236 Morningside Drive
Corte Madera, California 94925
USA
Tel: +1-415-693-3000
Email: gat@n-h-i.org
www.n-h-i.org

Summary and Key Findings of the Sustainable Hydropower Master Plan for Xe Kong Basin in Lao PDR

The Master Plan was developed by the Natural Heritage Institute (NHI) and a team of international experts in full collaboration with the Government of Lao PDR (GoL). The purpose was to assist the GoL in implementing its Policy on Sustainable Hydropower Development that was decreed by the Prime Minister on January 12, 2015. The Master Plan has the potential to meet the country's energy goals and preserve the last intact remnant of the most productive freshwater fishery in the world, second only to the Amazon in terms of biodiversity, with some 1200 aquatic species identified. In the Xe Kong, a tributary of the Mekong, up to 81 migratory species of fish and the livelihoods of millions are under threat from Lao's hydropower development plans, including 7 large dams that are proposed for the mainstem of the Xe Kong.

Submitted to the GoL in early February 2018, the Master Plan was endorsed by the Prime Minister of Lao through an official directive to the relevant line ministries to adopt and implement the findings and recommendations of NHI's Master Plan as the basis for further hydropower development for the entire nation. It is not often that a head of state so explicitly directs the implementation of recommendations from a foreign NGO on a course of development for sectors as sensitive and controversial as water and power.

This document summarizes the process behind and the key findings of the Master Plan. All volumes of the Master Plan, including the implementation strategy, can be downloaded from the links provided on page 6.

Background

- Lao's Policy on Sustainable Hydropower Development instructs the GoL line ministries and the hydropower developers to avoid and mitigate environmental and social impacts. It also improves the procedures for determining sustainability by requiring that environmental and social impact assessments include consideration of siting and design alternatives and account for cumulative and transboundary impacts. It also requires that hydropower development be conducted in an open and transparent manner.

- Neither the Policy nor its implementation guidelines provide substantive standards or criteria for determining the sustainability of proposed hydropower projects. Therefore, an early step in preparing the Master Plan was to set forth a set of attributes of sustainable hydropower that are based on measures to counteract the main environmental impacts that hydropower dams inflict on the natural functions of river at each of the three key decision points in developing a hydropower project. Those impacts are:

    1. Barriers to fish migration
    2. Trapping of sediments and nutrients
    3. Alteration of natural flow patterns

    The three decision nodes for hydropower planning are:

    1. Siting
    2. Design
    3. Operations

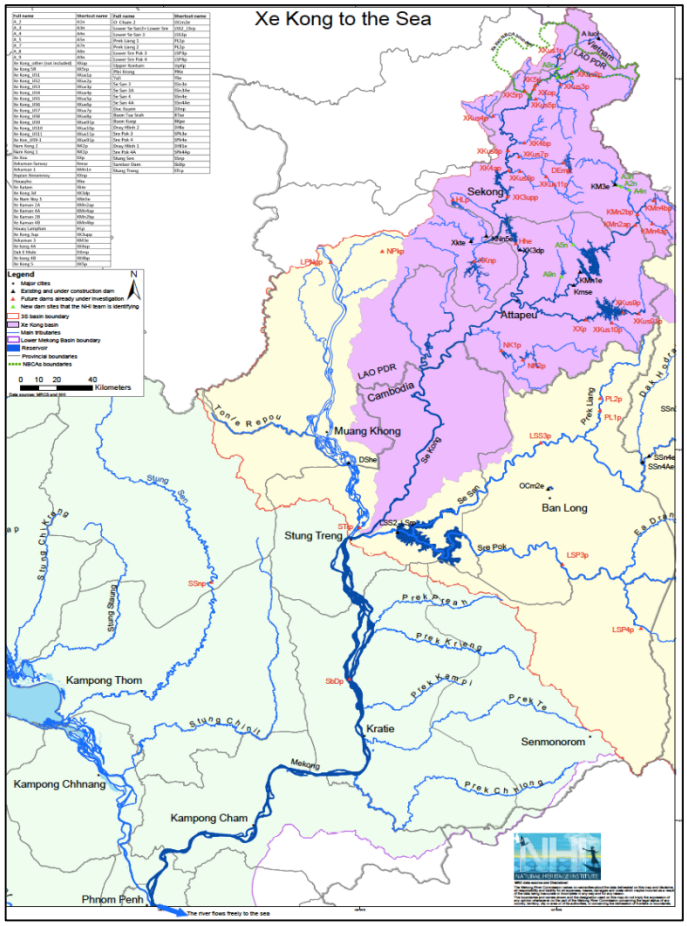

Figure 1: Path of the Xe Kong to the sea and hydropower development.

- NHI focuses on the Xe Kong because it is the last unobstructed major tributary of the Lower Mekong Basin, and exhibits extraordinary fishery values that are under intense threat by imminent hydropower proposals – GoL has signed MoUs for at least 70 such projects, of which 15 are already under construction or completed (http://www.poweringprogress.org/new/power-projects). The Xe Kong is free-flowing all the way from the headwaters at the Vietnam border through the Sekong and Attapeu provinces of Lao, through Cambodia to the confluence with the mainstream Mekong and thence through the Vietnam Delta to the South China Sea. Fish move up into this tributary all the way from the Delta and the Tonle Sap Great Lake to complete their lifecycle and reproduce. Therefore, it is irreplaceable for spawning of migratory fish for the Lower Mekong River Basin.

- Estimates of the total number of species and the number of migratory species and economically important species in the Xe Kong River vary somewhat. The Mekong River Commission Secretariat (MRCS) catch data from 2003-2006 has registered 265 species in the Xe Kong River, while more recent studies estimate 175 to 213 total species (Cowx, 2015; Baran et al., 2013). Migratory species range between 64 to 81 in the Xe Kong River and some of these species are the most economically important fish for many riverside communities. The number of endemic species – meaning they exist nowhere else in the Mekong –range from 15-25, including the critically endangered species *Aaptosyax grypus* (giant salmon carp), *Catlocarpio siamensis* (giant carp), and *Pangasianodon gigas* (giant catfish).

- Several studies have shown declines in the number of fish species in the '3S' (Sesan, Srepok, Sekong) (Baran and Sopheak, 2011), including populations of Henicorhynchus siamensis & H. lobatus, Hypsibarbus pierrei, Hypsibarbus wetmorei, Labeo erythropterus, Scaphognathops bandanensis, Bangana behri, and Wallago attu. Furthermore, there are varying estimates in loss of fishery yield from the region of between 15 and 40%, which equates to loss of up to 300,000 ton of fish per annum, but more importantly threats biodiversity, sustainable livelihoods and food security in the region (Cowx, 2015).

- The Xe Kong is also the most important remaining source of sediment contributions to the Mekong Delta in Vietnam. According to the IPCC, it is one of the three major delta systems in the world most vulnerable to sea level rise, with its attendant storm surges and salinization. The resilience of the delta to the effects of climate change depends directly on this annual replenishment of sediment. This delta is home to 18 million people, produces half of the rice harvest for Vietnam, the world's second largest rice exporter, and the epicenter of fish harvesting and biodiversity. The sediments coming out of the Xe Kong basin also nourish the food chain in the Tonle Sap Great Lake.

- Feasibility studies have been submitted for seven large hydropower dams in the Xe Kong mainstream that would convert it into a series of lakes. Fishery experts convened by NHI and the National University of Lao have concluded that these reservoirs would severely impair the migratory fishery because of the barriers they pose to fish migration and the large extent of spawning habitat that they inundate. While fish pass facilities can be constructed that would allow the fish to get past the dams (in theory), the high mortality of adult fish and their reproductive products in the reservoirs cannot be mitigated. The impacts would be exponential in the cascade of dams, and the effects on the downstream fish yield would be profound, particularly downstream in Cambodia. The impacts of the dams are most severe at the downstream dams because of extent of penetration declines as the migratory fish move up the mainstream. Thus, the lowermost dams are the least sustainable. These dams would also capture 80% of the sediments and nutrients.

NHI's Master Plan

- The Master Plan presents an alternative development scenario that does satisfy the proposed sustainability criteria. It is based on sites that are not accessible to migratory fish because they are above existing barriers (already constructed dams in the Xe Kaman tributary) or so far up in the catchment that the fish visitations are relatively minor. These alternative projects (Figure 2) would be designed and operated to allow flushing of sediments and to maintain a flow pattern conducive to the needs of the migratory fish. In the aggregate, these sustainable alternatives would provide enough power to replace the mainstreams dams.

- A key element of this alternative scenario is the augmentation of power output at the largest of the existing hydropower dams in the basin, the Xe Kaman 1 Hydropower Project, owned and operated by Viet Lao Power Joint Stock Company (a Vietnamese Company). This 290 MW facility is ideally suited for deployment of floating solar photovoltaic panels that would be fully integrated with the hydropower powerhouse and operated as single unit (see Figure 2 for location). This is because the reservoir is very large and shallow; it can store more than a year of inflow which gives it great

operational flexibility to counteract the daily fluctuations in power output from solar panels; it has excess transmission capacity that can facilitate the solar component; and it has a smaller reservoir immediately downstream, which is owned by the same company, that can re-regulate the flow distortions from Xe Kaman 1 when operated in this manner.

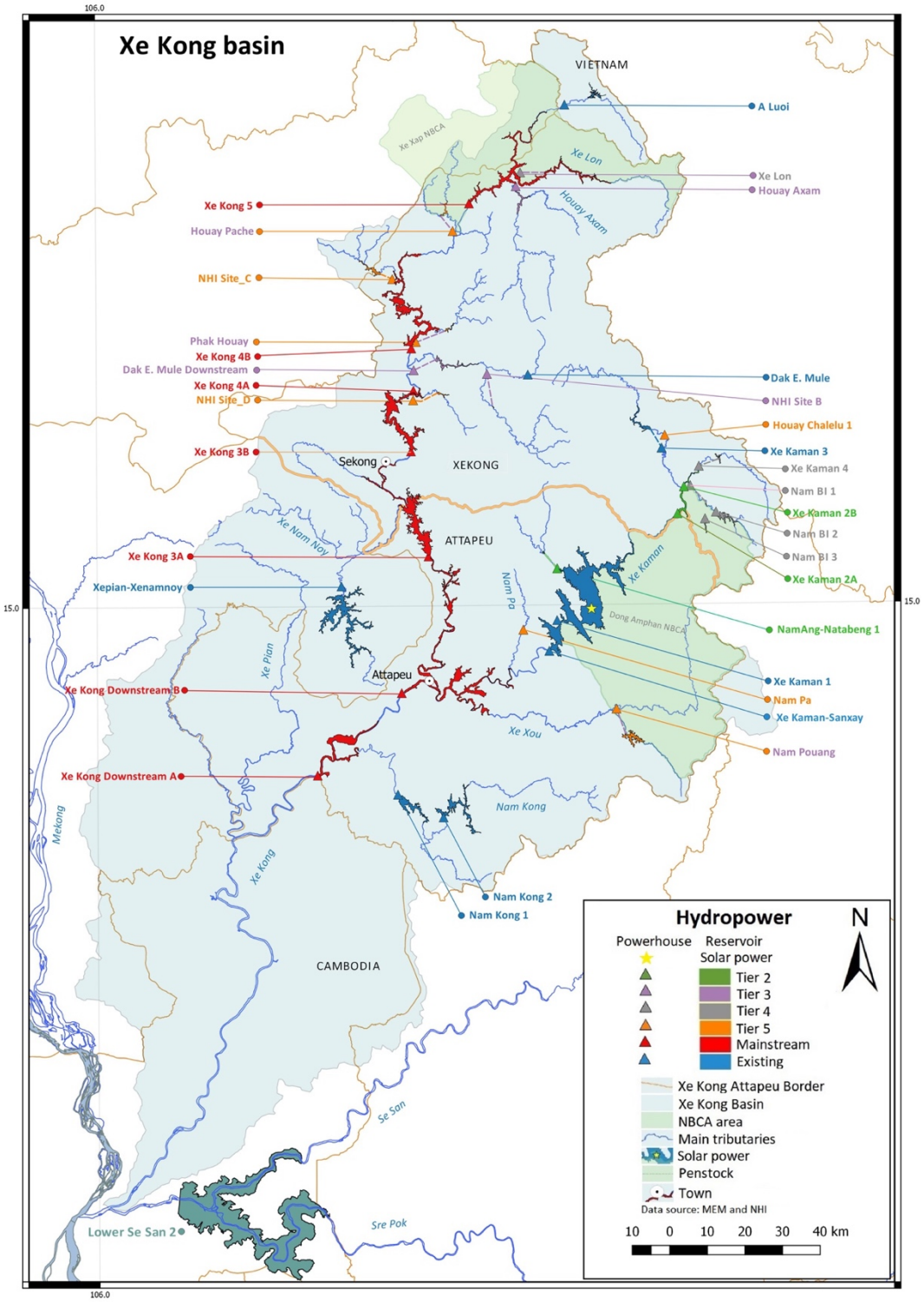

Figure 2: Map of the Xe Kong basin with NHI Alternatives (by Tiers), including solar.

- Modeling was conducted to ascertain the optimal scale for the solar component and how the hydropower reservoir would need to be operated to buffer the fluctuations in the solar generation. The NHI team looked at scales ranging from 150MW-400MW-500MW-to ~ 1200MW (which would represent covering 15% of the reservoir area with solar panels). This alternative would avoid negative impacts of developing new hydropower, while approximately doubling energy output, improving firm power reliability, reducing GHG emissions – as much as 357,000 tons per year[1] (for a 280 MW facility), and greatly reducing financial risks to the investors. Also, the floating solar technology can be brought on line much more quickly than any other alternative, and the costs of such systems have decreased rapidly over the past decade and further cost decreases are likely. Present costs of $1,000/kW for floating systems are likely to reduce to $900/kW over the next decade.

- The Master Plan also includes an implementation strategy. It modifies the respective roles of the hydropower developers and the GoL with respect to the selection of sites, designs and operations of future hydropower facilities. Today, those decisions are made by the developers with minimal oversight by the GoL. Under the Master Plan approach, the GoL itself would conduct a study, illustrated by the NHI Master Plan, to determine in advance the sites, designs and operations that best benefit the people of Laos and the downstream neighboring countries over the long term. This would include a programmatic environmental and social impact assessment. These projects would then be offered to developers to submit competitive applications to undertake full-fledged engineering and economic feasibility studies and a project-specific environmental and social impact assessment. The GoL would select the winning bid on the basis of capabilities and performance record of the developers rather than on the price point. Developers who win a MoU and show that the project is feasible would have an exclusive right to a concession agreement to build, own, operate and then transfer the project to the GoL.

- The Master Plan recommends setting up a dedicated funding mechanism for the GoL to play this proactive role in conducting basin-or system-wide hydropower development in other basins in Lao PDR. Based on experience of The Nature Conservancy (TNC), the best approach for setting up a financial mechanism for master planning in Laos would be to create a revolving fund that would be initially infused from a multi-donor trust fund and then replenished from assessments of projects as they move through the approval process.

- The major recommendation of the Master Plan is to ***defer any commitment to the mainstream Xe Kong dams and pursue instead the sustainable options in the rank order in which they are presented in the Master Plan, with the solar augmentation of existing reservoirs as the top priority.*** If there comes a time when additional power development from the Xe Kong basin is needed, the uppermost dams should be given a higher priority. The lowermost dams should not be developed under any circumstance because of their very large impacts, including blocking passage of migratory fish and sediment to the Mekong Delta.

[1] Source: solarmango.com. Assumes that reduction of CO2 emission per 1 kWh of solar power = 1 kg of CO2. Please note that the above calculation considers only the reduction in CO2 emissions for the electricity generated from a solar power plant vs. a coal plant and does not take into account CO2 from other parts of the value chain.

The Master Plan can be downloaded by clicking the name of the file or volume that you wish to review from the following link: **HTTPS://DRIVE.GOOGLE.COM/OPEN?ID=1Z51P-28TJ_6KBRBC_WDQRFPVZ1MSEYXJ**. *Alternatively, you may send a request for the documents to Jessica P. Nagtalon at NHI: jessnagtalon@n-h-i.org*

VOLUME 1: EXECUTIVE SUMMARY IN ENGLISH & LAO

VOLUME 2: SUSTAINABLE HYDROPOWER MASTER PLAN, SECTIONS 1-10

TECHNICAL ANNEXES FOR VOLUME 2

VOLUME 3: FLOATING SOLAR PV ALTERNATIVE, SECTION 11

VOLUME 4: IMPLEMENTATION PLAN (SECTION 12), WITH EXECUTIVE SUMMARY IN ENGLISH & LAO

Further information about NHI's projects can be found on the NHI website: www.n-h-i.org