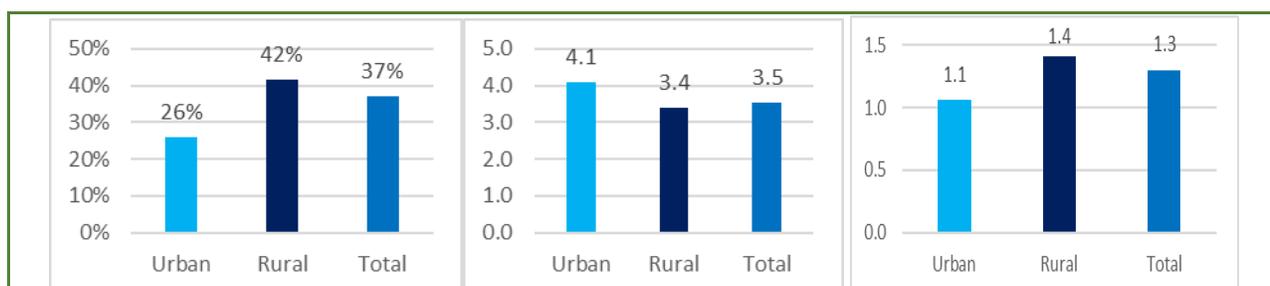
Source: LECS-5 data from LSB.

Figure A1.53: Households having fish culture and/or engaging in fishing in Khammouane, 2012–13



Source: LECS-5 data from LSB.

Figure A1.54: Fishing location among households engaging in fishing in Khammouane, 2012–13



Source: Calculated from LECS-5 data from LSB.

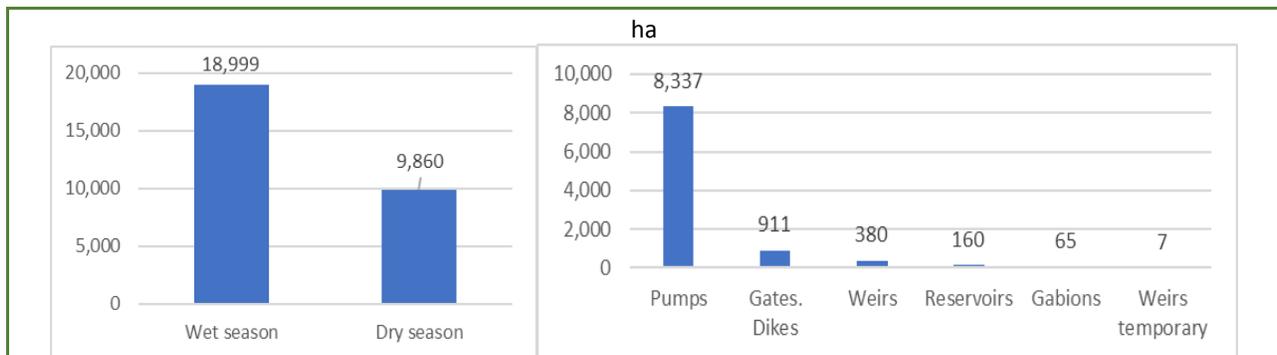
Note: Left: Percent of households engaged in fishing in the past 24 hours. Middle: Hours spent on fishing in the last 24 hours among households fishing in the past 24 hours. Right: Hours spent per household per day on fishing throughout the year.

Figure A1.55: Frequency and time spent on fishing in Khammouane, 2012–13

A1.6.5 Irrigation

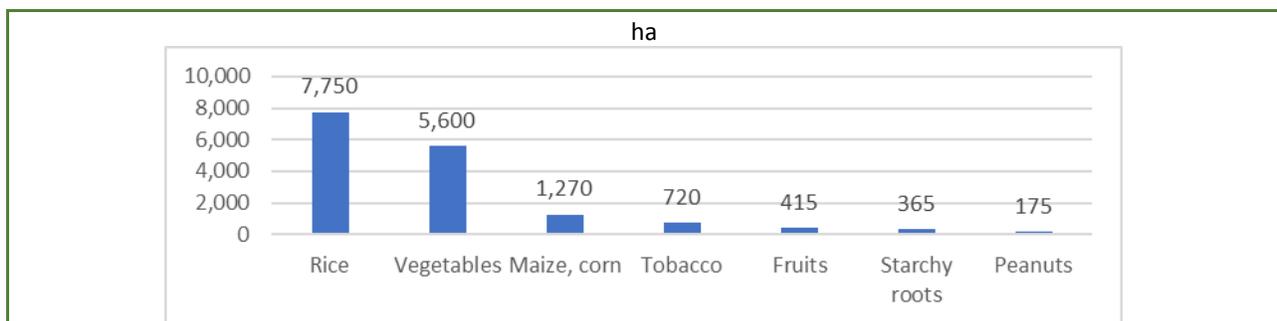
98. **Twenty-eight percent of total planted area in Khammouane is irrigated, of which 18 percent is wet season irrigation and 10 percent is dry season irrigation.** This is slightly above the national average of 24 percent of total planted area, of which less than 16 percent is wet season and less than 9 percent is dry season irrigation according to data reported in DOA (2018).

99. **About 19,000 ha in Khammouane are irrigated in the wet season and nearly 10,000 ha in the dry season in 2017.** As much as 85 percent of irrigated area in the dry season was pumped irrigation systems (Figure A1.57). About 16,300 ha were planted in the dry season with irrigation, of which 48 percent was rice and 34 percent vegetables (Figure A1.58). This reflects two crop cultivations during the dry season.



Source: Produced from data in DOA (2018).

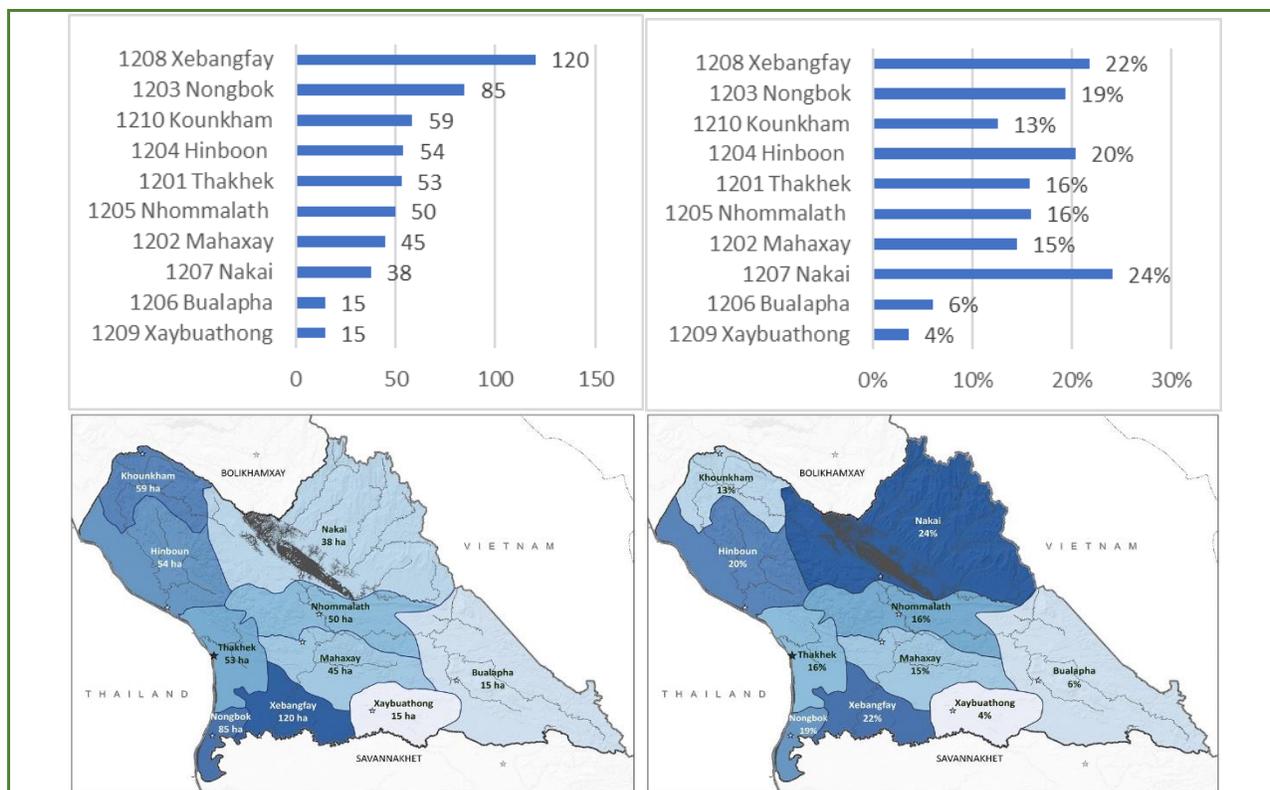
Figure A1.56: Irrigated area in Khammouane by season and system, 2017



Source: Produced from data in DOA (2018).

Figure A1.57: Irrigated crops in the dry season in Khammouane, 2017

100. **Dry season irrigation varies tremendously across districts, ranging from 15 ha per 1,000 rural people in Bualapha and Xaybuathong to 120 ha in Xebangfay.** The share of dry season irrigated cultivation in total planted area is also low in Bualapha and Xaybuathong. Notably, the highest share is in Nakai District, albeit at a relatively low hectareage of 38 per 1,000 rural population (Figure A1.59).

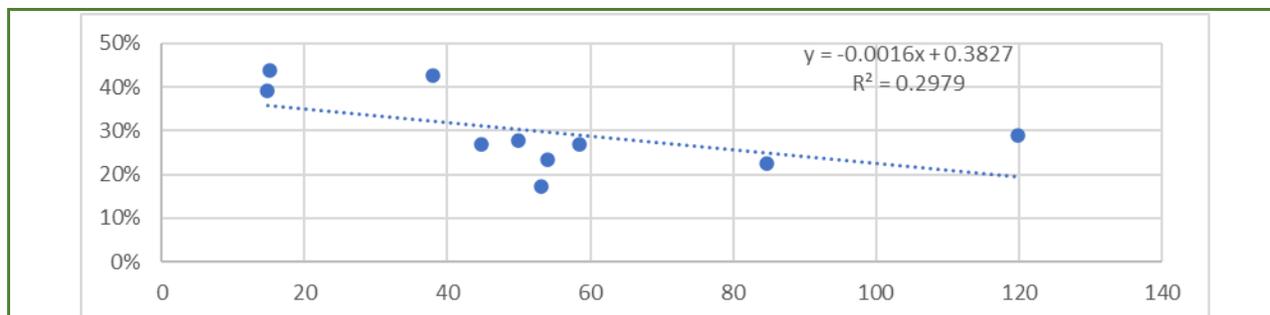


Source: Produced from data in DOA (2018).

Note: Left: ha per 1,000 rural population. Right: Irrigated area as percent of total planted area.

Figure A1.58: Dry season irrigation in Khammouane in 2017

101. **Dry season irrigation is associated with lower poverty incidence at the district level (Figure A1.60).**⁵² The association between poverty incidence and dry season irrigation is much stronger than for total non-irrigated and irrigated planted area per 1,000 rural population.



Source: Produced from data in DOA (2018) and LSB (2016b).

Note: Horizontal: District dry season irrigation (Ha per 1,000 rural population) in 2017. Vertical: District poverty incidence in 2015.

Figure A1.59: District dry season irrigation and poverty incidence in Khammouane

102. **Almost all irrigation in Lao PDR relies on surface water, which has restricted irrigation to areas near waterways and reservoirs.** An alternative is the use of groundwater. A recent pilot community-managed dry season irrigation project in the Vientiane plain during two consecutive dry seasons

⁵² The correlation coefficient across the 10 districts is -0.55.

demonstrated the viability of dry season irrigation with groundwater for cash crops. The irrigation system investment cost, including boreholes, pumps, water pipes, and irrigation system (sprinklers, drip), was US\$2,200 per ha. With full utilization of the irrigation system and reasonably successful cultivation of cash crops the estimated IRR on project investment was as high as 45 percent (Clement et al. 2018).

A1.6.6 Household water supply

103. **Information on household water supply is available in the LSIS II Survey in 2017.**⁵³ Analysis of the survey's household data using Stata software is presented in this section.⁵⁴

104. **Over half of the urban population in Khammouane had piped water supply to their dwelling or yard in 2017.** The sources of piped water supply are treated surface water (for example, from the Mekong River for Thakhek) and groundwater wells. The district towns of Mahaxay, Nongbok and Xebangfay have piped water supply from the Xebangfay River and the town of Nakai from the Nam Theun. Upstream watershed protection in Khammouane is therefore important for the quality (e.g., turbidity) and seasonal availability of these household water supply sources. The piped water supply to these towns comprises one-third of the urban population in Khammouane outside of Thakhek.

105. **Another third of the urban population obtained water from public taps/standpipes, tube wells/boreholes, and protected wells/spring;** and about 10 percent relied on unprotected wells/springs and open, unprotected surface water (that is, rivers, streams, ponds, lakes) (Table A1.8).

106. **Among the rural population, the most common water types were protected wells/springs and tube wells/boreholes.** Over a third of the rural population, however, continued to rely on unprotected wells/springs and surface water.

107. **The LSIS II data do not indicate the district of the surveyed households.** Some indication of household district location can be derived from the ethnicity and religion of the household head. This indicates that as many as 40 percent of the population in Nakai and Bualapha Districts source their water from open, unprotected surface water. The large majority of the population in these districts are mon-khmer and non-Buddhists.

Table A1.8: Household water supply in Khammouane, 2017

	<i>(% of population)</i>		
	<i>Urban</i>	<i>Rural</i>	<i>Total</i>
Piped water	54	8	19
Public tap/standpipe	1	9	7
Tube well/boreholes	15	19	18
Protected well/spring	17	27	24
Unprotected well/spring	8	17	15
Rainwater	3	2	2
Surface water (open, unprotected)	2	17	13

Source: Produced from LSIS 2017 household data.

108. **The type of household water supply varies greatly with household living standard.** Nearly two thirds of the poorest quintile of the population relied on unprotected wells/springs and surface water,

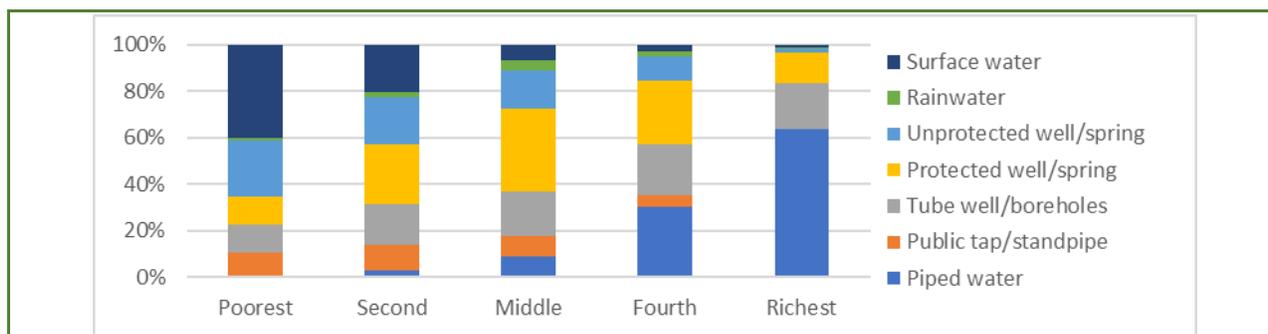
⁵³ The survey contains 1,460 households in Khammouane Province, of which 360 are urban and 1,100 are rural households.

⁵⁴ The dataset (Multiple Indicator Cluster Survey 6 Lao PDR) is publicly available at <https://mics.unicef.org/surveys>

while nearly two thirds of the richest quintile of the population had piped water supply to dwelling or yard (Figure 6.11).⁵⁵

109. **Many households do not rely on their water supply for drinking, but rather purchase bottled water.** As many as 40 percent of the population in Khammouane used bottled water for drinking in 2017: 73 percent in urban areas and 29 percent in rural areas. Bottled water use ranged from less than 1 percent among the poorest quintile to 90 percent among the richest quintile of households (Figure A1.61). Geographically, only about 5 percent of the population in Nakai and Bualapha Districts purchased bottled water for drinking.⁵⁶

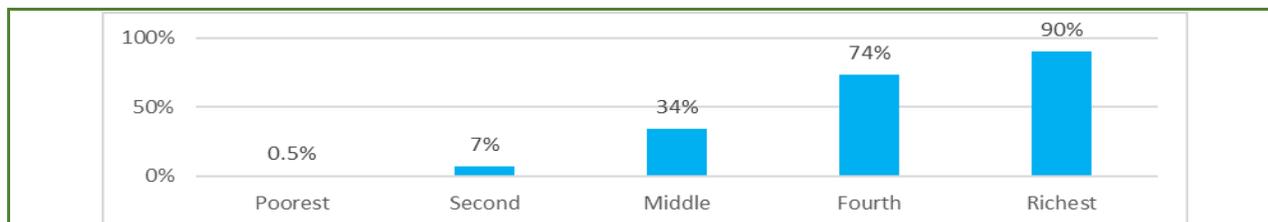
110. **About 18 percent of the households in Khammouane reported that their water supply was located elsewhere than in their dwelling or yard.** Average roundtrip to fetch water was 25 minutes for these households and one-third of the households used more than 30 minutes.



Source: Produced from LSIS 2017 household data.

Note: Percent of population.

Figure A1.60: Type of household water supply by living standard in Khammouane, 2017



Source: Produced from LSIS 2017 household data.

Note: Percent of population.

Figure A1.61: Use of bottled water for drinking by living standard in Khammouane, 2017

111. **Piped water supply in urban areas in Khammouane increased from 44 percent in 2011-12 to 54 percent in 2017, while the use of dug wells declined by the same percentage points.** In rural areas the use of dug wells declined by as much as 17 percentage points from 2011-12 to 2017 while the use of public taps/standpipes and tube wells/boreholes increased by 9 percentage points and of piped water supply by 5 percentage points. However, the use of open, unprotected surface water increased by 9 percentage points. It appears from these data that many households switched from unprotected dug wells to open, unprotected surface water sources, although the reason for this is not clear. The use of bottled water for

⁵⁵ The LSIS II classifies households by a wealth index into five quintiles ranging from poorest to richest. The wealth index is based on household durable goods and housing characteristics.

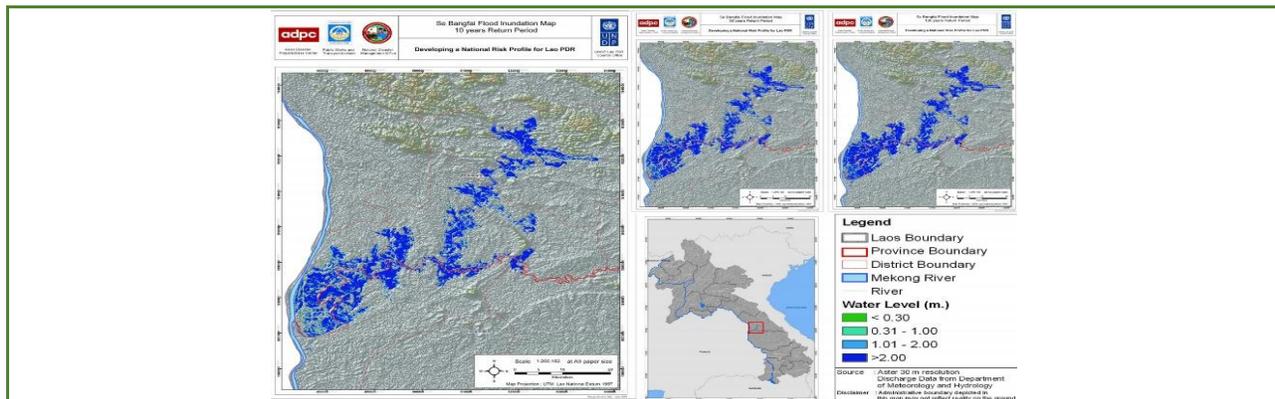
⁵⁶ Calculated based on the ethnicity and religion of the household heads.

drinking was relatively unchanged from 2011-12 to 2017 in urban areas (73 percent) but increased from 15 percent to 29 percent in rural areas.

A1.6.7 Seasonal flooding

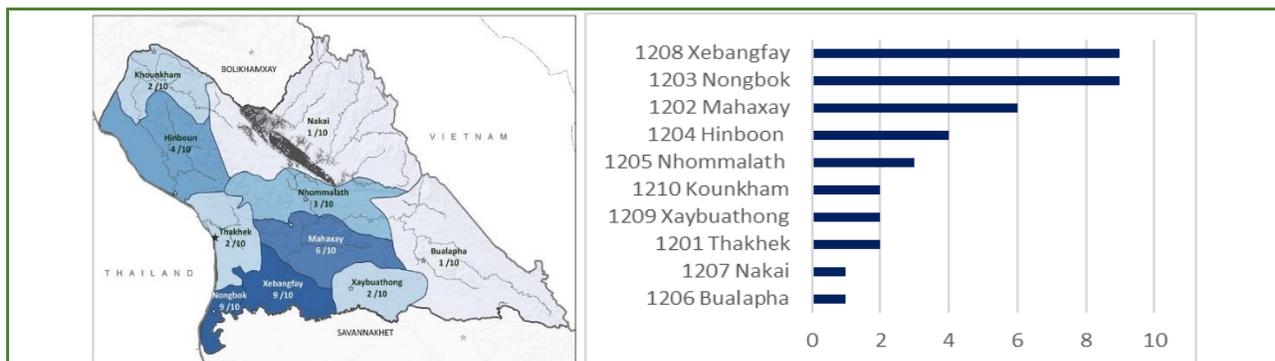
112. **Natural capital is not only associated with positive economic and social benefits.** This is the case with seasonal flooding that arises from the everchanging influence of water resources.

113. **The largest seasonal flood risk in Khammouane arises from the Xebangfay River, with its tributaries (Figure A1.62).** Nongbok, Xebangfay and Mahaxay districts are most affected by seasonal flooding from the river. Flooding also takes place along the Nam Hai and Nam Hinboon Rivers in the north, exacerbated by the diversion of water by the Theun Hinboon hydropower project. Flood risk also occurs from the Mekong River as the water rises to critical levels in some years. A preliminary flood risk index for each district in Khammouane is presented in Figure A1.63.



Source: UNDP 2010.

Figure A1.62: Flood risk in the Xebangfay River basin in Khammouane



Source: Produced by the author.

Note: Flood risk from 1 (low) to 10 (high).

Figure A1.63: Preliminary district flood risk index in Khammouane

Annex 2. National household surveys

1. The LECS-5 2012–13 contained 544 households from 34 villages in Khammouane Province, of which 432 households were rural and 112 households were urban (Table A2.1). The sample contained villages in all districts in Khammouane except for in Nakai. Only rural villages were included in four of the districts (Table A2.2).

Table A2.1: LECS-5 household sample in Khammouane Province, 2012–13

	Urban	Rural	Total
Households	112	432	544
Households per village	16	16	16
Villages	7	27	34

Source: LECS-5 data provided by LSB.

Table A2.2: LECS-5 village sample by district in Khammouane Province, 2012–13

Code	District name	Number of villages surveyed		
		Urban	Rural	Total
1201	Thakhek	4	5	9
1202	Mahaxay	1	3	4
1203	Nongbok		4	4
1204	Hinboon	1	5	6
1205	Nhommalath		3	3
1206	Bualapha	1	2	3
1207	Nakai	-	-	0
1208	Xebangfay		4	4
1209	Xaybuathong		1	1
	Total villages	7	27	34

Source: LECS-5 data provided by LSB.

Note: 1210 Kounkham district did not exist at the time of the LECS-5. No households were surveyed in 1207 Nakai District.

2. The LSIS II (2017) contained a total of 1,460 households from 73 villages in Khammouane, of which 1,100 households were rural and 360 were urban (Table A2.3). The survey does not specify the district of the surveyed households.

Table A2.3: LSIS II household sample in Khammouane Province, 2017

	Urban	Rural	Total
Villages	18	55	73
Households per village	20	20	20
Households	360	1,100	1,460

Source: LECS-5 data provided by LSB.

Annex 3: District natural capital landscape profile summary

	1201 <i>Thakhek</i>	1202 <i>Mahaxay</i>	1203 <i>Nongbok</i>	1204 <i>Hinboon</i>	1205 <i>Nhommalath</i>	1206 <i>Bualapha</i>	1207 <i>Nakai</i>	1208 <i>Xebangfay</i>	1209 <i>Xaybuathong</i>	1210 <i>Kounkham</i>	<i>Khammouane</i>	<i>Lao PDR</i>
District area, km ²	989	1,405	347	1,885	1,525	3,251	4,404	944	923	1,063	1,632	1,600
POPULATION												
District population, 2015	90,491	36,708	47,458	49,958	32,990	32,327	25,344	28,576	26,182	22,018	39,205	43,866
Population (% of province)	23	9	12	13	8	8	6	7	7	6		
Population density, 2015	91	26	137	27	22	10	6	30	28	21	24	27
Rural population share, 2015	58	86	84	82	85	86	89	75	92	73	78	67
POVERTY												
Poverty incidence, 2015	17	27	22	23	28	44	43	29	39	27	27	25
District number of poor, 2015	15,564	9,911	10,631	11,640	9,138	14,127	10,797	8,258	10,263	5,945	10,627	10,967
GOL priority district	NO	2nd	NO	NO	2nd	1st	1st	NO	2nd	NO		
UXO												
UXO problem (% of villages)	0	82	0	18	67	78	22	63	79		42	29
Severe UXO problem (% of villages)	0	32	0	4	29	64	8	6	31		20	14
High UXO problem (% of villages)	0	27	0	2	21	5	2	31	23		10	7
Moderate UXO problem (% of villages)	0	23	0	11	17	8	12	27	25		12	8
FOREST AND BIODIVERSITY												
FOREST AREA ('000 ha)												
National CFA	13	4	0	77	64	91	339	0	0	45	63	31
National protection forest area	0	0	0	0	0	49	0	0	1	0	5	54
National PFA	0	56	0	0	0	46	0	66	86	0	25	21
Conservation and protection forest area (province/district)	7	28	0	4	0	55	0	2	5	18	12	*
Total forest area	20	89	0	81	64	241	339	68	91	63	105	106
FOREST AREA (% of district area)												
National CFA	13	3	0	41	42	28	77	0	0	42	39	20
National protection forest area	0	0	0	0	0	15	0	0	1	0	3	35
National production forest area	0	40	0	0	0	14	0	70	93	0	15	13
Conservation and protection forest area (province/district)	7	20	0	2	0	17	0	2	5	17	7	*
Total forest area	20	63	0	43	42	74	77	72	99	59	63	68
NPAS												
NPA (% of territory)	13	3	0	41	42	28	77	0	0	42	39	14

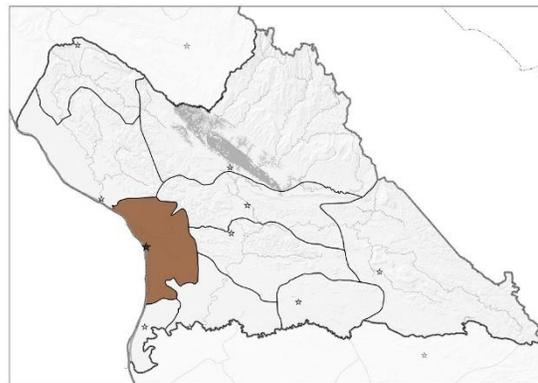
	1201	1202	1203	1204	1205	1206	1207	1208	1209	1210		
	Thakhek	Mahaxay	Nongbok	Hinboon	Nhommalath	Bualapha	Nakai	Xebangfay	Xaybuathong	Kounkham	Khammouane	Lao PDR
District population in or adjacent to NPA (%)	8	21	0	35	50	34	98	0	0	67	25	
FUEL FOR COOKING (% OF HOUSEHOLDS)												
Biomass fuels for cooking	93						99				97	92
Fuelwood for cooking	27						92				62	64
Charcoal for cooking	66						7				35	28
PLANTATIONS												
Plantation potential (scale 1-10)	2	6	1	2	2	5	2	8	10	2		
NATURE-BASED TOURISM												
Nature-based tourism potential (scale 1-10)	7	5	2	7	5	10	10	4	2	10		
AGRICULTURAL LAND												
District agricultural land, cultivated 2017, Ha	17,484	9,721	17,389	10,834	8,767	6,847	3,546	11,850	9,914	7,440	10,379	12,188
Cultivated land per rural capita, 2017, Ha	0.34	0.31	0.44	0.26	0.31	0.25	0.16	0.55	0.41	0.46	0.34	0.41
Cultivated share of total land, 2017	18	6.9	50	5.7	5.7	2.1	0.8	13	11	7.0	6.4	7.6
WATER RESOURCES												
DRY SEASON IRRIGATION												
District irrigated area, 2017, Ha	2,768	1,411	3,370	2,212	1,393	416	854	2,579	355	937	1,630	1,584
Irrigation per 1,000 rural population, 2017, Ha	53	45	85	54	50	15	38	120	15	59	54	54
Irrigated share of total planted area, 2017 (%)	16	15	19	20	16	6	24	22	4	13	16	13
WATER SUPPLY (% OF HOUSEHOLDS)												
Improved water sources	88						52				69	75
Piped water supply	43						3				19	24
Unprotected surface water	1						45				13	6
Households without water supply on premises	6						36				18	
For which: Roundtrip to water source (Minutes)	33						24				25	
Bottled water for drinking	70						6				40	51
SEASONAL FLOODING												
Seasonal flood risk (scale 1-10)	2	6	9	4	3	1	1	9	2	2		

Note: * Included in the national forest area figures.

Annex 4: District natural capital landscape profiles

A4.1 Thakhek District

1. **Geography:** Thakhek district is located adjacent to the Mekong River in the south-western part of Khammouane. Most of the district is relatively flat lowlands of altitude 160-210 masl. The exception is the hilly areas in the east that reach altitudes of 400-500 masl.



2. **Population:** Thakhek, with an area a little over half of the average district in Khammouane, is by far the most populous district in the province. Its population is nearly two times the population in Hinboon and Nongbok districts and nearly four times the population in Kounkham. Its population density of over 90 people per km² is only superseded by the density in Nongbok, which is nearly four times the provincial average and fifteen times the density in Nakai. The large population and high population density is explained by the district's high urban population share dominated by Thakhek city.

3. **Poverty:** Poverty incidence in Thakhek was the lowest of all districts in Khammouane in 2015, and less than half of the rate in Xaybuathong, Bualapha and Nakai. But because of its large population, the number of poor in Thakhek was still larger than in any other district in the province.

4. **UXO contamination:** While a large number of villages in some districts in Khammouane reported to be affected by UXO in the national 1997 survey, no villages are affected in Thakhek.

A4.1.1 Forest Resources and Biodiversity

5. **Forest land area:** About 20 percent of the land in Thakhek district is classified as forest land area, of which 13 percent is CFA and 7 percent is district conservation and protection forest area. This is the second lowest of the districts in Khammouane after Nongbok. The forest land area is about 20,000 ha compared to the district average in the province of 106,000 ha.

6. **NPAs.** Phou Hin Poun NPA spans into Thakhek district in the north-eastern section of the district, covering 13 percent of Thakhek's area with 8 percent of the district's population living in or adjacent to the NPA. This is substantially less than for Khammouane as a whole.

7. **Energy for cooking:** Only 3 percent of households in Khammouane used clean energies for cooking in 2017 (that is, electricity, LPG). Even in Thakhek, the richest and most urbanized district in the province, only 7 percent of households used clean energies. 66 percent used charcoal and 27 percent used wood fuel. The use of charcoal has been particularly rapid, disproportionately increasing the use of wood for cooking due to the energy losses of converting wood to charcoal.

8. **Plantation potential:** Thakhek district has no land classified as production forest, while about 13 percent of its area is conservation forest. About 7 percent is district protection and conservation forest and 18 percent of the land is cultivated. This leaves some opportunities for plantation forest, albeit relatively limited. Thakhek is therefore given a low rating of 2 on a scale from 1 to 10.

9. **Nature-based tourism potential:** Thakhek district is given a relatively high rating of 7 on a scale from 1 to 10. The district already has most tourists of any district in Khammouane, it has the old temple

of Wat Sikhotabong, the lovely old city, the Buddha cave, the Green Climbers Camp and it is the starting point of the 'loop'.

A4.1.2 Land Resources:

10. **Agricultural land:** Cultivated land in Thakhek reached almost 18,000 ha in 2017, 70 percent more than the district average in the province, despite Thakhek's much smaller land area. Cultivated share of total land area in the district was therefore 18 percent, only superseded by Nongbok, and 10–20 times higher than in Bualapha and Nakai. Cultivated land per rural capita stood at 0.34 ha, the same as the provincial average.

A4.1.3 Water Resources:

11. **Irrigation:** Dry season irrigation has the potential to substantially augment farm incomes. Nearly 2,800 ha were cultivated with dry season irrigation in Thakhek in 2017, representing 16 percent of total wet and dry season cultivated area, or about the same as the province average. Dry season irrigation was 53 ha per 1,000 rural population, also about the same as the provincial average, but substantially less than in Xebangfay and Nongbok districts.

12. **Household water supply:** Nearly 90 percent of the population in Thakhek district had improved water supply in 2017, compared to about 70 percent in the province. The most common sources of improved water supply were piped water supply to dwelling or yard (43 percent) and tube wells/boreholes (44 percent), while 1 percent relied on unprotected surface water and 10 percent on unprotected shallow dug wells. 95 percent of the urban population, versus 80 percent of the rural population had improved water supply. 72 percent of the urban population had piped water supply while the most common source of improved water supply in rural areas was protected shallow dug wells (45 percent). Less than 6 percent of households had a water source located away from their dwelling or yard, compared to 18 percent in the province. The average roundtrip to the water source was however as much as 33 minutes. Notwithstanding the high rate of improved water supply, as many as 70 percent of households relied on purchased bottle water for drinking, compared to 40 percent in the province.

13. **Seasonal flood risk:** Thakhek district is not among the districts with the highest seasonal flood risk. The district is given a relatively low preliminary seasonal flood risk rating of 2 on a scale from 1 to 10.

Table A4.1: Natural capital of Thakhek District

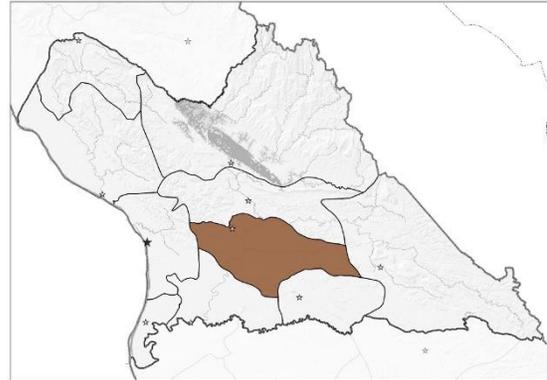
	<i>Thakhek</i>	<i>Khammouane</i>	<i>Lao PDR</i>	<i>Ranking</i>	
District area, km ²	989	1,632	1,600	9	Largest (1) to smallest (10)
POPULATION					
District population, 2015	90,491	39,205	43,866	1	Largest (1) to smallest (10)
Population (% of province)	23				
Population density, 2015	91	24	27	2	Highest (1) to lowest (10)
Rural population share, 2015	58	78	67	10	Largest (1) to smallest (10)
POVERTY					
Poverty incidence, 2015	17	27	25	10	Highest (1) to lowest (10)
District number of poor, 2015	15,564	10,627	10,967	1	Highest (1) to lowest (10)
GOL priority district	NO			NO	
UXO					
UXO problem (% of villages)	0	42	29	10	Highest (1) to lowest (10)
Severe UXO problem (% of villages)	0	20	14	10	Highest (1) to lowest (10)
High UXO problem (% of villages)	0	10	7	10	Highest (1) to lowest (10)
Moderate UXO problem (% of villages)	0	12	8	10	Highest (1) to lowest (10)
FOREST AND BIODIVERSITY					
FOREST AREA ('000 ha)					
National CFA	13	63	31	6	Largest (1) to smallest (10)
National protection forest area	0	5	54	10	Largest (1) to smallest (10)
National PFA	0	25	21	10	Largest (1) to smallest (10)
Conservation and protection forest area (province/district)	7	12	*	4	Largest (1) to smallest (10)
Total forest area	20	105	106	9	Largest (1) to smallest (10)
FOREST AREA (% of district area)					
National CFA	13	39	20	6	Highest (1) to lowest (10)
National protection forest area	0	3	35	10	Highest (1) to lowest (10)
National PFA	0	15	13	10	Highest (1) to lowest (10)
Conservation and protection forest area (province/district)	7	7	*	4	Highest (1) to lowest (10)

	<i>Thakhek</i>	<i>Khammouane</i>	<i>Lao PDR</i>	<i>Ranking</i>	
Total forest area	20	63	68	9	Highest (1) to lowest (10)
NPAS					
NPA (% of territory)	13	39	14	6	Highest (1) to lowest (10)
District population in or adjacent to NPA (%)	8	25		7	Highest (1) to lowest (10)
FUEL FOR COOKING (% OF HOUSEHOLDS)					
Biomass fuels for cooking	93	97	92	10	Highest (1) to lowest (10)
Fuelwood for cooking	27	62	64	10	Highest (1) to lowest (10)
Charcoal for cooking	66	35	28	1	Highest (1) to lowest (10)
PLANTATIONS					
Plantation potential (scale 1-10)	2				Highest (10) to lowest (1)
NATURE-BASED TOURISM					
Nature-based tourism potential (scale 1-10)	7				Highest (10) to lowest (1)
AGRICULTURAL LAND					
District agricultural land, cultivated 2017, Ha	17,484	10,379	12,188	1	Largest (1) to smallest (10)
Cultivated land per rural capita, 2017, Ha	0.34	0.34	0.41	5	Highest (1) to lowest (10)
Cultivated share of total land, 2017	18	6.4	7.6	2	Highest (1) to lowest (10)
WATER RESOURCES					
DRY SEASON IRRIGATION					
District irrigated area, 2017, Ha	2,768	1,630	1,584	2	Largest (1) to smallest (10)
Irrigation per 1,000 rural population, 2017, Ha	53	54	54	4	Highest (1) to lowest (10)
Irrigated share of total planted area, 2017	16	16	13	5	Highest (1) to lowest (10)
WATER SUPPLY (% OF HOUSEHOLDS)					
Improved water sources	88	69	75	1	Highest (1) to lowest (10)
Piped water supply	43	19	24	1	Highest (1) to lowest (10)
Unprotected surface water	1	13	6	10	Highest (1) to lowest (10)
Households without water supply on premises	6	18		10	Highest (1) to lowest (10)
For which: Roundtrip to water source (Minutes)	33	25			
Bottled water for drinking	70	40	51	1	Highest (1) to lowest (10)
SEASONAL FLOODING					
Seasonal flood risk (scale 1-10)	2				Highest (10) to lowest (1)

Source: The author.

A4.2 Mahaxay District

14. **Geography.** Mahaxay district is located in the south-central part of Khammouane. The district is a mix of flat lowlands of altitudes 150-210 masl and hilly areas with altitudes up to 600-700 masl. The Xebangfay River crosses its territory, joined by the diversion from Nam Theun in the north of Mahaxay District.



15. **Population.** The area and population of Mahaxay is slightly smaller than the district average in Khammouane. Population density is somewhat higher than the average and the rural population share is the third highest in the province, only exceeded by Nakai and Xaybuathong.

16. **Poverty.** Poverty incidence and the number of poor in Mahaxay was the same as the district average in Khammouane in 2015. Yet Mahaxay is one of GoL's three second priority districts in the province for poverty reduction and development.

17. **UXO contamination.** Many parts of Mahaxay district, especially in the east, is reported to be affected by UXO. According to the national 1997 UXO survey, as many as 32 percent of villages were reported to be severely affected, only exceeded by Bualapha.

A4.2.1 Forest Resources and Biodiversity

18. **Forest land area.** About 63 percent of the land in Mahaxay district is classified as forest land area, of which 3 percent as CFA, 40 percent as PFA and 20 percent as district conservation and protection forest area. This is the fourth highest of the districts in Khammouane. The forest land area is about 89,000 ha, of which 56,000 ha are FPA.

19. **NPAs.** As little as 3 percent of the territory of Mahaxay is NPA, being Phou Hin Poun NPA in the north of Mahaxay. Nevertheless, 21 percent of the population in Mahaxay live in or adjacent to the NPA, only slightly below the district average in the province.

20. **Plantation potential.** Mahaxay District has 56,000 land classified as PFA. About 20 percent is district protection and conservation forest and 7 percent of the land is cultivated. This leaves opportunities for plantation forest. Mahaxay is therefore given a rating of 6 on a scale from 1 to 10.

21. **Nature-based tourism potential:** Mahaxay District is given a medium rating of 5 on a scale from 1 to 10. The district is on the 'loop' but has less nature-based tourism attractions and opportunities than many of the other districts.

A4.2.2 Land Resources

22. **Agricultural land.** Cultivated land in Mahaxay reached almost 10,000 ha in 2017, slightly below the district average in the province. Cultivated share of total land area in the district (7 percent) was slightly higher than the district average while cultivated land per rural capita stood at 0.31 ha, slightly below the district average.

A4.3.3 Water Resources

23. **Irrigation.** Dry season irrigation has the potential to substantially augment farm incomes. A little over 1,400 ha were cultivated with dry season irrigation in Mahaxay in 2017, representing 15 percent of

total wet and dry season cultivated area, or about the same as the province average. Dry season irrigation was 45 ha per 1,000 rural population. This is somewhat lower than the district average in the province, and substantially lower than in the districts further downstream of the Xebangfay River, that is, Xebangfay District with 120 ha and Nongbok district with 85 ha per 1,000 rural population.

24. **Seasonal flood risk.** Mahaxay District is among the three districts with the highest seasonal flood risk from the Xebangfay River. The district is given a relatively high preliminary seasonal flood risk rating of 6 on a scale from 1 to 10.

Table A4.2: Natural capital of Mahaxay District

	<i>Mahaxay</i>	<i>Khammouane</i>	<i>Lao PDR</i>	<i>Ranking</i>	
District area, km ²	1,405	1,632	1,600	5	Largest (1) to smallest (10)
POPULATION					
District population, 2015	36,708	39,205	43,866	4	Largest (1) to smallest (10)
Population (% of province)	9				
Population density, 2015	26	24	27	6	Highest (1) to lowest (10)
Rural population share, 2015	86	78	67	3	Largest (1) to smallest (10)
POVERTY					
Poverty incidence, 2015	27	27	25	6	Highest (1) to lowest (10)
District number of poor, 2015	9,911	10,627	10,967	7	Highest (1) to lowest (10)
GOL priority district	2nd			YES	
UXO					
UXO problem (% of villages)	82	42	29	1	Highest (1) to lowest (10)
Severe UXO problem (% of villages)	32	20	14	2	Highest (1) to lowest (10)
High UXO problem (% of villages)	27	10	7	2	Highest (1) to lowest (10)
Moderate UXO problem (% of villages)	23	12	8	3	Highest (1) to lowest (10)
FOREST AND BIODIVERSITY					
FOREST AREA ('000 ha)					
National CFA	4	63	31	7	Largest (1) to smallest (10)
National protection forest area	0	5	54	10	Largest (1) to smallest (10)
National PFA	56	25	21	3	Largest (1) to smallest (10)
Conservation and protection forest area (province/district)	28	12	*	2	Largest (1) to smallest (10)
Total forest area	89	105	106	4	Largest (1) to smallest (10)
FOREST AREA (% of district area)					
National CFA	3	39	20	7	Highest (1) to lowest (10)
National protection forest area	0	3	35	10	Highest (1) to lowest (10)
National PFA	40	15	13	3	Highest (1) to lowest (10)
Conservation and protection forest area (province/district)	20	7	*	1	Highest (1) to lowest (10)
Total forest area	63	63	68	4	Highest (1) to lowest (10)
NPAS					
NPA (% of territory)	3	39	14	7	Highest (1) to lowest (10)
District population in or adjacent to NPA (%)	21	25		6	Highest (1) to lowest (10)
FUEL FOR COOKING (% OF HOUSEHOLDS)					
Biomass fuels for cooking		97	92		Highest (1) to lowest (10)

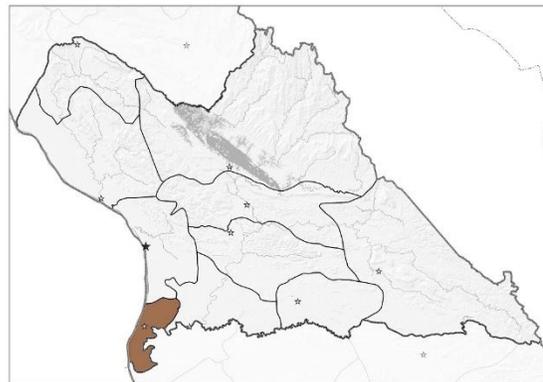
	<i>Mahaxay</i>	<i>Khammouane</i>	<i>Lao PDR</i>	<i>Ranking</i>
Fuelwood for cooking		62	64	Highest (1) to lowest (10)
Charcoal for cooking		35	28	Highest (1) to lowest (10)
PLANTATIONS				
Plantation potential (scale 1-10)	6			Highest (10) to lowest (1)
NATURE-BASED TOURISM				
Nature-based tourism potential (scale 1-10)	5			Highest (10) to lowest (1)
AGRICULTURAL LAND				
District agricultural land, cultivated 2017, Ha	9,721	10,379	12,188	6 Largest (1) to smallest (10)
Cultivated land per rural capita, 2017, Ha	0.31	0.34	0.41	7 Highest (1) to lowest (10)
Cultivated share of total land, 2017	6.9	6.4	7.6	6 Highest (1) to lowest (10)
WATER RESOURCES				
DRY SEASON IRRIGATION				
District irrigated area, 2017, Ha	1,411	1,630	1,584	5 Largest (1) to smallest (10)
Irrigation per 1,000 rural population, 2017, Ha	45	54	54	7 Highest (1) to lowest (10)
Irrigated share of total planted area, 2017	15	16	13	7 Highest (1) to lowest (10)
WATER SUPPLY (% OF HOUSEHOLDS)				
Improved water sources		69	75	Highest (1) to lowest (10)
Piped water supply		19	24	Highest (1) to lowest (10)
Unprotected surface water		13	6	Highest (1) to lowest (10)
Households without water supply on premises		18		Highest (1) to lowest (10)
For which: Roundtrip to water source (Minutes)		25		
Bottled water for drinking		40	51	Highest (1) to lowest (10)
SEASONAL FLOODING				
Seasonal flood risk (scale 1-10)	6			Highest (10) to lowest (1)

Source: The author.

A4.3 Nongbok District

25. **Geography.** Nongbok district is located adjacent to the Mekong River in the south-western corner of Khammouane. The district is relatively flat lowlands of altitude 14-160 masl

26. **Population.** Nongbok is by far the smallest district in Khammouane covering only a little over 2 percent of the province. Nongbok is nevertheless the third most populous district with the highest population density of 137 people per km² in 2015, nearly six times the district average in the province. The district has one of the highest rural population shares.



27. **Poverty.** Poverty incidence in Nongbok was the second lowest of all districts in Khammouane after Thakhek in 2015, and half the rate in Bualapha and Nakai. But because of its large population, the district nevertheless has a fairly sizable poor population.

UXO contamination. While a large number of villages in some districts in Khammouane reported to be affected by UXO in the national 1997 survey, no villages are affected in Nongbok.

A4.3.1 Forest Resources and Biodiversity

28. **Forest land area.** The district has no land classified as forest area according to the three forest categories of PFA, protection forest area and CFA. It is the only district in Khammouane without any of these forest areas.

29. **NPAs.** None of the land area of Nongbok is in a NPA, as is also the case with Xebangfay and Xaybuathong Districts.

30. **Plantation potential.** Nongbok district is given a low rating of 1 on a scale from 1 to 10. The district is largely an agricultural district.

31. **Nature-based tourism potential.** The district is given a low rating of 2 on a scale from 1 to 10.

A4.3.2 Land Resources:

32. **Agricultural land.** Cultivated land in Nongbok reached almost 18,000 ha in 2017, 70 percent more than the district average in the province, despite Nongbok being the smallest district. Cultivated share of total land area in the district was therefore 50 percent, or 8 times higher than the district average in Khammouane. Cultivated land per rural capita stood at 0.44 ha, the third highest in the province after Xebangfay (0.55) and Kounkham (0.46).

A4.3.3 Water Resources:

33. **Irrigation.** Dry season irrigation has the potential to substantially augment farm incomes. Nearly 3,400 ha were cultivated with dry season irrigation in Nongbok in 2017, representing 19 percent of total wet and dry season cultivated area, somewhat higher than the province average. Dry season irrigation was 85 ha per 1,000 rural population, only exceeded by Xebangfay District (120).

34. **Seasonal flood risk.** Seasonal flood risk from the Xebangfay River is the high in Khammouane along with Xebangfay District. The district is given high preliminary seasonal flood risk rating of 9 on a scale from 1 to 10.

Table A4.3: Natural capital of Nongbok District

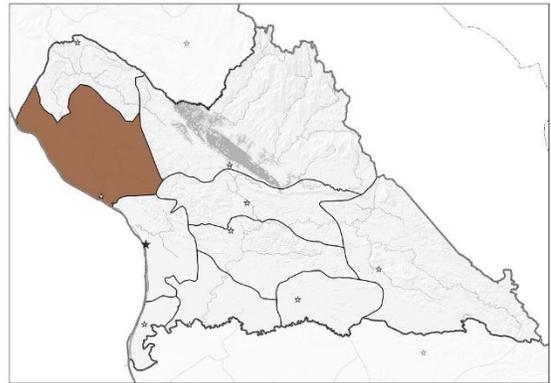
	<i>Nongbok</i>	<i>Khammouane</i>	<i>Lao PDR</i>	Ranking	
District area, km ²	347	1,632	1,600	10	Largest (1) to smallest (10)
POPULATION					
District population, 2015	47,458	39,205	43,866	3	Largest (1) to smallest (10)
Population (% of province)	12				
Population density, 2015	137	24	27	1	Highest (1) to lowest (10)
Rural population share, 2015	84	78	67	6	Largest (1) to smallest (10)
POVERTY					
Poverty incidence, 2015	22	27	25	9	Highest (1) to lowest (10)
District number of poor, 2015	10,631	10,627	10,967	5	Highest (1) to lowest (10)
GOL priority district	NO			NO	
UXO					
UXO problem (% of villages)	0	42	29	10	Highest (1) to lowest (10)
Severe UXO problem (% of villages)	0	20	14	10	Highest (1) to lowest (10)
High UXO problem (% of villages)	0	10	7	10	Highest (1) to lowest (10)
Moderate UXO problem (% of villages)	0	12	8	10	Highest (1) to lowest (10)
FOREST AND BIODIVERSITY					
FOREST AREA ('000 ha)					
National CFA	0	63	31	10	Largest (1) to smallest (10)
National protection forest area	0	5	54	10	Largest (1) to smallest (10)
National PFA	0	25	21	10	Largest (1) to smallest (10)
Conservation and protection forest area (province/district)	0	12	*	10	Largest (1) to smallest (10)
Total forest area	0	105	106	10	Largest (1) to smallest (10)
FOREST AREA (% of district area)					
National CFA	0	39	20	10	Highest (1) to lowest (10)
National protection forest area	0	3	35	10	Highest (1) to lowest (10)
National PFA	0	15	13	10	Highest (1) to lowest (10)
Conservation and protection forest area (province/district)	0	7	*	10	Highest (1) to lowest (10)
Total forest area	0	63	68	10	Highest (1) to lowest (10)
NPAS					
NPA (% of territory)	0	39	14	10	Highest (1) to lowest (10)
District population in or adjacent to NPA (%)	0	25		10	Highest (1) to lowest (10)
FUEL FOR COOKING (% OF HOUSEHOLDS)					
Biomass fuels for cooking		97	92		Highest (1) to lowest (10)
Fuelwood for cooking		62	64		Highest (1) to lowest (10)
Charcoal for cooking		35	28		Highest (1) to lowest (10)
PLANTATIONS					

	Nongbok	Khammouane	Lao PDR	Ranking	
Plantation potential (scale 1-10)	1				Highest (10) to lowest (1)
NATURE-BASED TOURISM					
Nature-based tourism potential (scale 1-10)	2				Highest (10) to lowest (1)
AGRICULTURAL LAND					
District agricultural land, cultivated 2017, Ha	17,389	10,379	12,188	2	Largest (1) to smallest (10)
Cultivated land per rural capita, 2017, Ha	0.44	0.34	0.41	3	Highest (1) to lowest (10)
Cultivated share of total land, 2017	50	6.4	7.6	1	Highest (1) to lowest (10)
WATER RESOURCES					
DRY SEASON IRRIGATION					
District irrigated area, 2017, Ha	3,370	1,630	1,584	1	Largest (1) to smallest (10)
Irrigation per 1,000 rural population, 2017, Ha	85	54	54	2	Highest (1) to lowest (10)
Irrigated share of total planted area, 2017	19	16	13	3	Highest (1) to lowest (10)
WATER SUPPLY (% OF HOUSEHOLDS)					
Improved water sources		69	75		Highest (1) to lowest (10)
Piped water supply		19	24		Highest (1) to lowest (10)
Unprotected surface water		13	6		Highest (1) to lowest (10)
Households without water supply on premises		18			Highest (1) to lowest (10)
For which: Roundtrip to water source (Minutes)		25			
Bottled water for drinking		40	51		Highest (1) to lowest (10)
SEASONAL FLOODING					
Seasonal flood risk (scale 1-10)	9				Highest (10) to lowest (1)

Source: The author.

A4.4 Hinboon District

35. **Geography.** Hinboon district is located adjacent to the Mekong River in the north-western part of Khammouane. Much of the western part of the district toward the Mekong River is relatively flat lowlands of altitude 150–200 masl. Much of the eastern part is hilly with altitudes of 400–700 masl.



36. **Population.** Hinboon is the third largest and second most populous district in Khammouane. Its population density of 27 people per km² is slightly above the province average while its rural population share of 82 percent is among the highest.

37. **Poverty.** The poverty incidence of 23 percent in Hinboon was among the lowest of all districts in Khammouane in 2015. But because of its large population, the number of poor in Hinboon was only exceeded by two districts.

38. **UXO contamination.** While a large number of villages in some districts in Khammouane reported to be affected by UXO in the national 1997 survey, only 4 percent of villages reported to be severely affected in Hinboon.

A4.4.1 Forest Resources and Biodiversity

39. **Forest land area.** About 43 percent of the land in Hinboon district is classified as forest land area, of which 41 percent as CFA and 2 percent as district conservation and protection forest area. The forest land area is about 81,000 ha, the fifth highest of the districts in the province.

40. **NPAs.** Phou Hin Poun NPA spans 41 percent of the area of Hinboon district. As many as 35 percent of the district's population live in or adjacent to the NPA. This is substantially more than the 25 percent for Khammouane as a whole.

41. **Plantation potential.** The district already has thousands of ha of industrial-scale plantations outside of the forest land area classified according to the three forest categories. Plantation potential within the three categories is limited as the district has no PFA nor protection forest area. Nongbok district is therefore given a relatively low rating of 2 on a scale from 1 to 10.

42. **Nature-based tourism potential.** Hinboon district is given a relatively high rating of 7 on a scale from 1 to 10. The district is on the 'loop' and 41 percent of its area is NPA.

A4.4.2 Land Resources

43. **Agricultural land.** Cultivated land in Hinboon was less than 11,000 ha in 2017. Cultivated share of total land area in the district was consequently 5.7 percent, and below the provincial and national average of 6.4 percent and 7.6 percent respectively. Cultivated land per rural capita stood at 0.26 ha, also well below the provincial and national average.

A4.4.3 Water Resources

44. **Irrigation.** Dry season irrigation has the potential to substantially augment farm incomes. Over 2,200 ha were cultivated with dry season irrigation in Hinboon in 2017, representing 20 percent of total wet and dry season cultivated area, well above the province average of 16 percent and only exceeded by two districts. Dry season irrigation per 1,000 rural population was, however, no more than the provincial average of 54 ha.

45. **Seasonal flood risk.** The district faces some seasonal flood risk from the diversion of water from Theun Hinboon hydropower plant. The district is given a moderate preliminary seasonal flood risk rating of 4 on a scale from 1 to 10.

Table A4.4: Natural capital of Hinboon District

	<i>Hinboon</i>	<i>Khammouane</i>	<i>Lao PDR</i>	Ranking	
District area, km ²	1,885	1,632	1,600	3	Largest (1) to smallest (10)
POPULATION					
District population, 2015	49,958	39,205	43,866	2	Largest (1) to smallest (10)
Population (% of province)	13				
Population density, 2015	27	24	27	5	Highest (1) to lowest (10)
Rural population share, 2015	82	78	67	7	Largest (1) to smallest (10)
POVERTY					
Poverty incidence, 2015	23	27	25	8	Highest (1) to lowest (10)
District number of poor, 2015	11,640	10,627	10,967	3	Highest (1) to lowest (10)
GOL priority district	NO			NO	
UXO					
UXO problem (% of villages)	18	42	29	7	Highest (1) to lowest (10)
Severe UXO problem (% of villages)	4	20	14	7	Highest (1) to lowest (10)
High UXO problem (% of villages)	2	10	7	7	Highest (1) to lowest (10)
Moderate UXO problem (% of villages)	11	12	8	6	Highest (1) to lowest (10)
FOREST AND BIODIVERSITY					
FOREST AREA ('000 ha)					
National CFA	77	63	31	3	Largest (1) to smallest (10)
National protection forest area	0	5	54	10	Largest (1) to smallest (10)
National PFA	0	25	21	10	Largest (1) to smallest (10)
Conservation and protection forest area (province/district)	4	12	*	6	Largest (1) to smallest (10)
Total forest area	81	105	106	5	Largest (1) to smallest (10)
FOREST AREA (% of district area)					
National CFA	41	39	20	4	Highest (1) to lowest (10)
National protection forest area	0	3	35	10	Highest (1) to lowest (10)
National PFA	0	15	13	10	Highest (1) to lowest (10)
Conservation and protection forest area (province/district)	2	7	*	6	Highest (1) to lowest (10)
Total forest area	43	63	68	7	Highest (1) to lowest (10)
NPAS					
NPA (% of territory)	41	39	14	4	Highest (1) to lowest (10)
District population in or adjacent to NPA (%)	35	25		4	Highest (1) to lowest (10)
FUEL FOR COOKING (% OF HOUSEHOLDS)					
Biomass fuels for cooking		97	92		Highest (1) to lowest (10)
Fuelwood for cooking		62	64		Highest (1) to lowest (10)
Charcoal for cooking		35	28		Highest (1) to lowest (10)
PLANTATIONS					

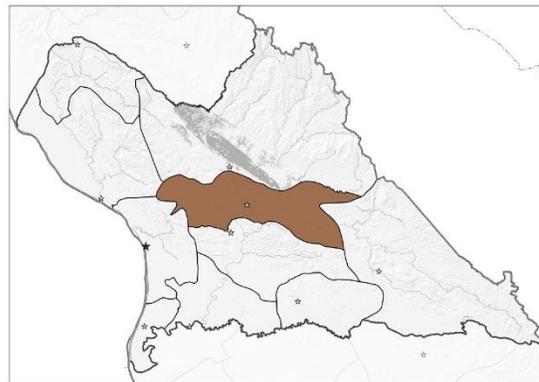
	<i>Hinboon</i>	<i>Khammouane</i>	<i>Lao PDR</i>	Ranking	
Plantation potential (scale 1-10)	2				Highest (10) to lowest (1)
NATURE-BASED TOURISM					
Nature-based tourism potential (scale 1-10)	7				Highest (10) to lowest (1)
AGRICULTURAL LAND					
District agricultural land, cultivated 2017, Ha	10,834	10,379	12,188	4	Largest (1) to smallest (10)
Cultivated land per rural capita, 2017, Ha	0.26	0.34	0.41	8	Highest (1) to lowest (10)
Cultivated share of total land, 2017	5.7	6.4	7.6	7	Highest (1) to lowest (10)
WATER RESOURCES					
DRY SEASON IRRIGATION					
District irrigated area, 2017, Ha	2,212	1,630	1,584	4	Largest (1) to smallest (10)
Irrigation per 1,000 rural population, 2017, Ha	54	54	54	4	Highest (1) to lowest (10)
Irrigated share of total planted area, 2017	20	16	13	3	Highest (1) to lowest (10)
WATER SUPPLY (% OF HOUSEHOLDS)					
Improved water sources		69	75		Highest (1) to lowest (10)
Piped water supply		19	24		Highest (1) to lowest (10)
Unprotected surface water		13	6		Highest (1) to lowest (10)
Households without water supply on premises		18			Highest (1) to lowest (10)
For which: Roundtrip to water source (Minutes)		25			
Bottled water for drinking		40	51		Highest (1) to lowest (10)
SEASONAL FLOODING					
Seasonal flood risk (scale 1-10)	4				Highest (10) to lowest (1)

Source: The author.

A4.5 Nhommalath District

46. **Geography.** Nhommalath district is located in the center of Khammouane. The district consists of a varied landscape with flat lowlands of altitudes down to about 160 masl and hilly, mountainous areas with altitudes up to about 700 masl

47. **Population.** Nhommalath, with an area of about the average district in Khammouane, has a population and population density somewhat below and a rural population share somewhat above the average district in the province.



48. **Poverty.** Poverty incidence in Nhommalath was 28 percent in 2015, or just about the district average in the province. The number of poor in the district was among the smallest in the province due to its relatively small population. Nhommalath is a GOL second priority district for poverty reduction and development.

49. **UXO contamination.** Nhommalath is among the districts in Khammouane most affected by UXO according to the national 1997 UXO survey, with 29 percent of villages reported as severely affected.

A4.5.1 Forest Resources and Biodiversity

50. **Forest land area.** About 42 percent of the land in Nhommalath district is classified as forest land area, all of which is national CFA. This is the second highest CFA in the province. However, in terms of total forest land area, according to the three forest categories, the district is ranked number eight out of ten.

51. **NPAs** Phou Hin Poun and Nakai Namtheun NPAs span into Nhommalath district in west and north-east, covering 42 percent of Nhommalath's area with 50 percent of the district's population living in or adjacent to the NPA, compared to the province's average of 25 percent.

52. **Plantation potential.** Nhommalath district has no land classified as PFA or protection forest area. This leaves limited opportunities for plantation forest. Nhommalath is therefore given a low rating of 2 on a scale from 1 to 10.

53. **Nature-based tourism potential.** Nhommalath district is given a medium rating of 5 on a scale from 1 to 10. The district on the 'loop' and has areas with beautiful landscape.

A4.5.2 Land Resources

54. **Agricultural land.** Cultivated land in Nhommalath reached almost 9,000 ha in 2017, somewhat below the district average in the province. Cultivated share of total land area in the district was only 5.7 percent, among the lowest in the province. Cultivated land per rural capita stood nevertheless at 0.31 ha, only slightly below the provincial average.

A4.5.3 Water Resources

55. **Irrigation.** Dry season irrigation has the potential to substantially augment farm incomes. Nearly 1,400 ha were cultivated with dry season irrigation in Nhommalath in 2017, representing 16 percent of total wet and dry season cultivated area, or about the same as the province average. Dry season irrigation was 50 ha per 1,000 rural population, also about the same as the provincial average.

56. **Seasonal flood risk.** Nhommalath district is not among the districts with the highest seasonal flood risk. The district is given a relatively low preliminary seasonal flood risk rating of 3 on a scale from 1 to 10.

Table A4.5: Natural capital of Nhommalath District

	<i>Nhommalath</i>	<i>Khammouane</i>	<i>Lao PDR</i>	Ranking	
District area, km ²	1,525	1,632	1,600	4	Largest (1) to smallest (10)
POPULATION					
District population, 2015	32,990	39,205	43,866	5	Largest (1) to smallest (10)
Population (% of province)	8				
Population density, 2015	22	24	27	7	Highest (1) to lowest (10)
Rural population share, 2015	85	78	67	5	Largest (1) to smallest (10)
POVERTY					
Poverty incidence, 2015	28	27	25	5	Highest (1) to lowest (10)
District number of poor, 2015	9,138	10,627	10,967	8	Highest (1) to lowest (10)
GOL priority district	2nd			YES	
UXO					
UXO problem (% of villages)	67	42	29	4	Highest (1) to lowest (10)
Severe UXO problem (% of villages)	29	20	14	4	Highest (1) to lowest (10)
High UXO problem (% of villages)	21	10	7	4	Highest (1) to lowest (10)
Moderate UXO problem (% of villages)	17	12	8	4	Highest (1) to lowest (10)
FOREST AND BIODIVERSITY					
FOREST AREA ('000 ha)					
National CFA	64	63	31	4	Largest (1) to smallest (10)
National protection forest area	0	5	54	10	Largest (1) to smallest (10)
National PFA	0	25	21	10	Largest (1) to smallest (10)
Conservation and protection forest area (province/district)	0	12	*	10	Largest (1) to smallest (10)
Total forest area	64	105	106	7	Largest (1) to smallest (10)
FOREST AREA (% of district area)					
National CFA	42	39	20	2	Highest (1) to lowest (10)
National protection forest area	0	3	35	10	Highest (1) to lowest (10)
National PFA	0	15	13	10	Highest (1) to lowest (10)
Conservation and protection forest area (province/district)	0	7	*	10	Highest (1) to lowest (10)
Total forest area	42	63	68	8	Highest (1) to lowest (10)
NPAS					
NPA (% of territory)	42	39	14	2	Highest (1) to lowest (10)
District population in or adjacent to NPA (%)	50	25		3	Highest (1) to lowest (10)
FUEL FOR COOKING (% OF HOUSEHOLDS)					
Biomass fuels for cooking		97	92		Highest (1) to lowest (10)
Fuelwood for cooking		62	64		Highest (1) to lowest (10)
Charcoal for cooking		35	28		Highest (1) to lowest (10)
PLANTATIONS					

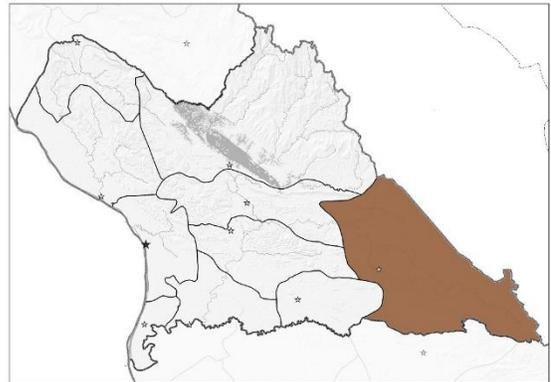
	<i>Nhommalath</i>	<i>Khammouane</i>	<i>Lao PDR</i>	<i>Ranking</i>	
Plantation potential (scale 1-10)	2				Highest (10) to lowest (1)
NATURE-BASED TOURISM					
Nature-based tourism potential (scale 1-10)	5				Highest (10) to lowest (1)
AGRICULTURAL LAND					
District agricultural land, cultivated 2017, Ha	8,767	10,379	12,188	7	Largest (1) to smallest (10)
Cultivated land per rural capita, 2017, Ha	0.31	0.34	0.41	6	Highest (1) to lowest (10)
Cultivated share of total land, 2017	5.7	6.4	7.6	7	Highest (1) to lowest (10)
WATER RESOURCES					
DRY SEASON IRRIGATION					
District irrigated area, 2017, Ha	1,393	1,630	1,584	6	Largest (1) to smallest (10)
Irrigation per 1,000 rural population, 2017, Ha	50	54	54	6	Highest (1) to lowest (10)
Irrigated share of total planted area, 2017	16	16	13	5	Highest (1) to lowest (10)
WATER SUPPLY (% OF HOUSEHOLDS)					
Improved water sources		69	75		Highest (1) to lowest (10)
Piped water supply		19	24		Highest (1) to lowest (10)
Unprotected surface water		13	6		Highest (1) to lowest (10)
Households without water supply on premises		18			Highest (1) to lowest (10)
For which: Roundtrip to water source (Minutes)		25			
Bottled water for drinking		40	51		Highest (1) to lowest (10)
SEASONAL FLOODING					
Seasonal flood risk (scale 1-10)	3				Highest (10) to lowest (1)

Source: The author.

A4.6 Bualapha District

57. **Geography.** Bualapha district is located in the south-east section of Khammouane. Most of the district is hilly and mountainous with altitudes of 300-700 masl

58. **Population.** Bualapha is the second largest district in Khammouane with a somewhat smaller than average population. Its population density of about 10 people per km² is the second lowest while its rural population share of 86 percent is among the highest in the province.



59. **Poverty.** Poverty incidence in Bualapha (44 percent) was the highest of all districts in Khammouane in 2015, and more than twice as high as in Thakhek district (17 percent). The number of poor in Bualapha was the second largest of the districts. Bualapha is a GOL first priority district for poverty reduction and development.

60. **UXO contamination.** Bualapha has the highest share of villages in the province that is severely affected by UXO (64 percent) according to the national 1997 UXO survey.

A 4.6.1 Forest Resources and Biodiversity

61. **Forest land area.** About 74 percent of the land in Bualapha district is classified as forest land area, of which 28 percent as CFA, 15 percent as protection forest area, 14 percent as PFA, and 17 percent as province conservation and protection forest area. This is the third highest of the districts in Khammouane. Production and protection forest area amount to 95,000 ha. The protection forest area is the highest in the province and the PFA is the fourth highest.

62. **NPAs.** The Hin Nam No National Park covers about 28 percent of Bualapha's area with 34 percent of the district's population living in or adjacent to the NPA.

63. **Energy for cooking.** . As many as 99 percent of households in Bualapha used solid fuels for cooking in 2017 of which 92 percent used wood and 7 percent used charcoal. This is the highest use of solid fuels of all the districts along with Nakai.⁵⁷

64. **Plantation potential.** Bualapha district is given a medium rating of 5 on a scale from 1 to 10, behind Xebangfay and Xaybuathong, and about the same as Mahaxay.

65. **Nature-based tourism potential.** Bualapha district is given a high rating of 10 on a scale from 1 to 10, along with Nakai and Kounkham. The district offers many nature-based tourism opportunities with unique experiences.

A4.6.2 Land Resources

66. **Agricultural land.** Bualapha has the second lowest cultivated land area, cultivated share of total land area, and cultivated land per rural capita. Cultivated land per rural capita is only 0.25 ha compared to the average of 0.34 ha in Khammouane.

A4.6.3 Water Resources

67. **Irrigation.** Dry season irrigation has the potential to substantially augment farm incomes. Only a little over 400 ha were cultivated with dry season irrigation in Bualapha in 2017, representing only 6

⁵⁷ These estimates of solid fuel use are for Bualapha and Nakai jointly based on data from the LSIS II 2017.

percent of total wet and dry season cultivated area, compared to the province average of 16 percent. Dry season irrigation was only 15 ha per 1,000 rural population, or the lowest in the province. The province average was 54 ha.

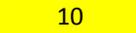
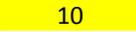
68. **Household water supply.** Only about 52 percent of the population in Bualapha had improved water supply and 45 percent relied on unprotected, open surface water sources in 2017. Over one-third (36 percent) do not have water supply on their premises. Only 6 percent of the population used bottled water for drinking.⁵⁸

69. **Seasonal flood risk.** The district is given a low preliminary seasonal flood risk rating of 1 on a scale from 1 to 10.

⁵⁸ These estimates are for Bualapha and Nakai jointly based on data from the LSIS II 2017.

Table A4.6: Natural capital of Bualapha District

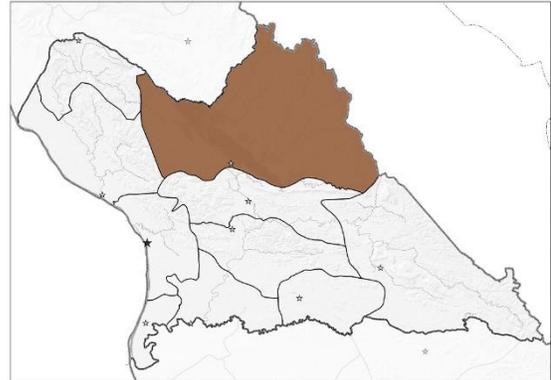
	<i>Bualapha</i>	<i>Khammouane</i>	<i>Lao PDR</i>	Ranking	
District area, km ²	3,251	1,632	1,600	2	Largest (1) to smallest (10)
POPULATION					
District population, 2015	32,327	39,205	43,866	6	Largest (1) to smallest (10)
Population (% of province)	8				
Population density, 2015	10	24	27	9	Highest (1) to lowest (10)
Rural population share, 2015	86	78	67	3	Largest (1) to smallest (10)
POVERTY					
Poverty incidence, 2015	44	27	25	1	Highest (1) to lowest (10)
District number of poor, 2015	14,127	10,627	10,967	2	Highest (1) to lowest (10)
GOL priority district	1st			YES	
UXO					
UXO problem (% of villages)	78	42	29	3	Highest (1) to lowest (10)
Severe UXO problem (% of villages)	64	20	14	1	Highest (1) to lowest (10)
High UXO problem (% of villages)	5	10	7	5	Highest (1) to lowest (10)
Moderate UXO problem (% of villages)	8	12	8	7	Highest (1) to lowest (10)
FOREST AND BIODIVERSITY					
FOREST AREA ('000 ha)					
National CFA	91	63	31	2	Largest (1) to smallest (10)
National protection forest area	49	5	54	1	Largest (1) to smallest (10)
National PFA	46	25	21	4	Largest (1) to smallest (10)
Conservation and protection forest area (province/district)	55	12	*	1	Largest (1) to smallest (10)
Total forest area	241	105	106	2	Largest (1) to smallest (10)
FOREST AREA (% of district area)					
National CFA	28	39	20	5	Highest (1) to lowest (10)
National protection forest area	15	3	35	1	Highest (1) to lowest (10)
National PFA	14	15	13	4	Highest (1) to lowest (10)
Conservation and protection forest area (province/district)	17	7	*	2	Highest (1) to lowest (10)
Total forest area	74	63	68	3	Highest (1) to lowest (10)
NPAS					
NPA (% of territory)	28	39	14	4	Highest (1) to lowest (10)
District population in or adjacent to NPA (%)	34	25		5	Highest (1) to lowest (10)
FUEL FOR COOKING (% OF HOUSEHOLDS)					
Biomass fuels for cooking	99	97	92	1	Highest (1) to lowest (10)
Fuelwood for cooking	92	62	64	1	Highest (1) to lowest (10)
Charcoal for cooking	7	35	28	10	Highest (1) to lowest (10)

	<i>Bualapha</i>	<i>Khammouane</i>	<i>Lao PDR</i>	<i>Ranking</i>
PLANTATIONS				
Plantation potential (scale 1-10)	5			 Highest (10) to lowest (1)
NATURE-BASED TOURISM				
Nature-based tourism potential (scale 1-10)	10			 Highest (10) to lowest (1)
AGRICULTURAL LAND				
District agricultural land, cultivated 2017, Ha	6,847	10,379	12,188	 9 Largest (1) to smallest (10)
Cultivated land per rural capita, 2017, Ha	0.25	0.34	0.41	 9 Highest (1) to lowest (10)
Cultivated share of total land, 2017	2.1	6.4	7.6	 9 Highest (1) to lowest (10)
WATER RESOURCES				
DRY SEASON IRRIGATION				
District irrigated area, 2017, Ha	416	1,630	1,584	 9 Largest (1) to smallest (10)
Irrigation per 1,000 rural population, 2017, Ha	15	54	54	 10 Highest (1) to lowest (10)
Irrigated share of total planted area, 2017	6	16	13	 9 Highest (1) to lowest (10)
WATER SUPPLY (% OF HOUSEHOLDS)				
Improved water sources	52	69	75	 10 Highest (1) to lowest (10)
Piped water supply	3	19	24	 10 Highest (1) to lowest (10)
Unprotected surface water	45	13	6	 1 Highest (1) to lowest (10)
Households without water supply on premises	36	18		 1 Highest (1) to lowest (10)
For which: Roundtrip to water source (Minutes)	24	25		
Bottled water for drinking	6	40	51	 10 Highest (1) to lowest (10)
SEASONAL FLOODING				
Seasonal flood risk (scale 1-10)	1			 Highest (10) to lowest (1)

Source: The author.

A4.7 Nakai District

70. **Geography.** Nakai District is located in the north-east section of Khammouane. Most of the district is hilly and mountainous with altitudes of 500-800 masl while reaching above 2,000 m in the northeast. Several rivers run north-east to south-west, along which about a dozen villages are located, draining into the Nam Theun 2 reservoir.



71. **Population.** Nakai is the largest district in Khammouane with a substantially smaller than average population. Its population density of about 6 people per km² is the lowest while its rural population share of 89 percent is the second highest in the province.

72. **Poverty.** Poverty incidence in Nakai (43 percent) was the second highest of all districts in Khammouane in 2015, and more than twice as high as in Thakhek district (17 percent). The number of poor in Nakai was about the same as the district average in the province. Nakai is a GOL first priority district for poverty reduction and development.

73. **UXO contamination.** Nakai is moderately affected by UXO according to the national 1997 UXO survey, with 22 percent of villages reported to have a UXO problem.

A4.7.1 Forest Resources and Biodiversity

74. **Forest land area.** About 7 percent of the land in Nakai District is classified as forest land area, of which all is CFA. No area is classified as production (PFA) or protection forest area. The CFA in Nakai is by far the largest of CFAs in the districts in the province.

75. **NPAs.** Phou Hin Poun NPA covers about 11 percent of Nakai's area and Nakia Nam Theun covers 66 percent. As many as 98 percent of the district's population live in or adjacent to the NPAs.

76. **Energy for cooking.** As many as 99 percent of households in Bualapha used solid fuels for cooking in 2017 of which 92 percent used wood and 7 percent used charcoal. This is the highest use of solid fuels of all the districts along with Bualapha.⁵⁹

77. **Plantation potential.** Nakai District is given a low rating of 2 on a scale from 1 to 10 as much of the land is CFA, and no areas are classified as PFA or protection forest area.

78. **Nature-based tourism potential.** Nakai District is given a high rating of 10 on a scale from 1 to 10, along with Bualapha and Kounkham. The district offers many nature-based tourism opportunities with unique experiences.

A4.7.2 Land Resources

79. **Agricultural land.** Nakai has the lowest cultivated land area, cultivated share of total land area, and cultivated land per rural capita. Cultivated land per rural capita is only 0.16 ha compared to the average of 0.34 ha in Khammouane.

⁵⁹ These estimates of solid fuel use are for Nakai and Bualapha jointly based on data from the LSIS II 2017.

A4.7.3 Water Resources

80. **Irrigation.** Dry season irrigation has the potential to substantially augment farm incomes. A little over 850 ha were cultivated with dry season irrigation in Nakai in 2017, representing 24 percent of total wet and dry season cultivated area, compared to the province average of 16 percent. Dry season irrigation was nevertheless only 38 ha per 1,000 rural population, and the third lowest in the province. The province average was 54 ha.

81. **Household water supply.** Only about 52 percent of the population in Nakai had improved water supply and 45 percent relied on unprotected, open surface water sources in 2017. Over one-third (36 percent) do not have water supply on their premises. Only 6 percent of the population used bottled water for drinking.⁶⁰

82. **Seasonal flood risk.** The district is given a low preliminary seasonal flood risk rating of 1 on a scale from 1 to 10.

⁶⁰ These estimates are for Nakai and Bualapha jointly based on data from the LSIS II 2017.

Table A4.7: Natural capital of Nakai District

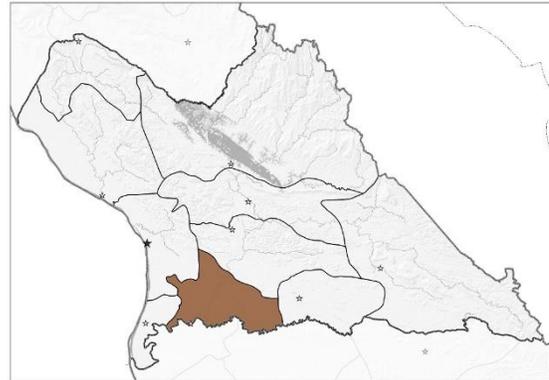
	<i>Nakai</i>	<i>Khammouane</i>	<i>Lao PDR</i>	<i>Ranking</i>	
District area, km ²	4,404	1,632	1,600	1	Largest (1) to smallest (10)
POPULATION					
District population, 2015	25,344	39,205	43,866	9	Largest (1) to smallest (10)
Population (% of province)	6				
Population density, 2015	6	24	27	10	Highest (1) to lowest (10)
Rural population share, 2015	89	78	67	9	Largest (1) to smallest (10)
POVERTY					
Poverty incidence, 2015	43	27	25	2	Highest (1) to lowest (10)
District number of poor, 2015	10,797	10,627	10,967	4	Highest (1) to lowest (10)
GOL priority district	1st			YES	
UXO					
UXO problem (% of villages)	22	42	29	6	Highest (1) to lowest (10)
Severe UXO problem (% of villages)	8	20	14	5	Highest (1) to lowest (10)
High UXO problem (% of villages)	2	10	7	6	Highest (1) to lowest (10)
Moderate UXO problem (% of villages)	12	12	8	5	Highest (1) to lowest (10)
FOREST AND BIODIVERSITY					
FOREST AREA ('000 ha)					
National CFA	339	63	31	1	Largest (1) to smallest (10)
National protection forest area	0	5	54	10	Largest (1) to smallest (10)
National PFA	0	25	21	10	Largest (1) to smallest (10)
Conservation and protection forest area (province/district)	0	12	*	10	Largest (1) to smallest (10)
Total forest area	339	105	106	1	Largest (1) to smallest (10)
FOREST AREA (% of district area)					
National CFA	77	39	20	1	Highest (1) to lowest (10)
National protection forest area	0	3	35	10	Highest (1) to lowest (10)
National PFA	0	15	13	10	Highest (1) to lowest (10)
Conservation and protection forest area (province/district)	0	7	*	10	Highest (1) to lowest (10)
Total forest area	77	63	68	2	Highest (1) to lowest (10)
NPAS					
NPA (% of territory)	77	39	14	1	Highest (1) to lowest (10)
District population in or adjacent to NPA (%)	98	25		1	Highest (1) to lowest (10)
FUEL FOR COOKING (% OF HOUSEHOLDS)					
Biomass fuels for cooking	99	97	92	1	Highest (1) to lowest (10)
Fuelwood for cooking	92	62	64	1	Highest (1) to lowest (10)
Charcoal for cooking	7	35	28	10	Highest (1) to lowest (10)

	<i>Nakai</i>	<i>Khammouane</i>	<i>Lao PDR</i>	<i>Ranking</i>	
PLANTATIONS					
Plantation potential (scale 1-10)	2				Highest (10) to lowest (1)
NATURE-BASED TOURISM					
Nature-based tourism potential (scale 1-10)	10				Highest (10) to lowest (1)
AGRICULTURAL LAND					
District agricultural land, cultivated 2017, Ha	3,546	10,379	12,188	10	Largest (1) to smallest (10)
Cultivated land per rural capita, 2017, Ha	0.16	0.34	0.41	10	Highest (1) to lowest (10)
Cultivated share of total land, 2017	0.8	6.4	7.6	10	Highest (1) to lowest (10)
WATER RESOURCES					
DRY SEASON IRRIGATION					
District irrigated area, 2017, Ha	854	1,630	1,584	8	Largest (1) to smallest (10)
Irrigation per 1,000 rural population, 2017, Ha	38	54	54	8	Highest (1) to lowest (10)
Irrigated share of total planted area, 2017	24	16	13	1	Highest (1) to lowest (10)
WATER SUPPLY (% OF HOUSEHOLDS)					
Improved water sources	52	69	75	10	Highest (1) to lowest (10)
Piped water supply	3	19	24	10	Highest (1) to lowest (10)
Unprotected surface water	45	13	6	1	Highest (1) to lowest (10)
Households without water supply on premises	36	18		1	Highest (1) to lowest (10)
For which: Roundtrip to water source (Minutes)	24	25			
Bottled water for drinking	6	40	51	10	Highest (1) to lowest (10)
SEASONAL FLOODING					
Seasonal flood risk (scale 1-10)	1				Highest (10) to lowest (1)

Source: The author.

A4.8 Xebangfay District

83. **Geography.** Xebangfay District is located in the south-western part of Khammouane. Most of the district is lowlands of altitude 150–200 masl. The Xebangfay River runs through the district.



84. **Population.** Xebangfay, with an area a little over half of the average district in Khammouane, has one of the smallest district populations in the province. Its population density of 30 people per km² is the third highest while its rural population share is among the lowest in the province.

85. **Poverty.** Poverty incidence in Xebangfay was slightly above the average in Khammouane in 2015. The number of poor was, however, the second smallest of any other district in the province due to its relatively small population.

86. **UXO contamination.** A large number of villages (63 percent) in Xebangfay reported to be affected by UXO in the national 1997 survey. Most of the villages were highly or moderately affected while only 6 percent were severely affected.

A4.8.1 Forest Resources and Biodiversity

87. **Forest land area.** About 72 percent of the land in Xebangfay District is classified as forest land area, of which 70 percent is PFA and 2 percent is district conservation and protection forest area. The PFA is the second largest of all the districts in Khammouane after the PFA in Xaybuathong.

88. **NPAs.** Xebangfay District has no NPA.

89. **Plantation potential.** Xebangfay is given a high rating of 8 on a scale from 1 to 10. The district has the second largest PFA of all the districts in the province.

90. **Nature-based tourism potential.** Xebangfay District is given a relatively modest rating of 4 on a scale from 1 to 10.

A4.8.2 Land Resources

91. **Agricultural land:** Cultivated land in Xebangfay reached almost 12,000 ha in 2017, the third largest area of all the districts in Khammouane. Cultivated share of total land area in the district was 13 percent, only superseded by Nongbok and Thakhek. Cultivated land per rural capita stood at 0.55 ha, the highest of all districts.

A4.8.3 Water Resources

92. **Irrigation:** Dry season irrigation has the potential to substantially augment farm incomes. Nearly 2,600 ha were cultivated with dry season irrigation in Xebangfay in 2017, representing 22 percent of total wet and dry season cultivated area, well above the province average. Dry season irrigation was 120 ha per 1,000 rural population, more than twice the provincial average and the highest of all districts.

93. **Seasonal flood risk:** Xebangfay District is among the districts with the highest seasonal flood risk. The district is given a high preliminary seasonal flood risk rating of 9 on a scale from 1 to 10.

Table A4.8: Natural capital of Xebangfay District

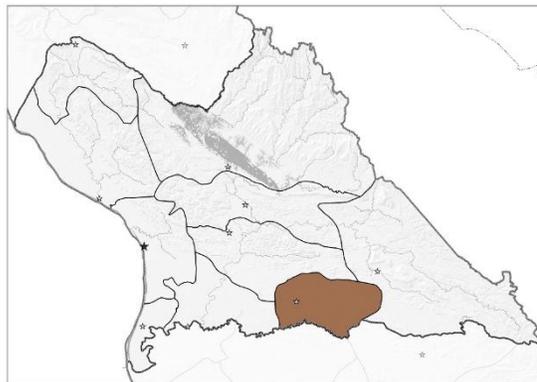
	<i>Xebangfay</i>	<i>Khammouane</i>	<i>Lao PDR</i>	Ranking	
District area, km ²	944	1,632	1,600	8	Largest (1) to smallest (10)
POPULATION					
District population, 2015	28,576	39,205	43,866	7	Largest (1) to smallest (10)
Population (% of province)	7				
Population density, 2015	30	24	27	3	Highest (1) to lowest (10)
Rural population share, 2015	75	78	67	8	Largest (1) to smallest (10)
POVERTY					
Poverty incidence, 2015	29	27	25	4	Highest (1) to lowest (10)
District number of poor, 2015	8,258	10,627	10,967	9	Highest (1) to lowest (10)
GOL priority district	NO			NO	
UXO					
UXO problem (% of villages)	63	42	29	5	Highest (1) to lowest (10)
Severe UXO problem (% of villages)	6	20	14	7	Highest (1) to lowest (10)
High UXO problem (% of villages)	31	10	7	1	Highest (1) to lowest (10)
Moderate UXO problem (% of villages)	27	12	8	1	Highest (1) to lowest (10)
FOREST AND BIODIVERSITY					
FOREST AREA ('000 ha)					
National CFA	0	63	31	10	Largest (1) to smallest (10)
National protection forest area	0	5	54	10	Largest (1) to smallest (10)
National PFA	66	25	21	2	Largest (1) to smallest (10)
Conservation and protection forest area (province/district)	2	12	*	10	Largest (1) to smallest (10)
Total forest area	68	105	106	6	Largest (1) to smallest (10)
FOREST AREA (% of district area)					
National CFA	0	39	20	10	Highest (1) to lowest (10)
National protection forest area	0	3	35	10	Highest (1) to lowest (10)
National PFA	70	15	13	2	Highest (1) to lowest (10)
Conservation and protection forest area (province/district)	2	7	*	10	Highest (1) to lowest (10)
Total forest area	72	63	68	4	Highest (1) to lowest (10)
NPAS					
NPA (% of territory)	0	39	14	10	Highest (1) to lowest (10)
District population in or adjacent to NPA (%)	0	25		10	Highest (1) to lowest (10)
FUEL FOR COOKING (% OF HOUSEHOLDS)					
Biomass fuels for cooking		97	92		Highest (1) to lowest (10)
Fuelwood for cooking		62	64		Highest (1) to lowest (10)
Charcoal for cooking		35	28		Highest (1) to lowest (10)
PLANTATIONS					

	<i>Xebangfay</i>	<i>Khammouane</i>	<i>Lao PDR</i>	<i>Ranking</i>	
Plantation potential (scale 1-10)	8				Highest (10) to lowest (1)
NATURE-BASED TOURISM					
Nature-based tourism potential (scale 1-10)	4				Highest (10) to lowest (1)
AGRICULTURAL LAND					
District agricultural land, cultivated 2017, Ha	11,850	10,379	12,188	3	Largest (1) to smallest (10)
Cultivated land per rural capita, 2017, Ha	0.55	0.34	0.41	1	Highest (1) to lowest (10)
Cultivated share of total land, 2017	13	6.4	7.6	3	Highest (1) to lowest (10)
WATER RESOURCES					
DRY SEASON IRRIGATION					
District irrigated area, 2017, Ha	2,579	1,630	1,584	3	Largest (1) to smallest (10)
Irrigation per 1,000 rural population, 2017, Ha	120	54	54	1	Highest (1) to lowest (10)
Irrigated share of total planted area, 2017	22	16	13	2	Highest (1) to lowest (10)
WATER SUPPLY (% OF HOUSEHOLDS)					
Improved water sources		69	75		Highest (1) to lowest (10)
Piped water supply		19	24		Highest (1) to lowest (10)
Unprotected surface water		13	6		Highest (1) to lowest (10)
Households without water supply on premises		18			Highest (1) to lowest (10)
For which: Roundtrip to water source (Minutes)		25			
Bottled water for drinking		40	51		Highest (1) to lowest (10)
SEASONAL FLOODING					
Seasonal flood risk (scale 1-10)	9				Highest (10) to lowest (1)

Source: The author.

A4.9 Xaybuathong District

94. **Geography.** Xaybuathong District is located in the south-central part of Khammouane. Much of the district is lowlands of altitude 180–250 masl. The exception is the hilly areas in the east that reach altitudes of about 500 masl.



95. **Population.** Xaybuathong, with an area a little over half of the average district in Khammouane, has one of the smallest populations of the districts in the province. Its population density of 28 people per km² is slightly above the province average. The rural population share is 92 percent and is the highest in the province.

96. **Poverty.** Poverty incidence in Xaybuathong (39 percent) was the third highest of all districts in Khammouane in 2015, and more than twice as high as in Thakhek. The number of poor in Xaybuathong was about the province average. The district is a GOL second priority district for poverty reduction and development.

97. **UXO contamination.** A large number of villages (79 percent) in Xaybuathong reported to be affected by UXO in the national 1997 survey, with 31 reporting to be severely affected. Xaybuathong is thus among the 2-3 most affected districts in Khammouane along with Bualapha and Mahaxay.

A4.9.1 Forest Resources and Biodiversity

98. **Forest land area.** As much as 99 percent of the land in Xaybuathong District is classified as forest land area, of which 93 percent is PFA, 1 percent is protection forest area, and 5 percent is province conservation and protection forest area. The PFA is the largest of all districts in the province.

99. **NPAs.** Xaybuathong District has no NPA.

100. **Plantation potential.** Xaybuathong is given a high rating of 10 on a scale from 1 to 10. The district has the largest PFA of all the districts in the province.

101. **Nature-based tourism potential.** Xaybuathong District is given a low rating of 2 on a scale from 1 to 10.

A4.9.2 Land Resources

102. **Agricultural land.** Cultivated land in Xaybuathong reached almost 10,000 ha in 2017, or about the district average in the province. Cultivated share of total land area in the district was 11 percent, only superseded by three districts. Cultivated land per rural capita stood at 0.41 ha, above the provincial average of 0.34 ha.

A4.9.3 Water Resources

103. **Irrigation.** Dry season irrigation has the potential to substantially augment farm incomes. Only 355 ha were cultivated with dry season irrigation in Xaybuathong in 2017, representing only 4 percent of total wet and dry season cultivated area, the lowest in the province. Dry season irrigation was 15 ha per 1,000 rural population, the lowest in the province along with Bualapha.

104. **Seasonal flood risk.** Xaybuathong District is not among the districts with the highest seasonal flood risk. The district is given a relatively low preliminary seasonal flood risk rating of 2 on a scale from 1 to 10.

Table A4.9: Natural capital of Xaybuathong District

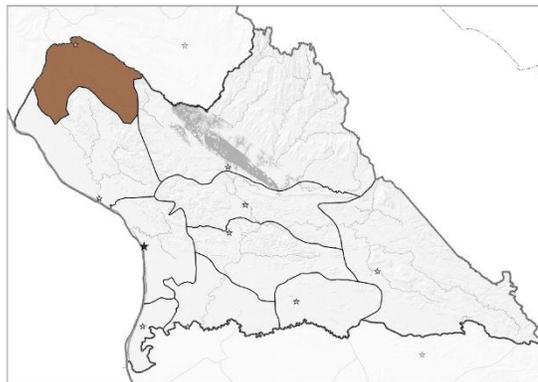
	<i>Xaybuathong</i>	<i>Khammouane</i>	<i>Lao PDR</i>	<i>Ranking</i>	
District area, km ²	923	1,632	1,600	9	Largest (1) to smallest (10)
POPULATION					
District population, 2015	26,182	39,205	43,866	8	Largest (1) to smallest (10)
Population (% of province)	7				
Population density, 2015	28	24	27	4	Highest (1) to lowest (10)
Rural population share, 2015	92	78	67	1	Largest (1) to smallest (10)
POVERTY					
Poverty incidence, 2015	39	27	25	3	Highest (1) to lowest (10)
District number of poor, 2015	10,263	10,627	10,967	6	Highest (1) to lowest (10)
GOL priority district	2nd			YES	
UXO					
UXO problem (% of villages)	79	42	29	2	Highest (1) to lowest (10)
Severe UXO problem (% of villages)	31	20	14	3	Highest (1) to lowest (10)
High UXO problem (% of villages)	23	10	7	3	Highest (1) to lowest (10)
Moderate UXO problem (% of villages)	25	12	8	2	Highest (1) to lowest (10)
FOREST AND BIODIVERSITY					
FOREST AREA ('000 ha)					
National CFA	0	63	31	10	Largest (1) to smallest (10)
National protection forest area	1	5	54	10	Largest (1) to smallest (10)
National PFA	86	25	21	1	Largest (1) to smallest (10)
Conservation and protection forest area (province/district)	5	12	*	5	Largest (1) to smallest (10)
Total forest area	91	105	106	3	Largest (1) to smallest (10)
FOREST AREA (% of district area)					
National CFA	0	39	20	10	Highest (1) to lowest (10)
National protection forest area	1	3	35	10	Highest (1) to lowest (10)
National PFA	93	15	13	1	Highest (1) to lowest (10)
Conservation and protection forest area (province/district)	5	7	*	4	Highest (1) to lowest (10)
Total forest area	99	63	68	1	Highest (1) to lowest (10)
NPAS					
NPA (% of territory)	0	39	14	10	Highest (1) to lowest (10)
District population in or adjacent to NPA (%)	0	25		10	Highest (1) to lowest (10)
FUEL FOR COOKING (% OF HOUSEHOLDS)					
Biomass fuels for cooking		97	92		Highest (1) to lowest (10)
Fuelwood for cooking		62	64		Highest (1) to lowest (10)
Charcoal for cooking		35	28		Highest (1) to lowest (10)
PLANTATIONS					

	<i>Xaybuathong</i>	<i>Khammouane</i>	<i>Lao PDR</i>	<i>Ranking</i>	
Plantation potential (scale 1-10)	10				Highest (10) to lowest (1)
NATURE-BASED TOURISM					
Nature-based tourism potential (scale 1-10)	2				Highest (10) to lowest (1)
AGRICULTURAL LAND					
District agricultural land, cultivated 2017, Ha	9,914	10,379	12,188	5	Largest (1) to smallest (10)
Cultivated land per rural capita, 2017, Ha	0.41	0.34	0.41	4	Highest (1) to lowest (10)
Cultivated share of total land, 2017	11	6.4	7.6	4	Highest (1) to lowest (10)
WATER RESOURCES					
DRY SEASON IRRIGATION					
District irrigated area, 2017, Ha	355	1,630	1,584	10	Largest (1) to smallest (10)
Irrigation per 1,000 rural population, 2017, Ha	15	54	54	10	Highest (1) to lowest (10)
Irrigated share of total planted area, 2017	4	16	13	10	Highest (1) to lowest (10)
WATER SUPPLY (% OF HOUSEHOLDS)					
Improved water sources		69	75		Highest (1) to lowest (10)
Piped water supply		19	24		Highest (1) to lowest (10)
Unprotected surface water		13	6		Highest (1) to lowest (10)
Households without water supply on premises		18			Highest (1) to lowest (10)
For which: Roundtrip to water source (Minutes)		25			
Bottled water for drinking		40	51		Highest (1) to lowest (10)
SEASONAL FLOODING					
Seasonal flood risk (scale 1-10)	2				Highest (10) to lowest (1)

Source: The author.

A4.10 Kounkham District

105. **Geography.** Kounkham district is located in the north-western part of Khammouane. Most of the district is hilly and mountainous of altitudes up to about 800 masl. Smaller areas of lowlands are at altitudes of 160-200 masl.



106. **Population.** Kounkham, with an area a little over half of the average district in Khammouane, has the smallest population in the province. Its population density of 21 people per km² and rural population share of 73 percent are among the lowest in the province.

107. **Poverty.** Poverty incidence in Kounkham was the same as the average in Khammouane in 2015, and the number of poor was the smallest of any other district in the province.

108. **UXO contamination.** Kounkham district did not exist at the time of the national 1997 UXO survey. UXO contamination in the district is, however, not much different from the situation in Hinboon district which reported that 18 percent of villages were affected by UXO, well below the Khammouane provincial average.

A4.10.1 Forest Resources and Biodiversity

109. **Forest land area.** About 59 percent of the land in Kounkham district is classified as forest land area, of which 42 percent as CFA and 17 percent as district conservation and protection forest area. The CFA is among the highest in the province.

110. **NPAs.** Phou Hin Poun NPA covers 42 percent of Kounkham's area with 67 percent of the district's population living in or adjacent to the NPA. This is the second highest population share in or adjacent to NPAs in the province.

111. **Plantation potential.** Kounkham is given a low rating of 2 on a scale from 1 to 10. A large share of the land area is CFA.

112. **Nature-based tourism potential.** Kounkham district is given a high rating of 10 on a scale from 1 to 10. The district is on the "loop" and already has many tourists visiting its nature sites.

A4.10.2 Land Resources

113. **Agricultural land.** Cultivated land in Kounkham reached almost 7,500 ha in 2017. Cultivated share of total land area in the district was 7 percent, or about the province average. Cultivated land per rural capita stood at 0.46 ha, the second highest in the province.

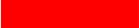
A4.10.3 Water Resources

114. **Irrigation.** Dry season irrigation has the potential to substantially augment farm incomes. Nearly 1,000 ha were cultivated with dry season irrigation in Kounkham in 2017, representing 13 percent of total wet and dry season cultivated area, or slightly below the province average. Dry season irrigation was 59 ha per 1,000 rural population, slightly above the provincial average.

115. **Seasonal flood risk.** Kounkham district is not among the districts with the highest seasonal flood risk. The district is given a relatively low preliminary seasonal flood risk rating of 2 on a scale from 1 to 10.

Table A4.10: Natural capital of Kounkham District

	<i>Kounkham</i>	<i>Khammouane</i>	<i>Lao PDR</i>	Ranking	
District area, km ²	1,063	1,632	1,600	6	Largest (1) to smallest (10)
POPULATION					
District population, 2015	22,018	39,205	43,866	10	Largest (1) to smallest (10)
Population (% of province)	6				
Population density, 2015	21	24	27	8	Highest (1) to lowest (10)
Rural population share, 2015	73	78	67	9	Largest (1) to smallest (10)
POVERTY					
Poverty incidence, 2015	27	27	25	6	Highest (1) to lowest (10)
District number of poor, 2015	5,945	10,627	10,967	10	Highest (1) to lowest (10)
GOL priority district	NO			NO	
UXO					
UXO problem (% of villages)		42	29		Highest (1) to lowest (10)
Severe UXO problem (% of villages)		20	14		Highest (1) to lowest (10)
High UXO problem (% of villages)		10	7		Highest (1) to lowest (10)
Moderate UXO problem (% of villages)		12	8		Highest (1) to lowest (10)
FOREST AND BIODIVERSITY					
FOREST AREA ('000 ha)					
National CFA	45	63	31	5	Largest (1) to smallest (10)
National protection forest area	0	5	54	10	Largest (1) to smallest (10)
National PFA	0	25	21	10	Largest (1) to smallest (10)
Conservation and protection forest area (province/district)	18	12	*	3	Largest (1) to smallest (10)
Total forest area	63	105	106	8	Largest (1) to smallest (10)
FOREST AREA (% of district area)					
National CFA	42	39	20	2	Highest (1) to lowest (10)
National protection forest area	0	3	35	10	Highest (1) to lowest (10)
National PFA	0	15	13	10	Highest (1) to lowest (10)
Conservation and protection forest area (province/district)	17	7	*	2	Highest (1) to lowest (10)
Total forest area	59	63	68	6	Highest (1) to lowest (10)
NPAS					
NPA (% of territory)	42	39	14	2	Highest (1) to lowest (10)
District population in or adjacent to NPA (%)	67	25		2	Highest (1) to lowest (10)
FUEL FOR COOKING (% OF HOUSEHOLDS)					
Biomass fuels for cooking		97	92		Highest (1) to lowest (10)
Fuelwood for cooking		62	64		Highest (1) to lowest (10)
Charcoal for cooking		35	28		Highest (1) to lowest (10)

	<i>Kounkham</i>	<i>Khammouane</i>	<i>Lao PDR</i>	<i>Ranking</i>
PLANTATIONS				
Plantation potential (scale 1-10)	2			 Highest (10) to lowest (1)
NATURE-BASED TOURISM				
Nature-based tourism potential (scale 1-10)	10			 Highest (10) to lowest (1)
AGRICULTURAL LAND				
District agricultural land, cultivated 2017, Ha	7,440	10,379	12,188	 8 Largest (1) to smallest (10)
Cultivated land per rural capita, 2017, Ha	0.46	0.34	0.41	 2 Highest (1) to lowest (10)
Cultivated share of total land, 2017	7.0	6.4	7.6	 5 Highest (1) to lowest (10)
WATER RESOURCES				
DRY SEASON IRRIGATION				
District irrigated area, 2017, Ha	937	1,630	1,584	 7 Largest (1) to smallest (10)
Irrigation per 1,000 rural population, 2017, Ha	59	54	54	 3 Highest (1) to lowest (10)
Irrigated share of total planted area, 2017	13	16	13	 8 Highest (1) to lowest (10)
WATER SUPPLY (% OF HOUSEHOLDS)				
Improved water sources		69	75	Highest (1) to lowest (10)
Piped water supply		19	24	Highest (1) to lowest (10)
Unprotected surface water		13	6	Highest (1) to lowest (10)
Households without water supply on premises		18		Highest (1) to lowest (10)
For which: Roundtrip to water source (Minutes)		25		
Bottled water for drinking		40	51	Highest (1) to lowest (10)
SEASONAL FLOODING				
Seasonal flood risk (scale 1-10)	2			 Highest (10) to lowest (1)

Source: The author.

Annex 5: Biodiversity values of the main protected areas

A5.1: Biodiversity values in Phou Hin Poun NPA

1. **The Phou Hin Poun NPA “is globally important for the Lao Langur *Trachypithecus laotum*, and contains nationally important populations of Assamese Macaques and White-cheeked gibbons.** Phou Hin Poun also provides part of the range for one of the largest and most viable populations of Asian Elephant, and for gaur. Furthermore, Phou Hin Poun contains good populations of both species of bear, a nationally significant Serow population and at least 43 species of bat (largest bat diversity of any NPA). The bare-faced bulbul *Pycnonotus hualon* is a member of the bulbul family, was newly described from the Central Indochina Limestone in 2009. Phou Hin Poun is also a type locality for the Sooty Babbler *Stachyris herberti*. A new species – Limestone Leaf Warbler – is also present. Phou Hin Poun NPA also contains at least 14 species of turtle and is nationally significant for the conservation of reptiles.”

Source: Phou Hin Poun Fact Sheet (DOF 2018)

A5.2: Biodiversity values in Hin Nam No National Park

2. **Surveys of surface habitats in Hin Nam No have recorded 377 vertebrate species including 55 mammals, 184 birds, 21 reptiles, 21 amphibians and 96 fish.** Of these, 37 species are of conservation interest, with 11 of these being globally threatened. Most notably, Hin Nam No protects seven species of primates, five of which are globally threatened. The Red-shanked Douc Langur *Pygathrix nemaeus* and the Southern White-cheeked Gibbon *Nomascus siki* are charismatic ‘flagship’ species of Hin Nam No, and along with the Black Langur *Trachypithecus hatinhensis* are globally endangered. Hin Nam No harbours the largest and one of the last viable populations of these two endangered langurs in the world. Other globally threatened mammals include: Bear Macaque *Macaca arctoides*, Pig-tailed Macaque *Macaca nemestrina*, Smooth-coated Otter *Lutrogale perspicillata*, Southern Serow *Capricornis sumatraensis*, and Sambar Deer *Rusa unicolor*.

3. **A total of 25 species of bats have been identified in Hin Nam No,** including three new records for Lao P.D.R, namely Horsfield’s Fruit Bat *Cynopterus horfieldi*, Harlequin Bat *Scotomanes ornatus* and Great Evening Bat (*Ia io*).

4. **Charismatic bird species include four species of hornbill (Bucerotidae), one of which, the Rufous-necked Hornbill *Aceros nipalensis*, is globally threatened.** Another globally threatened species includes Crested Argus *Rheinardia ocellata*. The Sooty Babbler *Stachyris herberti* is a bird species endemic to the Central Indochina Limestone.

5. **The only reptile and amphibian survey conducted in Hin Nam No collected or observed 46 species of reptiles and amphibians.** All six turtle species collected are key species. These include Asiatic softshell *Amyda carilaginea*, Wattle-necked Softshell *Palea steindacheri*, Yellow-headed Temple Turtle *Hieremys annadlaei*, Asian Leaf Turtle *Cyclemys dentata*, Keeled Box Turtle *Pyxidea mouhotii*, and Elongated Tortoise *Indotestudo elongata*.

6. **A total of 130 species of fish have been collected in the Xebangfay River, 25 of which were found in and around Hin Nam No NPA. At least two species are possibly endemic to the Xebangfay River.** Additionally, 29 of the 130 species (or 17.5 percent) of fish surveys in 1996 were previously unnamed.

7. **Recent initial surveys of cave habitats in Hin Nam No have recorded at least 70 fauna species, with seven of these being new species and five endemics, including a cave-adapted fish species *Bangana***

musaei which is endemic and globally threatened. The caves of Hin Nam No are also home to the Giant Huntsman Spider *Heteropoda maxima*, the world's largest spider by leg-span.

8. **In addition, many underground caves are found in Hin Nam No National Park, which are critical refuges for fish during the dry season.** For example, the well-known Hou peo pa “fish cave” is an underground cave hosting fish during the dry season. Fish emerge from the caves to appear in nearby rivers at the beginning of the wet season when the drainage from the heavy rains flood into the cave entrances. At the end of the wet season the fish return to the fish caves.

Source: Hin Nam No Fact Sheet (DOF 2018).

A5.3: Main forest biodiversity values in Nakai Nam Theun National Park

9. **There is a complex range of habitats in Nakai Nam Theun National Park which reflect pronounced gradients in soils, altitudes and microclimates.** Habitat types usually blend into one another, and there is rarely a sharp divide between them. Component species of habitat floras are poorly known and will remain so until a systematic collecting programme is in place. Evergreen forest has plant families and genera typical for other parts of Southeast Asia. Commonly found were species of *Dipterocarpus* and *Shorea* in the *Dipterocarpaceae*, and species of *Myristicaceae*, *Annonaceae*, *Rutaceae*, *Sapindaceae*, *Fabaceae* etc. The upper canopy reaches generally around 20 m, with emergent trees reaching to about 30 m. The diameter of larger trees is in the 50-60 cm class, with occasional emergent trees having diameters exceeding 120 cm. Palms, including rattan, are uncommon in the northern portion of the protected area, but frequent in the central and southern areas.

10. **Montane Fagaceous forest occurs at higher elevations toward the Vietnam border in the southern part of the NPA, which have scattered and small populations of cypress.** Fagaceous forest shows a mosaic of species associations and distribution patterns. Within the *Fagaceae* and other families, some species are generalists, found everywhere, and others are highly localized. Cloud forest occurs on mountains south of Ban Nameo. The transition between montane Fagaceous and cloud *Ericaceous* forest was sharp, occurring at about 1,600 m. *Ericaceous* species dominated this habitat, in particular *Rhododendron cf. veitchianum* Hooker. Riverine forest is the only habitat where a tree species of *Poikilospermum* (*Urticaceae*) was seen. The habitat protects a large variety of herbs. In the Nam Sot area where riverbanks are shallow and many areas appear to flood regularly, component species of habitat floras will remain unknown until a thorough collecting program is in place.

11. **One of the unique features of Nakai Nam Theun National Park is the occurrence of highly restricted 'everwet forest'.** This occurs only in narrow bands where there are low elevation saddles in the Sai Phou Louang (Annamite) chain. These saddles allow the Vietnamese northeast monsoon to penetrate across the border and consequently these areas receive rain for up to ten months of the year. These areas are typically wet in January-February when adjacent areas of habitat are in the midst of harsh dry season. It is probable that the fauna and flora assemblages are unique as the habitat occurs nowhere else in Lao PDR.

12. **Three intensive biodiversity surveys undertaken in the mid-1990's form the foundation of knowledge on the vertebrate taxonomic groups found within the protected area.** Confirmed species in the NPA include 35 mammals, 45 species of bats and 8 species of rodents, 53 species of reptiles and amphibians, approximately 430 species of birds, and 60 species of fish.

13. **Three of the last five large mammals to be discovered or re-discovered worldwide occur within the protected area.** The most distinct of these remarkable discoveries is the Saola *Pseudoryx nghetinhensis*. Other newly discovered species, a small dark muntjac and large-antlered Muntjac

Megamuntiacus vuquangensis also have restricted world ranges centered on Nakai Nam Theun National Park. The Indochinese Warty Pig *Sus bucculentus* was rediscovered in the area after being considered extinct. Field surveys indicate that mammal communities within the protected area are exceptionally diverse. At least nine species of primate occur, including four threatened taxa to which the Nakai Nam Theun National Park represents a global stronghold (Pygmy Loris *Nycticebus pygmaeus*, Douc Langur *Pygathrix nemaeus*, Francois' Langur *P. nemaeus francoisi* and Southern White-cheeked Gibbon *Nomascus siki*).

14. Along one stretch of abandoned logging road above the village of Ban Navang in the NPA, 16 species of carnivore have been recorded, and further species have been found elsewhere in the NAP.

This is the highest diversity of mammalian predators reported at a single site in Lao PDR-Cambodia-Vietnam. Included amongst these are many rare cats (Fishing Cat *Prionailurus viverrinus*, Golden Cat *Catopuma temmincki*, Marbled Cat *Pardofelis marmorata*, Clouded Leopard *Pardofelis nebulosa* and Tiger *Panthera tigris*), several of which have not been recently observed by biologists elsewhere in Lao PDR. The Nakai Plateau holds significant populations of many mammals including an estimated 100–150 Asian Elephants *Elephas maximus*; few viable populations of elephants currently exist elsewhere in Lao PDR. However, it should be acknowledged that some of the large mammalian species like tiger and saola have undergone severe population declines, or even extinction, within the reserve since the surveys in the 1990s.

15. A wildlife monitoring program (with forest transects and camera-traps) was set up in 2005 with technical assistance from the Wildlife Conservation Society.

However, the programme was not continued after 2010 and survey were not repeated preventing an analysis of population trends. The database was however reviewed for small-carnivores and macaque species. Since 2013 a French non-for-profit Project Anoulak has been conducting biodiversity research and monitoring programs in the area notably focusing on the red-shanked douc, the white-cheeked gibbons, otters and other wildlife using techniques such as ground and arboreal camera-traps, environmental DNA and animal observations. Project Anoulak is assisting the Watershed Management and Protection Authority (WMPA) with their Biodiversity Monitoring Strategy which involves systematic camera-trapping and foot surveys. The overall objective of the strategy is to facilitate an assessment of whether wildlife populations and threats are increasing, decreasing or remaining stable as a result of management interventions.

Source: Nakai Nam Theun Fact Sheet (DOF 2018).

Annex 6: Nature-based tourism potential in the main protected areas

A6.1: Phou Hin Poun NPA

1. **Konglor Cave: This amazing 7.5 km-long limestone cave was formed by the Hinboon River, which flows through the cave all-year-round.** There is a boat ride through the main cave, which is up to 90 meters wide and 100 meters high. The cave received an estimated 25,000 visitors (18,000-20,000 international / 4,000-5,000 domestic) in 2015 and supports a boat association, homestays and guesthouses in Ban Konglor, one of the best examples of community-based tourism in the country. Visitors can boat through Konglor Cave, stopping to visit spectacular stalactites and rock formations within the vast cavern, and can stay in homestays on the other side of the cave in Ban Natan.
2. **Nahin is one of the best sites for seeing the newly discovered bird species of the Indo-China Karsts, the Bare-faced Bulbul, and the Sooty babbler.** The viewpoint to the south of the District town is also one of the best locations to observe the endemic Lao Langur *Trachypithecus laotum*, particularly at dawn. The area is also known for having a wild Asian Elephant population. In the Nahin area are the Tad Namsanam and Tad Mouang waterfalls, which can be reached from Ban Khoun Kham on the way to Konglor. The waterfalls receive less than 3,000 visitors per year.
3. **The Phalaem 2-day Trek goes through the heart of Phou Hin Poun NPA to caves and rural villages.** The limestone landscape offers pristine monsoon lakes and spectacular caves.
4. **One of the closest attractions in the protected area to Thakhek is Khoun Khong Leng, which a crystal blue lagoon surrounded by limestone mountains.** The lagoon receives approximately 10,000 visitors per year.
5. **Nong Paa Fa (Buddha Cave) is one of the most important religious sites in Khammouane Province, a cave containing over 200 ancient Buddha images that lay forgotten for hundreds of years.** The cave receives 20,000-30,000 visitors annually.
6. **There is a well-known forest walk, which involves stopping for a refreshing swim at Nong Tao (Turtle Lake) and Tham Nong Paseum cave.**

Source: Phou Hin Poun Fact Sheet (DOF 2018).

A6.2: Hin Nam No National Park

7. **In Nong Ping village, there are three cooperative groups, a boat tour cooperative group, a guesthouse cooperative group, and a homestay cooperative group.** The main tourism product is a boat trip to the Xebangfay cave with village guides.
8. **Nongbua village has two service groups, a village trekking guide cooperative group and a cooperative group of elderly history guides.** The main attraction here is to follow the Ho Chi Minh trail which is a heritage route; certain sections are close to the original state. The Ho Chi Minh Trail tour takes in the villages of Nongbua, Phanop, Vangkon, and Senphan, retracing a small part of this amazing feat of human engineering, ingenuity and endurance. One can visit caves and talk to villagers to learn the history of the Mu Gia Pass, a narrow valley through which 75 percent of all trucks carrying supplies to the Viet Cong in the south traversed. During the Indochina War, this was a muddy track passing through stream beds and squeezing between steep sandstone mountains and giant limestone monoliths. A further “choke-point” through the karsts near Phanop and Vangkhon proved to be the narrowest constriction

along the entire trail, causing the area to be one of the most heavily defended sites and the focus of the most concentrated aerial bombardment.

9. **A visit can be made by car to the Mu Gia Pass along Route 12, which offers spectacular views of the valley; this takes about two hours.** Then there are two caves where villagers used to hide during the bombing raids: at Tham Num and Tham Loung. These caves are within 30 minutes walking distance from Nongbua village. Village elders are happy to tell the stories about their childhood there to visitors. The second attraction is a one-and-a-half hour trek to the Song Xue waterfall, 2 km, where tourists can picnic for lunch and enjoy swimming in the crystal clear pool at the foot of the waterfall. Thirdly, visits can be made to the neighboring villages. Visitors can observe the numerous bomb craters, now being turned into fishponds in Vangkhone village, or observe the wing of an airplane that was shot down in Phanop village and a house made of aluminum bomb parts in Senephan village.

10. **Nong Saeng village has one group of six households providing hiking tours.** The main attraction is a short hike of around two to three hours around a small rock called Phakod. A group of macaques and numerous bird species can be observed in the early morning or in the late afternoon.

11. **Thong Xam village has one service group of six households providing trekking services.** The main attraction is a one-day forest trek along the Nam Hok River visiting three caves which the river passes through. Visitors may have a good chance of seeing black langurs and various bird species. One cave has spectacular formations, another still contains items from Vietnamese soldiers camping there during the war. A picnic can be taken in one of the caves.

Source: Hin Nam No Fact Sheet (DOF 2018).

A6.3: Nakai Nam Theun National Park

12. **Nakai Nam Theun National Park also offers important tourist attractions.** Tourists traveling 'The Loop' typically start and end in Thakhek and visit Khammouane's major attractions including Kong Lor Cave, Lak Xao, and Buddha Cave. Most visitors stop in Thalang for one night, located on the north-western side of the Nam Theun 2 reservoir just across from the protected area. Nakai's unique location offers an amazing opportunity to tap Khammouane's tourism market.

13. **Nakai Nam Theun National Park offers one of the best chances in Lao PDR to see Douc langurs and may potentially be a relatively good location for seeing Asian elephants and gibbons.** The area also holds potential to be the main area accessible to tourists for viewing key species of the Annamites. Nakai's vast, dense forests hold good opportunity for true wilderness camping experiences. Its many rivers also hold relatively good potential for kayaking and boating, as rivers in other areas are increasingly becoming dammed and inaccessible. The site also offers an interesting component of cultural tourism, based upon the ethnic diversity found within the site at the key village entry points for trekking and wildlife viewing.

14. **Access requires entry by boat from the Nam Theun 2 reservoir, followed by local village transport into the three village clusters.** Access to some of the more remote areas that hold the greatest abundance of species can require significant amounts of time. Currently there is a lack of any accommodation or services inside the protected area, and approval for tourism has yet to be made official, which has limited tourism activities to date. The prevalence of international, armed poachers is one potential concern that has caused authorities to not fully open the area to tourism yet. The incidence of malaria is also high in the area.

Source: Nakai Nam Theun Fact Sheet (DOF 2018).