UNIVERSITÄT BERN

WYSS ACADEMY FOR NATURE

Towards sustainable futures for nature and people

An appraisal report for Laos in the stewardship hub of Southeast Asia

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WYSS ACADEMY REPORT 3

South East Asia Hub

September 2021

Publisher

Wyss Academy for Nature at the University of Bern, Kochergasse 4, 3011 Bern, Switzerland. info@wyssacademy.org

Citation

Breu T., Bieri S., Bouasavanh S., Eckert S., Ehrensperger A., Epprecht M., Eshoo P., Fischer M., González-Rojí S.J., Hergarten C., Hett C., Hurni K., Messmer M., Nguyen A-T., O'Kelly H., Phayvanh T.E., Phonvisay A., Raible C.C., Snethlage M., Stocker T.F., Thanasack P., Torre-Marin Rando A., Wiesmann U., Zähringer J. 2021. Towards sustainable futures for nature and people: An appraisal report for Laos in the stewardship hub of Southeast Asia. Wyss Academy Report 3, Wyss Academy for Nature, Bern, Switzerland. https://doi.org/10.48350/161383

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Cover photo: View of landscape in Khammouane province. © Michael Epprecht, December 2020.

DOI: https://doi.org/10.48350/161383

The Wyss Academy for Nature

at the University of Bern is a place of innovation, where researchers, business people, policymakers and communities come together to co-design solutions for sustainable futures.

The Wyss Academy's mission is to transform scientific knowledge into action. Combining ambitious, innovative goals with a transformative approach, it was founded to develop innovative long-term pathways that strengthen and reconcile biodiversity conservation, human well-being and the sustainable use of natural resources in a variety of landscapes throughout the world. We co-design and implement concrete projects across a swathe of regions and countries. This global structure facilitates the replication of successes and learnings. The Wyss Academy for Nature currently operates Hubs in Central Europe (Bern, Switzerland), Southeast Asia (Laos), East Africa (Kenya) and South America (Peru).

Photo by Haley Wiebel, October 2018

Wyss Academy Reports

Wyss Academy Reports contain research, analysis, findings and recommendations. They are circulated with the aim of sharing knowledge, initiating debate on emerging issues, and eliciting comments and critical feedback on our current focal topics and regions.

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Executive summary

Christian Hergarten, Thomas Breu

The values of nature play a key role for sustaining societies, ensuring human wellbeing and driving our economies. However, often overlooked and easily taken for granted, nature's capacity to provide services globally is seriously affected by unsustainable development, climate change and resource degradation. As a result, we are now experiencing some of the most dramatic declines in biodiversity and climate change impacts humankind has ever caused and faced. Shortsighted economic development has led to fatefully unsustainable pathways proving now so challenging to correct. Altering the course of events turns out to be a wicked endeavor; developing just and fair solutions seems almost impossible without disenfranchising marginalized communities and disempowering underprivileged social groups. In the face of these predicaments, the Wyss Academy for Nature at the University of Bern seeks innovative pathways so as nature conservation and human wellbeing reinforce each other. To this end, the Wyss Academy is set to catalyze solutions that transform interactions between people and nature through knowledge and the creativity of engagement to empower agents of change. Accordingly, the Wyss Academy engages directly with civil society, policymakers, and the private sector in East Africa, South America, Southeast Asia, and the canton of Bern in Switzerland.

The report at hand makes an appraisal of the state, trends and opportunities for sustainable people-nature relations in Laos. The country's recent impressive economic growth has reduced poverty and improved human wellbeing, and Laos is on track to graduate from the LDC list soon. The investment-friendly policy environment has attracted foreign investments in land in the form of agricultural and tree plantations, mining concessions, hydropower production or transportation infrastructure projects. As a result, Laos is undergoing drastic changes affecting not only easily accessible regions, but also remote rural communities. The increase in large-scale agricultural investments pushes traditional smallholders to explore and claim previously undisturbed forest frontier areas, and increased demand from a growing middle-class is intensifying also hunting and collection of non-timber forest products (NTFPs) beyond sustainable limits. Forests still play a key role for local livelihoods - with 39 % of rural families' income originating from NTFP harvests. However, the contribution of biodiversity in securing human wellbeing is rarely acknowledged in Laos; instead, short-term economic profits benefiting only few are given priority. The importance of nature's multiple values is not well reflected in national policy agendas, which led to the perception

that socio-economic development is systemically at odds with conservation priorities. Weak governance institutions and insufficient capacities are hampering effective environmental law enforcement. Laos' land tenure system is characterized by institutional bricolage, embodying the country's predicament many frontier countries confront today.

Although the SARS-CoV-2 pandemic has devastating consequences, it also forces us to scrutinize linkages and relationships between zoonotic diseases and environmental change, human behavior and economic development. Another opportunity for awareness raising is the growing interest and taste the urban population that is developing for healthy food and nutrition. Ecotourism is slowly developing, creating benefits particularly for local communities living in emblematic tropical mountain environments.

Nevertheless, important shifts are necessary for changing people's mindset and strengthening the awareness for nature's multiple values beyond commodification of nature. The development of inclusive value chains involving the private sector beyond extractive or large-scale land investments will be crucial. Identifying creative ways for strengthening the role of the currently underdeveloped civil society and securing its agency in the development of the will be pivotal for the thriving of the country.

Shared models of knowledge production breaking the dominant silo mentality have proven to lead to more transparent and evidence-based policymaking, improving trust and embracing new forms of good governance reaching beyond the hierarchical structures and paving the way towards more inclusive and just people-nature relations.

1 Introduction

Thomas Breu, Christian Hergarten

Our current decade will be decisive in determining the extent to which humanity can cope with interlinked global challenges such as climate change, social disparities, and alarming rates of biodiversity loss. We argue that concrete pathways to sustainable development must reconcile nature conservation and human well-being. Focusing on the Lao People's Democratic Republic from a sustainable nature conservation perspective, this report presents key elements and features relevant for development in this particular social and geographic context. Halting and reversing habitat loss and nature degradation can only happen through improvements in human well-being, prosperity, and self-determination of local communities: this report offers integrated knowledge needed to design and implement ways of achieving this.

The appraisal report for the Lao People's Democratic Republic summarizes the status of – and trends relevant for – the relationships between nature and people. On the one hand, we examine nature's contributions to – and limitations for – livelihoods and human well-being. On the other, we investigate people's impacts, both positive and negative, on natural resources. To this end, we provide a description of ecosystem services and underlying drivers of change. Further, we present an overview of different stakeholders' interests and power relations, existing initiatives, projects, and networks that could be aligned or overlap with initiatives of the Wyss Academy. The report identifies approaches and opportunities enabling and supporting transformation processes for reconciling objectives of nature conservation and human well-being. In addition, it identifies knowledge gaps and research needs related to the various topics addressed.

Guided by an adapted and simplified IPBES conceptual framework (Figure 1.1) we compiled information relevant to status of and trends in biodiversity, ecosystem services, and direct drivers of change such as land degradation including invasive species, climate change, and others. Taking the view that local communities are the solution to, and not the problem for, nature conservation, we gave due attention to *indirect* drivers of change. Indirect drivers of change occur within the socioeconomic system, reflecting the complex interplay of demography, culture, economy, governance, at different scales. Indirect drivers are directly linked to the human use of land – for different purposes and in different contexts.

This report draws on the body of knowledge accumulated over the past 30 years by the Centre for Development and Environment (CDE) of the

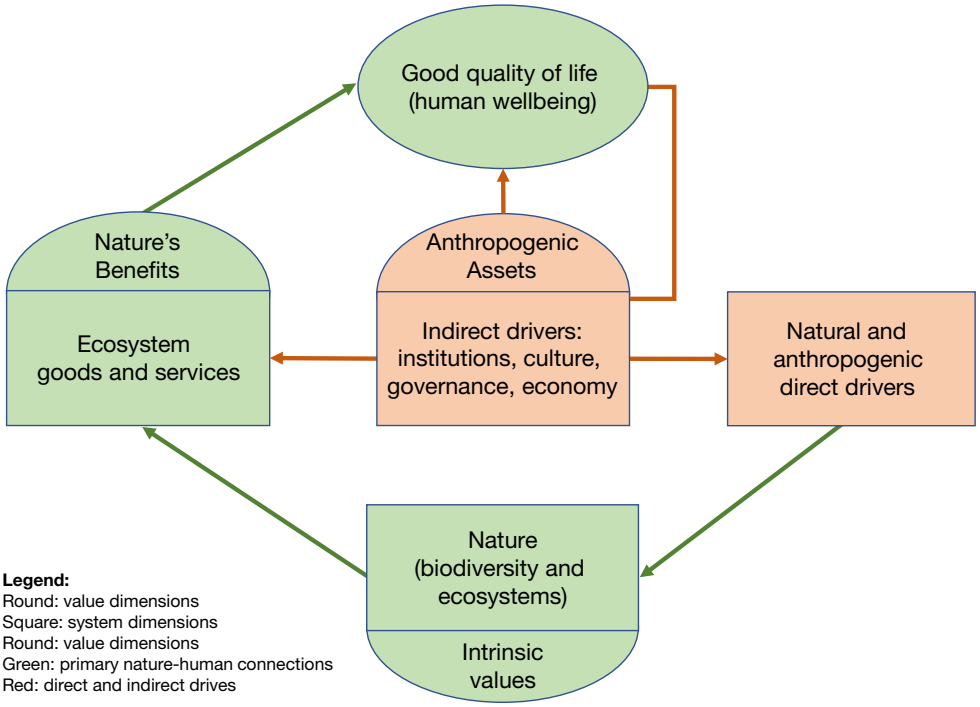


Figure 1.1: Conceptual framework based on IPBES and adapted for the Wyss Academy hub regions. Source: CETRAD derived from Díaz et al. (2015)

University of Bern, and its partners. The land cover analysis is based on data released by the Lao Ministry of Agriculture and Forestry every five years. Information on systems dynamics is based on satellite imagery (Landsat, MODIS) and publicly available global datasets provided by International Geosphere-Biosphere Programme (IGBP), Global Biodiversity Information Facility (GBIF), and others. Climate models are based on the Coupled Model Intercomparison Project, included in the Fourth and Fifth Assessment Reports of the Intergovernmental Panel on Climate Change (IPCC). The ecosystem and biodiversity assessments are based on a review of peer-reviewed literature, complemented with grey literature such as biodiversity strategies, climate change adaptation, and mitigation action plans. The ecosystem service assessment is based on a range of comprehensive nationally spatial datasets for the supply side, while the ecosystem service demand analysis is based on household sample survey data collected in Savannakhet province in December 2020. The analytical work on indirect drivers of change relies on data from the Lao National Population and Housing Census, as well as numerous project reports and government documents.

2 Status and trends of ecosystems and biodiversity

Michael Epprecht, Anh-Thu Nguyen, Christian Hergarten, Mark Snethlage, Amor Torre-Marin Rando, Markus Fischer

Laos lies at the center of one of the highest-ranking areas for global conservation significance, the Indo-Burma biodiversity hotspot (Tordoff et al. 2020). The area is home to a large number of endemic species and irreplaceable habitats and ecosystems, with many new species still being discovered every year in the Greater Mekong region (WWF 2017). Within Laos, the Annamite mountain range along the Lao-Vietnamese border (Map 1, Annex) is widely recognized as the most important area for biodiversity conservation.

Laos has a very high species diversity of fauna and flora, with around 10,000 different species of plants, up to 200 species of reptiles and amphibians, around 500 species of fish, 700 species of birds, and over 100 species of large mammals. Lao wildlife includes flagship species such as the Asian tiger, Asian elephant, Siamese crocodile, crested gibbon, and Irrawaddy dolphin. New species continue to be discovered, some of them just short of extinction. The critically endangered saola, for instance, a large bovid mammal, was discovered only in 1992, and has never been seen in the wild by a biologist. A total of 420 of the species found in Laos are on the red list of the International Union for Conservation of Nature (IUCN), with five of the species "critically endangered" and 23 endangered.

Agrobiodiversity is also high in Laos. Many of the plants and animals are economically important as non-timber forest products (NTFP) for a wide range of uses, including as a major source of protein, and thus represent an important aspect in the livelihoods of large parts of the rural population (Map 17, Annex).

2.1 Main ecosystems of Laos representing key hotspots of biodiversity

Evergreen forest

The wet evergreen forests of Laos are particularly rich in biodiversity and those within the Annamite mountain range (see Map 1 and Map 5, Annex) represent the highest global priority for biodiversity conservation in Laos, as they contain a large a number of endemic taxonomic groups (Parr et al. 2019). At the same time, these ecosystems are under tremendous threat, due

to the high value of their resources. Furthermore, there are globally very few such ecosystems remaining, and Laos accounts for a high proportion of these areas (ibid.). The most important wet evergreen forest areas in Laos are found in the headwaters of the Nam Chat and Nam Pan rivers, partly within the Nam Chat–Nam Pan provincial conservation forest area, as well as in Nakai-Nam Theun National Park, Khong Xe Nong Ma and Xe Sap National Protected Areas, and some forest areas of Xe Kong to the south of Xe Sap National Protected Area (ibid.) (see also Map 2, Annex).

These forest areas are topographically very diverse, ranging from lowland wet evergreen forests to wet evergreen hardwood and coniferous forest habitats at higher altitudes. This diversity of vegetation supports a unique and wide range of important species – many of them with a limited distributional range in this habitat. Big gaps in knowledge about the biodiversity in these areas remain, as many of the relevant surveys were conducted over 20 years ago and many of the large mammalian species have since severely declined in number or even become extinct. Iconic species that have been reported as declining include the saola (*Pseudoryx nghetinhensis*) and the Asian tiger (*Panthera tigris*), as well as – among many others – the Asian elephant (*Elephas maximus*), clouded leopard (*Pardofelis nebulosa*), white-winged duck (*Cairina scutulata),* red-shanked douc langur (*Pygathrix nemaeus*), white-cheeked gibbons (*Nomascus siki/leucogenys*), oriental small-clawed otters (*Aonyx cinereus*), and e.g. sambar (*Rusa unicolor*) (Parr et al. 2019).

The primary threat to evergreen forest areas is industrial-level snaring and illegal logging (see Chapter 4 of this report discussing direct drivers of change).

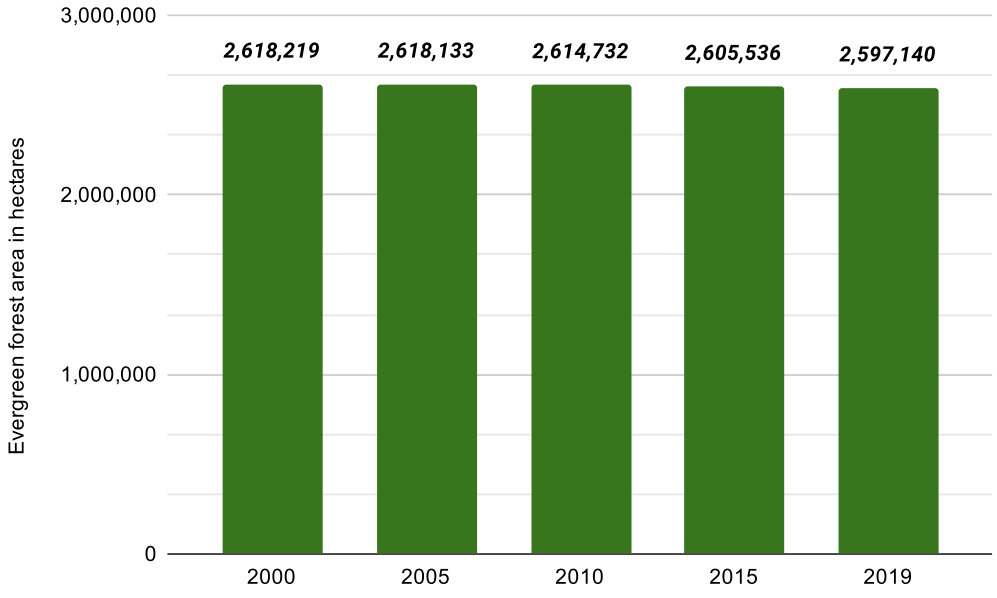


Figure 2.1: Evergreen forest cover in hectares, for the years 2000, 2005, 2010, 2015, and 2019. Source: Authors' design, based on data from the Government of Lao PDR (GoL), 2019

Limestone karst and montane forest ecosystems

The other main area of very high global priority for biodiversity conservation in Laos are the Indo-China limestone karst areas (Map 6, Annex) (World Bank 2020a), particularly the karst formation in central Laos, best represented in Hin Nam No National Park and Phou Hin Poun National Protected Area

(Map 2, Annex). These areas, too, are home to many endemic species, several of which are under high threat, although the rugged landscape affords them slightly more protection than other forest types.

Important species include the Lao rock rat (*Laonastes aenigmamus*) – which belongs to a new mammalian family which was, until recently, thought to have gone extinct millions of years ago – and the equally endemic Lao langur (*Trachypithecus laotum*), as well as restricted range bird species such as the red-collared woodpecker (*Picus rabieri*), sooty babbler (*Stachyris herberti*), and bald-headed bulbul (*Pycnonotus hualon*) (Parr et al. 2019).

The main threat to this ecosystem comes from limestone quarrying, which is prevalent in Phou Hin Poun National Protected Area, as well as from hunting and snaring (see also Chapter 4 in this report).

Another priority for biodiversity conservation are the upper montane forest ecosystems above an elevation of 1,800 m (Ministry of Natural Resources and the Environment 2020) (Map 6, Annex). Montane forests are globally significant, due to high representation of species within restricted altitudinal ranges (Parr et al. 2019). These forests are characterized by a limited tree flora, but an abundance of epiphytes, particularly ferns and mosses, many of which are local or regional endemics. The most important montane forest areas in Laos are those on the border with Vietnam in Xieng Khouang province (around Tor Sip National Protected Area) and those to the south of Xe Sap National Protected Area (in Xekong province) (ibid.).

Dry dipterocarp forest

The dry dipterocarp forest (Map 6, Annex) ecosystems of Laos are of global importance and a global priority for biodiversity conservation because they contain an exceptional variety of animals and plants and are representative of this type of ecosystem, of which only very few remain on the planet. They are home to globally significant species such as the threatened Eld's deer (*Rucervus eldii siamesis*), white-shouldered ibis (*Pseudibis davisoni*), giant ibis (*Thaumatibis gigantea*), and green peafowl (*Pavo muticus*) (Parr et al. 2019).

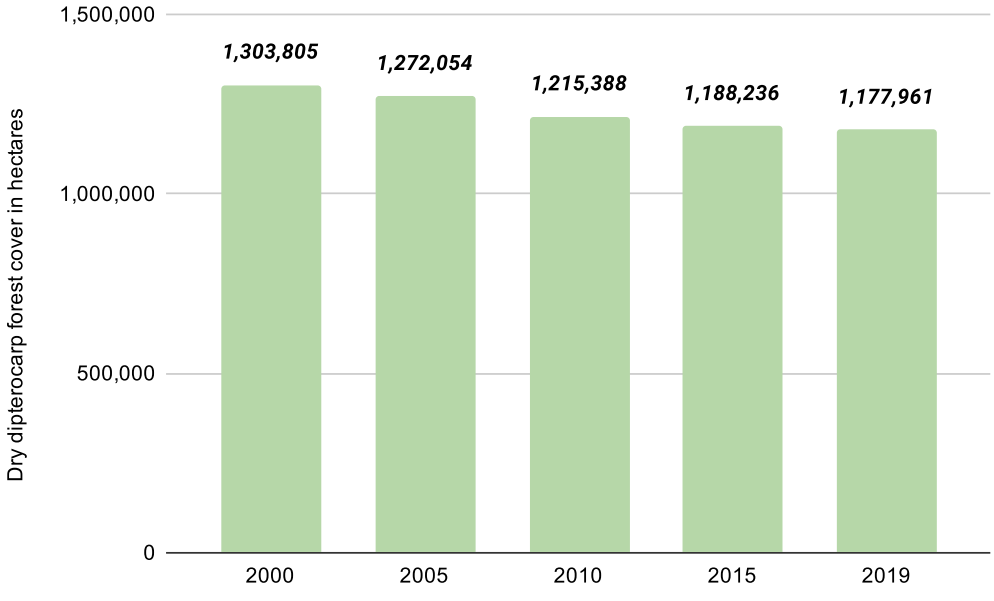


Figure 2.2: Dry dipterocarp forest cover in hectares, for the years 2000, 2005, 2010, 2015, and 2019. Source: Authors' design, based on data from the Government of Lao PDR (GoL), 2019

Wetlands

Swamps and wetlands across Laos are of high ecological significance for aquatic and amphibic wildlife, migratory birds, and household subsistence through fisheries and collection of other wild products. There are a large number of important wetlands throughout the lowland areas of Laos (Map 7, Annex), including seasonally flooded shrublands and permanently flooded swamp forests, although the total extent and respective dynamics are still poorly known. Many of these areas, under pressure from agricultural development, have shrunk in recent years (Figure 2.3). An inventory conducted in 1996 identified around 30 wetlands throughout Laos covering a total area of around 1 million ha (Claridge 1996). In 2011, five wetlands were selected as priority sites for conservation (Phiapalath et al. 2011); two have since fallen victim to urban expansion: the That Luang marsh in Vientiane capital, and the Nam Theun wetlands, both of which have been largely inundated by the Nam Theun 2 hydropower reservoir.

Laos designated two sites as "wetlands of international importance" (or "Ramsar sites", under the Ramsar Convention) in 2010. The Beung Kiat Ngong wetland complex in Champasak province is partly within the Xe Pian and Dong Hua Sao National Protected Areas (Map 2, Annex), and includes swamps, lakes, and marshes – it is also the only place in Laos with peatland. The Xe Champhone wetlands in Savannakhet province include areas of marsh, swamp, and flooded forest. These wetlands harbour the largest of the few populations of the critically endangered Siamese crocodiles (*Crocodylus siamensis*) in Laos, and support important riverine bird communities, with significant concentrations of several waterbird species, such as river lapwing (*Vanellus duvaucelii*) and small pratincole (*Glareola lacteal*), as well as a population of the recently described Mekong wagtail (*Motacilla samveasnae*) (Parr et al. 2019). Native habitats of these species have also come under significant threat from the invasive woody shrub, *Mimosa pigra*, in the southern part of these wetlands.

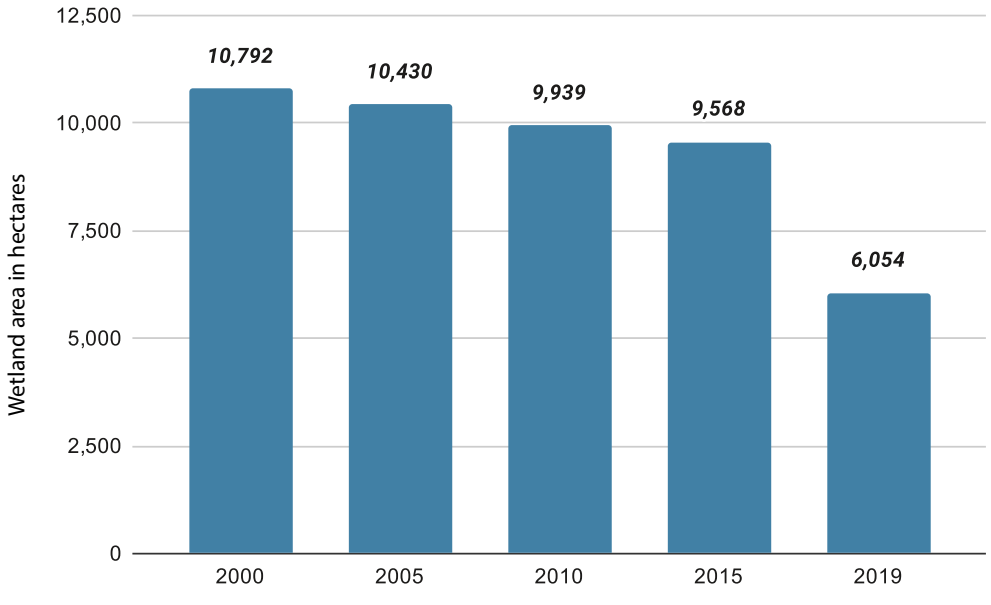


Figure 2.3: Wetland area in hectares, for the years 2000, 2005, 2010, 2015, and 2019. Source: Authors' design, based on data from the Government of Lao PDR (GoL), 2019

River ecosystems

Like wetlands, river ecosystems play an important role in Laos (Map 7, Annex). The Mekong river, running through the length of Laos from north to south, is one of the world's most biodiverse rivers, second only to the Amazon. The Mekong and its major tributaries – now reduced to the Sesan and Sekong rivers, with the Nam Ou river a cascading hydropower reservoir system – represent the best remaining riverine ecosystems of the region. Although the biodiversity of these rivers is far from fully understood, the rivers are known to provide vital ecosystem services to millions of people, and are home to globally threatened fish species such as the Giant Mekong catfish. They are also home to the Irrawaddy dolphin – one of the world's three freshwater dolphin species, which inhabits the southernmost parts of the Mekong in Laos – as well as turtles, otters, and riverine bird communities such as the white-shouldered ibis, river tern (*Sterna aurantia*), great thick-knee (*Esacus recurvirostris*), river lapwing (*Vanellus duvaucelii*), and small pratincole (*Glareola lactea*) (Tordoff et al. 2020).

The main threats to the river system's biodiversity are overfishing and major hydropower projects. Biodiversity has already sharply diminished over the past decade as a direct result of the construction of a series of hydropower dams. Dams have been built along the Nam Ou river, a major tributary to the Mekong in the northern part of Laos as well as along the Mekong river in Xayabury and Don Sahong, and along the Sesan river in the country's south (ibid.).

Forest degradation

Forest cover in Laos has changed dramatically in the last 50 years. While 64% of the country was covered in forest in the mid-60s (World Bank 2001), this was down to roughly 40% at the start of the 21st century (MoNRE and IUCN 2016) due to deforestation and forest degradation (Thomas 2015). According to the Global Forest Resource Assessment published by the Food and Agriculture Organization (FAO), the deforestation trend seems to have slowed down after 2000, and forest cover may even have increased in recent years, particularly in some areas of northern Laos (FAO 2015). However, this should not hide the fact that the process of forest degradation has continued, but in a more fragmented way: Compact forest areas of over 1,000 ha have decreased from 88% of the total forest area in 1992 to 54% in 2004 (Tong 2009).

Table 2.1: Changes in forest cover in the Mekong Region countries. (FAO 2015)

			Annual change in forest area (%)		
Country	**Forest area 2015 (ha)**	**Forest area 2015 (%)**	**1990–2000**	**2000–2010**	**2010–2015**
Cambodia	9,457,000	54	-1.1	-1.3	-1.3
Lao PDR	18,761,000	81	-0.7	0.8	1
Myanmar	29,041,000	44	-1.2	-0.9	-1.8
Thailand	16,399,000	32	2	-0.5	0.2
Viet Nam	14,773,000	48	2.3	1.9	0.9

While Laos is still very rich in biodiversity, this biodiversity is declining at an alarming rate – as is the quality of the habitat provided. This decline in quality in shown particularly in the forests, despite Laos still having the highest proportion of tree cover among the countries in the lower Mekong basin (Figure 2.1). This is because forested areas are now in large part comprised of secondary forests (Heinimann et al. 2007), primarily as a result of selective logging and extensive shifting cultivation with shortened fallow periods – which, in turn, are due to increasing land scarcity and competition for available arable land amid a growing population. While such secondary forest areas still have the potential to sustain a high degree of bio- and agro-biodiversity (ibid.) and may even support a higher biomass of wildlife (Robinson and Bennett 2004), a range of species that cannot survive in such altered ecosystems has been lost (Boonrotpong et al. 2004; Robinson and Bennett 2004).

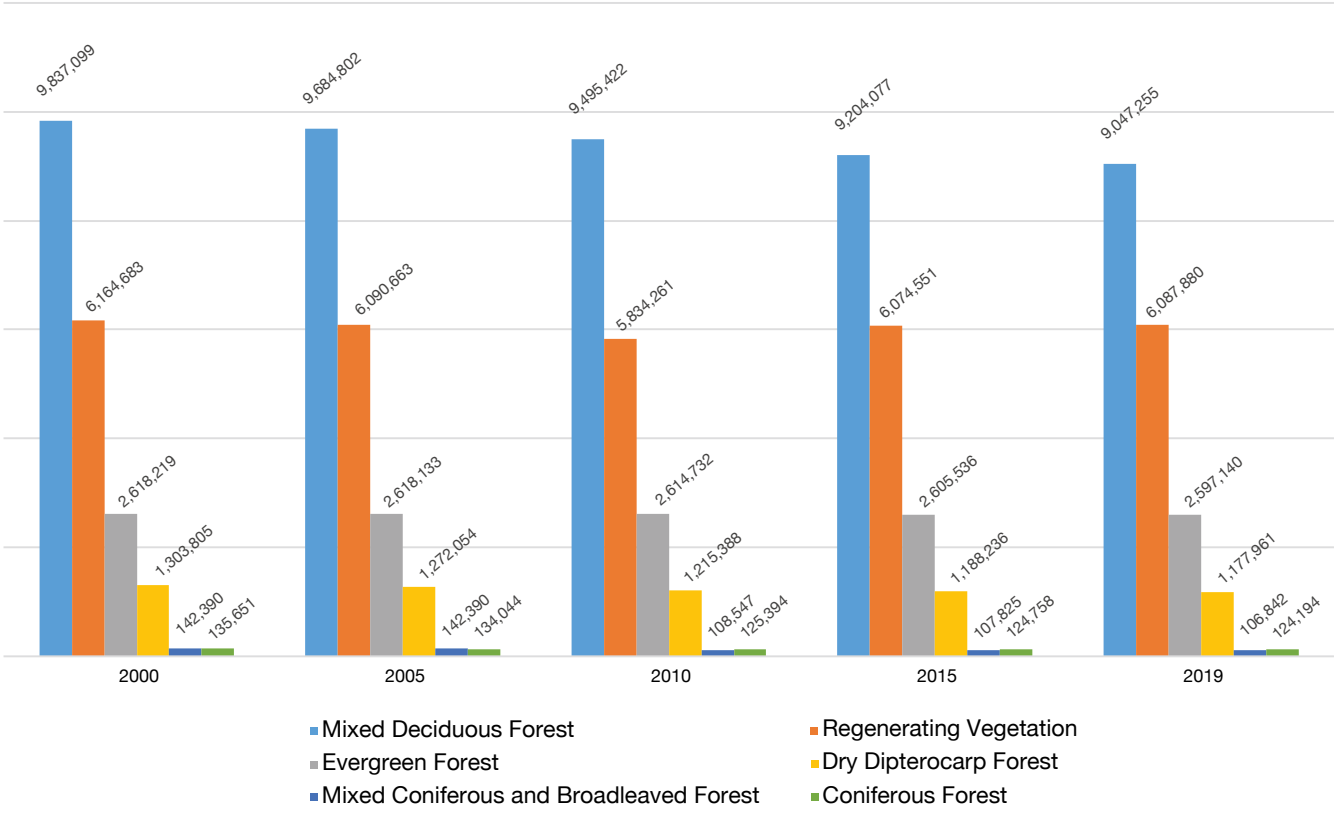


Figure 2.4: Subtle changes in natural forest areas 2000–2019. Source: Authors' design, based on GoL, 2019

The extinction or critical endangerment of a wide range of large and iconic species in Laos – such as the large carnivores tiger and leopard, the large herbivores saola, rhinoceros, and kouprey, as well as large aquatic species such as the Irrawaddy dolphin and the Giant Mekong catfish – is indicative of the magnitude of general biodiversity loss in the region, both on land as in water.

2.2 Status and trends of major agroecological regions

Two thirds of Laos is mountainous, implying both challenges and opportunities. The country's high biodiversity and agro-biodiversity values, as well as the different agricultural production systems, are present in a number of distinctive main agro-ecological regions (Map 4, Annex):

1. *The northern uplands and highlands* are characterized by a rugged terrain of steep mountains covering much of the country's north, intersected by valleys with smaller flood plains known as the northern lowlands. The sub-tropical seasonal wet and dry climate supports wet season rainfed upland and lowland rice cultivation, dry season irrigated lowland rice, and limited dry season upland crops. Shifting rice and maize cultivation is predominant on the steeper slopes and irrigated and rainfed paddy rice predominates in the valleys. Hunting and collection of non-timber forest products, both for domestic consumption as well as for trade, are an important aspect of rural livelihoods in the area. Commercial tree plantations – rubber and teak in particular – as well as household-level agricultural commercialization, including contract farming – especially maize, cassava, and banana – have expanded in many parts of the northern uplands, rapidly transforming the local agroeconomic and environmental landscapes.
2. *The south–central midlands and highlands*, including the Annamite mountain range along the Lao-Vietnamese border, have a sub-tropical monsoon climate. During the winter months, the cold and mostly dry northeastern monsoon brings only infrequent light rain – although some saddle areas receive higher rainfall up to ten months a year. During the summer months, the warm and moist southwestern monsoon causes heavy rainfall in the wet season. Occasional typhoons reach the area with heavy downpours, typically in later summer. The region is characterized by high and steep sandstone and granite mountains in some parts, and by limestone karst landscapes in other parts, intersected by narrow valleys and smaller alluvial plains. The geography and the monsoon climate supports similar agricultural practices as in the northern uplands. Hunting and collection of non-timber forest products in the predominantly wet evergreen forests, both for domestic consumption as well as for trade, are particularly important in this region, and almost industrial-level snaring has depleted many of the region's forest areas of its wildlife. Logging and timber extraction have been a threat to the region for decades, although the government has increased its efforts to better enforce the existing logging bans in the past years, with some positive effects.
3. *The alluvial plains* along the Mekong river and its major tributaries comprise the Mekong corridor, the Vientiane plain, and the northern and southern lowlands. The sub-tropical seasonal monsoon climate of the plains supports irrigated and rainfed lowland agriculture. Rice is by far

the most predominant crop, followed by maize, sweet corn, and cassava.

4. *The area on and around the Boloven plateau,* a basaltic plateau in the south of Laos, has fertile soils and a moderate climate. The main forms of agricultural production are small-scale and larger-scale commercial horticultural agriculture as well as coffee plantations.

Agricultural production and land use systems

Only around 6.5% of the country's land area is under permanent agricultural use, with another 9.6% considered potentially suitable for agricultural use (Lao Statistics Bureau 2015a). The amount of land used for shifting cultivation or slash-and-burn agriculture is difficult to quantify, particularly as the land involved is under different stages of use and regeneration. Messerli et al. (2009) estimate the amount of land under shifting cultivation systems – i.e. all land at all stages of the rotational cycle – at around 67,000 km^2, or 28% of the total land area.

Two main types of agricultural production and respective land use systems exist in Laos:

Lowland irrigated and rainfed agriculture, mixed with varying degrees of livestock. In the rainy season, the lowland rainfed production system involves mainly paddy rice production. In the dry season, it involves livestock grazing on the harvested fields and limited dry season crops such as sweet corn and long beans. Fruit trees, vegetables, and small livestock are kept in and around home gardens for home consumption as well as for sale of surplus. Livestock – mainly cattle and buffalo; and sometimes goats, chicken, and ducks – are an important source of income and savings; they are also used for home consumption, and in some cases, for field preparation. Livestock manure is sometimes used as fertilizer, but less so during the dry season, when there is less grazing land available. This means that typically, more chemical fertilizer inputs are used on dry season crops, which are grown on irrigated fields in the lowland irrigated production system. The system is characterized by an additional dry-season rice crop that is used primarily for market purposes.

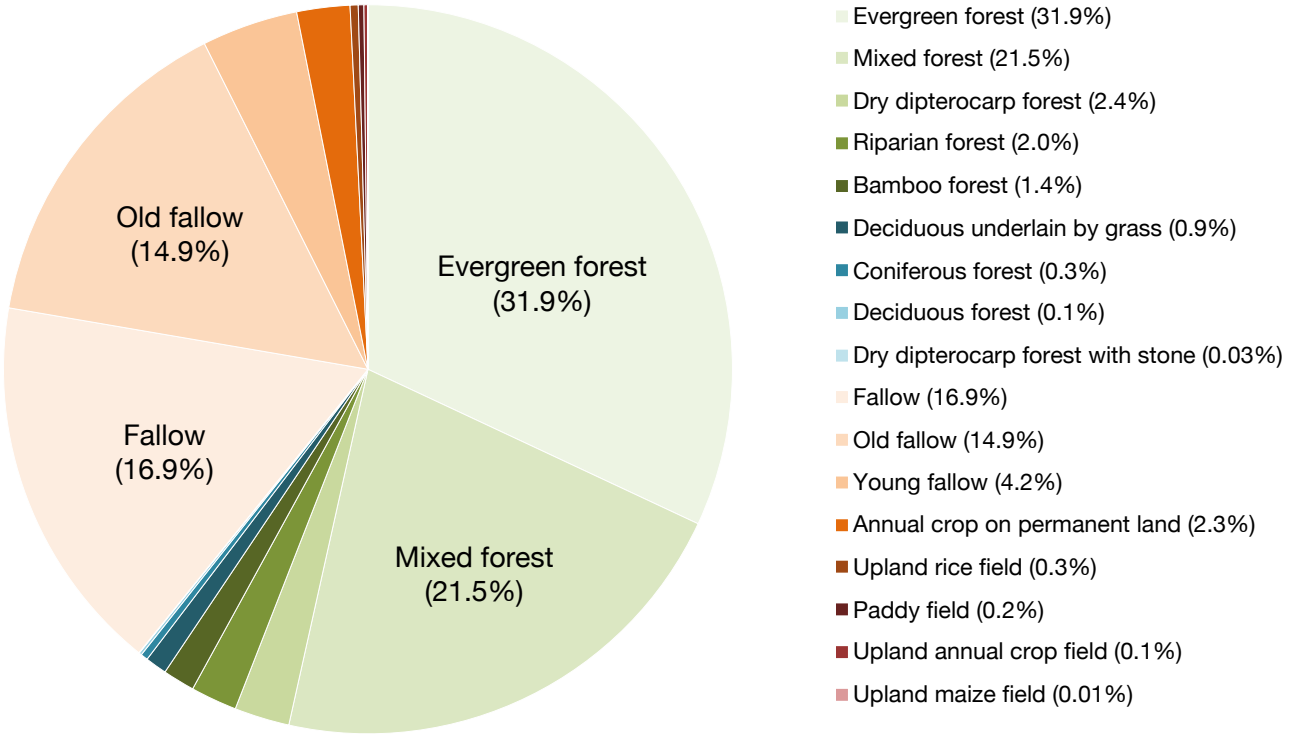
Upland rotational agriculture, mixed with varying degrees of livestock. Uplands rice cultivation in the rainy season is the main aspect of this production system. On the gentle slopes, upland fields are cultivated on a rotational basis, with fallow periods of anywhere between 2–7 years, whereas the steeper slopes are characterized by the practice of swidden, or shifting cultivation, with typically longer fallow periods between 4–10 years. Rice production is predominantly for domestic use, whereas limited cash income is generated through cultivation and sale of home-grown vegetables and fruits, as well as through collection and sale of forest products. Livestock grazing in forest and fallow lands in the wet season, and on harvested upland rice fields in the dry season, is used for domestic consumption, as a source of savings, and for sale.

Non-timber forest products (NTFPs)

Non-timber forest products (NTFPs), including hunting, play a particularly important role in the livelihoods of households in the production systems discussed above. Over 450 edible species have been documented thus far, utilized by households for subsistence consumption as well as for cash income (Foppes and Ketphanh 2004). The study of NTFPs and their use by local people presents a number of methodological challenges. Foremost is the inexact definition of an NTFP, defined by what is it not (Neumann et al. 2000).

Under CDE's TABI program ("The Agrobiodiversity Initiative") between 2010 and 2019, complete census-level NTFP-related data were collected in 189 villages across the provinces of Huaphanh, Xiengkhouang, and Luang Prabang, as well as ad hoc collection in the provinces of Phongsaly, Oudomxay, Bokeo, Xaysomboun, Bolikhamxay, Savannakhet, Champassak, Sekong, Salavan, and Attepeu. This dataset contains 3,689 records of NTFPs collected and sold as cash income by 18,511 households. Preliminary analysis conducted by CDE shows that NTFPs originate from a variety of landscapes, including but not limited to forests. Approximately half of reported NTFPs collected in the study sites originated from agricultural land, including fallow areas and rice paddy (Figure 2.5).

Figure 2.5: Proportion of NTFPs collected by landscape, greenish colors stand for current forest landscapes, reddish colors represent agricultural landscapes. Source: Based on 3,689 NTFP records collected in TABI study sites. Source: Authors' design.



Further, there have been numerous efforts to quantify the role of NTFPs for households and the economy at large. Additional analysis of the TABI study sites found that approximately 14% of households reported cash income from NTFPs. Deeper examination across income quintiles revealed that poor and poorest households were the most reliant on income from

NTFPs (Table 2.2). Naturally, there is a large degree of heterogeneity between villages in the role of NTFPs. Previous studies, including surveys and village-level case studies, have estimated the cash income contribution of NTFPs to range from 20–50% for rural households (Foppes and Ketphanh 2004; Van Der Meer Simo et al. 2019). Estimates of the role NTFPs in the wider national economy conducted by the National Agriculture and Forestry Research Institute (NAFRI) as part of the Switzerland funded 'Knowledge for Development' (K4D) project have highlighted first, that the official contribution to the national economy values several million USD, and second, that official quotas of NTFPs undervalue the true production and economic value by potentially seven to eight times. Still other studies highlight that due to the complexities associated with defining NTFPs, calculation of subsistence and forest income, issues with informant recall, and underreporting associated with illegal harvesting activities, there remains a high degree of underestimation (Nguyen and Parvathi 2017). Nonetheless, the assumption that forests will be better conserved under sustainable NTFP harvesting warrants further study, with attention paid to the economic values of NTFPs.

Table 2.2: NTFP income across income quintiles in sample villages of northern Laos

	Income quintiles				
Indicator	Poorest	Poor	Medium	Rich	Richest
Mean total household income (LAK/year)	1,888,240 (770,826)	4,813,701 (909,562)	8,615,618 (1,439,833)	15,791,695 (3,033,096)	42,381,237 (35,957,370)
Mean NTFP income (LAK/year)	241,681 (435,297)	703,989 (1,110,355)	935,625 (1,610,162)	1,039,146 (2,286,870)	1,003,526 (3,880,861)
% of NTFP in total income	12.03*	14.81*	11.19*	6.93*	2.83*

Note: Household statistics are not adjusted for composition, i.e. adult equivalent units, due to lack of necessary data. Standard deviation presented in brackets.

** Indicates differences between the income groups are significant at the 1% level according to Kruskal-Wallis tests, where the critical value of (4 d.f.) = 862.82. Pairwise comparisons using Wilcoxon rank sum tests with Benjamini and Hochberg correction confirm differences between all groups at the 1% significance level.*

Source: Analysis conducted by CDE, based on 18,511 household observations collected in TABI study sites

Commercial and industrial agriculture

Commercialization of agriculture is a key strategy for rural development and poverty reduction in Laos. This includes transitioning smallholder production from subsistence to market orientation, encouragingcontract farming or outgrower schemes, and increasing the number of land concessions for agriculture and tree plantations. Focus crops for commercial plantations include coffee, cassava, maize, tobacco, and sugarcane, with the parallel aim of growing the agro-processing industry for these products (Alexander et al. 2017). This transition towards

commercial and industrial agriculture has prompted a move away from traditional shifting cultivation systems, which coincides with the national policy of eradicating shifting cultivation as a driver of deforestation and forest degradation, although this is widely contested (Ornetsmüller et al. 2016). Production has shifted towards agricultural intensification, including rapid growth of industrialized agriculture and plantations in often monoculture systems (Rigg 2006; Byerlee 2014).

Forest use

All forests – and the natural resources they contain – belong to the State. The State, however, recognizes usage rights of the land and its resources. There are three forest management categories defined in the Forestry Law (National Assembly 2007): protection, conservation, and production forests. These categories are delineated as broader management areas (Map 3, Annex), and do not necessarily include only forested areas, but all types of forest such as primary forests, secondary forests, regenerated forest land, and forests used by villages. Conversely, not all forests are covered by those three forest management areas. These national forest management areas are national level administrative categories. Provinces and districts can designate additional province- and district-level forest management areas. The three categories are defined as follows:

- *Protection Forests* have the function to protect natural resources, such as water and soil (e.g. by preventing soil erosion and managing soil quality). Protection Forests also play a role in national defense by protecting against natural disasters.
- *Conservation Forests* have the purpose of conserving nature, including plant and animal species, forest ecosystems, and recreational, cultural, and spiritual services.
- *Production Forests* are natural and planted forests that serve to produce wood and forest products and contribute towards national socioeconomic development.

The following uses are permitted or restricted in the different forest categories:

Protection and Conservation Forests are divided into designated areas of use. “Prohibited areas” may be accessed for scientific research and ecotourism only. In “designated utilization areas”, villages in or adjacent to such forest areas are allowed to engage in agricultural activities, NTFP collection, ecotourism, and tree planting. Timber harvesting for commercial purposes is prohibited. Conservation Forests may also have adjacent buffer zones with broader usage than the designated utilization areas. Conservation Forest areas of particularly high value can additionally be designated as wildlife conservation areas, national parks, or regional or world heritage sites, implying extra protection and designated funding (Forestry 2019).

Production Forests can comprise natural forests and forest plantations. Owners of forest plantations can harvest timber and NTFP upon notifying the authorities. Natural forests in Production Forest areas are managed by the Ministry of Agriculture and Forestry (MAF), which can grant usage rights to individual and commercial users (Forestry 2019).

3 The value of nature, ecosystem services, and biodiversity

Cornelia Hett, Julie Zähringer, Phetsaphone Thanasack, Sandra Eckert

The imbalance between socially driven economic growth and naturally limited resources poses the enormous challenge of how to deal with the overuse of resources – and the associated losses of natural processes that are vital to people's lives (Syrbe and Grunewald 2017). Ecosystems contribute to human welfare through a supply of natural goods, the control of material and energy flows that help to reduce natural hazards, and opportunities of nature and landscape-related cultural experiences (Bastian et al. 2014). Ecosystems provide clean drinking water, air, food, or heating. They are supported by a variety of other natural functions which may not be directly used by humans but which, such as biodiversity, support the proliferation and preservation of essential resources.

Viewing these important contributions as Ecosystem Services (ES) enables them to be mapped, typologized, and analyzed within a landscape; now in widespread use, the ES concept is becoming integrated into political decisions from regional to local levels (Vannier et al. 2019). Focusing on ES supply within a landscape is crucial to understand types, amounts, locations of ES – as well as synergies and trade-offs between ES – within a given geographic area. Equally, focusing on ES demand is crucial to understand the claims and requirements that people living in a certain landscape have on the ecosystems. Finally, juxtaposing ES supply and ES demand through comparable mapping within a study region makes it possible to examine areas of conflict between the use, and use intensity, of natural resources, and it can help to identify potentially needed conservation efforts to stop or prevent depletion of the natural system and processes (Syrbe and Grunewald 2017). After all, nature's supply of multiple ES should match societal demand, if self-sustaining human–environmental systems and a sustainable utilization of natural capital are to be achieved (Burkhard et al. 2014).

This study assessed supply and demand of key ecosystem services in Laos in a spatially explicit manner. For the assessment of supply, we focused on the national level (i.e. the proliferation of ES across the whole country). For the assessment of demand, we focused on Savannakhet province, a Wyss Academy focal area. The assessment provides valuable research inputs for discussions with key stakeholders, particularly state actors at province

and district level, policymakers from various sectors, private-sector representatives (e.g. in the commodity production or tourism sectors), and environmental protection agents.

3.1 Assessing ecosystem service supply at national level

The ecosystem services assessed in this study (using the INVEST model) are listed in Table 3.1 and mapped in Figure 3.1. Total carbon storage nationwide (including aboveground, belowground, soil, and woody debris carbon) has a per hectare and village maximum of 175 t and a mean value of 111 t/ha and village. These values can be considered slightly higher than values obtained in a similar study using the same approach for central Vietnam, which used as a baseline forest carbon stored since 2005 (Paudyal et al. 2020). In our study, carbon is greatest in the mountainous and forested regions of Laos, from north to the south, mostly along the border to Vietnam. Nationally modelled annual water yield per village is comparably small for the mountainous north.

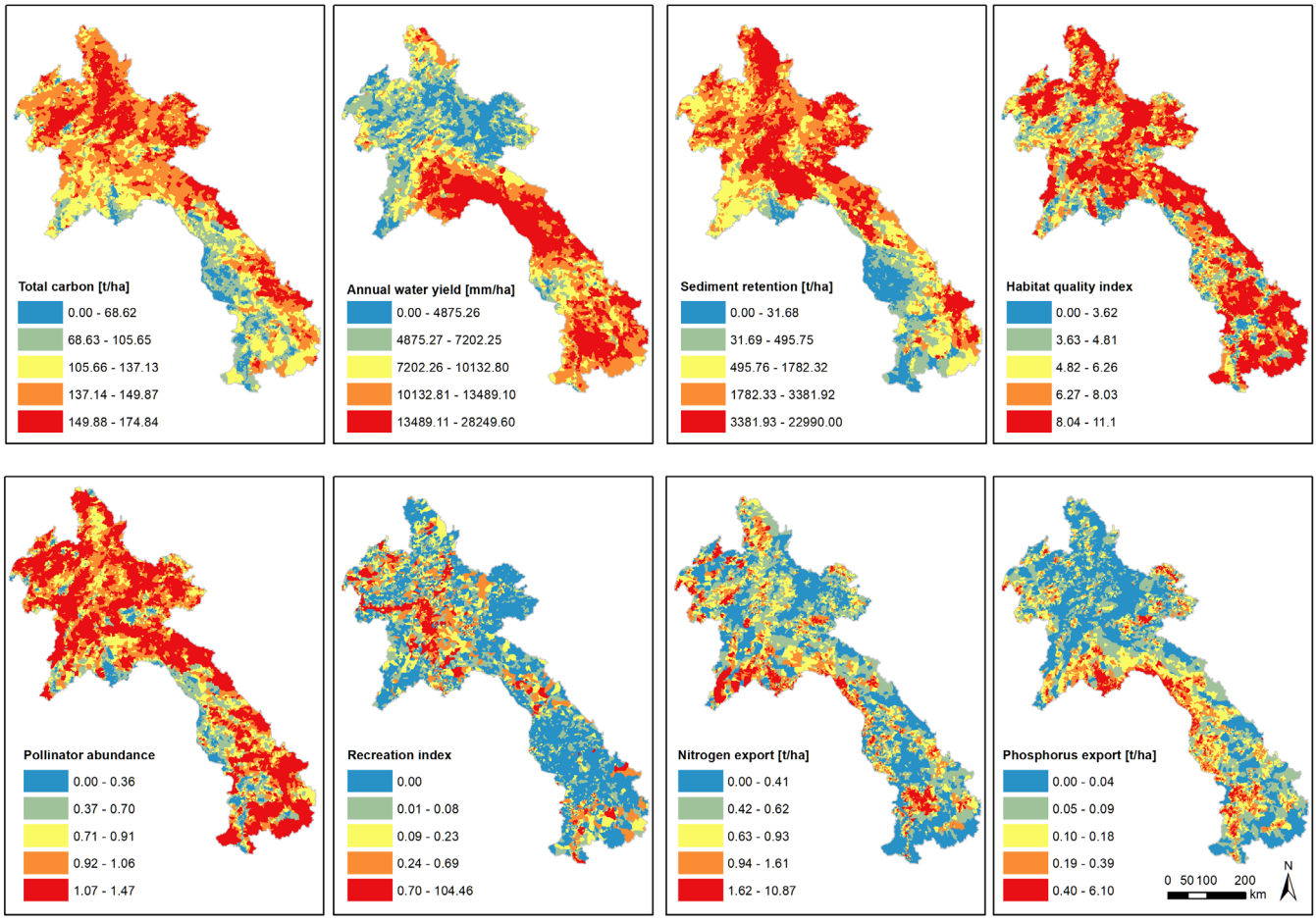
Table 3.1: Descriptive statistics for INVEST-modelled key ecosystem services. Values are averages per hectare and village (i.e., normalized for each village, depending on village size)

Service type	**Regulating**	**Provisioning**	**Provisioning disservice (clean water)**		**Regulating**	**Provisioning & regulating**	**Regulating**	**Cultural**
ES	***Carbon (t/ha)***	***Annual Water Yield (mm/ha)***	***Nutrient (N, P) Export (kg/ha)***		***Sediment Retention Index (t/ha)***	***Habitat Quality Index***	***Pollinator Abundance***	***Recrea-tion & Tourism***
Min.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1st Qu.	77.92	5417.20	0.46	0.05	57.24	3.91	0.85	0.00
Median	124.28	8488.76	0.74	0.13	1124.83	5.51	1.42	0.00
Mean	111.45	9296.30	1.11	0.26	1831.39	5.72	1.29	0.38
3rd Qu.	146.96	12724.40	1.38	0.32	2914.34	7.56	1.76	0.15
Max.	174.84	28249.60	10.87	6.10	22990.00	11.06	2.57	104.46

Modelled nutrient export is highest in areas of permanent or intensive agriculture. Nitrogen export maximum is 10.8 kg/ha, while phosphorus export peaks at 6.1 kg/ha. Both nutrient maxima can be considered outliers. For nitrogen we found them in six villages in Namtha, Kenethao, and Paksxong district, while for phosphorus they are located in four villages, all in Kham district. Excluding these outliers, our results can be compared to values found in a similar ecosystem service assessment conducted for the lower Mekong Basin, in which the value maxima lay slightly higher for both nitrogen and phosphorus. Modelled sediment retention is lowest in the west

of Savannakhet and Champasack as well as in Vientiane capital. The index identifies villages contributing more to retention with reference to a watershed where all land use/land cover is considered bare ground. Thus, it is not the amount of sediment retained in each village and therefore cannot be compared with values obtained for other countries or similar regions. However, the average sediment export for the entire country is about 120 t/ha and year, which in a global context is at the high end (Li et al. 2016). Habitat quality is highest in forested areas, including protected areas, particularly in regions that are difficult to access and/or scarcely populated. Pollinator abundance is lowest in urban areas and in areas with permanent or intensive agriculture. It is highest in forested areas and areas with regeneration vegetation. Ecosystem services linked to recreation and tourism are typically highest in villages featuring cultural sites along the Mekong river, in scenic regions, and in easily accessible protected areas.

Figure 3.1: INVEST-modelled key ecosystem services: absolute values or indices. Nutrient export ES consisting of nitrogen and phosphorus export are shown separately. Source: Authors' design



Food production services

All seven food production services show distinct typical spatial patterns across Laos (Figure 3.2). And all crops, except for Job's tears, are produced in the vast majority of all villages in Laos, albeit at generally low intensities of production.

Many crops show their own distinct spatial patterns. Lowland rice production is highest in the plains surrounding Vientiane and along the

Mekong river leading south along the Lao-Thai border. Upland rice, widely produced throughout the country, shows highest production intensities in the northeastern upland areas of Laos covering Bokeo, Luang Namtha, and Oudomxay provinces. Maize (mostly for livestock feed) and sweet corn (for three main purposes: human consumption, animal feed, and industrial products) show similar production hotspots, namely in Sayaboury province, in Oudomxay province, along the Beng river plains, and around Muang Kham in Xieng Khouang province. Production of Job's tears is highest in Sayaboury, Luang Prabang, and Vientiane province. It is found to a lesser extent in Oudomxay and otherwise produced only marginally in other areas of Laos. Hotspots for this traditional crop are likely related to ethnicity of smallholder farmers; Job's tears are cultivated mainly by Khmu and Hmong for household consumption as well as for animal feed (Epprecht et al. 2015). Finally, cassava and banana are widely popular and grown throughout the country, but our data indicate no particular high-production hotspot areas.

Table 3.2: Descriptive statistics for individual crops which, together, form the ecosystem service of "food production". Values are averages per hectare and village; for each crop, data are given in t/ha for each village. For the summary (i.e. the ecosystem service), the values are based on the standardized values of each of the seven crops.

Food production ES [t/ha]	Lowland rice	Upland rice	Maize	Sweet corn	Cassava	Job's tears	Banana	Sum of all food production
Min.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1st Qu.	0.033	0.000	0.000	0.000	0.000	0.000	0.000	0.0202
Median	0.130	0.002	0.000	0.001	0.000	0.000	0.000	0.0526
Mean	0.430	0.023	0.060	0.036	0.078	0.010	0.018	0.1289
3rd Qu.	0.522	0.021	0.005	0.010	0.004	0.000	0.003	0.1554
Max.	4.405	2.240	7.610	6.301	30.270	5.505	5.794	2.3961

The ecosystem service of "food production", calculated as the sum of the normalized production scores of all seven crops, is also given in Figure 3.2 below. Most food – i.e. the highest amount of the seven most common food crops (in terms of their production area) – is produced in the lowlands and in areas with gentle topography, particularly along the Mekong plains and in the wide river valley of its main tributaries including the Ngum, Beng, and Khan rivers. Food production is lower in areas of rough terrain and steep topography. Table 2 provides key descriptive statistics of production intensities at village level of each food crop as well as for the food production ES.

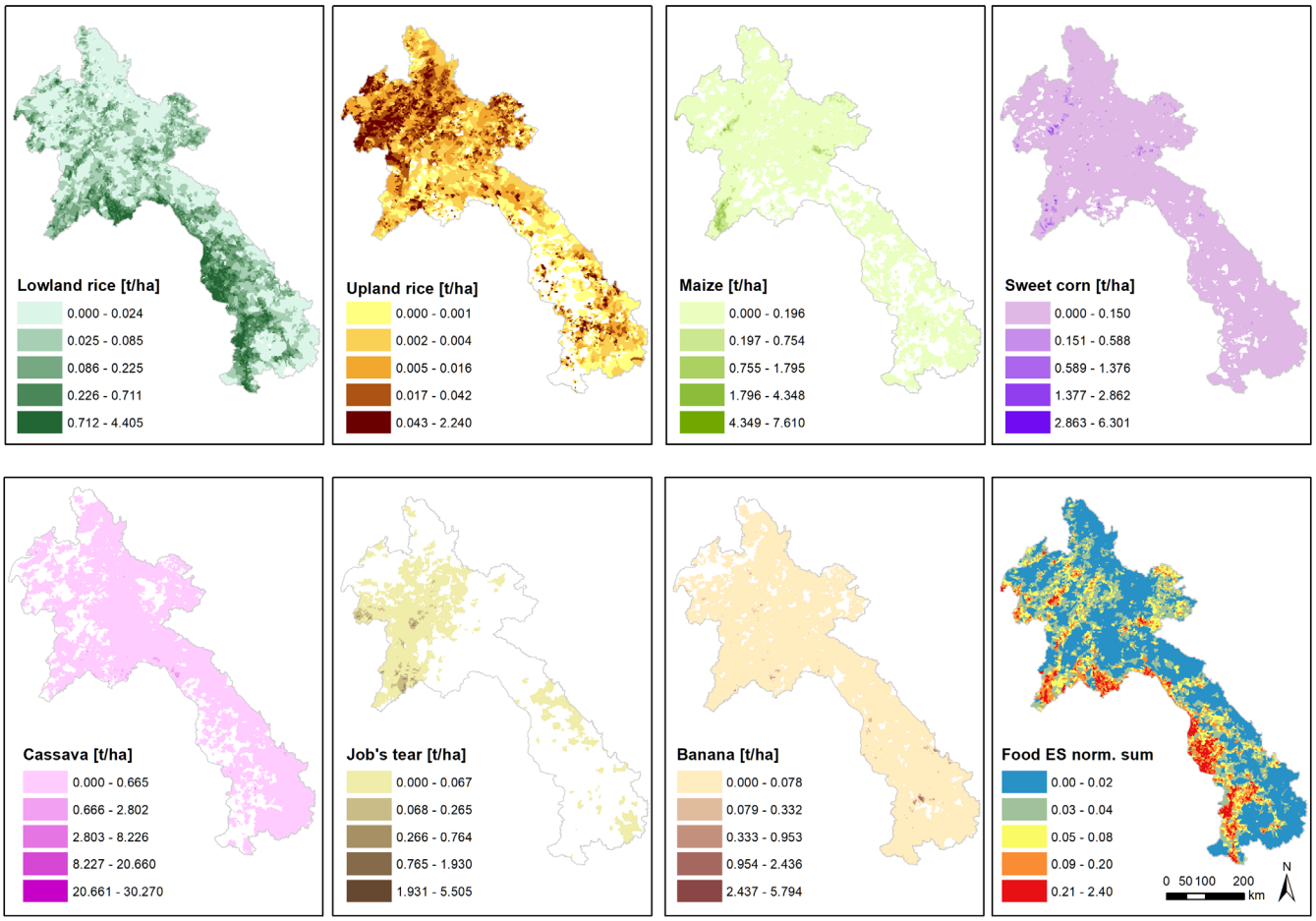
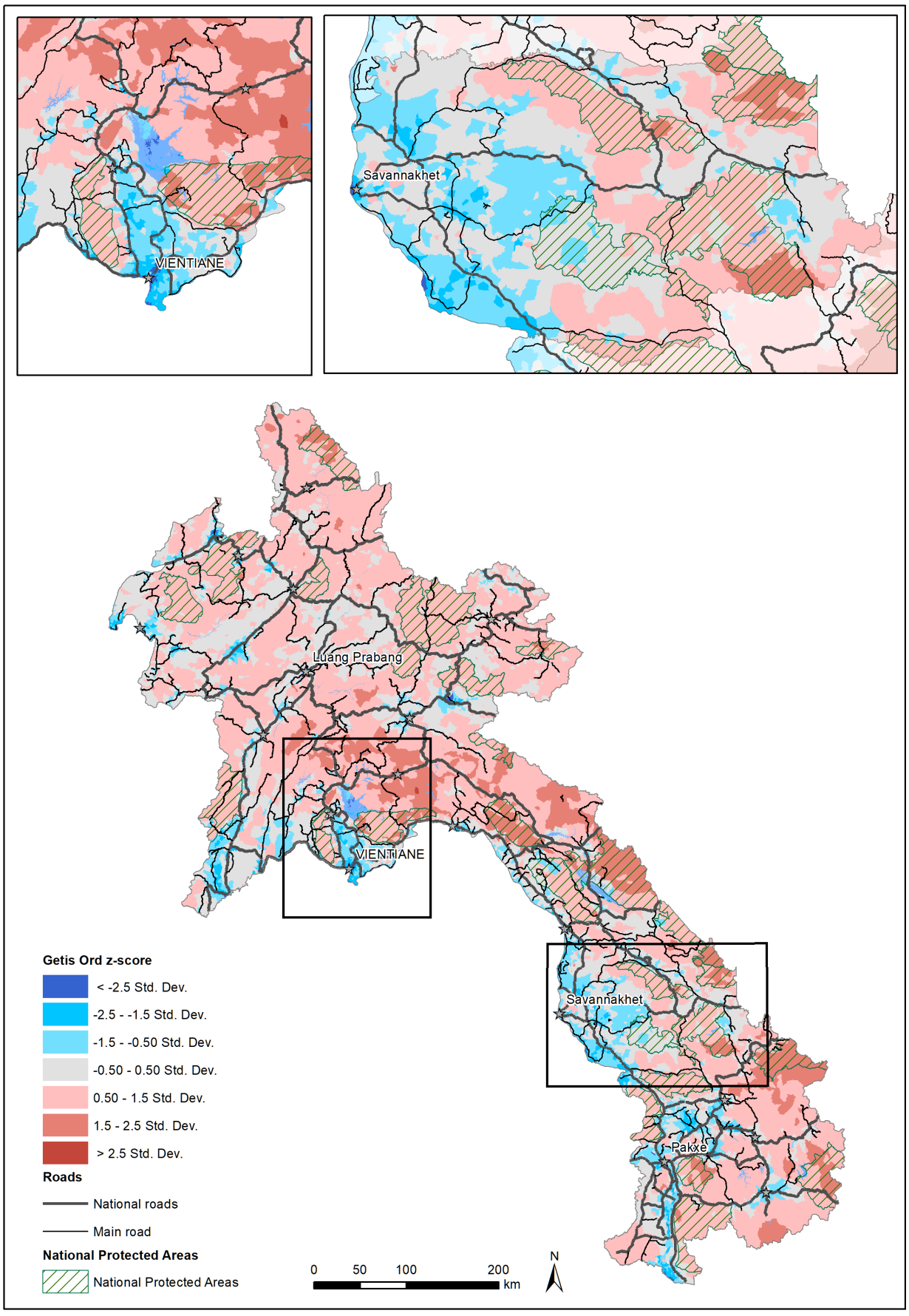


Figure 3.2: Maps for the seven most important food crops in Laos: lowland rice, upland rice, maize, sweet corn, cassava, Job's tears, and banana (from top left to bottom second from right). The bottom right map shows a summary of the food production service, calculated as the sum of all normalized food production values. Source: Authors' design

Hotspots and cold spots of ecosystem service supply

Figure 3.3 below shows the results of our hot- and cold spot analysis of ecosystem service supply using the Getis-Ord z-scores (Gi* statistics). For statistically significant positive z-score values: the larger the z-score, the more intense the clustering of high values (hotspot). For statistically significant negative z-score values: the smaller the z-score, the more intense the clustering of low values (cold spot). The Gi* statistic is two-tailed: for example, a score of ±2 represents strong clustering, as 95% of the data under a normal distribution should be within 2 standard deviations of the mean. Similarly, values between ±2 may be interpreted as weakly clustered and values lower than 2 standard deviations are expected to indicate no spatial clustering. While positive values of Gi* represent clusters that are, on average, greater than the mean (hotspots), the negative values represent clusters that are lower than the mean (cold spots) (Reddy et al. 2016) (Getis and Ord 2010). The result map shows larger cold spot areas in the area around and north of Vientiane capital, in Savannakhet province, particularly in Songkhone and Champhone District, as well as along a bow/curve reaching from Saravane province, crossing Pakse, and south along the Mekong river. Another cold spot area is in Sayaboury province, along the main road towards the border with Thailand. Visual interpretation of the cold spot areas suggests that they frequently occur in lowland and flat areas, along main transport axes, and along, or in the vicinity of, rivers and larger water bodies. Positive z-score

Figure 3.3: Getis-Ord Gi* Z-score calculated for the eight ES supplies. Dark blue areas indicate cold spots, red areas indicate hotspots; national protected areas are hatched in green. Source: Authors' design



values are found predominantly in more remote areas of the country, and hotspots of ES supply are found in central Laos, e.g. in southern Xaysomboun, and stretching from Bolikhamxay into the national protected area of Nakai in Khammouane Province, along the border to Vietnam (Figure 3.3). The overlay of national protected areas over the ES supply hotspot/bright spot data and visual interpretation suggests that hotspots are frequently located within protected areas.

3.2 Trade-offs and synergies in ecosystem service supply

The pairwise-wise correlation among the eight variables rendered the following results (Figure 3.4). Strong negative correlations were found between the summary of the food production service and the services of total carbon, sediment retention, habitat quality, and pollinator abundance. This is not surprising: total carbon is particularly low for annual food crops (in our food production services all crops except banana are annual crops), as compared to areas with forest cover. Agriculturally used landscapes lead to diminished habitat quality for wildlife animals and pollinator abundance due to loss of diversification of landscape elements. Food production and nutrient export are negatively correlated. It is slightly surprising that the

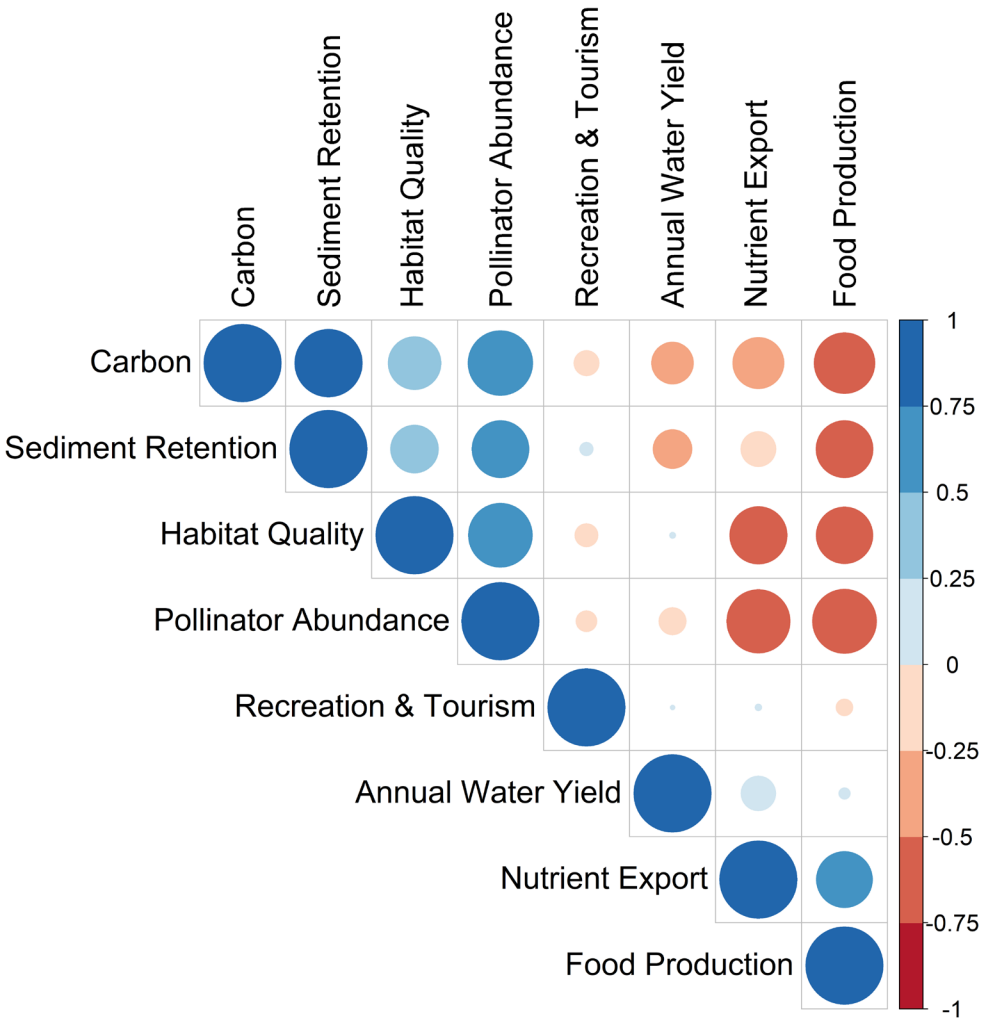


Figure 3.4: Correlation plot of the selected eight key ecosystem services. Red and blue indicate positive and negative correlations, respectively. Source: Authors' design

ES recreation & tourism is neither correlated with regulating nor with provisioning services but somewhere in between. This indicates that it is distributed across rural and urban areas. Pollinator abundance is positively correlated with total carbon, sediment retention, and habitat quality, which we link back to the land use classes of forest and natural areas, where all these services are in high supply.

Ecosystem service supply bundles are created in an attempt to understand relationships among multiple ES, in order to avoid unwanted trade-offs and take advantage of synergies between these services. Furthermore, ES bundles when analysed in conjunction with socioeconomic indicators can help in evidence-based decision-making and spatial planning. For example, identifying spatial mismatches between areas of ES bundle supply and demand – e.g. along rural–urban gradients – can help guide decision-makers on which areas need special conservation strategies and at what institutional scales ES need to be managed (Quintas-Soriano et al. 2019). In order to create ES supply bundles, we carried out a PCA analysis (see Figure 3.5). The first two components of the PCA explain 60% of the variation in our eight key ES variables. The relationship among the variables for the two first components differs at the national level compared to the Savannakhet province level and nutrient export and annual water yield have completely changed direction. Recreation & tourism has shifted a bit and sediment retention and habitat quality have changed direction.

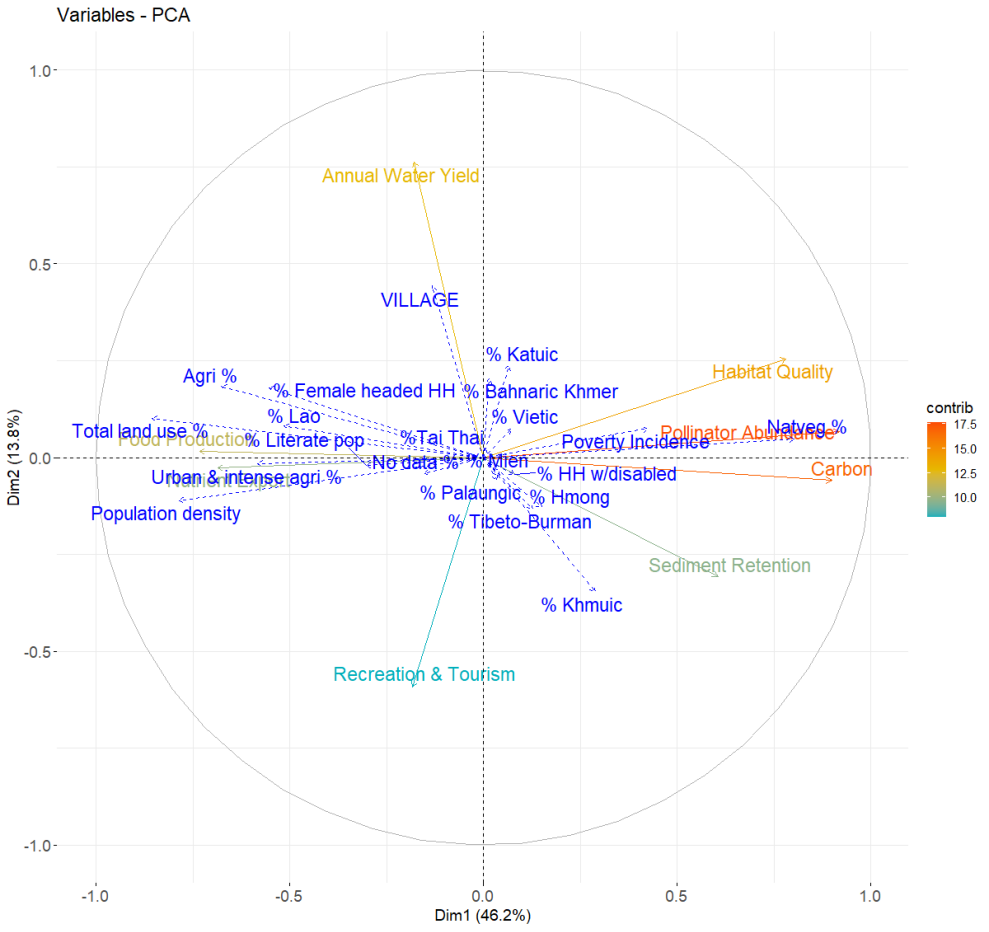


Figure 3.5: PCA variable plot. Contribution and direction of ES (in turquoise to red) to the first two dimensions (i.e. principal components). The supplementary variables are plotted in blue. Source: Authors' design

Nutrient export and food production are aligned, which seems logical and expected. At national level, annual water yield is positioned between provisioning and regulating services, while at provincial level it was clustered more closely with the regulating services.

Based on the eight ES, Figure 3.5 suggests that three is the optimal number of clusters to be formed. The bundle characteristics expressed as the mean of each ES (ES are normalized and log-transformed) are illustrated in Figure 3.6. One bundle of ES ("ES bundle 3" in Figure 3.6) has a very high average for the service of total carbon – much higher than those of the other two bundles. Habitat quality and pollinator abundance also show higher means in bundle 3 as compares to the other bundles. At the same time, food production and nutrient export are low (lower than in the other two bundles), and recreation and tourism is very low. Areas that fall under bundle 3 (see Figure 3.7) are rural, more remote areas, in a natural environment or with low use intensity. They are found predominantly in the northern uplands of Laos, areas that have a high ratio of natural forested areas and have otherwise historically been used mainly in shifting cultivation (Heinimann et al. 2013; Messerli et al. 2015). We call this bundle "upland biodiversity and climate regulation conservation areas". The second ES supply bundle (entitled "ES bundle 2" in Figure 3.6 and Figure 3.7) shows a similar pattern across individual ES supplies in Figure 3.6. However, while ES bundle 2 has lower average values for total carbon, habitat quality, pollinator abundance, and sediment retention than bundle 3, it has higher average values for annual water yield, food production, and nutrient export than bundle 3. Bundle 2 areas are predominantly located in lowland areas with more gentle terrain, as shown in Figure 3.7. We interpret bundle 2 as a

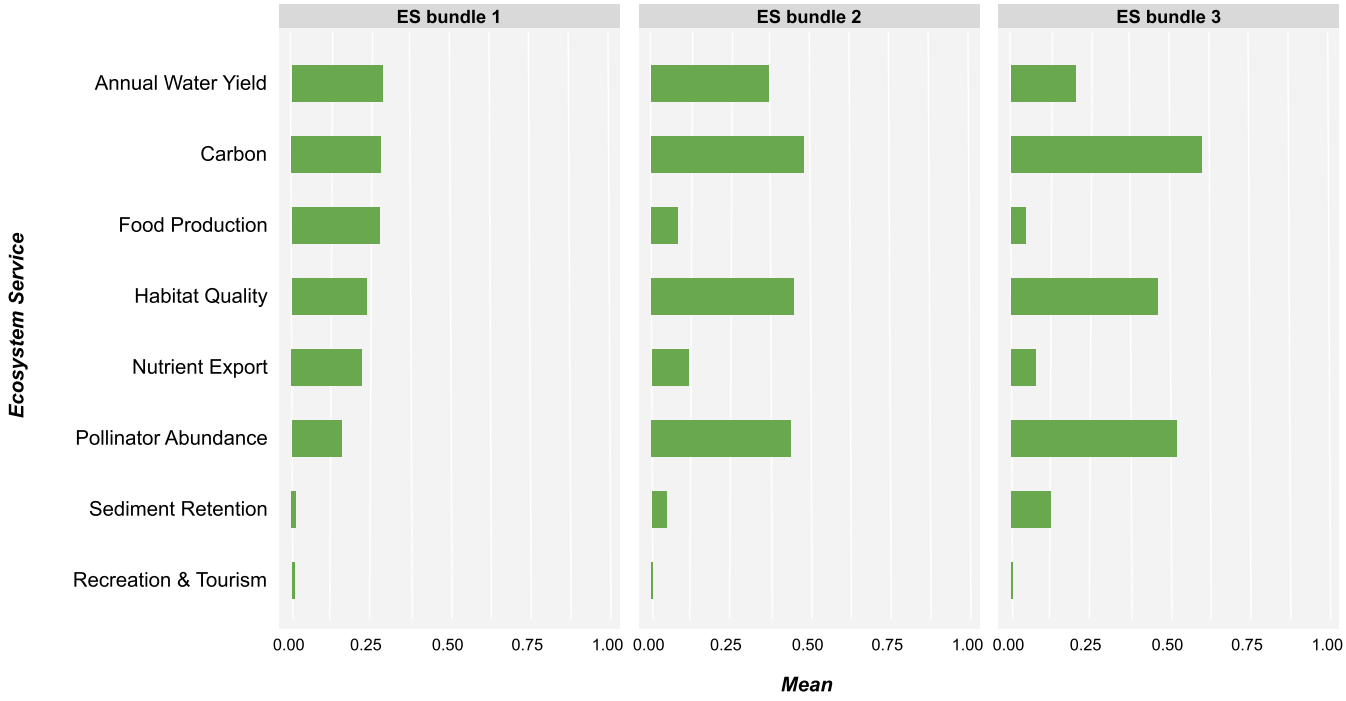
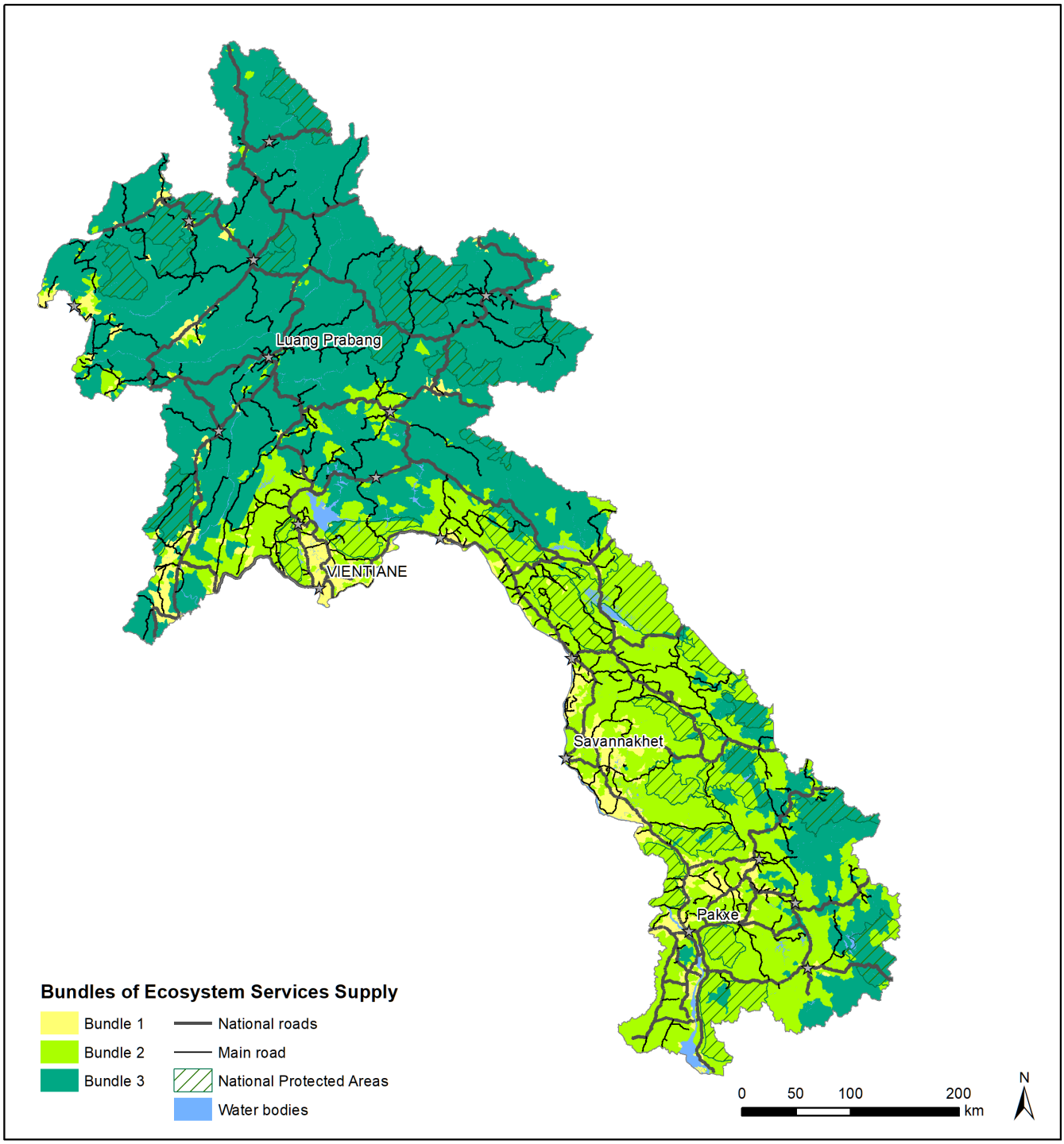


Figure 3.6: Ecosystem services supply bundle characteristics expressed as the mean of each ES (ES are normalized and log-transformed). Source: Authors' design

zone of increased agricultural production, while the landscape still has high capacity for regulating services – and hence term this bundle "lowland traditional mosaic croplands". Finally, compared to bundles 2 and 3, bundle 1 shows a lower ES supply of the regulating services carbon, habitat quality, pollinator abundance, sediment retention, and annual water yield, and significantly higher values of nutrient export and food production. We thus call bundle 1 "intensive croplands". It is located in the flat and lowland areas where the landscape is characterized by permanent agricultural production and residential areas, and in the vicinity of the urban hubs of Vientiane, Savannakhet, and Pakse.

Figure 3.7: Spatial distribution of ecosystem service supply bundles in Laos. Source: Authors' design

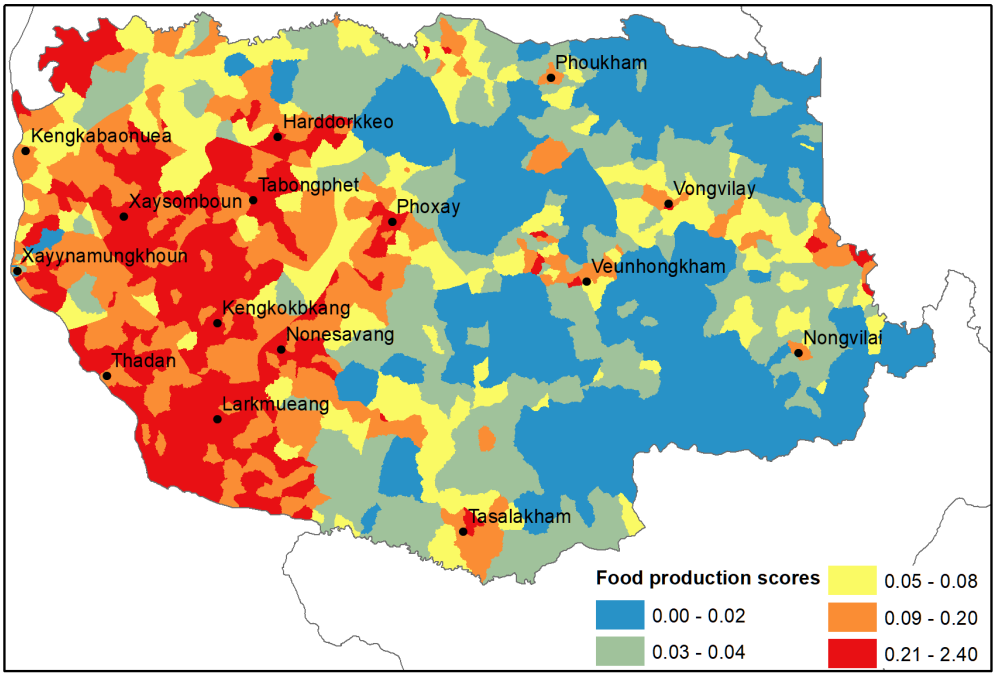


Ecosystem services supply in Savannakhet province

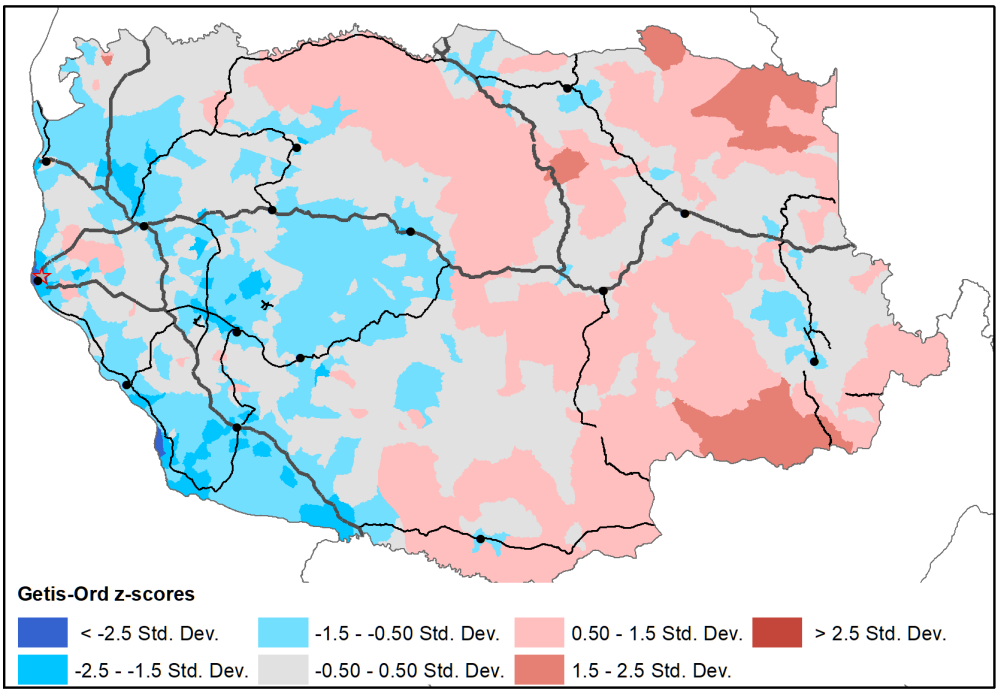
For Savannakhet province, ES supply was analyzed following the same steps as for the national-level assessment, the only difference being that eight crops were assessed for food production rather than seven. These eight crops comprise the most important agricultural food crops produced in Savannakhet province, measured by total area planted: wet season lowland rice, dry season lowland rice, upland rice, sugarcane, sweet corn, banana, mango, and watermelon. The food production summary service was then calculated again as the sum of all normalized crop production services (scale from 0 to 1) at village level. Based on all eight ES supplies – total carbon, annual water yield, nutrient export, sediment retention, habitat quality,

Figure 3.8: Selected results of the various steps of the ES supply mapping and analysis.

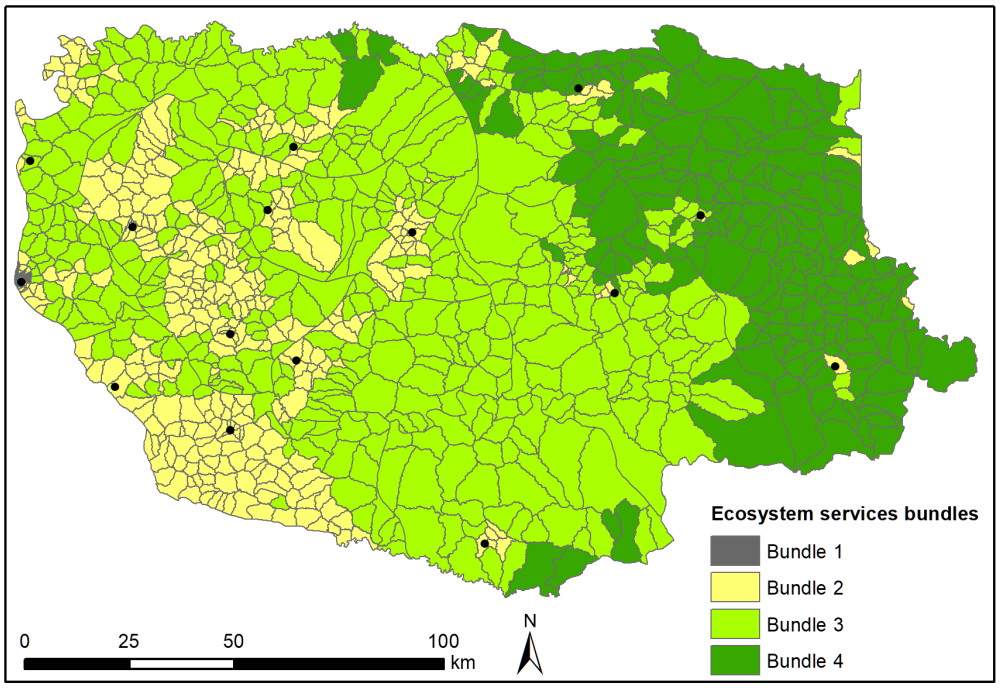
3.8a: Summary of the food production ES, as an example of one of the eight ES supply maps across the three CICES ES categories of provisioning, regulating, and cultural.



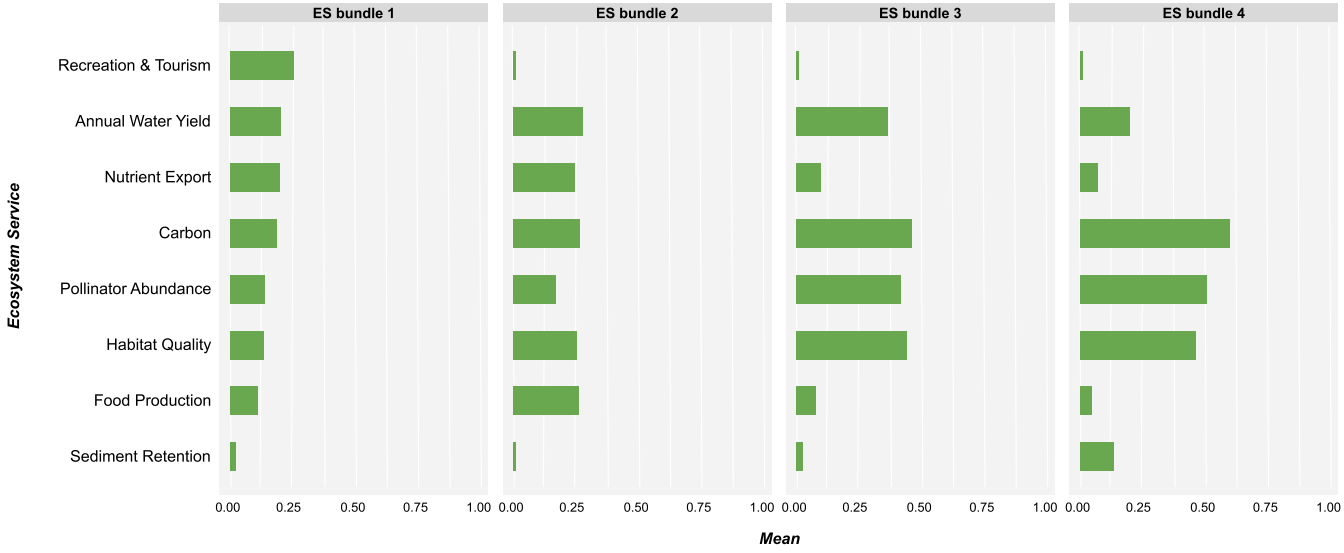
3.8b: Getis-Ord hotspot and bright spot map.



pollinator abundance, summary food production, and recreation and tourism – we then calculated ES supply hotspot and bright spot maps, and finally maps for characteristic ES supply bundles using the principal component analysis, and hierarchical clustering thereof.



3.8c: ES supply bundles map.



3.8d: characteristics of ES supply bundles expressed as the average of each ES supply (normalized and log transformed). Source: Authors' design

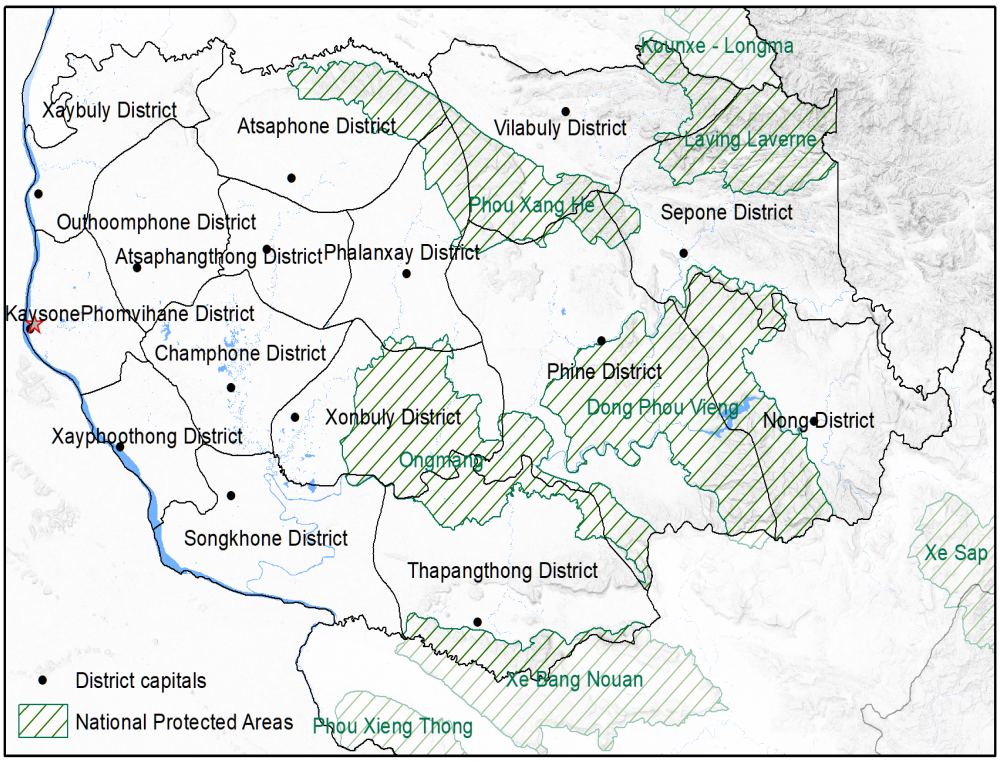
The hotspot/bright spot analysis shows moderate to strong synergies of ES supply from the center of the province towards the eastern areas that border Vietnam. Areas with the highest ES supply synergies (= hotspots) largely overlap with existing National Protected Areas. At the same time, food production in these hotspot areas is generally low (Figure 3.8b). An interesting exception is the Protected Area of Xebangnoua in the very south of Savannakhet Province, where ES-supply synergies (still) seem to exist despite a gradient of agricultural crop production intensity.

Four ES supply bundles resulted for Savannakhet province. Bundle 1 stands out with a very unique scheme/pattern of the individual average ES supply values and particularly high values for tourism. As bundle 1 is found solely in and around the area of Savannakhet city, we call it "urban production and recreational areas". Bundle 2 stands out with low values for pollinator abundance, total carbon, and habitat quality, as compared to bundles 3 and 4, where food production and nutrient export are comparatively higher. Bundle 2 describes the "agricultural production dominated areas" which are located in the lowlands of Savannakhet, mainly in Songkhone, Xonbuly, and Champone districts in the flatlands of the Mekong and its large tributary, the Banghiang river. It is noteworthy that many villages in areas classified under bundle 2 are predominantly oriented towards subsistence agriculture only, while in villages classified under other bundles, agricultural production is for sale as well as subsistence. With an average share of small-scale agriculture of nearly 60% (Table 3.3 below), the share of areas allocated for agriculture in bundle 2 largely exceeds the percentages of the other bundles (2.0%, 8.3% and 8.4% in bundles 1, 3 and 4 respectively). Furthermore, the population density in villages of bundle 2 (319 people per km^2) is much higher than in bundle 3 (62.7 people per km^2) and bundle 4 (26.5 people per km^2).

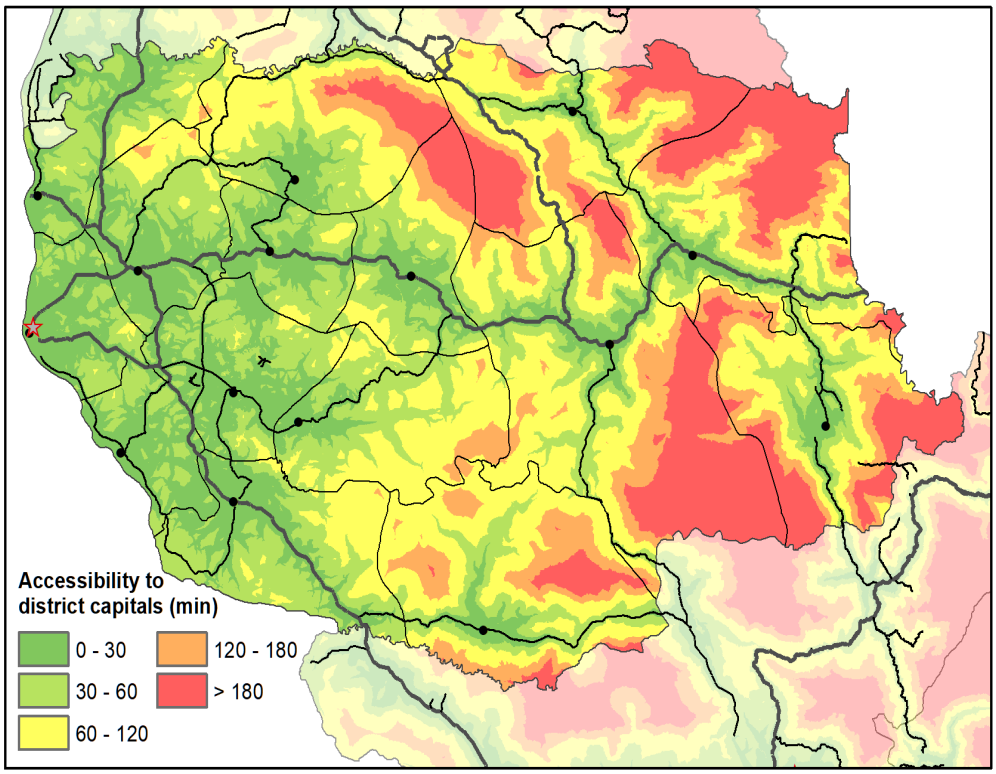
Bundle 4 is characterized by very high average values for the ES of carbon, pollinator abundance, and annual water yield, and covers the ecological zone of evergreen forests located in the eastern highlands and mountainous areas of Savannakhet province. We call this ES supply bundle "biodiversity and climate regulation conservation areas". Finally, bundle 3 seems to describe an in-between state, a transition between the dominance of intensive agricultural production and vast natural areas. A large continuous area classified as ES supply bundle 3 is located in central Savannakhet and leading southward. Average carbon values, pollinator abundance, and annual water yield are lower than in bundle 4, but higher than in bundle 2. Bundle 3 is located primarily in the dry lowland zone of Savannakhet, which explains lower average carbon values alongside increased agricultural production. What stands out in bundle 3 is its habitat quality value, which is higher than in bundle 4 (the bundle that contains designated areas of high conservation value). Factors that contribute to this high value for habitat quality may be the very high share of natural habitats in villages of bundle 3 (>75% of the village area) and the landscape of small-scale cropping mosaicked with (semi-) natural areas.

Figure 3.9: Selected spatial features of Savannakhet province.

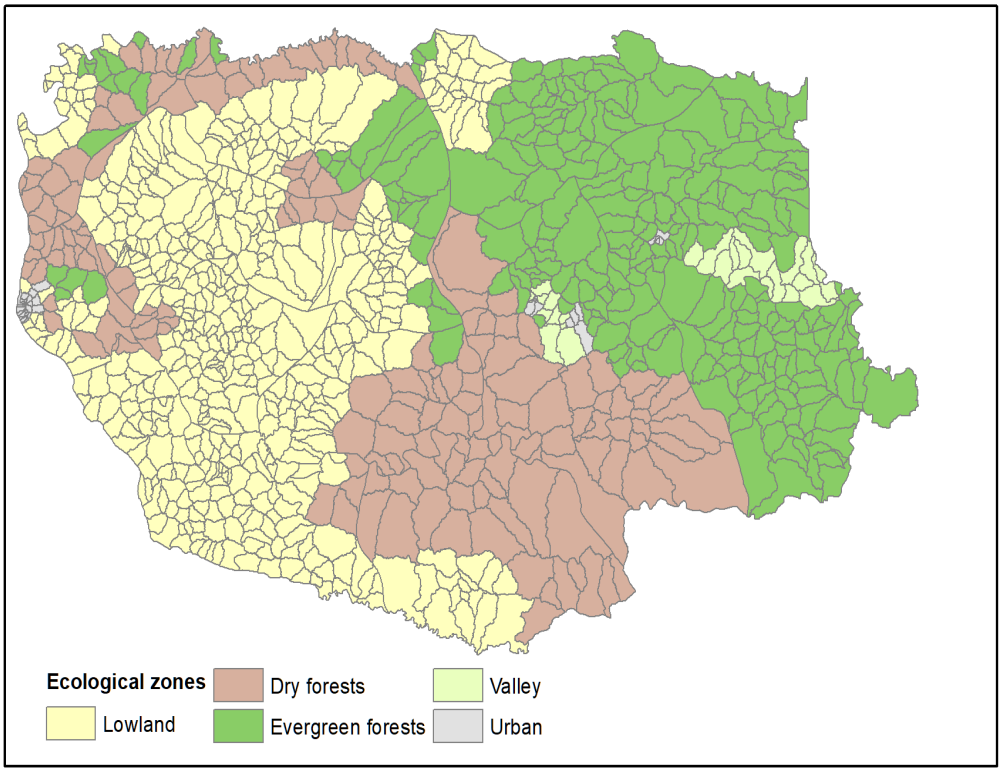
3.9a: topographic features, location of major water bodies and the Mekong river along the Lao-Thai border, and location of National Protected areas (hatched green areas).



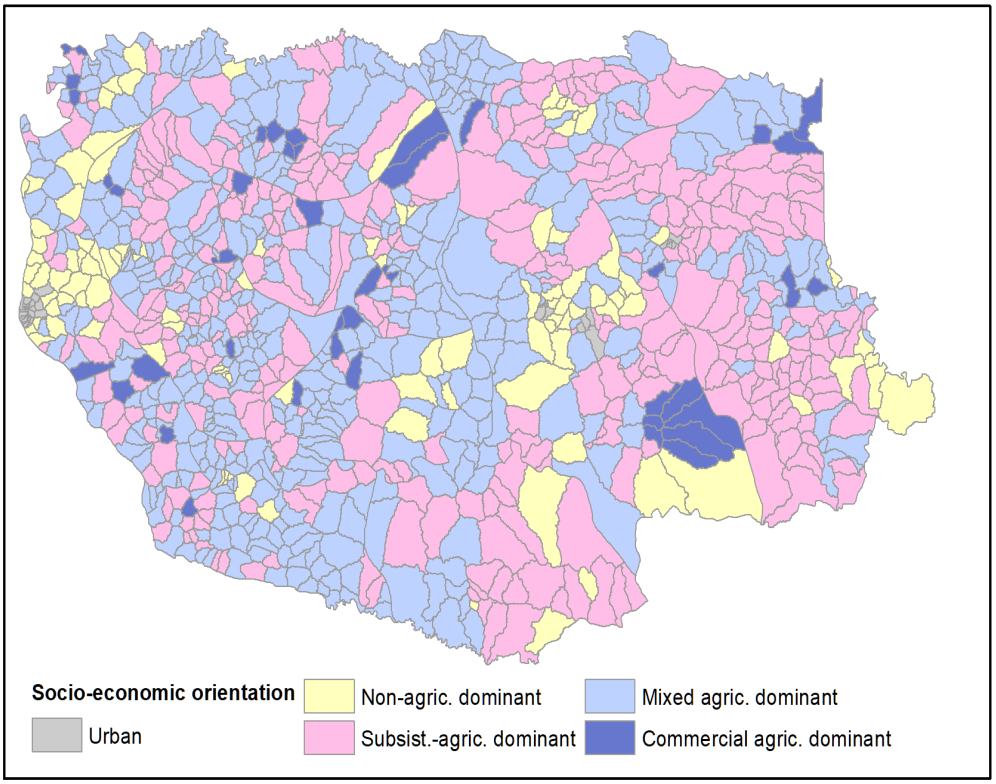
3.9b: accessibility to nearest district capitals.



3.9c: classification of Lao villages according to major ecological zone.



3.9d: according to main socioeconomic activity and orientation. Source: Authors' design



	ES Supply Bundles			
Supplementary variables	**1**	**2**	**3**	**4**
Share of no data in village	0.299	0.076	0.004	0.018
Share of natural habitats in village	43.185	39.247	75.478	87.385
Share of small-scale agriculture in village	2.040	55.989	20.274	8.376
Share of urban & intense agriculture in village	54.540	4.692	4.249	4.225
Share of total “land use” in village	56.580	60.681	24.523	12.601
% female-headed HH	28.625	19.458	12.081	3.918
Population density	2976.959	319.010	62.764	26.534
Literacy	89.756	84.911	67.029	40.704
% HH with disabled people	9.611	8.994	9.795	12.577
% Lao	81.201	71.819	39.278	2.453
% Tai Thai	2.020	13.850	17.833	14.772
% Khmuic	0.222	0.152	0.289	0.260
% Palaungic	0.000	0.009	0.031	0.033
% Katuic	12.171	12.562	40.771	81.055
% Bahnaric Khmer	0.014	0.019	0.091	0.059
% Vietic	0.002	0.013	0.052	0.026
% Tibeto-Burman	0.002	0.006	0.046	0.010
% Hmong	0.008	0.003	0.004	0.072
% Mien	0.000	0.000	0.001	0.000
Poverty Incidence	13.893	27.762	41.024	50.194

Table 3.3: Ecosystem Service-supply bundles characterized by a set of socioeconomic variables (Data source: Epprecht et al. 2015, average values calculated for the ES-supply bundles by the authors.)

3.3 Investigating demand for ecosystem services in Savannakhet province

To assess people’s demand for ecosystem services in Savannakhet province in a representative manner, we conducted household interviews through a stratified sampling design in 22 villages throughout the province. We stratified the province according to ecological zones, livelihood strategies, and socioeconomic status, resulting in five main strata (13 detailed strata). We sampled 336 households in total, with a team of 16 enumerators working in pairs. In each village, they first approached the village head to introduce themselves, explained the content of the survey, and requested to interview a certain number of households. The village head provided a list of households, which the enumerators then visited. Before each interview, which lasted about one hour, the household members were asked for their willingness and consent to participate in the interview. Interviews were conducted mainly in the Lao language, although sometimes minority dialects were used which the village head and committee members

No.	Village names	District names	Strata	Detailed strata	HH interviews
1	Kha nin	Phine	evergreen and fallow forests	evergreen and fallow forests NA	16
2	Sy boun hueng	Phine	urban	urban	16
3	Nonh xai	Phine	valley	valley NA	16
4	Vong sy keo	Phine	dry forests	dry forests SA	16
5	Xang thaeng	Phine	evergreen and fallow forests	evergreen and fallow forests SA	16
6	Thoun kharm	Phine	dry forests	dry forests CA	16
7	Na	Sepone	evergreen and fallow forests	evergreen and fallow forests CA	16
8	Pa ngar	Sepone	evergreen and fallow forests	evergreen and fallow forests SA	16
9	Ar lang	Sepone	valley	valley SA	16
10	Ka dap	Sepone	valley	valley CA	16
11	Nonh fay	Songkhone	lowland	lowland NA	16
12	Don muang	Songkhone	lowland	lowland SA	16
13	Nong mek	Songkhone	lowland	lowland SA	16
14	Phai lorm	Champhone	lowland	lowland SA	16
15	Phia kao	Champhone	lowland	lowland SA	16
16	Kaeng kok neua	Champhone	lowland	lowland NA	9
17	Ta laew noy	Champhone	lowland	lowland SA	16
18	Nohn Hang Mee	Xonbuly	lowland	lowland CA	13
19	Na phaeng	Xonbuly	lowland	lowland CA	13
20	Na thong	Xonbuly	dry forests	dry forests NA	16
21	Mai sa nam xai	Xonbuly	dry forests	dry forests SA	16
22	Xieng home	Xonbuly	lowland	lowland CA	13

Table 3.4: Overview of households sampled per village and strata. NA=non-agriculture, SA=subsistence agriculture, CA = commercial agriculture

(local governance body) helped translate. The responses were directly entered into a tablet version of the questionnaire and synchronized with an online database daily, or whenever the enumerators had access to internet. The interviews were conducted during eight days in December 2020. Data collection was conducted in collaboration between the Centre for Development and Environment (CDE) of the University of Bern, Switzerland (Country Office in Laos PDR) and the Department of Agricultural Land Management (DALaM), Ministry of Agriculture and Forestry, Lao PDR, supported closely by the Provincial Agriculture and Forestry Office and local authorities in Savannakhet province.

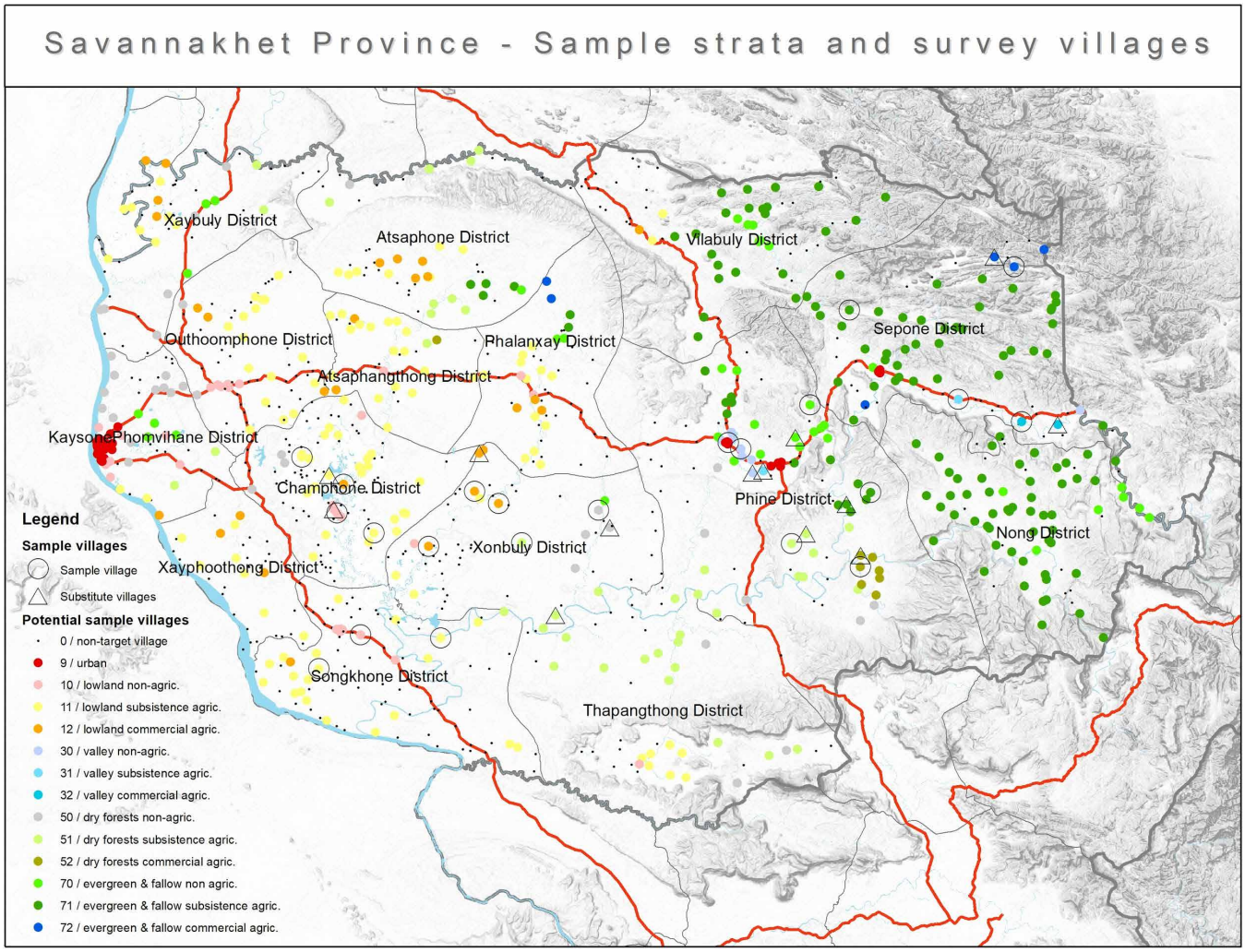


Figure 3.10: Overview of potential sample villages in different strata and actually sampled villages (black circles). Source: Authors' design

The questionnaire consisted of two parts: a first, general part on characteristics of the household, and a second part on ecosystem service demand. Ecosystem services had been preselected by the Swiss–Lao research team, based on the CICES classification (provisioning, regulating, cultural) and complemented by two additional classes: "biodiversity" and "ecosystem disservices". Each respondent's first task was to rank an overall ES category according to its importance in their life, on a scale of 1–5, where 1 = Extremely unimportant, 2 = Unimportant, 3 = Neutral, 4 = Important, 5 = Extremely important. We asked, for example, "How important is cultivating crops and trees for your well-being?" If the answer was 3 or higher, we requested scores for specific ES in this category (e.g. "cultivating annual commercial crops"). If however the ES category was given a score of 2 or 1, the specific services in that category were given a score of 0 and the enumerator moved directly to the next ES category. This method reduced the load of questions for each respondent. The data was exported into a .csv database and frequency of responses was calculated in R statistics package.

The large majority (more than 75%) of the sampled respondents cultivate crops for self-consumption and are self-employed. The majority of respondents had primary education, followed by respondents without formal education. A lack of formal education was most frequent among respondents in the dry forest, followed by the evergreen forest strata.

Respondents were from 11 different ethnicities; the majority of Lao ethnicity, closely followed by Phouthay and Katang ethnicities. Crop production was ranked as the most important income source, livestock rearing as the second, and non-agricultural as the third most important income source. Almost none of the respondents leased land. Only in the lowland strata did most respondents have titles for their agricultural land. For residential land this was the case in the lowland and urban (all respondents have titles) strata. The largest land holdings were reported in the valley strata, followed by the lowland strata, averaging around 4 ha per household. In all strata except urban, households use between 60% and 70% of their land for crop production and around 10–20% each for livestock and other uses, respectively. Households size on average is between maximum 8 in dry forests and 6 in urban strata. On average, households had spent around 38 years in the village in all strata. While the overall sample of households contained female respondents, this was substantially skewed, with less than 25% of the respondents being female in the dry forest, evergreen, and valley strata, and more than 50% of the respondents being female in the lowland and urban strata.

Importance of overall ES categories and specific ES among strata

Of the five overall ES categories assessed, only collecting & hunting wild animals and their products was not important in all strata. In total, we assessed demand for 25 specific provisioning ES from five overall ES categories (Figure 3.11). No provisioning ES were rated as "very important" by the majority of the respondents. However, groundwater quantity was considered "very important" by 27% of respondents in the urban strata.

The evergreen and forest fallow strata had most provisioning ES rated as "important" or "very important". This was also the case for wild plant fodder, and medicinal plants, which were not rated as important in any other strata. The only provisioning ES not rated as "important" or "very important" in this strata were annual commercial crops, rubber, banana, and resin. The lowland and valley strata had the same number of ES rated as "important" or "very important", but while in the valley strata banana and other perennial crops were important, in the lowland strata it was aquatic animals and water supply from lakes/reservoirs instead. In the urban strata, few provisioning ES were considered "important" or "very important". These included other perennial crops and animals for dairy or eggs, wood for energy, bamboo, groundwater quantity, and rainwater quantity. ES reported as "important" in all strata were animals for dairy or eggs, wood for energy, groundwater quantity, and rainwater quantity.

The land use types providing annual traditional crops were mainly paddy fields, followed by shifting cultivation, non-rice lowland agriculture, and wetland areas. Paddy rice was mainly destined for home consumption, and the majority of respondents said it had become more difficult to cultivate rice in paddy fields compared to five years ago, mainly due to climate change. The provisioning ES of cultivating banana, important mainly in the valley strata, was destined mainly for home consumption; in contrast

to paddy rice, the majority of respondents said there was no change in how difficult it is to cultivate. Other perennial crops were destined mainly for home consumption, and as with banana, for the majority of respondents it had not become more difficult or easier to cultivate them.

The provisioning ES of keeping and breeding animals for dairy or eggs was mainly provided by residential land. For the majority of respondents, it has become more difficult to do so due to climate change-related issues and animal diseases. Aquatic animals are mainly bred in rivers for home consumption and here, the difficulty of doing so has not changed for the majority of respondents.

The provisioning ES of collecting wild plant foods was mainly provided by forests and destined for home consumption. For the large majority of respondents, it has become more difficult due to various land-related issues, climate change, and other issues such as resource overharvesting and deforestation. Wood for energy as well as wood for construction were mainly provided by forests, and while for the majority of the respondents obtaining wood for energy is unchanged, it has become much more difficult over the last five years to obtain wood for construction, mainly due to deforestation. Rattan, also mainly provided by forests, has also become more difficult to find, mainly due to overharvesting, while finding bamboo has remained the same for the majority of respondents. Other wild plant foods, also provided mainly by the forest and used for home consumption, have also become more difficult to obtain, mainly due to overharvesting.

Wild animals for food or non-food were provided mainly by forests, followed by paddy rice fields and rivers and other water bodies. They were used mainly for home consumption and it has become more difficult to obtain those collected from forests, mainly due to overharvesting. The same was true for wild animal products, such as honey, which was mainly collected from forests.

River water quantity was perceived to be provided mainly by forests, and supply has remained relatively unchanged. The same was reported for groundwater and for rainwater supply, mainly provided by residential land.

The regulating ES included four overall ES categories (Figure 3.12). While maintenance of water quality, maintenance of soil fertility, and protection from disasters, pests, and diseases were considered important in all strata, while maintenance of pollinators was not considered important in the lowland. Furthermore, we asked respondents about the importance of 13 different specific ES. Only one ES, groundwater quality, was considered important throughout all strata. Strikingly, in the dry forest strata, the only two regulating ES rated as important were groundwater quality and rainwater quality. As with provisioning ES, the evergreen and fallow forest strata provided the highest number of regulating ES perceived as important. The only regulating ES perceived as unimportant in the evergreen and fallow forest strata was lake/reservoir water quality, with almost an equal number of respondents holding opposing views of storm protection as being either important or unimportant.

Figure 3.11: Importance of provisioning ES in different strata. Green = majority of respondents rated the respective ES as “important” or “very important”. Brown = majority of respondents rated the respective ES as “unimportant” or “very unimportant”. White = majority of respondents rated the respective ES as “neutral”. x = an almost equal share of respondents rated the respective ES in the opposite way. Source: Authors’ design

	Provisioning ES	Urban	Lowland	Valley	Dry forest	Evergreen and fallow forest
Cultivating crops and trees						
1	Annual traditional crops					
2	Annual commercial crops					
3	Rubber					
4	Banana					
5	Other perennial crop				x	
Keeping and breeding animals						
6	Animals for dairy / egg					
7	Animals for meat					
8	Animals for draught / labor					
9	Aquatic animals					
Collecting wild plants and their products						
10	Wild plant food					
11	Medicinal plants		x			
12	Resin					
13	Wood for energy					
14	Wood for construction	x	x			
15	Rattan					
16	Bamboo					
17	Other wild plant non-food					
18	Wild plant fodder					
Collecting & hunting wild animals and their products					x	
19	Wild animals for food or non-food					
20	Wild animal products for food or non-food					
Water supply						
21	River water quantity					
22	Groundwater quantity					
23	Rainwater quantity	x				
24	Lake / reservoir					
25	Springs					

In terms of land use types in which demand for certain regulating ES was present, we found the following. Demand for flood protection, for protection from direct sun, for storm protection, for disease control, for groundwater quality, and for rainwater quality was mainly linked to residential land. Demand for erosion protection and landslide protection was mainly linked to water bodies (i.e. rivers, lakes, ponds, and reservoirs). Demand for drought protection, fire protection, river water quality, and maintenance of pollinators was linked mainly to forest. Demand for pest control and soil fertility was mainly linked to paddy rice fields.

For cultural ES we considered three overall categories (Figure 3.13). Parts of landscapes that enable health, recreation, and education were considered important everywhere except in dry forest. Parts of landscapes that enable knowledge transfer were not considered important in dry forest and the urban strata, while parts of landscapes that have cultural, symbolic, heritage, sacred, or spiritual meaning were considered important everywhere. For the specific ES, traditional ecological knowledge, cultural meaning, and sacred/spiritual significance were important in all strata. As with provisioning and regulating ES, evergreen and fallow forest had the highest number of important cultural ES, together with the lowland strata. While in the lowland strata observing wild animals and pastime hunting were not important, symbolic meaning and

Figure 3.12: Importance of regulating ES in different strata. Green = majority of respondents rated the respective ES as "important" or "very important". Brown = majority of respondents rated the respective ES as "unimportant" or "very unimportant". White = majority of respondents rated the respective ES as "neutral". x = an almost equal share of respondents rated the respective ES in the opposite way. Source: Authors' design

	Regulating ES	Urban	Lowland	Valley	Dry forest	Evergreen and fallow forest
Protection from disasters, pests, diseases					x	
1	Flood protection					
2	Erosion protection					
3	Landslide protection					
4	Drought protection					
5	Fire protection					
6	Protection from direct sun (shade provision)					
7	Storm (wind) protection		x	x		x
8	Pest (e.g. insects) control					
9	Disease (e.g. viruses, bacteria) control					
Maintenance of water quality		x				
10	River water quality					
11	Groundwater water quality					
12	Rainwater water quality					
13	Lake / reservoir water quality	x	x	x		
Maintenance of soil fertility		x				
Maintenance of pollinators		x				

heritage were not deemed important in dry forest. In fact, dry forest had the smallest number of ES perceived as important. Respondents from the urban strata, by contrast, perceived several cultural ES as important, notably tourism, cultural and sacred/spiritual meaning, and all parts of landscapes that enable knowledge transfer, except for traditional agricultural knowledge.

Cultural ES were also provided by a variety of land use types. Parts of landscapes that enable enjoying nature, observing wild animals, pastime hunting, and transfer of traditional medicinal knowledge were mainly linked to forest. Parts of landscapes that enable tourism and that have symbolic meaning, or an importance for heritage, were mainly linked to other land (including cultural land, historical land, old temples, sacred places, museums) and forest. Parts of landscapes that enable transfer of traditional ecological knowledge and traditional agricultural knowledge were mainly linked to paddy rice fields. And finally, parts of landscapes that have cultural meaning and sacred/spiritual meaning were mainly linked to residential land (including big trees in villages).

For the additional overall ES category of biodiversity, the majority of respondents in all strata considered it important to maintain endangered plant and animal species for the future (Figure 3.14). For the 12 (groups of) species considered, three were not rated as important by the majority of respondents in any of the strata. These included the saola, Eld's deer, and the Siamese crocodile. Interestingly, these are iconic species of great conservation value in the Savannakhet province. The wild elephant was only

Figure 3.13: Importance of cultural ES in different strata. Green = majority of respondents rated the respective ES as "important" or "very important". Brown = majority of respondents rated the respective ES as "unimportant" or "very unimportant". White = majority of respondents rated the respective ES as "neutral". x = an almost equal share of respondents rated the respective ES in the opposite way. Source: Authors' design

	Cultural ES	Urban	Lowland	Valley	Dry forest	Evergreen and fallow forest
Parts of landscapes that enable health, recreation, education		x	x			
1	Enjoying nature					
2	Observing wild animals					x
3	Pastime hunting					
4	Tourism					
Parts of landscapes that enable knowledge transfer			x			
5	Traditional ecological knowledge					
6	Traditional agricultural knowledge				x	
7	Traditional medicinal / health knowledge	x				
Parts of landscapes that have cultural, symbolic, heritage, sacred, or spiritual meaning						
8	Cultural meaning					
9	Symbolic meaning			x		
10	Heritage					
11	Sacred / spiritual					

	Biodiversity	Urban	Lowland	Valley	Dry forest	Evergreen and fallow forest
Maintenance of endangered plant and animal species for the future						
1	Saola					
2	Wild elephant					
3	Primates					
4	Eld's deer				x	
5	Big cats					
6	Pangolin					
7	Siamese crocodile					
8	Asiatic softshell turtle			x		
9	Snakes					
10	Birds (e.g. green peafowl, great hornbill)					
11	Rare and valuable trees					
12	Rare and valuable plants					

Figure 3.14: Importance of biodiversity in different strata. Green = majority of respondents rated the respective ES as "important" or "very important". Brown = majority of respondents rated the respective ES as "unimportant" or "very unimportant". White = majority of respondents rated the respective ES as "neutral". x = an almost equal share of respondents rated the respective ES in the opposite way. Source: Authors' design

considered important in the urban strata. In dry forests, furthermore, only rare and valuable trees were considered important. Evergreen and fallow forest had the highest number of (groups of) species considered, including the pangolin, which was not important in any other strata. Apart from that, all other (groups of) species were shared with the valley strata. In the lowland strata, respondents only considered snakes and rare and valuable plants as important.

In terms of land use types, forest was the most important for all (groups of) species, except for the Siamese crocodile and the Asiatic softshell turtle, for which water bodies are the main habitat.

For the overall ES category of ecosystem disservices, we took into account four disservices (Figure 3.15). The results differed strongly between the strata. Only floods were regarded as a disservice by the majority of all respondents. By contrast, human–wildlife conflicts were not considered important by the majority of respondents, although they were considered important in the evergreen and fallow forest strata. Problems with insects, pest, and diseases – as well as with climate and land-related disasters – were considered important in all strata except urban. Problems with weeds were important in the lowland, valleys, as well as the evergreen and fallow forest strata. We also investigated demand for 15 specific ecosystem disservices. Respondents in the evergreen and fallow forest strata experienced the most different ecosystem disservices, including wild boars, which were not considered a problem elsewhere. Respondents in the lowland strata perceived the fewest ES disservices. The most prevalent specific ecosystem disservices across all strata were floods (important everywhere), rats

(neutral in the lowland strata), and drought (not important in the urban strata). Human–elephant conflict was not considered important by the majority of respondents in any of the strata. However, in the evergreen and fallow forest strata, 16 out of 52 respondents did consider human–elephant conflicts important or even very important.

In terms of land uses linked to the different ecosystem disservices by the respondents, paddy rice fields were responsible for most of the problems with insects, pests, and diseases, including rats, other rodents, grasshoppers/crickets, and stem borers. Wild boars/pigs were mainly linked to the land use type of forests and of shifting cultivation, while bird pests (e.g. red jungle fowl) were linked to forests and paddy rice fields. Problems with weeds were also mainly linked to paddy fields. Human–elephant conflicts were linked mainly to the land use types of shifting, rotational, small-scale agriculture, paddy rice, and forest. It was similar for other wildlife conflicts, although for those, forest was more important than paddy rice fields. Floods were mainly linked to paddy rice fields, and residential land, while erosion, landslides, and droughts were mainly linked to waterbodies (rivers, lakes, ponds, reservoirs) and shifting, rotational,

Figure 3.15: Importance of ES Disservices in different strata. Green = majority of respondents rated the respective ES as “important” or “very important”. Brown = majority of respondents rated the respective ES as “unimportant” or “very unimportant”. White = majority of respondents rated the respective ES as “neutral”. x = an almost equal share of respondents rated the respective ES in the opposite way. Source: Authors’ design

	Ecosystem disservices	Urban	Lowland	Valley	Dry forest	Evergreen and fallow forest
Problems with insects, pests, diseases		x				
1	Rats					
2	Other rodents					
3	Wild boars / pigs			x		
4	Birds (e.g. red jungle fowl)			x		x
5	Grasshoppers / crickets					
6	Stem borers					
Problems with weeds						
Problems with human-wildlife conflicts						
7	Human-elephant conflict					
8	Other wildlife conflicts					
Problems with climate and land related disasters						
9	Floods					
10	Erosion					
11	Landslides					
12	Drought					
13	Fire	x				
14	Lack of shade					
15	Storms (wind)			x		

small-scale agriculture. Fires were mainly linked to forest. Lack of shade and storms were mainly linked to residential land.

Research on ES demand in Laos is still in its infancy. Previously, Rasmussen et al. (2017) looked at provisioning ES and under which conditions these were considered services or disservices in a study area in northwestern Laos, bordering Nam-Et Phou Louey National Protected area. Our comprehensive study of ES demand with a representative sample design for Savannakhet province is the first to assess the full range of ES categories, including biodiversity and ecosystem disservices in Laos. Our results show the wide range of ES for which there is demand in Savannakhet province, with the majority of respondents considering 55 (out of 61) specific ES important for their well-being. However, there are also many problems linked to different ecosystems, which we conceptualized as ecosystem disservices. Of the 15 disservices assessed, 13 were considered important by the majority of respondents. Our analysis also demonstrates how context specific ES demand and disservices are, as they differed substantially between the five main agroecological strata. Furthermore, in the respondents' perception, a variety of land use types, not only forest, were important to provide the specific ES demanded. Nevertheless, forest does have an important role in providing ES across all categories, and especially in providing a habitat for different (groups of) species.

4 Direct drivers of change

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Direct or proximate drivers are immediate actions at the local level, including human activity, that drive change (Geist and Lambin 2002). This section will briefly summarize direct drivers of change, including development of agriculture, industry and hydropower; urbanization and infrastructure; exploitation of forest resources; climate change; pollution; and invasive species.

4.1 Land use changes

The land use system in Laos has undergone important changes in recent years. Figure 4.1 depicts the national forest cover dynamic based on satellite imagery for the years 2000, 2005, 2010, 2015, and 2019 (Department of Forestry, Ministry of Agriculture and Forestry, Government of the Lao PDR 2020).

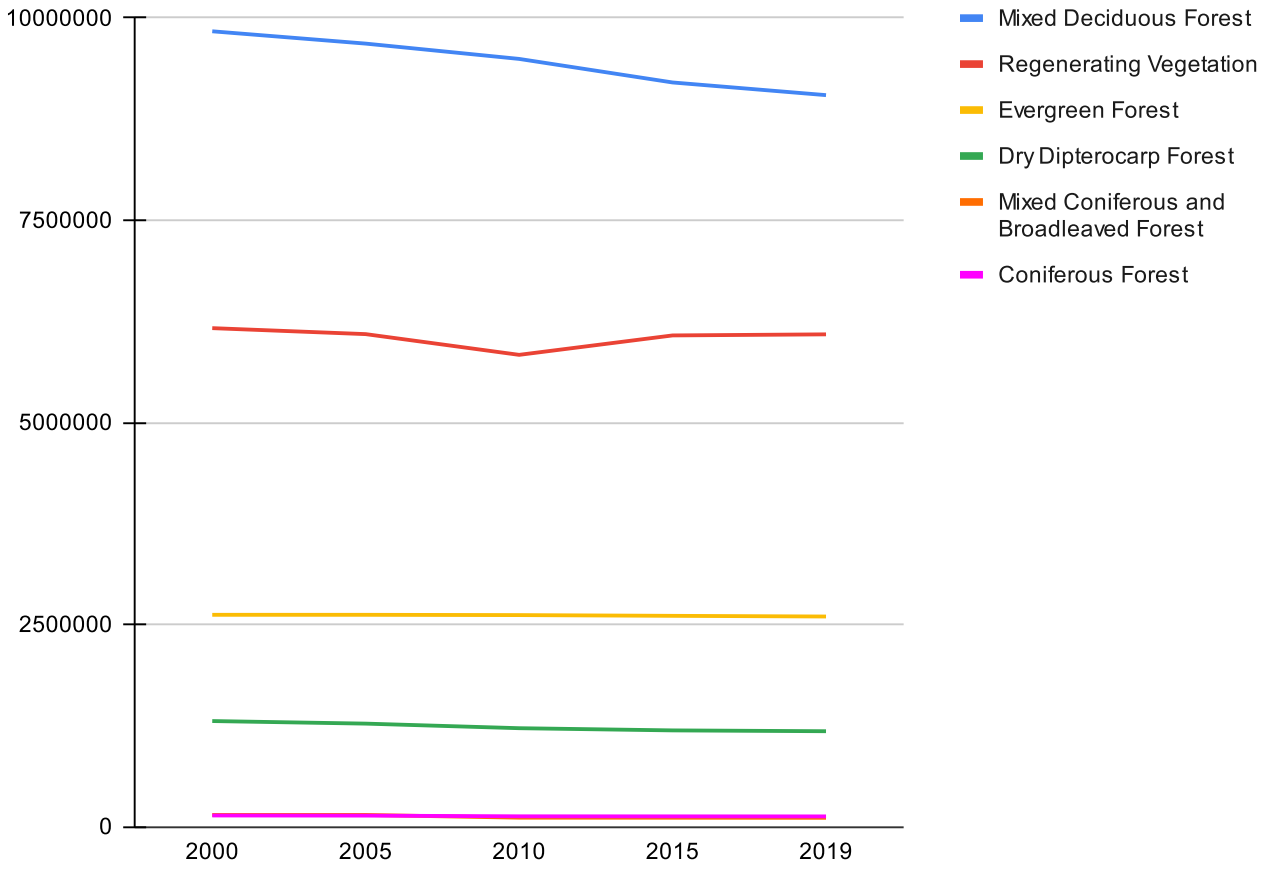


Figure 4.1: Forest and regenerating vegetation classes for the years 2000, 2005, 2010, 2015 and 2019. The lines for classes "mixed coniferous and broadleaved forest" as well as "coniferous forest" cover each other (due to similar values). Source: Authors' design, based on GoL 2019

Figure 4.2 provides the trend for the same years for planted or agricultural vegetation types.

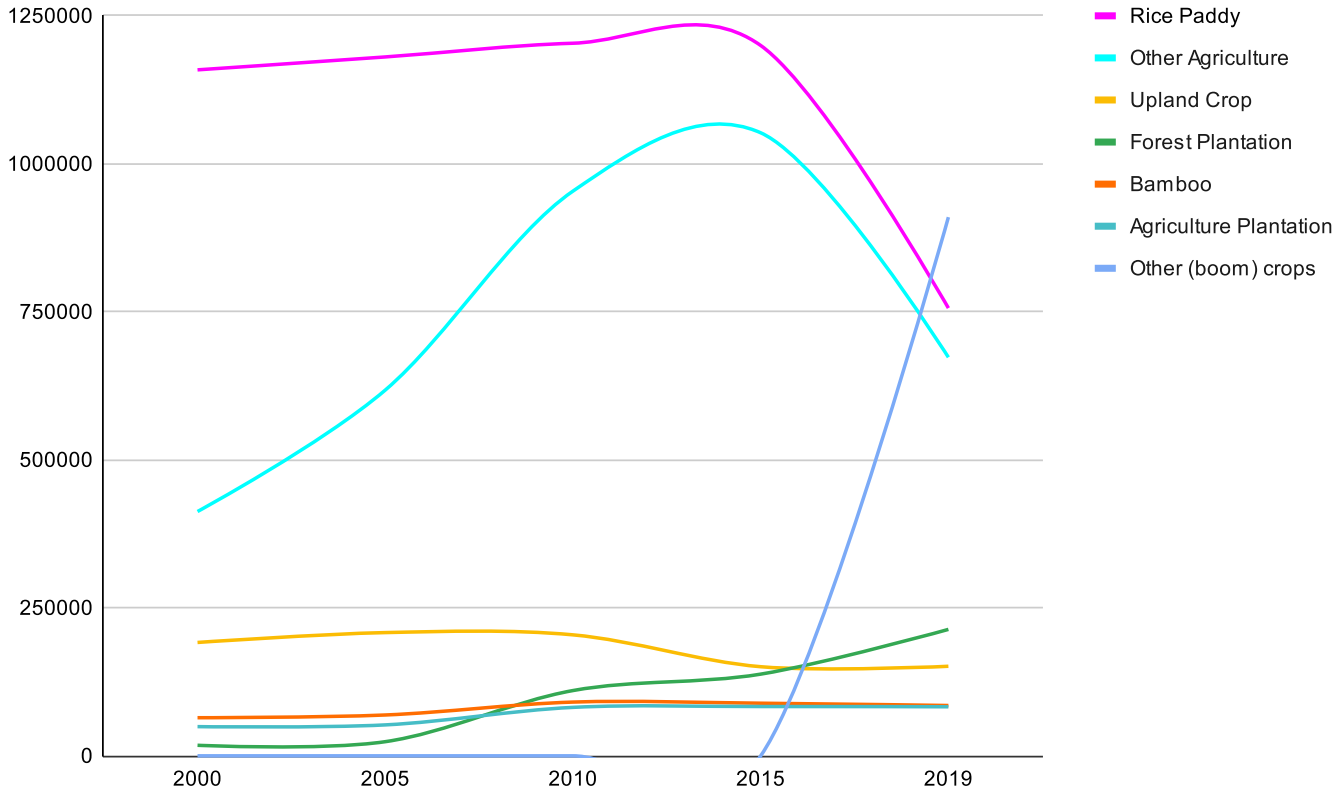


Figure 4.2: Planted vegetation classes for the years 2000, 2005, 2010, 2015 and 2019. Source: Authors' design, based on GoL 2019

The trend observed for the area covered by mixed deciduous, dry dipterocarp, or evergreen forest is decreasing or close to stable for almost all natural forest systems (Figure 4.1). There is however an increase, since 2010 and 2015, in land cover categories associated with cash crops (agricultural plantation, other agriculture, forest plantation, other boom crops) (Figure 4.2). By contrast, there has been a drastic drop since 2015 in the area planted with traditional agricultural crops (rice, other agriculture, upland crops). This pattern hints at an underlying process of agrarian transition – from subsistence agriculture focusing primarily on rice and other traditional agricultural crop production and extensive livestock rearing, to an export- and market-oriented agricultural production system growing crops for neighboring countries (Junquera et al. 2020).

Agriculture expansion and tree plantations

Laos remains a primarily agrarian country. Despite the decreasing share of the agricultural sector in the structure of the economy, two thirds of the population continue to rely on agriculture as the primary source of their livelihood.

Two main goals define the Agricultural Development Strategy to 2025 and Vision to 2030: first, ensuring food production; and second, enhancing agricultural commodity production towards rural development and poverty reduction (Ministry of Agriculture and Forestry 2015). As rice is the primary dietary staple, it accounts for 72% of total cultivated area. Notably, Laos

achieved rice self-sufficiency in 2000 (FAO) . Economically important commodity crops include coffee, sugarcane, maize, and cassava, driven by regional market demand from neighboring countries such as Thailand, Vietnam, and China (Oraboune 2008). Harvested areas of these commodity crops have expanded substantially in recent decades. Figure 4.3 depicts the change in harvested area of three key crops – cassava, coffee, and maize – between 2006 and 2018. Notably, areas of cassava and coffee have increased by 870% and 510% respectively in the last two decades.

As agricultural production is primarily smallholder driven, development policies in the country have focused on developing commercial agriculture as a mechanism for national poverty reduction. This process has supported an agrarian transition, as smallholders gradually move from subsistence production to engage in market-oriented commodity production (Cramb et al. 2009). Today, 33% of farmers produce primarily for the market, while 80% of the rural population continue to produce for subsistence consumption (FAO). The prevalence of contract farming or outgrower schemes has also grown in recent years (Setboonsarng 2008), however data on this is sparse. Additionally, the number of land concessions has risen since the early 2000s, although the rate has slowed recently. According to the Land Concession Inventory conducted by the Government of Laos and supported by CDE, agricultural and tree plantation concessions accounted for 44% of all deals granted with a total of 593,357 ha (Hett et al. 2020). Tree

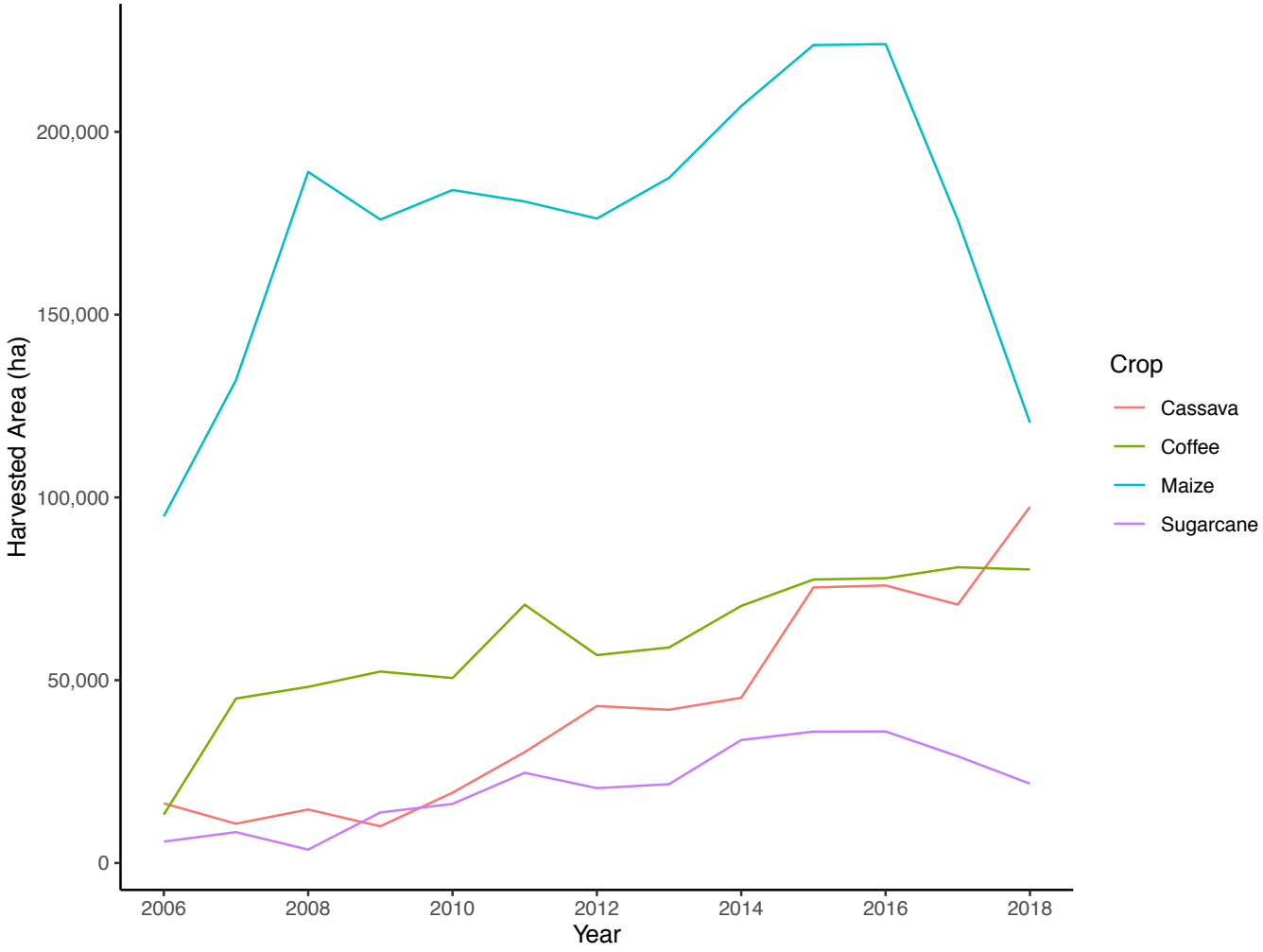


Figure 4.3: National, annual harvested area of selected crops in Lao PDR between 2006 and 2018. Source: Data provided by the Government of Lao PDR's Ministry of Agriculture and Forestry, Annual Agricultural Statistics Yearbook under CDE's k4d project

plantations account for 36% of the total granted area, primarily for rubber and eucalyptus plantations. Agriculture concessions make up 23% of total granted area, consisting primarily of sugarcane production, followed by cassava, and livestock (Hett et al. 2020).

The expansion of commercial and industrial agriculture through these modes of production has environmental impacts, including deforestation and disruption of ecosystem services, as well as threatening the conservation of biodiversity (Byerlee 2014). Recent analysis has estimated that a total of 945,000 ha of forest was lost in Laos between 2000 and 2015, 500,000 ha of which were converted to agriculture. Fifty percent of this area was converted to herbaceous crops, including maize, cassava, and sugarcane, while the remainder was converted to tree crops, including pulpwood and rubber (Tenneson et al. 2021). Thirty-four percent of the area granted for land concessions were primary or secondary forest (Hett et al. 2020).

Mining industry

The resource extractive industry – primarily mining for gold, copper, coal, and gravel/stone – has been a major driving force of economic growth over the past two decades in Laos. A recent inventory of land concessions indicates that a total of over 400,000 ha of land have been granted for mineral exploitation in over 600 land investment projects (Map 8, Annex), significantly larger than what was granted for agriculture (238,000 ha) or tree plantations (354,000 ha), although most projects are very small in size, with only a few (nine) very large projects with an area over 5,000 ha (Hett et al. 2020).

Over the last two decades, mining, especially large-scale mineral ore extraction, has become one of the main drivers of deforestation. More than around 100,000 ha of national conservation, protection, or production forest were converted to mineral development up to the time of the inventory (between 2016–2018, depending on the province). This not only contributes to forest loss but also to fauna and flora depletion. In addition, mining concessions make only a limited contribution to social development in terms of rural employment in the affected areas, and they threaten local livelihoods through land and resource displacement. While mining projects do create jobs, these do not match the skills available locally. Mining concessions jobs mainly go to skilled immigrants from neighboring countries: requiring higher labor skills, these jobs offer higher wages and stable employment opportunities than agricultural and tree plantation investments (Hett et al. 2020).

Hydropower

Laos's terrain and hydrological conditions provides a huge potential for hydropower development. In addition, the country's location amidst three "power-hungry" neighbors – Thailand, Vietnam, and China – is an opportunity to profit from this potential. The Government of the Laos therefore considers hydropower development a top priority and aims to transform the country into the "battery of ASEAN". Since the opening of

Laos to international investors in the late nineties, regional and global banks, often jointly with the World Bank and the Asian Development Bank, together with international power companies, invested heavily in the development of hydropower projects in Laos. In mid-2018, a total of 53 operational hydropower plants had a capacity to generate a total of over 7,000 megawatts (MW), with another 47 plants under construction, projected to produce another 6,000 MW. A further 61 hydropower plants were in planning (Map 9, Annex). Most of these projects are built and operated by mostly foreign consortia under a "BOOT" model (build, own, operate, and transfer), where Laos's publicly owned Electricité Du Lao (EDL) holds 20–25% of the initial equity. Typically, 90% of the energy produced by the country's large power plants is exported to Thailand, Vietnam, Myanmar, Cambodia and Malaysia, generating tax revenues for the Lao Government.

Laos's large hydropower projects have substantial social and environmental impacts. The reservoirs occupy large tracts of previously forested and agricultural land, displacing thousands of rural farm households and affecting their livelihoods in diverse ways. In addition, dams and water diversions alter river water regimes, water quality, biodiversity, and the livelihoods of upstream and downstream communities in complex ways. And safety concerns were highlighted by the catastrophic collapse of a dam in southern Laos in 2018, which led to widespread destruction, death, and homelessness among local communities.

4.2 Urbanization and infrastructure development

Urbanization

Although the majority of the Lao population still lives in rural areas – and despite a relatively small capital city Vientiane and only few medium-sized towns in Laos – urbanization dynamics are gaining in importance. However, what constitutes a town or an urban space in Laos is only very vaguely defined (Epprecht, Bosoni, et al. 2018a); for the national Population and Housing Census, for instance, villages are categorized as "urban" based on a set of characteristics that measure a village's degree of development (e.g. rate of electrification) rather than degree of urbanity. The national administrative system, on the other hand, classifies whole districts or a province as a city, irrespective of the degree of rurality in most parts of such districts (ibid.). Consequently, there are no dedicated governance structures for urban areas in the Lao administrative system and no boundaries between towns and their rural periphery. Given the substantial growth rates of the main towns and cities in Laos, uncontrolled urban sprawl is an obvious result of a lack of clear urban area delineations and planning, which results in large, unplanned, low-density expansion of towns. Coupled with a lack of coordination among government sectors in land management, such expansion is mostly at the expense of vital peri-urban ecosystems. In Vientiane city, for instance, almost all initially

designated natural conservation areas have now experienced a conversion into special economic zones or other large-scale investments. Not only does this mean a loss of agricultural production potential and green space in a sprawling urban environment – it also signifies the loss of important biodiversity areas – particularly marshland and wetlands – drastically reducing drainage and buffer capacities of the land and making floods more frequent, damage more costly, and the effects – particularly on the poor – more severe (ibid.).

Urbanization processes in Laos are relatively rapid, fueled by the migration of rural populations to towns and the rapid expansion of urban areas, which transforms rural communities into urban communities. These processes imply also changes in demand for specific natural resources, such as an increase in demand for bushmeat (Pruvot et al. 2019).

Additionally, Laos began developing new cities and special economic zones (SEZs) in the early 2000s. New cities are being developed in Boten and outside of Luang Prabang city. In Boten, Chinese developers are building a new city in an SEZ, providing homes, workplaces, and services (DiCarlo 2020) to Chinese immigrants. Outside of Luang Prabang city, Chinese investors are planning to construct the "Diamond City" development, which will provide homes for primarily Chinese citizens and provide a range of public and private services. With a differential regulatory scheme, such as incentive tax breaks and flexible customs regulations, the purpose of SEZs is to attract foreign direct investment and stimulate economic development in a controlled manner, to prevent the concentration of investment in only a few areas throughout the c ountry (Nolintha 2011; Oraboune 2011; Laungaramsri and Sengchanh 2019). The first SEZ in Laos was the Savan-Seno SEZ in Savannakhet province, located at the center of the East-West Economic Corridor (EWEC) near the Second Lao-Thai Friendship Bridge. From this location, investors would have easy access to ports in Thailand, Vietnam, and Myanmar (Nolintha 2011). Between 2011 and 2017, 13 SEZs were approved and 28 were under consideration, including the Golden Boten SEZ in Luangnamtha (Nolintha 2011; Laungaramsri and Sengchanh 2019). The Boten SEZ spans 1640 ha in a 50-year land lease and is wholly owned by a private Chinese developer for a reported investment of USD500 million (Krishnasamy et al. 2018).

Transport infrastructure development

Laos's land-locked and rugged geography, and relatively undeveloped physical infrastructure, is considered an obstacle to economic development and further regional economic integration, by the Government of Laos (GoL) and international development agencies (Pholsena and Banomyong 2006; Souvannavong 2013). The GoL's Transport Strategy to 2020 therefore envisions Laos becoming a regional logistics hub by 2020, transforming the country from "landlocked to land-linked," (Oraboune 2008; Asian Development Bank 2012; Souvannavong 2013). This policy supports national economic development, national economic defense, local economic

development, national and public security, and poverty alleviation (Asian Development Bank 2012).

Currently, there are approximately 35,600 km of existing road network (Asian Development Bank 2012). Historically, the two most important national roads are Route No. 13, running north to south from Luang Prabang, through Vientiane and south to Pakse, and Highway No. 9 linking Keysone Phomvihane City (Savannakhet) to the port city of Da Nang in Vietnam (Pholsena and Banomyong 2006). ADB's Greater Mekong Subregion (GMS) program, which seeks to increase connectivity in the region, supported the upgrading of the Highway No. 9 and cities along the highway as part of the EWEC initiative, with its East-West Corridor section in Savannakhet Province (Map 13, Annex).

Construction related to infrastructure projects has been a primary driver of economic growth in Laos (Asian Development Bank 2017; World Bank 2017). Among the largest infrastructure projects undertaken in Laos is the Chinese government's Belt and Road Initiative (BRI). Currently under construction, 414 km of railway will link Vientiane to Boten by the end of 2021 (Map 13, Annex), a northern city along the Chinese border, reducing travel time from 15 to four hours. An additional 595 km on the other side of the border links Boten to Kunming in China. The economic expectations attached to the railway are great. The drastic enhancement of infrastructure is forecast to attract foreign investment, increase access to global value chains, and boost logistics, agriculture, and tourism. Concerns have been raised regarding the enormous debt the railway represents of USD5.9 billion, the equivalent of nearly one-third of Laos's entire GDP in 2017, and issues related to social protection and inclusive growth (World Bank 2020b) . However, the environmental implications of the railway are not yet well understood. Parallel to the railway, and as part of the BRI, China is constructing a four-lane highway (Map 13, Annex), of which the section between Vientiane and Vangvieng is operational and the section between Boten and Luang Prabang under construction.

4.3 Exploitation of forest resources

Hunting, snaring, and wildlife trade

As described in Chapter 2, wildlife plays an important part in the livelihoods of the rural Lao population, both for domestic consumption as a significant source of nutrients, as well as for sale. Communities that rely on wildlife as an important source of protein and micronutrients could be faced with negative health effects, increased food insecurity, and malnutrition, if access to wild meat is restricted – either through policies or through depletion of resources, or both.

Besides wild meat as a vital source of nutrition for rural communities, wildlife also plays a significant role as a source of income, both for impoverished rural communities as well as for wealthier traders and businesspeople.

At the same time, hunting – and, in particular, snaring – present some of the greatest threats to wildlife in Laos. No other comparable region has as many endangered species in almost any taxonomic group as this region (Harrison et al. 2016; Benítez-López et al. 2017; Hughes). Snares are the simplest, cheapest – and also most effective – means for hunting, with millions of snares placed randomly throughout biodiversity hotspots of the region, indiscriminately capturing and killing a large number and wide variety of local wildlife. WWF estimates that there are between 8 and 24 million snares present in the forests of Laos, Vietnam, and Cambodia, with Laos being a hotspot for snaring (Belecky and Gray 2020).

While Laos has historically been known for the trade of local wildlife – such as pangolins, tigers, bears, and elephants – the rapid rise in hunting, snaring, and trading of wildlife in Laos is fueled by dramatically increased demand for wildlife products in non-forest-dwelling and urban societies, for food and "traditional medicine" (Pruvot et al. 2019), partly in Laos, but much more so in neighboring Vietnam and China. Feeding this increased demand is facilitated by improved access to wild areas through construction of roads and expansion of trade routes.

Furthermore, there has been a recent increase in trafficking of global wildlife such as the helmeted hornbill from neighboring countries, and ivory and rhino horns from Africa (Krishnasamy et al. 2018). A study conducted in the Boten SEZ highlighted both the diversity of illegal wildlife traded and the laxity of local enforcement of international and domestic regulations of wildlife trade (Krishnasamy et al. 2018).

Trade in wildlife is also a zoonotic disease concern, and a danger to human health, particularly with increased movement of wildlife products into more densely populated areas and markets, which provides increased possibility for cross-species transmission.

For policy, the challenges are to balance the trade-offs among sustainable use of forest products as an important pillar of rural subsistence livelihoods, nature conservation, and wildlife protection, as well as food safety, public health, and culture and traditions.

To limit the use of wildlife for local subsistence consumption – and thereby bring hunting back to a more sustainable level – there is a clear need to reduce demand in urban areas. This is a matter of challenging culture and traditional beliefs, where wildlife is not an essential source of protein and nutrition, nor an essential or realistic source of medication.

Logging

Laos's rich forest resources have been plagued by uncontrolled logging activities for years, when well-stocked forests were depleted of its most valuable trees (Kukkonen and Tammi 2019). Through the Prime Minister's Order No. 15, dated 13 May 2016, the Lao Government aimed at implementing strict management and inspection rules for timber exploitation, movement, and processing. This led to a drastic reduction in exports of logs and wood products, and managed to curb illegal logging substantially. Nonetheless, illegal harvesting and export of large logs,

as well as illegal selective harvesting of precious tropical hardwood logs continues, fueled by continuously high demand in Laos as well as in neighboring countries.

4.4 Climate change

According to the Köppen-Geiger climate classification, Laos is changing from southwest to northeast from a tropical savannah (Aw) to a tropical monsoon (Am) and to a temperate dry winter but hot summer (Cw) climate (Beck et al. 2018). This already indicates that rainfall in Laos is heterogeneously distributed across the country. Generally, the northern provinces receive the least amount of precipitation, while the central and southernmost regions receive the highest (Basnayake et al. 2006). There is a distinct wet season from May to September, which accounts for 84–90% of total annual rainfall (Basnayake et al. 2006). These high precipitation amounts in summer are related to the summer monsoon observed in Southeast Asia (Wangwongchai et al. 2010). Additionally, typhoons that originate in the South China Sea also impact the whole Indo-China Peninsula, especially from June to November (Wangwongchai et al. 2010; Lap 2019). Large-scale conditions associated with El-Niño–Southern Oscillation or the Indian Ocean Dipole can further alter rainfall patterns in some years (Behera et al. 2008; Ummenhofer et al. 2013; Salimun et al. 2014).

Temperature distribution is similar to that of precipitation, with the lowest temperatures in the north and higher temperatures in the central and southern provinces of Laos. This also correlates with elevation. The coldest month is January, with temperatures of around 28 °C, and the hottest month is April, just before the rainy season sets in, with around 35 °C (Basnayake et al. 2006).

In the last 40 years changes in climate can be observed. The years from 1981–2020 cover an era with good station network and satellite-based observations. A data set that includes not only precipitation amounts estimated from satellite images, but also station data, is CHIRPS V2.0 (Funk et al. 2015; https://chc.ucsb.edu/data/chirps). This data set is available on 0.25° and 0.05° spatial resolution. As the finer data set shows some interpolation errors especially in the most recent years, trend estimates based on the coarser data set are presented here. Trends for precipitation sums of the wet and dry season and of the whole year during two time periods are calculated, i.e., 1981–2000 and 2001–2020. The last period coincides with the satellite-based land-surface observations of MODIS. The estimation of the linear trend follows the Theil-Senn method, while the significance of the trend is tested with the Mann-Kendall approach. The Mann-Kendall test identifies trends which are monotonically in- or decreasing.

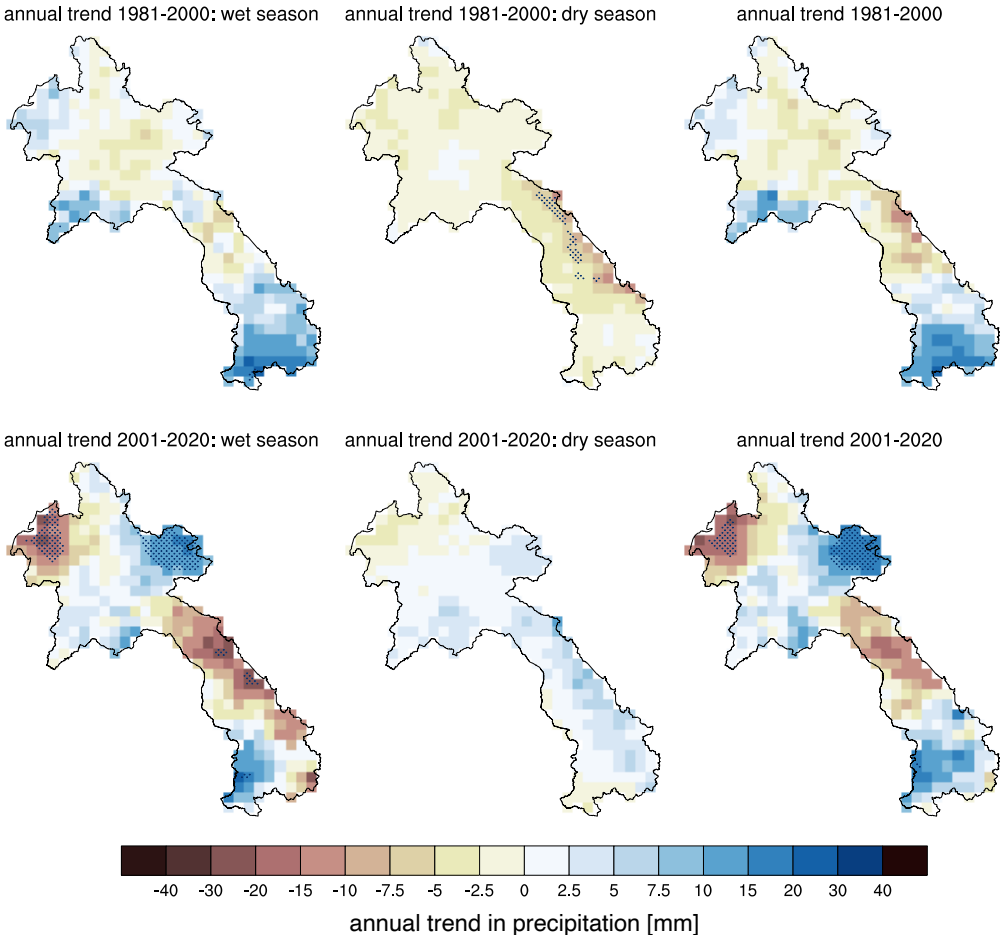


Figure 4.4: Trends in precipitation [mm] for the period 1981–2000 (first row) and 2001–2020 (second row). The first column shows trends for precipitation sums during the wet season (May-September), the second column depicts trends for precipitation sums during the dry season (October-April) and the third column provides trends for annual precipitation sums. Stippled areas show statistically significant monotonically in- or decreasing trends at α=10%. Source: Authors' design, based on CHIRPS V2.0 (Funk et al., 2015).

The wet season (May-September) shows some wetting in the southern provinces of Laos and also in some areas in the north of Laos, while in the center part of the country a trend towards a drying is observed (Figure 4.4, 1st column). The first period shows no significant trend in precipitation, while the second period is characterized by two regions that are receiving more precipitation with time (northeast and southwest of Laos) and two areas that see a decrease in precipitation (northwest and the higher elevated areas in the center of Laos). In the dry season (October-April) the trends are difficult to interpret, as they are rather small compared to the wet season and they point into different directions in the two periods (Figure 4.4, 2nd column). While there is a significant trend towards a drying in the center of Laos between 1981–2000, a general but not significant wetting is observed during 2001 to 2020. The annual precipitation trend is clearly dominated by the signal of the wet season (Figure 4.4, 3rd column). The central part as well as the most northern part of the country are indicating dryer conditions overall. This will affect protected areas considerably. Only few protected areas in the north are experiencing more humid conditions. By comparing Figure 4.4 with Map 5 in the Appendix (forest coverage), it is obvious that the trends observed in Figure 4.4 will sooner or later impact the evergreen forest covering large parts of the central region of the country. The underlying processes responsible for the trends in the wet season, which at the same time dominate the annual signal, are still not understood. Besides the possibility of a global climate change signal also internal climate

variability, e.g., modes of variability such as El-Niño–Southern Oscillation, can generate such trends, in particular as the trend signals over Laos show a heterogeneous pattern with rather weak statistical significance.

The model simulations used in the Coupled Model Intercomparison Project (CMIP5) and, thus, in the Fifth Assessment Report of the IPCC (IPCC 2013b) project an increase of around 5 °C on average over southern Asia, reaching as high as 8 °C in single simulations at the end of the 21st century in the high-emission scenario RCP8.5. The warming over Laos is simulated rather uniformly for both dry and wet seasons, with an estimated increase in temperature of around 3 °C. For precipitation the signal is not as clear as for temperature. Most model simulations suggest an increase in precipitation of up to 10% in both seasons, especially in the wet season (IPCC 2013a).

A number of different aspects – such as topography, and complex interplays between land and water bodies – are important for precipitation in Laos. Therefore, a fine-scale resolution can provide additional information to understand changes related to a warmer climate. As we cannot present a simulation performed by ourselves, we summarized findings based on the Coordinated Regional Climate Downscaling Experiment, CORDEX (Torres-Alavez et al. 2021). The CORDEX region 14 covers Southeast Asia (89.49°–146.51°E; 14.81°S–26.96°N) with a horizontal resolution of around 25 km. Some simulations are available for the present and future climates (Tangang et al. 2019). Here we show results from two simulations driven by the global model HadGEM2-ES (Hadley Centre, UK) and downscaled by the regional climate model RCA4 (SMHI, Sweden) (Tangang et al. 2019). The first covers the period of 1981–2010 and the second spans 2071–2099 under the high-emission scenario RCP8.5.

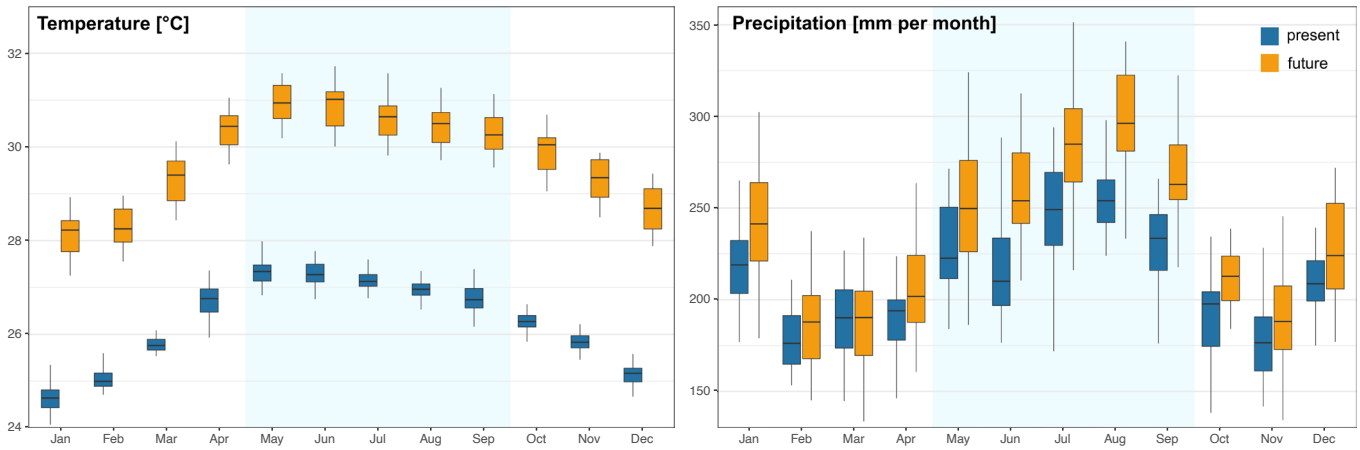


Figure 4.5: Climatology for each month using monthly mean 2 m temperature (in °C, left) and precipitation sums (in mm, right) over Laos. The blue boxes represent the present climate (1981–2010), while the orange boxes depict the future climate (2071–2099). The boxes cover the range of the 25th to the 75th quantile, while the whiskers extend to a maximum of 1.5 times plus or minus the distance between the first and third quartiles. Outliers are not shown to simplify the plots. Blue shading indicates the wet months. Source: Authors' design, based on a CORDEX simulation (Tangang et al. 2019).

Similar to the CMIP5 models, the regional climate model also simulates a strong increase in temperature of around 4 °C on average over the whole country throughout the year (Figure 4.5, left panel). At the end of the century, the coldest month – January – could be warmer than the presently warmest month – April. It must be noted that the model simulation underestimates the temperature in the present climate, but the change in temperature is in agreement with the general signal of CMIP5 models. The

spatial pattern of temperature mainly depicts the elevation of the country, with cooler temperatures in the north and the hottest temperatures in the southwest. In the elevated areas, the temperature increase in the future is around 3 °C, while it is around 4 °C in the lower lying areas (Figure 4.6, first and second panel).

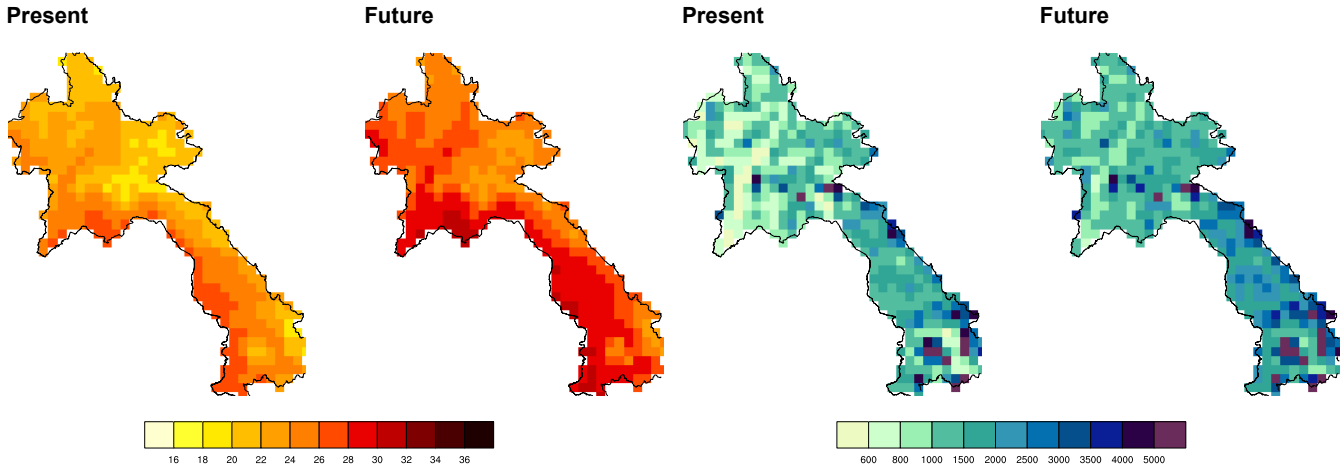


Figure 4.6: Annual mean 2 m temperature (in °C) for the present (1981–2010, first panel) and the future (2071–2099, second panel) and annual precipitation sums (in mm) for the present (1981–2010, third panel) and the future (2071–2099, fourth panel) are shown. Source: Authors' design, based on a CORDEX simulation (Tangang et al. 2019).

Precipitation also shows an increase in most of the months, but it is more pronounced during the rainy season (blue shading in Figure 4.5, right panel). Such an increase in precipitation could increase the occurrence of floods in the future. This is especially true for the central and southern provinces of Laos, as they still obtain the highest precipitation amounts. Generally, the spatial precipitation patterns show a relatively uniform increase in annual accumulated precipitation for the future (Figure 4.6, third and fourth panel).

Climate disaster risks

Laos is prone to a variety of natural hazards including droughts, floods, storms, and pests. Both floods and droughts occur regularly throughout the country (Map 11). Seasonal floods affect lowland plains and river valleys, while flash floods, often combined with landslides, pose a regular threat during the typhoon season in the Annamite mountain range along the Lao-Vietnam border, as well as in the northern mountain region. The damage caused by such natural disasters has become particularly costly in the last 15 years (UNDRR 2019), resulting, among others, from typhoons Ketsana (2009) and Haima (2011), the Con-Tinh storm in 2018, as well as major flooding events during the rainy seasons of 2013, 2015, 2016, 2018, 2019, and 2020 (Map 12).

A recent CORDEX study by Torres-Alavez et al. (2021) found a significant increase in tropical cyclone (TC, or typhoons) frequency over the South China Sea under the high-emission scenario RCP8.5. Given the fact that the relative humidity in the mid-troposphere is also increased under RCP8.5 conditions, precipitation amounts associated with TCs are projected to increase by the mid to the end of the 21st century. Moreover, the study by Torres-Alavez et al. (2021) shows that the most intense TCs over the Indo-

China peninsula are more frequent in the future. Still, the regional model simulations we used are rather coarsely resolved for the phenomenon "typhoon", so that significant uncertainties in the projection of TC characteristics remain.

4.5 Environmental degradation and invasive species

Waste management

High urbanization and economic growth rates have caused collection and disposal of solid waste to become a significant environmental problem. As of 2017, there were 130 landfills operating in the country, none of which meet international sanitation standards. Only about 60% of waste is collected in Vientiane capital, and 30% nationally. This includes plastic, electronic, hazardous, industrial, extractive, infectious, and agricultural waste. The lack of proper waste collection and disposal leads the accumulation of plastics in the environment, or to open burning, which can potentially release toxic and carcinogenic substances. Decomposition of organic waste can attract disease vectors, and leachate can contaminate soil and groundwater (Ministry of Natural Resources and the Environment 2020).

Water quality

Information on the state of groundwater is limited, as there is no systematic monitoring nor has a comprehensive study ever been conducted, despite the vulnerability of groundwater to contamination from salt deposits, arsenic from the Mekong floodplains, and human activity (Ministry of Natural Resources and the Environment 2020). Hydropower is affecting water quality as follows: decomposing biomass is leading to decreased levels of dissolved oxygen, ecological functions are disrupted through changes in river flow and in river and lake environments, and fish migration is impeded (Robichaud and Shoemaker 2018; Ministry of Natural Resources and the Environment 2020).

Air quality

The air quality across Laos is relatively good during the rainy season, but often at hazardous levels during the dry season. Averaging across seasons, outdoor pollution of particulate matter in Vientiane capital has been measured to be up to four times higher than the threshold recommended by the World Health Organization (WHO). In urban areas, this is largely a result of habitual open burning of garbage, traffic with very poor engine emission standards, and area-wide dust. Emissions of dioxins and furans are attributed to ferrous and non-ferrous metal production, as well as to waste incineration (Ministry of Natural Resources and the Environment 2020). Across the country, seasonal burning of harvested agricultural fields, burning of slashed forest and bushland as part of shifting cultivation practices in the uplands (Map 10), and forest fires are the main causes of very high PM 10 and PM 2.5 values throughout the region during the dry season.

The use of solid fuels for cooking is primarily a concern for indoor air quality (Hurd-Kundeti et al. 2019).

Invasive species

Alien species have been introduced to Laos for centuries – originally primarily for agroeconomic purposes. Examples include coffee, introduced in the 18th century, and today one of the top export products of Laos, or the mahogany trees lining the roads in the main towns of the country, which were introduced by the French in the 20th century. Species with clear negative environmental and economic impacts include *Mimosa invisa* and *Mimosa pigra,* woody shrubs which thrive in upland and lowland areas throughout the county, as well as e.g. *Echinochloa colonum* and *Echinochloa crusgalli,* grasses which have promoted increased use of herbicides, particularly in lowland rice production systems (Pallewatta et al. 2003). The golden apple snail (*Pomacea* sp.) – originally from Thailand in the early 1990s, and further introduced through Vietnam to the northern provinces as a food source – has spread throughout Laos, causing significant damage to young rice plantings and increasing pesticide use (ibid.). Water hyacinth (*Pontederia crassipes*) – like the mimosa, among the 100 worst invasive species in the world (Miththapala 2007), is widespread in Laos, blocking waterways and penetration of sunlight, reducing biodiversity underneath (Matthews and Brandt 2004).

5 Indirect drivers of change

Michael Epprecht, Anh-Thu Nguyen, Vong Nanhthavong

Indirect or underlying drivers refer to the fundamental social processes that underpin direct drivers of change. These typically include political, institutional, demographic, economic, cultural, and technological factors (Geist and Lambin 2002). This section will briefly summarize the most influential factors, including socioeconomic transitions and the institutional and policy framework.

Economic development

Laos has experienced exceptional economic growth in the last decade, averaging 7.8% GDP growth annually, primarily driven by exploitation of natural resources in electricity generation, large-scale investments in infrastructure and mining, and cash crop production and export (Asian Development Bank 2017; World Bank 2017). Where the agricultural sector accounted for 48.5% of GDP structure in 2000, it now accounts for less than 18% (Asian Development Bank 2020) (Figure 5.1); the bulk of growth is observed in construction and services, and mining and utilities (World Bank 2017).

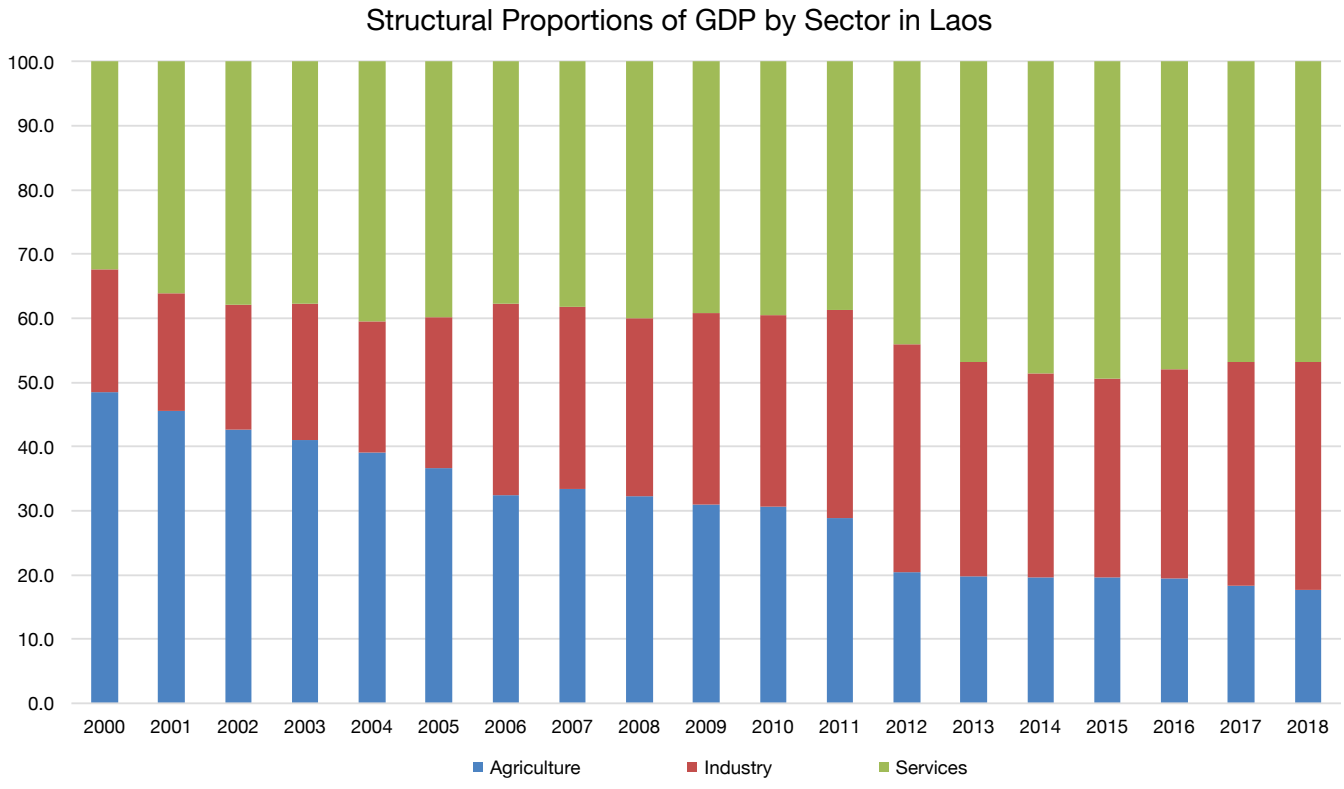


Figure 5.1: Structural proportions of GDP by year and sector in Laos. Source: ADB 2020

Nonetheless, two thirds of the country's population remain engaged in the agricultural sector (World Bank 2017). Due to this pattern of growth, there have been limited developments in human capital and employment generation.

The COVID-19 pandemic caused economic growth to slow, triggering the first recession in Laos since 1998. The World Bank estimates growth to decline to -0.6% in 2020, with the pandemic affecting labor-intensive sectors and those linked to global value chains, including tourism and manufacturing (World Bank 2021a).

Demographics

The population of Laos is estimated at 7.3 million in 2021, with an annual growth rate of around 1.5%. Average population density is 32 people per km^2. The majority of the country's population live in rural areas, and 72% of the working age population engage in agricultural activities (Lao Statistics Bureau 2015b). According to the Population and Housing Census of 2015, 32% of the population is younger than 15 years old, which makes it the youngest population in the ASEAN region. Laos could benefit from a demographic dividend through increased investments in economic developments via savings from reduced social services, if opportunities and education match the requirements of the workforce (Government of the Lao PDR and ILO 2017). The informal sectors are an important basis for livelihoods in Laos.

Migration

Prior to COVID-19, Thailand was a major labor migration destination for Lao workers, and the return of hundreds of thousands of migrant workers to Laos, many of them unpaid for the past months, is putting an additional strain on rural communities. Little information is available about internal migration in Laos. Population census data point to an emigration of the younger labor force, aged 15–25, from the most disadvantaged areas, particularly in the country's southeast (Map 4).

Poverty

Over the past two decades, Laos has made significant progress in human development, as indicated by a significant reduction in poverty and an overall improvement in literacy (Ministry of Planning and Investment and UNDP 2017). The incidence of poverty decreased across the country between 2005 and 2015, although certain areas, particularly in the south, experienced an increase in poverty, likely as a result of migration of poor populations into formerly less poor areas (Epprecht, et al. 2018a) (Map 16). Poverty reduction was strongest in the northern uplands, where many development cooperation projects focused their efforts, as well as in lowland communities, which benefited most from the general economic development of the country. Overall, the southeastern provinces of Saravanh, Sekong, and Savannakhet remain the most disadvantaged regions of the country in almost all aspects of human well-being (Map 15). People living in these areas are highly reliant on direct resources for subsistence livelihoods (Map 17).

Ethnicity

Ethnically, Laos is very diverse. The closely related Lao and Tai ethnic groups from the majority. They constitute around two thirds of the population and occupy mostly the urban and lowland areas. The 47 smaller and larger ethnic minority groups inhabit primarily the lower and upper slopes of the mountainous areas of the country (Epprecht, et al. 2018) (Map 18).

Tenure (in)security

Land tenure security is fundamental for the sustainable management of land resources, and as an incentive for agricultural land development. Formal land tenure in the form of registered land titles is, however, largely limited to urban and peri-urban areas of Laos. Customary land tenure rules – typically based on village-level rules of land use – are therefore the most common system used by rural people to manage local land resources. Family land books, temporary land use certificates (TLUC), land survey certificates (LSCs), and land tax receipts have been used by many households to demonstrate land use rights to achieve a degree of tenure security.

In Article 26 of the Prime Minister's (2008) Decree on the Implementation of the Land Law, customary land tenure is legally recognized only where applications for land registration are submitted to the Land Management Authority and official documentation in the form of Land Survey Certificates, Land Titles, or Land Certificates are issued on a case-by-case basis, as specified in the land law. Local land users often lack the necessary evidence to formally claim land ownership.

Institutional and policy framework

The Lao People's Democratic Republic (Lao PDR or Laos) as known today was founded on 2 December 1975 following the victory of the Lao People's Revolutionary Party (LPRP) and imposition of a one-party Leninist political system (Rathie 2017; Creak and Barney 2018). The country is ruled under the principle of "democratic centralism" (Creak and Barney 2018) and the economy was managed under socialist command until the introduction of the "chin thanakaan mai" or New Economic Mechanism (NEM) in 1986. The NEM reformed the economy towards a market-orientation, introducing policies supporting liberalization of the economy, privatization, and market integration (Rigg 2009). Since then, Laos has undergone numerous efforts to integrate into regional and global markets and institutions, including full membership of the Association of Southeast Asian Nations (ASEAN) in 1997 and ascension to the World Trade Organization (WTO) in 2012 (Leebouapao et al. 2012; WTO 2018).

In order to understand the institutional perspectives on nature and environment in Laos, it is essential to embed governance and policy frameworks within the government's national priorities.

National visions, strategies, and plans

Policies in Laos are organized in a hierarchy of visions, strategies, and plans. The first of these was an interim three-year plan for the period of 1978 to 1980, which set the primary objective of realizing rice production self-sufficiency through agricultural cooperatives. The chief guiding policy is set out in ten-year strategies and visions. The current Socioeconomic Development Strategy until 2025 and Vision to 2030[1], a government strategy published in 2016, is formulated on overarching objectives and goals of graduation from Least Developed Country status, attaining upper middle-income status, and achieving the Sustainable Development Goals by 2030. Implementation of the strategies is outlined in the five-year plans. The most recent 8th National Socioeconomic Development Plan (NSEDP) defined the period from 2016 to 2020 (Ministry of Planning and Investment 2016). The 9th NSEDP for the period 2021 to 2025 is currently under revision by the Ministry of Planning and Investment.

Other relevant strategies include the Agricultural Development Strategy to the Year 2025 and the National Biodiversity Strategy and Action Plan 2016-2015. The Agricultural Development Strategy is oriented around the two main goals of ensuring food production and increasing the commercialization of agricultural production towards rural development and poverty reduction (Lao Statistics Bureau 2015b). The goal of the National Biodiversity Strategy and Action Plan is to "enhance the role of biodiversity as a national heritage and as a substantial contributor to poverty alleviation, as well as sustainable and resilient economic growth," (Ministry of Natural Resources and the Environment 2016). Key pieces of recent legislation relevant to biodiversity conservation include two Prime Minister's Orders (PMOs). PMO 15 was enacted in 2016 and relates to the regulation of timber harvesting across the country while, PMO 5 was enacted in 2018 and relates to the regulations governing endangered wildlife, particularly controlling the illegal trade. Other key pieces of legislation are the 2019 Forestry Law, and a revision of the 2007 Aquatic-Wildlife Law.

Nested within these strategies is the Forestry Strategy to the Year 2020 of the Lao PDR. In support of these previous strategies, the overarching goal of the Forestry Strategy is to support forest policy and management towards poverty eradication. Objectives of the strategy include building capacity for law enforcement and sustainable management of production forests, and the conservation of forest ecosystems. Specifically, the Strategy sets the target of reaching 70% forest area by 2020 (Ministry of Agriculture and Forestry 2005).

Notably, all visions, strategies, and plans must be consistent and in accordance with the overarching, above-mentioned Socioeconomic Development Strategy until 2025 and Vision to 2030.

1 https://data.laos.opendevelopmentmekong.net/library_record/vision-2030-and-tenyear-socioeconomic-development-strategy-20162025/resource/a7e114b2-468c-4a75-9119-4b2d52b7fa94

Land management

Since the revolution in 1975, the GoL has sought to achieve the dual national priorities of creating a unified national identity and delivering promised development. The country's rugged terrain and its geographically and culturally scattered population present a challenge to both (Stuart-Fox 1997). A process of resettlement was introduced and continues today to relocate upland communities to more accessible areas, closer to markets and public services (Lestrelin et al. 2012). This process is justified first from the perspective that traditional upland livelihoods perpetuate poverty and are unsustainable, contributing to a "chain of degradation" (Lestrelin 2010). In particular, the practice of shifting cultivation is held primarily responsible by the GoL for deforestation and threats to biodiversity and water supply, causing a reduction in national forest cover from 70 to 50% between 1950 and 2000 (Lestrelin 2010; Evrard and Baird 2017). The ongoing resettlement process is expected to have displaced around 1,200 villages with 450,000 people, accounting for 12% of the country's population (Lestrelin et al. 2012). In the 1980s, a policy of decentralization provided provincial and district administrations greater autonomy in implementing development plans. This resulted in institutionalized resource exploitation through state and sub-national companies, rapid depletion of natural resources, and growing mismanagement and corruption.

In reaction to this and to the growing influence of international development agencies, policymakers made sustainable development a key objective. The rationale for sustainable development was predicated on disrupting this chain of degradation, eradicating shifting cultivation, and increasing the efficiency of land use. In 1993, Prime Ministerial Decree No. 169 defined five categories of forest. These are: protection, conservation, and regeneration (in which economic activities are prohibited); production (where logging and collection of forest products are permitted), and degraded forests (allocated to tree plantation or agriculture). This process also defined 20 protected conservation areas, which were renamed to National Protected Areas (NPAs) in the early 2000s (Lestrelin et al. 2012). As of 2018, there are 23 protected areas covering 3.8 million ha. Since 2018, the protected area system has been under the management of the Department of Forestry (DOF) in the Ministry of Agriculture and Forestry (MAF). Between 2018 and 2019, three of the country's existing National Protected Areas (NPAs), Nakai Nam Theun, Nam Et-Phou Louey, and Him Nam No were upgraded to National Parks status (Map 2). Him Nam No National Park is now on course to become the country's first UNESCO Natural World Heritage Site.

The narrative of land degradation driven by local communities and the associated resettlement programs has been heavily criticized by international observers. Despite empirical evidence that upland communities' practices actually contribute to conservation, and that the resettlement processes have introduced new forms of poverty, the previous narratives are accepted in a political consensus that favors conservation and forest over agriculture in remote areas (Lestrelin 2010; Evrard and Baird 2017).

Turning land into capital

In the late 1990s, development models introduced by the World Bank and the Asian Development Bank advanced market forces as an instrument for sustainable development. Coupled with a land use planning campaign, the GoL sought to capitalize on the country's natural resources to generate economic value by identifying "empty" spaces for the development of large-scale investment projects, such as mining, hydropower, agriculture, and tree plantations (Lestrelin et al. 2012; Hett et al. 2020). This process was legislatively supported by Prime Ministerial Decree No. 192 in 2005 (updated as Decree No. 84 in 2016) on compensation and resettlement (Wellmann 2012; Government of the Lao PDR 2016) and the Environment Law in 2005, which provided a legal framework for environmental impact assessments (EIA) (Vuola et al. 2020). "Turning land into capital" was officially formulated as a policy in 2006 (Kenney-Lazar et al. 2018).

Following an initial boom period in which large numbers of land deals were granted in rapid succession, concerns about their adverse impacts on local livelihoods and the environment prompted the GoL to issue moratoria on land deals in 2007, 2009, 2012, and 2018 (Hett et al. 2020). Concerns included the inappropriate use and disposal of agrichemicals, as well as villagers' loss of access to land and resources. Notably, CDE's analysis of Land Concession Inventory data showed there was not a significant difference in environmental impact between land deals that conducted EIA and those that did not, indicating that EIA alone are not effective in ensuring environmental protection and have only a limited role in project planning and implementation (Nanhthavong et al. Forthcoming). Analyses further revealed that land deals typically adversely affected local people's well-being or triggered trade-offs, particularly through environmental impacts through the use of agrichemicals and impacts on local water level and quality (Nanhthavong et al. Forthcoming).

Under Prime Ministerial Decree No. 136, the National Land Management Authority (NLMA) was charged with systemically inventorying State land leases and concessions and for grading potential concession areas (Lestrelin et al. 2012). In 2011, NLMA was merged with the Science, Technology, and Environment Agency to create the Ministry of Natural Resources and Environment (MoNRE) (Vuola et al. 2020).

Green growth

Most recently, the policy mindset has shifted towards a "green economy." Debuting at the United Nations Rio+20 conference in 2012, a green economy is one in which "growth in income and employment are driven by public and private investments that reduce carbon emissions and pollution, enhance energy and resource efficiency, and prevent the loss of biodiversity and ecosystem services," (Vuola et al. 2020). Laos's green growth agenda is coordinated by the inter-ministerial Green Growth National Steering Committee (GGNSC), which consists of members from the Ministries of Natural Resources and Environment; Agriculture and Forestry; Energy and

Mines; Industry and Commerce; and Public Works and Transportation, and heavily influenced (and financed) by the World Bank.

The National Green Growth Strategy (NGGS) was developed in 2018 as, "a supplementary strategy," or "translation of the Resolution of the 10th Party Congress, the Vision 2030 and 10-year Strategy (2016-2025) and the 8th Five-Year Socio-Economic Development plan (2016–2020)," (Ministry of Planning and Investment 2016; GoL 2019). Notably, the overall objectives of the NGGS specifies its contribution to economic growth and to rural development and poverty reduction – as well as to optimizing the use of natural resources, reducing national vulnerability, and reducing pollution – but it does not specifically mention conservation of the environment or biodiversity (Secretariat for Formulation of National Green Growth Strategy of the Lao PDR 2019).

The NGGS is reflected in the 8th NSEDP's priority themes. Environmentally sustainable growth is embodied in Outcome 3, stating that, "Natural resources and the environment are effectively protected and utilized according to green growth and sustainable principles; there is readiness to cope with natural disasters and the effects of climate change for the reconstruction following natural disasters," (Ministry of Planning and Investment 2016). Yet the performance indicators for this outcome only specify variables of the Economic Vulnerability Index, including the index for victims of natural disasters and instability of agricultural production due to natural shocks (Ministry of Planning and Investment 2016). The NGGS has been further criticized for its lack of social inclusion measures, focusing primarily on employment generation through the growth of tourism, and its definition of hydropower as "clean and environmentally friendly energy," (Vuola et al. 2020).

Technology

Digitalization and related technologies are an important potential driver of change at the human–environment intersection. New digital technologies facilitate communication across sectors and administrative levels within government structures as well as across stakeholder groups. Integrated spatial planning (ISP) approaches have been developed and tested in Laos, but are still in their infancy. Insufficient information exchange and integration across institutional boundaries is still a major obstacle to more integrated planning, particularly also with regard to land management.

At the national level, CDE supports national government institutions across the different sectors with tools and capacities for information integration and sharing towards better-informed, integrated, development planning. A national inter-ministerial land concession inventory system (http://lcis.k4d.la/) supports land governance across sectors, while the thematically broader www.decide.la as well as www.savannakhet.k4d.la and www.k4d.la (forthcoming) support exchange and integration of digital information across sectors and to the wider public, in support of integrated development planning and transparency.

As a national repository and knowledge hub on biodiversity in Laos, CDE supported the creation of, and maintains, the Pha Khao Lao online platform on https://www.phakhaolao.la/en/home.

In the field of hunting and wildlife trade, the SMART (spatial monitoring and reporting tool) online platform (https://smartconservationtools.org/) is designed and used to support wildlife law enforcement and site-based conservation activities. It is used in a range of local conservation projects throughout Laos, although systematic information integration and exchange across projects has not been realized yet, something that would facilitate broader coordination of action.

6 Current and future interactions between nature and people

Christian Hergarten, Paul Eshoo

Laos can be characterized as a regional and global priority for biodiversity conservation, owing to its extensive tracts of high-quality habitats and high levels of species diversity and abundance (Duckworth et al. 1999; Tordoff et al. 2005; Duckworth et al. 2012; Tordoff et al. 2020). However, a confluence of interacting socio-economic, historical, cultural, and geographic factors severely curtail the success of conservation initiatives. Among these factors, the seemingly insatiable demand for land, energy, wildlife and other natural resources from neighboring countries with vigorous economies, particularly Vietnam and China, plays a key role (McNeely et al. 2009; Nijman 2010). The situation is compounded by deep-rooted cultural perceptions regarding hunting and the collection of NTFPs to provide health benefits (Nijman 2010; Schweikhard et al. 2019), creating high pressure on the ecosystems.

Laos is aiming to graduate from the least-developed country status by 2024, and this process will likely involve greater resource consumption given the country's economic reliance on extractive industries. In fact, people's interaction with nature is also shaped by the increasing pressure on land through the continued granting of large areas for commercial investments for agriculture, tree plantations, mining, hydropower and large-scale transport infrastructure projects, which pushes smallholder farmers beyond the fringes of the agricultural frontier, results in a continuous encroachment on natural forest and wetland areas causing a rapid decline in natural habitats.

The development of transport corridors under the Chinese BRI drastically increases the accessibility of previously remote and inaccessible areas, turning Laos from a 'land-locked' to a 'land-linked' economy. While this undoubtedly advances the economic development and regional integration of the country, this also has far-reaching consequences for people's interaction with nature, as it increases the vulnerability of rural communities and jeopardizes largely untouched ecosystems. At the same time, it may also create new opportunities for a more sustainable agricultural production, e.g. by designing innovative landscapes complying with agroecological principles, optimizing the interactions between animals, plants, humans and the environment, while addressing also the

requirement for socially equitable food systems. There is a potential for involving the private sector for developing more sustainable and inclusive value chains and marketing instruments in order to secure added value for producing smallholder communities.

Despite the lack of a strong civil society due to the dominant role the central government is playing, there is a growing urban middle class developing a cautious interest in an intact environment and also a taste for healthy food, which creates a promising opportunity and potential role for advocating greater environmental awareness, nature conservation and agroecological food production in Laos.

However, people's interaction with nature will also be affected by the daunting impacts climate change is likely to exert in the region, including changing precipitation patterns and seasonal shifts, more frequent dry spells and very heavy rains. Mitigating these looming challenges in addition to the potential negative impacts of current partly unsustainable development pathways discussed above will require to explore new and more inclusive approaches of cooperation among actors and stakeholders who used to work in separate domains and silos, calling also for more transparent and sound decision-making and stronger evidence-based resource governance processes at various scales.

7 Challenges, assets, and opportunities for people and nature

Christian Hergarten, Urs Wiesmann, Albrecht Ehrensperger, Paul Eshoo, Michael Epprecht, Hannah O'Kelly, Aloun Phonvisay, Somephone Bouasavanh, Thong Eth Phayvanh, Sabin Bieri

In this chapter, we identify and discuss challenges, assets, and opportunities towards a more harmonious mutually reinforcing relationship between people and nature. The first part of the chapter draws primarily on a synthesis workshop conducted with a small group of experts in June 2021, as well as on bilateral exchanges with other experts. Due to the limited number of workshop participants, no claim is made to completeness of the assessment. Nevertheless, given the longstanding regional and broad thematic expertise of the participants, the workshop contributed to producing a rich picture of relevant development challenges, opportunities, and knowledge gaps. The second part of this chapter draws on the results of a stakeholder analysis conducted during the second half of 2020.

7.1 General considerations on human well-being and the value of nature in Laos

Unless COVID-induced[2] restrictions and impacts continues for much longer, Laos is likely to graduate from least developed country (LDC) status in 2024 (World Bank 2021a), partly thanks to the government's efforts to create a welcoming environment for foreign direct investments (Bertelsmann Stiftung 2020). However, the government's strategy focuses on rapid economic growth, and prioritizes investments that rely heavily on natural resource extraction and on generating high, short-term monetary returns. This one-sided perspective of the economic value of nature prevents a more integral view that includes other values of nature. As a result, the government's strategy to foster human development and well-being has been repeatedly questioned (Manolom and Promphakping 2016). Indeed, the impressive GDP growth of recent years has been accompanied by rising inequalities (Bader et al. 2017). The impacts of

2 Referring to the SARS-CoV-2 pandemic situation: https://en.wikipedia.org/wiki/Severe_acute_respiratory_syndrome_coronavirus_2

land-based investments on human well-being vary widely: on the one hand, they contribute to the creation of – albeit limited – employment and income opportunities; on the other, they lead to land dispossession and hinder access to important natural resources such as firewood, NTFPs, or water. A recent study suggests that scale matters: while small-scale, locally integrated land concessions tend to contribute positively to well-being, large-scale (mostly externally controlled) investments generally have negative impacts on human well-being (Nanhthavong et al. 2021).

The spatial patterns of human development and wellbeing in Laos reveal the poorest and most marginalized areas of the country, which are largely inhabited by ethnic minority groups. Some ethnic groups in remote rural areas bear a disproportionate brunt of the externalities of land concessions (Baird and Le Billon 2012; Baird 2014). Such rural farmer communities, typically practicing shifting cultivation, a traditional form of locally adapted 'slash-and-burn' agriculture, have been affected by policies aiming at eradicating this form of agriculture (Hanssen 2007). The government considers shifting cultivation backward and blames it for being the most important cause of deforestation. Even though this narrative has changed in recent years (Robichaud et al. 2009), eradication efforts continue since shifting cultivation often clashes with the interests of land concessions. The shifting cultivation eradication efforts jeopardize the livelihoods and wellbeing of numerous minorities particularly in upland areas.

As the livelihoods of the majority of people in Laos still directly depend on a narrow natural resource base, their well-being continues to be under pressure and endangered by the above-mentioned processes. This applies – to varying degrees – to all small agricultural producers, and in spite of national economic growth.

The problem of well-being of rural populations is rooted in three distinct and conflicting valuation systems of nature. First, the value ascribed to nature by the local populations are framed by their livelihood needs, their complex and multifaceted production strategies, and their cultural and spiritual wants. This value is typically contextually constituted and includes a wide range of components of nature on the gradient between intensively used areas to extensively used natural forests and habitats. Second, the intrinsic value of the country's nature, which is globally outstanding and which forms a global heritage attracting the attention and preservation efforts of the global conservation community. The intrinsic value of nature overlaps to a large degree with the value of nature as experienced by local populations, but can also conflict with it when it comes to questions of the sustainable use of components of nature, especially hunting. Third, the value of nature as ascribed by the political and economic elites and decision-makers, who see nature mainly as an economic commodity. This view strongly conflicts with the multifaceted perspectives of the other two valuation systems.

Recent economic policy developments imply that the commodity perspective on nature dominates decision-making, and that many policies are difficult to reconcile with the perspectives of nature by the local population and with the intrinsic value of nature. Hence, many of the policy

instruments that aim to promote economic development have led to disdain for nature's non-commodity value and have de-incentivized aspirations to aim for more just and balanced nature–people relations.

7.2 Analytical perspective through the GSDR framework

The following sections of this chapter deal with challenges and dilemmas (section 7.3), assets and opportunities (section 7.4), stakeholders (section 7.5), and strategic gateways for innovative and participative action (section 7.6) related to the nature–people nexus in Laos.

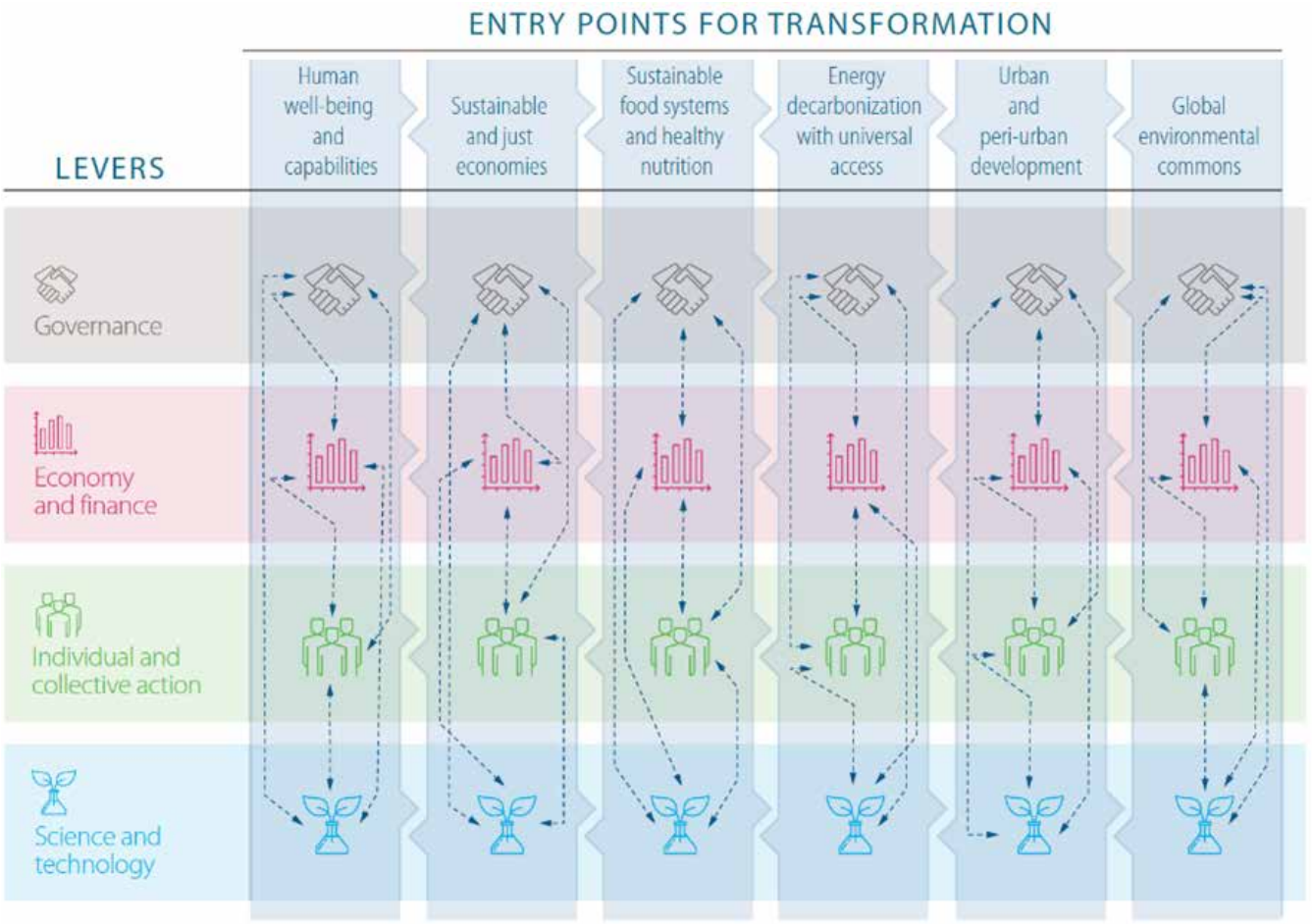


Figure 7.1: Framework of the Global Sustainable Development Report (Independent Group of Scientists appointed by the UN Secretary-General, 2019)

Drawing on the competencies and knowledge of well-versed experts, we used the framework developed and applied in the latest Global Sustainable Development Report (GSDR)[3] to address the above issues systematically. The GSDR framework builds a matrix of six *entry points* (columns) and four *levers* (rows) to structure transformation towards more sustainable development (see Figure 7.1). It allows us to embed the specific focus of the present appraisal report on the nature–people nexus within a broader context of sustainable development.

3 https://sustainabledevelopment.un.org/gsdr2019

This appraisal report uses the four GSDR *levers* to structure the discussion with our group of experts. The six *entry points* serve as a normative reference and will be discussed in terms of their specific importance for the nature–people nexus.

GSDR entry points with a focus on the nature–people nexus

The specific importance and local contexts of the six entry points shall be briefly discussed here.

Human well-being

Despite overall economic growth, precarious livelihoods persist in Laos, including pockets of extreme rural poverty (World Bank 2018). In some areas of the country, poverty has increased over the past decade – even before the economic downturn induced by the COVID-19 pandemic. Rural people are highly vulnerable to fluctuating prices for agricultural commodities, as well as to droughts or other effects of climate change (CFE-DMHA 2017), and strongly depend on a narrow natural resource base. Insecure land tenure and land use rights affect the lives of the rural population, particularly minorities (Ironside 2017; Keovilignavong and Suhardiman 2020). A sustainable improvement in human well-being depends critically on just and prosperous configurations of nature–people relations.

Sustainable and just economies

In Laos, fair development is intrinsically tied to the challenges of growing disparities (Warr et al. 2018), inequality of treatment, and unequal opportunities (Epprecht et al. 2008; Chareunsy 2012). According to the World Bank (2021b), the Gini index has increased from 32.6 in 2002 to 38.8 in 2018, reflecting a 19% increase in inequality (Warr et al. 2018). Even though this measure does not reflect some of the benefits people have experienced, mostly in terms of improved education or access to electric energy or health services (Menon and Warr 2013), these benefits are also very unequally distributed (Epprecht et al. 2018). Laos's current growth pathway mostly favors economic elites, with few benefits for rural communities, highlighting the exploitative character of resource-based development strategies. The principles of sustainable and just economies would require a fair negotiation process that can empower socially and environmentally deprived groups to participate in the discourse of goal-setting, in order to achieve and nourish more equitable people–nature relations in Laos.

Food systems and nutrition

Agricultural commercialization has important ramifications for food systems (Alexander et al. 2017; Hepp et al. 2019) and for the rich but degrading agrobiodiversity in Laos (TABI 2021). "Food systems" also include NTFPs, whose importance for most rural communities (Foppes and Ketphanh 2004; Ingalls et al. 2020; Baird 2021) is testament to the multiple

functions and values of landscapes and ecosystems in Laos for nutritious food sourcing. The conservation of the country's high agrobiodiversity is tightly linked to the preservation of knowledge and wisdom of local communities who act as custodians of nature's benefits. Ensuring the continuous capacity of nature to support the resilience of the food system is key in view of an uncertain future likely to be affected by environmental and climate change in Laos and beyond.

Energy decarbonization and access

As a major component of the country's economic growth strategy, the development of hydropower has been heavily promoted in Laos as an export commodity rather than a decarbonization opportunity (Menon and Warr 2013), often with major ecological and social ramifications (Blake and Barney 2018; Robichaud and Shoemaker 2018). At the same time, one large coal-based power plant is in operation in Laos, and two new ones are in planning. However, the country has significant potential to produce renewable energy sustainably, and could meet national decarbonization targets by developing small-scale hydropower projects, and photovoltaic and wind energy systems (Vicente and Bludszuweit 2012; Luukkanen et al. 2019; Siala et al. 2021). Small-scale renewable energy production systems are less disruptive, can be better adapted to the needs of locally growing consumer groups, and can be flexibly embedded into a preservation approach to nature's values.

Urban development

Although the degree of urbanization in Laos is comparatively low, urban areas are increasingly expanding into wetlands and other ecosystems (Epprecht et al. 2018), highlighting the need for appropriate prospective planning measures, not least also in the context of mega infrastructure projects (MIP), since urban sprawl often occurs along transportation corridors (Sharifi et al. 2014). Securing and upgrading access and user rights of rural communities affected by urban development of any kind will be crucial for the achievement of more just people–nature relations in Laos, where the interests of rural communities are easily overridden by the development agendas of urban economic elites and decision-makers.

Global environmental commons

Laos is a hotspot of high intrinsic natural value. Nevertheless, overexploitation of flora and fauna have been documented repeatedly (Schweikhard et al. 2019; Kasper et al. 2020). In terms of wildlife, one of the greatest threats in Laos is the demand for wild meat, both nationally and internationally (Harrison et al. 2016; Gray et al. 2017). Apart from devastating impacts on wildlife populations, the emergence of zoonotic pathogens into human populations is also directly linked to wildlife markets (Greatorex et al. 2016; Pruvot et al. 2019). Fair governance of the environmental commons is therefore a high priority for the sustainable configuration of people–nature relations.

These six *entry points* have guided the discussion and identification of challenges related to the four *levers* forming the second dimension in the transformation pathway matrix of the GSDR framework. The four *levers* provide a mechanism to catalyze transformative development processes. They include *governance*, *economy*, *individual and collective action,* as well as *science and technology*. In the following sections, they are used as starting points to discuss challenges, dilemmas, assets, and opportunities.

7.3 Challenges and dilemmas in the nature–people nexus

Guided by the GSDR framework, the group of experts who worked on this appraisal identified challenges and dilemmas in the nature–people nexus. Figure 7.2 depicts the results of the workshop discussions along the four *levers* of *governance*, *economy*, *individual and collective action*, and *science and technology*. These results are briefly summarized and discussed hereafter.

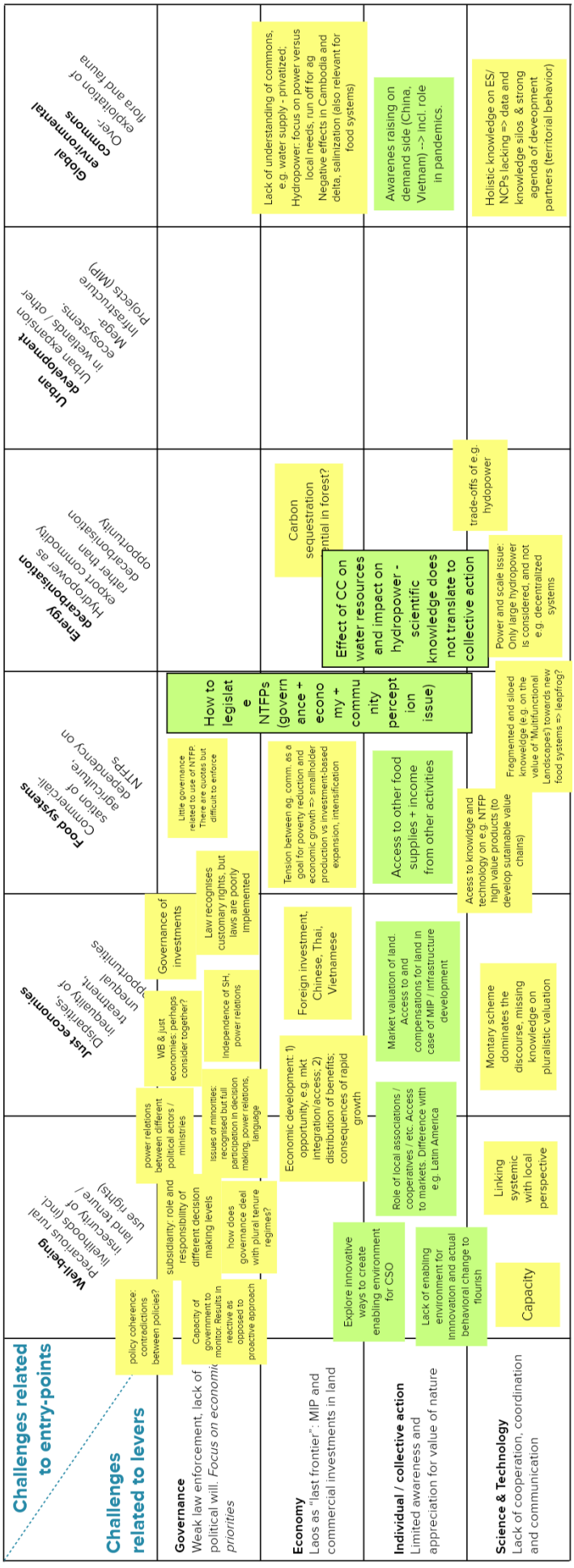
GSDR levers with a focus on challenges in the nature–people nexus

Governance

Structural challenges: Good governance is critical to achieve just and sustainable people–nature relations. However, the current weak law enforcement (Thomas 2015), lack of political will (de Koning et al. 2017), and narrow economic priorities represent major hurdles towards good governance in Laos. In addition, policy incoherence and institutional inconsistencies between ministries lead to competing and contradicting actions that play off conservation against economic development. While the legal framework would largely suffice, insufficient capacity to interpret and enforce laws is a major hindrance. This also hints to the governance challenge related to the asymmetric power relations between different government actors. The strictly hierarchical structure tends to paralyze governance processes at the subordinate level, due to poor understanding and interpretation of subsidiary decision-making. While minorities are officially recognized, their participation in decision-making is limited, in part due to discriminatory power relations and unrecognized minority languages as well as poorly implemented customary rights (FAO and MRLG 2019). This implies that unjust and unsustainable people–nature relations are aggravated by poor governance structures, ill-conceived policies, and elite capture – and unfold unimpededly due to the lack of a mitigating civil society.

Biodiversity conservation: Weak law enforcement poses a challenge to biodiversity conservation at all governance levels: in protected areas (which are cornerstones of conservation efforts), at national level (responsible for enforcing compliance with regulations governing large infrastructure and development projects), and at the international level (where measures to control the movement and trade of wildlife and timber are taken). The

Figure 7.2: Challenges and dilemmas in the nature–people nexus identified by experts in June 2021



majority of protected areas in Laos are extensive in size, they are typically remote and difficult to access and traverse, and they often incorporate long stretches of Laos's international borders. Effective protection of wildlife and habitats in such circumstances is challenging, particularly for understaffed, undertrained, poorly equipped, and poorly paid rangers and patrol managers. Wildlife and conservation staff are not recognized as professionals, and this type of position is perceived as undesirable. Therefore, while adequate environmental legislation exists, enforcement of laws and regulations governing the management of biodiversity tends to be lax or non-existent (Gomez and Shepherd 2018).

Land rights and policies: Governance challenges also affect land tenure, as the complex tenure realities of rural populations are confronted with a hierarchical and rigid interpretation of land governance. The country's strategy to prioritize rapid economic growth over other aspects reinforces unsustainable land management. Managing mega infrastructure projects and large land concessions is a challenge in itself, but ensuring sustainable outcomes for the country and its natural resources can overstrain the government's capacity to enact regulations. In such settings, the priorities of local communities tend to have a lesser weighting, while investors have free rein due to fewer restrictions. As a result, the commodity perspective on nature by elites overrides the multifaceted values of nature as for rural populations and the high intrinsic value of nature. Similarly to other countries, the Government of Laos faces difficulties in regulating and monitoring natural resource extraction, including in the NTFP sector. While theoretically, quotas for collection and harvest exist, these can hardly be controlled and enforced given the informal ways of collection, processing, and marketing.

Recently adopted instruments such as the REDD+[4] mechanism introduced under the green economy paradigm aim to halt deforestation and forest degradation, and to support conservation, sustainable management of forests, and enhancement of forest carbon stocks. However, evidence from studies in northern Laos suggest that in asymmetric power contexts, they also tend to contribute to increasing social injustice and elite capture (Pichler and Ingalls 2021). Such challenges are pronounced in relation to minority groups whose protection of rights and interests are often insufficiently implemented and secured.

Economy

Dominance of large-scale investments: In the lower Mekong region, Laos is often portrayed as one of the "last frontiers" in Asia in the context of resource exploitation and development (Barney 2009). This notion extends to the sphere of policymaking, with a lack of integrated planning in regard to nature conservation and socioeconomic development in general. Not only in the context of the Chinese government's Belt and Road Initiative (BRI)

4 Reducing Emissions from Deforestation and forest Degradation: https://redd.unfccc.int

has this led to the proliferation of a large number of investment projects on infrastructure development, and industrial agricultural and mining concessions – all of which can have profoundly detrimental consequences for the ecological integrity of an area (Bourgoin et al. 2012; Costenbader et al. 2015; Robichaud and Shoemaker 2018; Hett et al. 2020; Yoshida et al. 2020). Investors from China, Vietnam, and Thailand dominate large-scale investments in Laos, forming systemic cluster risks and creating political dependencies that potentially limit the options and maneuverability of the Lao government in the long term. The large fiscal debts of Laos towards its neighbors Thailand and China already weaken the country's bargaining power on the use and exploitation of its natural resources. While improved market access and integration are important drivers of economic growth and contribute to human well-being, benefits are unequally distributed due to poor benefit-sharing mechanisms. As a result, an increase in tensions between local communities and investors have been reported – not least due to a disaster following the failure of a hydropower dam[5] in Laos in 2018, which has contributed to changing the economic development discourse. Increasingly, policymakers are beginning to acknowledge the emerging trade-offs between export-oriented power production and water needs for local agriculture.

Forests and agricultural systems: There are concerns that deforestation and climate change are threatening the country's natural capital, depriving the forests of their capacity to sequester carbon, meet national reforestation targets of 70% forest coverage, and accommodate local needs. This is particularly important in relation to the NTFP sector, which plays a significant role in local livelihoods and rural food security.

Not only deforestation and the territorial exclusion of rural populations affect multifaceted local land use systems, but also the increasing commercialization of small-scale agriculture near urban areas and large transport corridors, and the ongoing expansion of hydropower in the country. This includes off-site effects of Lao hydropower production in downstream Cambodia and Vietnam, including salinization in the Mekong delta in Vietnam, which affects food production at a regional scale. In this context, the question of water supply privatization has sparked concerns about the commodification of common resources, and it is unclear how this challenge can be tackled through governance and economic systems.

Trade in wildlife and wild products: Illegal and unsustainable trade in wildlife and wild products is one of the greatest challenges facing conservation today in Laos (Nijman 2010; Cooney et al. 2017; Thomas-Walters et al. 2020). Middlemen from Vietnam and China capitalize on traditional habits and incentivize community members to hunt wildlife, a process further facilitated by improved transport infrastructure in

5 Radio Free Asia online article covering the flooding in 2018 resulting from a dam failure: www.rfa.org/english/news/laos/xe-pian-xe-namnoi-two-year-07222020211103.html

rural areas (Tordoff et al. 2020, Wong 2020). Wild meat markets and restaurants are common in Laos (Greatorex et al. 2016), but overshadowed by the voracious demand from neighboring countries (Schweikhard et al. 2019; Davis and Glikman 2020), which results in significant overexploitation.

Individual and collective action

Limited space for action: Taking action and shaping one's physical and social environment individually or as a group is a powerful *lever* to engage citizens in a transformation process, particularly to improve the well-being of marginalized social groups and minorities (Independent Group of Scientists appointed by the Secretary-General 2019). In authoritarian systems, however, the space for individual and collective action is limited. The lack of an enabling environment and space for innovation restricts opportunities to engender actual behavioral change. The inferior role played by local associations and cooperatives in mediating behavior change is a case in point. The restricted political and legal environment is limiting people's potential to influence and mediate power relations in favor of local communities and their interests, e.g. to defend access to land or gain compensation for resources lost to MIPs. For instance, the drastic effects of climate change on water resources, and the potentially devastating impact of poorly constructed hydropower infrastructure, are contributing to a growing collective consciousness of problems associated with development. However, awareness and scientific evidence are not translating into collective action, due to authoritarian and structural limitations of debate and expression within civil society.

Societal awareness and knowledge levels: The low awareness of nature and lack of appreciation of ecosystem integrity is a unanimous concern among stakeholders in Laos. There needs to be a much greater awareness of the intrinsic value of biodiversity, as well as a greater appreciation of the potential long-term, tangible, or economic benefits that can accrue from the conservation of wildlife and forests (Eshoo 2020). The consumption of wildlife occurs at all levels of society and is driven by a range of factors, from subsistence necessity or a belief in the beneficial properties of wild products, to a desire to demonstrate wealth and status (Singh 2010). Many ethnic groups in Laos have deeply engrained traditions relating to the hunting and consumption of wildlife (Singh 2008). The lack of awareness or understanding is generally attributed to a lack of environmental education within all sectors of society (EEA-Laos 2013). The low importance attached to biodiversity conservation is exacerbated by broader societal and government issues such as low levels of capacity, both in terms of human resources and technical competence (OECD 2017), and an overdependence on cyclical, short-term, and unstable funding streams which are often dictated by donor agendas.

Local individual and collective action: Local rural communities traditionally embrace a broad range of local institutions and regulations, which balance livelihood needs and the requirements of local sustainable natural resource use, and which form the basis for individual and collective action. However, many of the local informal institutions have been neglected, and struggle to keep up with the pace of recent development dynamics. As an effect of the strictly hierarchical governance system – coupled with the process of exclusion of rural populations in areas of MIPs and large-scale land investments, as well as the commercialization of agriculture – the traditional base of local individual and collective actions is eroding, or at least losing its negotiating power within hierarchically dominated national discourses. Paired with low levels of awareness and knowledge, the poor recognition of customary tenure rights is a major cause of the limited significance of individual and collective action in Laos.

Science and technology

Capacity gaps: Laos is facing major capacity gaps in science and technology. Scientific evidence is crucial for rational and prospective policymaking. However, science and policymaking operate in different knowledge systems and knowledge cultures. Inadequate capacity means that Lao researchers often fail to produce the evidence-based knowledge that would be necessary for policymaking (Clarke et al. 2015). This is linked with the predominance of research that seeks to solve individual problems, without connecting systemic with local perspectives. The current discourse on the valuation of nature's contributions to people (NCP) in Laos is strongly dominated by monetary perspectives, while the foundations and knowledge for more pluralistic and innovative valuations are largely lacking and the data available are locked in silos. These challenges are given for most crucial aspects of people–nature relations – be it on food systems including NTFPs, high-value products and respective value chains, the importance of the multidimensional character of functional landscapes producing vital ecosystem services, or the trade-offs between different energy production and distribution systems.

Limited cooperation and communication: An issue consistently identified is a perceived lack of cooperation and communication as a base to create and spread knowledge (Eshoo 2020). This is apparent in both vertical and horizontal communication systems. Within the government, mechanisms for communication between central, provincial, and district offices is often poor, and coordination between sectors and ministries is largely absent, impeding territorial politics in relation to e.g. land use planning (Lestrelin et al. 2012; Suhardiman et al. 2019). There is also a lack of communication and coordination between many civil society organizations (CSOs) including international NGOs and bilateral donors. This is partly a result of a strong focus on their respective missions and workloads, but there are tendencies toward feeling proprietorial over certain areas and over respective donor funding. There is a widely felt lack of mechanisms or

initiatives promoting stakeholder coordination and knowledge circulation on environmental issues, and that would avoid duplication and instead promote synergies.

Untapped local knowledge: Rural communities generally embrace a wealth of contextual and environmental knowledge (e.g. traditional ecological knowledge, or indigenous and local knowledge and practices). However, due to the strongly hierarchical structures discussed above, and the lack of CSOs, this knowledge does not bear fruit beyond the local context and even tends to fade, due to commercialization tendencies. In addition, the weak formal structures of science and technology are not able to harness and incorporate this wealth of local knowledge in spite of its great potential, e.g. in inclusive development and land use planning processes, or in the development of more sustainable systems to harvest and maintain NTFPs.

7.4 Assets and opportunities in the nature–people nexus

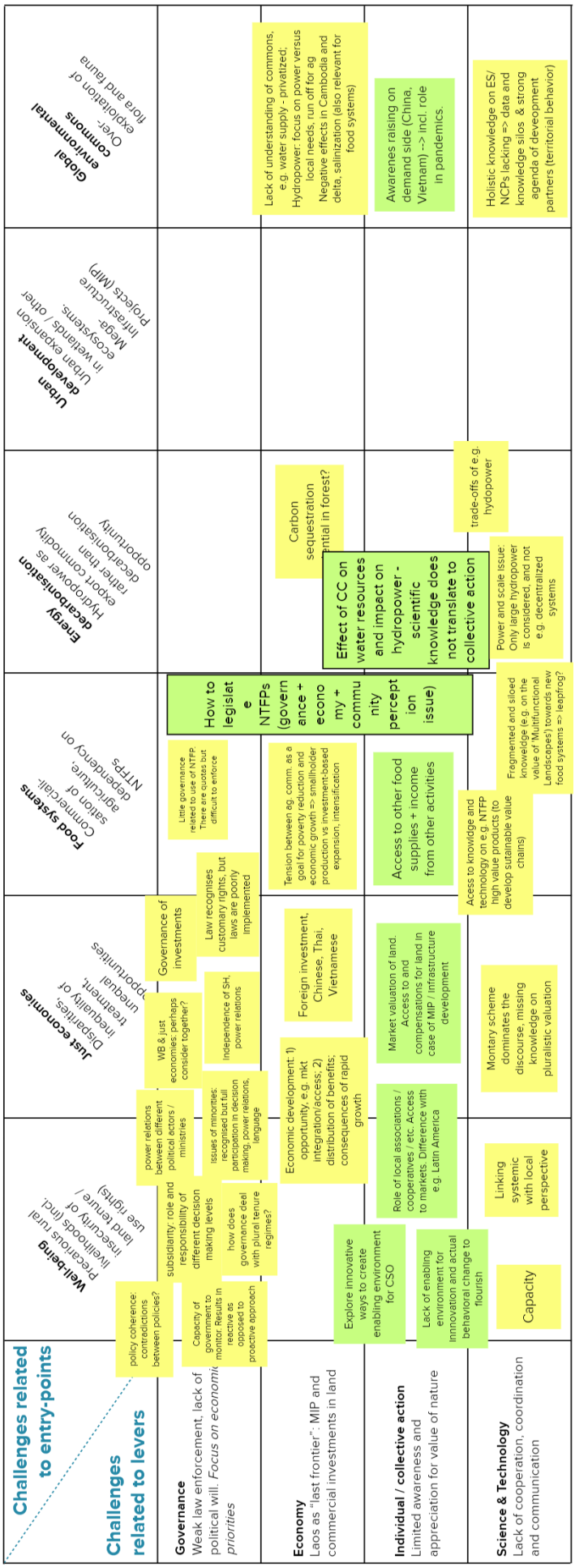
In an analogy to Figure 7.2, Figure 7.3 lists the assets and opportunities in the nature–people nexus identified by experts in a workshop in June 2021. They are again displayed in the GSDR framework and will be briefly summarized and commented below, along the four *levers* of *governance*, *economy*, *individual and collective action*, and *science and technology*.

GSDR levers with a focus on assets and opportunities in the nature–people nexus

Governance

Broadened perspective: The recent political transition to a newly appointed secretary general of the country's ruling communist party has sparked hopes that the government will embark on more sustainable economic development pathways after recognizing that a strategy focusing narrowly on the resource commodity and export sectors is unsustainable in the long run. The Lao government has adopted a green growth strategy outlining national development goals by 2030. This strategy includes an improved and consolidated investment climate, effective poverty reduction and improved well-being, addressing gender roles and empowerment of women's position in society, and increasing the country's resilience to the effects and consequences of climate change (Secretariat for Formulation of National Green Growth Strategy of the Lao PDR, 2019). This provides an opportunity to shift the balance and reconcile macro-economic interests with local livelihoods and conservation requirements. It is also a chance for the government to reinforce and implement its commitments in international treaties and conventions, and to step up efforts and sustainable development pathways in order to reap the benefits from international compensation schemes such as REDD+.

Figure 7.3: Assets and opportunities in the nature–people nexus identified by experts in early 2021



Economy

High demand for Laos's rich natural capital: The high international and national demand for the rich natural capital and its products could give Laos bargaining power and create an opportunity to connect natural assets with responsible and sustainable investments. This process can be supported by international transparency and certification initiatives. Together with broadening governance perspectives, this natural potential could provide a creative space for developing and trialing innovative land tenure instruments (e.g. the "continuum of land rights", which offers an alternative to titling of individually held private property as the ultimate form of tenure security[6]) and novel resource governance approaches (e.g. participatory adaptive resource governance), thereby increasing security of local livelihoods. Along the same line, the domestic and international demands for NTFPs create a significant potential for developing inclusive, transparent, and resilient value chains with a considerable market share in the country. This can go hand in hand with the development of local production capacity to meet the increasing demand of the urban population for organic products, benefitting local farmers and production associations.

Alternative economic sectors: The highly valued forest landscapes, together with the promises of a greener economy, form an important opportunity for a strengthened nature-based national tourism that attracts foreign investments, creates green jobs, and secures nature's contributions to people (NCP) (World Bank 2019). This can also create a stronger sense of appreciation for the values of nature among some local communities that benefit from sustainable nature-based tourism development. The upgrade of transportation infrastructure will increase accessibility, thereby supporting efforts in the nature-based tourism industry. At the same time, this infrastructure will create a significant potential for developing Laos's industrial processing capacity, for upgrading local value chains, and for exploring alternative economic avenues, e.g. by pursuing a circular economic development model (UNDP 2017).

Individual and collective action

Momentum created by increased awareness: The above-mentioned increased awareness, especially among the young urban elites, creates a crucial momentum for individual and collective action. In addition, the COVID-19 pandemic has contributed substantially to creating a new consciousness about the linkages between nature and human health. This consciousness can provide an important starting point for raising awareness for more sustainable human–nature relations, especially linked to NTFPs, within Laos but also abroad, especially in China, Vietnam, and Thailand. However, this awareness needs to grow, and to manifest itself in social structures that foster individual and collective action.

6 https://unhabitat.org/framework-for-evaluating-continuum-of-land-rights-scenarios

Growing awareness: There is a limited but growing awareness for ecology and sustainability among some of the urban political and economic elites and populations, especially the young generation, who are expressing higher appreciation for a healthy environment and food. At a low level, this has translated into an increasing demand for organic food produce in cities – a trend that possibly hints at an important "window of opportunity". This growing awareness is also expressed by the increased challenging of the ecological and social unsustainability of the politically promoted export-oriented hydropower sector and the demand for more flexible and decentralized power systems.

Science and technology

Potentials of the university and the education system: The National University of Laos (NUoL) holds an important potential, as it does not operate detached from local realities, and is well connected to national policy and administration levels, which provides important starting points for shaping and influencing policymaking at the nature–people nexus. This key position of the university holds the potential to streamline national and international research towards more sustainable people–nature relations, as well as to promote issues of sustainable development in the curricula of the overall education system of Laos. Harnessing this potential may require long-term and consistent partnerships with like-minded knowledge institutions from abroad, and strengthening of the local science–policy interface.

Potentials of digitized knowledge and of pilot approaches: The rapid spread of digital technologies, particularly social media, can help to create awareness of the multifaceted value of nature. Science and technology will take a key position in the form of digitalization of measures for valuating NCP, thereby improving transparency and reducing transactional costs. CDE's history in Laos is an important opportunity in this respect, as its long-term presence and partnerships have enabled the building of strong networks and alliances with local actors. This partnership-based approach and the related knowledge products hold the potential to increase knowledge levels and awareness on issues of the people–nature nexus, which can even be increased by actively involving students or citizens in related data and information collection, e.g. within real-time monitoring approaches. In addition, Laos still counts many multifunctional landscapes despite the ongoing agricultural transition. They are an innovative space for experimenting and piloting new approaches beyond the beaten paths (Dewi et al. 2013), such as the testing of international experiences and knowledge on how to shift towards wider and more sustainable people–nature perspectives.

7.5 Actors and stakeholders

A stakeholder analysis based on a rich set of interviews, and focusing on the people–nature nexus in Laos, was conducted by "Asian Arks"[7] (Eshoo 2020). This comprehensive analysis reveals a wealth of insights, and forms an important piece of information for any future transformative action. The present appraisal report presents only a brief overview of the four main stakeholder categories – government, private sector, civil society and international stakeholders – and their position on biodiversity conservation.

Government stakeholders in biodiversity conservation

Central-level government stakeholders are pivotal when considering key national strategies for biodiversity conservation, which are set at the central level, even though there are variances regarding implementation at provincial and local levels. The *Aquatic Wildlife Law* of 2007 is perhaps the most important piece of legislation relating to biodiversity conservation, and it is referenced in almost all official documents and policy instruments associated with biodiversity conservation and protected area management. Connectivity, responsibilities, and relationships between the *Aquatic and Wildlife Inspection Division* under the *Department of Forestry* and the *Protected Area Management Division* are often not clear. The *Aquatic and Wildlife Inspection Division* does not interact with the *National University of Laos* and other research institutions regularly. Government-sponsored wildlife studies and policy updates are few in number in comparison to agriculture-related studies and policy documents. The *Forestry Research Center* and the *National Agriculture and Forestry Research Institute*, which are responsible for research and policy in relation to biodiversity conservation in agroforestry systems, have generated many studies focusing largely on NTFPs and more generally livelihood-related themes of biodiversity.

The *Ministry of Natural Resources and Environment* is responsible for setting policy and standards for managing and minimizing negative environmental impacts and addressing fossil industry issues broadly, as well as the management of officially protected wetland landscapes. The same ministry is also the central authority mandated with ensuring that impacts on biodiversity from large infrastructure and development projects are kept to a minimum, primarily through an environmental impact assessment process, through the *Department of Environment*.

The *Ministry of National Defense* is also a key stakeholder, as they have designated many high priority biodiversity areas with national strategic security significance and thus requiring special management. All areas within 15 km of the border are considered strategic. Any conservation or other activities in them require approval by the military. This creates redundancy at best and conflict at worst, between overlapping remits

7 www.asianarks.org

and competing policies, often resulting in grey areas in authority. The overarching responsibility for policy development and coordination lies with the *Prime Minister's Office* and the *National Assembly*. These bodies wield the greatest power when it comes to actualizing biodiversity conservation outcomes. The *Prime Minister's Office* grants final approval for large infrastructure projects, and coordination with the latter and the *National Assembly* by departments and organizations responsible for the development and implementation of policy on biodiversity conservation has been limited and remains an ongoing challenge. Awareness and understanding of biodiversity issues at the ministerial level and above is fundamental for the creation and adoption of functional conservation policies. With the exception of some multilateral agencies such as the World Bank, this area remains neglected.

At the level of administration and implementation, the main government agencies are the *Provincial Agriculture and Forestry Offices* (inside protected areas) and the *Provincial Offices of Forest Inspection* (outside protected areas), plus their respective district equivalents. The main challenges they face include lack of human resources and capacity, shortage and unpredictability of funding, conflicting development and conservation agendas at provincial and district level, and lack of inter-agency cooperation. This is compounded by the high demand for natural resources and the lack of sustainable livelihood alternatives for rural, forest-dependent communities.

Private sector and biodiversity conservation

There are many private actors, who are either directly or indirectly relevant to the sphere of biodiversity conservation. They include plantation, agroforestry, wood processing, hydropower, and mining companies, whose business activities impact upon biodiversity conservation, as well as private zoo operators and other licensed wildlife traders and farmers whose livelihoods depend on the utilization of wild animals and products. Although recently, greater attention has been paid by some conservation organizations to gaining a better understanding of the private sector and of opportunities for more positive engagement with this sector, much work remains to be done in this regard. One example of a positive relationship are WWF's timber trade initiatives, through which WWF provides support to business partners, such as wood processing and furniture manufacturers, to improve their production models, while ensuring transparency along the supply chain and bringing in a *Forest Stewardship Council* certification system. This allows commodity production to be delinked from deforestation, and helps enterprises to market legal and sustainable products.

There are many other businesses with a stake in improving biodiversity conservation, for example enterprises marketing nature-based tourism. However, many conservation projects are reluctant to work with the private sector. There is also a subset of ecotourism concessionaires, who operate inside protected areas and actively support and cooperate with forest-edge

communities in an effort to protect forests and wildlife in their respective concession areas. Despite the fact that they operate for the most part without any technical or financial support from conservation organizations, donors, governments, or academic institutions, some of these concession-based enterprises have achieved demonstrably positive conservation outcomes at a local scale.

Civil society stakeholders in biodiversity conservation

In comparison with neighboring countries, there are few non-profit associations (i.e. local CSOs) in Laos. Most are based in the capital and only a handful have programs directly relating to biodiversity conservation. Some CSOs have strong linkages with local and district authorities, as their activities are often site-based and include community development activities alongside conservation. However, they are subject to scrutiny from government agencies, who may be suspicious of their activities. Lack of funding and capacity are also major constraints for many CSOs. Lack of funding can cause permission difficulties because, as stipulated in the *Association Decree*, a failure to operate over a period of over 12 months can lead to nonrenewal of operation licenses. This has motivated some CSOs to convert their organization type to freelance consultancy.

Overall, the influence of local CSOs remains localized and relatively limited. Perhaps the most important actors within the civil society group are the citizens of Laos, who include consumers, hunters, farmers, traders, students, elders, and all the individuals who, collectively, constitute "the general public". The relationship between Laos's citizenry and their natural heritage is of central importance to biodiversity conservation endeavors, but this relationship remains poorly understood. Academics and the NUoL have strong influence on awareness of and interest in biodiversity conservation issues. This also applies to religious leaders and representatives, who have a profound impact on the consciousness of the Lao people regarding the importance of biodiversity – a phenomenon often overlooked by government and organizations focused on management strategies.

The role of international stakeholders in biodiversity conservation

International conservation organizations in Laos typically seek "memoranda of understanding" with partner government agencies, mandating them to build capacity and provide technical and financial support to their partner agencies. However, they are increasingly involved in providing technical services to private-sector resource-based industries, for example functioning as watershed management technicians in hydropower projects and as biodiversity offset designers for mining companies. In these instances, conservation organizations typically assist with the development of conservation management plans for watershed protection or for biodiversity offset sites. The conservation INGOs also provide a link to regional and global conservation programs and networks. In addition to INGOs dedicated to biodiversity conservation, there are

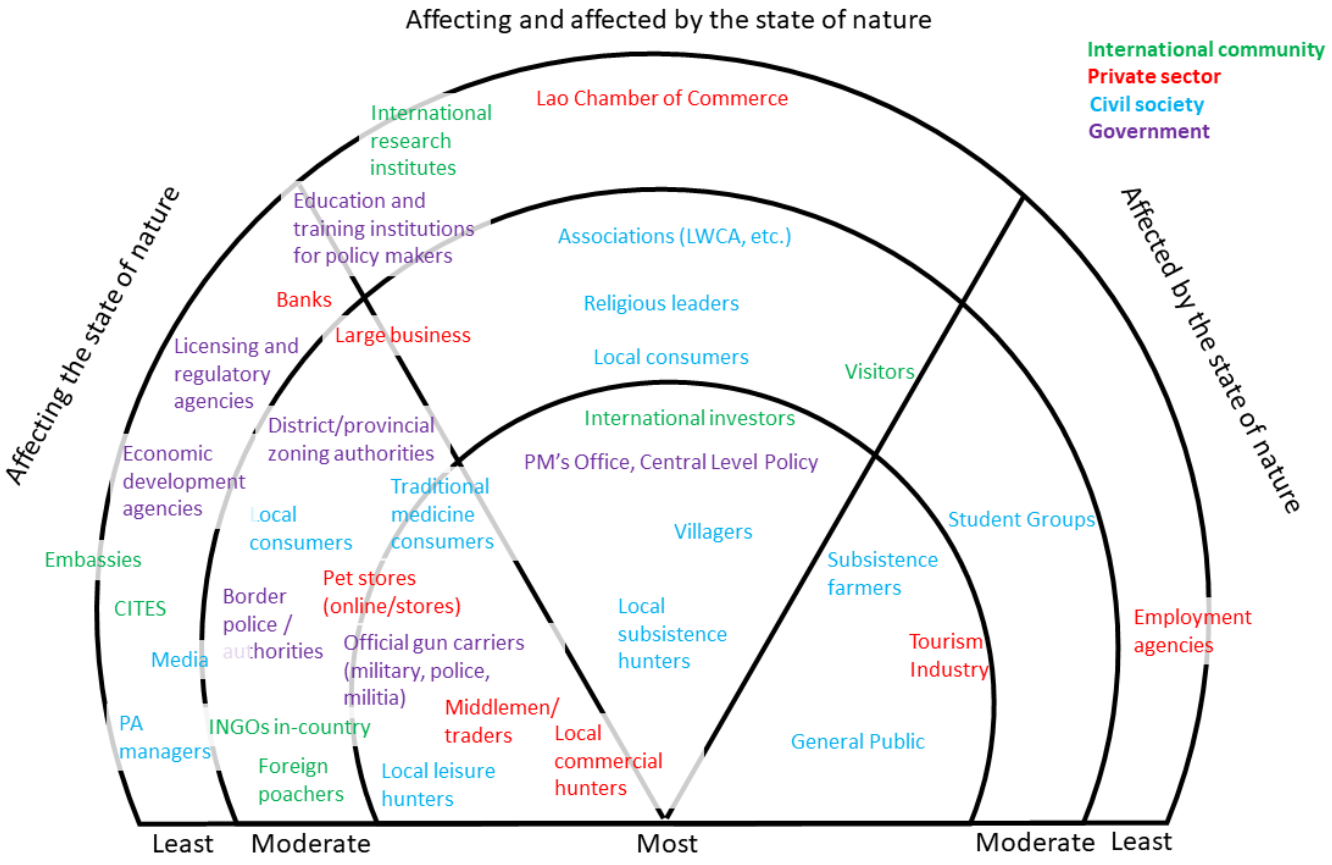
many organizations that indirectly shape the conservation landscape through programs focussing on natural resource management, development of sustainable livelihoods, climate change resilience, land rights, population planning, and health. Coordination between organizations and the development of crosscutting initiatives are largely lacking, except in some specific instances where donors or geography demand it.

Stakeholders affecting, and affected by, the "state of nature"

Figure 7.4 below differentiates four broad stakeholder categories according to the degree to which they affect or are affected, and influence or are influenced by, the state of nature. The left segment of the graph depicts stakeholders who affect the state of nature, but are hardly affected by it. The right segment of the graph shows stakeholders who are mainly affected by the state of nature but have low influence on it. The middle segment contains stakeholders who affect, and affected by, the state of nature. The concentric circles indicate the degree of affecting or being affected by the state of nature, which means the closer to the lower center of the figure the stakeholder groups are located, the stronger the relationship described above.

Figure 7.4: Stakeholders mapped according to their degree of affecting, or being affected by, the "state of nature". (Source: modified after Eshoo [2020])

The stakeholders of the four categories are scattered all over the segments and concentric circles, but with different weights and patterns. Government stakeholders affect the state of nature more than they are affected by it, and they mostly have a low to moderate influence, apart from a few, such as the Prime Minister's office, or the military. Not surprisingly, private-sector stakeholders whose economic activities directly rely on



natural resources and who are engaged in primary production for subsistence or markets are concentrated in the center of the graph. This means that they strongly affect, and are affected by, the conditions of nature and its resources. Civil society stakeholders are most scattered, depending on the closeness to nature of their livelihoods and lifestyles. Finally, international stakeholders strongly affect (large-scale land investments, INGOs), but are also affected by (tourism sector) by the state of nature.

7.6 Foci for transformative action

Section 7.3 revealed that a just and sustainable nature–people nexus faces significant and deep-rooted challenges and dilemmas stemming from centralized governance, economic structures that polarize investors and rural populations, weak civil society, and science and technology structures, as well as strongly conflicting valuations of nature. Assets and opportunities to address these challenges and dilemmas include the rich natural capital and the country's potential bargaining power as an important transit corridor, as well as promising trends in governance, civil society, and academia. Section 7.5 highlighted the diversity of actors and stakeholders who need to be considered when addressing challenges and dilemmas as well as building on assets and opportunities in view of more just and sustainable nature–people relations.

Based on the above, participants to the synthesis workshop identified promising options for transformative action, again structured along the GSDR framework. Obviously, the options listed below have to be reviewed, complemented, prioritized, selected, and tested in view of their feasibility.

Human well-being

- *Governance:* Capitalizing on long-term trust-based partnerships with the government to prioritize promising *levers* (e.g. pressure from top leaders to foster sustainable development). Channel the achieved momentum into ongoing policy processes to (a) change well-being paradigms towards a better integration of non-monetary aspects (access to resources, participation, consent, etc.), and (b) clarify roles and responsibilities, and mainstream sector integration for more effective governance.
- *Economy and finance:* Identify, assess, innovate, and test best practices in terms of inclusive value chains or responsible investment schemes. Strengthen local leadership for better enforcement of consent-seeking mechanisms.
- *Individual and collective action:* Identify, create, and make use of safe spaces for dialogue and participation, e.g. using knowledge as an entry point. Experiment with awareness creation and networking tools. Identify change agents and champions.
- *Science and technology:* Identify and support champions in academia to use policy–society interfaces proactively, and to contribute to the

creation of a more enabling environment for stakeholder dialogue. Foster mainstreaming of research results on the valuation of natural resources.
- *Overarching:* Focus on designing, testing, and bringing to maturity various engagement and negotiation platforms composed of champions from government, economy, civil society, and science.

Sustainable and just economies

- *Governance:* Build an enabling institutional environment and develop staff capacity at the government level; control brain drain and income leaks; introduce adaptive governance mechanisms ensuring flexible valuation schemes to allow for multiple perspectives.
- *Economy and finance:* Introduce benefit-sharing mechanisms to reduce disparities, form self-organized producer groups, link traditional livelihoods (NTFPs) with carbon markets and *payment for ecosystem services* (PES) schemes.
- *Individual and collective action:* Explore and highlight multidimensional values of nature other than invasive and encroaching MIPs, empower user and producer groups to expand their agency to the extent possible through citizen-focused interventions.
- *Science and technology:* Take advantage of the COVID-19 pandemic to strengthen the discourse on inclusive approaches e.g. the concept of "planetary health", fostering broader valuation perspectives.
- *Overarching:* Foster a multidimensional value definition of NCPs in the national context, ensure an inclusive environmental accounting scheme, and promote transparent and empowering policies.

Sustainable food systems & healthy nutrition

- *Governance:* Test "smart" and adaptive governance frameworks, ensuring productivity and resilience of food systems, and conserving agrobiodiversity and nutritious value while conserving nature.
- *Economy and finance:* Explore complementary approaches that ensure productivity and conservation; test domestication of NTFPs, develop certification and marketing tools to protect local interests.
- *Individual and collective action:* Draw on people's food preferences and habits, and strengthen the momentum for healthy food and nutrition observed in emerging urban communities in Laos.
- *Science and technology:* Multifunctional landscapes provide a space for experimenting and testing solutions beyond the beaten paths that require new partnerships between research institutions across silos. Platforms for linking consumers and producers benefit from technological solutions.
- *Overarching:* Transform food systems towards agroecologically sound outcomes, optimizing interactions between plants, organisms, humans, and the environment, while also satisfying the need for socially acceptable food production. Embrace a systemic approach to address the complex and interdependent challenges related to the realms of food production, livelihood security, health, and the management

of natural resources. This also relates to the concept of "planetary health" (De Paula 2018), expanding the connotation of health beyond the human sphere.

Energy decarbonization with universal access

- *Governance:* Identify innovative ways to build institutional capacity for renewable energy production at the government level, encourage data and information sharing across ministries.
- *Economy and finance:* Refocus on domestic energy needs met with decentralized production – and sell the surplus abroad.
- *Individual and collective action:* Sensitize the population with campaigns and engaging citizen science to develop a small-scale renewable energy sector.
- *Science and technology:* Promote national science actors to engage in sustainable power production schemes.
- *Overarching:* The energy sector has an important role to play in Laos, and the industry can play a leading role in the green economy transition of Laos if carefully managed and developed.

Urban and peri-urban development

- *Governance:* Focus urban development on citizens' needs and requirements; consider important functional interaction between urban–peri-urban areas in the design.
- *Economy and finance:* Develop urban areas with a green economy focus, considering the principles of circular economy.
- *Individual and collective action:* Public spaces are crucial for citizens to express ideas, visions, and needs - and must be considered in the urban design and planning.
- *Science and technology:* Aim for participatory communication and public management instruments and tools to engage citizens in the public dialogue.
- *Overarching:* In authoritarian systems, urban areas often represent sensitive key contexts. At the same time, they are a starting point for triggering change processes towards a nature-positive lifestyle and economy.

Global environmental commons

- *Governance:* Aim for cross-sectoral integration and coherence for the management of environmental commons, through a better clarification of roles and responsibilities as well as collaborative mechanisms.
- *Economy and finance:* Identify, assess, and test best practices in terms of responsible investment schemes. Strengthen local leadership for better enforcement of consent-seeking mechanisms.
- *Individual and collective action:* Take advantage of newly emerging awareness on the importance of environmental protection. Experiment with awareness creation and networking tools. Identify "change agents" or "champions".

- *Science and technology:* Aim for highly explicit, real-time information on the environmental situation to boost public awareness. Explore the potential of digitalization to ensure fuller transparency regarding the various claims made on commons.
- *Overarching:* Aim for a "social pact" on environmental protection, based on national values and global awareness. Seek to instill a sense of pride to protect natural heritage through various avenues, but with a close look at the potential of the booming digital technology.

7.7 Conclusion

None of the options for transformative actions in the above list are easy to implement; nor will they lead to significant short-term success, because of the imbalance between significant and deep-rooted challenges and dilemmas, and the limited or untapped assets and opportunities for more just and sustainable nature–people relations. The list of foci also shows that most of the proposed transformative actions are bound to sociopolitical processes, implying that they cannot be steered directly but can be initiated, moderated, and supported by institutions such as the Wyss Academy for Nature. The success of such actions depends strongly on building trust with partners and stakeholders, and achieving recognition as a non-partisan knowledge institution.

From the perspective of the people–nature nexus, the options related to the *entry points* of "well-being" and "global environmental commons" deserve highest priority. However, the list illustrates that the options identified in the other *entry points* of the GSDR framework provide important supplementary actions for more just and sustainable nature–people relations, in particular, "sustainable food systems" and "energy decarbonization".

As most options for transformative action depend on sociopolitical processes, capacity development at all levels, institutional and leadership support, as well as support of champions in government, economy, civil society, and academia will be important. According to the group of experts and to stakeholders, the partnership-based knowledge and engagement channels and platforms, which are foreseen in the basic concept of the Wyss Academy for Nature, will be crucial triggers of such sociopolitical processes. Working on the mutual understanding and harmonization of contradicting values and perspectives, especially in relation to well-being of rural populations and the different values of nature, will be important to promote broadly based transformative action.

The list of foci also implies that pilot activities in specific contexts are a meaningful approach to testing transformative actions before scaling up those that are successful. Some of the remaining multifunctional landscapes of Laos could be pilot areas in which rural livelihoods, biodiversity conservation, use and trade of NFTPs, and alternative energies, etc. can be integrated based on strengthened community involvement and empowered

local leaderships. In other words, the experts and stakeholders are proposing that, in a first step, the “incubators” foreseen in the concept of the Wyss Academy should be initiated in such multifunctional contexts.

8 Knowledge gaps and research needs

Christian Hergarten, Urs Wiesmann, Albrecht Ehrensperger, Paul Eshoo, Michael Epprecht

During the synthesis workshop of June 2021, the group of experts took a twofold approach to identifying knowledge gaps and research needs. On the one hand, they departed from the challenges and opportunities presented in chapter 7, to identify knowledge gaps in terms of transformative processes or actions. These gaps refer mainly to the "*how*" of transformation. They are therefore called "transformative knowledge gaps" (section 8.1). On the other hand, the participants identified missing systemic scientific knowledge and baseline information needed for transformative action. These gaps refer to the "*what*" and "*why*" in the socio-ecological system of Laos and its sub-contexts. They are therefore called "baseline and systemic knowledge gaps" (section 8.2).

8.1 Transformative knowledge gaps

In a first step, transformative knowledge gaps were identified for each individual field of the GSDR matrix (section 7.2). They are summarized in the tables below in relation to the GSDR's six thematic *entry points*. For easier reference, the tables include summaries of the challenges and opportunities identified earlier (chapter 7). Therefore, the tables can be read as a tabulated summary of chapters 7 and 8 of this report. In a second step, the group of experts distilled and synthesized the research gaps presented in the tables below into a number of key transformative knowledge gaps. They are grouped along the four *levers* presented in the second part of this section.

On the following pages are six tables summarizing challenges and opportunities faced in Laos in achieving the four levers of the GSDR framework and corresponding transformative knowledge gaps.

Human well-being

	Challenges	Opportunities	Transformative knowledge gaps
Governance	• Unjust power relations • Lacking participation • Weak enforcement • Unclear roles and responsibilities	• Increased pressure from top leaders for more sustainable development. • Multi-dimensional welfare perspective	• What are the needs in terms of capacity and skills? • How to manage institutional memory? • Mapping policy contradictions and incoherencies
Economy	• Overwhelming speed of development • Unjust distribution of benefits	• Responsible investment schemes • Options for more employment generation	• How to convince private sector to engage in inclusive value chain development? • What responsible investment schemes work where and why? • How to achieve better co-benefits from land investments for local communities?
Individual and collective action	• Authoritarian regime with limited space for individual/collective action • Lack of enabling environment for innovation to flourish	• Young generation returnees • Increasing availability of social media and other digital information	• What knowledge tools work to spark individual and collective action? • How to empower people to use these tools? • How to integrate local knowledge into knowledge hubs? What is the potential of crowd-sourced information?
Science and technology	• Weak capacity • Difficulties to link systemic and local perspectives	• Increasing number of local academics at the policy-society interface	• How can knowledge create an enabling environment for CSOs / stakeholder dialogues? • How to promote a pluralistic and fairer evaluation of natural resources?

Sustainable and just economies

	Challenges	Opportunities	Transformative knowledge gaps
Governance	• Poor governance and monitoring of investments, poorly implemented customary rights protecting local interests	• Taxes, fees and compensations to be collected from investors and MIP; local communities still value nature highly	• Lack of knowledge on natural capital analysis • How to integrate local (non-economic) cultural and environmental / ecological values into economies?
Economy	• Rapid economic development fosters increasing disparities, lack of benefits sharing	• If cooperation works, local farmers and production groups can develop and leverage important bargaining power	• How to consider socio-historical perspectives e.g. regarding land tenure? • How to develop 'basket approaches' linking NTFP & carbon markets?
Individual and collective action	• Market valuation of land resources complicates access and compensations in case of infrastructure development	• Affected citizens can form alliances following the example of 'communities of practice' and share experiences and knowledge	• How to create an enabling environments/constructive dialogue addressing critical issues without being considered 'subversive' in Laos?
Science and technology	• Narrow monetary valuation dominates the discourse, lack of knowledge on pluralistic valuation schemes	• Science can help to develop approaches to expand the narrow valuation concept, and use technology to attribute transparently	• How can pluralistic valuation of NCP be achieved and what role can science & technology play here?

Sustainable food systems & healthy nutrition

	Challenges	Opportunities	Transformative knowledge gaps
Governance	• Little governance related to the use of NTFP; quotas exist but are difficult to control and enforce	• Growing urban demand for ecological products; development and promotion of value chains certification.	• How can food systems, marketing and their governance for more viable, sustainable and inclusive solutions be strengthened?
Economy	• Smallholder production vs investment-based expansion and intensification of agricultural sector; tradeoffs between smallholders aiming for poverty reduction vs rapid economic growth	• High demand for NTFP, domestically, regionally and internationally • High productivity with low inputs • Opportunity for agroecological transition	• How to 'manage' the use of NTFPs sustainably? • How can local NTFPs harvest be linked to transparency platforms? • Can NTFP be 'domesticated' so to preserve 'active ingredients' to reduce pressure on nature?
Individual and collective action	• Difficult access to other food supplies, income diversification from other activities	• Increasing awareness of public for the importance of natural resources	• Which incentives are necessary to change use of land? • Risk transfer mechanisms? • What potential role for citizen science?
Science and technology	• Access to knowledge and technology on e.g. NTFP high value products (to develop sustainable value chains)	• Multifunctional landscapes are an opportunity for science and technology to play a key role	• What technologies exist to certify supply chains from farmer to markets and consumers?

Energy decarbonization with universal access

	Challenges	Opportunities	Transformative knowledge gaps
Governance	• Poor governance in energy sector reinforces strong export focus rather than national decarbonization efforts	• Important potential for green energy production (solar, wind, geothermal) • a centralized governance approach conducive for exploring these options	• How can the expertise gained in energy production for export be harnessed for small-scale domestic renewable energy production?
Economy	• Large scale hydropower detrimental to local economy, lack of benefit sharing	• Small-scale and decentralized hydropower systems; complemented by other solar, wind, geothermal energy are promising – also for export	• Which mechanisms work to ensure benefit sharing at local level? • How can the economy be convinced to embark on decentralized energy production?
Individual and collective action	• Effect of CC on water resources and impact on hydropower - scientific knowledge does not translate to collective action	• Citizen science potential to sensitize the communities and sharpen perception for renewable energy production	• What role can citizen science play for engaging and empowering communities and citizens in taking action in an authoritarian context?
Science and technology	• Power and scale issues: only large hydropower is considered; not decentralized small-scale production.	• Science and technology have a role to play in promoting the potential for small-scale renewable energy production	• How to leverage the role of science for making sense of available data and info at various ministries?

Urban and peri-urban development

	Challenges	Opportunities	Transformative knowledge gaps
Governance	• Urban sprawl into sensitive ecosystems as a result of poor urban planning	• Developing governance system is open to accommodate and test and pilot new approaches	• How can the population be involved in urban design and development in Laos?
Economy	• Accelerated urban development and high urban demand result in mismatch of demand and supply	• Urban population open to nature positive economy • Education	• How to use the momentum and mainstream nature positive economic perspectives?
Individual and collective action	• Poorly designed property right schemes and unclear tenure regimes impede citizens' engagement	• Growing ecological / sustainability awareness in urban population, esp. among the young generation	• What are promising ways for engaging urban populations in nature conservation?
Science and technology	• Lack of participatory urban design • Weak public engagement	• Sciences and technology can drive and support better urban design and efficient services	• Supply chain transparency beyond certification (farmer to market)

Global environmental commons

	Challenges	Opportunities	Transformative knowledge gaps
Governance	• Weak enforcement • Unclear roles and responsibilities	• International treaties signed and ready for translation into national context	• How to achieve policy coherence for the management of environmental commons?
Economy	• Lack of understanding of commons • Strong domestic and foreign demand for wildlife products	• High natural capital • Options for usage • Agenda 2030 and increased global awareness	• What responsible investment schemes work where and why? • How to achieve better co-benefits from land investments for conservation?
Individual and collective action	• Awareness raising on demand side, including role in pandemic	• New awareness about link between nature and human health because of COVID-19	• What knowledge tools work to spark individual and collective action? • How to empower people to use these tools? How to integrate local knowledge into knowledge hubs? • What is the potential of crowd-sourced information?
Science and technology	• Lack of holistic knowledge on ecosystem services • Data and knowledge are in silos	• Technology for real-time monitoring and information sharing • Transparency through digitization	• What is the potential of digital technology to achieve pluralistic evaluation of natural resources? What system design for the establishment of conservancies?

As indicated before, the knowledge gaps presented in the tables above were further distilled into the key transformative knowledge gaps presented below, for each of the four *levers* (governance, economy, individual and collective action, science and technology). In the view of the group of experts, they are fundamental for initiating transformative processes and action.

Transformative knowledge gaps and research needs in the "governance" *lever*:

1. What are the reasons for existing policy incoherencies that impede effective environmental governance in Laos, and how can these be addressed?
2. What are promising entry points to strengthen inclusive and fair food systems governance in Laos? What role do co-benefits play for the successful promotion of sustainable food systems, in addition to the benefits of a healthy and nutritious diet?
3. What are promising entry points to raise awareness among/activate the young generation on the benefits and imperative to embark on a more sustainable strategy for economic development?
4. What is the socio-political history of land tenure and use agreements (including customary user rights) in Laos, and what are solution-oriented pathways to prevalent land tenure challenges?
5. What are promising incentives and strategies to improve the government's capacity for evidence-based policy and decision-making?
6. What innovative ways and incentives exist (or can be imagined), in terms of institutional governance, to reduce staff turnover rates leading to constant capacity leaks and brain drain?

Transformative knowledge gaps and research needs in the "economy" *lever*:

7. How can multifunctional landscapes be co-designed with local communities, considering local perceptions and values, including the testing of "basket approaches" (e.g. NTFPs + carbon markets) – without simply imposing western values?
8. What conditions must be met for commodity production in Laos to be sustainable and allow local communities to benefit and thrive?
9. How can proper monitoring and evaluation procedures be introduced and established systematically, to assess environmental and socioeconomic impacts of conservation measures, including randomized control trials for land tenure interventions?
10. How do various forest and conservation management schemes compare in terms of economic competitiveness, in monetary but also in non-monetary terms, e.g. PES vs. traditional hunting vs. traditional conservation?
11. What arguments and incentives work best to convince land users to embark on more resilient and sustainable land use strategies; what are the catalyzing or inhibiting roles of risk transfer systems and subsidies?

12. How can a diversified agricultural production system be promoted, as an alternative to a uniform land use system resulting from the profit-oriented logic of the agrarian transition?
13. What can be learned from innovative examples of harmonized nature and people relations elsewhere, and how can they be successfully replicated, adapted, and scaled up in Laos?

Transformative knowledge gaps and research needs in the "individual and collective action" *lever*:

1. Which transparent knowledge platforms work to induce individual and collective action? How can these platforms be translated into/ positioned as valuable assets? How can people be empowered to use them effectively?
2. What are the potential and acceptance of crowd-sourced and citizen science-based data collection and information generation tools in Laos? To what extent can such tools help to overcome the authoritarian tradition of the political system?
3. What is the potential of crowd-sourced information to create awareness for pressing issues such as climate change or biodiversity loss? How can the potential of citizen science be leveraged for data collection and knowledge generation, including the empowerment of marginalized groups?
4. Are there new opportunities to engage the growing urban middle-class in nature conservation? What are new ways for engaging urban populations in nature conservation?

Transformative knowledge gaps and research needs in the "science and technology" *lever*:

1. What conditions are necessary (and realistically possible) in Laos to enable the evolution of a knowledge and science-based "ecosystem of innovation"?
2. What societal processes are required to move from a resource-intensive to a knowledge economy? What conditions help to harness the promises of digitalization without harm?
3. How can science and technology improve supply chain transparency – beyond certification (farmer to market)?
4. What role can technology play for the sustainable development of the NTFP sector (e.g. through smart contracts/block-chain technology enabling transparent and efficient value chains)?
5. What role can science and knowledge play in creating an enabling environment for developing civil society organizations in a centralized and hierarchical regime? Through which channels, and with which tools/ technologies?
6. What approaches and systems exist (or can be conceived) to allow allocation and charging of concession holders for externalities in an efficient and transparent manner?

8.2 Baseline systemic knowledge gaps

The quality and effectiveness of transformative research and action strongly depend on the quality of baseline information and systemic knowledge on the socio-ecological systems concerned. The group of experts therefore also turned to questions of "*what*" and "*why*", and identified some pertinent knowledge gaps in the information and understanding of socio-ecological systems in Laos. These baseline and systemic knowledge gaps are briefly discussed and presented below. This time, the discussion does not follow the structure of the GSDR framework, but unfolds along research themes related to key components of the socio-ecological system.

- **Improved data, understanding, and modelling of climate in the region:** To date, the processes that drive the climate in Southeast Asia are not understood well enough to produce reliable seasonal forecasts (Ratna et al. 2017). The lack of weather station data or restricted access to this data make it difficult to understand the past climate and to identify recent changes related to global warming. There is also a lack of studies based on regional climate model simulations. Furthermore, large-scale phenomena such as El Niño–Southern Oscillation or the Indian Ocean Dipole affect the local climate in ways that are as yet barely understood. Highest-resolution simulations could help to understand such complex interactions. A deeper understanding of changes in extreme events (frequency and intensity) is also needed: typhoons, floods, and droughts affect ecosystems and people more radically than gradual changes (Franzke and Torelló i Sentelles 2020), with clear implications for conservation measures.
- **Ecological and biological baseline information and monitoring:** The lack of basic ecological and biological information limits the assessment of conservation status and the identification of main threats to key species. Baseline data collection for environmental monitoring is not yet fully developed in Laos. For example, biodiversity monitoring has not been identified by the Lao government as a priority beyond the reporting mechanism related to international treaties (CBD). Some ecological baseline data (e.g. land cover and land use change) suffer from methodological inconsistencies and definition flaws; e.g. forest definitions vary between institutions such as FAO or the government (Koch 2017).
- **Diversity of valuation of nature and environmental services:** Efforts to conserve and preserve the rich intrinsic value of nature and the sustainability of environmental services will strongly depend on whether common ground can be found with local land and forest users and rural communities. This implies that there is an important need, on the one hand, to develop spatially explicit valuation methods of the intrinsic value of nature and, on the other, to understand and map the local economic and cultural value attached to nature and its components, as

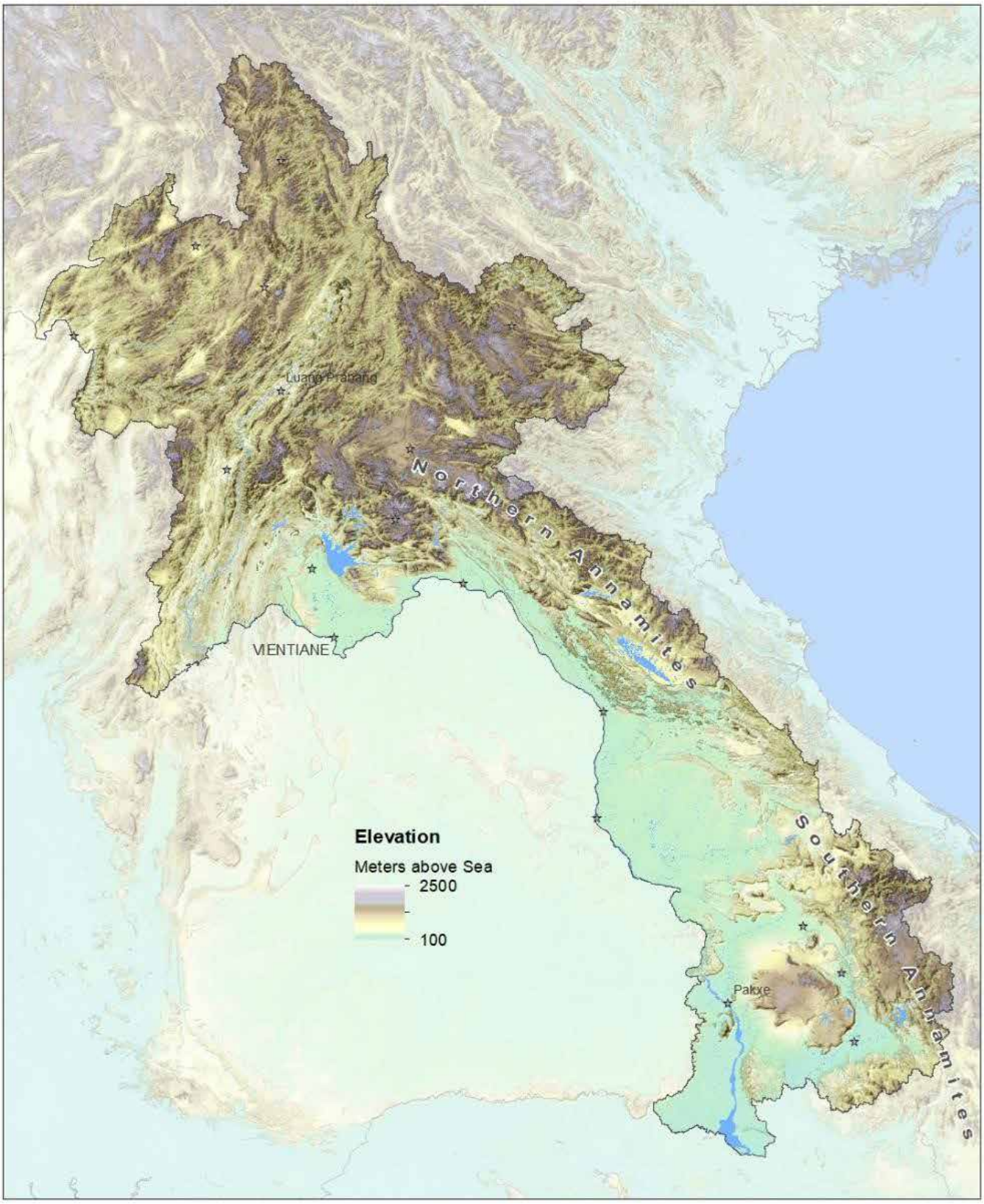
well as the local interpretation of environmental services. Comparing these two sets of values of nature will reveal conflicting views but also congruent perspectives, which can form a basis for approaches that combine conservation and local needs and values.

- **Agrarian transformation, vulnerability and resilience of rural communities:** With the agrarian transition, rural communities often experience pressure on their multi-strategies and agency, and thus on their prospects of a self-determined future. Customary land tenure and resource access rights may lose their important function and start fading, thus affecting locally rooted safety nets in the form of "non-commodified resources" (land, forest, rivers, and lakes) accessible to vulnerable community members. This challenges the overall resilience of rural communities, often forcing members to migrate or engage in detrimental agricultural practices – and often with important consequences for the people–nature nexus. Therefore, more research is needed on the role of locally managed resources acting as "non-commodified subsistence guarantee" (Barney and Van Der Meer Simo 2019) for communities and how they can be safeguarded and retained throughout the transition process. More research is also required to understand the interactions between the local traditional exchange of goods and market-oriented approaches.
- **Role and functions of customary governance rules and norms:** Rural Lao communities have a long tradition in managing and governing access to common forest resources. However, customary rights and rules tend to fit poorly with formalized land tenure systems and are therefore prone to be discarded and lost. This can result in disenfranchisement and pauperization of marginalized groups. It also implies the loss of means and knowledge for governing natural resources in a frontier development context characterized by weak formal and predatory corporate governance arrangements. Customary informal access rights and rules tend to be very effective and efficient, but also highly context specific. Therefore, more research is needed to understand the intricacies and effectiveness of customary governance rules in Laos, and to assess how they can complement, inspire, and improve the formal governance structure.
- **Managing large-scale foreign land investments:** The Lao PDR has opened its economy to foreign investments with little experience in managing such investments, and poorly developed steering capacity and control mechanisms. There is therefore an urgent need for reliable monitoring tools and impact analysis instruments that would enable better governance and management of such processes, and better anticipation of environmental and social challenges and consequences. In order to control and minimize negative side-effects, as well as to unlock the potential for more sustainable and just nature–people relations, actors in negotiation processes must be aware of, understand, and consider the needs, interests, and perceptions of affected communities acting as stewards of the value of nature.

- **Options of managing and marketing NTFPs and their livelihood impacts:** Research is needed on the systemic interaction between changing land use, forest-based livelihoods, wild food availability, and nutritional security. Conservation efforts and cash crop expansion not only influence rural people's livelihoods, but also people's habits in the collection of NTFPs, thus affecting diet and nutrition quality. Strengthening market mechanisms in a rural village may lead to various outcomes. The development of entrepreneurial skills and mindsets in order to upgrade value chains for NTFPs and local traditional crops is certainly an important asset for Laos. However, there are also risks associated with commodification strategies, e.g. through marketing local niche products from remote mountain areas in urban centers. Apart from overharvesting, increasing demand and the higher prices paid on urban markets may also lead to the perverse effect of malnutrition in rural areas. This has been observed when poor rural communities start substituting their healthy and nutritious crops with imported, cheap, and low-value food products in order to improve their cash income.
- **Payment for Ecosystem Services and other compensation mechanisms:** PES schemes have been developed in various projects in Laos with mixed success; in the hydropower industry, for example, this was due to unclear institutional arrangements and low motivation by the investors (Robichaud 2014). PES schemes applied in ecotourism projects at the village/protected-area scale have been mostly successful, resulting in much less illegal hunting activity compared to non-PES communities (Eshoo et al. 2018). However, more research is needed to understand the determinants of successful schemes.
- **Conservation, technology, and co-production of knowledge:** Technology holds promises for conservation efforts of endangered species. Artificial intelligence has the potential to generate relevant information from a plethora of observations and data collected by sensors of any kind (Kwok 2019). This can help to monitor key ecosystem features and to map valuable iconic species (Xing et al. 2019), and thus to create awareness among people for the value of nature. However, technical applications must be refined and incentives identified to create the momentum required for change. At the same time, more research and development are needed on how to combine novel technologies with the co-production of knowledge with local communities and actors in view of shared ownership of conservation efforts.

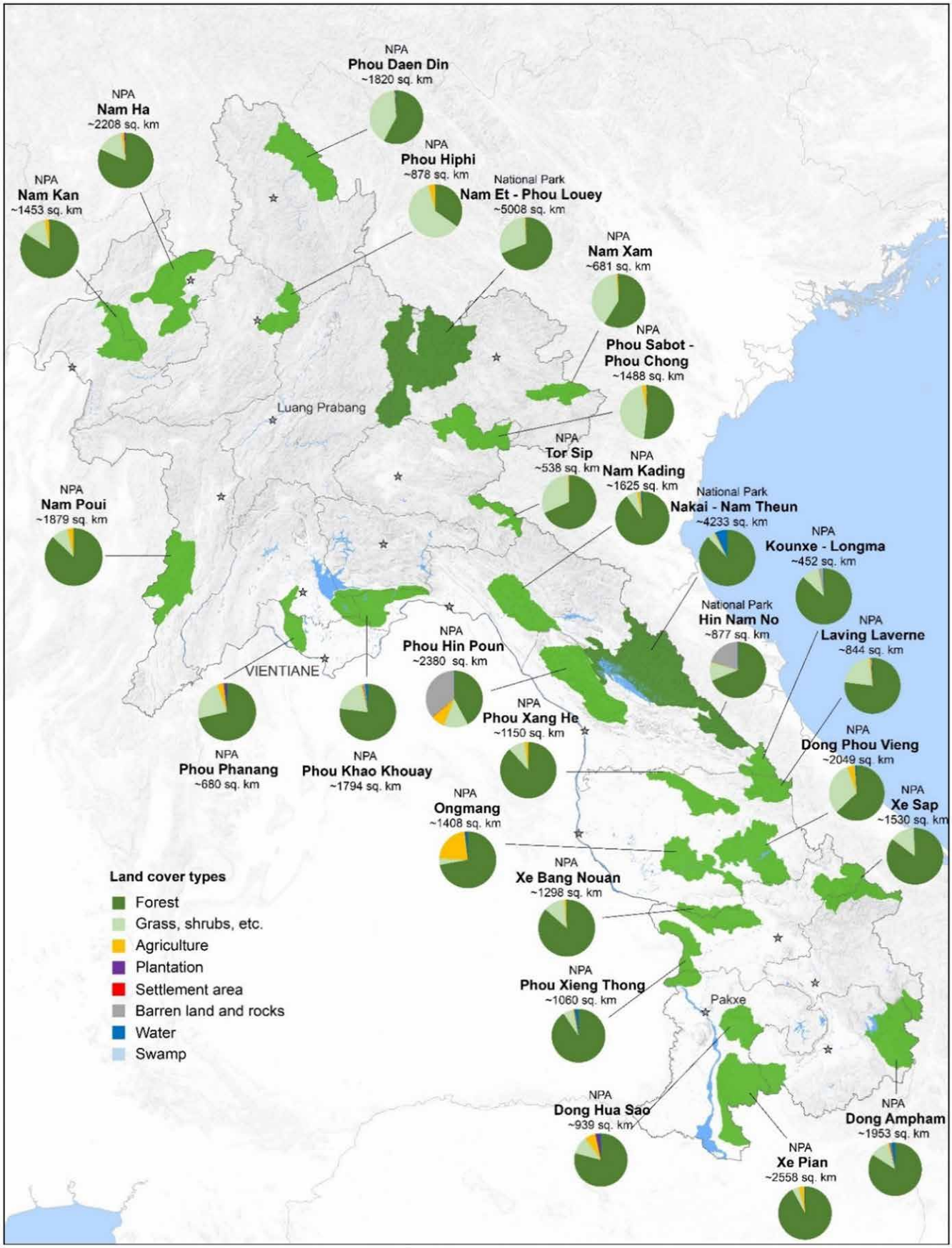
It is important to note that the above list of research themes related to systemic and baseline knowledge gaps is not comprehensive or complete. However, it represents promising research priorities identified by the group of experts who worked on this appraisal. Depending on the scope and concepts of the Wyss Academy for Nature, these themes will have to be modified, prioritized, and enriched, in order to achieve more just and equitable people–nature relations in Laos in the long term.

Appendices



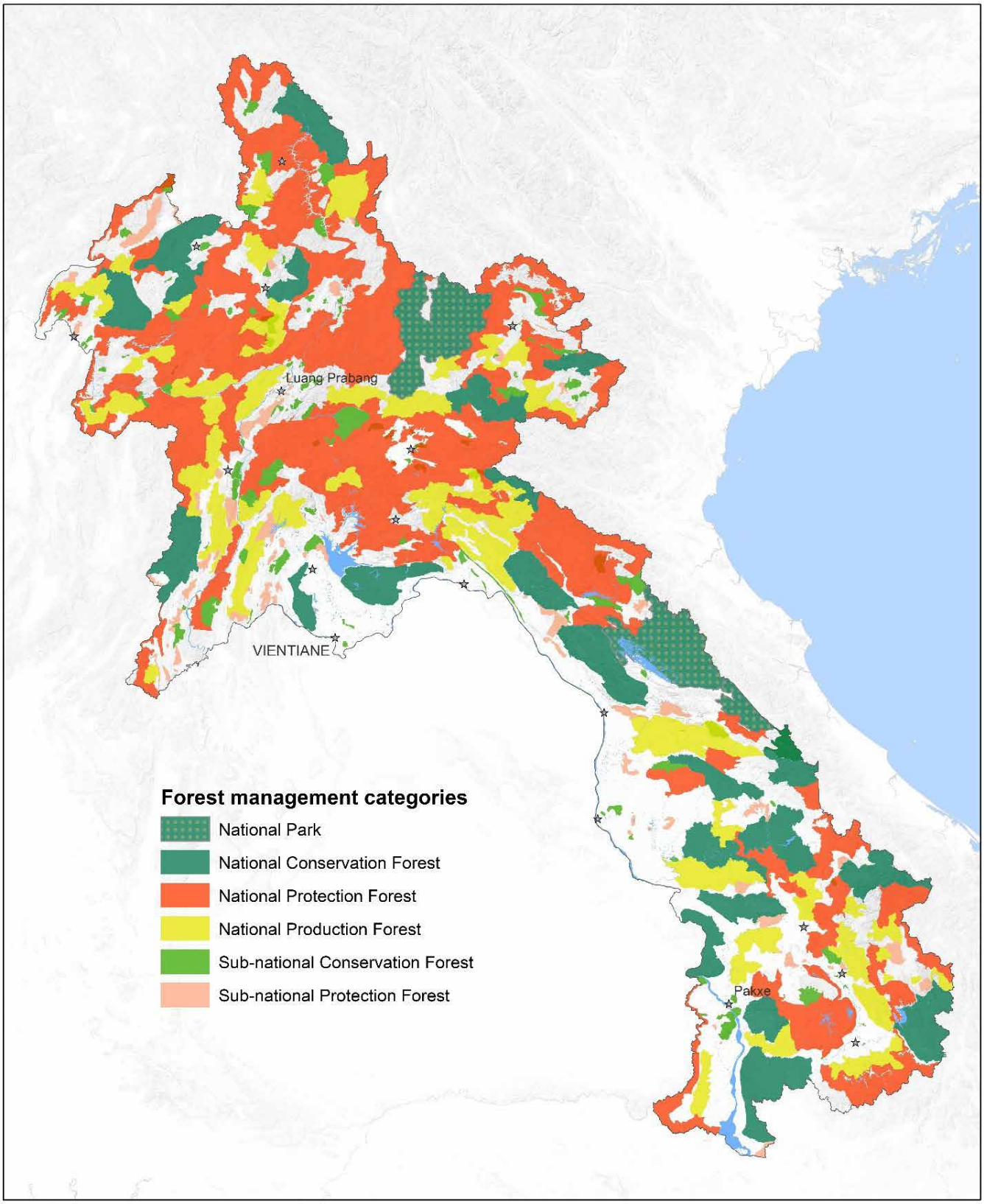
Map 1: Topography of Laos

Source: Elevation data from Shuttle Radar Topography Mission (SRTM)

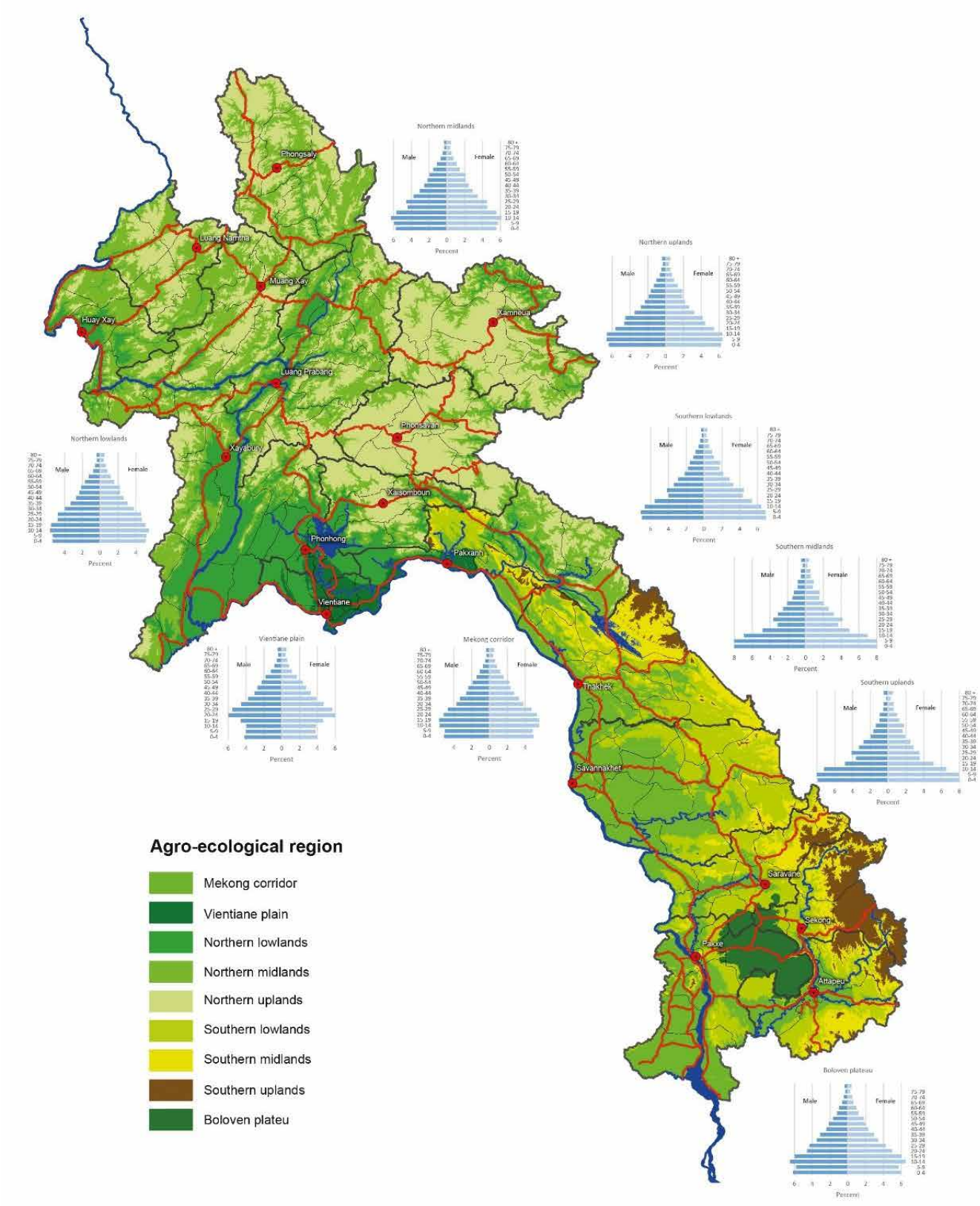


Map 2: National Parks and National Protected Areas in Laos

Source: Three Forest Management Categories 2020, Department of Forestry, Ministry of Agriculture and Forestry, Government of the Lao PDR (2020)



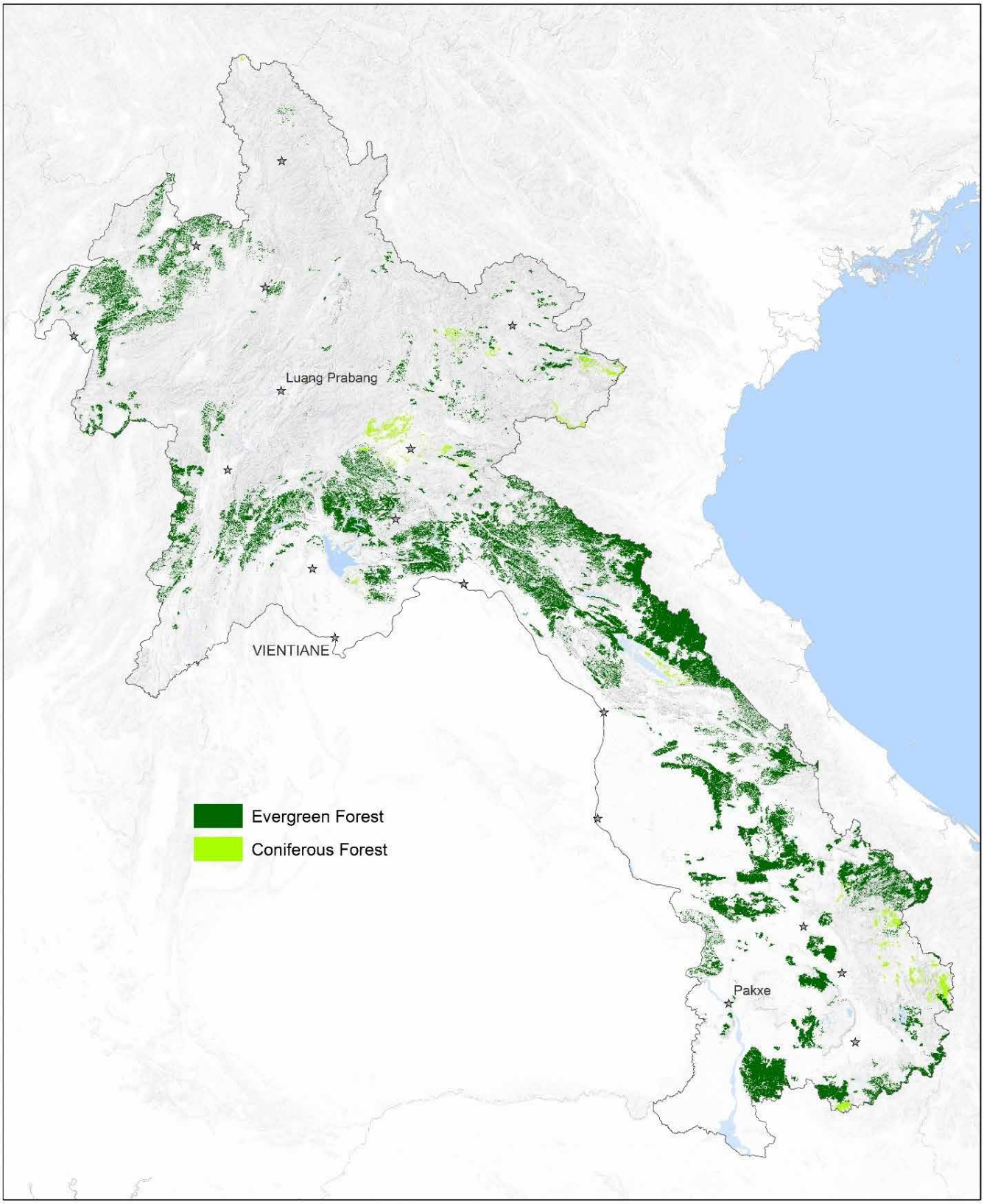
Map 3: Forest management categories



Map 4: Agroecological regions and population age distribution (2015)

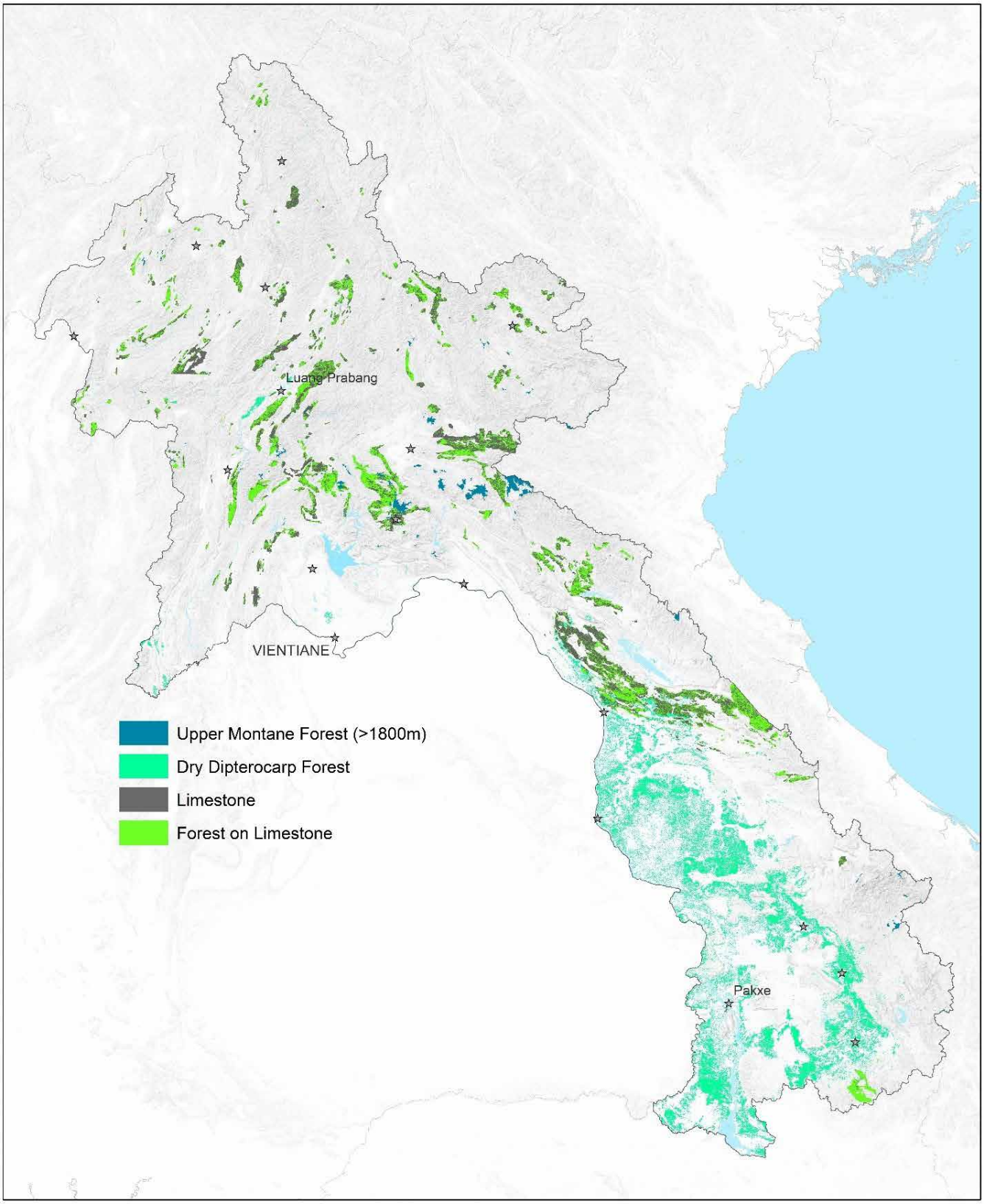
Sources: Elevation data from Shuttle Radar Topography Mission (SRTM)

Population data from Population and Housing Census 2015, Government of the Lao PDR (2015)



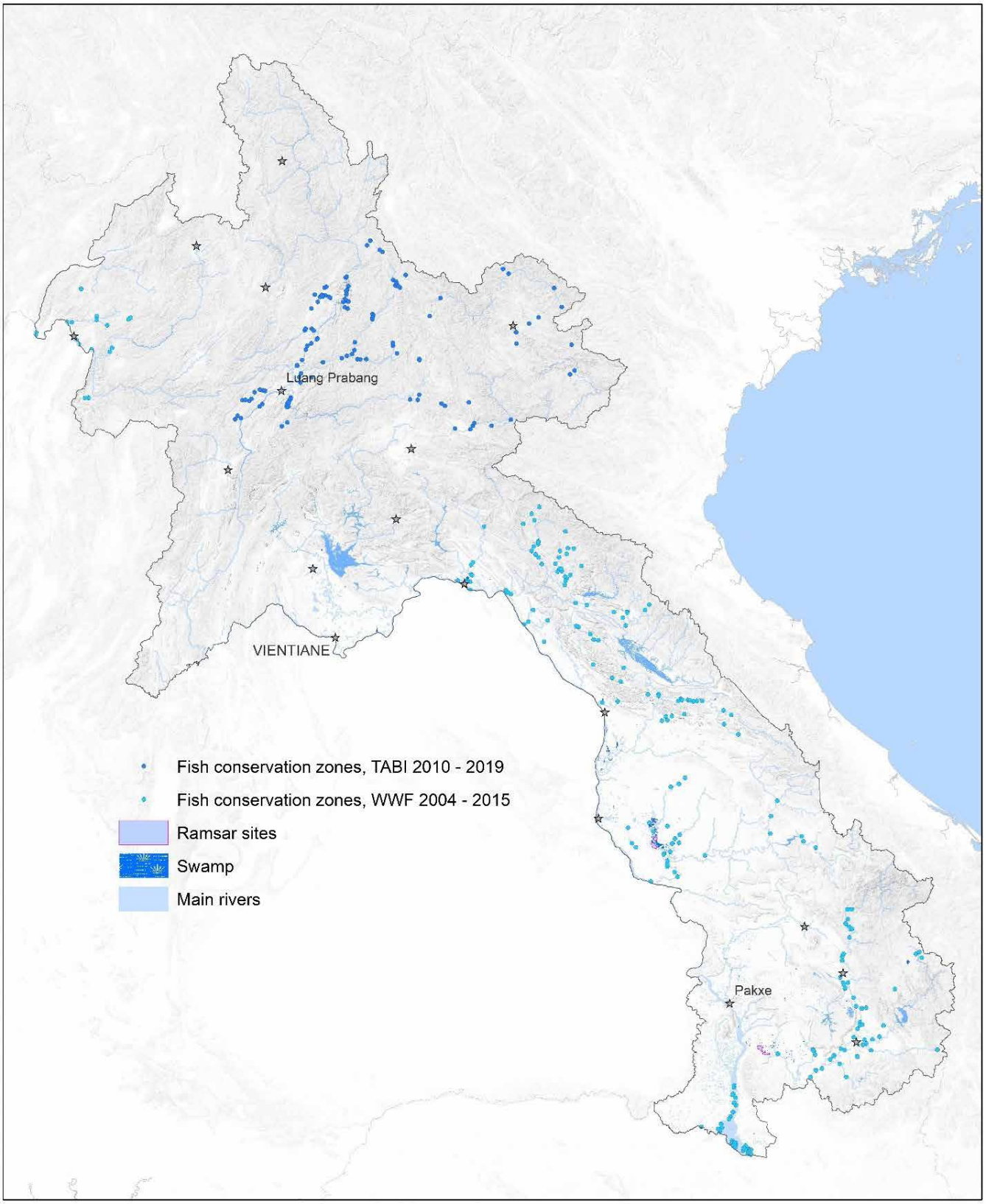
Map 5: Distribution of evergreen and coniferous forests in Laos (2020)

Source: Forest Cover Data 2020, Department of Forestry, Ministry of Agriculture and Forestry, Government of the Lao PDR (2020)



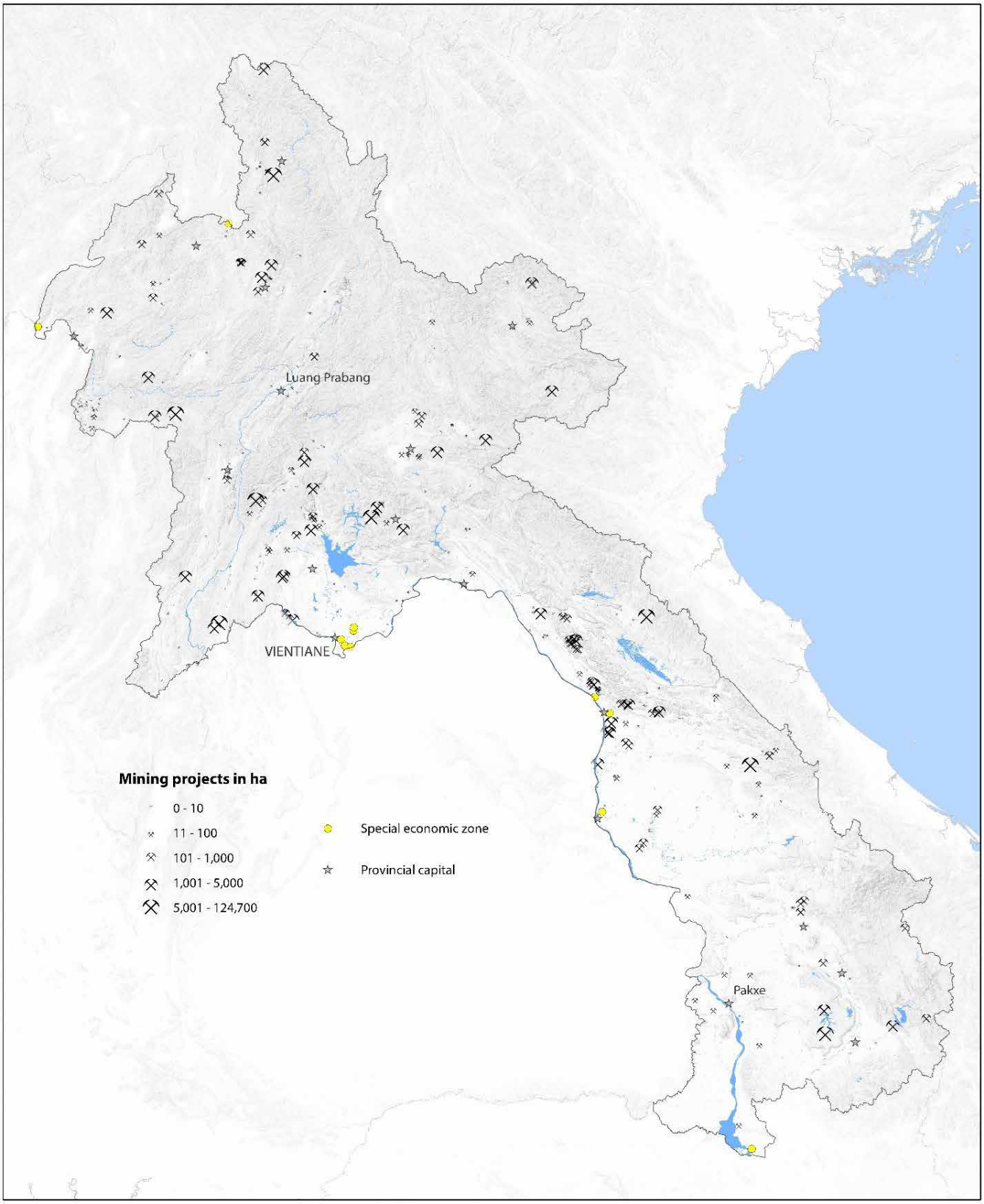
Map 6: Distribution of limestone karst, karst forests, dry dipterocarp forests, and upper montane forests

Source: Forest Cover Data 2020, Department of Forestry, Ministry of Agriculture and Forestry, Government of the Lao PDR (2020)



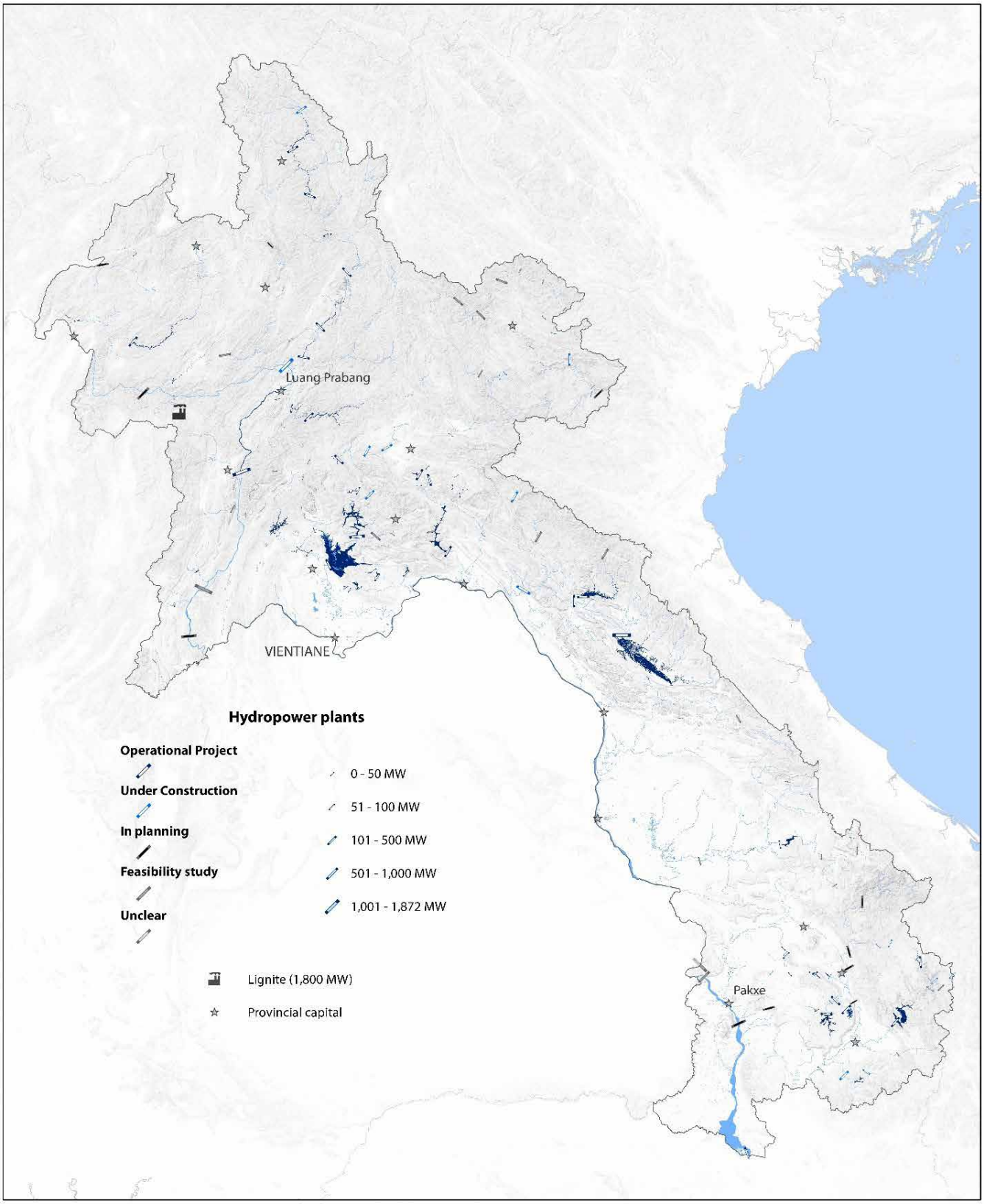
Map 7: Wetlands and fish conservation zones in Laos

Sources: Fish conservation zone locations from WWF Laos and from TABI



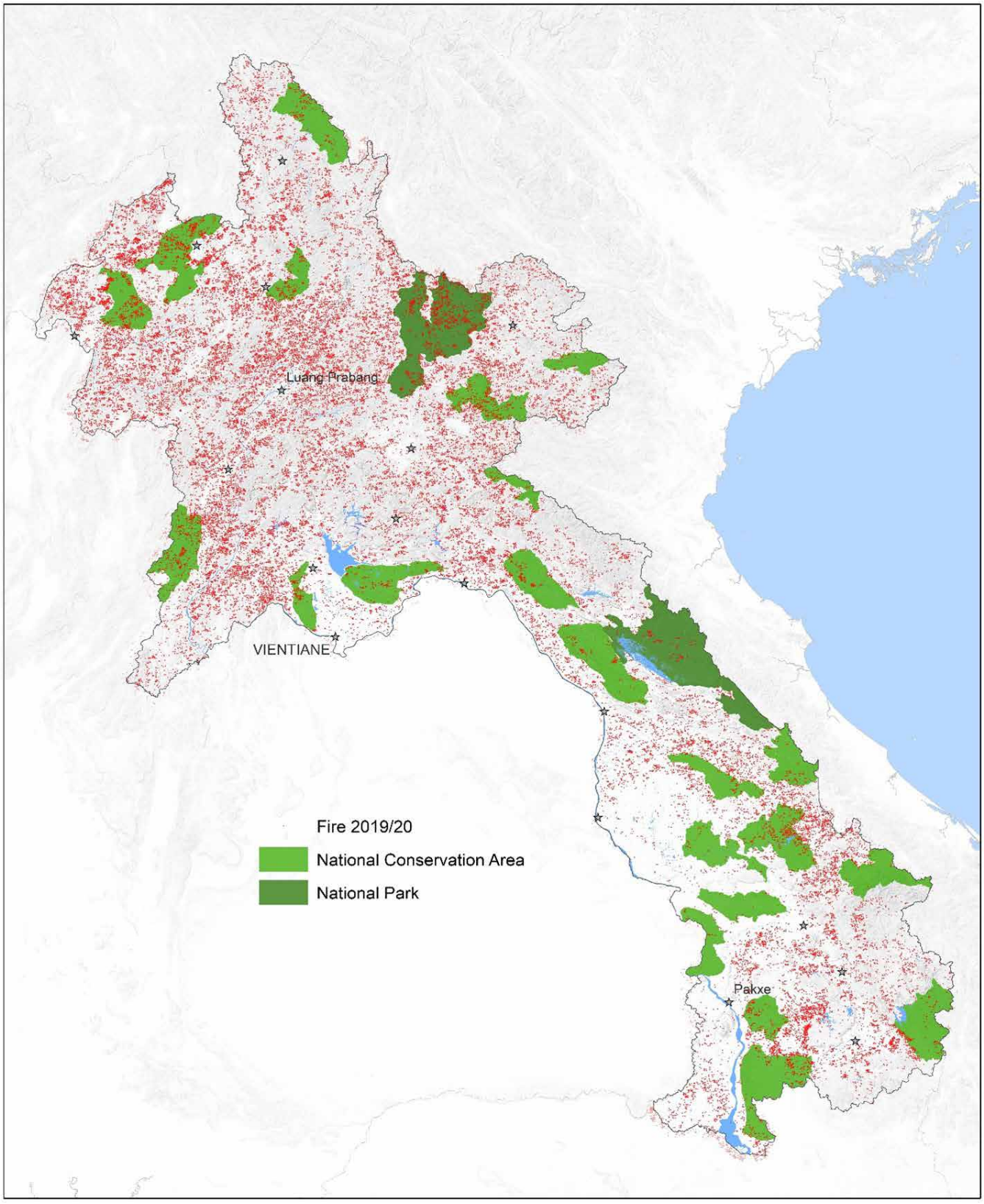
Map 8: Location of mining projects in Laos

Source: Lao National Land Concession Inventory, Hett et al.*, 2020*



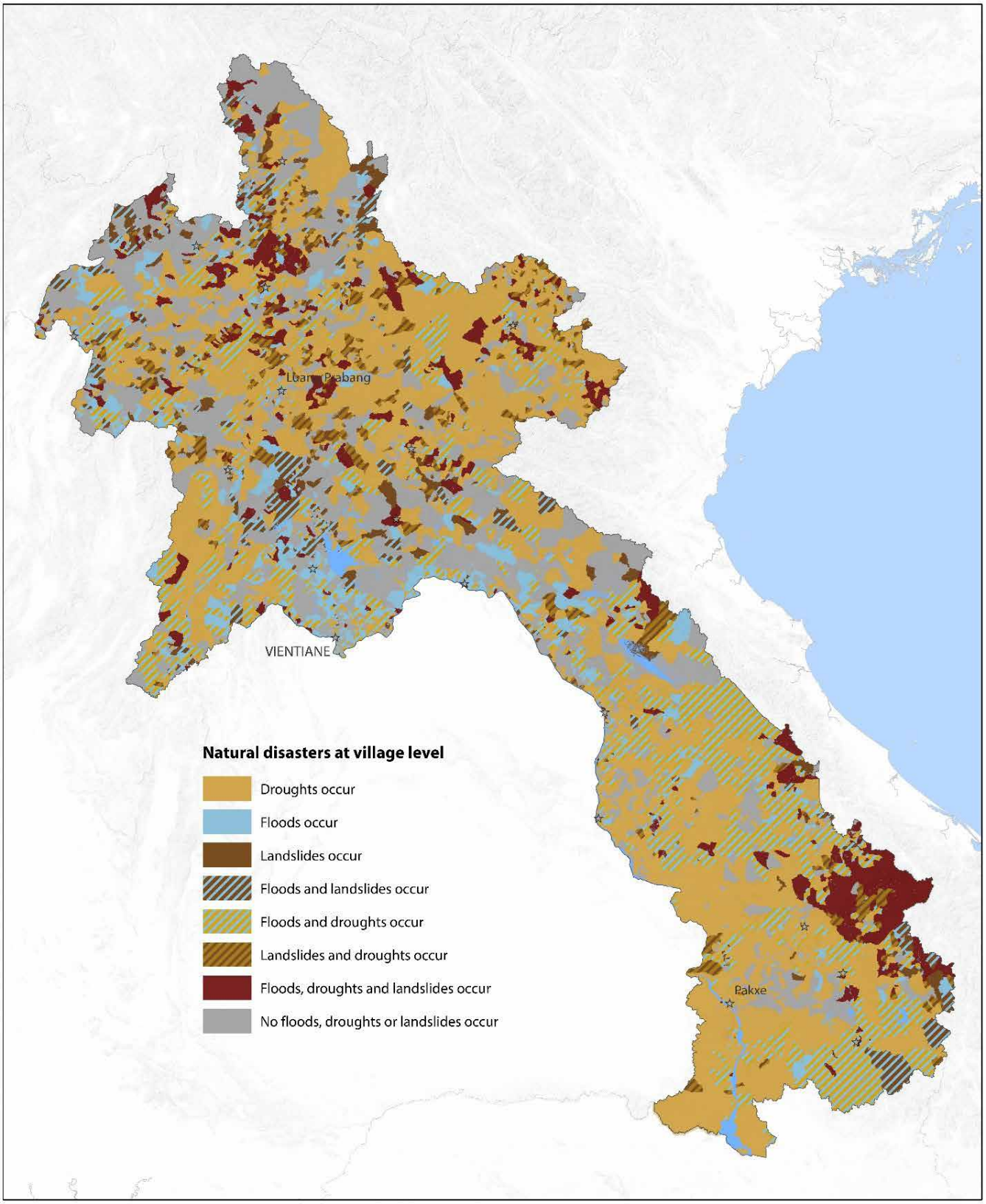
Map 9: Location of large hydropower projects in Laos

Source: Lao National Land Concession Inventory, Hett et al.*, 2020*



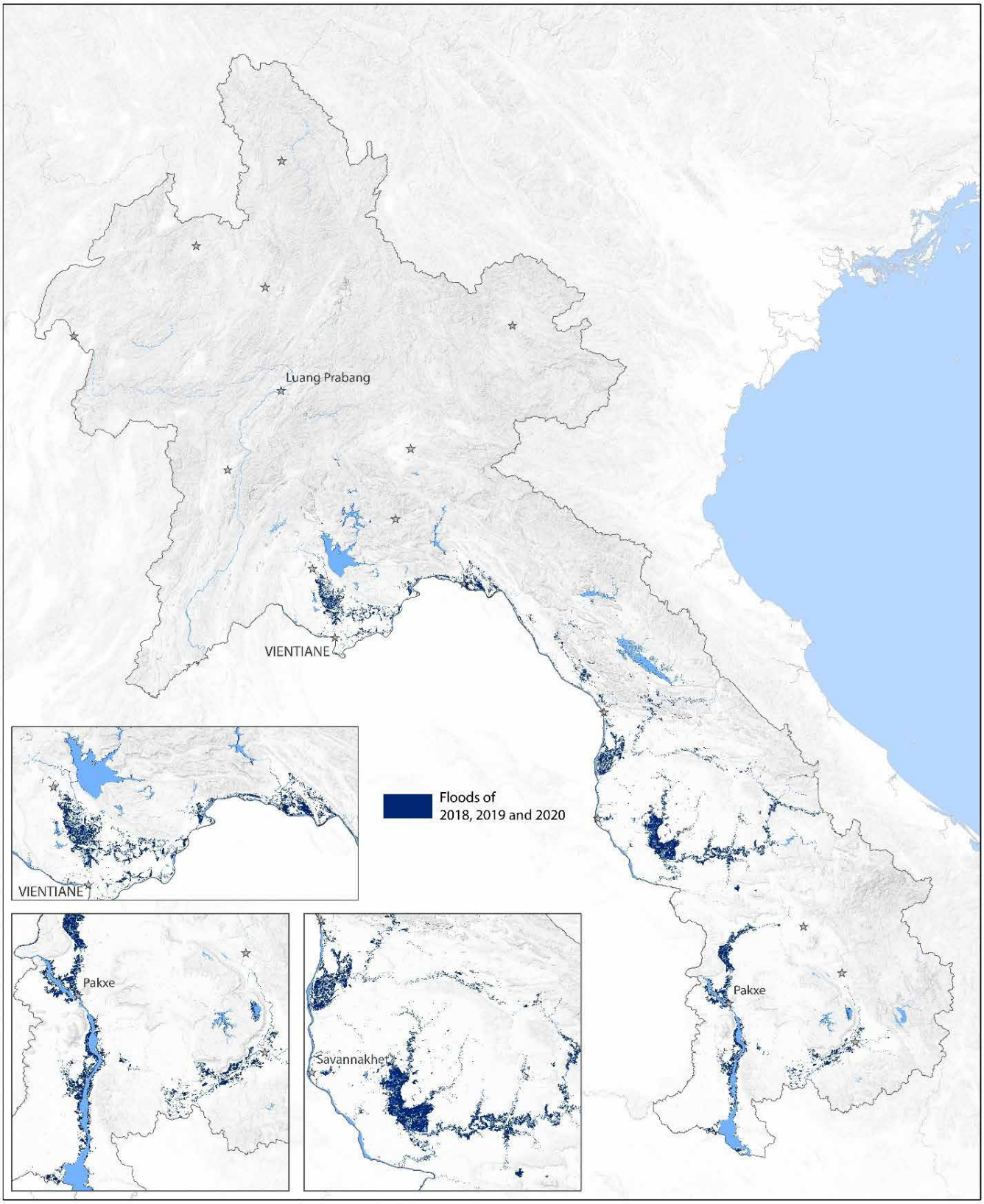
Map 10: Detected fires in 2019 and 2020

Sources: Three Forest Management Categories 2020, Department of Forestry, Ministry of Agriculture and Forestry, Government of the Lao PDR (2020). Fire information from NASA's Fire Information for Resource Management System (FIRMS)



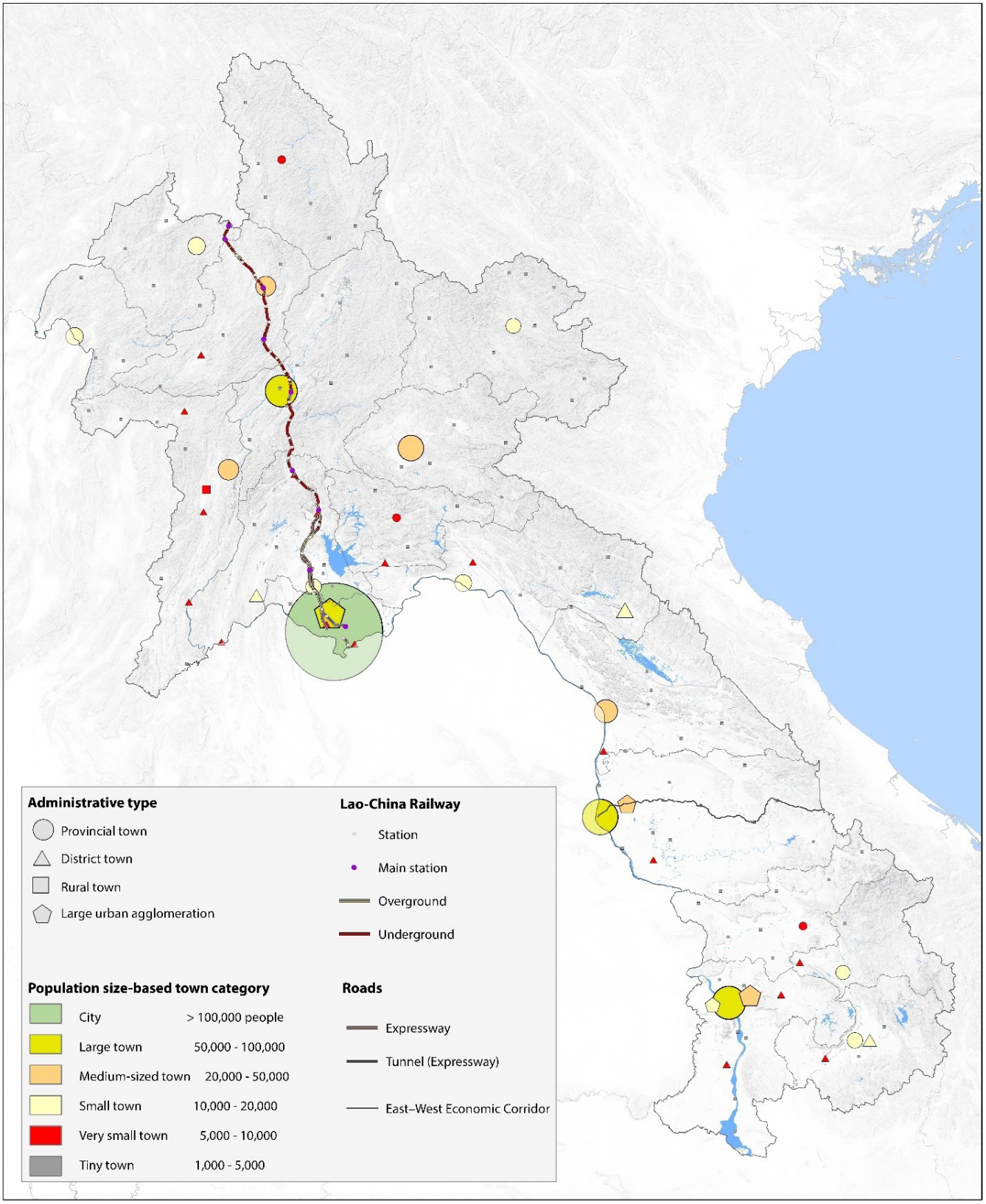
Map 11: Occurrence of natural disasters

Source: Census of Agriculture (2011), Ministry of Agriculture and Forestry, Government of the Lao PDR; in: Epprecht et al.*, 2018a*



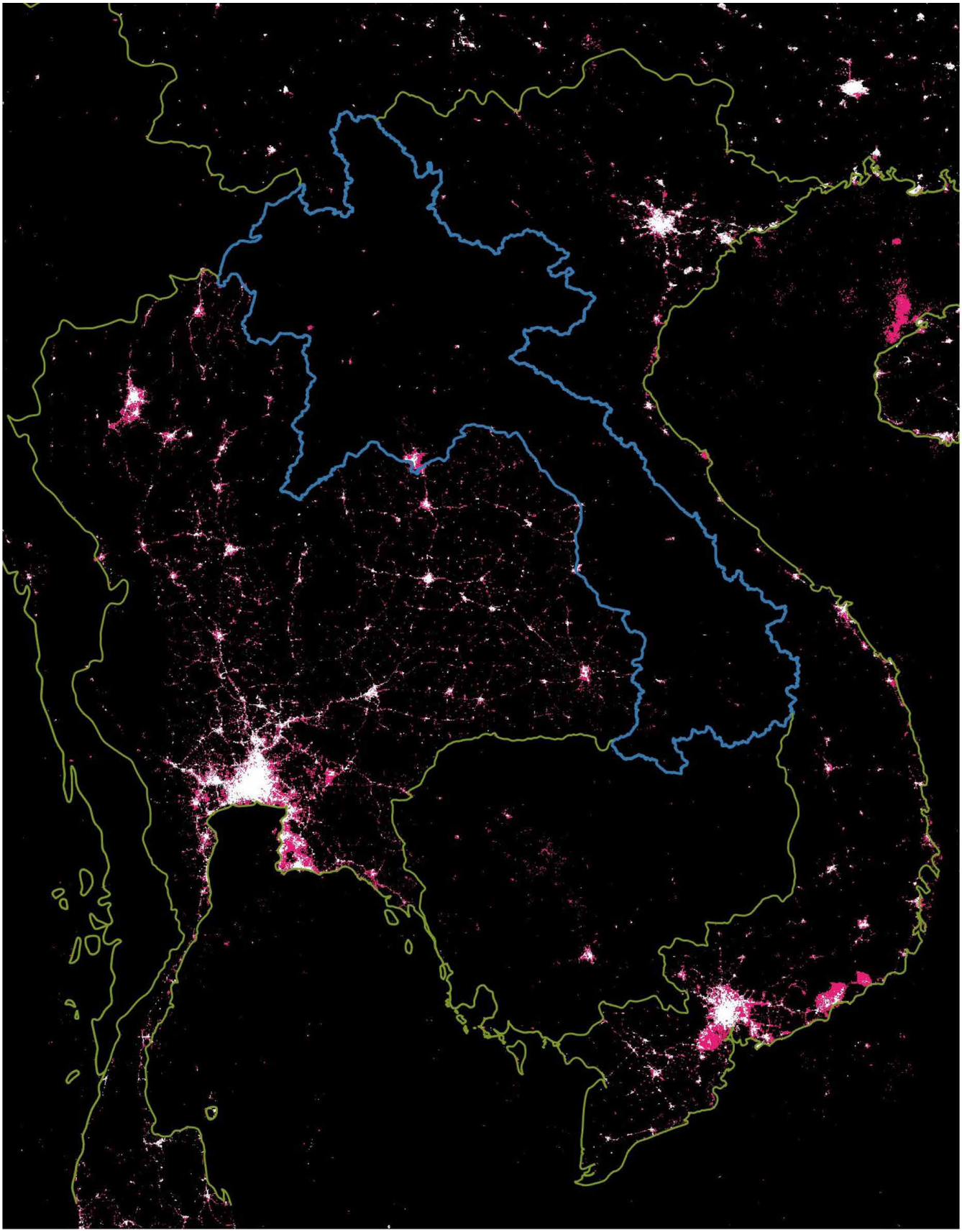
Map 12: Inundated areas of major flooding events during 2018-2021

Source: Digitized by CDE from SENTINEL 1 ESA



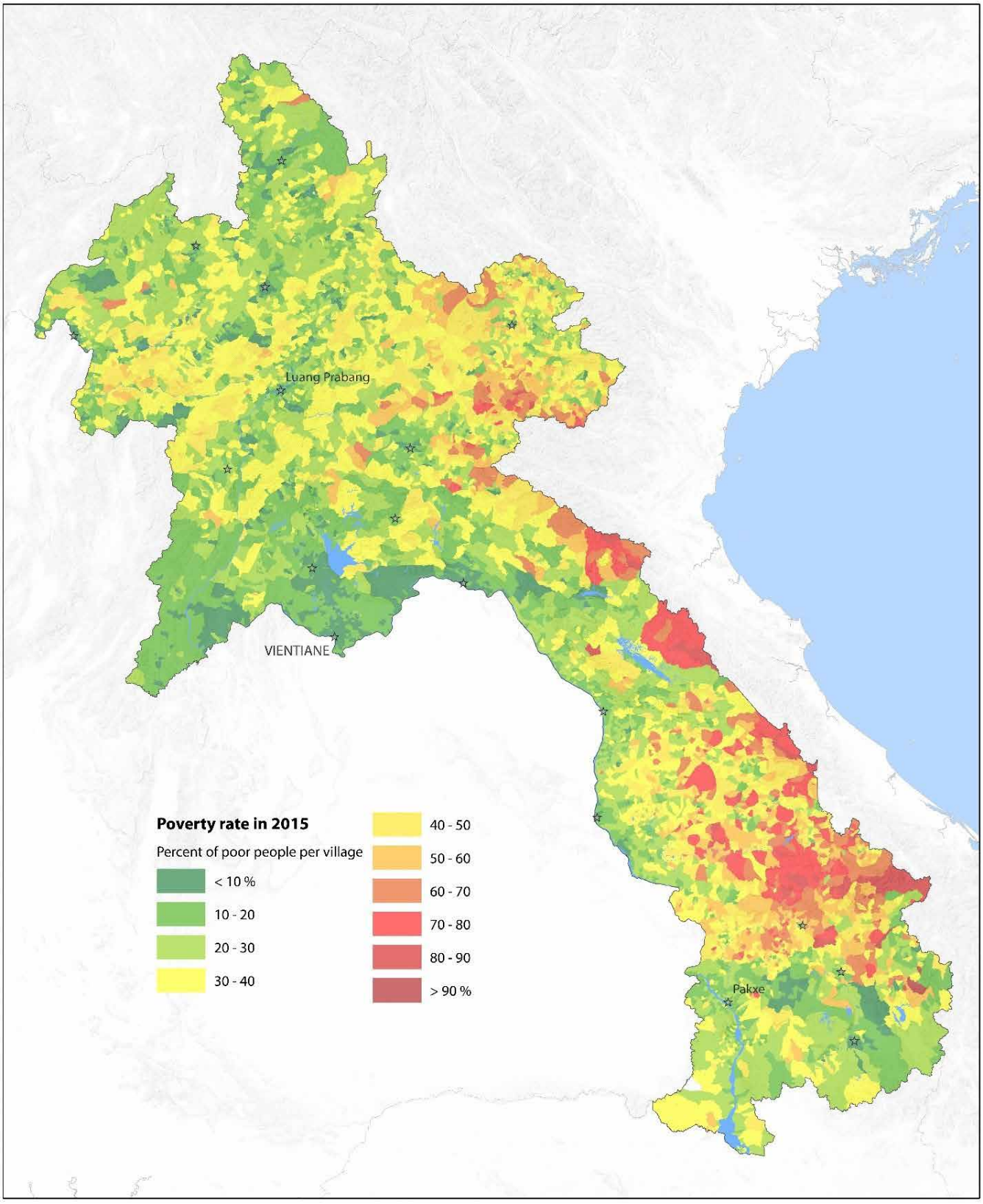
Map 13: Location, type, and size of towns, and mega transportation infrastructure projects in Laos

Sources: Roads and railways digitized by CDE, towns in Epprecht et al.*, 2018*



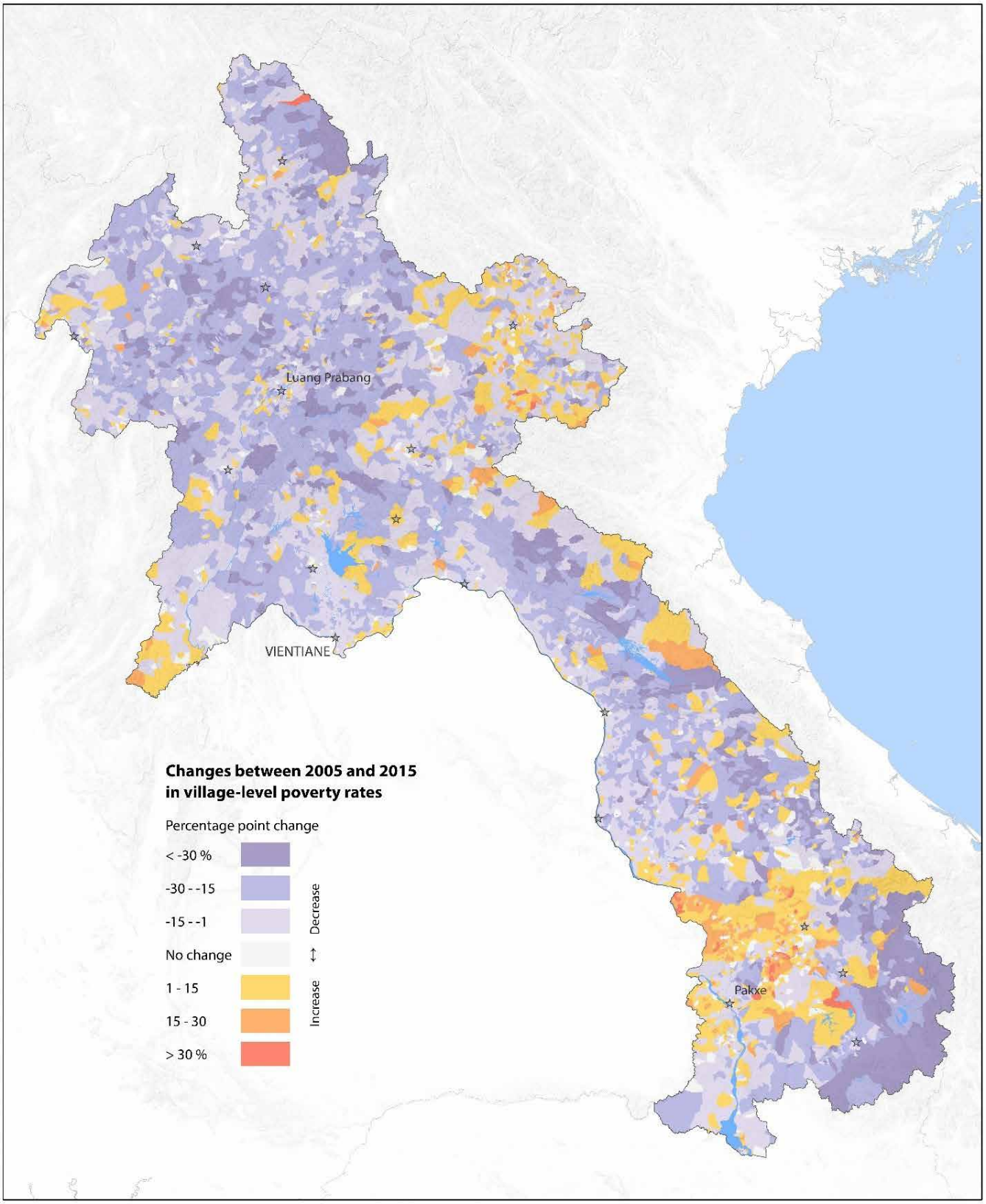
Map 14: Night-time light emissions on the Indochinese peninsula

Source: Prepared by CDE, based on Suomi NPP Satellite imagery, NASA Earth Observatory https://earthobservatory.nasa.gov/images/79765/night-lights-2012-map



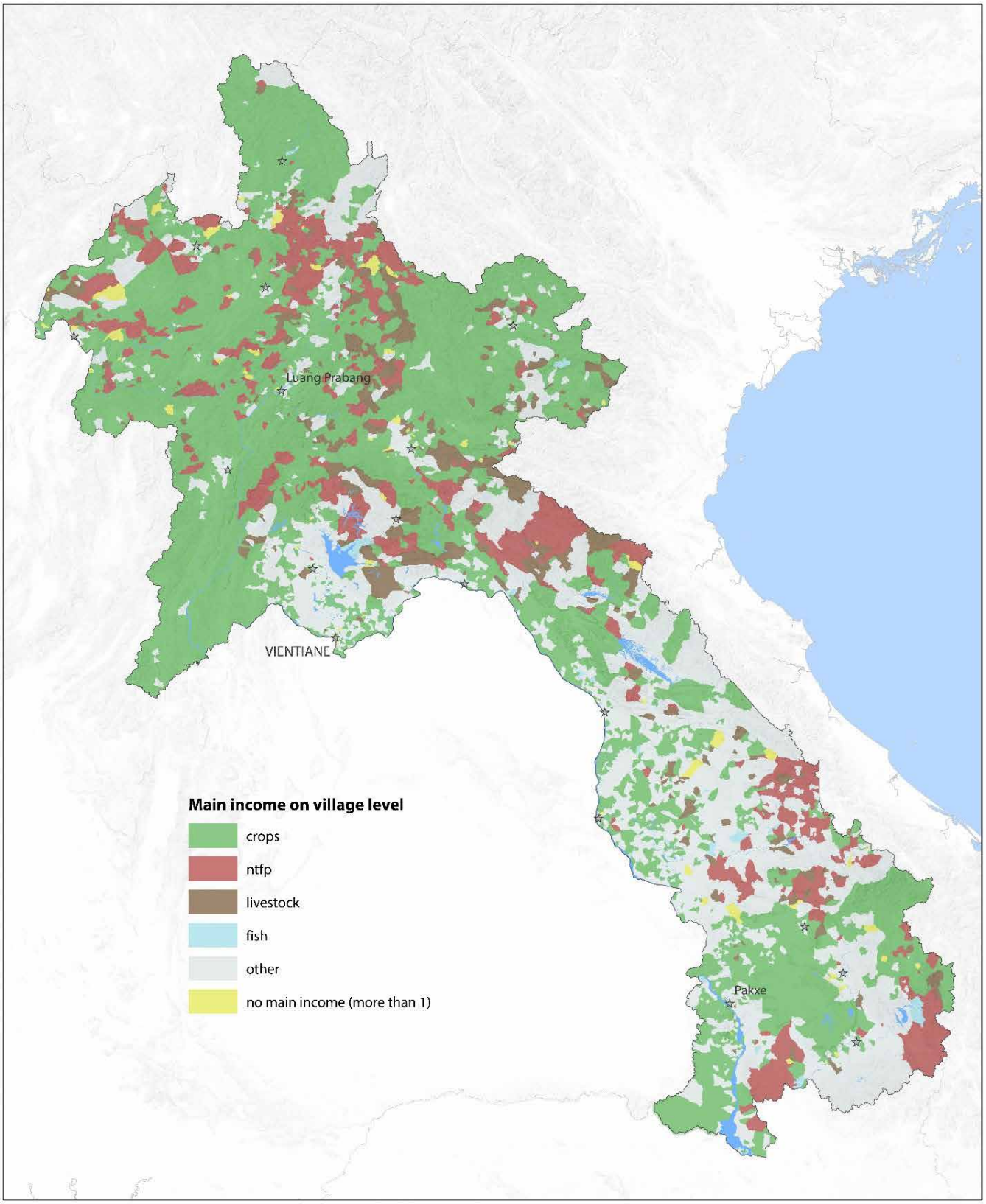
Map 15: Incidence of poverty at the village level (2015)

Source: Epprecht et al.*, 2018*



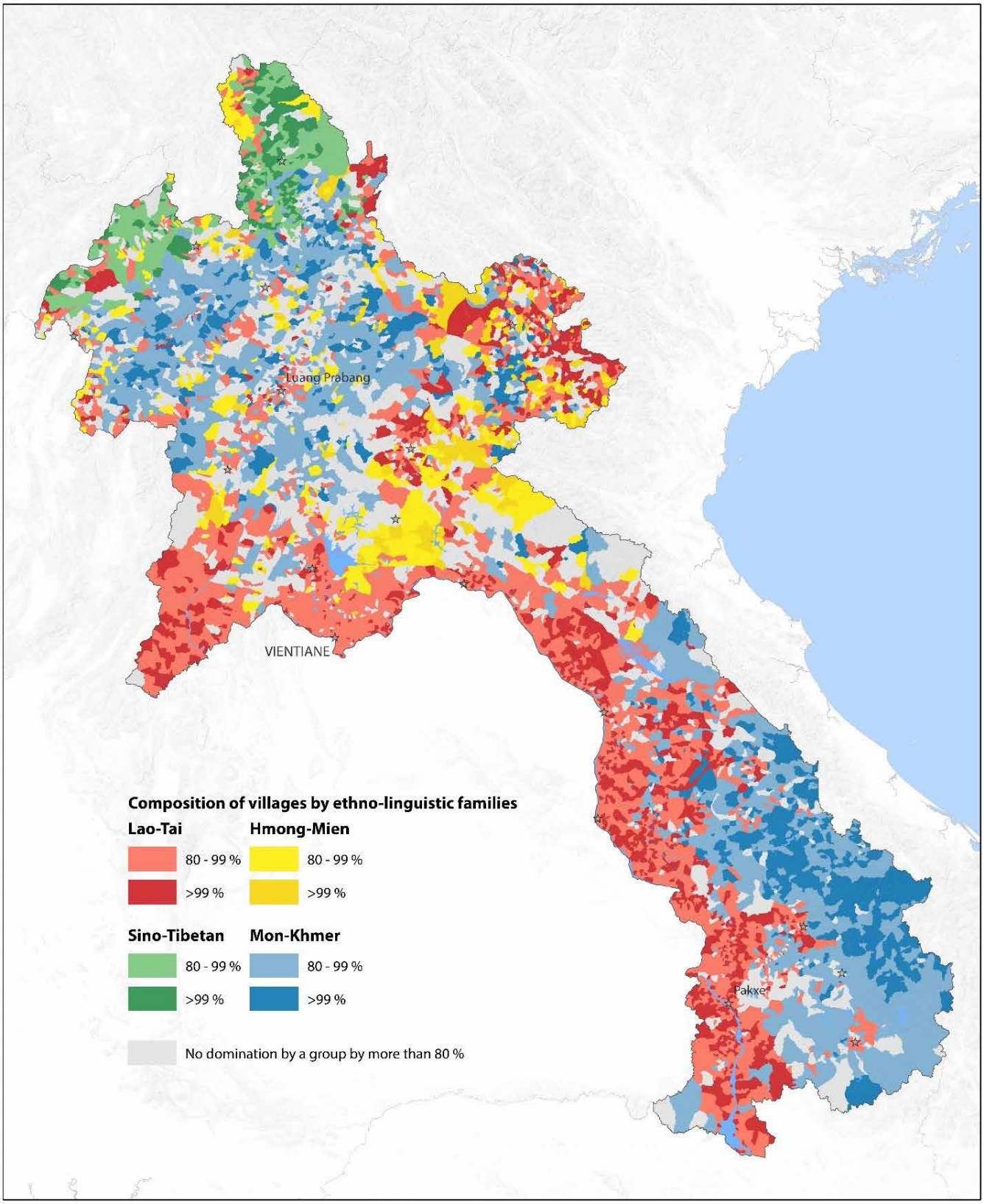
Map 16: Changes in incidence of poverty at the village level (2005-2015)

Source: Epprecht et al.*, 2018*



Map 17: Main source of household income per village (2011)

Source: Epprecht et al.*, 2018*



Map 18: Main ethno-linguistic family per village (2015)

Source: Epprecht et al.*, 2018*

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