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The linkages of energy, water, and land use in Southeast Asia

Challenges and opportunities for the Mekong region

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Abstract: This paper aims to contribute to understanding the existing knowledge gaps in the linkages of energy, water, and land use in Southeast Asia and explores the political economy of energy transition in the Mekong region (MR). Investigating the struggle over hydropower development and decision-making on water and land across the region, this study shows that countries that are the winners or losers in the hydropower development schemes are not the only ones managing the Mekong; rather, it is part of the region-wide strategy of nations to sustain the MR. The analysis also explores the key issues involved in each nation, as the rush to acquire sources of alternative energy and other benefits to meet rapid growth demand has led to circumstances of risk within the MR. The relationship between MR cooperation programmes and China is a main concern, and the paper discusses the roles of issue linkages as a mechanism for achieving sustainable development.

Keywords: transboundary water resources, Mekong River, hydropower, issue linkages, externality games
JEL classification: Q42, C78, D62, D74

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1 Introduction

The Mekong region (MR) is a natural economic area, consisting of Cambodia, Laos, Myanmar, Thailand, Viet Nam, and the Yunnan province of China, bound together by the Mekong River.[1] Originating at an elevation of over 4,500 m in the Tibet Qinghai plateau, the Mekong River, with a total catchment area of 795,000 km^2, not only is the major water source in Southeast Asia but also harbours a wealth of natural resources including important stocks of forest, fish, biological biodiversity, transportation, wetlands, and tourism (ADB 2004; Mehtonen et al. 2008; MRC 2005). Land and water resources are central to agriculture and rural development, and are intrinsically linked to regional challenges of food insecurity and poverty. For over 20 years, Southeast Asia has been one of the fastest growing regional economies in the world and water resource has assumed a central role in the region's economic growth (ADB 2013). Economy and population, particularly in urban centres, have grown remarkably, leading to increased use of energy and natural resources. The basis for sustainable development[2] is the access to these resources and their sustainable management (FAO 2011).

In the MR, the linkages between energy, water, land use, and development are numerous and complex, driven by increasing demands for clean energy, cheap electricity, and potential profits. Water is not only lifeblood, it is also a source of economy. The production and consumption of goods and services require energy. Energy development requires water. Food production and land-use planning require water and energy. The fast development of hydropower, mining, infrastructure, and urbanization are main factors for change in land use. As the most populous region and the world's manufacturing hub, Southeast Asia and the MR demand water, energy, and land resources in ever increasing amounts, leading to shortages that are creating serious choke points in the country's development. Pressure on water is at the heart of these resource constraints facing the MR (ADB 2013; Kubiszewski et al. 2012; Matthews and Geheb 2015).

Owing to sustainable development and managing natural resources, especially given the very high economic growth rates in China, the MR is of global importance, in terms of population size, land use, resource base, regime, gross domestic product (GDP) size, GDP per capita, or comparative advantages (Table 1). Currently, over 100 larger dams are planned for the main stream of the Mekong River and its tributaries (MRC 2010). Figure 1 shows the commissioned, under construction, and planned dams in the Mekong River Basin (MRB). Power distribution within the MR is defined by strategic position, making the region a scene for one of the most intensive hydropower developments globally. Dam construction has almost always created conflicts between energy supply and related economic interests and their social and environmental impacts (King et al. 2007; MRC 2010). Life in the MR is facing threats as major dams begin to rise. Deforestation for timber or fuel wood supplies, agricultural expansion, urbanization, and infrastructure creation, all contribute to increased erosion. Consequently, about 21 per cent of the MR area is experiencing problems with erosion;[3] only 31 per cent of its original forests have been left intact and only 5 per cent are under regulated protection (UNEP

[1] 'The boundary of the Mekong River region includes the entire Mekong River Basin (MRB) and the coastal area adjacent to the Mekong Delta' (UNEP 2006).

[2] Sustainable energy is one of 17 global goals that make up the 2030 United Nations Development Programme (UNDP) Agenda for Sustainable Development (United Nations 2015).

[3] The 'increased rates of surface water run-off resulting from deforestation and land clearance in upland areas of the MRB are causing increased soil erosion and the consequent entrainment of suspended and bed-load sediments into water courses' (UNEP 2006: 12).

2006). Together with climate change adaptation and mitigation, the livelihoods of some hundred million rural people across the MR are affected by degradation and depletion of natural resources.

Table 1: Selected aggregate indicators for the Mekong region (MR) and China in 2014

	Population (million)	Population growth (%)	Density (per km^2)	Land area (10^3 km^2)	Water (10^3 km^2)	GDP growth (%)	GNI per capita (US$2014)[a]
Cambodia	15.18	1.50	84	181.04	4.5	7.0	1020
Laos	6.77	2.00	29	236.80	6.0	7.4	1650
Myanmar	51.42	1.17	76	676.59	23.1	7.7	1270
Thailand	67.09	0.40	131	513.12	2.2	0.7[b]	5370
Viet Nam	91.52	1.05	274	330.95	21.1	6.0	1890
China	1367.82	0.48	143	9569.96	27.1	7.4	7380

Note: GDP, gross domestic product; GNI, gross national income. [a]Data from World Bank (2015). [b]The Thai economy, however, has slowed significantly since the fourth quarter of 2013 because of the delay of a complete election and the limited role of the caretaker government.

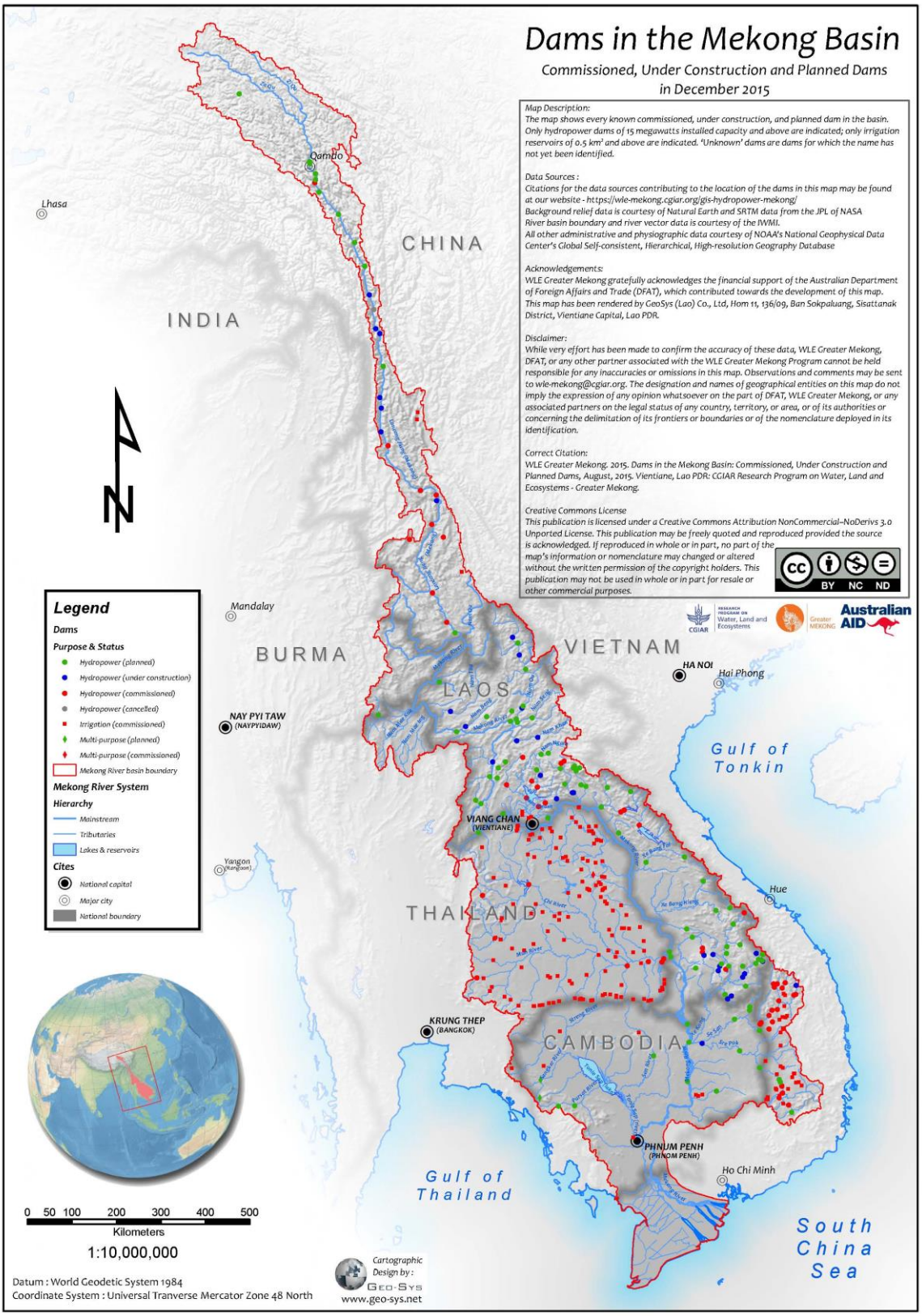
Source: ADB (2015) and World Bank (2015).

To meet demands of population growth and energy development, the increase in water consumption as alternative energy is intensive. Water needs to be part of energy strategies, and the management of water resources is one of the most urgent development challenges. To maximize benefits for all in a sustainable manner and to promote sustainable development and management of the MR, it is vital to understand how transboundary rivers can meet water, food, and energy needs of riparian populations while minimizing negative impacts (Bach et al. 2012). This study addresses the relationship between energy, water, and land use in the MR.[4] The aim of the paper is to: (i) provide a comprehensive overview and identify historical indicators of regional conflict and cooperation; and (ii) create a framework to enhance understanding management for sustainable development in the context of the transboundary water resources. It sheds light on the opportunities to mitigate the possible negative impacts of hydropower development for simultaneously protecting the environment and growing the economy by highlighting the role of issue linkages in achieving a regional agreement (Pham Do et al. 2012). The results contribute to policy-making as recommendations of how the Mekong River Commission (MRC) should deal with and without the rising power of China and the role of the United Nations as well as the Association of Southeast Asian Nations (ASEAN) in the Greater Mekong Sub-region (GMS).

The rest of the paper is organized as follows. Section 2 presents an overview of the MR and its water resources. Section 3 provides a brief historical development and regional integration. Section 4 analyses the role of issue linkages in designing a mechanism of regional and international cooperation. Concluding remarks follow in the last section.

[4] This paper seeks to update and add to previous studies on transboundary water management (see Pham Do et al. 2012; Pham Do and Dinar 2014).

Figure 1: Dams in the Mekong Basin



Source: WLE Greater Mekong (2015), reproduced with permission.

2 Overview of the MR

With a total land area of 2,334,000 km^2 (Xing 2013: 180), a long history of wars and peace, and the recent challenges in of the potential alteration of complex ecological and social systems (Campbell 2009; Dore and Xiaogang 2004; Kaisti and Kakonen 2012; Pham Do and Dinar 2014), the MR has attracted considerable international attention since 1950.

As seen in Table 1, economic disparities are very wide, ranging from four low-income member countries (Cambodia, Laos, Myanmar, and Viet Nam) with a low gross national income (GNI) per capita (formerly, gross national product per capita) of US$1020–1890 (at 2014 US$ price) to two middle-income member countries (Thailand and China) with a high GNI per capita of US$5370–7380. Populations range from 6.8 million people in Laos to over 90 million in the combined Yunnan and Guanxi regions. Generally, the average growth of real GDP in the MR has continuously increased in recent years (ADB 2015). However, poverty is a critical issue across the MRB, despite the significant economic growth of China, Laos, Cambodia, and Myanmar. According to UNEP (2008), the proportion of population living below the poverty line exceeds 30 per cent in many different ethnic groups of Laos, Cambodia, and Viet Nam.

2.1 Water resources in the MR

Historically and geographically, the MRB can be divided into two parts: the Upper Mekong Basin (UMB) constituting China and Myanmar (24 per cent of the total catchment area) and the Lower Mekong Basin (LMB) constituting Cambodia, Laos, Thailand, and Viet Nam (76 per cent of the total catchment area). The MRB is home to nearly 75 million people with 90 distinct ethnic groups (Matthews and Geheb 2015). Encompassing a vast range of geographic and climatic zones, the amount of water resources internally renewable annually varies widely by country. Moreover, land and water resources in the region also vary with location and season. For example, although only 16 per cent of the total discharge originates from the UMB, during the critical dry season, China discharges water to most of the Mekong mainstream flow in Laos and Thailand and contributes to almost 45 per cent of the average flow in Cambodia (Goh 2004).

As the longest river in Southeast Asia, the name roughly translating to 'mother of water' in the Lao and Thai languages, the Mekong is the region's largest water resource and provides the largest related resources with power generation potential that support on-going economic development and MRB community livelihoods. Particularly, water use for irrigation is expected to increase in the LMB (FAO 2012). Table 2 reports a summary of distributions of water and land resources in the MRB.

Table 2: Territory of six countries and their contribution to the Mekong's flow

Description	Yunnan (China)	Myanmar	Laos	Thailand	Cambodia	Viet Nam
Area (10^3 km^2)	165	24	202	184	155	65
Catchment area as percentage of MRB	21	3	25	23	20	8
Percentage of total area of country/province	38	4	97	36	86	20
Flow as percentage of MRB	16	2	35	18	18	11
Average flow (m^3/sec)	2410	300	5270	2560	2860	1660

Note: MRB, Mekong River Basin.

Source: MRC (2005).

Although the MRB is one of the richest areas of biodiversity in the world, six riparian states have quite different long-term major use patterns of the river. Three primary economic services for the millions who live in the MR are transportation, renewable freshwater, and electric power

(Roland-Holst and Heft-Neal 2012). Water resources are used mainly for hydropower production and irrigation (MRC 2010). Based on the calculated models of four main different sectors of water uses in 2010, Houba et al. (2013) show that (i) water use for irrigation generates the highest aggregate economic value for China and the LMB, and (ii) water use for hydropower generation contributes the second highest economic value for China, whereas fishery is the second highest for the LMB.

2.2 Energy demand and hydropower plants in the MR

The MR is endowed with abundant resources that have power generation potential, such as hydropower, natural gas, and coal. However, many countries in the region face difficulties in accessing financial resources and technologies to exploit the energy potential of these resources. Most of the oil and gas for potential development is located in the territorial waters of Cambodia, Myanmar, Thailand, and Viet Nam, whereas coal is in Yunnan province of China (ADB 2013). Owing to the regional diversity in economic development and rise in population, growth in primary energy demand differs by nations (Table 3).

Table 3: Energy demand in business-as-usual and alternative case scenarios

	Primary energy demand (Mtoe)		Annual growth	Primary energy demand per capita (toe)		Primary energy demand and growth rate with advanced technology	
	2010	2035	rate (%)	2010	2035	2035 (Mtoe)	Growth rate (%)
Cambodia	5.0	8.9	2.3	0.36	0.5	7.4	1.7
Laos	2.8	7.9	4.3	0.45	0.99	7.7	4.0
Myanmar	14.0	30.3	3.1	0.29	0.55	29.2	3.0
Thailand	117.4	204.8	2.2	1.70	2.79	183.5	1.8
Viet Nam	67.7	186.0	4.1	0.77	1.80	167.9	3.7
China	2471.1	4218.1	2.3	1.80	3.05	3418.7	1.4

Note: Mtoe, million tons of oil equivalent.

Source: ADB (2013).

As shown in Table 3, China has a higher potential for saving energy compared with any other nations in the MR: its annual growth rate reduces from 2.3 per cent in a BAU case to 1.4 per cent in the alternative case. Within the MR, it must be recognized that hydropower is only one of a number of purposes for which water is diverted or stored. Houba et al. (2013) report that hydropower generation in the LMB takes place in the tributaries and produces only 2 per cent of the total economic value of the LMB. This low value reflects the undeveloped hydropower potential. To date, China is the only country to have built dams on the Mekong mainstream.

According to King et al. (2007), Cambodia has a hydropower potential of 10,000 MW but an installed capacity of only 160 MW. With 90 per cent of land area in the basin, Laos has the greatest potential for hydropower development (13,000 MW) and could become a power hub for Thailand, Viet Nam, and the ASEAN power grid. Whereas Thailand is a major importer of hydropower and a potential hub for the ASEAN power grid, Viet Nam and Myanmar are important both as hydropower developers and as potential importers. The MRC has proposed many plans for developing this potential through dam projects; there are 11 mainstream dam proposals and 30 planned tributary dams to be developed between 2015 and 2030 (Kubiszewski et al. 2012). Moreover, Laos has started constructing the first of 11 planned hydropower projects on the Lower Mekong River mainstream, and hopes to become the 'battery of Southeast Asia', selling electricity to MR neighbours. Yunnan also installed 68 per cent of provincial power generation and is constructing a cascade of hydropower plants on the mainstream of the Mekong with 15,600 MW to be completed by 2025 (King et al. 2007: xi). Construction of dams on the Mekong River may pose immediate and long-term threats to the food security and livelihoods of over 60 million people in the LMB (MRC 2010).

2.3 Land-use change

Land and water are ecologically linked in a natural system (called a catchment,[5] drainage basin, or watershed). One of the major components that would affect future water and energy resources is change in land use. Different drivers cause different changes in land use. The impact that land-use changes can have on water resources is large, but quantifying these impacts presents many challenges. According to Rowcroft (2008), land-use changes are multifaceted and mainly caused by prices of agricultural and forest products. To maintain the MR as an important food production area with irrigation farmland, aquatic agriculture, and pasture, governments in the region have undertaken land reforms and put limits on shifting cultivation for conservation since 1980. However, rapid land-use change has occurred in the region since 2000.

The MRC Strategic Environmental Assessment report identifies expanding irrigation and loss of forest, farmland, and aquatic resource as the main consequences of mainstream dams (ICEM 2010). The loss of land is a direct impact of hydropower projects (MRC 2010) through construction of reservoirs, access roads, and transportations. According to Smajgl and Ward (2013), there are six national developments that would significantly influence land-use change in the MR till 2050: (i) expansion of mainstream dams, (ii) water diversion, (iii) rise in sea level, (iv) adaptation strategies in the Mekong delta, (v) expansion of rubber plantations, and (vi) transnational transport infrastructure (in particular, railway projects linking Kunming to Cambodia).

Having provided an assessment of the impacts of these developments related changes in land use, Xing (2013) shows that during 2000–08 farmland increased in Yunnan (61.3 per cent) and Laos (42.5 per cent) whereas pasture increased in Cambodia (61.3 per cent) but decreased in Yunnan (21.3 per cent). In addition, it is expected that 22,692.42 km^2 of forest will be converted to commercial plantations and mainstream dams may submerge 119.66 km^2 of riverbank gardens. Total area of land-use change is predicted to be 34068.71 km^2, as shown in Table 4. As all countries in the MR are undergoing rapid economic growth and modernization, hydropower is seen as a key component of this transition. The six riparian states of the MR have been grouped into different water institutions and programmes for managing the region since 1950.

Table 4: Accumulated area of land-use change

Possible decrease	Area (km^2)	Possible increase	Area (km^2)	Possible timeframe
Forested land	22,692	Reservoir	4101	
Farmland	8509	Irrigated farmland	4501	
Riverbank garden	120	See water	4768	By 2030
Pasture	787	Rubber	15,980	By 2050
Wetland	1230	Built-up	59	
Build-up	730	Mining area	4659	By 2030
Total	34,068	Total	34,068	

Source: Xing (2013: Table 6.10), reproduced with permission.

3 Regional development, integration, and challenges

The MR has a long history of development and dialogue among lower riparian countries. An increasing number of river-based cooperation institutions have emerged in mainland Southeast

[5] The catchment surface can be one of three types: water, forest (sparse dry deciduous), or agricultural land (including all non-forest land uses).

Asia since the early 1990s. Among these are the MRC, the GMS, and the Mekong Basin Development (MBD) that take place under the overarching framework of the ASEAN.

3.1 Regional development and integration

The MRC is an intergovernmental organization for regional dialogue and cooperation in the LMB, established in 1995, based on the Mekong Agreement on Cooperation for Sustainable Development of the MR (the so-called 1995 Mekong Agreement). As a successor of the Mekong committee, which was established in 1957, the MRC has the longest history of cooperation in the region. This regional institution works with many different partners, responsible for promoting and developing sustainable management strategies across all sectors including sustaining fisheries, identifying opportunities for agriculture, maintaining the freedom of navigation, flood management, and preserving important ecosystems (see MRC 2016: Annex A). However, the MRC has failed to attract China and Myanmar to join.

In 1992, the MR nations launched the GMS Economic Cooperation Program to promote integrative economic links among riparian nations. The GMS comprises Cambodia, Laos, Myanmar, Viet Nam, and the Yunnan province and the Guangxi Zhuang Autonomous Region of China. Unlike the ASEAN or the MRC, the GMS has all six riparian nations as members. With support from the ADB and other donors, the GMS programme has become a key for growth and development in mainland Southeast Asia over the past few decades. Particularly, the new GMS Strategic Framework for 2012–22, adopted in December 2011, expands the GMS programme from conventional infrastructure to multi-sector investments designed to allow the implementation of large-scale water infrastructures (such as building commercial relationships in terms of cross-border trade and transportation, energy development, investment, and water resource usage). This was also considered as a peaceful resolution of conflict in Indo-China relationships in the early 1990s: the integration of Cambodia, Laos, Myanmar, and Viet Nam into the ASEAN; the gradual opening of the Yunnan province and China itself to its southern neighbours; and with financial support.

ASEAN was established on 8 August 1967 in Bangkok, Thailand, with the signing of the ASEAN Declaration by five countries: Indonesia, Malaysia, the Philippines, Singapore, and Thailand. It was extended to five other nations: Brunei (1984), Viet Nam (1995), Laos (1997), Myanmar (1997), and Cambodia (1999). Having recognized the economic potential of the MRB and the opportunity for collaboration in the MR, the ASEAN set up an ASEAN-MBD Cooperation (AMBDC) on 17 June 1996, consisting of all member states of ASEAN and China. One of main objectives of the AMBDC is to strengthen the interconnections and economic linkages between ASEAN MR countries. The AMBDC is considered an important framework to enhance and sustain growth of the MR and a policy dialogue for ASEAN and China to foster economic development and cooperation.[6] In addition, the establishment of the ASEAN Economic Community (AEC) in December 2015 is a major milestone for regional economic integration in ASEAN. According to Petri et al. (2012), the AEC offers many opportunities to the business community and general public because it permits free movement of goods, services, foreign direct investment, and skilled labour and free flow of capital.

As all Mekong riparian countries are committed to developing market economies and have experienced rapid economic growth in the past few decades, the growing demand for electricity

[6] ASEAN's Mekong concept document emphasizes the complementarity of existing development programmes linking them to the Asian Development Bank–Greater Mekong Sub-region and the UNDP–Mekong River Commission (MRC) (Weatherbee 1997).

and the abundant hydroelectricity potential make hydropower development in the MR inevitable. How Mekong countries decide to pursue future hydropower development is perhaps one of the most challenging strategic decisions they have faced since the signing of the 1995 Mekong Agreement (MRC 2010).

3.2 Hydropower projects in the MRB and their impact

Transiting from its headwaters to a delta, with more than 4500 km of flow, the Mekong River provides a major source of energy potential through its basin. Hydropower projects in the MRB were first constructed in Laos and Thailand during the late 1960s and early 1970s. In 1986, China began building the first of a series of dams in the upper mainstream. At present (2015), hydropower opportunities are largely related to the mainstream and its immediate tributaries. The total potential for hydropower generation in the MRB is estimated as ~250,000 MW (ADB 2010). However, only a portion of this potential could be considered economically and environmentally feasible.

In its datasets released on March 2016, the CGIAR research programme on 'Water, Land and Ecosystems' lists a total of 392 dams ('datapoints') for the Mekong River (see Figure 1; WLE Greater Mekong 2015). Of these, 198 hydropower dams (installed capacity of ≥15 MW) are in various stages of planning and construction on both the Mekong mainstream and its tributaries. Table 5 presents an inventory of hydropower development in the MRB, revealing 66 hydropower dams that have been commissioned, 37 dams that are under construction, and 93 dams that are planned or proposed. Note that the total number of hydropower projects in China is 46 dams. However, two dams have been cancelled because of environmental problems (WLE Greater Mekong 2015). Before 1990, most hydropower development in the MR was publicly funded. However, this development has been transferred and led by commercial partnerships between private sector developers and local governments since the early 1990s (Hirsch 2011). Hydropower projects in the MR have generally been profitable for both host governments and private sector sponsors. The total monetary profits of hydropower operations in the next 20 years in the region is estimated to be US$15–20 billion, according to Li (2012).

Table 5: Number of hydropower development projects in the MRB

Country	Commissioned	Under construction	Planned	Total
China	17	10	17	44
Myanmar	0	0	6	6
Laos	20	26	57	103
Thailand	7	0	0	7
Cambodia	0	1	11	12
Viet Nam	22	0	2	24

Source: WLE Greater Mekong (2015).

Although dams can help with flood control in the wet season and with increased water supply for irrigation and navigation during the dry season for downstream riparian states, the potential negative consequences for the LMB are multifaceted and likely to materialize in ecological, economic, and negative political outcomes (Biba 2012). Ziv et al. (2012) also show that the completion of 78 dams on tributaries would have catastrophic impacts on fish productivity and biodiversity. According to Kubiszewski et al. (2012), the value of lost capture fisheries, future

aquaculture production in the LBM,[7] and the value of lost ecosystem services are estimated to be in the range of US$33 billion to 274 billion.

3.3 Challenges and opportunities in the MR

The rich human and natural resources, as well as the current peaceful political situation in the MR, have attracted many foreign investments and made it one of the world's fast growing regions (UNEP 2008). However, with globalization and population growth, development in the MR has had losses as well as benefits, thereby increasing pressure on land and water use. The series of floods in Laos (in later 2011, 2013, 2015) and the current drought in the Mekong delta (one of the world's granaries and Viet Nam's rice bowl) provide dramatic examples of how environmental mismanagement can be costly for the region (for details, see MRC 2012). Particularly, the heavy socioeconomic costs are disproportionately borne by downstream countries, especially Cambodia, Viet Nam, and riverine parts of Thailand (Cronin and Hamlin 2012).

According to Cronin (2012), the cumulative net economic profit was US$33.4 billion over 20 years, and total economic profits for 11 proposed dams ranged from a small positive sum of US$6.6 million to a larger negative (cost) sum of US$274.4 billion. Moreover, under the MBD plan, only Laos has a net profit whereas three other members of the MRC faced a loss ranging from US$50 billion to 128.9 billion (Kubiszewski et al. 2012). A particular challenge for the Mekong River is its tremendous diversity of fish species, which contribute to the wellbeing of more than 60 million people in the LMB. , all of the giant fish is highly threatened by pressure on fishing, and will be possibly driven to extinction by the construction of mainstream dams (Matthews and Geheb 2015; Ziv et al. 2012).

The growing human population and increasing energy demand have been accompanied by the spread of land-use change. Managing land resources, therefore, is a major challenge in meeting with demand for agricultural production, urban expansion, and other uses. In terms of electric power trading, exporting countries are China, Myanmar, and Laos (Table 6). China and Laos have the most potential for mainstream hydropower generation and are positioned to reap the most benefits from building dams on the Mekong. However, owing to climate change and to meet growing energy needs, the promotion of regional power generation, boosting low carbon source trade, reduction of the dependence on oil and coal imports, and the lowering of greenhouse gas emissions from power generation are not only challenges but also opportunities.

Table 6: Electric power trade and net import in 2010 (GWh)

Country	Import	Export	Total	Net import	Energy resources (2009)
China	1720	5659	7379	–3939	104,370
Myanmar		1720	1720	–1720	39,669
Laos	1265	6944	8209	–5679	17,979
Thailand	6938	1427	8365	5511	4566
Cambodia	1546		1546	1546	9703
Viet Nam	5599	1318	6917	4281	35,103

Source: ADB (2012: Tables 1 and A1.1).

In terms of intra-regional trade dependence and the degree to which China plays a role in that dependence, China has grown faster than the other five GMS countries (Cambodia, Laos, Myanmar, Thailand, and Viet Nam). As the China–ASEAN Free Trade Agreement (CAFTA)

[7] Further details of future impact on hydropower development in the Mekong region can be found in Kuenzer et al. (2013).

came into force in January 2010, it established the third-largest free trade area in the world, following the European Union and the North American Free Trade Area (NAFTA). However, since then China has been facing a challenge in getting the agreement formally implemented because the trade structure between China and ASEAN countries is competitive rather than complementary (Wang 2011).

Although China and Myanmar are not members of the MRC, the ASEAN has played an important role in economic development of the MR and has attracted international attention since 1995 (Hensergerth 2009; Weatherbee 1997). In this regard, the MRC, ASEAN, and GMS play a role in analysing opportunities of issue linkage in reaching a basin-wide agreement and clean energy transaction.

4. The role of issue linkages in managing the MR

As in most transboundary river basins, the relationships between upstream and downstream nations in the MR is politicized and disputed. China views the UMB primarily as a source of hydropower and as a trade route. Laos also considers the MR primarily as a source of hydropower, whereas Thailand seeks cheap energy and water for irrigation and agricultural sectors. More than 90 per cent of electricity in Laos is produced from hydroelectric plants, whereas the main value of the Mekong River for Cambodia is for fishery (Campbell 2009). Cambodia prefers the conservation of the current hydrological region, including the seasonal flooding, which gives rise to its significant fishery industry. Viet Nam, on the other hand, relies on the water to support the Mekong delta's agricultural production.

Owing to the impact of climate change and the rise in sea level, Viet Nam wants to protect its efficient agriculture and aquaculture production in the delta from saltwater intrusion. In addition, it is believed that the highly centralized Chinese government has more grips on its water resources than the fragmented MRC with its less effective management (Houba et al. 2013). Hence, potential conflicts exist between these demands for water, land use, and energy, which will require trade-offs among water-using sectors. The next section is based builds on the model framework of linked games with externalities in Pham Do et al. (2012) and its application to the MRB (Pham Do and Dinar 2014) and illuminates how issue linkage can be used as a mechanism in managing the MR.

4.1 A basic framework

Game theory is the formal study of conflict and cooperation.[8] In the context of the historical development and integration of the MR, Pham Do and Dinar (2014) argue that a negotiation process between upstream (China) and downstream (four LMB countries, represented by MRC) can be considered as a two-stage game. In the first stage, countries (China and LMB) can play at being non-cooperative over independent policy issues (strategies) such as energy (hydropower generation), trading, and the ecosystem (fishery and agriculture) to determine (evaluate) their policy (variables). Final outcomes, as the results of linked issues,[9] are then considered in the second stage for negotiating nations.

[8] Conflict or non-cooperative strategy refers to a situation in which a binding agreement cannot be achieved; while it is possible in cooperative strategy.

[9] The idea is that linking two (or more) policies (regimes) could allow countries to use surplus enforcement power that may be available in one policy domain to discipline cooperation in other domains.

Although the main task of the MRC is the nurturing of MBD plans for the mutual benefit of MR countries, it has weak policy instruments and seems politically biased in favour of hydropower generation (Grumbine et al. 2012). On the water management issue, LMB nations and China can be considered as having two strategies (regimes). LMB strategies are (i) weak governance (i.e. the four countries act individually/independently/as many voices) or (ii) strong governance (four countries can act collectively/jointly/as one voice, i.e. MRC). China can choose either to cooperate or not to cooperate with the LMB via the MRC.

On other hand, the GMS-5, consisting of Cambodia, Laos, Myanmar, Thailand, and Viet Nam as members of ASEAN, has advances on trading issues (such as introducing elements of the AEC as well as the AFTA and new international agreements with external partners) in negotiating with China. Hence, on the trade issue, implementing blueprints for building the ASEAN community by December 2015, each of these five players also has two strategies: to remain open (cooperative) or not (non-cooperative) with the others.

Mathematically, let $N=\{1,2 \ldots, n\}$ be a set of policy issues. Assuming that the upstream (U) and downstream (L) simultaneously make a policy choice or action $a_J=(a_{J1}, \ldots a_{Jn}) \in A_J$, where $J=U,L$; and each action (policy) profile $a=(a_U,a_L) \in A=A_U \times A_L$ specifies a policy choice for each player (region) with respect to each $i \in N$. Furthermore, for each issue[10] $i \in N$, each player J has a measurable payoff function w_{Ji}^a on action profile a with the objective function of players being linearly separable in policy issues; that is, $w_J = \sum_{i=1}^{n} w_{Ji}^a$. The corresponding stage game with strategy space $a_J=A_{J1} \times A_{J2} \ldots \times A_{Jn}=\{c,d\}^n$ is denoted by Γ. For example, for policy profile $a=(a_U,a_D)$ and two issues i and k (e.g. water and trading), the two-person games $\Gamma_i(a)$ and $\Gamma_k(a)$ can be described in the following two matrices:

	$\Gamma_i(a)$	Lower C	Lower D
Upper	C	$(w_{Ui}^{cc}, w_{Li}^{cc})$	$(w_{Ui}^{cd}, w_{Li}^{cd})$
	D	$(w_{Ui}^{dc}, w_{Li}^{dc})$	$(w_{Ui}^{dd}, w_{Li}^{dd})$

	$\Gamma_k(a)$	Lower C	Lower D
Upper	C	$(w_{Uk}^{cc}, w_{Lk}^{cc})$	$(w_{Uk}^{cd}, w_{Lk}^{cd})$
	D	$(w_{Uk}^{dc}, w_{Lk}^{dc})$	$(w_{Uk}^{dd}, w_{Lk}^{dd})$

To achieve a basin-wide agreement through linked issues, each player can consider two possible actions: C (or c) for cooperating or D (or d) for defection (selfish policy action). For any two independent games, the values of a two-linked game are determined as the sum of two values in these games. Hence, in a linked game, player J's payoff is $w_j = w_{Ji}^a + w_{Jk}^a$. The objective of each player is to maximize the final outcome $w_j = \max_a \left\{ w_{Ji}^a + w_{Jk}^a \right\}$ (for further details, see Pham Do et al. 2012). Without loss of generality, it is assumed that both the LMB and China (UMB) are faced with two strategies—cooperation and non-cooperation—in each independent game.

[10] Such as dam construction plan, trading and energy plan, ecosystem protection, and environmental policy, and so on.

4.2 Independent games in the first stage

A water game

China's water resources can be used for industrial and household activities during the wet season and then stored for use in the dry season. China's outflow in the wet season fosters local fish reproduction before it runs to the mainstream of the LMB downstream. During the dry season, water inflow plus the stored water can be used for similar purposes as in the wet season and outflow from the dams can also be used for irrigation. For the tributaries of the LMB, water inflow can be used for similar economic activities as in China; water flows in the LMB are similar to those in the UMB, except for the impact of dams on the flow of tributaries.

Water inflow for the mainstream LMB solely consists of the outflow received from China. In each region (UMB and LMB), the economic values of water use are determined by aggregating four main activities for each season (wet and dry) (for details, see Houba et al. 2013): (i) dam capacity for hydropower generation and mitigation of flood damage, (ii) industrial and household activities, (iii) irrigated agriculture, and (iv) environmental services or damages (i.e. wetland benefits or damage from saltwater intrusion in the estuary during the dry season). From the annual economic net values under cooperation and non-cooperation, a water game can be determined as shown in Table 7.

Table 7: MR water game

		LMB	
		Strong governance	*Weak governance*
China	*Cooperation*	(2.75, 22.06)*	(3.76, 21.05)
	Non-cooperation	(2.73, 22.03)	(2.73, 20.03)

Note: *Nash equilibrium.

Source: Pham Do and Dinar (2014: 500).

In the water game, the dominant strategy is either not to share water (i.e. upstream) or not to pay for the water (i.e. downstream), because sharing or making side payment always costs China/LMB some welfare reduction.

As seen in Table 7, the total basin level annual incremental welfare gains are US$2.05 billion (i.e. 24.81–22.76) for moving from *non-cooperation* (22.76) to *cooperation* (24.81) under *weak governance*, and US$0.05 billion (24.81–24.74) under *strong governance*. In general, LMB nations can obtain almost the same joint welfare with strong governance, regardless of China's situation. If LMB nations act individually (*non-cooperation*), however, the total net aggregate economic welfare is lower. From the perspective of China, the incentives are quite different. China does not perform its best under the Nash equilibrium (2.75, 22.06), although the total economic welfare could be better under the cooperative situation for both parties. Particularly, China can gain more with weak governance in the LMB. This observation could explain why China is interested in signing bilateral agreements rather than multilateral ones, as shown in studies of Naohiro (2012) and Yongqi and Anfei (2013).

A trade game

Over the last two decades (1990–2010), the trade/GDP ratio is 131 per cent (in 2010) for the region as a whole (Petri et al. 2012). ASEAN markets are especially important for Laos and Viet

Nam. However, Laos appears to be a 'free rider' in ASEAN and Viet Nam is a loser, although the latter is a potential player for agricultural productions.[11]

As trade is an important driver of economic growth, ten members of ASEAN agreed to implement the AEC by the end of 2015, which commits to free movement of goods, services, foreign direct investment, and free flows of capital (ASEAN 2010). Hence, all ASEAN economies are open to trade and investment. With AEC, the strategy of LMB members of ASEAN is either to retain barriers with non-ASEAN partner economies (such as China) or to remove the barriers (i.e. open trade with more partners of the world). According to Petri et al. (2012), the region's share pattern is essentially symmetric. About one quarter of overall ASEAN trade is shared within ASEAN as well with the United States, the European Union, China, and Japan, and the rest of the world. China, therefore, is considered as a partner of ASEAN and is involved with AEC only under two arrangements: (i) increased bilateral free trade area with the four LMB states (under CAFTA) where the states are members of AFTA, or (ii) bilateral free trade area with AEC (under AFTA).

Table 8 represents the MR trading game. Note that the welfare gain of the LMB is defined as the aggregated gains obtained from all four LMB nations in ASEAN. One can easily see that the LMB has open trade as the dominant strategy, whereas China's dominant strategy is CAFTA. In this game, the Nash equilibrium (*CAFTA, Open*) is not efficient as the total outcome is less than in (*AFTA, Open*). Scrutiny of the MR water game and the MR trade game (Tables 7 and 8) suggests clearly that playing each game separately will lead to nowhere.

Table 8: MR trade game

		LMB	
		Open	*Restrict*
China	*CAFTA*	(–7.8, 15.4)*	(0.4, 2.8)
	AFTA	(–12.2, 52.9)	(–4.6, 12.0)

Note: *Nash equilibrium (*CAFTA*, *Open*), (*CAFTA*, *Restrict*), (*AFTA*, *Open*), and (*AFTA*, *Restrict*) values are taken from columns AEC, AFTA, AEC++, and AFTA+, respectively, in Petri et al. (2012: Table 6).

Source: Pham Do and Dinar (2014).

4.3 Linked game in the second stage

As mentioned earlier, *cooperation* is the dominant strategy in the water issue, whereas *open* is the dominant strategy in the trade issue. Taking into account the two outcomes of the water issue and the two outcomes of the trade issue, a linked game[12] can be presented, as shown in Table 9.

Table 9: The linked MR game

		LMB	
		Liberalize (*c*)	Status quo (*d*)
China	Liberalize (*c*)	(–5.05, 37.46)*	(–4.04, 36.45)
	Status quo (*d*)	(–9.25, 74.96)	(–8.24, 73.95)

Note: *Nash equilibrium.

Source: Pham Do and Dinar (2014: 500).

[11] Owing to lack of data in a water game, the values of the trade game is based only on trade results related to the four states of the Lower Mekong Basin (LMB) and China.

[12] As we aim to investigate whether or not China will consider joining the MRC in the context of ASEAN, we assume the LMB states act in one voice in the linked game.

In Table 9, the values of the linked game are determined from two games (Tables 7 and 8). For example, (−5.05, 37.46)=(2.75−7.8, 22.06+15.4), (−4.04, 36.45)=(3.76−7.8, 21.05+15.4), (−9.25, 74.96)=(2.75−12.0, 22.06+52.9), and (−8.24, 73.95)=(3.76−12.0, 21.05+52.9).

The linked game indicates that the total social welfare will increase when water and trade issues are considered together. Note that the main uses of water are taken into account in the water game, whereas all agricultural products and the electric power trade are considered in the trade game. Hence, with a higher outcome, the LMB could make a side payment to China. The losses and gains are similar for China and the LMB in the linked game. For example, the outcome (−9.25, 74.96) indicates the total payoff of 65.71 which is 74.96−9.25, whereas for the total outcome (−8.24, 73.95) the payoff is 65.71 which is 74.96−9.25. For the others, the outcomes (−5.05, 37.46)* and (−4.04, 36.45) both lead to 32.41. Thus, linkage issue will give more opportunities for countries in the negotiation process.

5 Policy implications and concluding remarks

Like any developing economy of the world, the MR is influenced in various ways by pressures from global markets, increased demand for natural resource and energy, as well as the impact of climate change and mitigation efforts. The transboundary negative externality nature of the flow of the Mekong River adds an extra dimension of complexity to the debate about equitable sharing of resources in the MR, particularly for hydropower plants as alternative strategies in achieving clean energy transitions. In theory, benefit sharing can improve the livelihood of people impacted by hydropower development. In practice, however, benefit sharing in the MR has shown mixed results.

This paper demonstrates the advantages of linked issues in bringing together five (or six) countries into a common framework for coordinating and managing the MR. Issue linkages allow balancing the interests of all stakeholders in the MR. For example, the MRC is not a strong and solid organization. However, with international and regional support, LMB nations have the incentive to negotiate with China regarding the trade issue. This opportunity will help the LMB nations (via MRC) to decide on how to strike a balance between hydropower development and the preservation of conditions necessary for sustaining (fish and agricultural production) ecosystems in the future. In addition, further opportunities and investment should be considered and added.

Having examined the ability of facilitating cooperation (by allowing countries to tie together issues in which they have dissimilar interests), this paper also shows that LMB countries can benefit most from linked issues. Particularly, the MR problem is not a lack of mechanism but of creating an effective body out of a multiplicity. Hence, in managing the MR energy transition, water is just one issue to be taken into account, and is insufficient on its own to establish a viable regime in managing sustainable development. The policy measures, therefore, are to establish a legal framework in which more issues should be considered simultaneously, thus implementing the beneficial procedures of issue linkages.

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