3. Sekong Basin Profile

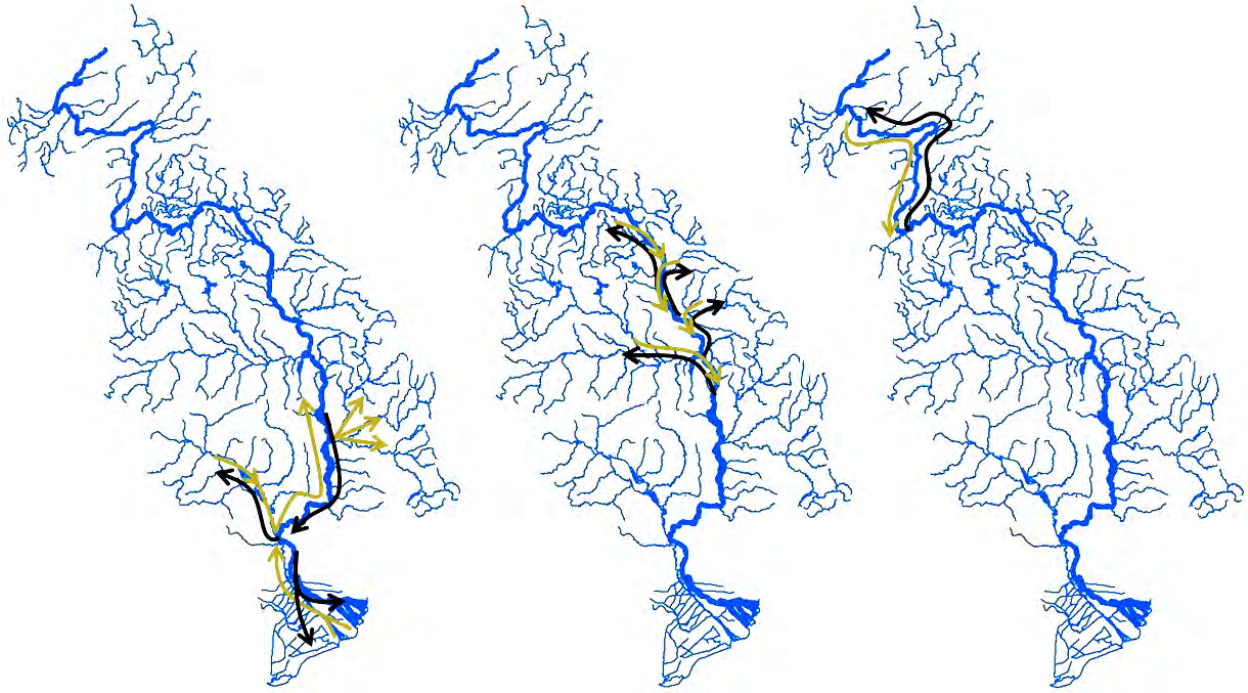
The current state of the basin serves as a reference for assessing cumulative impacts of future development pathways. The most extensive information on the Sekong Basin can be found in the monograph by Meynell (2014). Most information in this section is based on that publication, in addition to the *Atlas of the 3S Basins* by the International Union for Conservation of Nature (IUCN 2015). This section highlights background information on environmental conditions, natural resources, and social aspects that are relevant to assessment of impacts from renewable power development in the Sekong Basin (Map 3.1). For further details, see Appendix C.

The Sekong River is one of the few remaining major Mekong River tributaries with high biodiversity and few hydropower projects in operation. The Sekong also supports a highly diverse fish fauna. Meynell (2014) reports 213 fish species, of which 64 are migratory.

The Sekong Basin is also important for the lower Mekong (fish) migratory system (Figure 3.1) and thus the interaction between the Sekong, Sesan, and Srepok (3S) basins, Cambodian floodplains, Tonle Sap, and the Mekong Delta, with people relying on it as a source of income and food.

Map 3.1: Sekong River Basin

Figure 3.1: Lower, Middle, and Upper Migration Systems with Major Migration Routes in the Lower Mekong Basin



Source: MRC 2020; Schmutz and Mielach 2015, based on Poulsen et al. 2002.

Note: Black arrows indicate migrations at the beginning of wet season; gold arrows indicate migrations at the beginning of dry season.

3.1 Administrative Boundaries

The Sekong River is an important transboundary tributary of the Mekong River that rises in the central highlands of Vietnam and flows through Lao PDR and Cambodia before it joins with the Sesan and Srepok rivers approximately 7.5 kilometers upstream of the confluence with the Mekong River. The Sekong River has a catchment covering 28,414 square kilometers with 22,455 (78 percent) in Lao PDR, 5,417 (19 percent) in Cambodia, and 541 (3 percent) in Vietnam. In Lao PDR, the river overlaps with Attapeu, Champassak, Saravan, and Sekong provinces.

From the headwaters in Vietnam to the confluence with the Sesan and Srepok in Cambodia, the Sekong mainstream is 516 kilometers long (Meynell 2014). The total irrigated area is approximately 21,537 hectares, sourcing water from the Sekong mainstream and its tributaries.

3.2 Topography

Land resources and natural vegetation correlate closely with the Sekong Basin topography. Its upper parts are steep and have relatively extensive forest cover. The mountains and foothills occupy approximately one-quarter of the basin. The highly separated plateaus occupy another one-quarter and have good potential for a wide range of agricultural production, particularly perennial crops that depend on good drainage. The lowland, which occupies the remaining half of the river basin, comprises hills with moderate agricultural potential and river valleys and floodplains with potential for irrigated agriculture and hydropower development.

3.3 Hydrology and Water Resources

The 3S river basins account for approximately 23 percent of the annual flow (hydrology) and up to 25 percent of the sediment load in the Lower Mekong Basin (IUCN n.d.). Access to long-term, reliable hydrological data is crucial to the planning of hydropower investments and credible impact assessments, but detailed, accurate hydrological data are limited. Most of the gauging stations in the Sekong Basin are

in the lower parts (for example, at Attapeu). Moreover, the reliability of existing hydrological data series is unclear because information about the operation and calibration of gauging stations is limited. Most of the data series are intermittent, with many missing values.

Meynell (2014) reports that mean annual rainfall in the Sekong Basin ranges from 1,400 to 2,900 millimeters (mm). Nearly 60 percent of the basin receives 1,700 to 1,900 mm per year, and 23 percent receives 2,300 to 2,700 mm. Mean annual temperature of the Sekong Basin is 21°C to 28°C. Temperatures in 56 percent of the basin are 21°C to 22°C, but approximately 33 percent of the area experiences much higher temperatures. See Map C.1 and Map C.2 in Appendix C for rainfall and temperature details.

Average monthly river flows vary greatly from low-flow—about 100 cubic meter per second (m^3/s)—to high-flow season (about 1,200 m^3/s). Historically, huge flow variations ranged from low-flow season discharges of 16 to 25 m^3/s to extreme flood situations (as in 1996) reaching nearly 4,000 m^3/s (Meynell 2014). Figure 3.2 illustrates average monthly runoff and average monthly flows at Attapeu (Meynell 2014). This is contrasted with flows in a fully regulated Sekong River in Figure C.2 panel b, Appendix C.

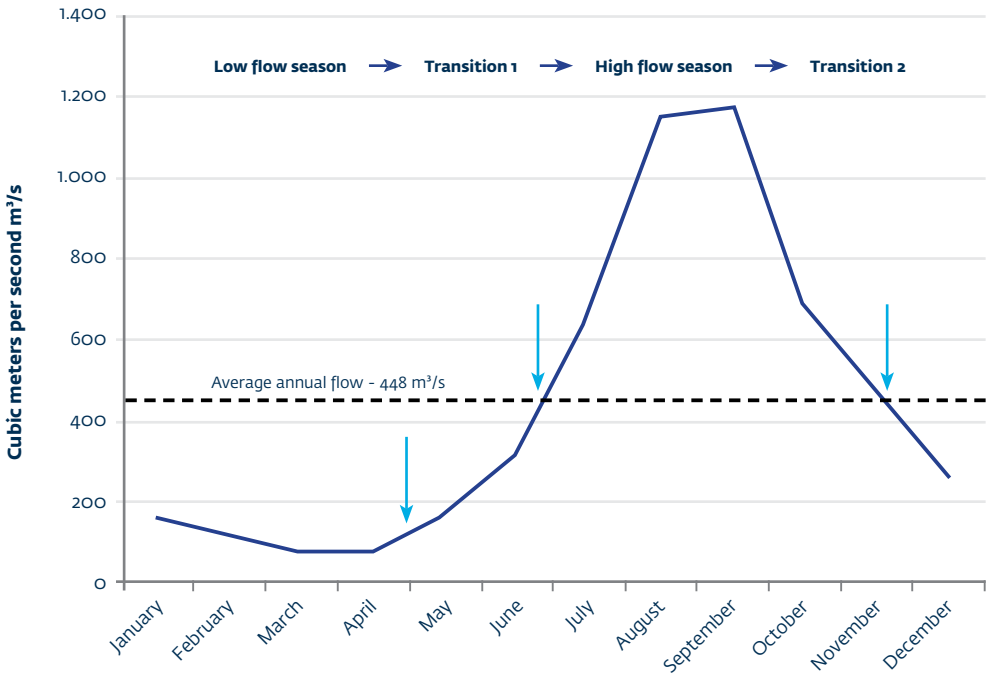
In general, water quality in the Sekong Basin is good (Freshwater Health Index 2018) but at risk of degradation (MRC 2008). Increases in agriculture, hydropower, and other infrastructure development could affect water quality.

3.4 Aquatic Biodiversity

The Sekong River is one of the few remaining major Mekong River tributaries with high biodiversity. The basin is also important for the Lower Mekong River fish migratory system (Figure 3.1), which is an important source of food and income for riparian populations. Fish migration is possible because of the absence of hydropower reservoirs along the mainstream of the river and a limited number of hydropower projects in its tributaries.

Meynell (2014) reports 14 endangered or critically endangered fish species in the 3S rivers. Data from IUCN for 2007 to 2013 suggest that 21 endangered and critically endangered fish species are present in the basin.[8] See a full list of endangered and critically endangered fish species in Table C.1, Appendix C. The list was discussed with local, provincial, and national stakeholders during stakeholder consultations and the interim

Figure 3.2: Mean Monthly Flow Distribution for the Sekong River at Attapeu, 1989–2005



Source: Meynell 2014.

Note: The arrows show the move from the low flow, dry season through to transition season 1 (May to mid-June) and to transition season 2 after the high flows (mid-June to mid-November).

[8] See IUCN, "More Than 32,000 Species Are Threatened with Extinction," https://www.iucnredlist.org/.

workshop. The existence of most of the species was confirmed, and several were reported to be very rare.

The consultations also revealed that fish diversity and abundance over the past 15 years have declined drastically in Champassak, Sekong, and Attapeu provinces. Stakeholders attributed this to the combined pressures of overfishing, industry, mining, agriculture, and hydropower development. Extremely large declines in total numbers of fish were noted, including important food fish species such as *Poropuntius* (barb, *Pa chat*), *Schistura* (loach, *Pa tit hin*), and *Sewillia* (river loach, no Lao name identified).

As the last major free-flowing tributary to the Mekong River, the Sekong River provides unobstructed passage for migratory fish between the Mekong mainstream, Tonle Sap Lake, and the Vietnam Delta (Lower Mekong Fish Migratory System). The Sekong River also contains a great diversity of fish, with many fish species unique to the basin and many spawning only in their unique habitats. Thirty-one of 62 fish conservation zones in Lao PDR are in the Sekong Basin (Map 3.2). Fish conservation zones are legally defined protected areas where fishing is prohibited as a means to help restore fish stock.[9] These use a community co-management framework, in which locals actively help enforce regulations.

A Sekong River with a high degree of connectivity (unrestrained mobility) is important for the Lower Mekong fish migratory system. Such uninhibited fish mobility is of immense value for conservation of fish habitats.

Map 3.2: Fish Conservation Zones in the Sekong Basin

[9] http://www.wwf.org.la/projects/comfish/

3.5 Terrestrial Ecosystems, Biodiversity, and Protected Areas

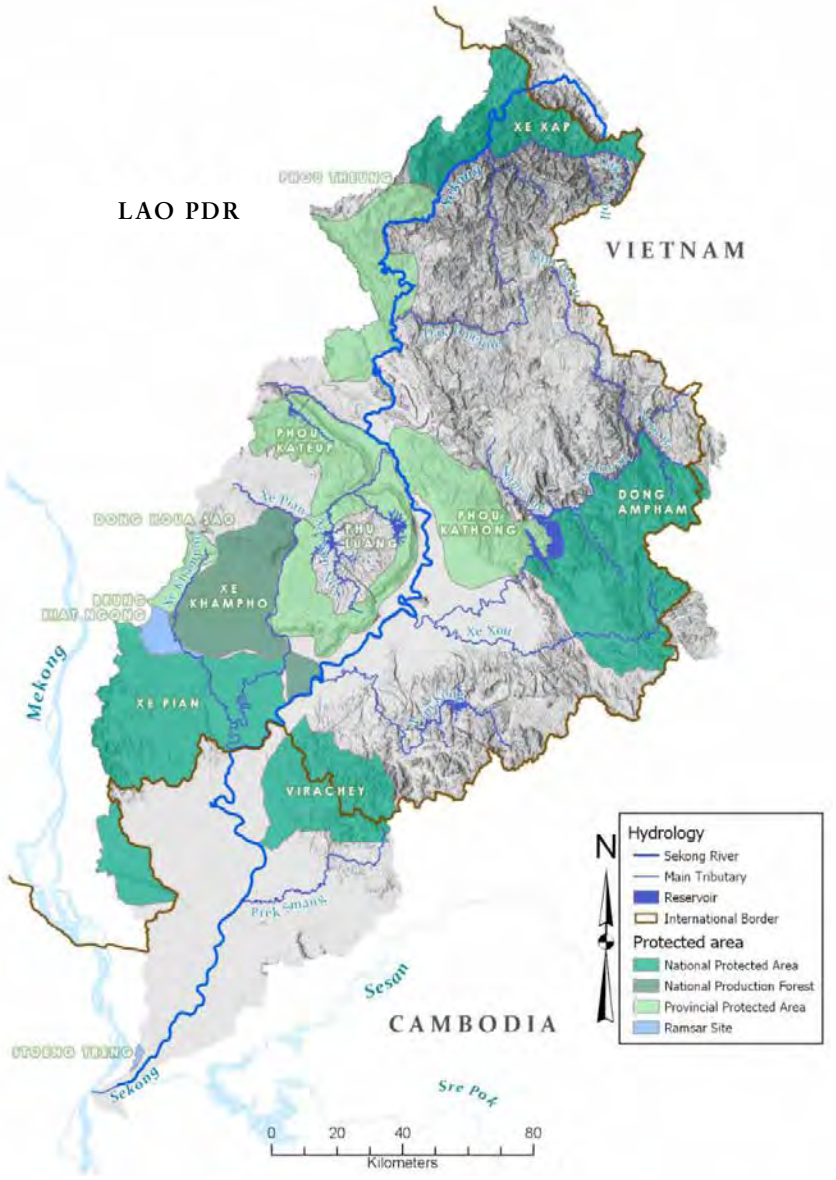
3.5.1 Protected Areas

The Sekong Basin has among the highest proportion of protected areas (Map 3.3) and key biodiversity areas out of all Mekong River tributaries.[10] Approximately 39 percent of the basin land area lies within protected areas, and 37 percent has been identified as lying within key biodiversity areas (Meynell 2014) and important bird areas.

These are unusually high numbers and show the importance of the Sekong Basin in terms of biodiversity conservation. Several of the terrestrial valued environmental components (VECs) depend on these forest habitats for sustainable use and conservation, including hardwood timber, non-timber forest products (NTFPs), and valued terrestrial fauna. There are four National Protected Areas (NPAs) and one Ramsar site in the Sekong Basin designated as of international importance.

The north and east of the Sekong Basin contain part of the Annamite Mountain Range, where the Xe Xap and Dong Ampham NPAs

Map 3.3: Protected Areas in the Sekong Basin



[10] Key biodiversity areas are sites contributing significantly to global persistence of biodiversity in terrestrial, freshwater, and marine ecosystems. Sites qualify as global key biodiversity areas if they meet one or more of 11 criteria, clustered into five categories: threatened biodiversity, geographically restricted biodiversity, ecological integrity, biological processes, and irreplaceability. The key biodiversity area criteria can be applied to species and ecosystems (IUCN 2016).

are located. This area is recognized as a regional, transboundary conservation corridor (being funded by the Asian Development Bank). The Bolaven Plateau, which reaches 1,300 meters above sea level, makes up a large portion of the west of the Sekong Basin. Temperate vegetable crops and coffee are cultivated there. The south of the basin is mainly floodplains along the Sekong River. The Xe Pian NPA, which ranks second in Lao PDR and 10th in Asia for biodiversity, is in this southern part of the basin.

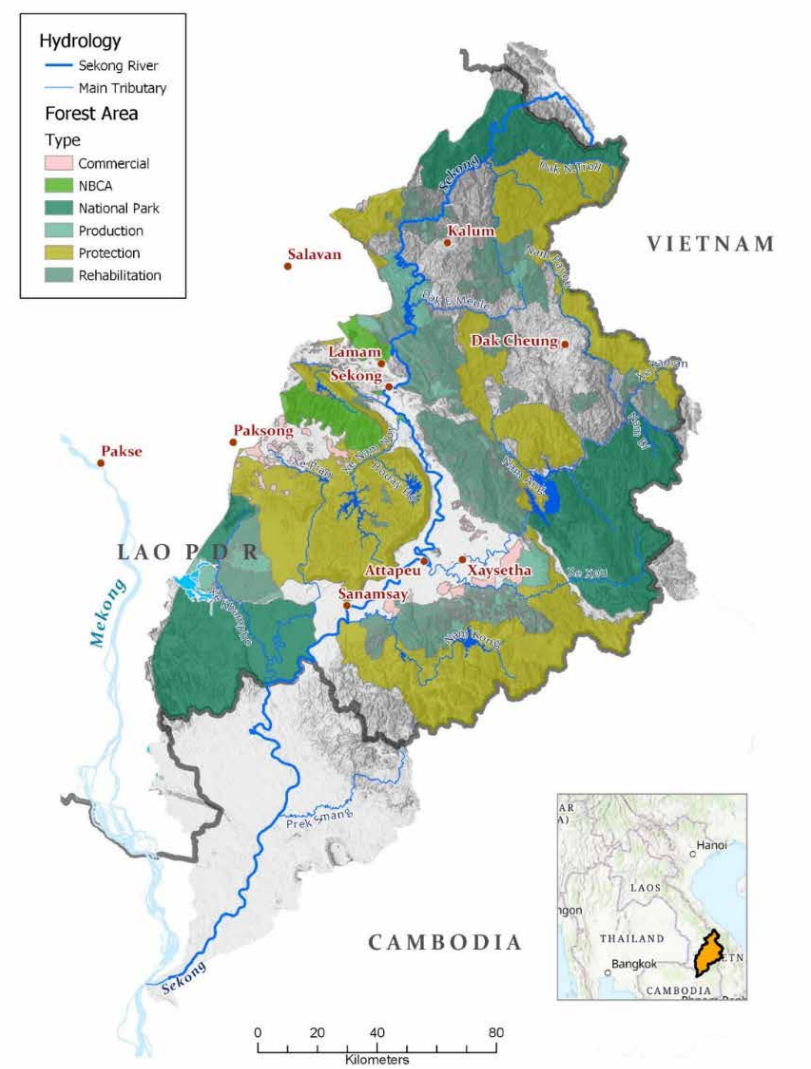
The Ramsar site is the Beung Kiat Ngong Wetland, which encompasses 2,360 hectares of swamps, lakes, and marshes important for spawning fish, turtles, and birds. It contains more than 350 species of medicinal plants and is the only place in Lao PDR where peatland can be found.

The floodplain area has a large portion of dry dipterocarp forest with wetland complexes (WWF 1997). Part of the Sekong floodplain is classified as an important bird area (BirdLife International 2020), with some critical habitats especially for water birds (Thewlis et al. 1998).

3.5.2 Forest

The various forest types and forest protected areas in the Sekong Basin are shown in Map 3.4. The forest cover is extensive (natural deciduous and evergreen forests) but has declined over the past decade, as it has been cleared for agricultural land, especially in the Lao PDR part of the basin—for crop cultivation in the west and hill rice cultivation in the north. In the south of the basin, there are extensive economic land concessions on the right bank of the Sekong River in Cambodia (Meynell 2014).

Map 3.4: Forest Types in the Sekong Basin



Human land and water use within a river basin can affect its geophysical processes, such as erosion and water quantity and quality (Bain and Loucks 1999). The amount and rate of change in forested areas and agricultural and other types of land can affect these processes.

Transformation of forest areas to agricultural land affects rivers by changing rainwater surface runoff. Bain and Loucks (1999) estimate that approximately 12 percent of rainfall in forest areas is surface runoff, with negligible soil loss, whereas 42 percent of rainfall on agricultural land is runoff, with high soil erosion rates.

Existing hydropower development has caused forest loss of at least 16,872 hectares (about 169 square kilometers) (Table 3.1). Approximately three-quarters of lost forest land was classified as protected forest, and nearly a quarter was conservation forest or forest within NPAs.

3.5.3 Terrestrial Wildlife

The IUCN Red List database reports many flora and fauna species in the Sekong Basin,

Table 3.1: Forest Loss Caused by Recent Development of Hydropower Projects, Including Transmission Lines

Project name	Production forest	Conservation forest or national protected area	Protected forest	Regeneration forest	Total forest
	hectares				
A Loui (Vietnam)					Unknown
Houay Ho HPP			2,758		2,758
Houay Ho transmission lines	104		319	9	432
Xe Kaman 3 HPP			564		564
Xe Kaman 3 transmission lines			116		116
Xe Namnoy 1[a]					0
Houy Lamphan Gnai HPP		109	990		1,098
Houay Lamphan Gnai transmission lines	15	19	10		44
Xe Namnoy 6[a]					0
Xe Kaman 1 HPP		3,270	33		3,304
Xe Kaman–Sanxay[a]					0
Nam Kong 2 HPP			77		77
Xe Katam 1 Xe Namnoy 2			18		18
Xe Pian–Xe Namnoy HPP			4,969		4,969
Xe Pian–Xe Namnoy transmission lines	303	10	4	109	426
Nam Kong 3 HPP			3,066		3,066
Total	**422**	**3,408**	**12,924**	**118**	**16,872**

[a] Run-of-river projects are those with no storage reservoir, so there is no significant forest loss.

Note: HPP = hydropower plant.

and according to the Integrated Biodiversity Assessment Tool (IBAT),[11] there are about 89 globally threatened vertebrate species, 21 of which are critically endangered, 32 endangered, and 36 vulnerable. The species list also contains 18 birds, 28 mammals, eight reptiles, 31 fishes, and two amphibians. Appendix C shows the number of globally threatened vertebrate species in the Sekong Basin according to IUCN.

Some prominent species under threat are the Asian elephant (endangered), banteng (endangered), gaar (vulnerable), buff-cheeked gibbon (endangered), red-shanked douc langur (endangered), Indochinese silvered leaf monkey (endangered), Siamese crocodile (critically endangered), tiger (endangered), and various bird species. More details can be found in Appendix C, which also presents the cumulative impact assessment (CIA)'s supporting analysis on terrestrial ecology.

The distribution of terrestrial wildlife in the Sekong Basin was discussed with local and national stakeholders. Many of the globally threatened species reported in the Sekong Basin have low population numbers and are threatened by hunting, habitat loss, land use change, and deforestation, although areas such as the Xe Pian NPA in the basin function as refuges for threatened species.

3.6 People and Livelihoods

3.6.1 Population and Minorities

The Sekong Basin has a low population density and a total population of approximately 324,000: 44,000 in Cambodia, 240,000 in Lao PDR, and 40,000 in Vietnam. The population is concentrated in the towns of Attapeu and Sekong in Lao PDR and in villages on the large surrounding plains.

Ethnic minority groups with distinct cultures and religious beliefs populate the Sekong River Basin (Table 3.2). The ethnic composition of the population in the Sekong Basin comprises mainly Mon-Khmer subgroups in the east and Lao in the west. In Attapeu Province, ethnic Lao is the

Table 3.2: Characteristics of Main Ethnic Groups in the Sekong Basin

Ethnic group	Language group	Characteristics
Nha Heun	Mon-Khmer Bahnaric branch	This is a small ethnic group found only in southern Lao PDR. Members live in small scattered villages in Champassak, Sekong, and Attapeu, with a concentration of villages south and east of Bolaven Plateau, in particular along the Xe Namnoy River. Previously it was a semi-nomadic group that settled at the beginning of the 20th century.
Brao	Mon-Khmer Bahnaric branch	Members are shifting cultivators in the uplands and skilled paddy farmers in the lowlands. They raise cattle and buffalo and hunt fish as well as gather non-timber forest products for supplementary livelihood. They are skilled basket makers and wood carvers and are found in Savannakhet, Salavan, Khammouan, and Sekong.
Ta-Oy	Mon-Khmer Kautic branch	Members are found in Aluoi District of Vietnam and Savannakhet, Salavan, Champassak, and Sekong provinces in Lao PDR. They are upland rice cultivators who also plant maize, sweet potatoes, and cassava.
Katu	Mon-Khmer Kautic branch	Members are found in Sekong Province along the Upper Sekong River and in Quang Nam and Thua Thien-Hue provinces of Vietnam. They are upland rice cultivators who also plant maize, sweet potatoes, beans, bananas, and vegetables. They keep mainly small domestic livestock such as pigs, chickens, and ducks. Formerly they were considered one of the most warlike ethnic groups, resisting intruders into their territories.
Yae	Mon-Khmer Bahnaric branch	Members are found in Attapeu and Sekong provinces. They make bamboo and rattan baskets and are skilled blacksmiths. Some villages also make pottery.
Kriang	Mon-Khmer Kautic branch	Members are found in Salavan, Champassak, and Sekong. They cultivate upland rice (shifting cultivation), millet, maize, and sweet potatoes. They generally do not keep large livestock but raise pigs and chickens for their own consumption. Hunting, fishing, and gathering of non-timber forest products play a large role in their livelihoods.

Source: Schliesinge 2003.

[10] See IBAT Alliance, Integrated Biodiversity Assessment Tool, database, https://www.ibat-alliance.org/.

largest single group, accounting for more than one-third of the population, with the Brao and the Oy accounting for roughly 17 percent and 16 percent of the population, respectively (Baird and Shoemaker 2008). Smaller ethnic groups in Attapeu Province, ranging from 4 percent to 9 percent of the population, include the Trieng, Cheng, Yrou, and Harak.

In Sekong Province, Katu (24 percent) and Trieng (22 percent) are the largest groups, followed by Harak (16 percent). Ethnic Lao, who are mostly found in and around the provincial capital, make up approximately 9 percent of the total population. Other smaller groups include the Xuay, Ta Oy, and Yrou.

In Champassak Province, ethnic Lao is the dominant group, with approximately 85 percent of the population. Ethnic Lao is also the most populous group in Pathoumphone District, which forms part of the lowlands of the Sekong River Basin. The Yrou and Nhaheun ethnic groups have historically inhabited the upper parts of the basin that fall within Champassak Province, including Paksong District.

Hydropower development has led to displacement and resettlement of a number of ethnic minority villages and populations. Table 3.3 provides an overview of the groups that have been resettled.

The provincial and district consultations for this study indicated that ethnic minority groups in the Sekong River Basin are increasingly aligning with the majority Lao lowland culture. Examples of integration include adoption of Buddhist practices and the *baci su kwan* ceremony (a common lowland ceremony with animist traditions), increasing use of the Lao language instead of ethnic mother tongues, and less wearing of traditional clothing. The drivers for this change are increasing education, greater contact and interaction between ethnic groups, and dominance of Lao culture because of economic development. The faster the pace of economic development, the faster cultural integration can be expected to proceed.

Table 3.3: Overview of Ethnic Groups Affected by Present Situation Projects

Project name	Resettled households	Resettled persons	Affected ethnic groups
A Loui (Vietnam)	218	872	Not known
Houay Ho	320	1,920	Nya Heun: 12 villages moved to adjacent Lavaen villages
Xe Kaman 3	57	342	Lao, Ta Leng, De
Xe Namnoy 1	0	0	
Houy Lamphan Gnai	251	1,660	94% of all resettlers are Katu
Xe Namnoy 6	-	-	Not available
Xe Kaman 1	220	1,094	Nya Heun
Xe Kaman Sanxay			Not known
Nam Kong 2	0	0	Brao: no resettlement but indirectly affected
Xe Katam 1–Xe Namnoy 2	15	92	Nya Heun
Xe Pian-Xe Namnoy	390	2,064	Nya Heun
Nam Kong 3	21	104	All resettlers are Brao
Total present situation	**1,492**	**8,148**	

3.6.2 Agriculture

Subsistence and semi-subsistence agriculture is by far the most common livelihood system component and source of sustenance for people in the Sekong Basin, although gradually declining in importance. In 2008, more than 90 percent of households in Attapeu engaged in agriculture and livestock, and agriculture was the main occupation for 92 percent in Sekong (Baird and Shoemaker 2008). Results from the Lao Census of Agriculture 2010/11 (Epprecht et al. 2018) show a slightly smaller percentage of farming households in the two provinces (86 percent for Sekong and 84 percent for Attapeu). Percentages of farming households may have fallen further since 2011.

Various agricultural and farming practices are used in the basin. Paddy rice cultivation is the most common farming system in the Attapeu lowlands but is also found in some upland areas, where the flat valley floors provide opportunities for irrigated or rain-fed wet-rice cultivation. Paddy rice cultivation and development of new fields are being promoted to increase rice sufficiency in the Sekong Basin.

Dry season riverbank vegetable gardens are found along the riverbanks of the Sekong River and its tributaries, where fluctuation in water levels between the dry and wet seasons leaves fertile soil that is used for dry season crops. Crops cultivated include maize and tubers planted high up on the banks at the end of the rainy season and watermelons, chillies, long beans, eggplant, and tobacco planted further down later in the season. Both paddy rice farmers and upland swidden farmers cultivate riverbank gardens in the dry season. In general, farming households consume most of the produce from riverbank gardens, with surpluses sold at local markets.

Domestic livestock is important for most people in rural Lao PDR, as it is for people in the Sekong Basin, where it is one of the main sources of income for villagers, especially in remote villages with poor market access. Most families raise some kind of livestock, including cattle, buffalo, pigs, goats, and poultry. Livestock plays an important role in the local economy and tends to be regarded as a kind of savings account that can be used to obtain cash for marriage, medical care, children's education, and other major expenditures.

Swidden agriculture involves clearing secondary forest or bushland for cultivation of crops for one or two years. Upland rice varieties are the main crop cultivated on swiddens, but other crops such as maize, taro, pumpkin, watermelon, beans, and peas are often grown together with rice. In the uplands and on the Bolaven Plateau, swidden agriculture is common, but yields are low. Most families must purchase rice using money earned from collection of NTFPs, sale of coffee, and day labor on agricultural plantations.

3.6.3 Coffee Production

The Bolaven Plateau, which forms a large part of the Sekong River Basin, has fertile volcanic soil that, along with its elevation, makes it an ideal area for growing coffee, fruits, and vegetables. Coffee is one of the main sources of income for the population on the plateau, which comprises several ethnic minority groups such as the Brao and Nja Heun. Coffee has been grown since the early 1900 in smallholdings, often cultivated in a kind of agroforestry system mixed with fruit trees. The ethnic Jru people were initially the primary coffee growers, but starting in the 1970s, ethnic Lao from the lowlands cleared and planted more land to grow coffee. In the early 1990s, coffee plantations were expanded in response to rising world coffee prices. In the stakeholder consultations conducted for this study, ethnic minority villagers mentioned coffee as an important source of cash—from selling their own production or working as day laborers on coffee plantations that others owned.

3.6.4 Non-Timber Forest Products

People in the Sekong River Basin collect NTFPs for consumption and to generate income. NTFPs comprise naturally occurring plants and wildlife such as forest fruits, edible leaves, resins, nuts, birds, and insects. NTFPs constitute a significant proportion of the livelihood of people in the basin (Baird and Shoemaker 2008). Many NTFPs are collected for consumption and use, including wild vegetables, bamboo shoots, and bamboo for building huts. Wild fruits are collected for consumption and sale. The economically most important NTFPs in the Sekong Basin include dry resins, wood resin, malva nuts, wild cardamom, fern roots, yellow vine, eaglewood, rattan, wild honey and beeswax, wild mushrooms, and medicinal plants.

Quantifying the economic value and significance of NTFPs in the Sekong Basin is difficult because it varies substantially from village to village, depending on location within the basin. One study undertaken in three villages (Rosales et al. 2003) estimated the direct-use value of NTFPs to be $398 to $525 per household annually. This is relatively high, considering that the average annual household income for Sekong was estimated at only $120 at the time of the study. Nevertheless, because NTFPs that villagers collect can reduce the need for households to buy building materials, food, and medicines, it is feasible that the value of NTFPs in monetary terms could be higher than annual cash income.

3.6.5 Fisheries

After agriculture, fishing provides the second largest source of income for the Sekong Basin population. The local stakeholders underlined the important role of fisheries during the consultations and peoples' perception of it as an important natural resource.

The IUCN Sekong Basin fact sheet (IUCN n.d.) reports that fish catches contribute 35 percent to 40 percent of annual household income, and 80 percent of protein consumption in the basin. The annual consumption of fish has been estimated at nearly 50 kilograms per person.

The significance of fish for livelihoods in villages along the Sekong River and on the Bolaven Plateau was assessed in the environmental impact assessment report for the Xe Pian–Xe Namnoy hydropower project (LCG 2013). The results from the survey, which was conducted in 11 villages on the plateau and 11 along the Sekong River, indicated the following:

- Bolaven Plateau households fished four days per week on average, and villagers along the Sekong River fished six days per week.
- Average fish catch per day for one person in the dry season was 3.2 kilograms (kg) for villages on the Bolaven Plateau and along the Sekong River; catches in the wet season were 3.2 kg and 3.9 kg, respectively.
- During the upstream fish spawning migration from April to June, fish catches were considerably higher, reportedly as much as 7.5 kg per person per day.
- Bolaven Plateau villages consumed 97 percent of their fish catch, with the rest normally given to relatives and neighboring households.
- Sekong River villages consumed 70 percent to 75 percent of their catch, with the remaining fish sold (about 15 percent) or preserved (about 15 percent) by smoking, drying, and fermenting.
- The sale of fish in Sekong villages contributed about 5.2 percent of household income.

Overfishing and other unsustainable fishing practices (gill nets, electroshock, and explosives) contribute to already high fisheries pressure (MRC 2017; Baran et al. 2013). Fish catch per unit of effort has declined, and undersized fish dominate the catch (MRC 2017). During district consultations, villagers attributed the decrease in fish stocks to uncontrolled fishing and hydropower development.

Fishing pressure will probably increase in the next decade because of population growth and advances in fishing gear technology. An increasing number of people fish not only for their own consumption but also to sell (MRC 2017), which suggests fisheries demand will increase.

3.7 Development Projects in the Sekong Basin

3.7.1 Hydropower Development

Twelve projects are already operating or are at advanced stages of construction and due to become operational by 2020 (Map 3.5, Table 3.4). Together these projects will have a capacity of approximately 1,550 megawatts (MW).

Twenty-three more projects are in various stages of preparation or preliminary stages of construction and are all proposed for completion by 2030 (Table 3.5). Construction has begun on some of these projects, but most environmental and social impact assessments are not yet completed.

These projects are distributed among the tributary basins of the Sekong as well as the mainstream. All tributaries except Xe Lon will contain at least one hydropower project by 2030. The Xe Kaman and Nam Bi tributaries have a very high project density, with 13 projects.

Map 3.5: Hydropower Projects Commissioned in the Sekong Basin

Table 3.4: Commissioned Hydropower Projects in the Sekong Basin

Project dam	Status	Date of commercial operation	Installed capacity	Mean annual energy[a]	Power destination		
			MW	GWh	Lao PDR	Thailand	Vietnam
A Luoi	Operational	2012	170	650			100
Houay Ho	Operational	1999	152	450	5	95	
Xe Kaman 3	Operational	2013	250	980	10		90
Xe Namnoy 6	Operational	2013	5	20	100		
Xe Namnoy 1	Operational	2014	15	80	100		
Houay Lamphan Gnai	Operational	2015	88	450	100		
Xe Kaman 1	Operational	2016	290	1,040	20		80
Xe Kaman–Sanxay	Operational	2017	32	110	20		80
Nam Kong 2	Operational	2017	66	260	100		
Xe Katam 1–Xe Namnoy 2	Operational	2017	22	120	100		
Xe Pian–Xe Namnoy	Under construction	2020	410	1,800	10	90	
Nam Kong 3	Under construction	2020	54	200	100		
Total present situation			**1,554**	**6,160**			

Note: MW = megawatt; GWh = gigawatt hour.

[a] The mean annual energy is based on numbers from developers, with slight adjustment in some cases to fit with other technical data (for example, decreased if stated generation is above what is technically possible). All numbers have been rounded.

Table 3.5: Status of Hydropower Projects in the Sekong Expected to be Complete by 2030

Project dam	Status	Date of commercial operation	Installed capacity (MW)	Annual energy (GWh)	Power destination
Dakchaliou 1	Under construction	2021	11	50	Unknown
Dakchaliou 2	Under construction	2021	13	60	Unknown
Nam Kong 1	Under construction	2022	150	560	Lao PDR
Nam Bi 1	PDA stage	2024	68	290	Not confirmed, possibly Vietnam
Nam Bi 2	PDA stage	2024	50	210	
Nam Bi 3	PDA stage	2024	12	50	
Nam Ang	PDA stage	2024	55	160	Lao PDR
Nam Emoun	Under construction	2024	129	430	Lao PDR
Nam Pangou	PDA stage	2025	33	140	Unknown
Xe Pian–Houysoy	PDA stage	2025	45	200	Lao PDR
Sekong 4A	FS approved	2025	165	780	Thailand
Sekong 4B	FS approved	2026	175	750	Thailand
Sekong 3A	FS completed	2027	114	430	Lao PDR
Sekong 3B	FS completed	2028	122	400	Lao PDR
Lower Xe Pian	FS ongoing	2030	15	60	Lao PDR
Xe Katam	PDA stage	2030	81	300	Lao PDR
Xe Kaman 2A	FS ongoing	2030	64	250	Lao PDR
Xe Kaman 2B	FS ongoing	2030	100	380	Lao PDR
Xe Kaman 4	PDA stage	2030	70	290	Vietnam
Sekong 5	FS completed	2030	330	1500	Thailand
Sekong Downstream A	FS completed	2030	86	380	Lao PDR
Sekong Downstream B	FS completed	2030	50	210	Lao PDR
Xe Namnoy 5	Unknown	2030	20	90	Lao PDR

Note: PDA = project development agreement; FS = feasibility study; MW = megawatt; GWh = gigawatt hour.

3.7.2 Solar and Wind Power

Several feasibility studies for wind and solar power are under way in the basin. See Appendix C for detailed descriptions. It is assumed that some development of wind and solar photovoltaic will take place up to 2030, by which time these technologies will be more competitive. The assumption is that 600 MW of solar (land based and floating) and 600 MW of wind power are in operation, providing approximately 3 terrawatt-hour (TWh) of energy annually.

3.7.3 Grid Expansion and Other Infrastructure

Appendix C reviews power grid and transmission infrastructure. Major existing and planned national transmission systems and international grid integration have been considered. Future layout of transmission lines will influence the pace and pattern of hydropower development in the Sekong Basin.

A planned cross-border interconnection between southern Lao PDR and Vietnam is of particular relevance for this study because domestic demand in Lao PDR is low, so most Sekong Basin renewable energy projects are premised on cross-border electricity sales. When complete, there will be a considerable increase in capacity to transfer power from the Sekong Basin.

On the basis of this proposed interconnection project, it has been assumed in this study that the future grid system will allow export of all power production in the full development pathway to Vietnam, with only a small percentage of power supplied to the Lao PDR grid.

3.7.4 Power Demand and Supply

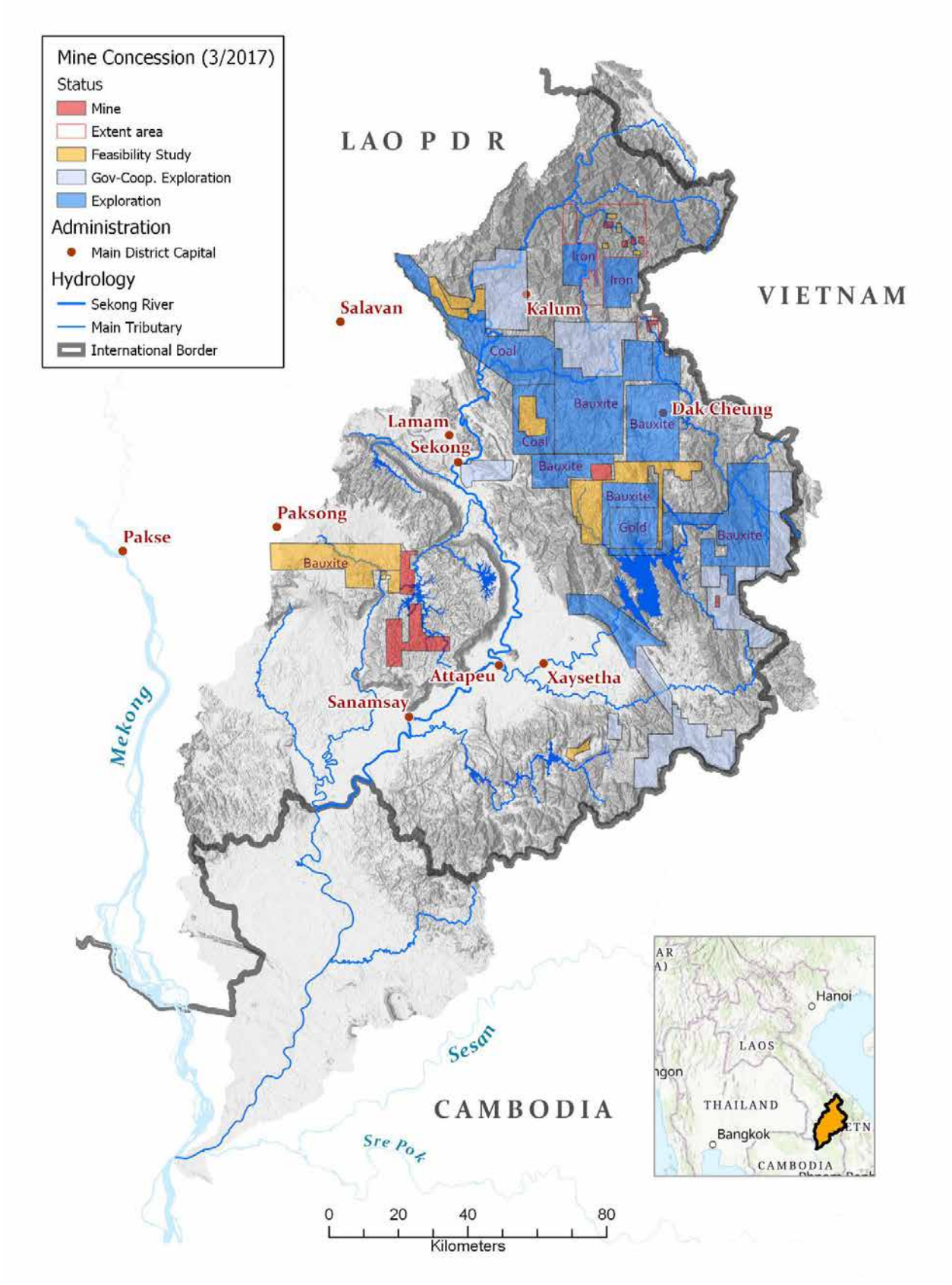
Domestic demand for additional power in Lao PDR is limited, particularly in the Sekong Basin. All proposed large hydropower projects in the Sekong Basin base their financial viability on exports through power purchase agreements with the Electricity Generating Authority of Thailand or Electricité de Vietnam. Thailand has agreed to import up to 9,000 MW from Lao PDR by 2030 (MEM 2017), and Vietnam has pledged to import 5,000 MW. Provisional information on Thailand's future power demand indicates only moderate demand for further power imports from Lao PDR (MRC 2018). In contrast, the demand forecast from Vietnam is such that Vietnam could use the majority of power generated by all 23 hydropower projects proposed for development in the Sekong Basin up to 2030. Power exports from the Sekong Basin to Vietnam and Thailand will mainly provide peak power, with thermal plants based in those countries providing baseload. Further details of the power supply and demand assessment conducted for this cumulative impact assessment (CIA) are presented in Appendix C.

3.8 Mining and Commercial Plantations

Numerous mining and exploration licenses have been issued within the Sekong Basin (Map 3.6). Active mining is concentrated in the Xe Kaman catchment. Geological exploration and feasibility studies are under way in the upper part of the Sekong Basin for bauxite and coal.

The extent of commercial plantations (mostly rubber tree plantations in the Xe Kaman sub-basin and coffee plantations in the Xe Katam sub-catchment) in the Sekong Basin is portrayed in Map 3.7. It is expected that the number of commercial plantations will continue to increase.

Map 3.6: Mining Projects in the Sekong Basin at Various Stages of Development



Map 3.7: **Commercial Plantations with Land Concessions in the Sekong Basin**