Ecosystem Services 30 (2018) 27–35

Contents lists available at ScienceDirect

Ecosystem Services

journal homepage: www.elsevier.com/locate/ecoser

Tradeoff analysis between electricity generation and ecosystem services in the Lower Mekong Basin

Apisom Intralawan [a,*], David Wood [a], Richard Frankel [b], Robert Costanza [c], Ida Kubiszewski [c]

[a] School of Management, Mae Fah Luang University, Chiang Rai, Thailand
[b] Natural Resources and Environmental Management, School of Science, Mae Fah Luang University, Chiang Rai, Thailand
[c] Crawford School of Public Policy, The Australian National University, Australia

ARTICLE INFO

Article history:
Received 2 August 2017
Received in revised form 18 December 2017
Accepted 15 January 2018

Keywords:
Mekong River Basin
Cost Benefit Analysis
Ecosystem services
Hydropower development
Wetland
Fishery
Sedimentation
Water Energy Food nexus

ABSTRACT

The Mekong River is the largest freshwater fishery and the third most bio-diverse river system in the world. Two of 11 planned mainstream hydropower projects, Xayaburi and Don Sahong, are nearly completed and a third project proposal, Pak Beng, has been submitted by the Lao PDR government for consideration. This paper builds on previous studies and examines the tradeoffs (between water use, food security supply and energy production) for the proposed mainstream hydropower projects in the Lower Mekong Basin (LMB).

The paper concludes that the forecast loss of capture fisheries, sediment/nutrients and social mitigation costs measured as Net Present Value (NPV at 10% discount rate) are greater than the benefits from electricity generation, improved irrigation and flood control. The paper also forecasts huge negative economic impacts for Cambodia and Vietnam in contrast to previous Mekong River Commission's (MRC) conclusions that all countries will benefit from hydropower development.

The paper recommends reassessing the economic impacts of hydropower development using full environmental cost accounting. It also recommends that a new LMB energy strategy be developed taking into account less hydropower income than previously anticipated, updated forecasts for LMB power demand and anticipated technology developments for improved energy efficiency & renewable energy (especially solar which is now competitive with hydropower).

1. Introduction

The Mekong River is the largest freshwater fishery in the world (Ziv et al., 2012). The estimated fish catch is approximately 2.0–2.6 million tons/year (Van Zalinge et al., 2004; Baran, 2010a,b; Mekong River Commission, 2010a; Mekong River Commission, 2011; An, 2015; Hortle, 2015; Nam, 2015; Lynch et al., 2016). It is the third most bio-diverse river system with nearly 800 fish species after the Amazon and Congo rivers (Dudgeon et al., 2006; Mekong River Commission 2010b; Winemiller et al., 2016). The estimated fish catch does not include another 0.5–0.7 million/tons of Vietnam coastal fishery, about 2 million ton/year of aquaculture and about 0.5 million tons/year of other aquatic animals which are all dependent on the intact ecosystem processes and functions (ICEM, 2010; Mekong River Commission, 2010a,b,c; Nam et al., 2015). The inter-seasonal variation on water level fluctuation and flooded area influenced by the southwest monsoon – about 1 meter in the dry season to roughly 10 m in the wet season – is the main driver of the productivity of the river (Kummu et al., 2014; Welcomme et al. 2016). The annual variation of the great lake and Tonle Sap area, for example, expand from 2200 in the dry months to 13,250 km^2 during the peak season. It is presently a home to about 70 million people – half of this population lives within a 15 km corridor and their livelihoods are closely linked to the Mekong River (Hall and Bouapao, 2010). Fish is the major source of protein for the local people accounting for 49–82% of animal protein consumed (Orr et al., 2012; Piesse, 2016; Pittock et al., 2016).

Like many other great rivers in the world, the Mekong River Basin is currently undergoing massive hydropower development. In the Upper Mekong-Lancang Jiang, six projects have been completed and have significantly altered the water flow at Chiang Saen, Thailand (Lu et al., 2014). For the Lower Mekong Basin, two of the 11 planned mainstream projects, Xayaburi and Don Sahong Dams are nearly completed. A proposal for a third dam, Pak Beng, has been submitted to Mekong River Commission (MRC) for

* Corresponding author at: School of Management, Mae Fah Luang University, 333 Moo 1 Tasud, Chiang Rai, Thailand.
E-mail address: intraa@mfu.ac.th (A. Intralawan).

https://doi.org/10.1016/j.ecoser.2018.01.007
2212-0416/

consideration by the Lao PDR government and construction is expected to start later this year (2018).

Hydropower development would bring electricity generation, increased irrigated area and reduction of flood and drought which will considerably benefit the economies of LMB countries. However, the proposed hydropower projects would also cause major changes to the river hydrology, capture fisheries and sediment/nutrients dynamics which would adversely affect the productivity of Tonle Sap and the floodplains in Cambodia and the Vietnam Delta coastal zone (Kummu and Varis, 2007; Kummu and Sarkkula, 2008; Kondolf et al., 2014). Furthermore, the planned projects would alter aquatic ecosystems effecting the processes and functions of the ecosystem critical to sustainable human well-being. Under the foreseeable future situation with eleven mainstream dams plus 30 dams planned on the tributaries scenario, it is expected that the dry season flow will increase and the flood season flow will be reduced. This will result in severe impacts including lost biodiversity, environmental hotspots, and risk of extinction of Giant Catfish and Irrawaddy Dolphin. It is recognized that capture fisheries will decline substantially unless new developments in fish passage facilities are provided.

However, the best available fish passage technology which can handle the huge volume of tropical fish migration—up to 34 tons of fish per hour or about 3 million fish per hour at peak migration near Tonle Sap—has yet to be tested and remains a speculation (Dugan, 2008; Kang et al., 2009; Baran, 2010a,b; Baumann and Stevanella, 2012; Schmutz and Mielach, 2015).

2. Materials and methods

Development of the Mekong River Basin has been a decades-long dream. In early 1950s, the Bureau of Flood Control of the United Nations Economic Commission for Asia and the Far East (ECAFE) suggested development of the basin's great potential for hydropower generation and irrigated agricultural production. It also suggested development coordination among four riparian countries, Thailand, Lao PDR, Cambodia and Vietnam (Bakker, 1999; Jacobs, 1999). Due to the political instability in the region, it was not until 1995 that the new era of Mekong cooperation was revitalized. The LMB countries now agreed to '*cooperate in all fields of sustainable development, utilization, management and conservation of the water and related resources of the Mekong River Basin*...'. The Basin Development Plan (BDP) is seen as a tool *'to identify, categorize and prioritize the projects and programs to seek assistance for and to implement at the basin level'* (Mekong River Commission, 2013). BDP1 (2001–2006) laid the foundation for LMB coordination and brought country level institutions and staffs together to analyze and formulate development plans and projects put forward by individual LMB countries. BDP2 (2007–2011) took a comprehensive view of national and sub-basin water related developments. Different scenarios which provide a range of plausible future developments were constructed and assessed against economic, environmental, and social criteria totaling 12 development objectives and 42 criteria. The objectives derived from the individual country's concerns of each water resources development ranged from increases in irrigated agricultural production, hydropower production, improved navigation, decreased flood and drought damages, maintain productivity of fishery sector to maintain environmental protection, social development and social equity issues. According to the BDP2 evaluation of economic costs and benefits for all scenarios, "the analysis clearly demonstrates the overwhelming economic significance of hydropower within the different developments under consideration ... and Lao PDR (as the largest investor and power generator) gains the most economic benefits in all development scenarios". (Mekong River Commission, 2011).

Following the publication of Basin Development Plan Phase 2—Assessment of Basin-wide Development Scenarios (BDP2), Costanza et al., (2011) analyzed the BDP2 conclusions and argued that by changing some key assumptions such as fish prices, value of the wetlands, along with using a lower discount rate with an infinite time horizon for natural capital, the Net Present Value of hydropower development would become negative. More thorough assessment of the ecosystem services value and better treatment of distribution of cost and benefits among stakeholder groups and with the future generation were recommended (Kubiszewski et al., 2013). At present, MRC is conducting another study on Sustainable Management and Development of the Mekong River—the Council Study to fill the knowledge gap of major development in the LMB countries.

This study builds on previous assessments of basin-wide scenarios (Costanza et al., 2011; Kubiszewski et al., 2013; Intralawan et al., 2015). It also updated some inputs including electricity price, loss of capture fisheries, fish price, hydropower project data, values of wetlands, sediment loss and social and environmental mitigation costs. The study followed the international practice of economic evaluation method and MRC methodology on Initiative on Sustainable Hydropower Guidelines for the Evaluation of Hydropower and Multi-Purpose Project Portfolios (Mekong River Commission, 2015).

2.1. Scenario

A scenario is a plausible set of possible outcomes in the future which may be used as a frame of reference for project evaluations. BDP2 developed several scenarios for development of the Lower Mekong Basin based on plans put forward by each country. The scenarios formulated in BDP2 were based on individual country water related development plans and are summarized below:

1. Definite Future Situation (DFS) refers to the cumulative impact assessment of water-related developments occurred up to 2015 including dams on the Lancang and 26 tributary reservoir development in the LMB.
2. Foreseeable Future Situation (FFS) refers to the transboundary impact assessment of water resources development plans including 1.6 million hectare irrigation expansion and 30 planned tributary dam plus 11 planned mainstream dams up to 2030.
3. Long-term Future Situation (LFS) refer to the impact assessment of water resources development up to 2050.

This study focused on the second scenario (FFS which is comprised of 11 Lower Mekong mainstream dams (nine in Lao PDR and two in Cambodia) plus 30 dams planned on the tributaries) as FFS was considered to be a more realistic future scenario and the third scenario (LFS) was considered too speculative. The total capital investment for FFS is approximately US$ 50 billion in 2017 prices (Fig. 1). However, the actual investment cost could be higher due to higher standards and safeguards recognized as essential to achieve sustainable development. This study also focused on the FSS scenario in order to allow comparison with BDP2. Furthermore, this tradeoff exercise is intended to raise awareness, promote a dialogue platform for various stakeholders, and provide detailed analysis in order to achieve a more balanced development with the objectives of economic efficiency, social justice and ecological sustainability.

2.2. Economic analysis

The economic calculations in this study are similar to methods described in Sustainable Management and Development of the