Strategic Environmental Assessment of the Myanmar Hydropower Sector

Executive Summary

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EXECUTIVE SUMMARY

The Myanmar hydropower sector, in the early stages of development, has the opportunity to develop sustainably by balancing electricity generation with environmental and social outcomes. The country is currently following a conventional hydropower development process, with individual projects identified and approved without due consideration of the overall cumulative impacts that multiple projects and other pressures have on the river basin. In many countries this process has resulted in most major rivers and tributaries suitable for hydropower being developed, regulating these watercourses for 50-100 years and beyond. Significant cumulative impacts on basin health and related ecosystem services have resulted, with minimal opportunity available to lessen these impacts.

This Strategic Environmental Assessment (SEA) of the Myanmar hydropower sector considers environmental and social values at the river basin level, recommending an approach to achieve sustainable hydropower development. The SEA recommends moving the initial planning focus away from individual projects to basin health to plan a sustainable sector development.

1. Background

Myanmar has a substantial need for power. The country has the lowest grid connected electrification rate in Southeast Asia, with only 40% of the population supplied. It is estimated that at least 500 MW of additional generation capacity is required to come on line annually up to 2030 to meet domestic demand. Additionally, Myanmar's electricity transmission grid requires considerable expansion and upgrading to meet demand.

The energy mix proposed in Myanmar is under review, with conventional and renewable power sources being analyzed in a national power sector strategy. Hydropower is likely to play an important role in the energy mix as it can generate large scale affordable renewable energy and help stabilize the grid, particularly intermittent power generation from other renewable sources.

Hydropower in Myanmar has experienced relatively limited development compared to the country's identified potential total capacity. The total installed capacity of projects of 10 MW and greater (29 projects) is 3,298 MW, accounting for 58% of national energy supply in early 2018. A further 1,564 MW capacity is under construction in six projects, but several of these are stalled or taking far longer to complete than scheduled. Currently, a total of 43,848 MW capacity is proposed in 69 projects nationally. These projects include six over 2,000 MW capacity each and seven between 1,000-2,000 MW capacity. To date, 80% of hydropower projects have been developed in cascade arrangements in sub-basins, with this geographic distribution driven by load center locations and the limited transmission grid, coupled with suitable sub-basin hydrology, topography and geology. Most development has occurred in the Ayeyarwady river basin where 64% of total installed capacity exists, with the Sittaung river basin accounting for 25%.

Myanmar, covering 671,700 km^2, has abundant freshwater resources. The main river basins are the Ayeyarwady, covering 55% of the country (with 90% of the basin lying within Myanmar), and the Thanlwin, covering 19% of the country (with 45% of the basin within Myanmar). An estimated 70% of Myanmar's population lives in rural areas, with a large proportion having a high livelihood dependency on riverine and other natural resources.

The health of Myanmar's river systems is reliant upon maintaining natural processes. Freshwater ecosystem services include:

- **Provisioning**: fish production, irrigation, and domestic water supply;
- **Regulating:** flow regulation, water purification, natural hazard (flood) regulation, maintenance of coastal landforms, and marine nutrient supply; and
- **Cultural:** cultural landscapes, recreation, and tourism.

The importance of Myanmar's aquatic resources is illustrated by fish production. An estimated 3.2 million people are employed in the freshwater and marine fisheries sector, consisting of 800,000 full-time and 2.4 million part-time (www.worldfishcenter.org/country-pages/myanmar). This sector is the fourth largest contributor to Myanmar's gross domestic product (GDP) and the fourth largest source of foreign exchange income, while providing an important source of dietary protein (estimated at 30 kg per person per annum).

Despite the potential for hydropower to make a substantial contribution to national socio-economic development, the sector has recently experienced challenges due to public opposition to large projects. Opposition has at least partly resulted from insufficient project transparency and stakeholder engagement and inclusion, as well as political shifts. Projects proposed on major rivers have received the most objections, leading the government to suspend the Myitsone, Tamanthi and Tanintharyi hydropower projects, totaling 7,800 MW capacity. Hydropower planning in Myanmar also has to contend with conflict affected areas, limited natural resource data and information (on river hydrology, geomorphology, aquatic ecology, social and livelihoods), and limited government capacity and resources.

2. Business-as-usual Development Limitations

Myanmar's current hydropower development process ('business-as-usual') is similar to conventional hydropower planning in most countries – focused on individual projects rather than basin- and sub-basin level planning. Feasibility analysis to select a project site is primarily founded on engineering and economic factors, which leads to project proposals with little consideration of the cumulative environmental and social impacts on the sub-basin or basin.

Business-as-usual hydropower development in Myanmar, assumed to be the installation of all currently proposed projects over the next 30 years, will not deliver basin sustainability. The development of large scale projects on the Ayeyarwady, Chindwin and Thanlwin mainstem rivers will cause significant impacts on system connectivity, basin processes and ecosystem services. These mainstem projects plus business-as-usual development in sub-basins will increase the total catchment area within Myanmar regulated by hydropower from 14% at present to 45%, regulating most hill and mountain catchments. This would result in the progressive degradation of basin health and the loss of important natural and social values across much of the country.

3. SEA Vision, Scope and Methodology

Ministry of Electricity and Energy (MOEE) and Ministry of Natural Resources and Environmental Conservation (MONREC) recognized the need to develop a sustainable hydropower sector, to balance development with natural resource maintenance. The ministries partnered with the International Finance Corporation (IFC) to prepare the SEA, setting the joint vision of:

Sustainable hydropower development based on integrated water, land and ecosystem planning, balancing a range of natural resource uses and priorities to achieve economic development, environmental sustainability and social equity.

This vision is supported by six objectives:

- maintain natural river basin processes and functions that regulate and maintain river health and ecosystem services;
- retain unique and important biophysical and cultural sites and values, as well as representative environmental values;
- avoid unacceptable social, livelihood and economic impacts;
- recognize, understand and avoid or manage conflict risks;
- provide development benefits to project affected people, communities and regions; and
- generate adequate, reliable and affordable hydropower energy for domestic consumption.

The scope of the SEA covers all projects of 10 MW capacity or greater in Myanmar. The main planning principles applied include:

i) **Whole-of-basin planning:** focusing on system health at a hydrological scale to guide project site identification;
ii) **Balanced natural resource utilization:** retaining the full functions and values of a number of intact rivers and sub-basins to offset hydropower development impacts in other rivers/sub-basins, thereby maintaining basin health; and
iii) **Natural resource capacity-based development:** hydropower developed within the capacity of the natural system (or, carrying capacity) without unduly degrading natural values or creating significant impacts on the communities who use these resources.

Issue scoping was undertaken to understand the current hydropower development process and environmental and social values of importance to different stakeholders. An SEA Advisory Group and six technical Expert Groups were convened to guide the SEA, identify the best available information, review draft findings and help engender broad understanding of and commitment to the SEA vision. These groups consisted of local and international specialists covering different technical fields, from government, non-governmental organizations, the private sector, development partners, multi-lateral agencies, academic institutions, ex-government officers and independent researchers.

Broad stakeholder engagement was undertaken to canvass views on the direction of the sector and issues of importance, involving over 55 consultation activities across Myanmar. Activities included regional river basin workshops with civil society organizations and state/region governments, multi-stakeholder workshops, direct consultation with local communities, political parties, ethnic armed organizations, and discussions with the Myanmar Hydropower Developers' Working Group.

A hydropower geographic information system (GIS) database was prepared, mapping existing, under construction and proposed projects of 10 MW capacity or greater. Eight basins were defined covering the country, consisting of six river basins: Ayeyarwady, Thanlwin, Mekong, Sittaung, Bago and Belin; and two coastal basins where coastal watersheds were grouped: Tanintharyi and Rakhine. Basin complexity was handled by identifying and analyzing two natural management units with related, but discernably different, primary functions:

i) **Mainstem rivers:** providing basin connectivity; and
ii) **Sub-basins:** providing the primary land/water interface, where physical, chemical and biological processes influence the ecological functioning of the basin.

A total of 58 sub-basins were defined and evaluated, covering the entire country. The business-as-usual development impact was then assessed to determine the likely outcomes of this development pathway, then a 'sustainable development framework' was prepared to guide future development.

4. Sustainable Development Framework

The sustainable development framework (SDF) for future hydropower sector development was formulated based on an evaluation of basin processes and values and likely hydropower impacts. This 'first edition' plan recommends balanced development over the long term, providing the initial planning framework for project siting. The SDF focuses on basin health and the retention of important natural and social values. This is supported by two subsequent levels of integrated hydropower planning necessary to deliver sustainable development:

- Cumulative Impact Assessment (CIA) - for a sub-basin or watershed where multiple projects or a single notable hydropower project is proposed; and
- Project environmental and social assessment (either an Environmental Impact Assessment or Initial Environmental Examination) - for each hydropower project of ≥1 MW, as required under Myanmar law as part of the project approval process.

The main component of the SDF is the Basin Zoning Plans that recommend: (i) mainstem river stretches to be retained to maintain basin connectivity; and (ii) sub-basins zoned for either potential development or protection. Mainstem rivers provide basin connectivity: an unimpeded pathway for water, sediment, fish and other aquatic organisms to move between sub-basins and the sea, maintaining essential ecosystem services. Connectivity-related basin functions include water cycling and river flow characteristics (seasonality, water levels), river channel maintenance, aquatic ecology cues and processes (e.g. for fish migration), riverine habitat maintenance, flushing of land derived nutrients into the sea, sediment replenishment in marine areas that maintains coastal landforms, natural hazard regulation (floods and coastal protection), and the prevention of saltwater intrusion in delta regions. Sub-basins provide the primary land/water interface in basins, where physical, chemical and biological processes influence basin ecological functioning.

Mainstem rivers in five basins have been identified to maintain critical basin processes. Each mainstem is a Strahler Order 4 or greater and has a very large average annual flow rate of greater than 1,000 m^3/s (except for the Sittaung mainstem). Approximately 4,100 km of mainstem river reaches are recommended to be reserved for their connectivity value, consisting of sections of the Ayeyarwady (1,500 km), Chindwin (900 km), Thanlwin (1,200 km), Mekong (200 km) and Sittaung (300 km) rivers.

Sub-Basins were zoned either for potential development or for protection, based on the evaluation of the baseline values of three biophysical factors:

i) **Geomorphology:** river connectivity and delta/coastline stability; potential sediment production; river flow;
ii) **Aquatic ecology and fisheries:** river reach rarity (WWF, 2014); and the presence of endemic species, key biodiversity areas, Ramsar sites and important wetland areas, confluences, karst geology, and the presence of threatened fish and aquatic organisms; and
iii) **Terrestrial biodiversity:** percentage of protected area / key biodiversity areas; and percentage of intact forest (≥80% crown cover).

Social and livelihood features were also evaluated, incorporating social vulnerability, dependence on natural resources, and poverty. Information was restricted to 2014 census data at the township level, with proxy indicators used for social vulnerability and poverty. The intention was to include this evaluation to help to determine sub-basin zoning, but this was not possible as the data did not provide a good indicator of likely social impacts that are usually highly location-specific within sub-basins.

The status of conflict between state and non-state armed groups was also evaluated for each sub-basin, identifying conflict risks that may pose significant or insurmountable obstacles for project development, or may be exacerbated by project development. The evaluation was based on the current and historic status of armed conflict, considering the presence of armed groups, historic population displacement, recent conflict incidents and estimated battle deaths. It provides an additional screening layer for proposed projects, to be applied by developers early in the project feasibility analysis to determine if the project should proceed. As conflict risk is dynamic over time and the level of risk can vary across a sub-basin, project planning in conflict-prone areas should include conflict sensitivity analysis that incorporates broad stakeholder engagement with directly affected people, historically displaced populations, ethnic armed organisations and ethnic political parties.

Ratings were given to each biophysical factor then totalled and scaled to determine one of three sub-basin 'zones':

- **High** - provides an important contribution to basin processes (such as high flows or a large sediment load), and/or has unique natural values for at least two biophysical factors;

- **Medium** - no high conservation value features over a notable area for two biophysical factors, although may contain notable values for a single factor or pockets of such values;
- **Low** - no high conservation value features over a notable area for any biophysical factor, although may contain pockets of high value.

The ten High zone sub-basins identified, covering 24% of Myanmar, are recommended for protection to maintain critical biophysical processes and values in these catchments. Hydropower development in these sub-basins is recommended to be restricted to smaller scale projects with low environmental and social risks that cumulatively will not unduly degrade significant sub-basin values. Five of the High zone sub-basins form a contiguous block in the headwaters of the Ayeyarwady basin, covering a combined area of 78,900 km^2 (21% of the basin in Myanmar). Important values in this area include the contribution of around 47% of total basin discharge and a substantial volume of sediment. This area also contains high value aquatic habitat and notable terrestrial ecosystems in Hkakaborazi National Park, four Wildlife Sanctuaries, numerous key biodiversity areas and 35% of all remaining intact forest (>80% crown cover) in Myanmar. Two other High zone sub-basins are located in the Tanintharyi basin, while one each is located in the Thanlwin, Mekong, and Rakhine basins.

Twenty-one Medium zone and 27 Low zone sub-basins were identified as being potentially suitable for hydropower development, covering 37% and 39% of Myanmar respectively. These sub-basins are recommended to be considered by government for potential hydropower development in the initial stages of zoning implementation. Over time, as new information is obtained on natural resources and social features, as basin modelling is refined and projects are approved, it is recommended that the government consider utilization trade-offs in this group of sub-basins to achieve a balance between developed catchments and catchments reserved to maintain system health, ecosystem services and other important values.

Sustainable hydropower development is recommended to incorporate cascade projects instead of similar generation capacity dispersed across many sub-basins. The advantages multiple projects in a sub-basin or watershed versus dispersed projects can include a lower overall magnitude of impact per unit of energy generated, and increased power generation per unit of water regulated as stored water is run through multiple powerhouses. This allows intact rivers to be retained while generating similar or greater hydropower within a basin. The development of Low and Medium zone sub-basins, assuming all business-as-usual projects are installed, would raise the total Myanmar catchment area regulated by hydropower from 14.4% to 23.5%, considerably less than 45% that would be regulated under business-as-usual.

The total capacity of the future hydropower sector developed in accordance with the sustainable development framework cannot be accurately predicted due to the range of natural resource, social and market variables that will have an influence. However, the approximate scale is estimated to be around 13,000 MW or greater installed capacity. This estimate is based on existing projects (3,300 MW), plus new generation from projects under construction (1,600 MW), currently proposed projects in Medium and Low zones (7,300 MW), some capacity from low impact hydropower projects in High zone sub-basins, as refurbishment of existing power stations and the installation of turbines on irrigation projects, not to mention small hydropower projects of less than 10 MW capacity. But as hydropower investigations proceed in priority sub-basins, additional overall capacity may well be developed.

The Basin Zoning Plans provide an initial planning tool for project siting, supported by the hydropower GIS database, sub-basin evaluations and a three-year framework implementation plan that includes:

- establishing of a Joint Planning Committee with the Government of Myanmar (MOEE and MONREC);
- developing a national Sustainable Hydropower Policy;
- developing a Basin Zoning procedure for Government of Myanmar implementation;
- recommending sustainable project design criteria;

- recommending improvements to environmental and social impact assessment and management planning; and
- collecting baseline data and conducting research.

As a first edition plan, it is recommended that the framework be reviewed after three years after the commencement of implementation, and revised as needed based on more detailed information and implementation findings and results.

5. Outcomes

The SEA seeks to provide a balanced pathway for sustainable hydropower development in Myanmar, based on important biophysical processes and values, the range of views of different stakeholders, and the power needs of the country that could be serviced by hydropower generation. It has promoted an important conversation among stakeholders on sustainability and the long-term direction of hydropower, and provides the first basin-wide view of hydropower development and related natural resource values in Myanmar.

The sustainable development framework serves as the planning nexus between hydropower development and natural resource protection, with both being achievable through basin-level planning. By shifting the initial planning focus away from individual projects towards long-term basin health and the maintenance of system-dependent ecosystem services, the environmental and social risks of hydropower to natural resources and river-dependent communities are substantially reduced. The framework recommends a development framework whilst recognizing current planning constraints, allowing the sector to move towards sustainable development before business-as-usual development plays out and results in significant basin regulation and degradation.

Application of the framework for hydropower sector planning is expected to:

- help maintain healthy basins over the next 100 years and beyond by avoiding significant natural resource degradation from the loss of mainstem connectivity and important sub-basin environmental and social values;
- preserve essential river-based ecosystem services;
- provide clear direction to decision makers and developers on the appropriate siting and design of projects;
- initiate meaningful stakeholder engagement, thereby improving project design and stakeholder acceptance of well planned projects;
- improve access to international financing by avoiding and reducing basin-wide cumulative impacts; and
- promote local and national development through the provision of affordable and reliable renewable electricity generation, to supply households, businesses and industry.

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