NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

HYDROELECTRIC DEVELOPMENT IN LAOS

by

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March 2020

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REPORT DOCUMENTATION PAGE			*Form Approved OMB No. 0704-0188*

1. AGENCY USE ONLY ***(Leave blank)***	**2. REPORT DATE** March 2020	**3. REPORT TYPE AND DATES COVERED** Master's thesis

4. TITLE AND SUBTITLE
HYDROELECTRIC DEVELOPMENT IN LAOS

5. FUNDING NUMBERS

6. AUTHOR(S) Clark J. Morgan

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Naval Postgraduate School
Monterey, CA 93943-5000

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
N/A

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release. Distribution is unlimited.

12b. DISTRIBUTION CODE
A

13. ABSTRACT (maximum 200 words)

Laos's pursuit of hydroelectric development for economic development and to become the "Battery of Asia" has achieved short-term goals. Long-term growth is inconclusive as environmental damage from each dam is changing agriculture and fishery production in Laos.

This thesis used the World Energy Council Trilemma to assess the impact of increased hydroelectric availability. Laos's energy security has remained marginally improved with the increased availability of electrical power, but this does not address deficiencies with access to petroleum. Energy equity improved from higher electrification and affordable energy to the population. According to the Trilemma, Laos's use of hydropower improves environmental sustainability. The Trilemma does not consider the social, agriculture, or fishery impacts of hydropower development. The Nam Theun 2 dam demonstrates that the people and environment are negatively impacted, but the full impact remains to be seen in the next ten years. Laos's actions reveal short-term economic goals were pursued over consideration of the impact on the people and environment.

14. SUBJECT TERMS hydroelectric, dams, environmental, renewable energy, development, developing states, trans-boundary, Laos	**15. NUMBER OF PAGES** 99
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	**18. SECURITY CLASSIFICATION OF THIS PAGE**	**19. SECURITY CLASSIFICATION OF ABSTRACT**	**20. LIMITATION OF ABSTRACT**
Unclassified	Unclassified	Unclassified	UU

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18

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HYDROELECTRIC DEVELOPMENT IN LAOS

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Submitted in partial fulfillment of the
requirements for the degree of

**MASTER OF ARTS IN SECURITY STUDIES
(FAR EAST, SOUTHEAST ASIA, THE PACIFIC)**

from the

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TABLE OF CONTENTS

I. HYDROPOWER IN LAOS 1
A. RESEARCH QUESTION 1
B. SIGNIFICANCE OF RESEARCH QUESTION 2
C. LITERATURE REVIEW 3
1. Organizations 4
2. The Lao Case 10
D. POTENTIAL EXPLANATIONS AND HYPOTHESES 11
E. RESEARCH DESIGN 12
F. THESIS OVERVIEW AND DRAFT CHAPTER OUTLINE 13

II. HISTORY AND FUNDING OF HYDROPOWER 15
A. DAM PROGRESS 16
B. BUILD-OWN-OPERATE-TRANSFER (BOOT) 21

III. ENERGY SECURITY, ECONOMIC, AND NATIONAL DEVELOPMENT IMPLICATIONS OF HYDROELECTRIC POWER IN LAOS 25
A. ENERGY SECURITY 25
B. ENVIRONMENTAL SUSTAINABILITY 29
C. ENERGY EQUITY 31
D. EVALUATING HYDROPOWER'S IMPACT ON ECONOMIC GROWTH 34
E. NAM THEUN 2 39
F. CONCLUSION 42

IV. ENVIRONMENTAL CONCERNS FOR LAOS HYDROELECTRIC POWER (WHAT DID THE FISH SAY AFTER SWIMMING INTO THE WALL? DAM!) 43
A. ENVIRONMENTAL IMPACTS 43
1. Impact on Fisheries 44
2. Expected Mainstream Impacts on Fishery Production 49
3. Floodplain Agriculture 52
B. FOOD SECURITY 54
1. Fishery Impact 55
2. Agricultural Impact 56
C. DAMS' SOCIAL CONSEQUENCES 58
D. CONCLUSION 65

V. CONCLUSION 67
A. FINDINGS 67
B. POSSIBLE OUTCOMES 69
C. RECOMMENDATIONS 71

LIST OF REFERENCES 73

INITIAL DISTRIBUTION LIST 83

LIST OF FIGURES

Figure 1. Total Number of Large Dams Completed between 1971 and 2019.....19

Figure 2. Total Electrical Production from Dams greater than 15MW.....19

Figure 3. Total Energy Consumed 26

Figure 4. Internal Energy Utilization 28

Figure 5. Internal Energy Consumption.....29

Figure 6. Coal use, Emissions, and Intensity 2000–2015 30

Figure 7. Carbon Dioxide Emissions by Source 30

Figure 8. Access to Electricity 32

Figure 9. Laos's Electricity Exports: Monetary Value and Share of Total Exports.....34

Figure 10. Sectors' contribution to Lao's GDP.....35

Figure 11. Gross Domestic Production (Current US$) 36

Figure 12. GDP per capita and GDP per capita Growth Rate.....36

Figure 13. NT2 Production and Projections.....40

Figure 14. Natural and Hydro-peaked Comparison 45

Figure 15. Erosion downstream of the Nam Theun-Hinboun Dam due to hydro-peaking of flows.....45

Figure 16. Flow Comparison Downstream of NT2.....47

Figure 17. Fishery Production in Xe Bang Fai River.....47

Figure 18. Diagram of Reduced Floodplains After Dam Construction 53

Figure 19. Reported NT2 Revenue Management Plan Distributions.....64

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LIST OF ACRONYMS AND ABBREVIATIONS

ASEAN	Association of Southeast Asian Nations
GoL	Government of Laos
GDP	Gross Domestic Production
IEA	International Energy Agency
WCD	World Commission on Dams
WEC	World Energy Council
MRC	Mekong River Commission
FAO	Food and Agriculture Organization
NT2	Nam Theun 2
LHS	Left Hand Side
RHS	Right Hand Side
BDP2	Basin Development Plan Programme, Phase 2
NREM	Natural Resources and Environmental Management Research and Training Center
NPV	Net Present Value
BOOT	Build-Own-Operate-Transfer
SPC	Special Purpose Company
EDL	Electricite Du Laos
EGAT	Electricity Generating Authority of Thailand
PPA	Power Purchase Agreement
OECD	Organization for Economic Cooperation and Development
LMB	Lower Mekong Basin
NGO	Non-Government Organization
XBF	Xe Bang Fai
NTPC	Nam Theun Power Company
POE	Panel of Experts
DSP	Downstream Programme

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ACKNOWLEDGMENTS

I would like to thank Greta Marlatt for assistance in researching this topic. I am grateful to Susan Hawthorne for her dedication and ensuring this thesis was completed. My gratitude to Dr. Meierding and Dr. Malley for their insight, patience, and editing. Most importantly to my family, Kara, Jonathan, Lorelai, Adalyn, Tanner, and Ezra, who supported me the most while I was away working on papers, thesis, or professional military education, especially Kara, without whom this would not have been possible.

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I. HYDROPOWER IN LAOS

A. RESEARCH QUESTION

The Lao People's Democratic Republic (Laos) has built more than 40 dams since 2000 and plans to expand to 100 by 2020.[1] Hydroelectric development could generate $33.4 billion annually for Laos, based on this ambitious government plan.[2] This would almost double the current gross domestic product of Laos, which in 2017 was estimated at $16.85 billion.[3] However, hydroelectric power carries significant risks. An example of risk is the July 2018 failure of the Xe-Pain Xe-Namnoy dam in southern Laos.[4] The failure of the dam, which was 90 percent complete, resulted in the displacement of 6,000 residents, 40 confirmed deaths, and 98 missing from six villages hit by the flash flood.[5]

Has Laos benefited from hydroelectric dam development and is further development the best course of action? Laos is currently pursuing economic development by selling surplus electricity in order to become the "Battery of Asia."[6] Hydropower has additional benefits, including being a renewable energy source and nearly carbon emission free. However, several downsides associated with hydroelectric projects include threatening the environment, biodiversity, social communities, and food security. Finding the balance between these positive and negative aspects is essential when considering hydroelectric projects. For developing nations like Laos, one must understand if an

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[1] Lia B. Xing, J. Paul Liub, Yoshiki Saitoc, and Van Lap Nguyene, "Recent Evolution of the Mekong Delta and the impacts of dams," *Earth Science Reviews*, No. 175 (July 2017), http://dx.doi.org/10.1016/j.earscirev.2017.10.008.

[2] Tom Fawthrop, "Killing the Mekong, Dam by Dam," *The Diplomat*, November 28, 2016, https://thediplomat.com/2016/11/killing-the-mekong-dam-by-dam.

[3] Lao PDR Statistics, World Bank Group, accessed 22 November 2018, https://data.worldbank.org/country/lao-pdr.

[4] "Laos hydroelectric power ambitions under scrutiny," BBC News, July 24, 2018, https://www.bbc.com/news/topics/c302m85q5jjt/laos&link_location=live-reporting-story.

[5] "Laos hydroelectric."

[6] Tae-jun Kang, "Laos: New Hydropower Dams, Old Mekong Worries." Accessed December 7, 2019. https://thediplomat.com/2018/04/laos-new-hydropower-dams-old-mekong-worries/.

overall benefit exists for all affected by the dam before entering into memorandums of understanding and starting construction. Unfortunately, the reverse continues to be the trend where minimal work is done before design to minimize effects to ensure the project is approved and moves forward. No work is then completed after construction to address known or unknown problems revealed after starting the operation of the dam.

B. SIGNIFICANCE OF RESEARCH QUESTION

Laos is a developing nation and landlocked in Southeast Asia. Limited access to the ocean and major international trade routes has limited the opportunities for this nation to progress economically. Laos also ranks low on many development statistics globally and within the Association of Southeast Asian Nations (ASEAN). However, most of the country is within the Mekong River watershed and is rich with ideal locations to install hundreds of dams for hydroelectric development.

Dams were a sign of development globally between the 1930s and 1970s, as primary, secondary, and tertiary benefits helped transform rural communities by providing access to irrigation, electricity, and infrastructure improvements.[7] In the 1970s, the number of dam projects tapered off globally as rising anti-dam social movements, non-government organization protests, and reduced access to funding resulted in a worldwide reduction in the construction of dams.[8] Non-governmental organizations and academics exposed the downsides of ill-conceived national development goals, which created hardships for local communities and severe environmental damage.[9]

Recently, developing nations have begun to reconsider hydroelectric dams to drive national development and economic activity. The World Bank, Asian Development Bank, and China have been providing funding to drive the economic growth of developing nations. An explosion of new projects worldwide in the 1990s created a

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[7] World Commission on Dams. *Dams and development: A new framework for decision-making: The report of the world commission on dams*. Earthscan, 2000 xxix–xxx.

[8] World Commission on Dams, xxix–xxx.

[9] Atif Ansar, Bent Flyvbjerg, Alexander Budzier, and Daniel Lunn. "Should we build more large dams? The actual costs of hydropower megaproject development." Energy Policy 69 (2014): 43–56.

worldwide debate and inspired a comprehensive study by the World Commission on Dams (WCD). Ten years after the release of the WCD report, some scholars believe these issues still have not been sufficiently addressed, and significant issues continue to plague these projects. The breadth of problems includes environmental damage, biodiversity loss, food insecurity, and community displacement. As world opinion swings between the positives and negatives of hydroelectric power in developing nations, it is essential to study both sides of the issue to determine whether net benefits truly exist before proceeding with massive infrastructure investments.

Hydroelectric dams already existed within Laos and were the only source of electricity from 2000 until 2013.[10] The proposed scale of projects and locations across the Mekong basin and specifically in Laos are under public scrutiny due to the potential adverse effects of this sudden increase in hydroelectric dams and disputed overall economic benefit. The thesis provides a comparison between the positive and negative aspects of dam development for Laos, to determine whether the short-term goals of hydroelectric power are being met and provide an overview of the impacts based on long term computer models. It is crucial to understand whether the proposed projects will meet the development goals with minimal negative impacts. Ill-conceived plans by the Lao government to move forward with these projects could result in a net negative result. However, if adequately studied and if plans are adjusted for local and regional impacts, the economic boost could drive development. There exists a burden on the government to understand the individual and cumulative effects of each hydroelectric project prior to breaking ground.

C. LITERATURE REVIEW

Understanding the positive and negative impacts requires drawing on the different views of dams across the globe. Surveying the spectrum of viewpoints brings greater

[10] OECD Development Centre, *Economic Outlook for Southeast Asia, China and India 2019: Towards Smart Urban Transportation.* Paris: OECD Publishing, 2018.

understanding to the situation in Laos and its intent to increase the number of hydroelectric dams within the country and specifically on the Mekong River.

There are two primary perspectives on the construction of new hydroelectric dams. The first camp, or pro-dam camp, claims that installing dams is beneficial to the nation, since the dams provide irrigation, foster aquaculture, and provide renewable energy. The second camp, or anti-dam camp, claims that installing dams is detrimental to the nation due to the negative impacts on the environment and people being greater than the economic benefit gained from hydroelectric dams.

The literature review first provides an introduction to the organizations that are involved in hydroelectric development internationally and regionally. Second, it provides the perspective of the pro-dam camp and positive results from new dams. Third, the anti-dam camp is introduced with its focus on environmental and social effects and the belief that many of the consequences outweigh the economic benefits. Fourth, the review observes that some organizations occupy the middle ground; they believe that dams can be beneficial, but only with proper study and mitigation efforts to address specific concerns. Finally, it reviews existing studies on Laos and how this thesis fills a gap in the information.

1. Organizations

The pro-dam camp is championed by development organizations such as the World Bank, International Commission on Large Dams, national associations such as Laos's National Hydropower Association, and the multilateral Mekong River Commission (MRC). The anti-dam arena is dominated by non-governmental organizations, environmental advocacy groups, and academic researchers focused on the environment and sociology. Groups such as International Rivers seek to bring together social movements, non-government organizations, and academics to address the consequences of dams before breaking ground on any project.

Some organizations, like the World Commission on Dams (WCD), attempt to find the middle ground by advocating for research and discussion with locals to ensure local

and national goals are accomplished or locals are compensated as part of the project cost. However, Deborah Moore, a former commissioner for WCD, believes the commission's work has pushed the conversation forward regarding new dams but failed to conclusively solve the issues ten years after the WCD released their work.[11]

Non-governmental organizations like Water Alternatives and International Rivers provide a forum for sharing research and articles to further the understanding of projects and raise awareness regionally and globally of the harmful consequences of dams. Both organizations are dedicated to promoting research and study before pursuing projects with a rudimentary understanding of the consequences on the people and environment.

a. The Pro-dam Camp

The pro-dam camp emphasizes the benefits of harnessing the river and converting the potential energy and kinetic energy of water into electricity.[12] These organizations tout the benefits of redirecting and focusing water for the production of electricity for use by nearby homes or businesses. Hydroelectric power is a better option than sourcing electricity from traditional fossil fuels due to the reduced carbon dioxide emissions, and because hydroelectric power is a renewable source of energy. Hydroelectric power has many other positive aspects that include energy security, economic development, agricultural irrigation, and flood control.

The idea of energy security is based on the ability of a nation to meet the energy demands of the population.[13] For developing nations, it is essential to understand the current sources of energy and potential threats to access. If access is denied, prices for energy rise, which affects economic development and drives recessions with severe consequences. Nations that are able to harness internal resources are able to improve their energy security. Hydroelectric power works towards this goal as untapped potential could

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[11] Deborah Moore, John Dore, and Dipak Gyawali, "The World Commission on Dams+ 10: Revisiting the large dam controversy," *Water Alternatives* 3, no. 2 (2010).

[12] Richard Dunlap, *Sustainable Energy* (Boston, MA: Cengage Learning, 2017).

[13] Bert Kruyt, Detlef P. van Vuuren, Han JM de Vries, and Heleen Groenenberg, "Indicators for energy security," *Energy Policy* 37, no. 6 (2009): 2166–2181.

be available to respond to increasing demand without seeking outside fuel sources. Hydroelectric power is also cleaner than fossil fuel sources.

In terms of economic development, dams of all sizes tend to be significant infrastructure projects. Developing a hydroelectric dam creates jobs. It also expands electrical networks and provides a new source of electricity for local use, and any surplus can be exported to energy-hungry neighbors seeking green energy.[14] Additionally, the electricity produced by hydroelectric dams does not produce greenhouse gases.[15] Yuksel points to the ability of these projects to pay for themselves over time and provide long term benefits after the debt is paid.[16]

Other economic benefits of dams are agricultural irrigation and drinking water for urban populations. Bruhl highlights the importance of access to water and the roles that dams play in supporting Millennium Development Goals, as eight of the eighteen target areas are associated with water.[17] For example, in India, poverty levels are 69 percent in non-irrigated areas compared to 26 percent in irrigated areas.[18] This disparity highlights the changes dams can have on the development potential of an area with effective water management practices.

The final benefit of dams is flood control. Just as beavers build dams to sustain growth, humans build dams to capture extreme rainfall or annual surges from melting snow. The Aswan Dam on the Nile River captures and stores the surge annually to protect agricultural fields and communities built in ancient floodplains.[19]

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[14] World Commission on Dams, *Dams and development: A new framework for decision-making: The report of the world commission on dams*. Earthscan, 2000.

[15] I. Yüksel, "Development of Hydropower: A Case Study in Developing Countries." *Energy Sources, Part B* 2, no. 2 (2007): 113–121.

[16] Yüksel, 113–121.

[17] Luis Berga, J. M. Buil, Eugeni Bofill, J. C. De Cea, JA Garcia Perez, Gabriel Mañueco, J. Polimon, A. Soriano, and J. Yagüe, eds., *Dams and Reservoirs, Societies and Environment in the 21st Century*, Two Volume Set: Proceedings of the International Symposium on Dams in the Societies of the 21st Century, 22nd International Congress on Large Dams (ICOLD), Barcelona, Spain, 18 June 2006. CRC Press, 2006.

[18] Berga.

[19] World Commission on Dams, *Dams and Development: A New Framework for Decision-Making: The Report of the World Commission on Dams*. Earthscan, 2000.

b. The Anti-Dam Camp

The anti-dam camp emphasizes the harmful effects of dams. These include environmental damage, social upheaval, food security loss, and projects which fail to meet economic expectations. The negative aspects are all based on the potential damage from changing the existing natural order of the environment and existing social communities.

Most arguments against dam building focus on environmental costs. Damage to the river channel and changing the natural flow of the river affects vegetation growth and by extension, the wildlife both in water and along the banks. Fishery, agriculture, and other natural cycles are altered depending on the resilience of the fish and animals to adapt to the new river. Another level of concern is how people whose subsistent lives are dependent on the environment will adapt after the environment has been changed.

As dams are built and filled, the reservoirs can displace thousands to millions of people, as highlighted in a WCD report.[20] For example, millions were displaced in the case of China's Three Gorges Dam, under an authoritarian system similar to Laos's.[21] Studies of dams' effects in India, Brazil, and China show that energy production and water storage often only benefit urban centers, while local displaced populations suffer the negative consequences of being relocated from ancestral homes with fertile agricultural fields to deserts or hillsides while receiving meager payments for relocation.

Since the 1960s, displacement-induced social protests have grown. Khagram documents the connection between social movements to oppose dams in India, which primarily harmed minority ethnic groups, and these groups' limited ability to mobilize effective protests against harmful projects to their livelihood.[22] Displacement of people, villages, and communities are common with large dam projects upsetting the history and

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[20] World Commission on Dams.

[21] Peter Bosshard, "Three Gorges Dam," https://www.internationalrivers.org/campaigns/three-gorges-dam and Brooke Wilmsen , Michael Webber, and Duan Yuefang. "Development for whom? Rural to urban resettlement at the Three Gorges Dam, China." *Asian Studies Review* 35, no. 1 (2011): 21–42.

[22] Sanjeev Khagram, *Dams and Development: Transnational Struggles for Water and Power* (Ithaca, NY: Cornell University Press, 2004).

connection of rural people to the land that their ancestors settled for centuries. These communities are commonly relocated to less fertile areas or displaced far from hunting, fishing, or an environment suitable to sustain the same population as the once fertile area supported.

Food insecurity is another negative consequence of dams. Loss of natural flood plain agricultural land increases the cost and labor associated with field productivity. Additionally, sedimentation trapping and reduced water quality harm the value of irrigation water by requiring supplement fertilizer to obtain the same yields before the placement of the water control structure. For example, a study of the Three Gorges Dam measured a 40 percent decrease in sediment transport.[23] The loss of sediment transport downstream of dams has risen significantly over the past years. China has seen a decrease in the productivity of floodplain fields. The reduced sediment load does not replace areas damaged by erosion in high flow conditions, which directly affects crop yields and land area.[24]

Piesse highlights the benefits of hydroelectric power generation to villages in Africa but raises concerns that its impact on subsistence farming in the eastern and southeastern Africa could cause more problems than solutions if improperly managed.[25] Another study highlights the balance that must exist among energy, food, and water.[26] Large dam projects are extremely disruptive as the natural order is changed to optimize electricity production at a loss of environment and possibly local food security from loss of fishery or agricultural lands.

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[23] Z-S Yang, H-J. Wang, Y. Saito, J. D. Milliman, K. Xu, S. Qiao, and G. Shi, "Dam impacts on the Changjiang (Yangtze) River sediment discharge to the sea: The past 55 years and after the Three Gorges Dam." *Water Resources Research*, 42, no. 4 (2006).

[24] Shilun L. Yang, Jianbo Zhang, and X. J. Xu, "Influence of the Three Gorges Dam on downstream delivery of sediment and its environmental implications, Yangtze River," *Geophysical Research Letters* 34, no. 10 (2007).

[25] Mervyn Piesse, "Dams in Africa: Balancing Food, Water, and Energy Security," 6 August 2018 http://www.futuredirections.org.au/publication/dams-in-africa-balancing-food-water-and-energy-security-4/

[26] Morgan Bazilian, Holger Rogner, Mark Howells, Sebastian Hermann, Douglas Arent, Dolf Gielen, Pasquale Steduto et al. "Considering the energy, water, and food nexus: Towards an integrated modeling approach." *Energy Policy* 39, no. 12 (2011): 7896–7906.

Although pro-dam activists believe fishery losses can be replaced by reservoir fisheries, recent studies are finding inconsistent support for this argument.[27] Other studies have researched dams' implications for fishery production and the biodiversity of migratory species. International Rivers claims the Mekong is second to the Amazon in terms of biodiversity and production of biomass.[28] The implications of placing artificial barriers on migratory fishery stocks, which account for 60 percent of annual catches in the region is of significant concern.[29] Another study by the United Nations Food and Agriculture Organization (FAO) published in 2001 outlined the need to understand the local environment and test various fish passage methods to prevent the collapse of the local fishery by preventing travel between feeding and spawning grounds.[30]

Manatunge, Nakayama, and Priyadarshara present a stakeholder approach to the impacts of dams and methods to address the problems from past projects.[31] Ptak discusses a different approach using a case study of the Nu River in China as it is the last remaining basin in Yunnan Province which has not been dammed by hydropower projects.[32] Ptak finds the reasons for which dams should not be pursued include the social consequences experienced by others from projects in the region.[33] Ptak also

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[27] Christiane Zarfl, Alexander E. Lumsdon, Jürgen Berlekamp, Laura Tydecks, and Klement Tockner, "A global boom in hydropower dam construction." *Aquatic Sciences* 77, no. 1 (2015): 161–170; Ling Teck Yee, Debbie D. Lee Paka, Norhadi Ismail Nyanti, and Justin JJ Emang, "Water quality at Batang Ai hydroelectric reservoir (Sarawak, Malaysia) and implications for aquaculture," *International Journal of Applied* 2, no. 6 (2012).

[28] International Rivers, "Mekong Mainstream Dams,," 26 November 2018, https://www.internationalrivers.org/campaigns/mekong-mainstream-dams

[29] Gaythri Vaidyanathan, "*Remaking the Mekong*," *Nature*, 478 (20 Oct 2011): 305–307

[30] Gerd Marmulla, ed., *Dams, Fish, and Fisheries: Opportunities, Challenges, and Conflict Resolution*. No. 419. Food & Agriculture Org., 2001.

[31] J. Manatunge, M. Nakayama, and T. Priyadarshana, "Environmental and social impacts of reservoirs: issues and mitigation," *Oceans and Aquatic Ecosystems* 1 (2008): 212–255.

[32] Thomas Ptak, "Dams and Development: Understanding Hydropower in Far Western Yunnan Province, China – ProQuest," accessed February 23, 2020. https://search.proquest.com/openview/8d7fa736002e5bb6fef75213966b198a/1?pq-origsite=gscholar&cbl=25768.

[33] Ptak.

highlights the new approach to meet sustainable power with hydroelectric power balanced against the environmental and social impacts seen with recent projects.[34]

c. Middle Ground

The WCD, which worked to create a middle ground, reinforced the need to understand all aspects of an individual project locally and nationally prior to construction. The WCD sought to ensure government involvement and discussion with the local populace to ensure equitable development for all impacted by the project. Through study and cooperation, developers and proponents of projects would have an understanding to adequately compensate displaced or negatively affected communities prior to construction to ensure the people were supported by revenue with education, housing, and or other services to ensure sustainable lives in the new environment.

A few authors, like Thayer Scudder, a member of the WCD, in the book, *The Future of Large Dams,* primarily focus on the impacts on population displaced and those living downstream.[35] He questions the idea of the win-win scenario of large dams, arguing that many costs are understated. He finds that dams are a necessary tool to provide development, but that governments lack the commitment and institutional capacity to ensure the concerned population's well-being is improved following completion of the dam. His work is seen as a continuation of his role and efforts as a member of the WCD.

2. The Lao Case

Previous studies have researched various effects of building dams on the tributaries of the Mekong, including food security, transboundary issues, and environmental damage. Other regional studies examine the tradeoffs between biodiversity and hydropower development to compare the risk and reward of current and proposed

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[34] Ptak.

[35] Thayer Ted Scudder, The Future of Large Dams: Dealing with Social, Environmental, Institutional and Political Costs. Routledge, 2012. https://doi.org/10.4324/9781849773904.

projects.[36] These studies usually cover Laos, Cambodia, and Vietnam, due to their similar topography and the environment of the lower Mekong.[37] They generally do not include China or Myanmar unless the actions of those states have impacted the annual flow rates. Other studies consider how dams have affected relations between China and the nations downstream from China.[38] Researchers have also examined the role of the MRC and the financing of these projects.[39] Much of the existing research on dams in Laos examines the dams' transboundary environmental, social, national development, or political effects as single issues. However, these works focus on one element of the issue. This thesis explores multiple elements to understand whether Laos has benefited from increasing hydroelectric power and if sufficient steps have been taken to mitigate the damage highlighted by the anti-dam camp and WCD.

D. POTENTIAL EXPLANATIONS AND HYPOTHESES

There are two clear perspectives on whether hydroelectric projects benefit Laos. One says that the dams have benefited Laos because of the increased economic activity from electricity exports, new infrastructure, and increased access to electricity driving GDP growth. The energy exports produce a significant boost to economic growth and secure Laos's own energy needs for domestic growth or light industrialization. Since Laos has limited access to fossil fuels and oil, which impedes economic growth, converting the potential energy of the mighty Mekong River may support growth.

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36 Guy Ziv, Eric Baran, So Nam, Ignacio Rodríguez-Iturbe, and Simon A. Levin, "Trading-off fish biodiversity, food security, and hydropower in the Mekong River Basin," *Proceedings of the National Academy of Sciences* 109, no. 15 (2012): 5609–5614.

37 Stuart Orr, Jamie Pittock, Ashok Chapagain, and David Dumaresq, "Dams on the Mekong River: Lost fish protein and the implications for land and water resources," *Global Environmental Change* 22, no. 4 (2012): 925–932.

38 Gregory J Knott, "China on the Mekong: Legitimacy Imperatives and Policy Case Studies," (master's thesis, Naval Postgraduate School, 2013). http://hdl.handle.net/10945/38964.

39 Jeffrey W. Jacobs, "The Mekong River Commission: transboundary water resources planning and regional security." *Geographical Journal* 168, no. 4 (2002): 354–364; Ellen Backer Bruzelius, "The Mekong River Commission: Does it work, and how does the Mekong Basin's geography influence its effectiveness?," *Südostasien Aktuell: Journal of Current Southeast Asian Affairs* 26, no. 4 (2007): 31–55.

The other perspective says that dams have harmed Laos. Hydroelectric projects can fail in multiple ways and may have harmed Laos's development because of local and regional problems. Construction and operation of hydroelectric dams have harmed the environment, created social upheaval without providing sufficient support for the displaced and affected populations from completed projects. Projects have failed to redirect revenues sufficiently or equitably to improve the lives of people harmed by dams compared to those who have benefited from increased energy production. This hypothesis proposes that social and environmental damage exceeds perceived positive outcomes in economics or access to electricity. Additionally, the debt load created by dam construction contributes to preventing investment in a sustainable manner by creating a renewable resource curse, further hindering growth and development.

E. RESEARCH DESIGN

The thesis examined completed projects' effects in Laos to analyze the impacts these projects have at a national level. This was accomplished by researching existing literature focused on Laos and applying the World Energy Council Trilemma framework of Energy Security, Energy Equity, and Environmental Sustainability.[40] Energy security is defined as the ability of Laos to meet current and future demand with reliability and adjust to system shocks.[41] Equity is the ability to provide universal access to affordable energy for residential and commercial use.[42] Environmental sustainability is the effort of the country to mitigate and avoid environmental harm from energy systems.[43] Comparing the economic equity to the environmental implications is most beneficial in the case of Laos as these are the biggest factors for consideration.

Evidence was derived from journals, books, and institutional reports. Prime sources include MRC reports, project reports from funding sources, and independent economic

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[40] World Energy Council, "World Energy Trilemma Index," 13, accessed November 8, 2019. https://www.worldenergy.org/transition-toolkit/world-energy-trilemma-index.

[41] World Energy Council, 13.

[42] World Energy Council, 13.

[43] World Energy Council, 13.

reports from the World Bank, and documents from the Association of Southeast Asian Nations (ASEAN). Research on the environmental impacts relies on scientific reports to include independent research, World Bank data, and FAO data.

F. THESIS OVERVIEW AND DRAFT CHAPTER OUTLINE

The thesis is broken down into five chapters. Chapter I introduces the issues surrounding dams globally and explores the concerns of academics on the Mekong region. The chapter introduces the WCD goals and WEC Trilemma Framework to provide an understanding of the positive and negative perspectives on dams.

Chapter II provides the context for a comparison of the economic benefits weighted against the environmental concerns in later chapters. This chapter presents the history and inventory of hydroelectric dams greater than 15 megawatts. The Nam Theun 2 (NT2) dam is introduced as a case study with an explanation for why it is used in this thesis. The current funding process is explained from the beginning of the project concept to turnover to the Government of Laos (GoL).

Chapter III delves into the economic growth and energy security of Laos. First, the chapter outlines the impact hydroelectric dams have on energy security, the first aspect of the WEC trilemma. Second, it discusses the second aspect of the trilemma, environmental sustainability. Third, the chapter covers the final dimension of the trilemma, energy equity. Additionally, the chapter discusses dams' effects on economic growth in terms of Gross Domestic Product (GDP). These points will provide essential knowledge to determine if hydroelectric power could be considered a renewable resourse curse. Lastly, the chapter explains how the World Bank and NT2 dam changed Laos's ability to build dams at the current rate.

Chapter IV focuses on the environmental and social effects of dam building within Laos. This is explored by looking at fishery and agricultural data before and after dam construction. Secondly, the chapter evaluates how many people have been displaced by construction. Third, the chapter looks at the NT2 dam project's efforts to improve the

lives of those affected by the project and if the WCD and World Bank-derived goals from the WCD were met.

Chapter V draws on the findings from chapters II–IV to draw conclusions as to the specific benefits of hydroelectric development for Laos weighing the presented examples against each other. The chapter introduces models that predict marginal benefit to Laos for continued hydroelectric development. This will help answer the question of whether Laos's hydropower dams are beneficial to the country and whether Laos should be used as a model for hydropower in developing nations.

II. HISTORY AND FUNDING OF HYDROPOWER

This chapter introduces the different types of dams and provides a brief discussion of completed and on-going projects in Laos. Second, it gives an overview of the funding model for past and current hydroelectric dam projects. Laos's goal is to become the "Battery of Asia" by exporting excess electrical power to its neighbors in order to foster domestic economic growth.[44]

Laos, a small nation of seven million people, has a comparative advantage for hydroelectric power.[45] Electricity production was estimated at close to 6 GW in 2018. Current construction could increase this to 14 GW by the end of 2020.[46] Laos has an estimated 26.5 GW of total hydroelectric potential, although only 18 GW is economically exploitable.[47] Continual increases in electricity exports to other Southeast Asian neighbors and potentially to China are projected to help Laos graduate from among the UN's Least Developed Nations.[48]

Producing this hydroelectric power has a significant upfront cost. The cost of constructing large dams is usually well above $100 million. Xayaburi dam in Laos had a final price tag of $4.4 billion, which is steep for a nation whose GDP was only $10.1 billion when construction started in 2012.[49] Thus, an essential aspect of assessing the costs and benefits of Laos's dams is understanding how Laos is able to afford expensive

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[44] Tae-jun Kang, "Laos: New Hydropower Dams, Old Mekong Worries," accessed November 22, 2019. https://thediplomat.com/2018/04/laos-new-hydropower-dams-old-mekong-worries/.

[45] "Lao PDR | Data," accessed December 7, 2019. https://data.worldbank.org/country/lao-pdr.

[46] Tae-jun Kang, "Laos: New Hydropower Dams, Old Mekong Worries," accessed November 22, 2019. https://thediplomat.com/2018/04/laos-new-hydropower-dams-old-mekong-worries/.

[47] "Laos," International Hydropower Association, May 2016, https://www.hydropower.org/country-profiles/laos

[48] Economic Analysis & Policy Division | Dept of Economic & Social Affairs | United Nations, "Least Developed Country Category: Lao People's Democratic Republic Profile | Department of Economic and Social Affairs," December 25, 2015. https://www.un.org/development/desa/dpad/least-developed-country-category-lao-peoples-democratic-republic.html

[49] "Lao PDR | Data," accessed December 7, 2019. https://data.worldbank.org/country/lao-pdr.; Radio Free Asia, "Laos's Controversial Xayaburi Dam on Mekong River Begins Operations," accessed December 9, 2019. https://www.rfa.org/english/news/laos/xayaburi-dam-begins-operations-10292019175158.html.

hydroelectric projects and whether these projects can drive economic growth and development without becoming an economic burden.

A. DAM PROGRESS

Laos's first large hydroelectric dam, the 150MW Nam Ngum 1, started operations in 1971.[50] However, the U.S. withdrawal from the region in 1975 and changing governments in the region delayed future plans for hydroelectric development in the basin. All large projects in Laos were delayed as the next large dam was not completed until 1994 As of 2017, Laos had 46 operational dams and 54 under construction; it expects to have 100 operational by the end of 2020.[51] Thirty of the 46 dams were large dams, defined as those producing 15 MW or more. Table 1 lists all projects commissioned by November 2019. Figure 1 represents the number of large dams commissioned from 1971 to November 2019. There are many other dams in Laos, but the impact of small hydro-projects is different from that of large ones and outside the scope of the thesis. Figure 2 represents the amount of electricity generated by large dams.

[50] Molle, François, Tira Foran, and Mira Kakonen, eds., *Contested Waterscapes in the Mekong Region: Hydropower, Livelihoods and Governance* (London, UK; Sterling, VA: Earthscan, 2009), 5–6

[51] Mekong Eye, "Laos Expects to Have 100 Hydropower Plants by 2020," July 12, 2017. https://www.mekongeye.com/2017/07/12/laos-expects-to-have-100-hydropower-plants-by-2020/.

Table 1. Large Hydroelectric Dams in Operation (15 MW or greater)[52]

Project	Commercial Operation Date	Megawatt (MW)	Cost (M USD)	Ownership
Nam Ngum 1	1971	148.7	97	EdL
Xeset 1	1994	45		EdL
Theun-Hinboun	1998	220	270	Theun-Hinboun Power Co.
Houay Ho	1999	152.1	243	Houay Ho Power C. Ltd.
Nam Leuk	2000	60	35.9	EdL
Nam Mang 3	2004	40	63	EdL
Nam Theun 2	2009	1075	1,450	Nam Theun Power Co.
Xeset 2	2009	76	135	EdL
Nam Lik 1–2	2010	100	110	Nam Lik 1–2 Power Company
Nam Ngum 2	2011	615	832	Southeast Asia Energy Limited (SEAN) 75% (Thailand), EdL 25%
Nam Ngum 5	2012	120	200	EDL 15%, Sinohydro (China) 85%
Theun-Hinboun exp.	2013	222	720	EdL 60%, Nordic Group (Norway) 20%, MDX (Thailand) 20%
Nam Beng	2014	36	61	China National Electrical Equipment 90%, EdL 10%
Xe Kaman 3	2014	250	273	Xekaman 3 Power Company Limited
Houay Lamphan	2015	88	206	EdL
Nam Khan 2	2015	130	308.5	EdL
Xe Kaman 1	2015	290	441	Viet Lao Power Joint Stock Company

[52] Adapted from “Reservoir Mapping Tool.” Accessed November 22, 2019. http://damtool-servir.adpc.net/.

Project	Commercial Operation Date	Megawatt (MW)	Cost (M USD)	Ownership
Nam San 3A	2016	69	57	Rohas Euco Industries Berhad (Malaysia) 75%; GoL 25%
Nam Khan 3	2016	60	132.7	Sinohydro (China)
Nam Mang 1	2016	64	95	Don Fang 75%, A&C 10.75%, EdL 10%, and one other 10%.
Nam Ou 2	2016	120	300	EDL (Laos) 15%, Sinohydro (China) 85%
Nam Ou 5	2016	240	415	EDL (Laos) 15%, Sinohydro (China) 85%
Nam Ou 6	2016	180	311	EDL (Laos) 15%, Sinohydro (China) 85%
Nam Chian 1	2017	104	61	EdL
Nam Nga 2	2017	15	30	Nam Nga 2 Hydropower Co., Ltd.
Xekaman-Sanxay	2018	32		Viet Lao Power Joint Stock Company
Nam Tha 1	2018	168	447	Nam Tha 1 Lao Power Co.
Houay Por	2018	15		Houay Por Power Co. Ltd.
Nam Ngiap 2	2018	180		China International Water & Electric Company
Nam Poen 1	2018	15		
Nam Ngiep 1	2019	272	640	Nam Ngiep 1 Hydropower Co.
Nam Ngiep (Downstream)	2019	18		Nam Ngiep 1 Hydropower Co.
Xayaburi	2019	1285	2,000	Xayaburi Power Co. Ltd.
Nam Bak 1	2019	160	124	Southeast Asia Energy Co. Ltd.
Nam Hinboun 1	2019	45		

Figure 1. Total Number of Large Dams Completed between 1971 and 2019[53]

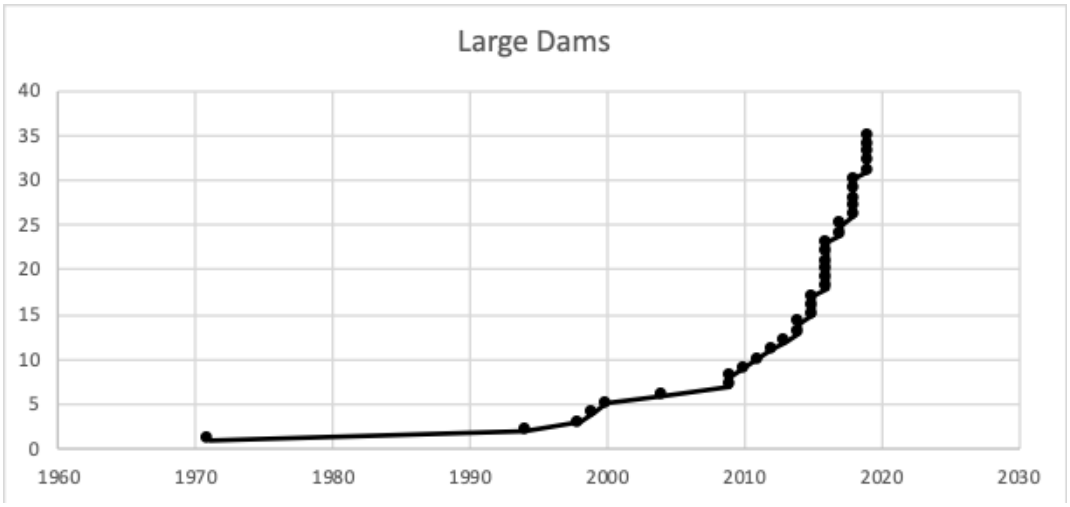
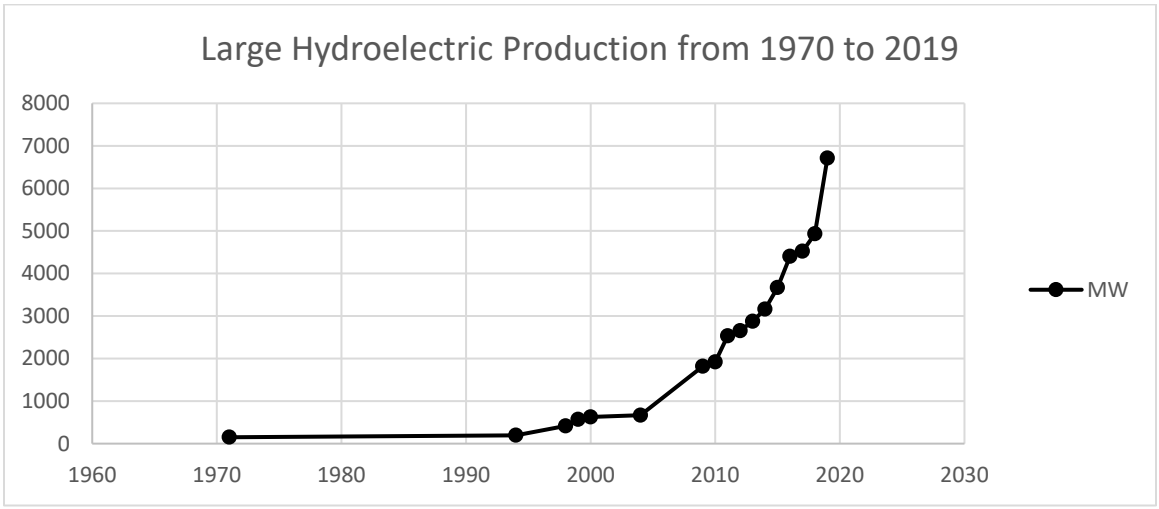


Figure 2. Total Electrical Production from Dams greater than 15MW[54]



The dam that changed Laos's future for dam construction was the Nam Theun 2 (NT2) dam. Due to the involvement of the World Bank and other development institutions, NT2 is the best-documented project in Laos and provides the best detail to understand both the economic and environmental impacts. The dam had been studied and

[53] Adapted from Reservoir Mapping Tool.

[54] Adapted from Reservoir Mapping Tool.

proposed to multiple development agencies and private firms in the 1990s, but due to its high cost, Laos's poor creditworthiness, and the unproven track record of the BOOT model (described below), few development banks or commercial firms were interested in financing it.[55] However, the World Bank, which had ceased supporting large hydroelectric projects in the 1980s, viewed NT2 as an opportunity to reframe the future of hydroelectric development following the WCD report released in 2000. NT2 will be discussed further in chapters III and IV, but following the completion of the project in 2010, it is a key project for Laos. More dams started construction after 2010 and are currently operational than all dams finished between 1971 and 2010.

Current construction and memorandums of understanding for future projects could quadruple the number of hydropower dams in the next 20 years.[56] Laos is estimating that it will have 100 operating dams by the end of 2020.[57] The majority of these dams are tributary dams. Tributary dams are built on the tributary rivers which merge with the Mekong River within the basin. The Mekong River is considered the mainstream as it runs from the mountains to the ocean. There are plans for 11 mainstream dams on the Mekong, 9 of which are within Laos. The Xayaburi dam, the first operational mainstream dam, began operation 29 October 2019 with two more under construction. Between 2020 and 2030, Laos estimates that it will add another 93 hydroelectric dams with an installed capacity of an additional 8.6 GW.[58]

The Mekong River Commission (MRC) coordinates dam construction on the Mekong River among the member states. However, it is a weak institution with little influence on hydroelectric development in Laos as the articles in the 1995 forming agreement are wide-ranging and vague. No single state is able to veto hydroelectric

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[55] Ian Porter and Jayasankar Shivakumar. Doing a Dam Better. The World Bank, 2010. https://doi.org/10.1596/978-0-8213-6985-2. 82

[56] Katy Scott, "Is Laos Facing a Dam Disaster? - CNN." Accessed December 9, 2019. https://www.cnn.com/2018/12/14/asia/laos-hydropower-dams/index.html.

[57] Mekong Eye, "Laos Expects to Have 100 Hydropower Plants by 2020," July 12, 2017. https://www.mekongeye.com/2017/07/12/laos-expects-to-have-100-hydropower-plants-by-2020/.

[58] Institute of Renewable Energy, "Renewable Energy Data in Lao PDR," n.d. https://www.irena.org/-/media/Files/IRENA/Agency/Events/2016/Dec/12/Laos-presentation.pdf?la=en&hash=C3EE41F35C533D50672C4A75B1AA0D9D10C8C66C.

projects of another state. Although all projects are subject to Procedures for Notification, Prior Consultation and Agreement, tributary projects only require notification and mainstream projects are subject to consultation.[59] However, projects are able to move forward even if a consensus is not reached following consultation as happened with the Xayaburi dam which started operation in 2019.

The operational impact of dams on the environment will be discussed in detail in Chapter IV, but it is important to note that the alteration of natural cycles is required to generate enough energy for profitable hydroelectric dams. The seasonal variation along the Mekong can vary from 2m depth in the dry season to 10m in the wet season, and alteration of these cycles has severe consequences for the people and environment downstream.[60]

B. BUILD-OWN-OPERATE-TRANSFER (BOOT)

Since Laos suffers from a scarcity of public funding due to its least developed country status, it requires external financial support for large dam projects. Laos pays for its dam projects with the Build-Own-Operate-Transfer (BOOT) model, which allows the nation to complete the project with outside investors. In this model, the principal investor for the project establishes a Special Purpose Company (SPC) with limited liability. Development banks supported early projects, but their involvement has diminished as foreign investors have gained confidence as more projects have been completed. Foreign independent and private banks are the principal investors and owners of the SPC and are predominately from Thailand, but others are from Malaysia, Vietnam, and China, as noted in Table 1. The SPCs generally finance 70 to 100 percent of the project.[61] If any remaining cost is required, additional banks will join, or the government of Laos (GoL)

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[59] Nathanial Matthews and Kim Geheb, "On Dams, Demons, and Development The Political Intrigues of Hydropower Development in the Mekong," In *Hydropower Development in the Mekong Region Political, Socio-Economic, and Environmental Perspectives* (New York, NY: Earthscan, 2015), 6–7.

[60] Alexander Smajagl and John Ward, *The Water-Food-Energy Nexus in the Mekong Region* (New York: Springer Science Media, 2013).

[61] Xaypaseuth Phomsoupha, "Project financing in Laos' hydropower for export of electricity to Thailand," *Hydro Nepal: Journal of Water, Energy and Environment* 10 (2012): 7.

will provide funding through the state-owned electric company Electricite du Laos (EDL).[62]

The SPC and GoL create a concession agreement that outlines the period in which the SPC will operate the dam; this generally lasts between 20 and 30 years. During the concession period, the SPC owns and operates the dam. The SPC collects all the revenue from the sales of electricity and is responsible for the operation, maintenance, and taxes. The GoL collects taxes on the electricity sold in-country or from tariffs on exports of the electricity to neighboring states. After the concession period, the dam is transferred to the GoL at no cost. Concession agreements include the tax rates set by the GoL for the duration of the project. The agreements can also include limits on dam operations, reparations for affected populations, and environmental mitigation plans for each project.[63] Additionally, the concession agreements provide neutral arbitration, according to the New York Convention of 1958.[64] Due to the high cost and risk of hydroelectric projects, the concession agreements are favorable to the SPC for the duration of the project. SPCs are granted complete control of the operation of the dam with few restrictions.

Following the establishment of a concession agreement, SPCs are able to establish a market share or guarantee a market for the electricity with a Power Purchase Agreement (PPA). A majority of PPAs for Laos's dams are between the SPCs and Electricity Generating Authority of Thailand (EGAT) due to the high demand for electricity in Thailand, which accounts for 80 percent of all Laos's electricity exports.[65] Other PPAs extend to Vietnam, Cambodia, China, Malaysia, Myanmar, and Singapore. SPCs enter into PPAs to ensure the economic viability of dam projects following construction. By setting the price rate for electricity sales for the duration of the concession agreement,

[62] Phomsoupha, 8.

[63] Phomsoupha, 9–10.

[64] Phomsoupha, 9.

[65] OECD Development Centre.

PPAs ensure that the project is profitable for the SPC to repay loans taken from development banks or private banks, which provided the initial funding to the SPC.

Both the concession and PPAs are established to protect the developer from government intervention and ensure profitability for the duration of the concession period. Laos depends on these agreements to attract foreign investment to construct massive infrastructure projects, although with delayed compensation due to the concession agreement. The BOOT model has enabled Laos to utilize foreign investment that is mutually beneficial to the GoL and SPCs. Chapter III will elaborate on the economic aspects of hydroelectric development enabled by the BOOT model and completed dams.

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III. ENERGY SECURITY, ECONOMIC, AND NATIONAL DEVELOPMENT IMPLICATIONS OF HYDROELECTRIC POWER IN LAOS

This chapter evaluates the impact of dam-building on Laos's energy security and economic development between 2005 and 2015. It proceeds in five parts. The first three parts examine each aspect of the World Energy Council's "energy trilemma": energy security, sustainability, and equity. In the fourth part, this chapter examines the impact of electricity exports on economic growth, measured in terms of gross domestic product (GDP). Lastly, it will discusses the Nam Theun 2 Dam, which has facilitated the current growth of hydroelectric power, as a proof of concept for other projects. These five sections will demonstrate how Laos's energy security has not changed, but its economic development has improved in the short term from building hydroelectric dams.

A. ENERGY SECURITY

As discussed in Chapter I, energy security is the first dimension of the WEC Trilemma. The WEC defines energy security as the "nation's capacity to meet current and future energy demand reliably, withstand, and bounce back swiftly from supply shocks with minimal disruption to supplies."[66] This is similar but more focused than the more widely known definition from the International Energy Agency (IEA) that defines energy security as the uninterrupted availability of energy sources at an affordable price.[67] The WEC definition will be applied in this thesis.

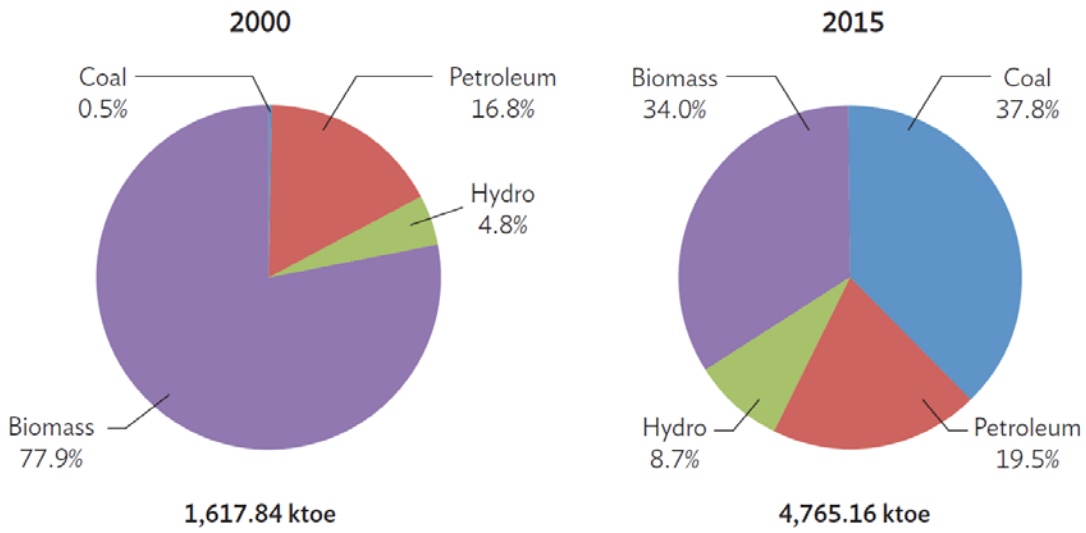
The first step to approaching energy security is defining a nation's energy portfolio to understand its mix of energy sources and whether vulnerabilities exist in the nation's ability to provide power. Figure 3 compares Laos's energy portfolio in 2000 and

[66] World Energy Council, "World Energy Trilemma Index," accessed 1 September 2019, https://www.worldenergy.org/transition-toolkit/world-energy-trilemma-index, 13

[67] International Energy Agency, "What Is Energy Security?" Accessed November 8, 2019. https://www.iea.org/topics/energysecurity/whatisenergysecurity/.

2015. As shown, Laos's energy consumption has increased from 1,617 to 4,765 ktoe.[68] Coal, biomass, and petroleum were the top three sources of energy generation in 2015.

Figure 3. Total Energy Consumed[69]



Coal is interesting as it was primarily mined and exported or used in heating for industrial processes until 2015 when the Hongsa coal power plant commenced operations, and all exports of coal stopped.[70] The Hongsa plant is part of Laos's "Battery of Asia" program as all the electricity from the coal plant is exported to Thailand. In 2015, Laos's domestic industries used 108 kt of coal, but the plant consumed 3,817 kt of coal to produce 1,878 MW of electricity.[71] Since there is minimal use of coal for industrial purposes and all the electricity is exported from the Hongsa plant, coal meets minimal internal demands and allows Laos to be energy secure for the limited industrial heating requirements.

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[68] ktoe = thousand tonnes oil equivalent.

[69] Source: Ministry of Energy and Mines, Lao PDR and The Economic Research Institute for ASEAN and East Asia, *Lao PDR Energy Statistics 2018*, 71.

[70] Lao PDR Energy Statistics 2018, 13.

[71] Lao PDR Energy Statistics 2018, 13.

Biomass in the form of wood or charcoal derived from wood is utilized in rural and urban locations primarily for residential cooking and minor commercial heating.[72] The share of biomass in Laos's energy mix has reduced from 77 percent in 2000 to 38 percent in 2015. However, consumption increased from 1,260 ktoe to 1,618 ktoe over the same period. Although biomass use has increased 30 percent over 15 years, Laos continues to source its requirements internally and is energy secure.

Petroleum is the only primary energy source in Laos's energy mix that is not domestically available. Laos is wholly dependent on petroleum imports, which accounted for 19 percent of its primary energy consumption in 2015. Transportation is the primary consumer of petroleum. As Laos's economy has grown, there has been an increase in petroleum use, as shown in Figure 3. The Economic Institute believes that Laos's energy security is correlated to its petroleum imports.[73] Laos has limited storage capacity, creating vulnerability to changes in international prices and the inability to adapt to price or supply of petroleum.

Between 2000 and 2015, hydroelectric production increased from 300 ktoe to 1232 ktoe, a 400 percent increase.[74] Hydropower is Laos's primary source of electricity.[75] Although hydropower made up only eight percent of the nation's total energy supply in 2015, it generated 99 percent of all electrical power consumed in Laos in 2010.[76] As shown in Figure 4, national electricity consumption is negative, because Laos is a net exporter of electricity. However, Laos does import electricity during the dry season and to remote areas closer to other national grids. Laos's energy security of electrical power did not change from 2000 to 2015 as it has consistently been a net exporter. Comparing Figures 4 and 5 shows that Laos's available amount of energy for export has continued to grow.

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[72] Lao PDR Energy Statistics 2018, xii.

[73] Lao PDR Energy Statistics 2018, 72.

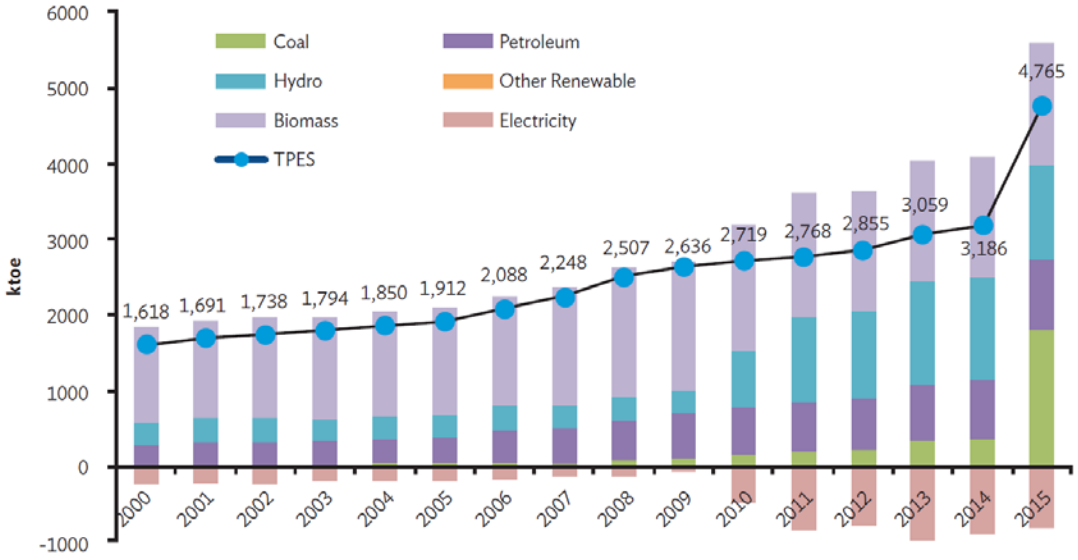
[74] Lao PDR Energy Statistics 2018, 72.

[75] OECD Development Centre.

[76] Mattijs Smits. "Hydropower and the green economy in Laos: sustainable developments?" *Towards a Green Economy: In Search of Sustainable Energy Policies for the Future* (2012): 106.

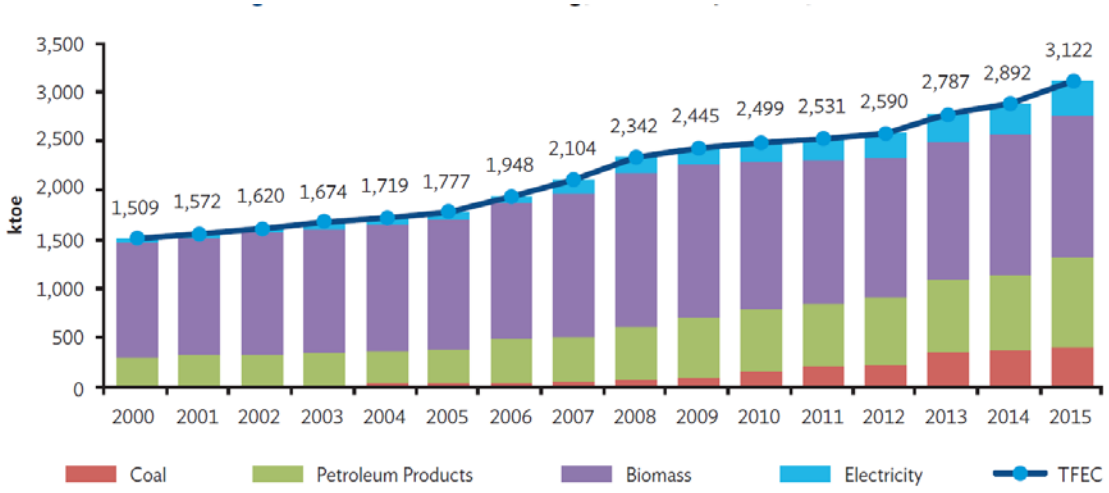
Laos is energy secure in all areas, except petroleum products which are solely imported. According to WEC's definition, Laos is unable to maintain a steady supply or mitigate price shocks from international markets. The increase in hydroelectric power has not increased Laos's energy security but has maintained the current level of security with the capacity to meet future demands. As electricity is not a replacement for petroleum in Laos, increasing electricity does not fill empty gas tanks. In the future, if vehicles were primarily hybrids or electric cars, trucks, or trains, then hydropower would increase energy security.

Figure 4. Internal Energy Utilization[77]



[77] Source: Ministry of Energy and Mines, Lao PDR and The Economic Research Institute for ASEAN and East Asia, Lao PDR Energy Statistics 2018, 70.

Figure 5. Internal Energy Consumption[78]



ktoe = thousand ton of oil equivalent, TFEC = total final energy consumption.

B. ENVIRONMENTAL SUSTAINABILITY

Environmental sustainability, the second element of the WEC energy trilemma, is based on a transition of energy production away from harmful environmental effects and climate change.[79] Laos is a unusual case as fossil fuel use has risen over time instead of being eliminated. The Hongsa coal power plant was built to support the "Battery of Asia" economic program in 2015 and has significantly increased carbon dioxide emissions from Laos. As seen in Figure 6, upon commencing operation in 2015, the use of coal, CO_2 emissions, and carbon dioxide intensity (emissions divided by GDP) quadrupled or doubled. As noted earlier, the electricity produced by the plant is only for export to Thailand. Increasing hydroelectric power benefits Laos economically, but the desire for economic growth with coal power harms environmental sustainability. Figure 7 shows a significant increase in total CO_2 emissions from all sources.

[78] Source: Lao PDR Energy Statistics 2018, 74.

[79] World Energy Council, "World Energy Trilemma Index." Accessed November 8, 2019. https://www.worldenergy.org/transition-toolkit/world-energy-trilemma-index.13.

Figure 6. Coal use, Emissions, and Intensity 2000–2015[80]

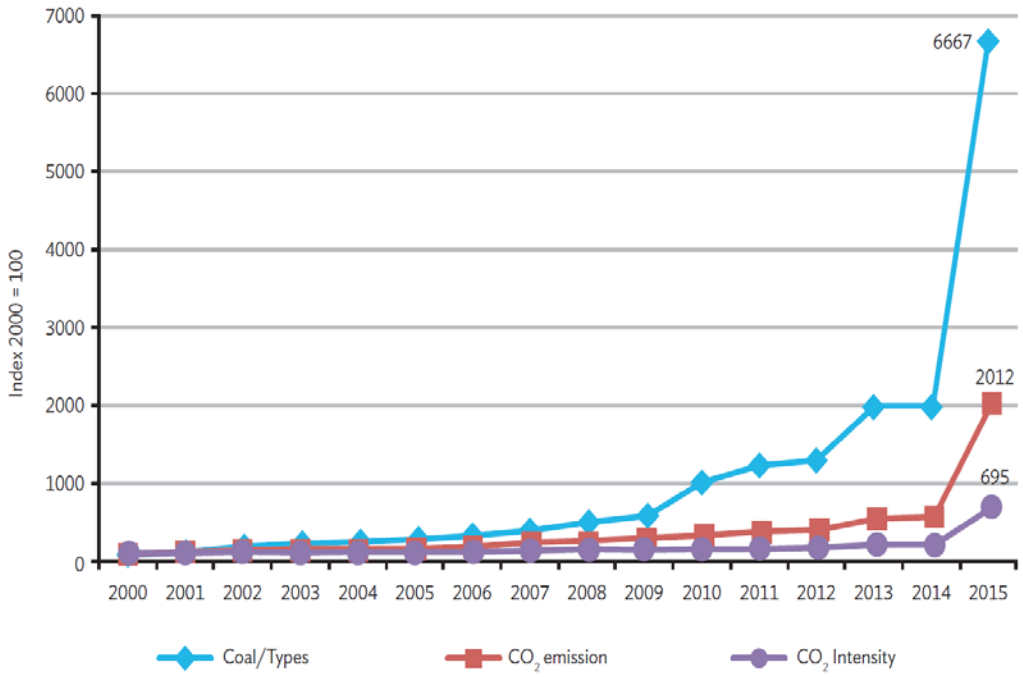
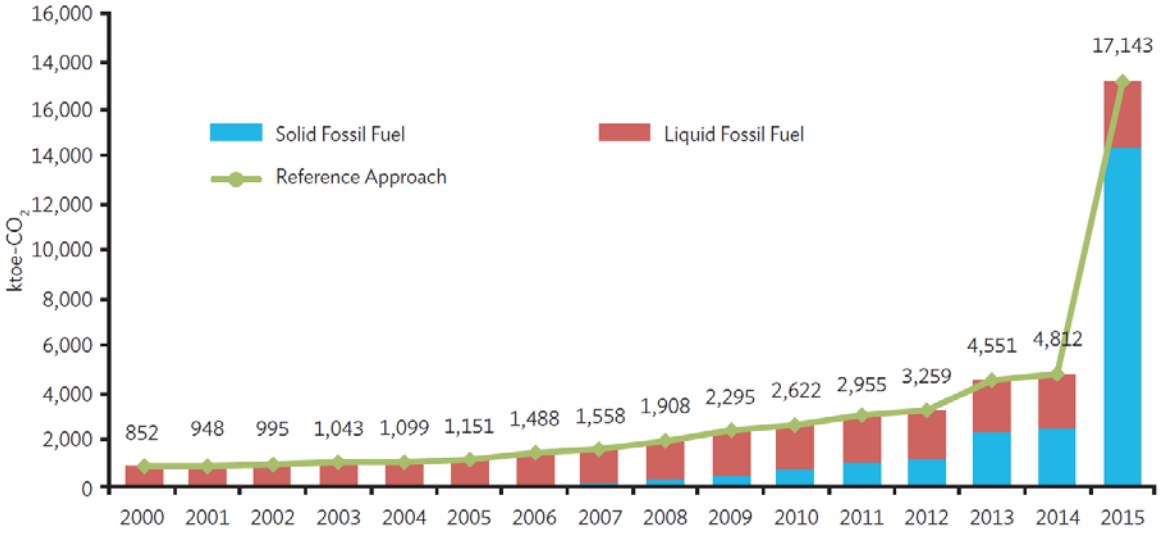


Figure 7. Carbon Dioxide Emissions by Source[81]



80 Source: Ministry of Energy and Mines, Lao PDR and The Economic Research Institute for ASEAN and East Asia, Lao PDR Energy Statistics 2018, 93.

81 Source: Lao PDR Energy Statistics 2018, 91.

According to WEC's definition, Laos should regress in sustainability due to increasing CO_2 emissions. Although Laos's CO_2 emissions per capita of 0.3 metric tons were small compared to Thailand's 4.6 metric tons in 2014, the 2015 increase in emissions was nearly three-fold, or nearly one metric ton per person.[82] However, nationally, hydropower now produces more power than the Hongsa coal plant, and the long-term impact of limited greenhouse gases from hydropower improves Laos's environmental sustainability rating. Although hydropower is environmentally sustainable, according to WEC, there other environmental factors the organization does not consider, such as local changes to the environment from changing river flow patterns which affect fishery, agriculture, and the livelihoods of the population which require discussion in the next chapter.

C. ENERGY EQUITY

The WEC defines energy equity as a "country's ability to provide universal access to reliable, affordable, and abundant energy."[83] The entire population does not have access to electricity but access has increased partly due to large hydropower projects. As seen in Figure 8, access to electricity has continued to increase since early hydroelectric development. Electrification reached 69 percent in 2009, due partly to the construction of new hydroelectric dam development.[84] EdL, the state-owned power company for Laos, addressed the communities near hydropower dams by making connections from new transmission lines from the dams. In 2015, electrification reached 91 percent. However, large hydropower projects had a minor impact from 2009–2015.[85] Instead, off-grid small hydropower, solar, and biomass were utilized in remote areas instead of connecting to established or new transmission lines. These projects were funded by foreign aid or

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[82] "Lao PDR | Data." Accessed December 7, 2019. https://data.worldbank.org/country/lao-pdr.

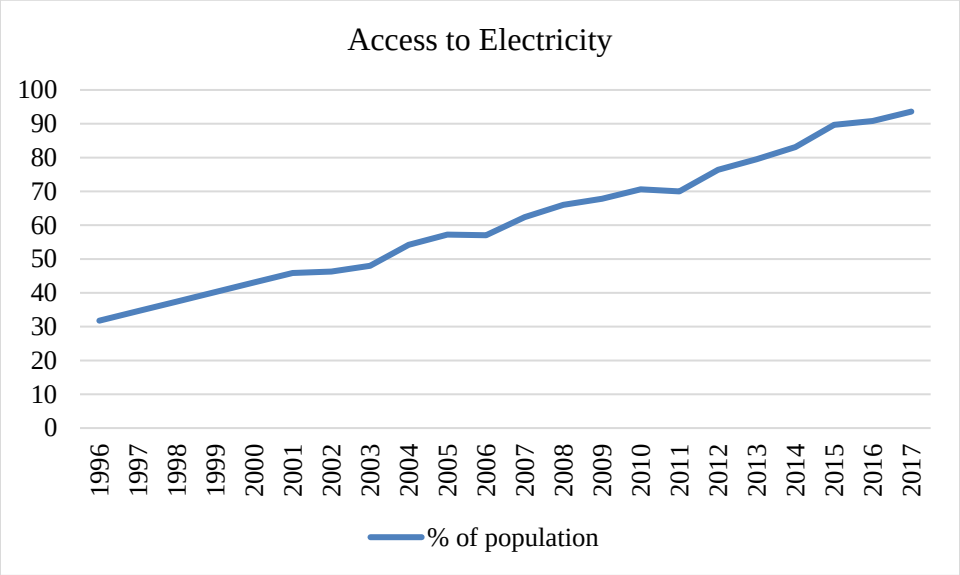
[83] World Energy Council, "World Energy Trilemma Index," 65, accessed November 8, 2019. https://www.worldenergy.org/transition-toolkit/world-energy-trilemma-index.

[84] Mattijs Smits, "Hydropower and the green economy in Laos: sustainable developments?," *Towards a Green Economy: In Search of Sustainable Energy Policies for the Future* (2012): 105.

[85] United States Agency International Development, Task 2 Report-A GIS-Based Technical Potential Assessment of Domestic Energy Resources for Electricity Generation (Bangkok Thailand, 2018), 39.

development banks to bring solutions to these remote villages under the Rural Electrification Master Plan (REMP).[86] The increase in electrification suggests that Laos's energy equity has improved, partly due to large dams.

Figure 8. Access to Electricity[87]



Another interesting statistic related to energy equity concerns delayed access to energy. This was one of the most significant complaints about new businesses and new homes since the average wait time for electrical connections was 135 days from 2009–2014. However, the wait time dropped to 105 days in 2015 and again in 2018 was reduced further to 87 days in 2019.[88] Due to long electrical connection times**,** the World Bank ranked Laos at 144 out of 190 in their *Ease of Doing Business* rankings for getting

[86] NAMA for the Renewable Energy Sector of Lao PDR, United Nations Development Programme, 29 October 2019 https://www.undp.org/content/dam/undp/library/Environment%20and% 20Energy/MDG % 20Carbon%20Facility/NAMA%20Final%20Lao%20PDR2.pdf.

[87] Source: "Lao PDR | Data." Accessed December 7, 2019. https://data.worldbank.org/country/lao-pdr.

[88] "Lao PDR | Data."

electricity category, but also noted that reforms are driving improvement, as noted in an 8.4 percent score increase for the category between 2018 and 2019.[89]

EdL supports energy equity in another way by providing low demand consumers with a reduced cost for electricity. Table 1 shows the residential price schedule from EdL in 2018. For comparison, the average price for electricity in the United States in 2018 was $0.106.[90] EdL is subsidizing the cost of energy to low demand users that only need power for lighting and other simple uses while passing the cost on to higher usage customers and commercial users, who pay between $0.09 and $0.17 per kWh.[91] This price schedule supports the development of rural and low-income rural areas.

Table 2. Residential Price Chart for 2018[92]

Electricity per kWh		
Price Zones (kWh)	**LAK**	**USD**
0-25	348	0.039
26-150	414	0.047
151-300	799	0.09
301-400	880	0.099
401-500	965	0.11
> 500	999	0.113

Overall, hydroelectric development has made energy more abundant and accessible to more people. Energy equity has improved in terms of access and providing cheaper energy to poor/low-intensity users and driving reforms to improve the ease of

[89] World Bank, "Explore Economies," accessed December 9, 2019. https://www.doingbusiness.org/en/data/exploreeconomies.

[90] "EIA - Electricity Data," accessed December 9, 2019. https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_5_6_a.

[91] "Welcome to ELECTRICITE DU LAOS," accessed December 9, 2019. http://edl.com.la/en/.

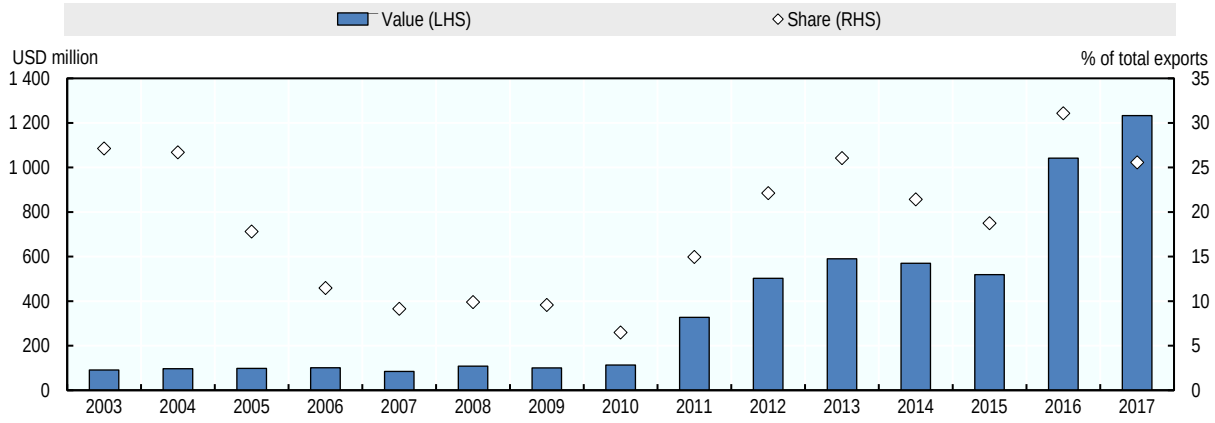
[92] Adapted from "Welcome to ELECTRICITE DU LAOS."

doing business in Laos. However, hydropower continues to grow primarily for economic reasons.

D. EVALUATING HYDROPOWER'S IMPACT ON ECONOMIC GROWTH

As shown in the discussion of Laos's energy security, Laos has consistently been a net exporter of electricity, and the value of exports has consistently grown. A 2018 report by the Organization for Economic Cooperation and Development (OECD) highlighted the economic impact of increasing exports of electricity. As shown in Figure 9, although electricity's share of Laos's exports varied between 5 and 30 percent of total exports from 2010 to 2017, the annual value of electricity exports is growing. From 2010 to 2017, the value of exports has increased by over 1000 percent.

Figure 9. Laos's Electricity Exports: Monetary Value and Share of Total Exports [93]

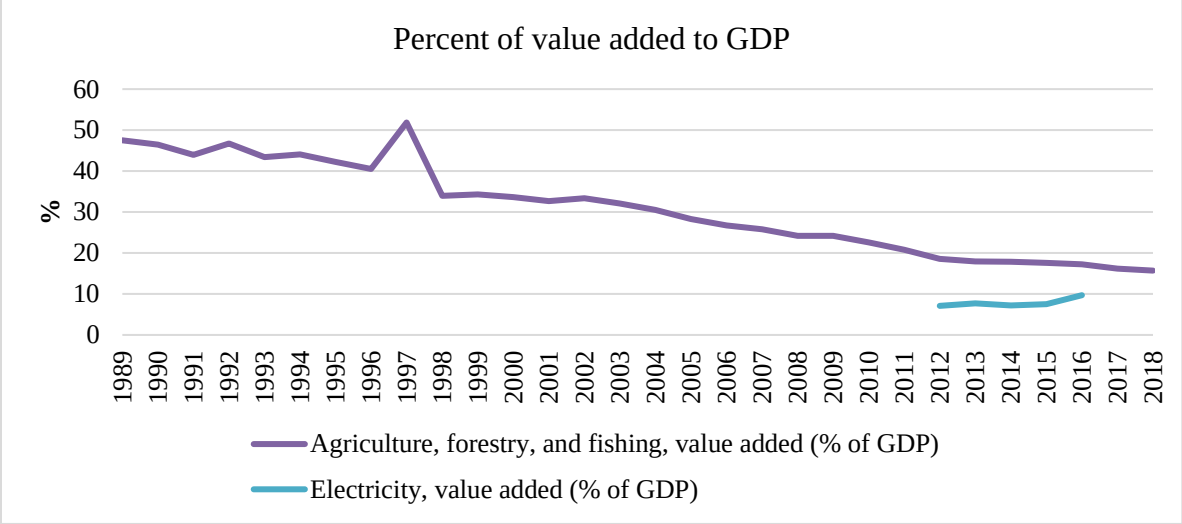


However, under the BOOT model, the GoL is not reaping all the benefits of rising electricity values, as the treasury is only collecting taxes on the sale of electricity. As each dam has individual agreements, and these are not in the public record, it is difficult to determine with any certainty the amount of tax revenue that the GoL collects from internal sales or exports. However, GDP data reveals clues about the overall value of

[93] Adapted from OECD Development Centre.

electricity exports, as shown in Figure 10. Although the data on electricity exports is limited to the 2012 to 2016 period, it is reasonable to conclude that Laos is increasing the revenue that it collects from electricity exports, as the country's GDP was also rising during this time period.

Figure 10. Sectors' contribution to Lao's GDP [94]



Laos's GDP has grown steadily as dam construction has increased. Figure 11 shows total GDP growth and supports the conclusion that hydropower exports contributed to national economic growth. Figure 12 also supports this conclusion about economic growth because GDP per capita quadrupled from 2004 to 2017. As Laos is among the world's least developed nations, turning to energy exports to increase development seems to be proving successful in the short term. Hydroelectric development provides an advantage as it is considered a renewable resource and could be an enduring economic earner versus the mining industry, which does not provide an unlimited supply of valuable minerals for export.

[94] Adapted from "Lao PDR | Data," accessed December 7, 2019. https://data.worldbank.org/country/lao-pdr; Ministry of Energy and Mines, Lao PDR and The Economic Research Institute for ASEAN and East Asia, *Lao PDR Energy Statistics 2018*, 44.

Figure 11. Gross Domestic Production (Current US$)[95]

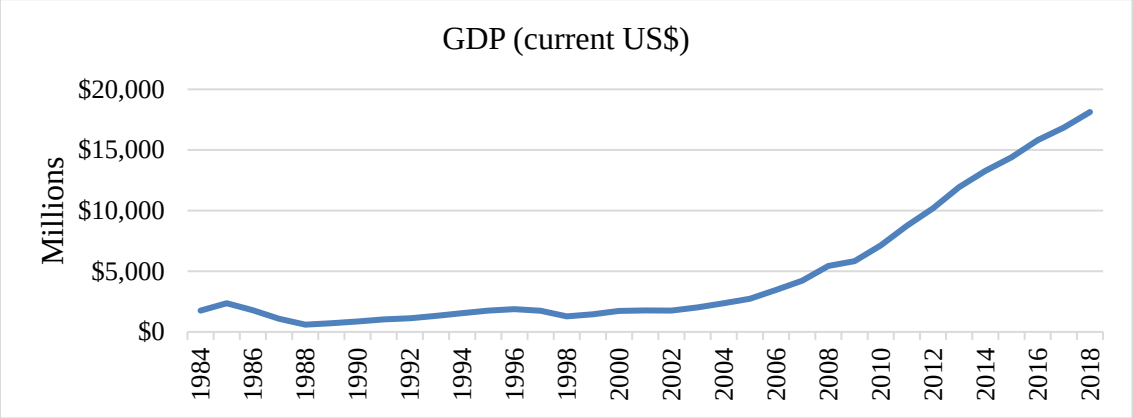
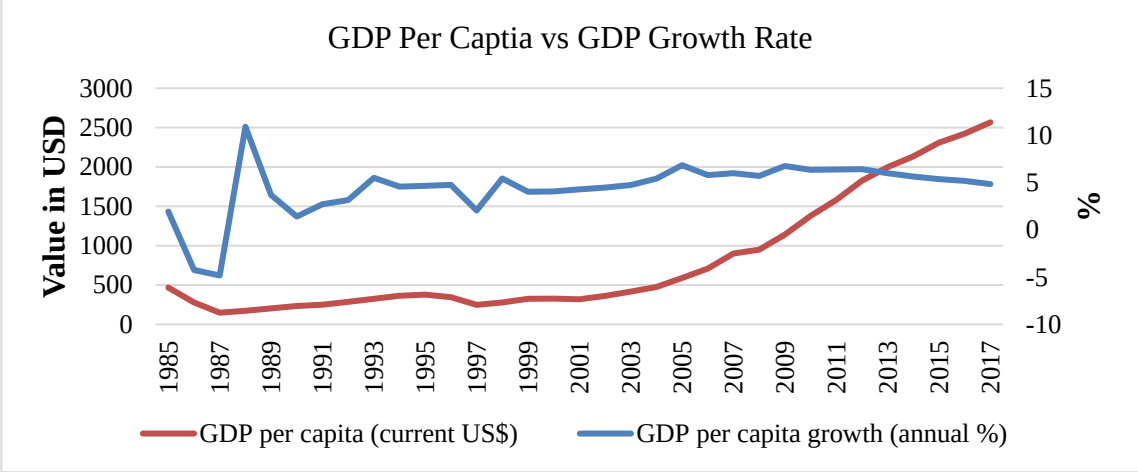


Figure 12. GDP per capita and GDP per capita Growth Rate[96]



As shown in Figure 10, electricity's contribution to Laos's GDP is increasing. This creates a risk that Laos could experience a version of the resource curse, which occurs as nations start to rely on the export of energy for economic growth. The Natural Resource Governance Institute defines the resource curse as the "failure of many resource-rich countries to benefit fully from their natural resource wealth, and for

95 Adapted from "Lao PDR | Data." Accessed December 7, 2019. https://data.worldbank.org/country/lao-pdr.

96 Adapted from "Lao PDR | Data."

governments in these countries to respond effectively to public welfare needs."[97] The resource curse has typically affected oil-producing states that became overly dependent on the sales of their natural resources, so applying this concept to a renewable resource seems counterintuitive. However, Lasse Eisgruber evaluated hydroelectric, wind, and solar in Laos, Mongolia, and the Middle East, respectively, to determine whether the resource curse applies to renewable energy sources as it does to oil and natural gas. In the case of Laos, Eisgruber found that dam construction and energy exports were not yet pushing out or competing directly with other sectors of the economy.[98] However, Eisgruber finds that the resource curse still applies in the form of corruption, reduced government accountability, and exchange rate appreciation.[99] In the case of Laos, corruption and reduced government accountability apply.

The World Bank also finds that Laos has an opaque business environment from a lack of transparent and dynamic government systems and regulation, ranking it in the 15th percentile in control of corruption.[100] Freedom House ranks Laos as "Not Free" (or 6.5/7) because corruption and lack of government accountability are not likely to be mitigated in the one-party state, and there is no separation between the state and judicial system.[101] A State Department report reinforces these findings as Laos continues to be plagued by "corruption, policy and regulatory ambiguity, and the uneven application of law.[102] Based on Eisgruber's research and Laos's weak institutional strength, a renewable resource curse is plausible from its hydroelectric development.

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97 National Resource Governance Institute, *The Resource Curse the Political and Economic Challenges of Natural Resource Wealth*, March 2015 https://resourcegovernance.org/sites/default/files/documents/nrgi_primer_resource-curse.pdf.

98 Lasse Eisgruber, "The resource curse: Analysis of the applicability to the large-scale export of electricity from renewable resources," *Energy Policy* 57 (2013): 437.

99 Eisgruber, 438.

100 World Bank Group, "Doing Business in Lao PDR," https://www.worldbank.org/en/country/lao/brief/doing-business-in-lao-pdr.

101 "Laos," Freedom House, 2018, https://freedomhouse.org/report/freedom-world/2018/laos.

102 "United States State Department, *2018 Investment Climate Statements* (Washington, DC, 2018), https://www.state.gov/e/eb/rls/othr/2018/eap/281510.htm.

Corruption could have other negative consequences. An example of corruption and lack of oversight is the July 2018 failure of an earthen retention dam as part of the Xe Pian Xe Namnoy project.[103] The failure of the dam, which was 90% complete, resulted in the displacement of 6,000 residents, 40 confirmed deaths, and 98 missing people.[104] The GoL's response was widely considered as weak by NGOs. The $1.2B project was merely delayed as work resumed despite international criticisms from international organizations.

The GoL's lack of accountability also decreases the likelihood that the proceeds of hydroelectric development will benefit all Laotians equitably. In their research on the political economy of hydroelectricity, Sovacool and Walter found that "hydropower will likely remain a contested energy option" as the tradeoffs between energy production and environmental damage are essential considerations.[105] Robert Looney finds a vital trade-off between agriculture and hydropower as only four percent of Laos is arable land and "these are ending up at the bottom of reservoirs."[106] Trading one resource for another without proper research and discussion hurts the prospects for sustained growth.

Hydropower exports contribute year-over-year to GDP growth. GDP per capita continues to grow, supported by each new dam built. In the short term, the dams have provided the desired benefit for Laos and prove the "Battery of Asia" program is useful for the nation. Additionally, at the end of the concession period, Laos will collect all revenue from the sale of electricity. However, an increasing reliance on profits from dams to sustain growth is in direct competition with productivity in agriculture and fishery production which is discussed in detail in the following chapter as the dams

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103 "Laos hydroelectric power ambitions under scrutiny," BBC News, July 24, 2018, https://www.bbc.com/news/topics/c302m85q5jjt/laos&link_location=live-reporting-story.

104 BBC News.

105 Benjamin K. Sovacool and Walter Götz, "Internationalizing the political economy of hydroelectricity: security, development, and sustainability in hydropower states," *Review of International Political Economy* 26, no. 1 (2019): 49–79.

106 Robert Looney, "Laos and the Hydropower Curse." Milken Institute Review, accessed November 9, 2019. http://www.milkenreview.org/articles/laos-and-the-hydropower-curse.

change the environment downstream. As noted in Chapter II, under the BOOT model, Laos provides SPCs with the ability to operate dams with few restrictions to maximize profits. The resulting hydropeaking (running water to match peak demand vice matching normal flow conditions) significantly impacts people and the environment.

E. NAM THEUN 2

The project that enabled Laos's current trajectory of nearly exponential growth in hydroelectricity generation was the Nam Theun 2 (NT2) dam. NT2 was the largest hydroelectric project in Laos when construction began in 2005, and the first dam in Laos capable of producing more than 1000 MW of electricity. Built at the cost of $1.45B, which was equal to nearly a third of the nation's GDP in 2005, construction was completed in early 2010.[107] The World Bank hailed NT2 as a model for future hydroelectric development, as the project intended to ensure that locals benefited from its proceeds. Due to the involvement of the World Bank, the project is the most well-documented dam in Laos. The dam also was a test case for the world to see if Laos could work with international institutions and banks on a project of unprecedented scale. NT2's purpose was to export 95% of electricity produced to Thailand and use the remainder for local use.

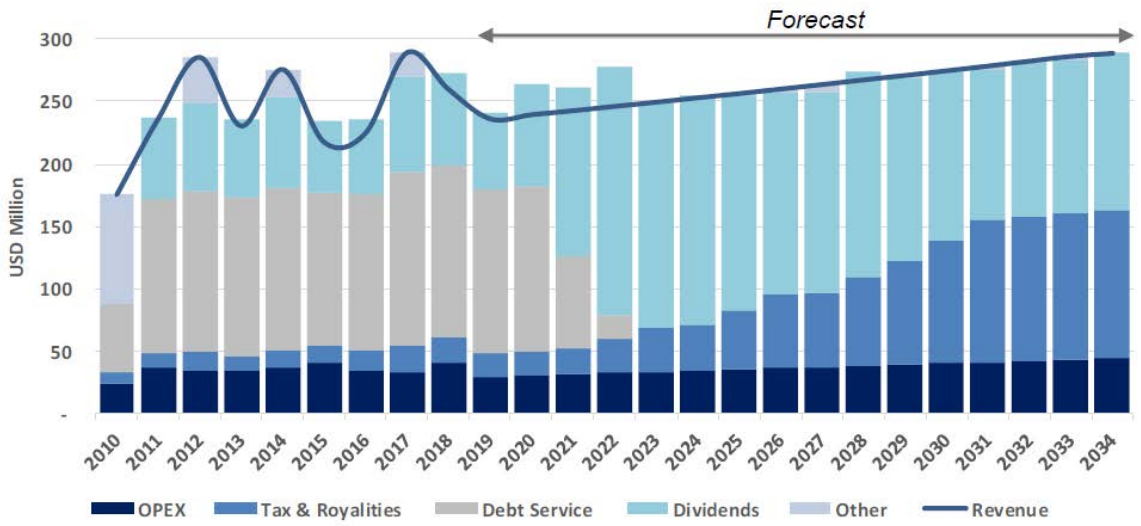
NT2 has been performing well in terms of revenues and production, according to the World Bank, as shown in Figure 13. Figure 13 outlines the total revenues from electricity sales, and each year (bar) is sub-divided by expense type. According to the World Bank, the project has averaged 5671 GWh and $252 million in revenue annually; both are above project estimates.[108] The concession period is for 25 years, but all debt is expected to be paid by the SPC to lenders in early 2023. In terms of return on investment, the project is on pace to meet the projected $2B return on investment over the 25-year

[107] Shannon Lawrence, "The Nam Theun 2 Controversy and its Lessons for Laos" in *Contested Waterscapes in the Mekong Region: Hydropower, livelihoods and governance*, ed. François Molle, Foran Tira, and Mira Kakonen (Earthscan, 2012), 81.

[108] The World Bank, "Implementation Completion and Results Report (IDA Grant Number H155-LA and IDA Guarantee Number B-0080-LA," 28 December 2018, 81.

operating period.[109] However, return on investment is the lone bright spot, as other claims from before construction ring hollow and will be explored in the next chapter.

Figure 13. NT2 Production and Projections[110]



In the World Bank's report, *Doing a Dam Better*, it stated that the goal of NT2 was five-part: become the cornerstone of growth and poverty reduction; reflect a shift of the GoL to engage globally; enable large investors to collaborate on a project for the first time; announce the World Bank's return to large hydropower projects; and demonstrate sustainable outcomes for the environment and people.[111] Based on an independent panel of experts' annual reports, the World Bank claimed that nearly all the project goals had been accomplished by the end of 2017, and there was no longer a need for the World Bank to remain involved with the project. In 2018, the World Bank claimed that "over $170 million in revenues were received by the Lao Treasury" and "in keeping with the

109 "Nam Theun 2 Project," accessed December 9, 2019. https://www.namtheun2.com/project.php.

110 "Implementation Completion and Results Report (IDA Grant Number H155-LA and IDA Guarantee Number B-0080-LA" The World Bank, 28 December 2018.

111 Ian C. Porter and Jayasankar Shivakumar, Editors, *Doing A Dam Better The Lao People's Democratic Republic and the Story of Nam Theun 2* (Washington, DC, The World Bank, 2011), https://openknowledge.worldbank.org/bitstream/handle/10986/2540/584400PUB0ID161Better09780821369852.pdf?sequence=1&isAllowed=y, 1–2.

project's legal agreements, these were allocated to poverty reduction or environmental management."[112] Laos's Prime Minister, Thongloun Sisoulith, stated, "I think that in the future, the government will refer to the success of the Nam Theun 2 power plant, as it is a good model. [The government] is now inspecting and evaluating [hydropower] projects to ensure that they are the best possible."[113]

The World Bank became the keystone and deal maker for the financial package to move forward. As noted by Eisgruber, government accountability and corruption were significant concerns of the World Bank and many others. Political risk guarantees issued by the World Bank and Asian Development Bank protected against government intervention, resolving the creditworthiness concerns of many investors. The World Bank's efforts enabled the financing of a board range of investors to reach the required $1.4B price tag.[114]

NT2 proved to private investors and banks that Laos would be able to support more and more substantial projects in the near term. As noted in *Doing a Dam Better*, "the World Bank raised the creditworthiness of Lao PDR, making it possible for international lenders and private developers to seriously consider taking Lao risk for future private sector projects without guarantees from the World Bank."[115] NT2 was a proof of concept. As construction continued, Laos increasing engaged with private investment groups regionally and globally, sovereign wealth funds, and state-owned enterprises from China to construct more dams, as shown in the increased pace of completed dams between 2010 and 2019.

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[112] World Bank, 28 September 2018 "Nam Theun 2 Project Overview" https://www.worldbank.org/en/country/lao/brief/nam-theun-2-project-overview-and-update.

[113] "Lao PM holds up Nam Theun 2 dam as a successful hydro model" *The Nation Thailand*, 10 September 2018, https://www.nationthailand.com/asean-plus/30354094.

[114] Ian Porter and Jayasankar Shivakumar, *Doing a Dam Better*, The World Bank, 2010. https://doi.org/10.1596/978-0-8213-6985-2. 85–86.

[115] Porter, 20.

F. CONCLUSION

This chapter concludes that hydropower development in Laos provides energy benefits. It enables Laos to meet current and future electrical demand. Nevertheless, Laos does not have complete energy security because reliance on petroleum is not affected. The environmental sustainability of Laos' energy production is improved from the increased production of hydropower. Energy equity has also improved because of subsidized power rates for low use consumers, growth in national electrification, and reductions in the wait for electricity connections for residences and businesses. National growth in terms of GDP has also been correlated with dam construction in the short term. NT2, in particular, enabled Laos to secure increased funding from private sources and sustain economic growth. However, concern exists about the dams' long-term economic and environmental effects in Laos.

IV. ENVIRONMENTAL CONCERNS FOR LAOS HYDROELECTRIC POWER (WHAT DID THE FISH SAY AFTER SWIMMING INTO THE WALL? DAM!)

This chapter will discuss how the construction of dams along the Mekong River and its tributaries has caused environmental damage throughout the river basin but especially in Laos. First, the chapter explores how altering the natural river flow has affected fishery and agricultural production. Second, it considers how these changes have impacted food security for the people living downstream of hydroelectric dams. Third, it examines whether the people displaced or otherwise impacted by dams are better off since the dams were constructed. The chapter uses multiple cases, including the Pak Peung Wetland project, the Xayaburi Dam, and the Nam Theun 2 (NT2) dam to illustrate its points.

A. ENVIRONMENTAL IMPACTS

Laos is 97 percent within the Lower Mekong Basin (LMB) watershed, and the population is 65 percent rural, of which 40 percent live below the World Bank poverty line.[116] These communities are reliant on the environment around them to provide for their daily needs. The environmental change caused by dams has already caused significant harm to the environment and the people. Just as the people are susceptible to natural disasters to include flooding and drought, the dams are creating human-made destruction with little assistance for the people to recover in the new environment. Before the dams, the population found a balance with nature, and their labor was sufficient to support their families. However, the dams are interrupting the natural flow of the river, which has grave concerns for the population, and their ability to adapt to the new river flows is suspect. Meanwhile, the SPCs and GoL have provided little assistance for the people to recover or adapt to the new environment.

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[116] Eric Baran, Teemu Jantunen, and Chiew Kieok Chong, *Values of inland fisheries in the Mekong River Basin*. No. 1812. World Fish, 2007; Central Intelligence Agency, "The World Factbook." https://www.cia.gov/library/publications/the-world-factbook/geos/la.html.

1. Impact on Fisheries

Upstream dam operations impact downstream fishery and agriculture productivity. As discussed in Chapter III with the NT2 case, hydro-peaking is operating the dam so that water flows meet peak energy demands in Thailand or for other export customers. Since demand determines when the water is released, the flows do not match natural patterns. The variation in releases cause significant problems in the immediate downstream environment, and the cumulative effects of all the dams on the watershed have additional impacts. Variation of the daily volume of water flowing determines the speed and level of water in the channel, which shapes the channel and thus the vegetation and wildlife suitable to these areas. In Figure 14, the numbers correlate to the depth of the river, and the blue zones reflect the frequency that the water level reaches the level. The green zones reflect the different vegetation areas based on the frequency of inundation of water. Due to the wide variation of flows and frequent inundation from hydro-peak flows, native vegetation growth is no longer compatible. In the natural flows, the river runs between 0.5m and 1.5m for 90 percent of the time with few incidents to exceed 1.5m from seasonal monsoons. The hydro-peak flows range between .5m and 2.5m daily.[117] The damage is depicted in Figure 15, which shows reduced vegetation and increasing erosion on both banks due to hydro-peaking.

[117] Jory S. Hecht, Guillaume Lacombe, Mauricio E. Arias, Thanh Duc Dang, and Thanapon Piman, "Hydropower Dams of the Mekong River Basin: A Review of Their Hydrological Impacts," *Journal of Hydrology* 568 (January 1, 2019): 285–300. https://doi.org/10.1016/j.jhydrol.2018.10.045; Maria Bejarano, Roland Jansson, and Christer Nilsson. The Effects of Hydropeaking on Riverine Plants: A Review. *Biological Reviews* 93 (August 2017). https://www.researchgate.net/figure/Schematic-illustration-of-the-vertical-zonation-of-plant-communities-across-a-sheltered_fig3_319158755.

Figure 14. Natural and Hydro-peaked Comparison[118]

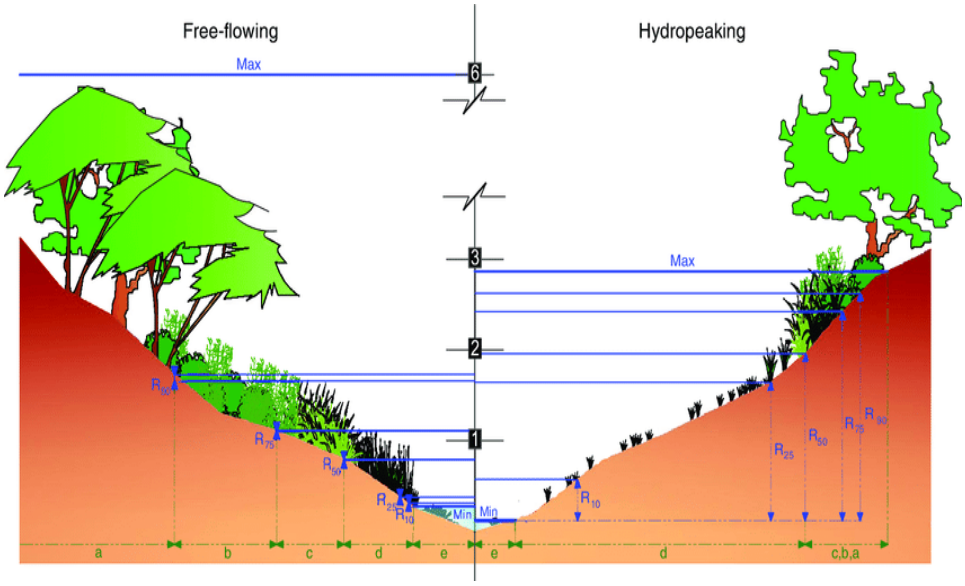


Figure 15. Erosion downstream of the Nam Theun-Hinboun Dam due to hydro-peaking of flows [119]

[118] Source: Maria Bejarano, Roland Jansson, and Christer Nilsson, "The Effects of Hydropeaking on Riverine Plants: A Review," *Biological Reviews* 93 (2017), https://www.researchgate.net/figure/Schematic-illustration-of-the-vertical-zonation-of-plant-communities-across-a-sheltered_fig3_319158755.

[119] Source: K.G. Hortle and So Nam, "Mitigation of the impacts of dams on fisheries — A Primer." Mekong Development Series No. 7. (Vientiane Lao PDR: Mekong River Commission, 2017), 48.

Native fish species are dependent on the natural flow and vegetation for feeding. As hydro-peak flows have destroyed the natural vegetation, food sources and protection have disappeared, and so have the fish. Fishery production in the Xe Bang Fai (XBF) basin downstream of NT2 suffered severely because of hydro-peaking due to the increased water diverted from the Nam Theun reservoir to the XBF river basin. Figure 16 is a depiction of flows before and after the installation of the NT2 dam, with the grey color displaying the actual flows after the operation began versus modeled flows before and after operations commenced. As shown in the difference between the grey and black lines after operations commenced, the average daily flow is significantly higher and the river's peaks from seasonal monsoons have been eliminated.[120] Although the grey line shows the variations in flow have evened out over the year, a graph of the daily flow rates would not be similar to the annual graph. A graph of hourly flows below NT2 would show far more variation from very high flows during peak power demand periods to very low when the dam's power is not needed in Thailand. There is little middle ground and the wide daily variation has increased the average daily flow as shown over the year, but the daily variation would resemble a plateau with steep slopes as the plant was operated based on power demand. The increased daily flow and constant daily change from hydro-peaking resulted in a fishery reduction of 35 percent in 2010 and an additional 25 percent in 2011.[121] One study, *A Ten Years Household Fish Catch Monitoring Study in the Xe Bang Fai River*, concluded there was an overall drop in the fish catch following the operation of the NT2 dam, although the dam was not the sole reason for the decrease.[122] Figure 17 depicts the mean weight of fish caught over a three-month span before and after the commercial operation of NT2. Families recorded the weight of fish caught each

[120] Hecht et al., 290.

[121] Ian G. Baird, Bruce P. Shoemaker, and Kanokwan Manorom, "The People and Their River, the World Bank and its Dam: Revisiting the Xe Bang Fai River in Laos," *Development and Change* 46, no. 5 (2015). 1089.

[122] Maud Cottet and Theodorus AM Visser, "A Ten Years Household Fish Catch Monitoring Study in the Xe Bang Fai River (Lao PDR): Assessment of Fisheries Evolution before and after the Start of Nam Theun 2 Hydropower Operations," *Journal of Fisheries & Livestock Production* 06, no. 04 (2018). https://doi.org/10.4172/2332-2608.1000286. 3.

month, and the researchers grouped the data into three-month periods and reported the mean weight in the figure.

Figure 16. Flow Comparison Downstream of NT2[123]

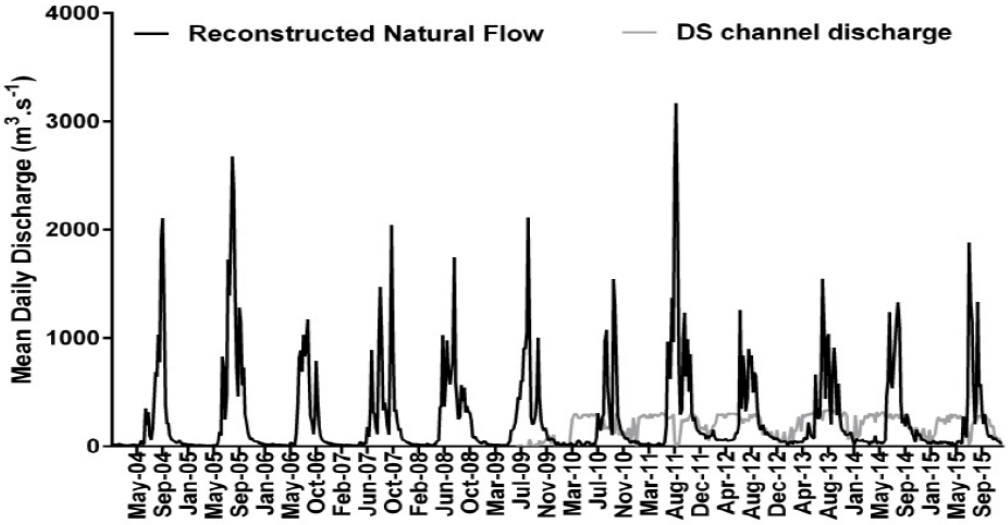
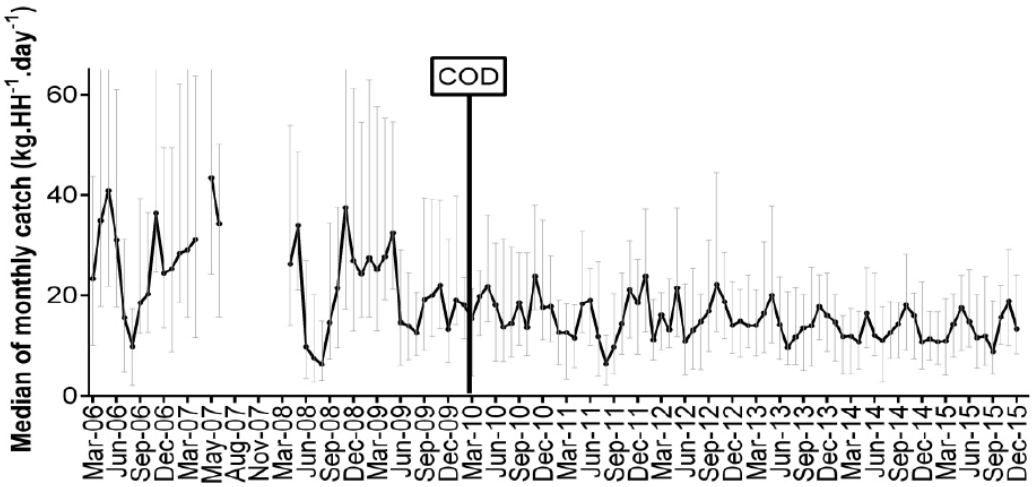


Figure 17. Fishery Production in Xe Bang Fai River[124]



[123] Source: Cottet and Visser, 3.

[124] Source: Cottet and Visser, 5.

A study by Jory Hecht et al., in *Hydropower Dams of the Mekong Basin*, finds that seasonal flow changes will cause significant changes as tributary flows are attenuated by the dams and captured by the reservoirs. Additionally, the study finds that the cumulative impacts of 88 planned tributary dams range from a 23 percent decrease of the water level during the wet season to a 63 percent increase during the dry season in the Mekong River.[125] These swings in the flows of tributary rivers, as seen in Figures 14 and 16, have significant impacts on fishery productivity basin-wide.

The combined effects of these flows alter the mainstream flows and fishery production. A study by Orr et al., *Dams on the Mekong*, estimated that the changing flows and dams would cause a loss in fishery production by as much as 26 percent basin-wide.[126] In Laos, the projection for tributary dams could cause a 19,800 to 63,360 tons/year loss in capture fisheries.[127]

Dams have also harmed fisheries by stopping annual flooding. Every year, the Mekong River floods, which creates the Tonle Sap flood pulse. The floods induced from monsoon rains change the direction of flow in the Tonle Sap River from flowing south to join the Mekong to flowing north, fed by the Mekong River. This reversal causes the Tonle Sap Lake to increase to over 60 times its dry season volume and expand to over five times the land area.[128] During the monsoon, the river carries millions of tons of sediment from northern areas to the floodplains of the Mekong and Tonle Sap Lake. At the peak, the lake transforms into a nursery for hundreds of species of fish. As the monsoons depart and the flow returns to draining the lake until the next flood pulse, millions of fish depart and travel north and south. Consequently, interruption of the Tonle

[125] Hecht et al., 293.

[126] Orr et al., 927.

[127] Orr et al., 929.

[128] Brian Eyler et al., Letters from the Mekong toward a Sustainable Water-Energy-Food Future in Cambodia (Washington, DC: The Stimson Center, 2019), 6.

Sap flood pattern will affect the capture fisheries from the far migrating species that account for 40 to 70 percent of all fish catches basin-wide to include Laos.[129]

Based on the models of Hecht et al. and Orr et al., Laos is projected to see the least impact from fishery losses from tributary dams.[130] However, as discussed in Chapter II, Laos is building nine of the eleven mainstream dams within the country. These will have additional impacts on fishery production.

2. Expected Mainstream Impacts on Fishery Production

Dam construction also interrupts fish migration in the Mekong basin.[131] In Laos, hundreds of species of fish utilize different parts of the Mekong basin ecosystem for critical phases of their lives. Dams pose problems for fish passage. Interruptions have occurred in multiple projects, including in the Pak Peung Wetland. In 1986, an irrigation regulator dam was constructed at the exit of the Pak Peung Wetland in support of an expansion of rice paddy fields for the local community.[132] The construction of the agricultural weir impeded the natural migration for many species of fish. Many older villagers, when interviewed, recounted the wetland as being healthier with several species of fish catches before the weir. Additionally, the wetland had "many trees, many small streams…now it is all joined together because of the weir." [133] Another villager recounted the following, "After [the] weir construction we can have a rice field and grow vegetables to sell in the market now better than before, but after the weir, big fish species

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[129] Patrick J. Dugan, Chris Barlow, Angelo A. Agostinho, Eric Baran, Glenn F. Cada, Daqing Chen, Ian G. Cowx et al. "Fish Migration, Dams, and Loss of Ecosystem Services in the Mekong Basin." *AMBIO* 39, no. 4 (June 1, 2010): 344–48. https://doi.org/10.1007/s13280-010-0036-1. 345.

[130] Hecht et al., 290; Orr et al.

[131] Eyler et al., 3.

[132] L. Baumgartner, T. Marsden, J. Millar , G. Thorncraft, O. Phonekhampheng, D. Singhanouvong, K. Homsombath, W. Robinson, J. McPherson, K. L. Martin & Boys, *Development of Fish Passage Technology to Increase Fisheries Production on Floodplains in the Lower Mekong Basin* (Bruce ACT, Australia: Australian Centre for International Agricultural Research (ACIAR), 2016).

[133] Baumgartner et al., 1844–45.

are not seen."[134] The locals did not thoroughly understand the impact of the weir on the wetland, and the trade-offs of the weir have harmed the local environment and fishery, but increased irrigation.

The Pak Peung Wetland case shows mitigation of fish passage can be solved if studied before construction. A study funded by the Government of Australia constructed a fish bypass around the regulator to provide an alternative route. The construction of the passage followed the WCD's framework to ensure technical experts discussed plans with all stakeholders in the region. An ideal design plan for fish was deemed too dangerous for small children fishing or playing in the bypass. However, an alternative design, approved by all parties, was first constructed from 2010–2012 and then modified in 2013–2014 with conical slots.[135] A survey of species in the passageway and survey of local fishers showed that 132 species were able to bypass. Some villagers mentioned new species were caught in the wetland following construction in 2014.[136]

However, fish passage is not usually a priority for dam projects in Laos. As noted by Baumgartner, "the [Pak Peung Wetland] project was the most active group on fishways in the Lower Mekong Basin, and there were few others involved in fish passage work."[137] Additionally, "there was no budget to support attendance of international experts. At some stage it would be good to establish and resource such a group, either within the Government of Lao PDR or the MRC."[138] An MRC report on *Mitigation of the Impacts of Dams on Fisheries*, published in 2017 supports Baumgartner's conclusion by stating that, "fish passes…have only been constructed at a handful of dams and it is

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[134] Joanne Millar, Wayne Robinson, Lee Baumgartner, Khampheng Homsombath, Malavanh Chittavong, Thonglome Phommavong, and Douangkham Singhanouvong, "Local Perceptions of Changes in the Use and Management of Floodplain Fisheries Commons: The Case of Pak Peung Wetland in Lao PDR," *Environment, Development and Sustainability* 21, no. 4 (August 2019): 1835–52. https://doi.org/10.1007/s10668-018-0105-3, 1845.

[135] Millar et al., 1837.

[136] Millar et al., 1845.

[137] L Baumgartner, T Marsden, J Millar , G Thorncraft, O Phonekhampheng, D Singhanouvong, K Homsombath, W Robinson, J McPherson, KL Martin & Boys (2016), *Development of fish passage technology to increase fisheries production on floodplains in the lower Mekong basin.* Australian Centre for International Agricultural Research (ACIAR), 25.

[138] Baumgartner et al., 25.

only recently that trials with Mekong species have set parameters for fish pass design based on systematic field experiments on Mekong fish."[139] Dams and other hydraulic control structures, regardless of size and purpose, are being built first by Laos and considering effects later.

Planned and current projects are not learning from the effects of completed projects in the basin. Disturbingly, fishery productivity declined severely after the Pak Mun dam, on a major tributary on the Mekong in Thailand, was completed in 1994, with immediate impacts on the fishery and people. Fish ladders installed in the Pak Mun dam were proven ineffective, and the fish catch upstream declined 60–80 percent.[140] In the years following construction, entire species were no longer found up or downstream of the dam, and losses ranged from 50–100 percent of fish catches.[141] At best, the design for fish passage in a region of the second most biodiverse watersheds could be described as trial and error.

Another recent example of the lack of study, design, or consideration of the results of hydroelectric development is the Xayaburi Dam. The Xayaburi dam project included minimal consideration of fish passage design. During the review by the MRC, experts issued a scathing report regarding the design deficiencies for fish passage and sediment transport.[142] The criticism was sufficient to cause a year-long delay in construction and an additional $200 million in construction costs.[143] The redesign technical paper was released in January 2019, which estimated peak fish migration in the area to be up to 5,000 kg/hr.[144] A new design attempted to address the abilities of many species with several inlets operating at various flow rates to facilitate passage; however,

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[139] Hortle and Nam, 77.

[140] Orr et al., 926.

[141] Orr et al., 926.

[142] Richard Cronin and Courtney Weatherby, "Letters from the Mekong: Time for a New Narrative on Mekong Hydropower," Stimson Center, October 2015, accessed November 5, 2019. https://www.stimson.org/content/letters-mekong-time-new-narrative-mekong-hydropower. 21.

[143] Cronin and Weatherby, 21.

[144] MRC, *Development of Guidelines for Hydropower Environmental Impact Mitigation and Risk Management in the Lower Mekong Mainstream and Tributaries,* 108.

many doubt the redesign will be able to provide sufficient passage to maintain the fishery production due to a lack of focused research or trials. The Xayaburi Dam is an example of maximizing hydroelectric production with little regard for the consequences. Blocking migratory species will severely degrade the production capacity of the fishery and negatively impact the livelihoods of the people in the area.

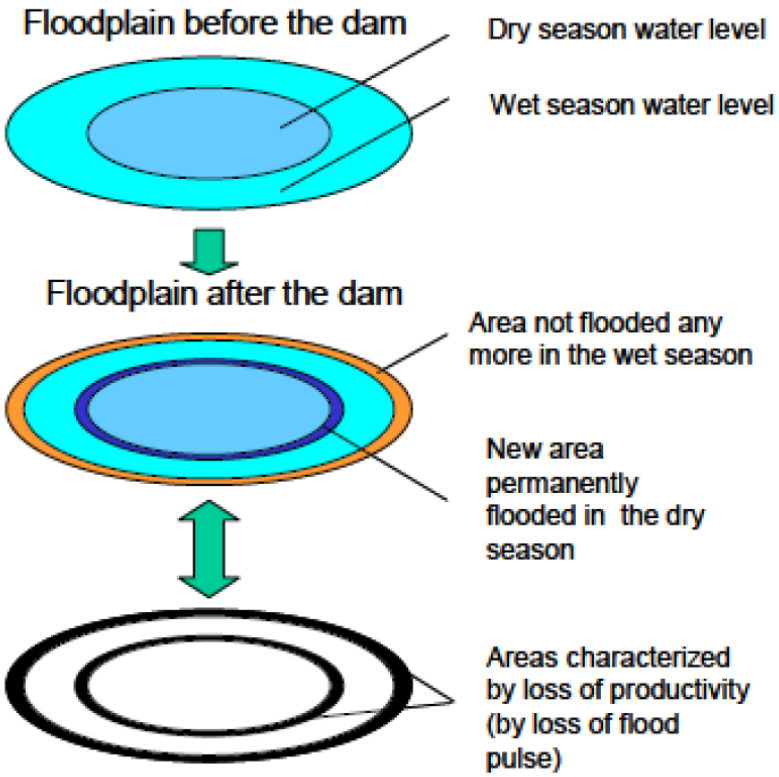
3. Floodplain Agriculture

Floods have traditionally played an essential role in agriculture in Laos and across the Mekong basin. Monsoon rains in the area push composting material from the forests and fields to the rivers and melting snow in the Tibetan plateau carries eroding sediment down the many tributaries to the mainstream. The speed of the flow determines the carrying capacity of the river to move the material. The monsoon rains and snowmelt flow combine to raise the river above the regular channel to the maximum level of a free flowing river as shown in Figure 14. As the water flow spreads beyond the normal channel, the water slows, and the carrying capacity of the water drops, causing the sediment to settle. The sediment and compost material fertilize the soil and provide sufficient water for crops by raising the water table. A hydro-peaked river does not allow the gradual recession and settling of sediment, but increases erosion from the daily change in flows as shown in Figure 15.

Variable flow affects tributary and mainstream floodplains in similar ways to its fishery impacts. As the seasonal flow peaks and valleys are attenuated, the villages lose ground to the river, and the floods do not reach as far as before leaving dry and unfertile soil. According to the MRC, the benefits from this annual flooding are estimated at $8-10 billion.[145] However, as shown in Figure 18, the variable flows have increased the dry season flows and reduced the peak flood levels, thus reducing the effectiveness of this natural cycle.

[145] Cronin and Weatherby, 9.

Figure 18. Diagram of Reduced Floodplains After Dam Construction[146]



The reduction of the floodplains continues with altered flows. The reduction negatively affects the environment and life cycles basin-wide, in and outside of Laos. Studies on the hydrological changes from the construction of dams within the basin show dire implications for the natural floodplain and river cycle. In 2008, completed dams only retained two percent of the basin's flow capacity but this could to increase to 20 percent around 2025 based on planned project completion dates, which further reduces the floodplains.[147] Hecht produces models that incorporate the impacts from China's dams, which account for most of the current active storage in the basin and increasing flows in

[146] Source: "The ISH 0306 Study Development of Guidelines for Hydropower Environmental Impact Mitigation and Risk Management in the Lower Mekong Mainstream and Tributaries Volume 2 – Hydropower Risks and Impact Mitigation MANUAL – Key Hydropower Risks, Impacts and Vulnerabilities and General Mitigation Options for Lower Mekong, Final Version." Mekong River Commission, March 2018. http://www.mrcmekong.org/assets/Uploads/ISH0306-Volume-2-Final-Manual2.pdf. 126.

[147] Hecht et al., 286.

the dry season. They show that flows as far as Southern Laos are likely to be 41–74 percent higher in the dry season with significant fluctuations.[148] The flow rates are essential as China controls 35 percent of the dry season flows from glacier and snowmelt from the Tibetan plateau.[149]

Some may argue that dams protect areas from flooding, which is true, but not in the case of Laos as the majority of dams were built for hydropower production with few incorporating flood protection. Although unpredictable, difficult to control, and at times outright destructive, the MRC recognized that in 2017 that flood damage was estimated to be only $60-70 million a year, but the natural cycle benefits from this annual flooding are estimated at $8-10 billion.[150]

B. FOOD SECURITY

Dams' environmental impacts directly correlate to the food security of rural communities. For centuries, rural residents living around the rivers have established a balance between farming and fishing to sustain their families. As discussed, the production level of Mekong basin fisheries and agriculture fields are directly related to the naturally occurring cycles of the river. The changing environmental conditions from the changes in flow patterns are threatening the food security of millions in Laos. Residents are struggling to adapt to this new environment. Centuries of knowledge passed down among the subsistence communities are no longer applicable in these changing conditions.

Rural communities focus predominantly on agricultural production for subsistence farming of rice or cash crops for export, while fishing and small gardens supplement diets. The increasing hydropower is creating problems for these rural

148 Hecht et al., 288.

149 Hecht et al., 286.

150 Brian Eyler and Courtney Weatherby, "Letters from the Mekong: Toward A Sustainable Water-Energy-Food Future In Cambodia," Stimson Center, February 2019. https://www.stimson.org/sites/default/files/file-attachments/WEB-FEB_Cambodia%20Report.pdf. 9.

populations. For most people, both fisheries and agriculture are suffering from reduced production.

1. Fishery Impact

The Mekong River fisheries are the primary source of protein for the basin's population. Across the basin, 30–80 percent of animal protein derives from the rivers.[151] Residents in Laos receive 38–50 percent of animal-derived protein from the rivers, according to the FAO.[152] Fishing for most people is a supplement to their work in the fields. In 2004, Sarkkula found a direct, positive correlation between flood level and annual fish catches in the Tonle Sap and highly migratory fish; thus, maintaining the natural monsoon pulse and subsequent floods are critical for the preservation of the basin's fisheries.[153] Orr et al. estimate that land for livestock production would have to increase by 14–43 percent for Laos to meet the minimum calorie and protein currently derived from local and migratory fisheries.[154]

Hecht's models predict a collapse of migratory fishery production.[155] The impact would not be as severe in Laos as basin-wide, but the main driver for the collapse would be the mainstream dams' effects combined with the 100-plus tributary dams basin-wide changing the natural flows. However, Orr et al. postulate that replacement of fish as the primary protein source would not be viable as the water and land required for the conversion of land-based protein would be in direct competition with current rice and agricultural lands already under pressure to sustain current production levels. Multiple

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[151] Eric Baran, "Mekong fisheries and mainstream dams." *ICEM 2010* (Hanoi, Viet Nam: Mekong River Commission Strategic Environmental Assessment of hydropower on the Mekong mainstream, International Centre for Environmental Management, 2010), 19–20.

[152] "FAO Food Balance Sheets" Food and Agriculture Organization (2019), http://faostat.fao.org/site/368/default.aspx. and Eric Baran 2010. Mekong fisheries and mainstream dams. Fisheries sections in: ICEM 2010. Mekong River Commission Strategic Environmental Assessment of hydropower on the Mekong mainstream, International Centre for Environmental Management, Hanoi, Viet Nam 19–20.

[153] Baran, 6.

[154] Orr et al., 930.

[155] Hecht et al.

studies have cross-referenced the study by Orr et al. to assist in drawing attention to the harm from dam projects.

2. Agricultural Impact

The Pak Peung weir increased agricultural production, but not all hydropower dams are providing irrigation, and most even prevent farming in the traditional floodplains. Rice accounts for 50 percent of agricultural production in Laos.[156] However, irrigation networks only provide sufficient water and material for 4 percent of fields during the dry season.[157] Although national agricultural production has increased according to the Asian Development Bank (ADB), hydropower development has driven people from the limited lowlands near the rivers to growing crops by clearing forests to increase available land for farming.[158] The ADB cites hydropower as a driver of land-use change and control of river flows as the primary factor affecting rural population livelihoods, due to the impacts on agriculture production.[159] As yields per hectare have dropped due to reduced sediment transport, fields are no longer being replenished for the next crop cycle.

In some cases, flooding has been too high and destructive in lower rice fields. These fields are abandoned by families living downstream, causing a shift to swidden agriculture, or slash and burn, in the hills and forests to replace lost land.[160]

Another example of the impact of changing flow comes from the Theun-Hinboun Expansion Project northwest of NT2 Dam. The powerhouse location of the dam was built

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156 Asian Development Bank, "Agriculture, Natural Resources, and Rural Development Sector Assessment, Strategy, and Road Map:: Lao People's Democratic Republic," Manila, Philippines: Asian Development Bank, December 2018. https://doi.org/10.22617/TCS189785-2. 2.

157 ADB, 2.

158 ADB, 9–10.

159 ADB, 10.

160 Ian G. Baird and Keith Barney, "The Political Ecology of Cross-Sectoral Cumulative Impacts: Modern Landscapes, Large Hydropower Dams and Industrial Tree Plantations in Laos and Cambodia." *The Journal of Peasant Studies* 44, no. 4 (July 4, 2017): 769–95. https://doi.org/10.1080/03066150.2017.1289921. 778.

3 meters below the level needed to maintain gravity irrigation systems downstream.[161] As a result, the rice fields downstream of the dam no longer receive floodwater surcharge and require water pumping to support any shortfall in rainfall in the wet season and all dry season farming.

Several projects, including NT2, relied on pumping as a solution to make up for the loss of agricultural production or replace lost land. Agricultural plots with irrigation were provided to the displaced population. However, they were not suitable for farming.[162] The promised irrigation for dry season rice farming was initially achieved with pumps or with limited repairs and small improvements to existing irrigation infrastructure.[163] However, dry season rice production failed to be productive and economical for numerous reasons. Residents lacked the capital to purchase fuel for the pumps or lacked the knowledge and ability to maintain them. Subsidized electrical power terminated after an interim period of a few years. Additional costs for dry season farming include fertilizer. Although dry season yields tended to be far less than the wet season, they depleted fields for the wet season, resulting in most farmers using a fertilizer with each crop, a practice unheard of before construction of the dam.[164] As one villager is quoted in Baird et al., "If [wet season] grows well, we do not want to do [dry season] because there is little profit."[165] However, some continue to farm in the dry season as no other options are available due to the severity of changes in their local environment.

The loss of food security creates hardships for people who are reliant on the environment and their labor to sustain their families. These people are unable to sustain their lives as the many generations before them have done. As the World Bank intended

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161 S. Sparkes, "Hydropower Development and Food Security in Laos." *Aquatic Procedia*, At the Confluence - Selection from the 2012 World Water Week in Stockholm, 1 (January 1, 2013): 138–49. https://doi.org/10.1016/j.aqpro.2013.07.012. 140.

162 Bruce Shoemaker, "Revenues Without Accountability," in *Dead in the Water*, Bruce Shoemaker and William Robichaud (The University of Wisconsin Press, 2018), 123.

163 Ian G. Baird, Bruce P. Shoemaker, and Kanokwan Manorom. "The people and their river, the World Bank and its dam: Revisiting the Xe Bang Fai River in Laos." *Development and Change* 46, no. 5 (2015): 1093–94.

164 Baird et al., 1093–94.

165 Baird et al., 1095.

to ensure these people are supported due to the changes from the dam, the conclusion report for the NT2 project was labeled, *Doing a Dam Better*. Next, the chapter examines the experiences of the people displaced and downstream of the NT2 dam following operations starting in 2010.

C. DAMS' SOCIAL CONSEQUENCES

In the NT2 project, the World Bank sought to improve the lives of the people displaced or affected downstream through equitable development and increased standards of living. The World Bank has advertised the relative success of NT2 as a model for future large dam projects, in terms of ensuring equitable treatment of the local population and economic benefits from the construction of the dam. However, the report's authors and even the GoL deems this to be an overly optimistic assessment. As a Vice-Minister for Energy and Mines stated, "They are saying that Nam Theun 2 is a very good project. But to use it as a standard, it's not possible. We can use it as a good example, a good guideline, but not as a standard. All the developers say that it is not possible to use Nam Theun 2 as a standard."[166]

Ian Baird, Bruce Shoemaker, and Kanokwan Manorom researched the XBF basin before construction of the dam and returned in 2014 to conduct fieldwork unsanctioned by the government to understand the impact of the dam on the affected people. Comparing their findings with the World Bank reports provides a unique perspective on the effectiveness of the NT2 project at achieving equitable development and better lives for those downstream.

Construction of NT2 displaced thousands of ethnic minority group members, permanently flooded 450 km^2 of land, and permanently changed the natural flow in the Nam Theun and Xe Bang Fai (XBF) Rivers.[167] As part of the funding agreement with

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166 Kim Geheb, Niki West, Nathanial Matthews, "The Invisible Dam" in *Hydropower Development in the Mekong Region*, ed. Nathanial Matthews, Kim Geheb (New York: Routledge, 2015), 111.

167 Shannon Lawrence, "The Nam Theun 2 Controversy and its Lessons for Laos" in *Contested waterscapes in the Mekong Region: Hydropower, livelihoods and governance*, ed. François Molle, Foran Tira, and Mira Kakonen (Earthscan, 2012), 81.

the World Bank, the project would have to provide funds for the development and relocation of the ethnic minorities from the Nakai Plateau. Under the Downstream Programme (DSP), the program was primarily to compensate displaced villages with minor mitigation efforts for people affected by the project. People displaced were to receive homes with land for personal gardens, .66-hectare lots with irrigation installed by 2009, access to protected forests for non-timber activity, and access to the newly formed reservoir and community boats for fishing.[168]

The World Bank established a Panel of Experts (POE), which reported directly to the GoL to ensure these requirements were met.[169] The POE's charge was to provide independent monitoring on the project, and their assessment of the project's commitments to environmental and social development, to the GoL. Several critics believe the POE was effective at addressing some issues for the displaced villagers but failed to secure adequate support for the estimated 50,000 people living in the XBF basin.[170]

Issues with housing were the first sign that development was not a priority of the project. The Nakai Plateau villagers were supposed to move in the dry season of 2006–2007. However, failure to construct their new homes on schedule resulted in the majority living for two years in temporary shelters.[171] The construction of the dam continued despite the delays in meeting social and environmental promises. The POE was ineffective at advocating for upstream assistance from the GoL to ensure the homes were built by Nam Theun Power Company (NTPC) until International Rivers (an NGO)

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168 Ian G. Baird, Bruce P. Shoemaker, and Kanokwan Manorom, "The people and their river, the World Bank and its dam: Revisiting the Xe Bang Fai River in Laos." *Development and Change* 46, no. 5 (2015): 1086.

169 Baird, 1086.

170 Baird, 1087.

171 Shannon Lawrence, "The Nam Theun 2 Controversy and its Lessons for Laos" in *Contested waterscapes in the Mekong Region: Hydropower, livelihoods and governance*, ed. François Molle, Foran Tira, and Mira Kakonen (Earthscan, 2012), 93–94.

brought international attention to the plight of the villagers. The attention prompted the GoL to ensure the homes were finished.[172]

Another example of the limited success of the POE is the failure to ensure equitable use of DSP funds. The POE advocated for direct payments to the residents living downstream. During the development of the project, the POE recommended a study to better understand how people would be affected downstream to ensure equitable development for all affected by the project. This study was prompted by effects on residents living downstream of the nearby Theun-Hinboun Dam, northwest of NT2. The NTPC commissioned a study, which consumed the part of the budget that was intended to support people downstream. The study revealed the affected population to be greater than 155,000 people.[173] As the majority of benefits were allocated to the villagers displaced by the reservoir, few funds remained for the people downstream. The GoL and NTPC decided to establish micro-loans confined to specific purposes. However, the loan interest rates ranged from between one and three percent, according to International Rivers, to as high as six percent, as noted by Baird et al..[174] Few villagers took advantage of these loans due to the interest rates and their unwillingness to accept the risk of a failed endeavor. Only the wealthier villagers, who would be able to recover in case of failure, generally benefited from the loans. Payments were also made directly to families who could attribute a direct loss, such as a river garden, to the dam operation.[175] No universal payments were made to support communal losses, such as fishery production.

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[172] Lawrence, 94.

[173] I Ian G. Baird, Bruce P. Shoemaker, and Kanokwan Manorom, "The people and their river, the World Bank and its dam: Revisiting the Xe Bang Fai River in Laos." *Development and Change* 46, no. 5 (2015): 1088.

[174] Shannon Lawrence, "The Nam Theun 2 Controversy and its Lessons for Laos" in Contested waterscapes in the Mekong Region: Hydropower, livelihoods and governance, ed. François Molle, Foran Tira, and Mira Kakonen (Earthscan, 2012), 99. and Ian G. Baird, Bruce P. Shoemaker, and Kanokwan Manorom. "The people and their river, the World Bank and its dam: Revisiting the Xe Bang Fai River in Laos." *Development and Change* 46, no. 5 (2015): 1095.

[175] Ian G. Baird, Bruce P. Shoemaker, and Kanokwan Manorom, "The people and their river, the World Bank and its dam: Revisiting the Xe Bang Fai River in Laos," *Development and Change* 46, no. 5 (2015): 1092.

The NTPC intended for a new fishery to grow in the reservoir to off-set fishery losses in the rivers. The projections for reservoir fishery to replace fishery losses in the basin proved false as the reservoir failed to produce, and NTPC's projections for losses were lower than actual data from Cottet. The XBF river flow has nearly doubled the mean average flow from NT2 releases.[176] Increased flows invalidated traditional fishing methods due to the reduction of shallow waters and steep banks created by erosion.[177] Village complaints reveal that the increased flow coincided with a dramatic drop in fish populations, and fishing is no longer beneficial due to the drop in the fish population. In Keng Pe, the entire fish market has disappeared due to the decline in the fishery, and many people have sought work in Thailand as manual workers to compensate for the losses of the fishery.[178] These families in the past were able to be sustained between the production of the fisheries and agriculture fields. However, the new environmental conditions affected production in both areas, and the population is suffering.

The project had some positive results. The World Bank promoted NT2 by citing improvements in development indicators, including that infant and maternal mortality rates have declined and life expectancies have increased nationally due to the redistribution of funds from hydroelectric dams.[179] Vocational training, which is offered to 20 to 25 people annually, has seen mixed results.[180] Training conducted in urban centers distant from the villages, with short training periods is deemed by many who have returned as insufficient.[181] The villagers are also conflicted about leaving home for

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[176] Hecht et al., 290.

[177] Ian G. Baird, Bruce P. Shoemaker, and Kanokwan Manorom, "The people and their river, the World Bank and its dam: Revisiting the Xe Bang Fai River in Laos," *Development and Change* 46, no. 5 (2015) :1089–1090.

[178] Baird et al., 1090.

[179] The World Bank, "Lao People's Democratic Republic - Nam Theun 2 Hydropower Project Update : Revenue Management." The World Bank, September 1, 2017. http://documents.worldbank.org/curated/en/343791510736969520/Lao-Peoples-Democratic-Republic-Nam-Theun-2-Hydropower-Project-update-revenue-management.

[180] Bruce Shoemaker, William Robichaud, Yos Santasombat, and Philip Hirsch, *Dead in the Water: Global Lessons from the World Bank's Model Hydropower Project in Laos*, University of Wisconsin Press, 2018. https://muse.jhu.edu/book/59181/ 131.

[181] Shoemaker et al., 131.

prolonged periods due to their responsibilities within their homes. The conflict is demonstrated in other ways at the Xayaburi dam, as many construction workers hired from the local area leave during wet season farming due to fear of the impact on their families.[182] Additionally, skills such as cosmetology have proven to be in low demand in the rural areas preventing growth in off-farm development.[183] The World Bank claims that 97 percent of household incomes have doubled since the displaced villagers were relocated, but there is no mention of the people downstream.[184]

The DSP was prematurely canceled, and the World Bank closed out its participation in 2018, saying that development goals have been achieved, and the GoL with the NTPC would continue to ensure long term growth in the region.[185] The 28th POE report concluded: "The POE has confidence that the project is on the road to overall sustainability. It is not there yet."[186] The World Bank claims that the construction of schools, pumps, two health centers, and upgraded district hospital and increased electrification has substantially improved the lives of all those affected by the dam. The Revenue Management Plan, the plan to distribute profits from the program back to the locals by the World Bank, touts that $156 million has been redistributed from NT2 profits.[187] The central government reports that poverty reduction, natural resources management, education, healthcare, public works, and projects implemented by

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[182] Richard Cronin and Courtney Weatherby, "Letters from the Mekong: Time for a New Narrative on Mekong Hydropower," Stimson Center, October 2015. https://www.stimson.org/content/letters-mekong-time-new-narrative-mekong-hydropower.

[183] Shoemaker et al., 131.

[184] World Bank, 30 January 2018 "Statement on the Closure of the World Bank-funded Nam Theun 2 Social and Environment Project," https://www.worldbank.org/en/news/press-release/2018/01/30/statement-on-the-closure-of-the-world-bank-funded-nam-theun-2-social-and-environment-project.print.

[185] World Bank.

[186] David McDowell, Elizabeth Mann, and Lee Talbot. "Nam Theun 2 Multipurpose Hydro Project International Environmental and Social Panel of Experts Twenty-Eighth Report," July 2018, 39. http://documents.worldbank.org/curated/en/227931535719837867/pdf/129708-WP-P049290-PUBLIC-SEPT-3-5AM-POEReportFinal.pdf. 24.

[187] The World Bank, "Lao People's Democratic Republic - Nam Theun 2 Hydropower Project Update : Revenue Management." The World Bank, September 1, 2017. http://documents.worldbank.org/curated/en/343791510736969520/Lao-Peoples-Democratic-Republic-Nam-Theun-2-Hydropower-Project-update-revenue-management.

provinces have received funds. However, the literature does not indicate that these funds were spent entirely in the local area.[188] Shoemaker and Robichaud find that the World Bank and GoL have caused irreparable damage to the lives of the people of the XBF basin and argue that those displaced from the Nakai Plateau require long term support.

Another assessment by Shoemaker, *Dead in the Water*, also challenges the World Bank's claims about local development. Shoemaker et al. conclude that the World Bank was unable to ensure a socially-focused redistribution of funds with strict control measures.[189] Shoemaker asserts that the revenue generated by the project would be treated as government revenue with no external auditor, separate account, or ability to directly tie profits from the project to local development.[190] For example, in June 2017, the GoL disclosed that dams only accounted for $6M of $54M of the Poverty Reduction Fund with the rest coming from foreign donations.[191] The Poverty Reduction Fund, a line item from the revenue management plan for NT2 as shown in Figure 19, was solely established to channel revenues from hydropower projects to development programs. Figure 19 is data from the World Bank as reported by Audit and GoL reports. The discrepancy between the figures reported by Shoemaker and World Bank supports the concerns that the money is no longer traceable once it reaches the GoL's accounts. There are concerns that the spending reports from the GoL are not reflecting real expenditures as intended by the World Bank.

188 The World Bank.

189 Shoemaker et al., 207.

190 Shoemaker, 208.

191 Shoemaker, 210.

Figure 19. Reported NT2 Revenue Management Plan Distributions[192]

Sector	US$mil	%
Education	65.81	35%
Health	62.14	33%
Public Works and Transport	15.67	8%
Energy, Mining and Agriculture	24.32	13%
Natural Resources and Environment	1.31	1%
Poverty Reduction Fund	9.91	5%
Projects Implemented by Provinces	7.05	4%
Total	**186.22**	

Sources: SAO Audit Reports 2009/10 - 2015/16 and, MoF Data FY2015/16 and 2017

As noted by a World Bank Report from 2015, "the government has partially met requirements related to the conduct of Public Expenditure Reviews, peer audit reviews and reporting on NT2 revenue allocations and expenditures, and has not met obligations regarding public disclosure, NT2 revenue allocations, and expenditures and regarding public consultations."[193] The findings by Shoemaker and reports by the World Bank show that Laos continues to not emphasize helping the local areas with revenues from the dams as the revenue management plans are not universally applied to all new dams. The poverty reduction fund continues to be an area that Laos relies on foreign donations to supply, and revenues from dams are funneled to other government projects or programs.

The likely outcome is that people with limited alternatives will continue to leave the basin for permanent work. The ensuing migration of low-educated, low-skilled people from rural areas to urban centers highlights the failed development of the impacted populace. Unrest and protest are likely to be suppressed by the government of Laos to ensure projects push forward to meet economic goals over the interest of the rural

192 Adapted from The World Bank, "Lao People's Democratic Republic - Nam Theun 2 Hydropower Project Update : Revenue Management." The World Bank, September 1, 2017. http://documents.worldbank.org/curated/en/343791510736969520/Lao-Peoples-Democratic-Republic-Nam-Theun-2-Hydropower-Project-update-revenue-management.

193 Shoemaker, 209.

population. As highlighted by Baird et al., “The common understanding was that NT2 was ‘a government project’ and that it could be dangerous to criticize it openly.”[194]

D. CONCLUSION

The control of the Mekong’s flow is affecting natural cycles that, for centuries, have supported a population that is dependent on the basin’s cycle. The development of hydroelectric power is being optimized to meet electrical demand in Thailand and Vietnam, while the residents in Laos are losing food security from decreased fishing catches and reduced yields from their rice fields. The ten-year study revealed that initial losses are below model predictions. However, the environmental impacts are creating significant hardship on rural populations that have little recourse to improve their situation.

[194] Ian G. Baird, Bruce P. Shoemaker, and Kanokwan Manorom. “The People and Their River, the World Bank and Its Dam: Revisiting the Xe Bang Fai River in Laos.” *Development and Change* 46, no. 5 (2015): 1080–1105. https://doi.org/10.1111/dech.12186. 1099.

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V. CONCLUSION

This chapter summarizes Laos's policy of hydropower development in the broad context of answering the question: Is Laos better from the dams or not? The pro-dam camp in Laos believed hydropower was the key to economic development and path to graduating from among the United Nation's least developed country list. The anti-dam camp claimed hydropower would cause food security concerns for Laos and cause irreparable harm to fishery and agricultural production. In 2000, the WCD sought to change the way hydropower development impacted nations by bridging the two camps to ensure benefits for all involved and affected by dams. Laos is a case that proves the commission's mission is not complete, due to mixed results.

Evidence from both camps has been presented and it shows there is no definite conclusion. Hydropower continues to plague the poor and vulnerable in the rural areas of Laos, due to environmental damage and social displacement. In contrast, urban areas enjoy cheap electricity and the nation profits from the export of the increasing surplus of electricity. Chapter II also highlighted that Laos is still constructing an ambitious program and has only completed one of the planned nine dams on the Mekong River.

A. FINDINGS

Applying the WEC model to Laos shows that the energy trilemma did not significantly change for Laos despite the nearly exponential growth in hydropower production since 2000. While hydropower increased Laos's available energy, it did not address energy security due to the country's continued reliance on the import of petroleum. Energy equity grew by contributing to the electrification of the nation and allowing Laos to provide reduced rates for low-use consumers. In addition, hydropower production continues to be a sustainable source, resulting in slightly improved environmental sustainability. However, during the same time period, Laos's use of coal has increased CO_2 emissions three-fold.

The Laotian economy has steadily grown over the last ten years and, as recorded by the World Bank, short term benefits of hydropower are driving current growth as demonstrated by the NT2 revenues. Projected future profits will increase as concession agreements expire in the next 20 to 30 years. Projections show that hydropower will continue to be a substantial source of income if exports or internal consumption keep pace with production levels. However, since the share of exports of electricity to Thailand and other regional neighbors continues to expand as a percentage of GDP, Laos remains susceptible to a natural resource curse if it creates an economic dependence on the export of energy.

Chapter IV laid out how changing the flow of rivers has changed the lives of the people and the environment forever. The environment and people are struggling to adapt. However, some results were not as dire as estimated, Cottet's survey of local fish catches found a consistent drop after commercial operation of NT2 started, but deemed the evidence inconclusive that the dam was the only reason for fishery losses. Studies of the affected population also show mixed results in the quality of the lives of people living downstream. The competing findings between the World Bank's *Doing A Dam Better* and their closing statement on involvement in NT2, compared to Shoemaker's *Dead In The Water*, show that there is no clear answer. The World Bank attempted to meet the WCD goal to ensure local development with the Revenue Management Plan. However, Shoemaker provides a strong argument that the World Bank failed to reach their goals.

It is too early to make a definite conclusion whether Laos has improved or regressed. GDP and other economic indicators have risen, but the lives of the rural population have not universally improved, and food security remains questionable as Laos continues to develop more dams across the country.

The research indicates that the GoL has taken a pragmatic, self-interested approach and will continue to build dams to drive economic growth. It acknowledges that the NT2 project was not fully attractive or sustainable as a standard, but remains within the pro-dam camp. The Prime Minister continues to profess that the NT2 model was

good.[195] However, Laos does not meet the WCD intent, as the Lao people, as a whole, are not better off.

Regionally, the MRC is the only coordinating body that could influence Laos's continued development of hydropower with the support of the other members. However, the other members of the MRC have taken a similar pragmatic approach to pursue hydropower potential within their borders for similar reasons of economic growth and increased supply of energy. Thailand and Vietnam enjoy the benefits of cheap power from Laos as well, and Cambodia is exploring options to construct two dams on the Mekong. Thus, significant regional or individual pushback from the downstream riparian states seems unlikely.

B. POSSIBLE OUTCOMES

Laos expects to have 100 operating dams by the end of 2020.[196] Between 2020 and 2030, Laos estimates that it will add another 93 hydroelectric dams with an installed capacity of an additional 8.6 GW.[197] In 2019, Laos commissioned the Xayaburi dam, continued the construction of two other dams, and initiated the MRC consultation processes to start construction of two additional dams on the mainstream within the next two years.

This thesis anticipates that Laos's GDP will benefit in the short-term and even more when concessions end and control with all profits are transferred to the GoL. However, the current pace of construction and trial and error approach will continue to negatively impact fishery production. The loss of floodplain agricultural land noted in

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[195] Kim Geheb, Niki West, Nathanial Matthews, "The Invisible Dam" in *Hydropower Development in the Mekong Region*, ed. Nathanial Matthews, Kim Geheb (New York: Routledge, 2015): 111.

[196] Mekong Eye, "Laos Expects to Have 100 Hydropower Plants by 2020," July 12, 2017. https://www.mekongeye.com/2017/07/12/laos-expects-to-have-100-hydropower-plants-by-2020/.

[197] "Renewable Energy Data in Lao PDR," *EAST and Southeast Asia Renewable Energy Statistic Training Workshop*, Institute of Renewable Energy Promotion Ministry of Energy and Mines, 14/12 2016, 31. https://www.irena.org/-/media/Files/IRENA/Agency/Events/2016/Dec/12/Laos-presentation.pdf?la=en&hash=C3EE41F35C533D50672C4A75B1AA0D9D10C8C66C.

this thesis also suggests a possible loss of food security locally. These issues are only some examples of problems that dams will cause to downstream populations in the near and long-term future.

Computer models have attempted to predict the outcome of the dams, in terms of economic benefit and cost associated with hydropower development. In 2011, the MRC published a study titled "Assessment of Basin-wide Development Scenarios-Basin Development Plan Programme, Phase 2" (BDP2).[198] This report focused on the economic valuations of several scenarios for mainstream dam development to include hydropower sales, capture fisheries, and indirect cost/benefits.[199] Another study conducted by the Natural Resources and Environmental Management Research and Training Center (NREM) used the same data as the MRC while including Social Mitigation and Sediment & Nutrient Loss in their model.[200]

Both studies used Net Present Value (NPV), which is an economical method to predict the current value of a future investment over time. BDP2 used a ten percent interest rate for all factors, while NREM used different interest rates for each category. The differences between the BDP2 and NREM results are striking. The BDP2 shows all MRC nations benefiting economically and Laos having the highest net gain of $22.6M annually. In contrast, NREM showed only slight gains of $700K Laos, $1.3M for Thailand, and negative projections for Vietnam and Cambodia. A follow-up study by Portland State University conducted a sensitivity analysis of the NPV interest rates using the same data used by BDP2. The sensitivity of 10, 3, and 1 percentage rates for NPV showed positive results between $14 and $21 billion over the lifetime of the projects for Laos.[201] The other nations showed increasingly negative results, as demonstrated by losses ranging from $8B to $128B for Thailand and similar negative projections for

198 Apisom Intralawan et al., Economic Evaluation of Hydropower Projects in the Lower Mekong Basin (OXFAM, 2017). 1.

199 Intralawan, 1–2.

200 Intralawan, 1–2.

201 Richard Cronin and Courtney Weatherby, "Obstacles to Equitable Hydropower Development Planning In The Lower Mekong Basin," September 2014, 9.

Cambodia and Vietnam.[202] Both studies predict hydropower will be an economic engine for Laos with different conclusions on overall performance.

Depending on the facts, calculations, assumptions, and variables for the future, there exists a generally positive economic consensus for Laos. The concerns for hydropower to deliver equitable results for the region seems doubtful, but this has not given reason to Laos to stop or even pause. These models and other studies provide sufficient cause for Laos to reconsider further development of hydroelectric development due to the long-term cost, but there is no evidence of Laos moving in this direction.

Laos continues to build more dams despite calls for studies from environmental and non-governmental organizations to better understand the impacts from Xayaburi or to ensure oversight improves after the dam's failure in 2018. The well-being of rural populations near dams mostly depends on their ability to adapt to the new environment created by the dams. The GoL will not stop building dams until it is no longer economical or in their best interest of the nation as a whole, not just the rural population. Only time will tell if the models prove true or false. The results in the next ten years will play out at the dinner table, markets, and stomachs of the most vulnerable people across the basin.

C. RECOMMENDATIONS

US AID has been working with the GoL to research wind and solar energy options across the country.[203] These engagements should continue to bring diversity to Laos's energy to prevent increased reliance on hydropower. Additionally, Laos is poised to be a compelling case for testing electrical vehicles, given the abundance of electricity and the ability to incorporate new transportation systems into a national infrastructure development plan. The dual effort of diversification of electrical energy and of transportation fuel sources will strengthen Laos's energy security and national

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[202] Cronin, 9.

[203] United States Agency International Development, Task 2 Report-A GIS-Based Technical Potential Assessment of Domestic Energy Resources for Electricity Generation (Bangkok Thailand, 2018).

development, with fewer negative side effects than focusing all efforts and investments on hydropower. An alternative supply of renewable energy provides Laos the flexibility to alter water releases to match natural flow patterns to mitigate the harmful effects currently experienced. The mixing of these sources offers options to continue to drive economic growth with the export of surplus electrical power.

NGOs should continue to voice the concerns to raise awareness of the plight of people living downstream and help other nations understand that the complications of hydropower have not significantly declined since the WCD released their report in 2000. These groups will not be able to stop construction. However, information on the trends in the region is crucial to understanding the impacts of the dams. The data will better inform future projects inside and outside of Laos.

For Laos, the abundance of energy provides a justification to research the feasibility of electrical vehicles to reduce dependence on petroleum imports. Given the increasing supply of electricity, Laos would greatly benefit from turning to a transportation system based on electrical power, such as the proposed China-Laos Railway, which will reduce Laos's dependence on imported fuel for transportation.[204]

[204] "China-Laos Railway Power Supply Project Launched in Lao Capital - World-Energy," accessed January 1, 2020. https://www.world-energy.org/article/5773.html.

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