UNDERSTANDING THE LAND USE AND WATER SYSTEMS OF THE MEKONG

IS CHINA USING THE LANCANG-MEKONG COMMISSION TO TAKE ADVANTAGE OF LESS STABLE SOUTHEAST-ASIAN COUNTRIES?

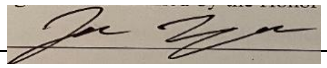
A Thesis Prospectus
In STS 4500
Presented to
The Faculty of the
School of Engineering and Applied Science
University of Virginia
In Partial Fulfillment of the Requirements for the Degree
Bachelor of Science in Systems Engineering

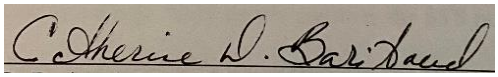
By
Jacob Walsh

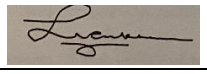
October 31, 2019

Technical Project Team Members
Jacob Kuchta
Chris Pufko
Charlie Rowe
Scott Stoessel

On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

Signed:  Date: 12/9/19

Approved:  Date: Dec. 13, 2019
Catherine D. Baritaud, STS Division, Department of Engineering and Society

Approved:  Date: 12/5/19
Venkataraman Lakshmi, Department of Engineering Systems and Environment

The Mekong River is the longest river in Southeast Asia, the seventh longest in Asia, and the 12th longest in the entire world. Its winding 4,350 km of running water provides irreplaceable resources for six different countries: China, Myanmar, Laos PDR, Vietnam, Thailand, and Cambodia (Jacobs, 2019). For centuries, millions of people have relied on the Mekong for agriculture, aquaculture, water needs for domestic and industrial purposes, and as a mode of transportation. As Southeast Asia continues to develop and urbanize, the need for energy, as well as agricultural and fishery production, steadily grows. The Mekong provides much needed food, water, and energy for a near 60 million people (Sabo, 2017, p.1). Since the early 1960's, the creation of hydropower infrastructure and sand-mining for concrete production have been crucial factors that have spurred urbanization and economic growth in the region (Sabo, 2017, p.1).

As a result, the ecosystems and communities of the Mekong have been facing increasingly serious threats to stability. As Sabo highlights: "Hydropower development is crucial to the region's economic prosperity and is simultaneously a threat to fisheries and agriculture that thrived in the natural-flow regime" (Sabo, 2017, p.1). As climate change becomes an increasing threat to ecosystems everywhere, and hydropower and sand-mining developments continue, there is a growing concern over preservation of the natural resources associated with river. The technical portion of this paper will analyze the land and water use of the Mekong in its current state to quantifiably model the dynamics and relationships of drivers of change in the Mekong river system as a whole. Very tightly coupled, the STS portion will explore the current dynamics of the Chinese government's involvement in the Mekong River system and its resources. The goal is to analyze current political structure between Mekong region countries and research potentially solutions to the political power of China in the region. Under the guidance of Engineering Systems and Environment professor Venkataraman Lakshmi and assistance of

fellow Systems Engineers Charles Rowe, Jacob Kuchta, Christopher Pufko, and Scott Stoessel, I will research the topics presented above.

UNDERSTANDING THE LAND USE AND WATER SYSTEMS OF THE MEKONG RIVER

The Mekong river region, one of the largest water systems in Asia, serves of enormous importance to both economic and industrial growth in southeast Asia, as well as way-of-life for millions of inhabitants. World Wildlife Fund (2016), one of the world's largest nonprofit conservation organizations, reports that the Mekong is currently facing a critical point in its existence where upcoming developments and environmental changes will define economic performance for decades to come (p.1). Of the many drivers of environmental change in the region, there exist three specific drivers of change on the Mekong river system with significant economic and social effect: hydropower development, climate change, and sand-mining. The effect of changes in hydropower development, general climate normality, and sand-mining can be split up in to two overlying categories: social and economic. Furthermore, the social and economic effects of these three drivers of change are felt most heavily in three particular industries reliant on the Mekong river: agriculture, aquaculture, and energy. To highlight the structure put forth, Figure 1 on page 3 is an overarching causal flow diagram for the greater Mekong region which aims to graphically represent the interactions between key drivers of change and the industry sectors those drivers are acting upon. As shown, both hydropower developments and climate change have effect on all three Mekong-reliant industries, however sand-mining has particular effect on agriculture and aquaculture, with negligible effect on energy.

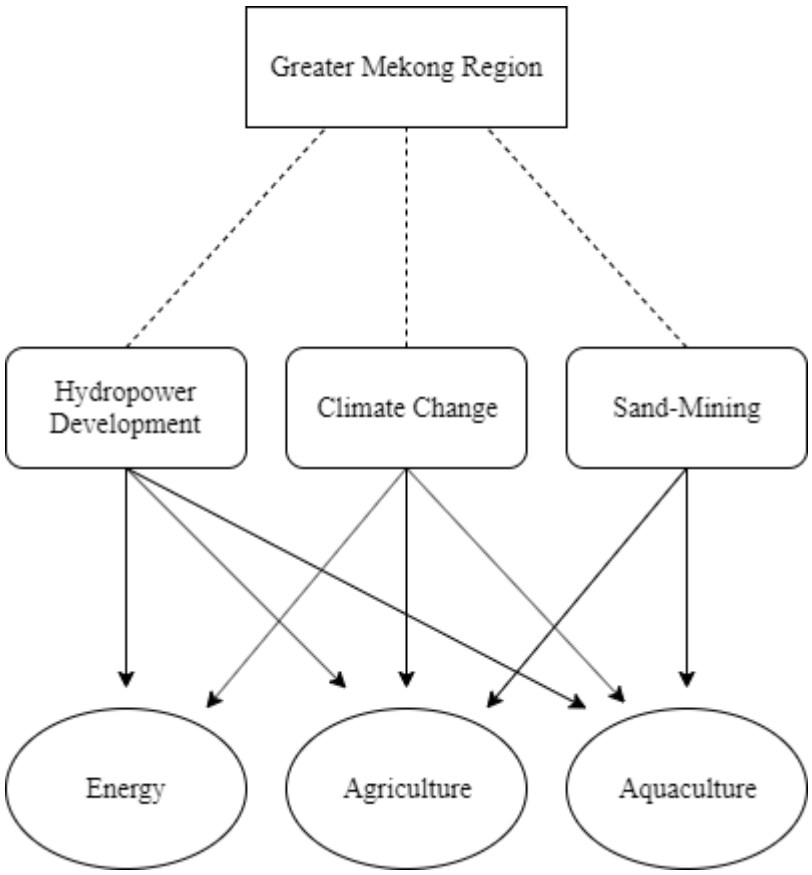


Figure 1: Land and Water Use Model of the Mekong: Shows the key drivers of change in the Mekong region, as well as the particular industries which are being changed (Walsh, 2019)

HYDROPOWER DEVELOPMENTS STRECH THE LENGTH OF THE RIVER

Sources of change are both unique in geographic location and relative effect. Hydropower in the Mekong, in particular, has large amounts of related research and data. Jory Hecht (2018), hydrologist with the United States Geological Survey, breaks down ecological factors involved with hydropower development, noting that changes to the ecology of the Mekong have serious implications for fishing and farming communities (p.3). Hecht (2018) uses the standard seasonal characterization of the wet season as June to November where there is a significant increase in rain, and the dry season from December to May where average rainfall significantly decreases (p.2). He goes on to note that "reduced wet season flows and increased

dry season flows will potentially damage the river's ecological productivity and the livelihoods of the people dependent upon it" (p.3). Long P. Hoang (2018), a postdoctoral researcher for Water Systems and Global Change at Wageningan University, has quantified potential flow changes in response to hydropower infrastructure as +160% in dry season and -40% in wet season (p.601). Hoang supports Hecht's argument that such seasonal changes have a significant effect on agriculture. In addition to the drying of soil in a crucial period for the agricultural industry of the lower Mekong region, dam construction and operation, particularly in upstream locations, both reduces vital nutrient transport and increases risk of saltwater intrusion (Hecht, 2018, p.3). From a geographic perspective, most of these agricultural changes are being felt in Vietnam and Cambodia; countries located in the Lower Mekong region, often referred to as the greater Mekong River Delta or downstream Mekong.

CLIMATE CHANGE

According to Wassmann (2004), a climate change expert at the International Rice Research Group, about 78% of land in the Vietnamese Mekong Delta in the year 2000 was used for rice production, and most of the land in the Delta is less than two meters above sea-level (p.90). Wassmann (2004) goes on to estimate that a one-meter increase in sea level caused by climate change would result in a loss of $17 billion in GDP from the agricultural sector in Vietnam (p.92). Along with sea level rise, there are increasing concerns about average temperature rise. Tuan Ahn Le (2014) of the Research Institute of Climate Change explains how temperature rise "in the upstream region of the Mekong River may affect the flood regime of the Mekong Delta, which may lead to an extension of the current boundaries of flooding patterns" (p.207). Tuan Ahn Le (2014) goes on to explain that these new environmental challenges are

extremely disconcerting for those in the Delta who make their living off of agriculture and aquaculture (p.207).

SAND-MINING IN THE MEKONG DELTA

Vietnam also faces many risks from another important market: sand and gravel mining. According to Vince Beiser (2018), journalist for National Geographic, sand-mining is becoming increasingly popular as sand is a main ingredient in cement and production of cement in Vietnam is skyrocketing to keep up with urban growth. A result however, of such rapid sand-mining, communities on the river bank have suffered. Beiser (2018) insists "towns and villages all along the Mekong River…are collapsing into the water, taking with them farm fields, fish ponds, shops, and homes" (p.1). There have been studies done on the amount of sand being mined by lower Mekong countries such as Thailand, Vietnam, and Cambodia. Jean-Paul Bravard (2013), Emeritus Professor of Geography at Lumiere University Lyon 2 in France, conducted studies and surveys on the gravel mining tactics and frequency in the Mekong Delta. Bravard made estimates for sand-mining volumes in 2011, stating that "the quantity of sand mined" in Laos, Thailand, Cambodia, and Vietnam "was 49.6 Million tons" (p. 7). As cities continue to urbanize in Southeast Asia, the demand growth for sand will continue. At the rate of extraction seen currently, there are major concerns for both ecological norms of the river as well as structural integrity of river-side communities.

With all of these changes occurring simultaneously, it becomes increasingly hard to understand both the positive and negative effects of each activity. Without quantification of economic and social interactions between facets of change in the Mekong region, countries of this sub-region of Asia face intense threats to the sustainability of current economic growth, conservation of extremely important and diverse ecosystems, and livelihoods of thousands of

below-average income communities along the Mekong River. The objective of this research study is to define the economic and societal impact of changes in quantitative terms, thus allowing for a better understanding of the challenges faced by the Mekong region. By mapping out both positive and negative effect of changes, and attempting to quantify these effects, a much clearer understanding of land and water use in the Mekong can be gained.

Wei Wang (2017) of the Changjiang Institude of Survey, Planning, Design and Research notes that problems are not limited to just one country; the millions of people reliant on the Mekong River are spread between China, Laos PDR, Thailand, Vietnam, and Cambodia (p.1). Moreover, particular actions and results related to the Mekong differ in each country. Prior to quantifying economic and social relationships between drivers of change and industries, each individual country must be segmented to properly model unique changes and challenges pertaining to that country in particular. Once there is a clear understanding of challenges being faced by each segment, connections between geographical segments can be modelled. It is clear that issues faced by the upper Mekong region are different than those faced by the lower Mekong region. However, actions taken in the upstream of the Mekong River, particularly in China, have clear effect on the changes being felt in the Vietnam Mekong Delta. It is imperative that connections between actions in different regions be quantified in order to promote sustainability of the region. It is anticipated that through data collection and quantitative research methods, a much broader and quantifiable model of land and water use in the Mekong River region can be created. Over the next two months, research and general model structuring will be conducted. Following this research timeframe, the data collection and model quantification period will begin. It is intended that this model will be created and quantified through a conference style paper over the following four months.

IS CHINA USING THE LANCANG-MEKONG COMMISSION TO TAKE ADVANTAGE OF LESS STABLE SOUTHEAST-ASIAN COUNTRIES?

Although the Mekong River stretches thousands of miles through Southeast Asia, there is one small portion of the River that seems to have an inordinate amount of control over the Mekong region. The Mekong River starts in the southern portion of Tibet in China and flows 4,350 km south to the South China Sea (Wang, 2017). Over the past 20 years, increasing concerns about carbon dioxide emissions have driven our Earth's biggest polluters, such as China, to look towards more renewable sources. China is notorious for its dam construction. In 1994, China started plans for the Three Gorges Dam on the Yangtze River, the largest engineering project in the country at the time (Wee, 2012). By 2006, when the dam was completed, it was the largest dam in the world (Wee, 2012). In the process, however, the Chinese government relocated 1.3M people. According to Sui-Lee Wee (2012), a reporter for Reuters, hundreds of thousands of people will continue to be relocated due to geological threats. Examples of previous hydropower projects in China, such as the Three Gorges Dam, highlight the Chinese governments commitment to political and economic agendas, regardless of the network in which those agendas are acting. From a historical perspective, the Chinese government has frequently made controversial decisions in regards to neighboring countries with the hope of economic expansion. For example, Lieutenant Michael Studeman (1998) of the U.S. Navy wrote about controversy arising in the South China Sea relating to Chinese attempts at securing natural resources, specifically oil, off the Vietnamese coastlines (p.68). Lt. Studeman explains that though China asserts sovereignty and nationalism as their claim to resources, "sensitivity to resource encroachments and a growing fear of economic dependence has emerged as a primary determinant of China's willingness to assert itself physically" (p.68)

It has long been understood that much of China's foreign policy in the Southeast Asian region relates to their motivation to economically expand and assert control. In more recent years, a great deal of focus has shifted to the hydropower energy potential of the Mekong River. The Chinese portion of the river, referred to as the Lancang River, has had seven dams built since the year 2000 (Beech, 2019). As China is in control of the very upper reaches of the river flow, decisions made by the Chinese government on hydropower operation and construction play a massive role in the economy of Lower Mekong Region countries; particularly Laos and Cambodia. In fact, as cited by the U.S. Secretary of State, Mike Pompeo (2019), river flows have been at all-time lows, predominantly caused by operations of the numerous dams in upstream China. At a conference with the Association of Southeast Asian Nations, Pompeo (2019) insisted there was "a spree of upstream dam building which concentrates control over downstream flows. The river has been at its lowest levels in a decade – a problem linked to China's decision to shut off water upstream". (p.1)

Chinese state-owned entities, under direct control of the Chinese government, have recently moved to building dams in the Lower Mekong with claimed hopes of providing "countries with a model for lifting themselves out of poverty" (Beech, 2019). For years, the Mekong River Commission has tried to balance the trade-offs of the river. According to Hannah Beech (2019) of the New York Times, the Mekong River Commission predicted damming plans in the early 2000s would "reap $30 billion in benefits", however, "a reassessment years later by the same commission, which China refused to join, produced a far different forecast." (p. 1) Reassessment led to the conclusion that hydropower plans would result in a $7 billion hit to the economies of the lower Mekong.

China's refusal to join the Mekong River Commission is emblematic of their commitment to their own political agenda. In recent years, however, China has attempted to change the narrative, as shown through their cooperation with downstream Mekong governments. The Lancang-Mekong Commission (LMC), established in 2016, has been China's main attempt at cooperation with other Asian countries reliant on the Mekong, but it is often seen as an attempt by the Chinese government to replace current mechanisms regulating the river (Wu, 2018). Speculation remains that China is only taking part in LMC as an attempt to gain political control. The chronology of the commissions is emblematic of Chinese cooperation in regards to resources. The original Mekong River Commission was established in 1995, meaning it took China nearly 21 years to attempt at cooperating with their Southeast Asian neighbors. In Beech's article in the New York Times, Maureen Harris, Southeast Asia program director at International Rivers asks "Are these dams for the good of the Mekong downstream countries, or are they for the good of a country like China that's trying to gain economic influence and offload excess capacity?" (Beech, 2019).

The complication arises in attempts to understand the Chinese government's true intention in plans to increase hydropower infrastructure in downstream countries. Countries like the United States are insistent that China is looking to gain control over the river, and thus gain control over countries like Laos and Cambodia (Pompeo, 2019). In Laos, specifically, hydropower will be its main industry and revenue generator by 2025, having signed off on 140 dams for the Mekong, and borrowing massive amount of money from China to aid construction (Beech, 2019). Actor-network theory (ANT), developed by Michel Callon and Bruno Latour (1984), will be used to describe the network of relationships between actors in policy related to China's hydropower developments. It becomes clear that certain actors, such as the Chinese

government, have inordinate amounts of power, while commission forces are becoming increasingly less relevant and a network of imperative individuals are suffering desperately. If the Chinese government will only cooperate with Laos and Cambodia through LMC, then entities originally created to protect everyone's interest, such as the original Mekong River Commission (MRC), will become irrelevant and only policy approved in LMC will take action. Additionally, as an actor, China is now able to influence government policy in Laos and Cambodia through two methods: Directly through control of seasonal flow via upstream dam operation, and indirectly via LMC. As shown in Figure 2 on page 11, the current state is one in which China has strong control of the Lancang-Mekong Commission and thus strong control over Laotian and Cambodian political action. The original Mekong River Commission (MRC), which China refused to join, has weak influence without the political and financial power of China, meaning China's control allows for increased hydropower infrastructure (Wu, 2018). Eventually, all of this interaction between actors leads to a network of fishers, farmers, and riverside villagers feeling the negative consequences of energy production the most. Through research of Chinese governmental policy and cooperation with Mekong River regulation groups,

this STS research paper aims to address the disproportionate amount of control one actor, China, has over other actors in the Mekong region both politically and economically.

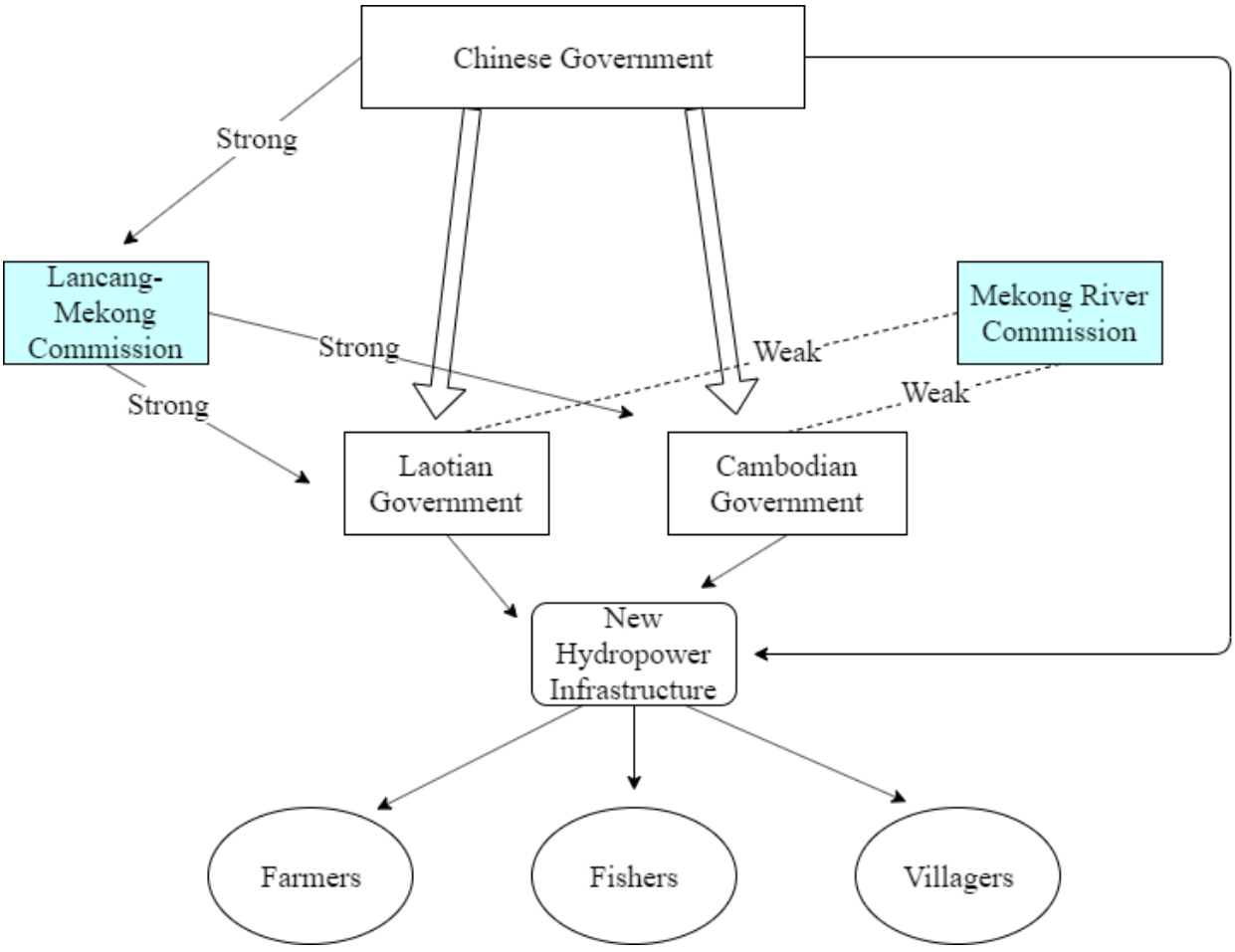


Figure 2: Current ANT of Political and Regulatory system in Mekong: China has significantly more power as an actor. Farmers, Fishers, and Villages are being acted upon in response to new hydropower infrastructure. (Walsh, 2019)

The desired outcome for the network is one in which the Chinese, Laotian, and Cambodian governments work together as actors under a unified commission to appropriately balance the trade-offs of the Mekong River. The current state, in which the Chinese government is gaining a disproportionate amount of power over downstream countries, is dangerous to the stability of the region both from a political and environmental standpoint. Figure 3 on page 12 displays an example Actor-Network model that is much more beneficial for fisheries, agriculture,

and overall economic health of downstream countries such as Laos and Cambodia. Governments are working together under a unified commitment to restoring the health of the Mekong, and creating environmentally and relatively economically positive trade-offs for resource usage. In addition, there is a connection from the network back to the actors, as ideally the network has some influence on the actor's policy decisions. This paper aims to assess the current state in Figure 1 and identify evidence of China's disproportionate power, and address the changes necessary to reach the desired state in Figure 2.

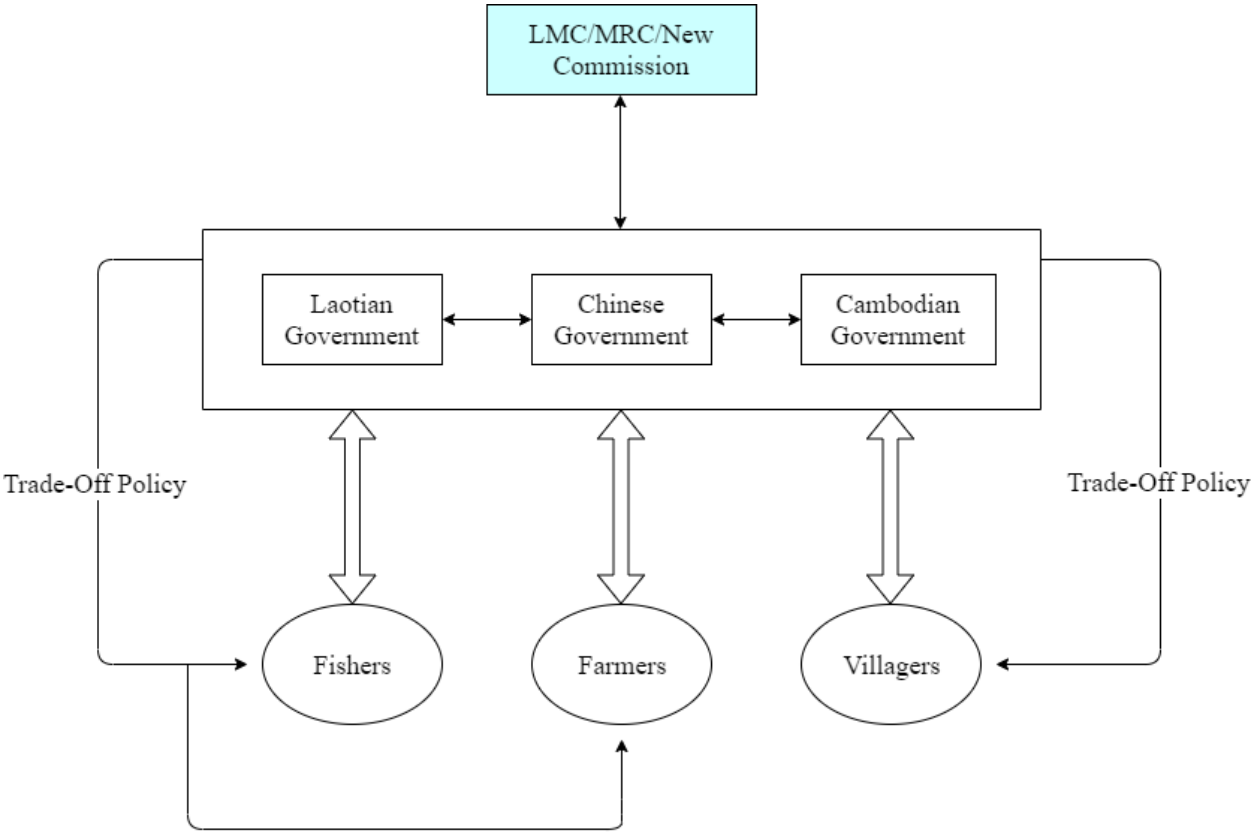


Figure 3: The desired ANT of the Political and Regulatory system in Mekong: A new commission is put forth with all actors in agreement of regulatory environment for trade-off policies relating to land and water usage on the Mekong. Fishers, Farmers, and Villagers being acted upon are now providing feedback to the actors for a more sustainable future. (Walsh, 2019)

The desired regulatory system in which there is a unified commission agreeing on trade-off policy is imperative to regional preservation, yet very difficult to establish and ensure. It is

highly reliant on the cooperation of the Chinese government as they have a great deal of economic power and influence in the region. It is unlikely that smaller nations such as Laos and Cambodia can exert enough pressure on China to reform plans for resource usage. It is far more likely for China to agree on a new unified commission if pressured by more powerful nations around the globe, such as the United States. Through foreign policy improvement with Mekong region countries, and increased pressure on an equality-based commission for resource usage, countries like the United States can work to reform the Mekong river hydropower actor-network. Ideally, these changes can provide consideration to forgotten actors, such as Farmers and Fishers, while also providing macroeconomic benefit to all Mekong-reliant Asian countries.

WORKS CITED

Beech, H. (2019, October 12). 'Our river was like a God': How dams and China's might imperil the Mekong. *The New York Times.* Retrieved from https://www.nytimes.com/2019/10/12/world/asia/mekong-river-dams-china.html?smid=nytcore-ios-share

Beiser, V. (2018, March). See how sand mining threatens a way of life in southeast Asia. *National Geographic.* Retrieved from https://www.nationalgeographic.com/news/2018/03/vietnam-mekong-illegal-sand-mining/

Bravard, J. P., Goichot, M., & Gaillot, S. (2013). Geography of sand and gravel mining in the lower Mekong river. *EchoGeo, 26*(1), 1-14. doi:10.4000/echogeo.13659

Hecht, Jory & Lacombe, Guillaume & Arias, Mauricio & Dang, Thanh & Piman, Thanapon. (2018). Hydropower dams of the mekong river basin: a review of their hydrological impacts. *Journal of Hydrology. 568. 285-300.* 10.1016/j.jhydrol.2018.10.045.

Hoang, Long & van Vliet, Michelle & Kummu, Matti & Lauri, Hannu & Koponen, Jorma & Supit, I. & Leemans, Rik & Kabat, Pavel & Ludwig, Fulco. (2018). The mekong's future flows under multiple drivers: how climate change, hydropower developments and irrigation expansions drive hydrological changes. *Science of The Total Environment.* 10.1016/j.scitotenv.2018.08.160.

Jacobs, J.W., Owen, L., White G.F., (2019). Mekong river. *Encyclopedia Britannica.* Retrieved October 22, 2019, from https://www.britannica.com/place/Mekong-River

Latour, B. (2005). *Reassembling the social: An introduction to actor-network-theory*. Oxford: Oxford University Press

Matthews, N., Motta, S. (2015). Chinese state-owned enterprise investment in Mekong hydropower: Political and economic drivers and their implications across the water, energy, food nexus. *Water 2015, 7*(11), 6269-6284. https://doi.org/10.3390/w7116269

Pompeo, M. (2019, August 1). *Proceedings from the 2019 ASEAN Summit conference.* Retrieved from https://www.apnews.com/949053513390424c881a1cdba4c80b1b

Sabo, J., Ruhi, A., Holtgrieve, G. W., Elliott, V., Arias, M. E., Ngor, P. B., ... Nam, S. (2017). Designing river flows to improve food security futures in the lower mekong basin. *Science, 358*(6368). https://doi.org/10.1126/science.aao1053

Studeman, M. (1998). Calculating China's advances in the South China Sea: Identifying the triggers of "expansionism". *Naval War College Review, 51*(2), 68-90. Retrieved from http://www.jstor.org/stable/44638139

Walsh, J. (2019). Figure 1: Land and water use model of the Mekong.

Walsh, J. (2019). Figure 1: Current ANT of political and regulatory system in Mekong.

Walsh, J. (2019). Figure 2: Desired ANT of political and regulatory system in Mekong.

Wang, W., Lu, H., Leung, L. R., Li, H.-Y., Zhao, J., Tian, F., Yang, K., & Sothea, K. (2017). Dam construction in lancang-mekong river basin could mitigate future flood risk from warming-induced intensified rainfall. *Geophysical Research Letters*, *44*, 10378– 10386. https://doi.org/10.1002/2017GL075037

Wassmann, R., Hien, N.X., Hoanh, C.T. et al. (2004). Sea level rise affecting the Vietnamese Mekong delta: Water elevation in the flood season and implications for rice production. *Climatic Change*, 6(1), 89-107. https://doi.org/10.1023/B:CLIM.0000043144.69736.b7

Wee, S.L., (2012, August 22). Thousands being moved from China's Three Gorges – again. *Reuters.* Retrieved from https://www.reuters.com/article/us-china-threegorges/thousands-being-moved-from-chinas-three-gorges-again-idUSBRE87L0ZW20120822

World Wildlife Fund. (2016, November 10). Development on the Mekong River risks entire region's economy: WWF report [Press release]. Retrieved from http://greatermekong.panda.org/our_solutions/mekongintheeconomy/

Wu, S.S., (2018, December 19). The trouble with the Lancang Mekong cooperation forum. *The Diplomat.* Retrieved from https://thediplomat.com/2018/12/the-trouble-with-the-lancang-mekong-cooperation-forum/