The Impact of Nam Theun 2 Hydropower Development Project on Human Wellbeing in Lao PDR

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Thesis
Submitted to Flinders University
for the degree of

Master of International Development

College of Humanities, Arts and Social Sciences

Adelaide, June 2021

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LIST OF ABBREVIATIONS

ADB	Asian Development Bank
AHPSR	Alliance for Health Policy and Systems Research
AusAID	Australian Agency for International Development
BOL	Bank of Lao People's Democratic Republic
IEA	International Energy Agency
IHA	International Hydropower Association
JICA	Japan International Cooperation Agency
Lao PDR	Lao People's Democratic Republic
LSB	Lao Statistics Bureau
LSIS	Lao Social Indicators Survey
LuxGOV	Luxembourg Government
MDGs	Millennium Development Goals
MICT	Ministry of Information Cultures and Tourism of Lao PDR
MOH	Ministry of Health of Lao PDR
MPI	Ministry of Planning and Investment of Lao PDR
MRC	Mekong River Commission
NT2 Plant	Nam Theun 2 Hydropower Plant
NT2 Project	Nam Theun 2 Hydropower Development Project
NTPC	Nam Theun 2 Power Company
PMNCH	Partnership for Maternal, Newborn and Child Health
SDC	Swiss Agency for Development and Cooperation
SDGs	Sustainable Development Goals
UN	United Nations
UNAIDS	The Joint United Nations Programme on HIV/AIDS
UNDP	United Nations Development Program
UNFPA	United Nations Population Fund
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WFP	World Food Programme
WHO	World Health Organization

ABSTRACT

Everywhere, people seek to improve their quality of life and wellbeing, including in health, education and living standards. Energy, particularly in the form of electricity, is needed for daily life and development. Therefore, access to electricity is vital for the improvement of human wellbeing. Several hydropower plants are being planned and constructed in developing countries like Lao PDR[1]. While there are several studies on the positive and negative impacts of hydropower development on the Lao economy, poverty and environment. So far, there is little understanding of how the development of hydropower impacts on human wellbeing in the context of Lao PDR.

This research aims to assess the impact of hydropower development in Lao PDR on the wellbeing of people affected by the project. The findings of the study are based on analyses of both qualitative and quantitative data to measure the wellbeing of people in the region of this power project. The statistical data used in this study are drawn from the Lao Social Indicator Surveys (LSIS) conducted by the Lao Statistics Bureau in 2006, 2012 and 2017. Wellbeing of the affected people has been assessed by using the Alkire et al., (2015) [2] method of measuring multi-dimensional poverty and subjective wellbeing, as modified by Saikia et al., (2018)[3] based on the concept of Gross National Happiness (GNH) Index. The Nam Theun 2 hydropower project (NT2 project) has been used as a comparative case study to assess how hydropower development impacts on the overall wellbeing of the people of Lao PDR.

The findings from this study suggest that, generally, the development of NT2 project has improved the wellbeing of the residents in the host communities, especially newer generations born after the completion of the development project. Electricity generated by the project offers greater positive economic externalities to the people outside the immediate vicinity. However, development projects such the NT2 project are not without negative effects on the people living in the region and surrounding areas. One of the major negative impacts is the displacement of peoples due to submersion of large areas by the construction

[1] Lao PDR has one of the world's largest hydropower dams.

[2] Alkire, S, Foster, JE, Seth, S, Santos, ME, Roche, J & Ballon, P 2015, 'Multidimensional poverty measurement and analysis: Chapter 5–the Alkire-Foster counting methodology'. Available online at https://ora.ox.ac.uk/objects/uuid:18453363-2bc0-4f3c-906c-0061968ee629

[3] Saikia, U, Dasvarma, G & Chalmers, J 2018, 'Methods of measuring human well-being and human development', in *Handbook of statistics*, Elsevier, vol. 39, pp. 545-75. Available online at https://www.sciencedirect.com/science/article/pii/S0169716118300013

of the dam. So far, around 6,300 effected people in 15 villages have been resettled and provided with support to obtain sustainable livelihoods. This study recommends that, despite the goals of the government to eradicate poverty at development agenda, wellbeing assessment should be integrated into the national development agenda in Lao PDR.

Keywords: wellbeing, Nam Theun 2, hydropower, Gross National Happiness, development, Lao PDR

DECLARATION

I certify that this thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Ketsana Xaiyasarn

17 June 2021

ACKNOWLEDGEMENT

I would like to express my thankfulness and appreciation to the following individuals and organisations for their unwavering assistance and support throughout my time studying and conducting research in Australia.

First, I would like to express my appreciation to the Government of Lao PDR for consistently collaborating with the Government of Australia to strengthen our partnership on education and development in Lao PDR. Without the assistance of the Australian Awards Scholarship, this paper would never have been completed, and I would have never been able to study in Australia. I desire to take this opportunity to express to the Lao National Mekong Committee Secretariat to allow me to apply for a scholarship to study in Australia.

Additionally, I would like to convey my gratitude to my supervisor, Assoc Prof Udoy Saikia, for his sage guidance in developing research questions, methodology, and direction. His supervision provided me with constant opportunities to improve my knowledge, skill, and attitude towards the concept of wellbeing and sharpen my research idea. I'd like to convey my gratefulness to Prof. Susanne Schech for her invaluable guidance throughout my studies. You guide me through the concept of development and point me in the right direction for completing my master's degree successfully. My sincere gratitude to Assoc Prof. Gour Dasvarma for his wise guidance and recommendation throughout my thesis.

I convey my sincere thanks to Flinders University and its professional staff for admitting me to the Master of International Development programme. The university provides a range of professional expertise in specialised areas and student support services that are highly beneficial to student life at Flinders. My special thanks to Flinders University's International Student Support for offering an on-time and comprehensive development programme and orientation to international students and their families while living in Australia.

Furthermore, I would like to thank the team involved in Global Multiple Indicator Surveys (MICS), UNICEF for supplying statistical data from the Lao Social and Indicators Surveys; without this organisation's quantitative data, I would have never completed my master thesis.

I wish to express our deepest gratitude to the Lao Australian Institute for arranging academic and logistical support during my time in my home countries. I would also like to express my gratitude to Miss Anong Phomkong and Miss Saymano Sanoubane, who have always

supported and understood my situation in Lao PDR and provided excellent instruction for my transition to Australia.

Finally, and perhaps most importantly, I will never forget my parents for their priceless support and patience as they gave me life and educated me since I opened my eyes. I would like to express my heartfelt gratitude to my lovely wife and adorable daughter, who often dedicate their time and energy to assist me while I am studying in Australia and preparing for a scholarship in Lao PDR.

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CHAPTER ONE: INTRODUCTION

1.1. Background and Rationale

“Wellbeing” as an attribute has become a central issue in the new global economy. Everywhere, people seek to improve their quality of life – or their wellbeing, in all aspect of daily living, including in health, education and living standards. Wellbeing has been identified as the ultimate goal of development since the beginning of this century when Millennium Development Goals (MDGs) were introduces by the United Nations (UN). Promoting and protecting wellbeing amplifies not only the growing national economy, but also improves the diverse experiences and living conditions of the population (Osberg & Sharpe 2002). Numerous nations, especially the Organisation for Economic Co-operation and Development (OECD) and some developing countries, are currently committed to ‘happiness economics’, with the goal of offering and measuring their citizens' wellbeing (Gough & McGregor 2007; OECD n.d.). For these reasons, wellbeing is an essential indicator for humans and countries.

There are several ways to improve human wellbeing. A key aspect is access to energy which is one of the vital elements to improve human wellbeing (United Nations Development Programme (UNDP) 2001, p. 28). Energy is needed for daily life and development, and the most common energy utilised for these factors is electricity (International Energy Agency (IEA) 2020; Nelson, Kelley & Orton 2012; Pereira et al. 2011). The arrival of electricity into communities, particularly those within developing countries, brings tremendous socio-economic advantages as well as improved livelihoods. One of the most notable advantages of electricity consumption is reducing human labour by using machines: for example, having electric light available for longer periods to enable students to study, and reducing cooking time. Moreover, electricity has the potential to support the broader development of the overall nation. Therefore, energy in the form of sustainable forms of electricity is vital for development and improvement of human wellbeing.

Over the last two decades, several hydropower plants are being planned and constructed in developing countries. These countries build hydropower plants to export electricity as a strategy to sustain economic growth and social development (Kaygusuz 2004; Sharma & Awal 2013). Lao People’s Democratic Republic (Lao PDR)[4] has one of the world’s largest

[4] See the official name of Lao PDR at https://laopdr.un.org/

of hydropower plants. The geography and the landscape of Lao PDR is mainly composed of high mountains, forests and rivers. The rivers in Lao PDR are highly useful for hydropower development which can be potentially useful for social and economic development in Lao PDR. As of June 2019, Lao PDR had 61 hydropower plants in operation and 36 hydropower projects are currently planned and under construction (Soukhaphon, Baird & Hogan 2021). By 2030, Lao PDR will have more than 145 hydropower plants in total, of which nine plants are expected to be in the Mekong River mainstream[5] (Kantoush et al. 2017; Zhong & Hao 2017). This showed an increase of 84 hydropower plants compared to 2019, representing a 230% increased of total hydropower plants in Lao PDR in the next 10 years. This can have major impacts on sustainable economic development and human wellbeing in Lao PDR in the next decades (Ministry of Planning and Investment (MPI) 2016).

While there are several studies on the positive and negative impacts of hydropower on Lao economy, poverty and environment (Baird, Shoemaker & Manorom 2015; Kouangpalath, Sacklokham & Kousonsavath 2014), there is still little understanding of how the hydropower development effects on wellbeing in Lao PDR – one of the significant goals in the world development agenda. The concept of wellbeing which is a prime focus of this research is quite similar to the concept of 'happiness' that Bhutan has introduced through, the Gross National Happiness Index (GNH) as a framework to monitor wellbeing of their population. Interestingly, Lao PDR and Bhutan have similar landscape and national development plans, however different outcomes in the level of human wellbeing. Bhutan ranks 95th out of 156 countries in the World Happiness Report 2019, while Lao PDR ranks 105th (Helliwell, Layard & Sachs 2019). Bhutan has potential to develop hydropower up to 30 Gigawatt (GW) (Tshering & Tamang 2004) and while Lao PDR has around 26 GW (Middleton & Allouche 2016). Both nations export hydropower to their neighbouring countries aiming at promoting economic growth and human wellbeing. However, Lao PDR has little studies about the impact of hydropower development on human wellbeing. Moreover, there is no previous research using the GNH concept to assess wellbeing in Lao PDR. According to Tideman (2011) GNH concept should be utilised as a significant tool to assess human wellbeing and sustainable development of the nation.

[5] Mekong river is an international river shared by China, Myanmar, Thailand, Lao PDR, Cambodia and Viet Nam

1.2. Research Question

This study aims to answer the question of whether the establishment of hydropower projects in the above identified areas has any impact on socio-economic development and wellbeing in Lao PDR. To answer this question, several objectives and tasks are outlined as discussed below.

1.3. Objectives of the study

This study seeks to identify how the wellbeing of Lao populations have been affected by the NT2 project by:

1. Examining the relationship of hydropower development and the socio-economic development in Lao PDR
2. Assessing the impact of establishment of Nam Theun 2 Hydropower Project and wellbeing of the people living in the vicinity
3. Comparing the wellbeing of people living in the hydropower project and people living far from the hydropower project, and the people living in the city.

1.4. Study Area

Nam Theun 2 hydropower Power Development Project (NT2 project) is a case study to assess how the hydropower development is impacting on the wellbeing of affected populations in the Lao PDR. NT2 project is one of the biggest multipurpose development projects in Khammuane province[6] in the central area of Lao PDR. This project is aiming at supporting the national strategy for socio-economic development towards eradicating poverty and improving social services to local people as well as protecting biodiversity and environment in Nakai-Nam Theun National Protected Area. The project comprises the construction of Nam Theun 2 Hydropower Plant (NT2 plant), dam, reservoir, resettlement and livelihood development program for the effected people in the hydropower plants and dam. NT2 plant is a trans-basin diversion hydropower plant. The plant uses a massive amount of water from the Nam Theun River in Bolikhamxay province, where is the dam site of NT2 plant, to generate electricity at a power station before releasing the water into Xe Bang Fai River in Khammuane province [7] (Figure 1.1).

[6] According to the statistical survey in 2020, there were 8 districts, 569 villages and 81,602 households (Lao Statistics Bureau 2020) with 39 0.701 people of which 199,420 were women.

[7] Xebangfai (sebangfay) and Nam Theun rivers are tributaries of the Mekong River in Lao PDR (http://www.wepa-db.net/policies/state/Lao PDR/river.htm)

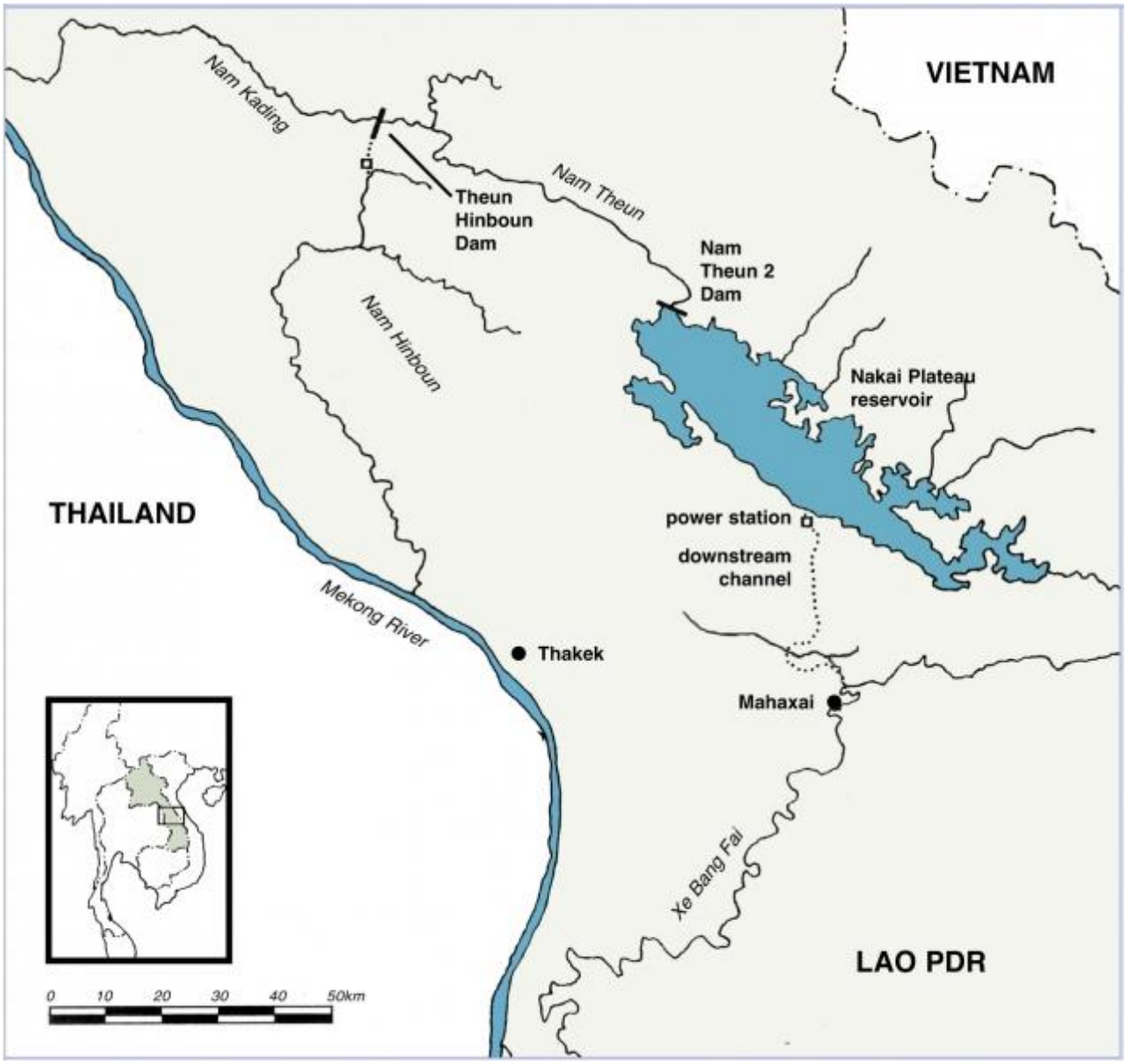


Figure 1:1 Map of Nam Theun 2 Hydropower Project Location

Source: https://archive.internationalrivers.org/campaigns/nam-theun-2-dam

NT2 project is a joint development project by the Nam Theun 2 Power Company (NTPC), the government of Lao PDR, and another 27 parties, including the World Bank Group (WBG) and the Asian Development Bank (ADB) (ADB 2019; World Bank 2019b). The concept of development of NT2 project started in the 1920s, however, due to the long process on the studies of the environmental and social impact of the development, the ground construction of the plant and dam took place between 2006 to 2010, while the resettlement program and livelihood development took place between 2006 and 2018 (NTPC 2021a). According to the NTPC (2021b) NT2 project had successfully displaced, resettled and supported the livelihood of around 6,300 people in 15 villages affected by the impoundment of the 490 Square kilometre (KM^2) reservoir, and had supported the resettlement and livelihood of

around 100,000 people living downstream of the dam as well as protecting of the biodiversity and ecosystem in the upstream watershed.

1.5. Significance of the study

This study seeks to document contributions to the fields of hydropower development and human wellbeing in Lao PDR which is significant to the future development of similar projects in Lao PDR and other developing countries around the world. Governments, international organisations and researchers may use these findings as a basis for future planning and design for the development of hydropower projects. The results of this study may assist governments to make strategic decisions to adapt development plans towards achieving sustainable development and enhancing human wellbeing. More importantly, international organisations like the World Bank as an investor, and United Nations Children's Fund as an organisation for humanitarian and development aid for children, use findings from this study as a basis to grant loan or conduct further survey with respect to sustainable development and wellbeing. For researchers, it will be a primary source for academic study in the field of hydropower development and wellbeing.

1.6. Outline of the Study

This thesis comprises five chapters as follows.

Chapter 2: Literature Review

The next chapter introduces the concept of wellbeing and sets out the critical literature on the subject in a global context. The review includes how Bhutan Gross National Happiness Index (GNH) is significant to quantify wellbeing and how the hydropower sector is significant for Lao economic development and human wellbeing. This chapter also highlights the source of data applied to quantify wellbeing in Lao PDR and it provides a critical review of the impact of hydropower projects on wellbeing globally.

Chapter 3: Data and Methodology

This chapter provides an overall methodology to assess human wellbeing in Lao PDR. It justifies how the wellbeing index developed in Lao context. This chapter also shows how and what wellbeing domains and variables were developed and utilised for this research context.

Chapter 4: Findings and Discussions

This chapter highlights the findings of the results of the data collection of wellbeing in the study area, Khammuane province. These results are compared with two other provinces where one province is the capital city in Lao PDR, and the other is a province that has no recent hydropower development plant. Comparison is made with respect to wellbeing domains: living standards, education, health and child wellbeing based on existing literatures. These comparisons provide the basis for the assertions in this study.

Chapter 5: Conclusions and Recommendations

This chapter summarises the key aspects of the research and provides recommendations for policy initiatives and future research on human wellbeing in Lao PDR and other similar regions.

CHAPTER TWO: LITERATURE REVIEW

This chapter provides a detailed literature review on development and wellbeing. The first part discusses the theory of wellbeing and its application to poverty reduction and happiness. It then discusses how economic and hydropower development impact on human wellbeing followed by a discussion on the data applied to quantify wellbeing in this research. By the end of this chapter, the gaps in the research on the impact of hydropower on wellbeing in Lao PDR are identified, and potential areas for further research is proposed.

2.1. Concept of Wellbeing

Since the fourteenth century, there have been global intentions for human wellbeing and happiness (Williams, cited in Gough & McGregor 2007). The term ‘wellbeing’ comes from the English word ‘welfare’ which means to journey well, to happiness and to prosperity (Gough & McGregor 2007). The concept of wellbeing is inextricably linked to Aristotle and Buddha's notions on human happiness and a ‘good life’. It includes the majority of living conditions that ordinary people require to function to the best of their abilities (Taylor 2011). Since then, wellbeing has been associated with the assessment and provision of the welfare needs in nation states, and has taken on a more objective and broad interpretation in the twentieth century (Gough & McGregor 2007). Wellbeing refers to peoples’ health, economic, and emotional conditions. The concept of wellbeing provides a comprehensive picture of living conditions and has become an indicator to measure progress of economic development for many countries in the twentieth first century (Michalos 2014). Standard of living, access to material resources as well as money impact on overall wellbeing.

Global literature on wellbeing classifies at least two distinct types of wellbeing: mental and physical wellbeing. These two types of wellbeing are further categorised as objective wellbeing and subjective wellbeing (Gough & McGregor 2007). The objective wellbeing refers physical and material attributes, including material goods, wealth, and physical health. Subjective wellbeing, however, relates to psychological matters such as the feelings of the person whose wellbeing is estimated. Subjective wellbeing is closely associated with happiness or human emotional state (Ford et al. 2014). Both forms of wellbeing are presented and investigated in the following sections. However, this thesis will mainly focus on the subjective wellbeing and refers to happiness.

It is essential to consider how poverty, an objective criterion, impacts on subjective wellbeing. At different times, poverty and thus human wellbeing are multi-dimensional.

Scholars have sought to understand the relationship between poverty and wellbeing for a long time (Nidup, Feeny & Ashton 2018). If people or the state are poor, the level of wellbeing is more influenced by economic conditions than for those who are wealthy. The individual who considers himself poor is often deprived of basic capabilities such as housing, income, employment, education and health. However, definitions of poverty should not be limited to only income or wealth to support household consumption and expenditure. According to the United Nations (1995) poverty is multi-dimensional, and development goals should provide social improvements to promote wellbeing. Social service and monetary are particularly critical in enabling people's wellbeing.

Moreover, happiness and wellbeing are interconnected. The use of happiness concepts to measure human wellbeing have been widely applied globally (Helliwell et al. 2020; Sundriyal & Kumar 2014). Numerous countries, especially the advanced and OECD countries, are currently committed to happiness economics, with the goal of measuring their citizens' wellbeing through established criteria (Gough & McGregor 2007; OECD n.d.). Sundriyal and Kumar (2014) analysed the relationship of happiness with wellbeing and found that the human state of mind developed through three interlinked elements: (1) physical health, (2) psychological health; and (3) social health. While social health is the essential element of human wellbeing, physical and psychological health play critical role in achieving social health. In this thesis, the happiness concept is used to measure human wellbeing and review how countries and international organisations apply happiness indicators to measure the wellbeing of nations.

2.2. Gross National Happiness Index (GNH)

The GNH is considered the most comprehensive method of measuring human wellbeing (Tideman 2011; van Norren 2020). GNH is developed based on the Alkire-Foster method of measurement multi-dimensional poverty[8]. It captures the multi-dimensional aspects of poverty and happiness by focusing on both material and spiritual deprivation. It also correlates internal and external factors of individual wellbeing dimensions. Unlike the orthodox measure of economic indicators such as Gross Domestic Product (GDP) and Gross National Product (GNP), GNH measures the actual wellbeing of people in society through people's perceptions on social inclusion (Saikia, Dasvarma & Chalmers 2018, p. 547). Moreover, the GNH provides a holistic approach to the ideas of economic indicators and sustainable development goals by balancing the value of both economic and non-

[8] More detail about GNH is available at https://ophi.org.uk/policy/gross-national-happiness-index/

economic dimensions of wellbeing. The GNH encompasses traditional socio-economic areas of concern including nine domains such as living conditions, health and education, traditional cultural and psychological aspects, governance, and the ecological situation; all combined they include 33 indicators (Figure 2:2). GNH can measure wellbeing of a smaller population group, e.g., household and individual levels by showing the composition of happiness among men and women, or by district, and by dimension.

Figure 2:1 Gross National Happiness Index and Variables

Source: (Ura et al. 2012)

Strong evidence supports the concept of GNH to measure the progress of development and wellbeing [9] (Saikia, Dasvarma & Chalmers 2018). Apart from using GNH to measure the progress of development in Bhutan, the United Nations Development Programme (UNDP)

[9] A notable application of GNH is in the national survey for Assam, measuring Assam's wellbeing as part the 2014 Assam Human Development Report (Saikia, Dasvarma & Chalmers 2018).

UNDP applies GNH as a holistic approach to measuring global happiness, as outlined in the 2012 World Happiness Report (Helliwell, Layard & Sachs 2012). Moreover, the method was widely promoted by the United Nations at a global level by international researchers and inter-government organisations. In 2017, the UNDP applied the same approach to measure wellbeing of the youth in Timor-Leste[10]. These reports have been recognised as policy documents for both Indian and Timor-Leste governments to consider defining their development policy and planning for youth in the future prosperity.

Other research identifies the GNH index to assess wellbeing. For example, Bhattacharjee and Bhattcharjee (2010) adapted Bhutan's Gross National Happiness concept for evaluating the wellbeing of employee at a workplace in Silchar, a town in Assam, India. In this study, five wellbeing domains adapted from Bhutan GNH, including economic, infrastructure, social and academic and democratic wellness were applied for assessing the individual's level of wellbeing. Moreover, during the Covid-19 pandemic, the government of Bhutan used the GNH index as a basis for formulating the policy in response to the impact of the outbreak and the GNH has helped to frame the government's policy to maintain wellbeing of Bhutanese during the critical time (Dorji 2020). This has been supported by numerous scholars suggesting other governments should also use GNH as a direction and scope in responding to improving the wellbeing of the population effected by the Covid-19 pandemic (El-Jahel & MacCulloch 2020; Greyling, Rossouw & Adhikari 2020). This indicates that the concept of GNH has been promoted internationally. That is the reason why this thesis attempts to adapt the GNH of measuring happiness for measuring human wellbeing in Lao PDR. The comprehensive method applied in this study is fully outlined in Chapter 3.

2.3. Economic Development and Wellbeing

Over time, extensive literature has been developed on economic progress as a way to improve living standards. Using wealth indicators, such as GDP and GNP to measure wellbeing has been deemed acceptable for various countries as it has several benefits. The first school of thought on economic development as a way to improve wellbeing goes back to the mid-eighteenth century when Adam Smith and his successors argued that the wealth of a nation impacts on the nation's society (Smith, cited in Michalos 2014). According to Smith allowing individuals to produce and exchange goods in society leads to a competition among individuals, which promotes economic efficiency and welfare distribution (Michalos

[10] The UNDP Timor-Leste Human Development Report 2018 is available at http://hdr.undp.org/en/countries/profiles/TLS

2014). A century and half later, welfare economics has theorised how economic development affects human wellbeing (Michalos 2014). Economic growth leads to improving the standard of living of people and reduce extreme poverty.

Numerous studies suggest that economic developments contribute to eradication of extreme poverty and improve human wellbeing (Stiglitz, Sen & Fitoussi 2008)[11]. A comprehensive study can be found in Banerjee (2016). He conducted a research by using quantitative and qualitative data in Mumbai, India and demonstrates that an increase in GDP has positively impacted on the quality of life and happiness of the citizens. His study reveals a strong correlation between macro-economic development and social indicators, including health, education, and standard of living. The growth of GDP correlates with the subjective quality of life, including, housing, education, health care, transportation, and recreation facilities (Banerjee 2016). Moreover, Estes and Sirgy (2019) claim that economic growth in any part of the world leads to cutting of extreme poverty in all. Having both higher GDP and GNP, often results in better healthcare, education and quality of life and happiness.

In the same vein, economists have developed other studies using econometric analyses to assess the relationship between economic development and wellbeing in Europe, the United States and Canada, and found that higher-income countries have greater wellbeing than the developing countries. According to Helliwell et al. (2020) people in wealthier countries with higher-quality life, especially Nordic countries,[12] are generally happier than people in poorer countries with a lower-quality life. In addition, using quantitative data to analyse economic development effects on human wellbeing, Guisan (2009) analyses the human wellbeing in European countries like Norway, Switzerland, Sweden, and the United Kingdom and found that the level of human wellbeing[13] highly correlates to economic indicators such as GDP and GNP. This study found that higher GDP and GNP results in greater expenditure on education and social services, ultimately leading to improved wellbeing (Guisan 2009). Moreover, an independent study using quantitative data from the World Bank and the UNDP claims that human wellbeing and economic development have steadily improved over the last 50 years. At the same time, the high rates of economic growth, especially the public-private investment projects in developing countries, lead to improvements in the quality of

[11] Recent findings on economic development and wellbeing tend to support Adam Smith's argument. Clear evidence has been found in various studies that since the 1960s, some of the East Asian nations, including Japan, Singapore, and Korea were witnessed rapid economic growth with higher education and living standards that resulted in reducing the nation's poverty and inequality. More detail see (Willis 2011).
[12] Nordic countries, including Finland, Denmark, Norway, Sweden, and Iceland
[13] This study included the following factor (1) life satisfaction, (2) income per capita, (3) governance, and (4) education level

health, education, and economic wellbeing. In addition, the UNDP (2020) claims that the relationship between economic growth around the world is correlated to average life expectancy at birth. In 2019, life expectancy at birth was 73 years old, compared to only 65.4 years old in 1990, same as the higher GDP per capita for most countries in the world (UNDP 2020).

However, the economic development process could potentially pose some negative impacts on human health and environment. Several social and environmental studies claim that heavily dependence on the market economy, especially to enhance higher incomes, without a comprehensive study on the negative impacts on wellbeing dimension may impact disproportionately on certain groups of people and animals. Environmental degradation reduces not only the value in land and occupation for the people who rely on the ecosystem for their livelihood but also the human quality of life and health conditions (Mongsawad 2009). Significant health related risks and disease due to poor environmental conditions lead to psychological stress and poor physical health conditions. For example, in China, millions of people have been displaced and impoverished because of dam projects, approximately 40% of affected farmers have lost productive land, and some farmers have been given inadequate, barren land in compensation (Jackson & Sleigh 2000). Many people have lost their jobs, and those who have moved to cities have often struggled to find work and eventually have a low quality of life (Jackson & Sleigh 2000).

2.4. Hydropower Development and Wellbeing

Hydropower development is one of the economic activities used globally to improve standards of living and wellbeing. The development of hydropower offers significant income to government and social services to people in the project vicinity. The investment in hydropower and related-infrastructure projects impacts on employment, tax, infrastructure and related economic indicators such as expenditure and consumption (Koch 2002; Owusu et al. 2019). Money from selling electricity can account as a national income and be allocated to improving social services and returned into rural development activities (Dijk 2008; Wolf 2012). For example, it is evident that per capita GDP trends in Nepal and Bhutan strongly correlate with their hydropower development. Hydropower is a major sector to sustain Bhutan's social and economic development in particular. Currently, Bhutan is recorded among the highest GDP per capita countries in South Asia and one of the most significant factors that contributes to higher GDP in this country is the income from exporting electricity (Ogino, Dash & Nakayama 2019). In 2019, GDP per capita in Bhutan was US$ 3,316: an

increase more than five times compared to year 2000, the period before development of hydropower in Bhutan[14]. This figure had classified Bhutan as a lower-middle income country (World Bank 2017b).

Hydropower developments enhance economic development. Several multi-purpose dams have been built to generate power, secure water supply, increased recreational opportunities, improved navigation, fisheries development, and cottage industries (MRC 2016; Nguyen-Tien, Elliott & Strobl 2018; Rex 2011). Various research found that climate change has increasingly impacted the Mekong basin (MRC 2019; VOA 2020). Building dams helps to mitigate the impact of climate change on water resources. The quantitative studies in numerous river basins in South Asia demonstrate that hydropower plants supply more water for irrigated crops in the dry season when water is scarce and limited (Kouangpalath, Lebailly & Ducourtieux 2016; Rex 2011). This water can help farmers plant rice, fruits, and vegetables during the late season which are then available during the food shortages which are element of human wellbeing. In addition, Hydropower plants assist to transition rural communities into urban ones, as shown in Lima Rímac in Peru. The project supplies water to the rural communities, connecting rural remote areas to urban areas by the highway that was constructed during the project (Hommes & Boelens 2018). Similarly, the Three Gorges dam built in the Yangtze River in China modernised China from a traditional economy state to an industrialised country. The smart hydropower design and modern technology in the Three Gorges dam benefited millions of humans and the government of China.[15] This development yields billions of US$ revenue to China making the country one of the most modern countries in the world (Sanjuan & Béreau 2001). These social benefits provide positive externalities for beneficiaries from hydropower development.

Literature tends to show that hydropower development improves quality of life and standard of living. Hydropower development and related infrastructure projects provides electricity, roads, industry and commerce to cities, thus expanding the economy, improving access to health care and education, and improving quality of life (Kaygusuz 2004; Yüksel 2010). Several reviews found that the packages of compensation and mitigation for the loss of human assets and resettlement is normally balanced by the provision of infrastructure, electricity, roads, clean drinking water, schools and hospitals which are essential elements

[14] According to information from https://borgenproject.org/hydropower-in-bhutan/, Hydropower development in Bhutan had started since 2000s

[15] The development of Three Gorges dam helps to control floods and mitigate drought for millions of people in both upstream and downstream communities, supplies substantial electricity to central and coastal parts of China; and provides a great inland riverway in China connected by navigation channels internationally. For more detail see (Sanjuan & Béreau 2001).

contributing to an increasing living standard (Anand & Sen 1994). Tshering and Tamang (2004) study of hydropower development in Bhutan found that hydropower development project empowers rural youth and women around the dam site. The arrival of electricity in homes helps the lamps, appliances, and other equipment to run smoothly and sustainably. In addition, A qualitative study in 213 households in Sikles village, Nepal found that micro-hydropower brings about social and economic wellbeing to rural people in Nepal (Anup, Ian & Sang-Eun 2011). Having electricity improves livelihood in direct and indirect ways. Villagers have access to clean, renewable and affordable electricity. Women in the village spend less time collecting firewood but have more time to play with children and other kinds of productive works which helps to earn higher income. The study also claims that women have more time to study, leading to improved female literacy. Children are free from traditional ineffective and health-hazardous kerosene lamps. Similar to China, the hydropower dam development brings about tremendous benefit to local mountainous people. With access to electricity, people can run their business, such as retail shop and tourism activities and work with the dam company. People with higher incomes have higher levels of happiness or subjective wellbeing (Veenhoven 1991).

Hydropower dams have also had extraordinary impacts on ecological wellbeing. Several hydropower projects have led to the development of new tourism destination and biodiversity sites that offer spiritual wellbeing. Despite the vast disturbance of natural resources and some tourism sites, the development of hydropower plants requires reservoirs that are mostly located in high geological landscapes and mountains, so they create new man-made tourism resources and biodiversity conservation site. As an example, the construction of the Pyrenees hydropower plant in the French-Spanish border converted a high mountain landscape into a seemingly natural tourism site (Rodriguez 2012). Each year a large number of visitors come to visit and enjoy the beautiful scenery around this dam. Worksites and houses have been converted into resorts that offer accommodation for millions of hikers and travellers who come to enjoy and absorb the beautiful scenery and biodiversity. Similarly, the Itaipu Dam, built on the trans-Brazil river between Brazil, Argentina and Paraguay, has become a famous tourist attraction due to the associated Iguassu Falls. Despite the gigantic dam structure and the powerhouse station, the project built numerous eco-tourism and innovative environmental recreation sites in both Brazil and Paraguay sides. These include an eco-animal museum for the animals lost during the construction of dams, a local zoo with an abundance of animal life, and an indigenous museum, tracing the life of the Guarani ancient people from ten thousand years ago and fish migration channels which contribute

to protecting fish and other aquatic animals in this area (Itaipu Binacional 2019; Visitefoz 2021).

Nevertheless, hydropower development projects may also impact negatively on human wellbeing. Constructing large infrastructure projects like dams and power stations is associated with social and environmental degradation. Extensive literature has highlighted the negative impact of hydropower development on ecological wellbeing. The construction of the Three Gorges dam led to a decline in sediment flux, discharge and water quality into the lower Yangtze river - an essential element of the health of the ecosystem and its impact on of millions of people, animals and the environment in downstream Yangtze river (Guo et al. 2012; Yang, SL, Zhang & Xu 2007; Yang, Z-S et al. 2006). Most of the affected and displaced people received little compensation and some of them were less better off than before resettlement due to the difficulty in adaptation to new livelihoods (Gebre 2003; Wilmsen, Webber & Yuefang 2011). Moreover, Parshina (2014) suggests that dam developments benefit more people in other areas especially cities where there are more modern lifestyles and opportunities. Meanwhile the local people who are directly impacted by the development and heavily depend on the ecosystem suffer a negative impact on wellbeing. Moreover, some of the local residents bear the cost for road repair and maintenance damage by heavy truck transport during project construction (Newell & Raimi 2015). Hydropower development may not always come with positive wellbeing results. Some communities may receive the negative impact from the development especially the downstream communities.

2.5. Sustainable Hydropower Development in Lao PDR

In Lao PDR, Hydropower development follows the concept of sustainable development within broader development studies. According to the Lao policy for sustainable hydropower development (2015), all hydropower projects in Lao PDR must provide three connecting benefits: economic, social and environmental sustainability[16]. The hydropower development project is responsible for measuring these benefits by undertaking comprehensive Environmental and Social Impact Assessment (ESIA), and Environmental and Social Impact Management, and Monitoring Plans (ESMMP) of the proposed project. These ensure any adverse effects to social and environmental conditions, including environmental issues,

[16] More detail about the decree is available at https://data.laos.opendevelopmentmekong.net/laws_record/decree-on-the-approval-and-promulgation-of-the-policy-on-sustainable-hydropower-development-in-lao-

hydrology, indigenous peoples, water quality, reservoir planning, and downstream flow regimes are avoided and mitigated.

Hydropower development plays a pivotal role in enhancing economic development in Lao PDR. Apart from contributing electricity to the national grid, hydropower is a national export commodity. Worldwide, hydropower generated 4,606 Terawatt hours of electricity while hydropower generated 1,308 gigawatts (GW) in 2019. Lao PDR generated electricity from hydropower at 1.89 GW[17] or 19.33 terawatt hour (TWh) of hydropower which ranked the country third highest in hydropower increases production behind Brazil and China which produced 4.92 GW and 4.17 GW respectively (IHA 2020a). In 2018, more than 80% or 27,220 Gigawatt-hours of electricity generation was exported to neighbouring countries (TheGlobalEconomy 2016) and the electricity generated from NT2 plant shared around 6,000 Gigawatt-hour or around 22% of the total electricity export in Lao PDR (IHA 2020b; World Bank 2020c, p. 9). As of December 2019, Lao traded around US$ 1,300 million electricity with neighbouring countries, an increase of around hundred times the 2005 figure and ten times that of 2010. This export lead to an increase of hydropower royalties from US$ 24.3 to 61.32 million between 2010 to 2019, accounting for above 2% of total government revenue annually (Bank of Lao PDR (BOL) 2019). This value is projected to increase with several more hydropower plants set to operate in Lao PDR. According to Cruz-del Rosario (2014), NT2 plant itself is expected to generate an annual income to the government of around US$ 30 million and may be up to US$ 2 billion over twenty five years of the concession period by 2035 (ADB 2019; Kouangpalath, Sacklokham & Kousonsavath 2014, p. 18; World Bank 2017a). During 2010 to 2017, the government earned over US$180 million of net revenue from NT 2 plant, on average revenues from the plant accounted for about 1% of the national budget.

Hydropower development also impacts on social dimensions for the Lao people. In 2019, more than 93% of Lao citizens had access to affordable electricity, an increase of over 70% compared to 2000 (IEA 2019; TheGlobalPetroPrice.com 2020). Furthermore, numerous hydropower projects offer social service and infrastructure improvements to local communities, including roads, early, primary and secondary schools, and sponsorship to upgrade teachers and other necessary equipment in the schools (Mekong River Commission (MRC) 2014; Syladeth & Guoqing 2016). Also, several hydropower

[17] 1 Megawatt-hour (MWh) = 1 MW for one hour or 1,000 kW for one hour. More detail please see https://www.vivintsolar.com/blog/what-is-a-megawatt-hour

development projects in Lao PDR have supported the local public health system by financing the construction of local hospitals, supplying doctors, medical equipment and vehicles (Sivongxay, Greiner & Garnett 2017). At a macro level, revenue from selling electricity is allocated back to the social services sector and supports rural development activities (Dijk 2008; Wolf 2012). The World Bank (2017) demonstrates that more than 70% of government revenues from NT 2 plant were spent on social and economic development and basic infrastructure services such as education, roads, water supply, and electrification (Figure 2:2). These packages contribute significantly to the government policy on poverty eradication towards enhancing the national socio-economic development plan of the Lao government.

Furthermore, the development of hydropower project in Lao PDR also offers ecological benefits enjoyed by local and international visitors. Some hydropower projects like, NT2 project and Nam Ngum Hydropower project have become popular tourist destinations in Lao PDR. The Nam Ngum 1 reservoir, in the upstream of Nam Ngum 1 hydropower plant, is a frequented spot for leisure and entertainment, including private boat tours around the reservoir, and accommodation which attract more than 21,000 visitors annually, 70% of which are foreigners, yielding around US$ 630,000 to local economy annually (Sustainable Hydropower 2005). Also, the Nakai reservoir, an upstream of NT2 plant, has also become one of the most attractive places for visitors from around the globe. Community-based tourism includes boating on the reservoir, picnics at the dam site, viewing endangered wildlife such as the Red-shanked Douc, gibbons and giant squirrels; and eco-tourism includes trails, camping, mountain hikes, and homestays with local people are available for visitor in this area. In 2014, Khammuane received more than 400,000 tourists of which 1,000 visitors visited NT2 project per month (Mcdowell, Scudder & Talbot 2015). This creates massive income and economic wellbeing for local government and local communities as well visitors.

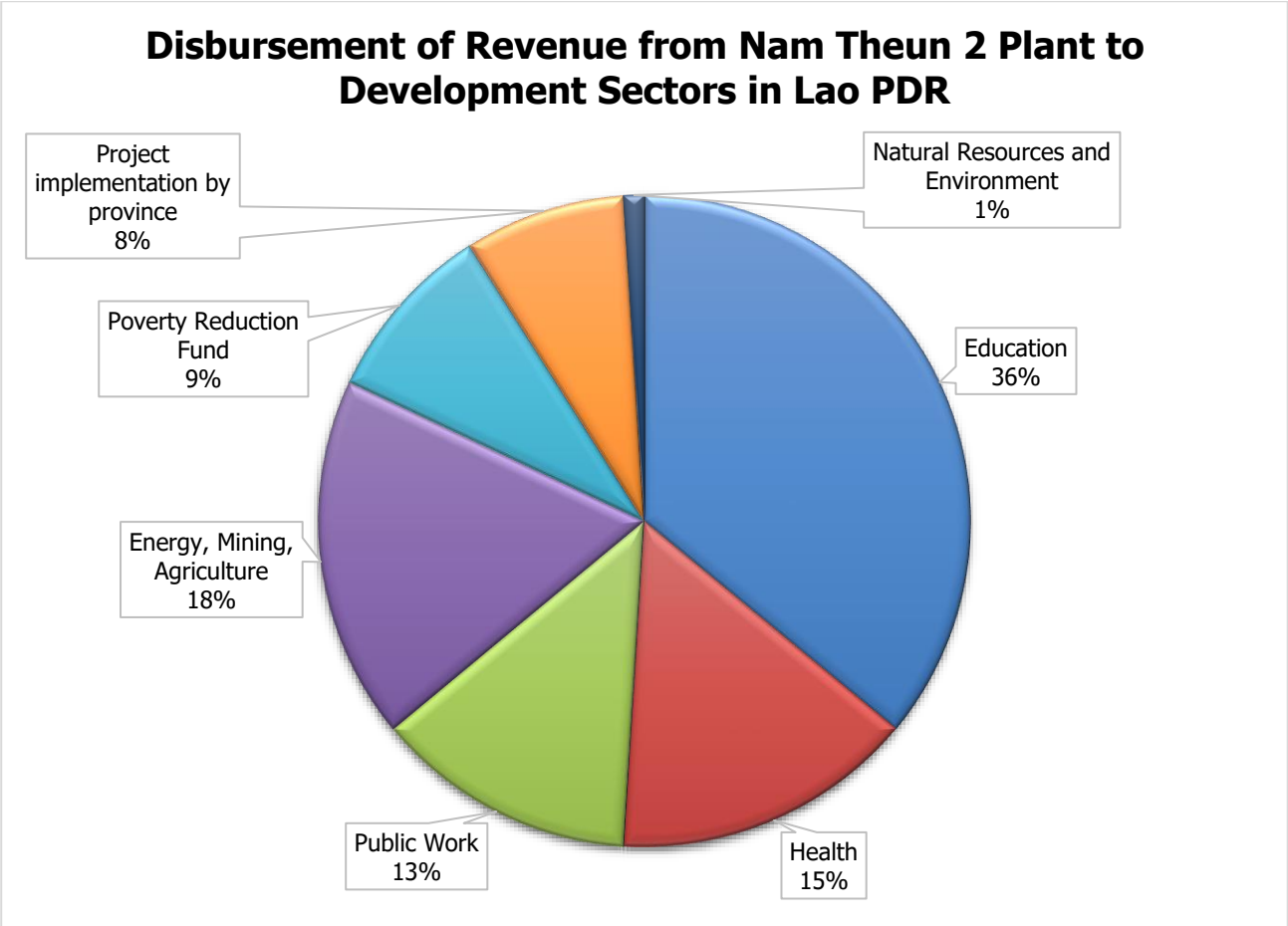


Figure 2:2 Disbursement of Income from Nam Theun 2 Plant by Sectors in Lao PDR

Source: World Bank, 2017

On the other hand, hydropower development may also lead to social and economic vulnerability and insecurity. Most of the hydropower plants were part of the Build-Operate Transfer (Mcdowell, Scudder & Talbot) Independence Power Producer (Kouangpalath, Lebailly & Ducourtieux) that allows private investors to cover the cost of investment, operating, maintenance in hydropower and transmission line projects plus some investment cost by the government of Lao PDR. The government of Lao PDR borrows money investing in hydropower projects. Despite the massive income generated from hydropower plant by exporting electricity, public external debt from investing in hydropower sectors is also high. As of 2019, Lao PDR public external debt was around US$ 9.9 billion, accounting for 52.64% of GDP in Lao PDR (BOL 2019, p. 17), of which around one-third of the public external debt was shared by the power sector's investment into hydropower plant and transmission line project (World Bank 2020a, p. 28). According to the World Bank (2020a) Lao PDR has around US$ 842 million of external debt payment in 2019, which is 4.6% of the total national

GDP in the same year. This amount is also projected to increase up to 1.2 billion in the later years due to the large depression currency between Lao Kip and US Dollar[18].

Moreover, unavoidably, hydropower development results in involuntary displacement, flow alternation, loss of biodiversity and ecosystems and traditional livelihoods (Baran & Myschowoda 2009; Sivongxay, Greiner & Garnett 2017; Smits 2012). Several hydropower projects in Lao PDR affect negatively on social factors and the environment, with a lack of compensation for whole affected communities (Sivongxay, Greiner & Garnett 2017). According to Sayatham and Suhardiman (2015) some resettlement villagers from hydropower projects in Lao PDR have had difficulty adapting to new environmental conditions, as their traditional occupations like agriculture and fishing for subsistence, have changed. Much of the agricultural land offered as compensation is worse than the previous land, and traditional occupations have vanished, especially rice farming and livestock raising (Souksavath & Nakayama 2013) that are two major incomes for local people (Phami et al. 2020). Consequently, those people forced to relocate due to hydropower development projects have to live under poor conditions leading to deprivation. This situation draws concerns from international NGOs regarding the sustainability of hydropower development in Lao PDR (Matthews 2012; Williams 2020). To sum up, It is crucial to have critical investigation into the both positive and negative impacts of hydropower development in Lao PDR. Next section discusses how to development in Lao PDR is monitored.

2.6. Lao Social Indicator Survey

In Lao PDR, one of the most crucial tools and source to monitor the outcomes of socio-economic development is a survey called 'Lao Social Indicator Survey (LSIS)'. The surveys are conducted almost every five years in Lao PDR, with the first survey conducted in 1990 and the most recent survey conducted in 2017. The LSIS questionnaires used in these surveys are based two surveys, the Multiple Indicator Cluster Survey (MICS) [19]as identified by the UNICEF, and the Demographic and Health Surveys (DHS) as supported by the United States Agency for International Development (USAID). These two surveys are significant for measuring the health and social development conditions of the population at household level in developing countries (Hancioglu & Arnold 2013).

[18] According to the World Bank (2020) the large of public external debt in Lao PDR is denominated in U.S. dollars

[19] Sometimes they called LSIS dataset as 'MICS' dataset, detail provided in https://mics.unicef.org/

The LSIS is a household-based survey that includes data on the social conditions of children, women, and men, such as health, nutrition, education, water and sanitation, marriage and sexual activity, fertility and mortality, contraception, HIV/AIDS, child protection, and the use of mass media and information technology. Each LSIS survey was conducted by the Lao Statistics Bureau in collaboration with the Ministry of Health under the technical and financial support of various international organisations[20]. The LSIS were undertaken in three separate domains: urban, rural with road and rural without road. Each province varies in the number sampled based on the enumeration designed by the LSB[21]. Most of the recent surveys conducted and recorded data by all 17 provinces in Lao PDR except the survey year 2006, which was conducted at regional level, while 17 provinces in Lao PDR were grouped into three parts: the northern, central, and south.

The government of Lao PDR uses the survey data from LSIS as a database for planning and defining socio-economic development since the first survey in 1990. Also, the survey results were used as benchmark data for the National Social Economic Development Plan (NSEDP). The survey data has been used as an indicator of reporting poverty status since 2011. The LSIS survey information is used to measure the implementation of the Millennium Development Goals (MDGs) indicators and the 2030 Sustainable Development Goals (SDGs) indicators at country level. At provincial level, the data from LSIS has been promoted and applied to support provincial socio-economic development plans and strategies since 1996. Moreover, LSIS has been widely used to measure multi-dimensional poverty, human wellbeing and happiness in several countries (Pengpid & Peltzer 2020; Roy & Haque 2018; Sekine & Hodgkin 2017). Therefore, this present research applied LSIS to quantify the wellbeing in Lao PDR and method of quantifying wellbeing is discussed in Chapter 3.

Conclusion

This chapter reviewed relevant literature on how economic development, through the experience of hydropower development, improves or enhances human wellbeing in the world. It is clear that hydropower development in Lao PDR follows the sustainable development concept by emphasising both economic, social and environmental conditions.

[20] Including, UNICEF, UNFPA, WHO, USAID, AusAID, JICA, UNDP, UNAIDS, WFP, SDC, LuxGOV (for the full name see list of abbreviation.

[21] LSB designed 50 to 75 enumerations per province and 15 to 20 households per enumeration depended on the size of village, population and province

The theoretical frameworks and empirical evidence discussed above highlight the arguments regarding economic growth and the links with human wellbeing. It can be argued that the GNH is a holistic, flexible approach to measuring human wellbeing as it includes both physical and psychological aspects of wellbeing. This literature review reveals that GNH can be applied to any specific situation such as national, local and organisation levels. Moreover, this research acknowledges that measuring wellbeing has different contexts starting from macro-economic indicators to social and human development indicators. Those indicators require economic development to enable their improvement. This literature review suggests that although there are various studies on economic development and human wellbeing, hydropower and economic growth, and poverty reduction, the research into hydropower development impacts on human wellbeing remains poorly documented. Hence, this research proposes a study on hydropower development impact wellbeing in Lao PDR based on knowledge gained from the literature provided in this chapter and experience from Lao PDR. Despite the limitations this literature review might have, this study concludes that the Bhutan Gross National Happiness Index offers a useful approach for examining the impact of hydropower development on wellbeing at the household level in Lao PDR. In the next chapter, application of data and the method of measuring wellbeing in Lao PDR is discussed in detail.

CHAPTER THREE: DATA AND METHODOLOGY

This chapter explains how wellbeing is measured in Lao PDR based on the Gross National Happiness Index (GNH) as discussed in Chapter 2. The first part of this chapter discusses the data applied to assess wellbeing, followed by the methodology used to measure wellbeing based on the happiness indicators. Finally, this chapter identifies the scope and limitations of this study.

3.1. Data

This study used two main data sources to examine the sustainable hydropower development and wellbeing in Lao PDR. The first set of data/information include relevant reports and information from international peer-reviewed journals, official government sources, reports from the World Bank and Asian Development Bank, MRC reports and studies, and the hydropower company website as well as non-government organisation reports. These data reinforce the questions of this study by highlighting how hydropower development impacts human wellbeing globally and in Lao PDR. However, to quantify the specific question on how hydropower development impacts human wellbeing in Lao PDR, this thesis utilised data from the survey undertaken by the Lao Statistic Bureau in Lao PDR in collaboration with UNICEF. Special permission was sought from UNICEF use the data. The permission was granted (See email from UNICEF for the grant of using LSIS dataset for this research in Appendix 1). The detail analysis is presented in the next chapter.

3.1.1. Data Use

Although, there are five LSIS surveys in Lao PDR conducted since 1996 to 2017, based on the data availability and the linkage to wellbeing indicators this research only used three of them[22], These three surveys from the years 2006, 2012 and 2017. The LSIS 2006 was conducted during the construction of NT2 hydropower project and is the only survey conducted at the regional level in Lao PDR that grouped some provinces into one region: Northern, Central and Southern parts (Figure 3.1). The second dataset, LSIS 2012, was conducted when the NT2 project began its operation in 2011. This was an improvement on the 2006 survey as it incorporated the technical constructs of the Multiple Indicator Cluster Survey (MICS) and the Demographic and Health Survey (DHS). Thus, LSIS 2012 included questions about social and environmental conditions in Lao PDR. The latest survey, LSIS

[22] The first survey was conducted in 1996 but dataset is unavailable to further analysis. The second survey in 2000, but there is limited question and data regarding indicators of wellbeing and satisfaction or poverty for this year

2017 which also asked questions about social and environmental conditions, is used here to assess the impact of the development of the NT2 project on the wellbeing of Lao PDR people. There are broader issues raised in the most recent surveys as there are more questions and a larger sample size in 2017 compared to 2012 and 2006 (Table 3.1). However, due to limitations of data collected to support wellbeing indicators, this current study focuses on three out of five survey questionnaires, including (1) the household questionnaire used to collect basic demographic information, household, and shelter; (2) questionnaire for individual women; and (3) a questionnaire administered to mothers (or carers) of all children under 5 living in the household.

Table 3:1 Details of LSIS surveys by years

Years/ Detail	Survey period	Household involved	Women interviewee	Child respondent	Survey Level
2006	March to June 2006	5,894	7,337	4,136	3 Regions in Lao PDR
2012	Oct. 2011 to Feb. 2012	19,018	23,937	11,067	17 Provinces
2017	July to November 2017	22,443	25.305	12,017	17 Provinces

Source: Prepared by researcher based on available information from the LSIS 2006, 2012 and 2017

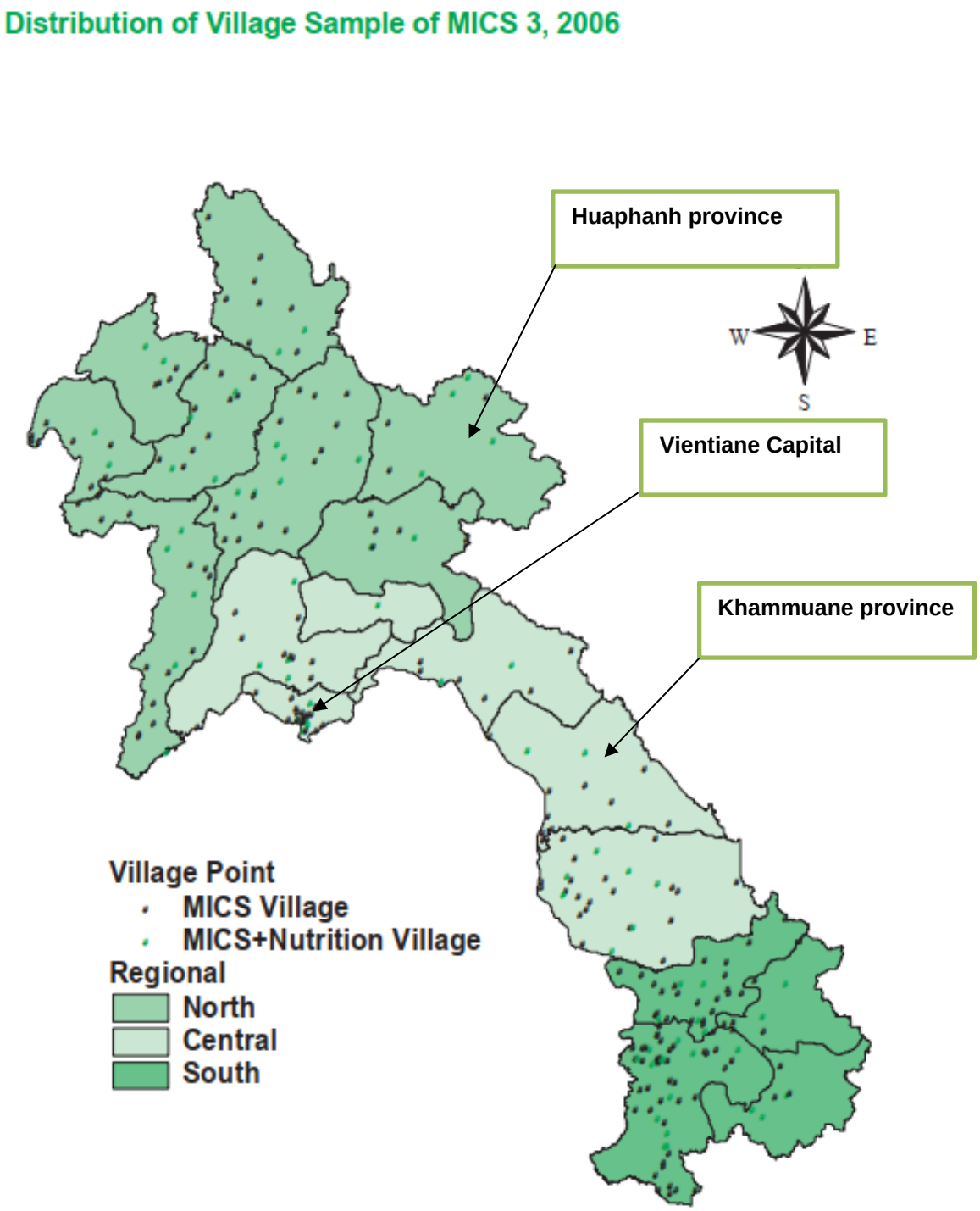


Figure 3:1 Map of grouping provinces into three parts for LSIS survey year 2006

Source: Lao Statistics Bureau 2006

3.2. Selection of Wellbeing Domains and Variables

The wellbeing framework applied in this research is derived from the Bhutan Gross National Happiness (GNH) research[23]. However, the wellbeing domains and variables were

[23] Detail of GNH is available at https://ophi.org.uk/policy/gross-national-happiness-index/

developed and contextualised based on the data available and the common questionnaires of the LSIS surveys in 2006, 2012 and 2017. Therefore, only four wellbeing domains and thirty-one variables were selected for this research. The nature of difference domain in this research brings the four-domain multidimensionality will help policy makers to have more integrated development approach. The 4 domains are (1) standard of living, (2) education, (3) health and (4) child wellbeing. Each domain has a number of variables available for further analysis and evaluation as explained below.

3.2.1. Standard of Living Domain

Two types of measurement of standard of living are used in this study, (1) material of the house and (2) household assets. If the material of the house consists of concrete floors, walls and roofs, the house is called permanent, but if the material consists of earth, dung, wood etc. then the house is considered non-permanent. The types of household assets are normally selected based on their properties, such as durability and semi-durability which is used as a proxy for income (the details about housing conditions and household assets are given in Appendix 2). There are a wide range of indicators applied in the GNH, however, for a small and less developed country like Lao PDR, the affordability of household items, household material and the household assets are used to assess the standard of living condition. Here, we use ten variables to assess the wellbeing impact of the project development, including (1) having a permanent home (2) household access to electricity, (3) household has television, (4) household has mobile phone, (5) household has washing machine, (6) household has fridge, (7) household has air conditioner; (8) household has fan, (9) household access to clean drinking water; and (10) household has own toilet.

3.2.2. Health Wellbeing Domain

Health condition is used in this study as a way to measure health wellbeing based on eight variables including (1) household has iodised salt for consumption, (2) household has a sanitised toilet, (3) women are free from domestic violence, 4) pregnant women receive professional birth delivery assistance, 5) pregnant women received antenatal care, (6) pregnant women receive tetanus toxoid protection, (7) women have knowledge of HIV/AIDS prevention and transmission, and (8) women have been immunised.

3.2.3. Education Wellbeing Domain

Seven variables relate to education wellbeing are: (1) children aged 3 to 5 years old attending early childhood education, (2) children aged 5 to 15 years had attended primary

school[24], (3) household head completed primary school, (4) women attend secondary school, (5) adult literacy, (6) women complete primary school (grade 5) and (7) women have knowledge about time/media.

3.2.4. Child Wellbeing Domain

Within the child wellbeing domain, six identified variables inform this study: (1) numbers of children registered or having a birth certificate, (2) children playing with parents or someone who supports their learning; (3) children have book(s) with pictures for early development, (4) children have toys for childhood development, (5) the number of children taking any vitamins during the first 6 months after delivery and (6) number of children having any vaccination upon delivery.

3.3. Method of Measuring Wellbeing

This study employs a quantitative approach at evaluating wellbeing of the people living in the project development. Measuring wellbeing in this study is drawn from both Alkire et al. (2015, p. 3) as modified by Saikia, Dasvarma and Chalmers (2018). This method is particularly useful in studying wellbeing on a small scale and with the limited data. Seven steps identify who falls into each category of achieved wellbeing or not achieved wellbeing. These are as follows:

Step 1. Defining the set of wellbeing domain indicators that are available for the each household, individuals and for each time period (years of the survey).

Step 2. Setting the wellbeing cut-offs for each variable, namely the level of achievement wellbeing (normatively) in order to be achieved wellbeing person/household in each indicator.

Step 3. Applying the cut-offs to ascertain whether each person/household has achieved wellbeing or not.

Step 4. Selecting the relative weight or value that each variable/domain has, to create one score. In this step, each domain and variable will be recoded with a binary values of 1 or 0 in the IBM SPSS Statistic 27 (Figure 3.2.); where 1 means **Achieved wellbeing** and 0 means **Not achieved wellbeing**. Each wellbeing domain and variable are granted equal weight because they are considered as

[24] This question about their level of attending the primary school

having equal importance for human wellbeing (See more detail about coding process in IBM SPSS Statistics 27 in Appendix 2).

Step 5. Creating the weighted sum of wellbeing for each person, which can be called 'wellbeing score' by using the at least 2/3rd rule for calculations at each of the eight domains (Saikia, Dasvarma & Chalmers 2018).

Step 6. This final step determines the wellbeing cut-off score, namely, the proportion of weighted wellbeing a person/household needs to experience in order to be considered to have achieved wellbeing overall, and identifying each person as achieving wellbeing or not, according to the selected wellbeing cut-off. For example, if there are 10 variables in the standard of living domain, this means that the maximum score an individual could get in this domain is 10 (i.e., if any household, he/she scores 1 in each variable) and the minimum could be 0 (i.e., if he/she scores 0 in each variable). Applying the 2/3rd rule, an individual would need to score a minimum of 6.66 = 7 (which is 2/3rd of 10) to be considered as having achieved wellbeing. The domain will be recoded as "0" for "not achieved wellbeing" (those who scored less than 7) and "1" for "achieved wellbeing" (those who scored at least 7). This is shown in Table 3:2.

Table 3:2 Determining achievement of wellbeing

Wellbeing Domains	Number of Variables	Result of 2/3 rule score	Score Achieved Wellbeing (at least)
Standard of Living	10	6.66	7
Education	8	6	6
Health	7	4.66	5
Child	6	4	4

Source: Prepared by researcher based on available information from the LSIS 2006, 2012 and 2017

Step 7. All wellbeing domains are averaged, and achievement are reported.

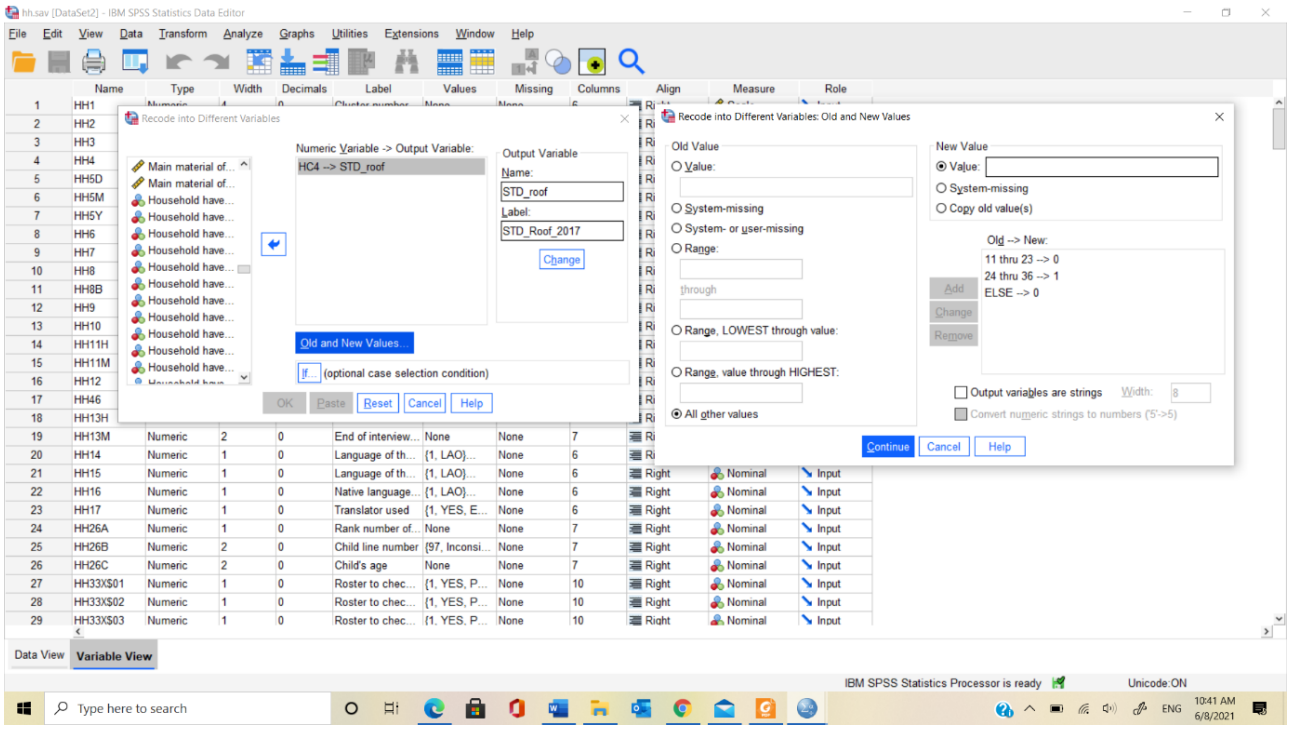


Figure 3:2 Snapshot of Recoding Data from LSIS in IBM SPSS Statistics 27

Source: Prepared by researcher based on method of analysis in IBM SPSS Statistics 27

3.4. Scope and Limitations

Studies on wellbeing usually require larger samples, eight or nine domains and longer time. However, given the time constraint, and viability of data, the present study has been focused on three regions and four domains. The regions selected are Khammuane province (the site of hydropower project), Vientiane Capital (capital city of Lao PDR) and Huaphanh province (province in which there is no recent hydropower development). The four domains are standard of living, health, education and child wellbeing. Khammuane province is the primary location where this thesis investigates how the progressive development of hydropower enhances wellbeing. In this province the analysis wellbeing has been conducted for the years 2006, 2012 and 2017. However, due to limited data comparative analysis of wellbeing for the other two provinces is done only for two years 2012 and 2017.

Vientiane, the capital city of Lao PDR, is located in the central part of the country. It has a higher population and more modernisation and faster development than other provinces. Vientiane capital is also the only province in Lao PDR that has no hydropower built within the province, which means no people are directly impact by any hydropower project. Vientiane capital city is assumed as benefits from the development projects more than other areas because it houses the central business district and the central government

headquarters. Social services and communications, education institutions, and healthcare facilities, are more advanced here than in other provinces in Lao PDR. Much of the electricity consumed in the capital city is from the grid from NT2 plant and Nam Ngum 1 hydropower plants are located in Khammuane and Vientiane provinces. The Government of Lao PDR has attempted to close the poverty gap between rural and urban regions as well as between the capital city and provincial areas. In this context the benefits derived from the hydropower project are expected to be spread throughout the country. Therefore, the choice of these three regions, Vientiane (Capital city), Khammuane (Site of hydropower project), and Huaphanh (no hydropower project) are chosen to see whether the hydropower development benefits throughout country.

Huaphanh province is used as a comparison with Khammuane, where the dam is located, It is assumed that hydropower development is the main difference between the provinces in Lao PDR. Huaphanh is a remote province located in the north of Lao PDR. It is one of the poorest provinces in Lao PDR; most of the economic development in Huaphanh is derived from agricultural activities such as upland rice farming and the mining industry. According to the National Growth and Poverty Eradication Strategy in Lao PDR, Five out of eight districts in this province are listed as among the 47 poorest districts in the Lao PDR and most household income depends on agriculture, livestock, handicraft, and labour.[25] According to Idsala (2019) there are three small hydropower plants in Huaphanh province, Nam San, Nam Aed and Nam Sad hydroelectric. These three hydropower plants are smaller compared to the NT2 hydropower project in Khammuane province where we analyse the impact on wellbeing. These plants were built during the period 1995 to 1999 to generate electricity for residential areas at the capacity of 110 kW, 60 kW and 250 kW respectively. The most recent hydropower projects in Huaphanh were operated in 2015 - Nam Sim, Nam Hao, Nam Peun 1 and Nam Peun 2. All of these hydropower plants generate only 62 megawatts electricity, which is 20 times smaller than the Nam Theun 2 hydropower plant. Therefore, it is suitable to compare the wellbeing between a province that does not have much hydropower development and one that does. This research acknowledged the global movement against hydropower developments specially on the negative impact on downstream communities, however, this is beyond the scope of this research to address these broader issues and hence remains a limitation in this study.

[25] More detail available at https://www.undp.org/content/dam/laopdr/docs/Reports%20and%20publications/Lao%20PDR%20-%20NGPES%20-%20Main%20Document.pdf

Conclusion

This chapter outlines the overall methodology of measuring the level of wellbeing in Lao PDR. Data applied to quantify the level of wellbeing in Lao PDR has been identified at the beginning of the chapter. The selection of wellbeing domains and indicators including how the level of wellbeing is measured in Lao PDR has been outlined above. The scope and limitation of conducting this study are also outlined. The result of applying this method is highlighted and discussed in Chapter 4 which includes the findings, discussion, and comparison with literature.

CHAPTER FOUR: FINDINGS AND DISCUSSIONS

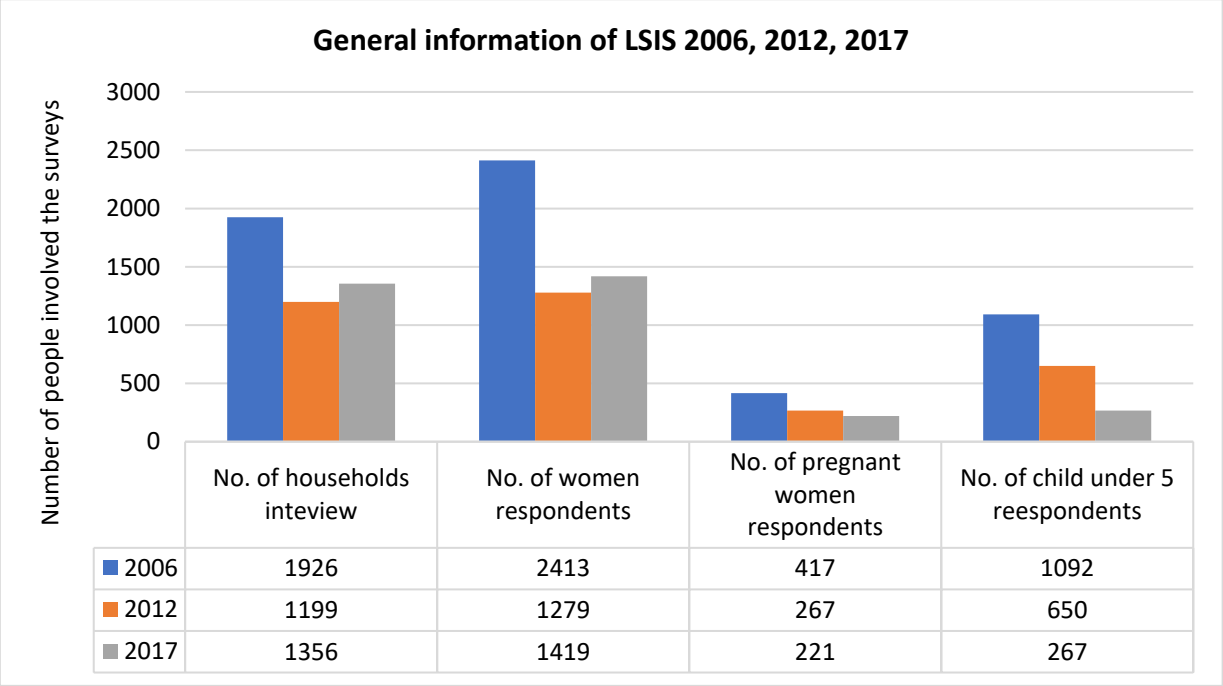
This chapter presents the findings based on the methodology discussed in the previous chapter. The results are organised into three parts: (1) the general information about the survey data; (2) the findings on the wellbeing situation in Khammuane province analysed by years and wellbeing domains, and (3) the comparison of levels of wellbeing between Khammuane and other parts of the country i.e., the capital city and a province in northern Lao PDR where there is no recent hydropower development project.

4.1. General Information on the surveys

To have an in-depth understanding of the impact of hydropower development on the wellbeing of household level in Khammuane, the analysis was conducted over two periods: the periods before and after the development of the hydropower project, by using data from the Lao Social Indicator Survey (LSIS) years 2006, 2012 and 2017.

In general, the number of surveyed households and female respondents in Khammuane province increased in each survey year. There were 1,356 households involved in the survey in 2017 while there were only 1,199 and 1,926 households involved in the survey in 2012 and 2006 respectively[26] (Figure 4.1). According to the LSIS, most of the household heads were men. However, the number of women heads of households had slightly increased over the period of the survey. Conversely, the number of children under five years old, and women who gave birth two years prior to conducting the survey, dropped each year from 2006, to 2012, and 2017. In 2006, there were 417 women who gave birth (in the past two years) before the survey, while this number dropped to 267 and 221 in 2012 and 2017 respectively. This number is based on the trend of children under five respondents which decreased from 1,092 in 2006 to 650 and 267 in 2012 to 2017 respectively. This shows a decline of 442 children under five since 2012, representing a 40% decline in total children (under five) in five years. The decline in the number of children under five is confirmed by the study of the MOH et al. (2014) showing that the fertility in Lao PDR dropped between 1990 to 2012, resulting in a decline in the number of pregnant women and children under five in the country. This can be partly explained by the fact that the fertility in Lao PDR has been declining over the last decade.

[26] The LSIS in 2006 grouped several provinces into one part. Therefore, the number of surveyed households per province is less than other years.



	No. of households inteview	No. of women respondents	No. of pregnant women respondents	No. of child under 5 reespondents
2006	1926	2413	417	1092
2012	1199	1279	267	650
2017	1356	1419	221	267

Figure 4:1 General Information of LSIS 2006, 2012 and 2017

Source: Prepared by researcher based on available information from the LSIS 2006, 2012 and 2017

4.2. Trend of Wellbeing in Khammuane Province

As discussed in Chapter 3 (Methodology), the results of the LSIS survey assist to assess the impact of the construction of the hydropower project in Khammuane on the wellbeing of its population. In this research, four wellbeing domains - standard of living, heath, education, and child wellbeing have been identified to measure wellbeing in the context of Lao PDR.

According to the data analysis of these four domains, the level of wellbeing of Khammuane's population has substantially increased since 2006. Figure 4:2 shows the trend of wellbeing in Khammuane province over the period of the development of NT2 project. In 2006, only 35% of the surveyed households achieved average wellbeing. This indicates that less than half the population in Khammuane achieved wellbeing before development of the hydropower project. However, the wellbeing of the population in this province continued to increase dramatically during 2012 and 2017. In 2012, almost half (49%) of the surveyed households achieved wellbeing, an increase of 14% points in six years. In addition, in 2017, more than half (68%) of the surveyed household achieved wellbeing showing the proportion almost doubled in eleven years. This means that a large percentage of household in

Khammuane province had achieved wellbeing throughout the period of construction of NT2 project.

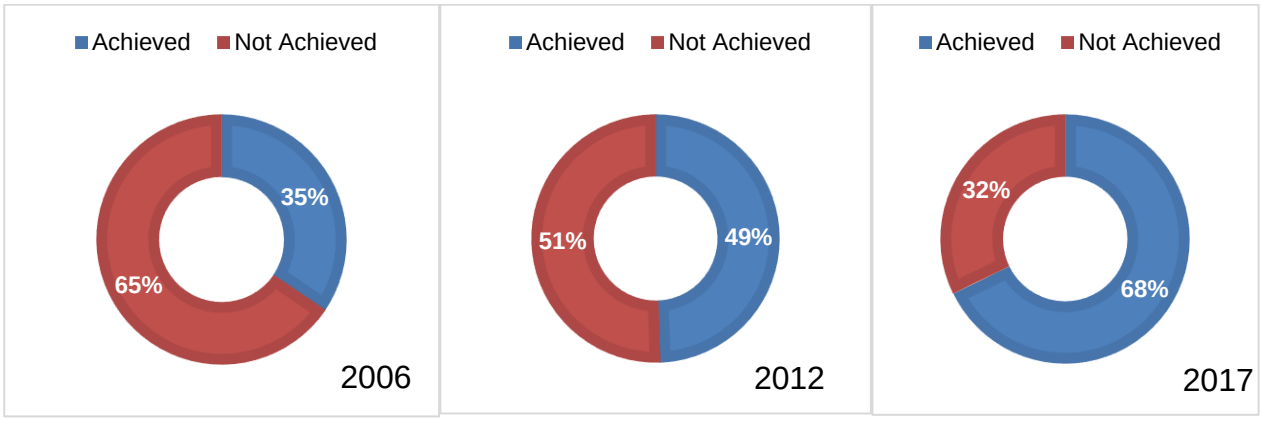


Figure 4:2 Percentage of achieved average wellbeing in Khammuane by years
Source: Prepared by researcher based on analysis of the LSIS 2006, 2012 and 2017

A comparison of the four-wellbeing domains reveals that each wellbeing domain has increased in a proportionately different pattern. Figure 4:3 shows the general trend of wellbeing in Khammuane by domains. Standard of living shows significant improvement during the period of construction of NT2. This is followed by health, education and child wellbeing. The standard of living of the population in Khammuane increased from nearly half (48%) to over three-quarters (78%) during 2012 to 2017 compared to only one third (34%) of the population who attained a decent standard of living in 2006. Similar with education wellbeing which increased 10% in five-years starting at nearly half (43%) in 2006 to just more than half (55%) in 2012, and then another almost quarter increase (68%) in 2017. Health wellbeing also improved significantly since launching the project. The percentage of the population in Khammuane in good health increased by approximately 4% points per year between 2006 and 2017. Similarly, child wellbeing increased from 24% in 2006 to 37% in 2012 and 56% in 2017. Several factors impact on these results, as discussed in the following section.

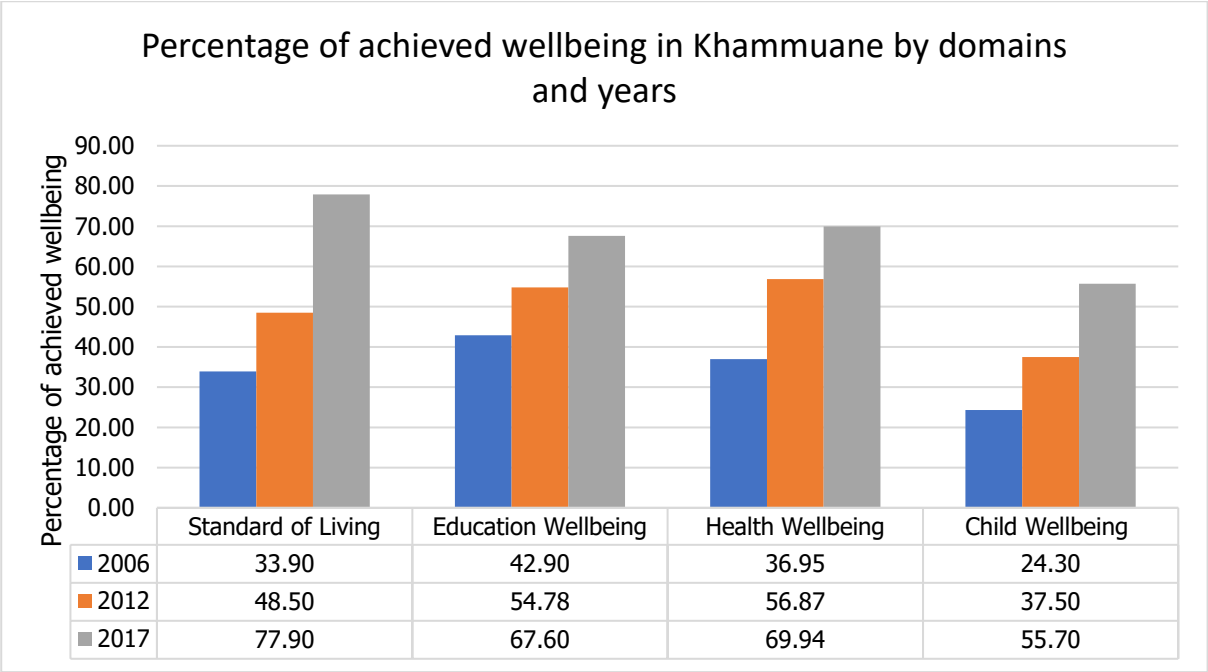


Figure 4:3 Percentage of achieved wellbeing in Khammuane by domains and years
Source: Prepared by researcher based on analysis of the LSIS 2006, 2012 and 2017

4.2.1. Standard of Living Domain

By definition, the standard of living domain refers to the material wellbeing representing an the individual level of consumption among people in different parts of the country countries (Galay 2007). It is one of the most critical aspects of wellbeing or happiness in both developed and developing countries (Galay 2007). Certain variables of standard of living which impact wellbeing, however, having permanent houses and household assets are two of the fundamentals for human psychological, biological and social needs (Ura et al. 2012). Various research indicates that poor housing impacts on human physical and mental health (Cashin & Balasubramanian 2019, p. 21; Chu, Thorne & Guite 2004). Moreover, household assets have been used as indicators to assess living standards in several studies (Filmer & Pritchett 2001; Montgomery et al. 2000; Morris et al. 2000). Household assets are a step towards measuring individual and household net worth representing the monetary status of individuals and families.

One of the most significant results leading to a higher level of standard of living domain in Khammuane is an improvement in housing conditions as shown by the number of households with access to electricity and number of households. Table 4:1 shows the results obtained from the preliminary analysis of the standard of living variables in Khammuane

over the years 2006 to 2017. In 2017 most households had access to electricity (93%) as compared to around 70% in 2012 and 27% in 2006. Moreover, in 2017, over 82% of the population owned permanent houses, compared to only above 74% and 17% in 2012 and 2006 respectively. Above 80% of resident had mobile phones, fan and televisions compared to around 70% in 2012 and around 50% in 2006. More than 77% of the household had access to clean drinking water compared to just over half of resident in 2012 and under half (47%) had access to clean drinking water in 2012 and 2006 respectively.

Table 4:1 Percentage of achievement standard of living wellbeing by variables

Variable	2006 (%)	2012 (%)	2017 (%)
Permanent Houses	17.4	74.0	82.6
Electricity	26.8	84.5	93.4
Television	58.3	76.1	83.5
Mobile phone	55.9	76.1	88.5
Washing machine	8.5	9.8	23.6
Fridge	42.5	56.5	77.3
Air conditioner	5.6	3.7	7.9
Fan	59.3	67.3	83.2
Own toilet	58.7	94.3	92.4
Clean drinking water	47.0	56.9	74.9

Source: Prepared by researcher based on analysis of the LSIS 2006, 2012 and 2017

The improvement in standard of living in Khammuane province over the years 2006 to 2017 may be explained by the establishment of NT2 project. During the construction period, 2005-2010, NT2 project employed over 8,000 workers and 80% were Lao workers of which 60% were local workers from the project area and nearby provinces (Kouangpalath, Sacklokham & Kousonsavath 2014). Presently, many Lao staff are being employed by NTPC. More significantly, as part of resettlement plans, the NTPC is supporting the construction of new permanent houses for all 1,330 houses in 16 villages. The houses are equipped with sanitised toilets, water, and power supply systems. In addition, the project supports livelihood improvement, including agriculture, forestry and fisheries. New markets and

warehouses were developed for the local people to trade their goods and services in the project area (Cruz-del Rosario 2014; World Bank 2019b). According to Kouangpalath, Sacklokham and Kousonsavath (2014), income generated from the fishing industry increased from 27% in 2006 to 44% of total income in 2009. As a result, the fishing industry in the area is growing as a necessary occupation due to the presence of the NT2 project. The project also financed massive amounts of funds to improve social and infrastructure activities in the downstream communities of the NT2 plant. According to the ADB (2019) NT2 plant supplies water during the dry season to the Xe Bang Fai river basin, which can be utilised for water supply and dry season crop planting in the downstream communities. This program contributes significantly to improve standard of living of the population in Khammuane, especially in the resettlement communities.

While we acknowledge the critical role of the development of NT2 project in sustaining social and economic development that benefits the people of Khammuane, other investment projects may also contribute positive impacts. There were several development and investment projects which took place in Khammuane during the same period. According to the MPI (2016) several projects and businesses emerged between 2010 to 2016, the period during which NT2 plant was constructed and began operations, including cement, mining, tourism industries, and the construction of a new bridge connecting Khammuane and Thailand. These projects also contributed to improving the living standards of the population in this area. A cohort of the population of Khammuane have worked in these companies. Another contribution to in an increase in the standard of living in Khammuane is remittance of funds. According to Dilen and Vasuprasat (2010) around 300,000 Lao migrant workers in Thailand, including some from Khammuane province, sent money home: on average, US$ 890 annually to improve the livelihood of their families. In addition, the value of timber exports during this time also improved the standard of living": according to the World Bank (2020d), during 2009 to 2017, the total value of timber exports estimated to be between US$184 million in 2009 and US$ 1,677 million in 2014, before dropping to around US$ 260 million between 2017 and 2018. This value was partly shared by the population in Khammuane (World Bank 2020d, p. 46).

The results from this study are consistent with several studies concerning hydropower development and economic and social conditions. Various studies highlighted that hydropower development supported socio-economic growth and ultimately improved the quality of life throughout the nation. The direct benefit of having hydroelectric plants allows household access to on-grid electricity for domestic consumption, and the indirect benefits

improve social and economic conditions. The development of hydropower dams contributes to improved living standards for people living in the reservoir vicinity, as illustrated by Liu et al. (2013), Wilmsen and Van Hulten (2017) who conducted research in the Three Gorges dams, and the research conducted in Ethiopia by Degefu, He and Zhao (2015) Yüksel (2009) also recognised hydropower's critical role in fostering standard of living and sustaining economic growth in Turkey. These results however, contradict that of Baird, Shoemaker and Manorom (2015) and Bazzana, Gilioli and Zaitchik (2020) who studied the negative impacts of hydropower development and social conditions. Those scholars claim that while recognising the positive impacts on a nation's economy, the construction of hydropower dams results in negative impacts on the livelihood of the people living downstream of the project due to the unpredictable river flow and river morphology which impacts on fishing and riverbank gardening activities. According to these studies, generating electricity via hydropower plants resulted in alterations in the natural flow. The variations of the natural flow regime leads to the extinction of natural aquatic animals, including fish, thus decreasing household income and agricultural land loss (Baird, Shoemaker & Manorom 2015). However, according to the MRC (2019, 2021) the change in hydrological condition in the Mekong river basin is a result of both dam operation or climate change.

4.2.2. Education Wellbeing Domain

Several studies have found increased education connects to wellbeing. In Bhutan, education domain is the most attention in GNH (Drupka & Brien 2013, p. 12). Also, this research acknowledges education improves wellbeing not only economically, but also in terms of non-market benefits such as improved individual and family planning, child mortality, and freedom of life. Increased levels of education are likely to be associated with a reduction in the risk of unemployment, and poor life quality. According to the 2030 UN sustainable development agenda, countries need to ensure their citizens have access to fair and affordable quality education and lifelong learning. This should include all levels of education, starting from early childhood, primary and secondary school, and ensure that all children and young people are ready to develop literacy. In Bhutan, the government highlights the significance of education and lists this as an approach to gain deep knowledge, common values and skills (Sherab, Cooksey & Maxwell 2014).

The factors impacting on the trend of education wellbeing were investigated further and it was found that there is a considerable increase in the percentage of education variables, including primary school attendance and its completion. Table 4:2 (below) depicts the trend of education wellbeing domain over the years 2006 to 2017. The most interesting aspect of

this table is the considerable increase in education variables in 2017. This year, more than 30% of children aged 3 to 5 years old attended early childhood education. This figure shows an increase of 13.7% compared to 2012 and 22.7% compared to 2006. More than 83% of child aged between 5 to 15 years old attended primary school - an increase of 17.5% compared to 2012 and 21% compared to 2006. Surprisingly, a majority of household heads (93%) completed primary school in 2017 compared to 76% in 2012 and 69% in 2006.

The above findings can be attributed of the development of the NT2 project, which financed the construction of 16 new nursery schools and 17 primary schools, as well as the construction of the total length of 270 km of roads to and from the project location, the provincial capital and other areas in the resettlement villages. Prior to the dam construction, more than half of the resettled villages lacked road access and were only accessible by boat. At this time, the majority of children spent their time gathering forest products and assisting their parents to collect agricultural and non-agricultural products in order to barter for rice and other goods. There were also insufficient teachers to conduct regular school classes (Souksavath & Nakayama 2013). However, following the completion of NT2, the social and educational conditions of the population in Nakai district improved significantly. According to the World Bank (2020b), by the end of the NT2, the primary school enrolment in Nakai district[27]28, compared to the period before construction of the dams, increased from 31% to 91%. The new road infrastructure connects villages, school and district centre for resettlement communities increased education access and school attendance.

However, some education wellbeing results show an adverse trend. There has been a significant drop in the percentage of women attending secondary school, dropping by 8% points from 2012 to 2017. It can be assumed that women leave school just after finishing or during primary school in Khammuane province. This is in line with other literature showing that women, especially in the rural areas of developing countries, are more likely to drop out of school than men for family and social reasons (World Bank 2019a). These may include leaving school for household responsibilities such as looking after (younger) siblings and early marriage (McCleary-Sills et al. 2015; Shahidul & Karim 2015). According to the literature discussed in Chapter 2, hydropower development projects also supported only primary education in the hydropower project area rather than both primary and secondary. NT2 project granted funding for the nursery and primary schools for resettlement villages,

[27] Nakai is a name of district in Khammuane province

while secondary or tertiary education is absent in the project resettlement plan (Cruz-del Rosario 2014).

This case seems to support the analysis conducted by Arnaiz et al. (2018) of the relationship between hydropower development and freedom of life. They point out that accessing electric lighting in either schools or households increases time to study, read books and magazines and use social media (Arnaiz et al. 2018). Moreover, Guisan (2009) analysis on the level of wellbeing and economic development in some European countries supports this: the increase in GDP leads to higher public expenditure on education which results in better quality of education and wellbeing overall such as life satisfaction, income per capita as well as absence of violence and political stability.

Table 4:2 Percentage of achievement education wellbeing by variables

Education wellbeing variables	2006 (%)	2012 (%)	2017 (%)
Child aged 3 to 5 years old attending early childhood education	9.8	18.8	32.5
Child aged between 5 to 15 years old attending primary school	62.6	66.2	83.7
Household head completed primary school	69.2	75.9	93.1
Women attended secondary school	31.8	33.6	26
Adult literacy	76	76.3	83.7
Women completing primary school (grade 5)	75.4	77.5	82.2
Women having knowledge about time/media	78	92.4	84.4

Source: Prepared by researcher based on analysis of the LSIS 2006, 2012 and 2017

4.2.3. Health Wellbeing Domain

Health conditions and wellbeing have been the top development priorities of many governments. Health is one of the key indicators of human happiness and wellbeing for many international agencies. Any policies that support access to health services are important to reduce multi-dimensional poverty (Nidup, Feeny & Ashton de 2018). There are two types of health conditions considered in this study: mental and physical. Good mental

health is vital to human wellbeing (World Health Organisation 2021). Household violence refers to how community, family and government consider violations among household members and the community as part of social development and improving wellbeing (Ura et al. 2012). Another indicator is the improvement in both human health and the environment, as per the UN 2030 development agenda. Also, the SDG indicators 1.4.1 and 6.2.1. promote the population accessing and using basic safe sanitation services, including hand washing, soap and water and toilets (UN 2020). According to MICS indicator TC 48, it is important to make sure that all households have sufficient iodised salt for consumption within the household. This is to ensure that Lao people, especially children, are prevented from having an iodine deficiency, malnutrition or disability (Strong et al. 2008). This research also aims to investigate how pregnant women are protected. Women's antenatal care and social wellbeing have a significant effect on early neonatal mortality (Roy & Haque 2018) ensuring present and future wellbeing. Hence good mental and physical health of the country's population should be investigated and promoted.

Table 4:3 shows the variables of wellbeing domain over the period 2006 to 2017. While there is a major improvement in health wellbeing variables, some variables identified above contradict the positive trend. Two significant patterns in health variables are the reductions in the percentage of women experiencing domestic violence, and the percentage of households lacking access to iodised salt during the survey years. The increase in women experiencing domestic violence may be explained by the change in women's roles in families. In addition to the health wellbeing variable, this study found that there was a significant increase in the percentage of pregnant women receiving antenatal care and medical assistance during birth. In 2017, over half of the women in the study area received professional birth assistance[29]. Similarly, the number of pregnant women receiving antenatal care doubled from 44.6% to 80% from 2006 to 2017 respectively. This demonstrates the population in Khammuane province are overall having better health conditions as a result of the hydropower development project.

As Robeyns (2005) claims, the hydropower project brings about social benefits and economic advantage to rural communities and the host villages. Cruz-del Rosario (2014) confirms that NT2 project contributed significantly to healthcare sectors in Lao PDR especially in Khammuane province. NT2 project funded the construction of two new

[29] compared to only one third in 2006 and just little above one third in 2012

healthcare centres and road access in resettlement villages and the project site. The resettlement works include, but are not limited to, upgrading the existing district hospital with sufficient medical equipment and staff to support health services to local patients and other people. Moreover, the new road access between resettlement villages to district and province central business areas helps to have more accessible and better for villagers. According to World Bank (2020b) child mortality in the resettlement villages dropped from 120 per 1,000 births to 50. Children's stunted growth rate also decreased from 43% to 34%, and 90% of children under the age of five have been immunised. This illustrates that children's lives in this area are more secure after the hydropower development.

Although the proportion of women with comprehensive HIV/AIDS knowledge increased from 11.5% to 18.4% between 2006 and 2012, but decreased to 14.4% in 2017 (Table 4:3). The reduction in the percentage of women with comprehensive of knowledge of HIV/AIDS can be linked to the withdrawal of the HIV/AIDS awareness program upon the completion of construction NT2 plant. Similar reductions in the percentage of women with comprehensive knowledge of HIV/AIDS have been found in other places in Lao PDR where HIV/AIDS awareness program were discontinued after the completion of development projects (de Faria et al. 2017; UNAIDS 2016).

The finding above is supported by several researchers. According to Arnaiz et al. (2018) and Tshering and Tamang (2004), having electric light generated by micro-hydro power schemes, rather than coal and kerosene lights, contributes to the reduction of health-related disease. Typically, health risk prevention programs for local people living near dam construction projects are always implemented prior to the start of the project. This is to ensure that the local community is safe from drugs, HIV, and human trafficking during the project's construction (Sparkes 2014). Moreover, (Kaygusuz 2004); Yüksel (2010) claim that hydropower-related infrastructure projects provide electricity, roads, and social services which facilitates connectivity between rural and urban people's access to health care and education, and ultimately improves quality of life. In terms of environmental sustainability, Uhunmwangho and Okedu (2009) argue that hydropower is a sustainable development. Building hydroelectric dams reduces greenhouse gas emissions and increases reliable power supply which means an improvement in air quality and public health (Uhunmwangho & Okedu 2009). These results, however, contradict the claim of Chandy et al. (2012, p. 127) that building dams is associated with increased noise and dust pollution and results in various health-related risks.

Table 4:3 Percentage of achievement health wellbeing by variables

Health wellbeing variables	2006 (%)	2012 (%)	2017 (%)
Iodine salt for consumption	77.8	77.5	87.6
Sanitised toilet	54.4	46.1	68.1
Women free from domestic violence	16.2	77.7	97.8
Pregnant women received professional birth delivery assistance	28.8	35.2	58.2
Pregnant women received antenatal care	44.6	54.4	80.5
Pregnant women received tetanus toxoid protection	50.1	62.9	60.2
Women have knowledge of AIDS prevention and transmission	11.5	18.5	14.7
Women immunisation (child immunisation)	59.7	57.3	70.5

Source: Prepared by researcher based on analysis of the LSIS 2006, 2012 and 2017

4.2.4. Child Wellbeing Domain

Child poverty and wellbeing are central factors in assessing wellbeing outcomes, particularly the health, stability and nutritional status of children under five (Ahmad, Lopez & Inoue 2000). In several states, families and individuals are increasingly investing in human capital aiming to meet their children's needs and quality of life (Greenberg et al. 2016; Piketty 2015). The dependency of children on their environments, and the provision of basic needs, are essential factors for child learning and development in the early stages (Roelen & Gassmann 2008). Children living in poor environmental conditions at birth are more likely to live in poverty as adults and thus reducing child poverty will also decrease adult poverty in the long term (Roelen & Gassmann 2008).

To better understand the trend of child wellbeing outlined in the first part of section 4.2, we need to examine child wellbeing variables. According to Table 4:4, the percentage of parents who have time to play with their children, monitor the vitamin intake of children, and the percentage of children immunised have all increased. Vitamin intake by children increased

from 36% in 2006 to 81% in 2017. This represents a 45% increase in the eleven years following the completion of NT2 project. Additionally, the percentage of immunised children increased from 32% in 2006 to over 87 % in 2012, before experiencing a slight decline in 2017. This reflects a 55% growth in six years. However, our research revealed that some variables, such as birth registration and children having birth certificates, fluctuated between 2006 and 2017. Between 2006 and 2012, the percentage of children registered at birth increased from 78% to 82%, but then sharply fell by 11% in 2017. (Table 4.4.). The proportion of children who have access to early learning books increased from 10.5% in 2006 to 40% in 2012, but then rapidly declined to around 6% in 2017. This result reflects the global increase of children spending less time reading books and more time on screens (television, computers, personal digital devices)[30]. The findings, however, indicate that child wellbeing has improved overall during the hydropower development period.

Table 4:4 Percentage of achievement child wellbeing by variables

Child wellbeing variables	**2006 (%)**	**2012 (%)**	**2017 (%)**
Numbers of children registered or with birth certificate	78	86.2	70.7
Children play with someone for childhood development	73.5	85.1	89.6
Children have book(s) with pictures for early development	10.5	39.2	6.3
Children have toys for childhood development	84.8	82.4	87.5
Children's intake of any vitamins during first six months after delivery	36.1	52.3	81.4
Number of children having any vaccination	31.9	86.9	84.3

Source: Prepared by researcher based on analysis of the LSIS 2006, 2012 and 2017

[30] The decrease in time spent reading by children may be due to an increase in household access to media, such as watching television and using a mobile phone.

The crucial point to highlight is the overall improvement in the public healthcare system in Lao PDR. This improvement may be a result of the NT2 project 's development: as highlighted, NT2 project sponsored healthcare facilities as part of its social and environmental program, including the construction of two new healthcare centres in the project area and the renovation of a district hospital near the dam. This support enables greater access for local residents to maternal and prenatal health services, as well as child vaccination. Moreover, as highlighted by Souksavath and Nakayama (2013), many residents rely on the village's medical services provided by the NT2 project to all resettlement villages. As a result, they can now use the village hospital as a public healthcare centre. This demonstrates an overall improvement in child wellbeing factors.

These findings support other trends, for example that the introduction of electricity benefits children's wellbeing. According to (Arnaiz et al. 2018) the arrival of electricity improves children’s schooling and electricity provides light after dark, increasing study time. Moreover, access to electricity enabled more play time between child and parent. Children can help parents with household chores more quickly at night, giving them more time to play and do homework with parents (Arnaiz et al. 2018). Sovacool and Bulan (2012) also assert that hydropower development provides local residents with electricity, clean water, road access, clinics, sanitation, and schools. These services bring children closer to school, which is critical for the wellbeing of future generations (Sovacool & Bulan 2012). The next section of the findings concerns the disparity of wellbeing between provinces in Lao PDR.

4.3. Comparison of Wellbeing Across Provinces

This section compares wellbeing between two provinces in Lao PDR – where hydropower projects have been undertaken and one with no hydropower development. Figure 4:4 demonstrates that there has been a general increase of wellbeing among the three provinces in Lao PDR during the years 2006 to 2017. However, not all provinces developed at the same pace. For example, Vientiane has the highest wellbeing in Lao PDR, followed by Khammuane province and the province with no recent hydropower development which also has the least wellbeing. In 2017 the average wellbeing in Vientiane was around 86% compared to only 69.5% in 2012. Wellbeing in Khammuane was around 68% in 2017 compared to nearly half (49%) in 2012. Similarly, in Huaphanh the wellbeing was nearly half (48%) in 2017 an increase by 12% as compared to 2012. The detail of wellbeing comparison among provinces is illustrated in the next section.

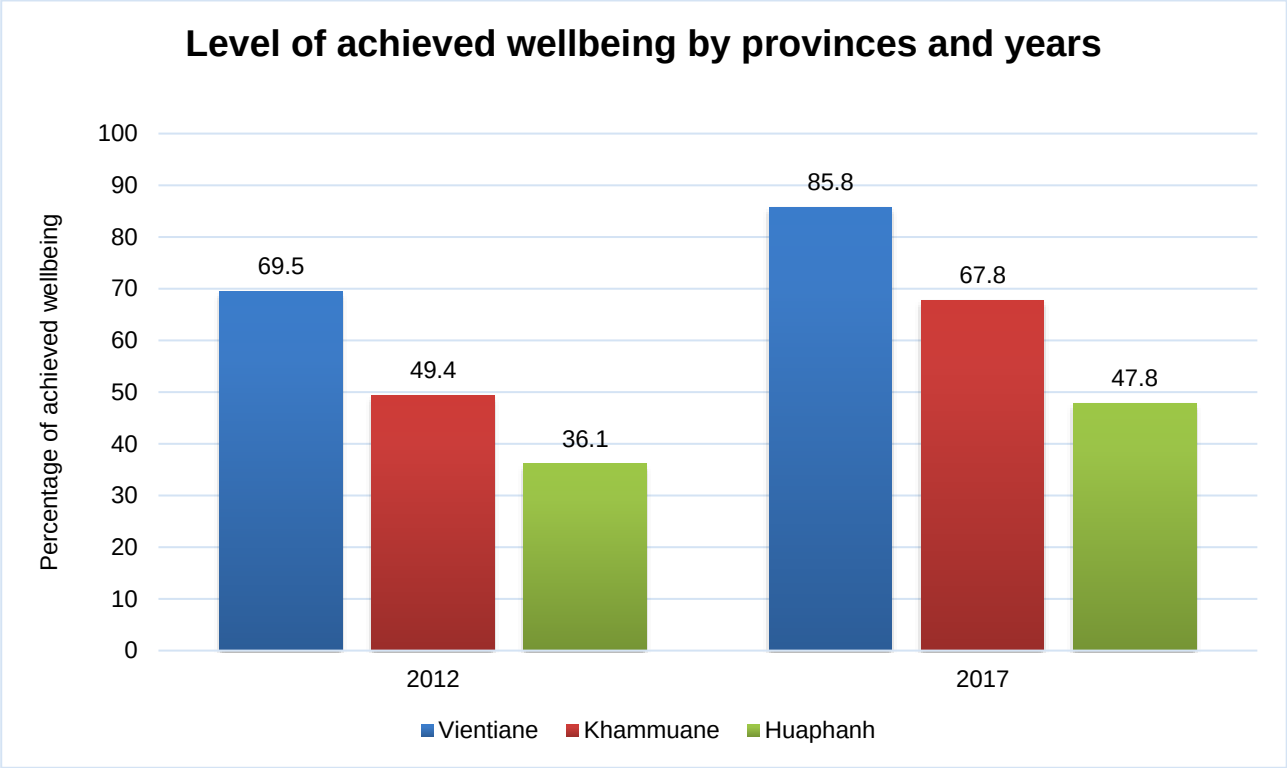


Figure 4:4 Comparison of wellbeing by provinces

Source: Prepared by researcher based on analysis of the LSIS 2006, 2012 and 2017

4.3.1. Vientiane capital and Khammuane Province

According to our findings, Vientiane has higher levels of wellbeing in all domains across the different LSIS surveys. Figure 4:5 distinguishes between the wellbeing domains of Khammuane province and Vientiane capital. In 2017, over two thirds of the population in Vientiane (69.5%) achieved wellbeing. Most of the residents achieved a satisfactory standard of living (85.4%) compared to around half of the population achieving overall wellbeing in 2012 (49.4%). This is similar to the situation in 2012 when most residents (85.8%) in Vientiane lived with higher wellbeing compared to just over two thirds (67.8%) of the population in Khammuane province. Almost all the population in Vientiane achieved a good standard of living and education (97% and 92%). The level of wellbeing of residents in Khammuane in 2017 was almost similar to the situation of Vientiane residents in the last five years (2012) at 67.8%.

These findings demonstrate that the disparity in standard of living and health wellbeing between regions with and without hydropower plants has narrowed significantly between

2012 and 2017 (Figure 4:5). It could be argued that the development of the NT2 project benefited not only the residents of the project's vicinity, but also the residents beyond this area. This study is consistent with other research demonstrating that hydropower development has positive economic externalities (Parshina 2014). The city dwellers benefited more than the rural residents who were immediately impacted by the development project. However, some studies conclude that the majority of capital cities in the world have higher levels of economic development than rural area and their lives are happier than other regions within and across countries (Helliwell et al. 2020)

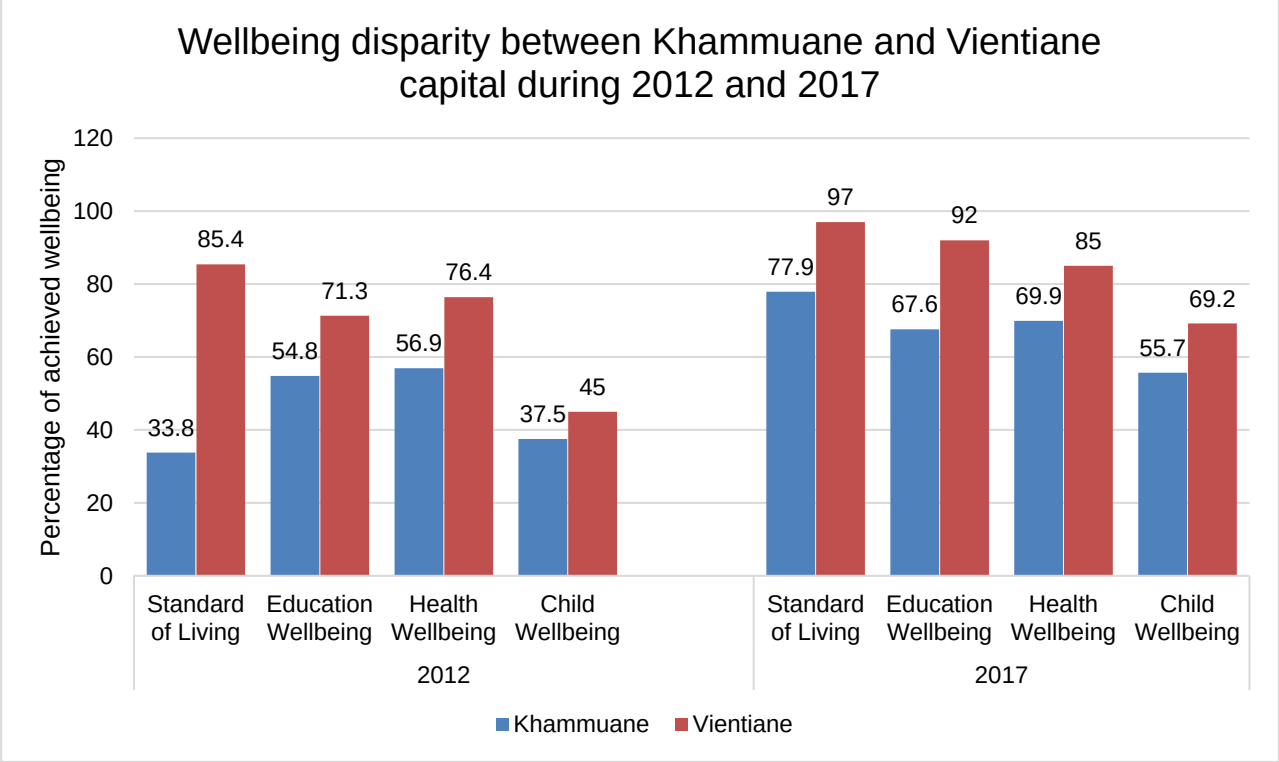


Figure 4:5 Wellbeing disparity between Khammuane and Vientiane capital during 2012 and 2017

Source: Prepared by researcher based on analysis of the LSIS 2006, 2012 and 2017

4.3.2. Huaphanh province and Khammuane province

According to the survey findings and analysis methodology discussed earlier, Huaphanh provinces had lower levels of wellbeing than Khammuane provinces. In 2017, the level of wellbeing in Huaphanh province (47.8 percent) was comparable to that of Khammuane residents in 2012. (49.5 %). In 2012, only about a third of residents in Huaphanh province achieved wellbeing, compared to nearly half in Khammuane province. However, in the same year, Huaphanh province's educational wellbeing was slightly higher than Khammuane's

(Figure 4:6). Further investigation revealed that, in 2017, significant disparities between Khammuane and Huaphanh existed for standard of living and child wellbeing. Over three-quarters (77%) of Khammuane residents achieved a high standard of living, compared to less than two-thirds (40%) in Huaphanh province. One factor for this significant disparity is difference between possession of household assets such as fans, refrigerators, and televisions in the two provinces. Khammuane residents enjoy a higher standard of living because more than 80% of residents own these household assets, whereas the majority of the population in Huaphanh province did not own such household assets.

The above results can be interpreted from various standpoints. One explanation aspect is there was no major hydropower development in Huaphanh province during the years 2006 to 2012 as opposed to in Khammuane. The low rate of household asset ownership result in lower standard of living may be because neither the population of Huaphanh province afford for household asset nor require cooling machines such as fans and refrigerators, as the location of the province are cooler than those of the other provinces in this study. The average temperature in Huaphanh is 7-degree Celsius lower than in Khammuane province[31]. As a result, air conditioners, fans, and refrigerators may be unnecessary for residents of this province. Moreover, there is less access to electricity compared to Khammuane province. Although there is an increasing proportion accessing electricity in Huaphanh province, from 76% to 92% during 2012 to 2017, more than 26% of households that accessed electricity are using off grid energy generated from generators and solar panels. The hydropower or on-grid electrical system was only 67% of the overall electrical city system. While recognising the vital role of the off-grid system for supplying wellbeing for local populations, this power has some limitations. For example, the power from these sources can only service some machines: lighting, television, fan, fridge or air-conditioning, and rarely generate income or recreation activities (Baurzhan & Jenkins 2016). Moreover, it is a costly renewable energy. According to Baurzhan and Jenkins (2016) the costs related to installation and maintaining of off-grid solar photovoltaic (PV) and generators are high compared to the interconnected electrical system that generally comes from hydropower stations. Also, the more advanced education wellbeing in Huaphanh province than Khammuane in 2012 can be seen to be related to some external aid. Since the 1990s UNICEF and AUSAID have invested in a number of education programs to develop early and primary education in Lao PDR, especially in the northern and southern parts of Lao

[31] According to data from https://www.worldweatheronline.com/, Average annual temperature in Huanphah province is between 9-30 degree Celsius while in Khammuane and Vietaneme is around 16-38 degree Celsius

PDR. During 1996 to 2002, there was some early childhood development programs in Huaphanh province to support improved early childhood education and preparation for children under 5 years old to attend primary school (Department of Foreign Affairs and Trade 2014; Plan International 2015). Accessing off-grid electricity may cause a negative impact on some wellbeing domains in Huaphanh province especially the standard of living, but it has a positive impact on the ecological system.

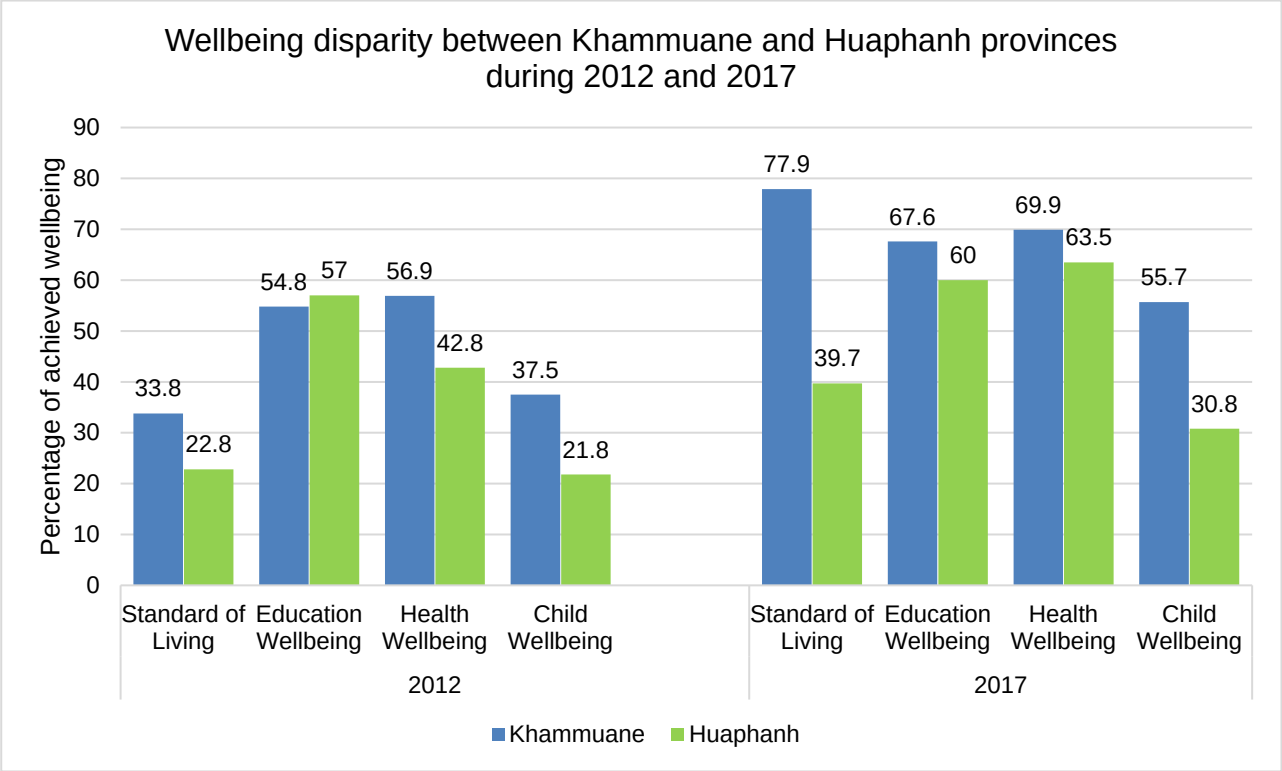


Figure 4:6 Wellbeing disparity between Khammuane and Huaphanh provinces during 2012 and 2017

Source: Prepared by researcher based on analysis of the LSIS 2006, 2012 and 2017

Conclusion

This chapter presents the findings of the wellbeing assessment in Lao PDR by using data from the Lao Social Indicator Surveys for 2006, 2012 and 2017. Analysis indicates that hydropower development contributes significantly to increasing the overall wellbeing of the Lao population at various levels. The wellbeing of people living in the hydropower-built province and non-hydropower-built province is shown to be significantly different. People's wellbeing in Khammuane province has improved substantially following the construction of Nam Theun 2 hydropower project. When compared to other provinces with no hydropower projects, the standard of living, education and health wellbeing for residents of provinces with hydropower development projects has increased markedly. Despite the research also

showing that residents in Vientiane enjoy a higher standard of living than those in other provinces, despite not being near a hydropower dam, it appears overall that province without hydropower have a lower level of wellbeing than those living in Khammuane, the site of the NT2 project.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1. Summary

This thesis attempts to understand the historical debates concerning hydropower development and wellbeing in Lao PDR. The main research question interrogated whether the construction of hydropower dams has led to higher wellbeing in Lao PDR, especially the residents living in the project location. A comparative case study covering two periods- pre and post dam construction, was conducted as a part of the research. The research approach was a mixed method, using both qualitative and quantitative micro and macro data levels to provide detailed information and to contextualise the case study. Data used to examine the wellbeing in Lao PDR in this thesis was drawn from the surveyed data from Lao Social Indicator Surveys (LSIS) in 2006, 2012 and 2017. The conceptual framework used in this research is drawn from Alkire-Foster (2015) method of measuring multi-dimensional poverty as modified by Saikia, Dasvarma & Chalmers (2018) methodology of measuring subjective wellbeing. The wellbeing framework on the whole comprise of four domains including standard of living, health, education and child wellbeing based on the concept of Gross National Happiness (GNH) Index. These four domains contain thirty-one variables. The final conclusion, recommendations and suggestions for further research and policy implications are explored below.

5.2. Main Findings

The primary objective in this research was to examine the relationship of hydropower development and social economic development in Lao PDR. Chapter 2 surveys the research on this topic which reveals that hydropower development projects in Lao PDR have a significant impact on the socio-economic development in Lao PDR. Within the context of this study, the positive impact outweighs negatives, but as I acknowledged in the limitation for this study it may be some negative impact when we extend this research to downstream communities (which was beyond the scope of this research). In the long term, hydropower generates income to the government of Lao PDR by exporting electricity generated from hydropower plants. The income can be allocated to sustain social and economic development in Lao PDR. Furthermore, this study found that the establishment of hydropower improved the standard of living of the rural communities where the hydropower plant is located. The resettlement and compensation programs for the loss of properties and

livelihood[32] to the impacted communities as a result of the creation of hydropower development projects helps to improve the standard of living.

On the other hand, hydropower development in Lao PDR also has some social and economic costs in the short term. The government must borrow money to finance the construction of the dam[33] . This puts the nation into economic risk of credit downgrade and stress due to the higher interest penalty. Moreover, hydropower development related projects also induce involuntary displacement. The affected communities must relocate to new villages and adjust to new living conditions and environments. Some local communities living in dam vicinities suffer from increased pollution and noise due to the construction and operation of hydropower plants.

In exploring the central tenet of this thesis, this study also investigated the effects of the construction of Nam Theun 2 project in Khammuane province on human wellbeing. Although the current study is based on a few wellbeing dimensions, the findings suggest a strong positive relationship between the hydropower development and human wellbeing of the people of Lao PDR. Our findings suggest that the establishment of NT2 project has resulted in improved overall wellbeing of the resident in the province. The project has offered electrification, infrastructure improvement, houses, schools and healthcare centres to local communities which is the foundation to improve human wellbeing in Lao PDR. Based on the adopted 4 wellbeing domains (as described in Chapters 3 & 4) to assess the overall wellbeing in Khammuane province, this study determines that the development of NT2 project has greatly improved the standard of living, child wellbeing, education and health wellbeing of the population living in the project vicinity.

The disparity of wellbeing between the provinces with hydropower-built projects and provinces without hydropower-built projects, and the capital city was also identified. The finding from this study indicates that a differential impact of NT2 project on wellbeing amongst various provinces in Lao PDR. This study found that the development of NT2 project share positive externalities to all people in Lao PDR[34]. Electricity, job opportunities, and income generated from the hydropower project benefits those far away from the project

[32] In the form of new houses, electrification, clean water supply, sanitation, infrastructure, public health, and education systems

[33] This huge loan is due to the investment in transmission and stations without these dams would not operate and the export of energy would not happen.

[34] Positive economics externality means development that causes a benefit to a third party who has no direct cost

vicinity, for example in the capital city, Vientiane, rather than just the people in the project vicinity.

However, this study showed higher levels of inequality between the province that far away from the hydropower project and the province with no local hydropower project. Therefore, notwithstanding their relatively small negative impacts, the establishment of hydropower, provides a pathway to an improved standard of living, education and health conditions leading to advanced wellbeing. Our findings from two years of quantitative data analysis also confirms the residents in Vientiane capital have the highest wellbeing followed by the residents in Khammuane and Huaphanh provinces. Vientiane capital has the highest standard of living, education and health wellbeing compared to Khammuane and Huaphanh provinces. However, the province without hydropower development project seems to have better environmental outcomes as there is rare disturbance on environmental conditions, and the use of less cooling applicant means the use of less energy compared to the province with built hydropower projects.

This paper concludes that, despite the short-term negative impact of hydropower development on the national economy, on downstream communities, and displaced people, hydropower development increases overall wellbeing to the Lao population. Despite the concern over the idea of hydropower development and environmental sustainability, hydropower development has greater positive effects on the new generation born after the development period. Huaphanh, the province which did not have hydropower development experienced little growth in some wellbeing domains especially the standard of living and child wellbeing compared to Khammuane province with hydropower development. Thus, it may be generally concluded that hydropower development contributes to improvement in people's wellbeing. Further, this study has shown that among all the four domains of wellbeing, the domain on child wellbeing has shown the most improvement. This ensures that new generations would be better off in their journey towards achieving sustainable development and wellbeing.

5.3. Recommendations

Based on the findings discuss above, there are several crucial recommendations that can be useful for future development projects in Lao PDR, especially for the government, and the local peoples impacted by hydropower project.

Some policy initiatives are identified below:

- Wellbeing assessment should be integrated into the national development agenda in Lao PDR. People's wellbeing reflects the happiness of the people in the whole country.
- Compensation and rehabilitation mechanisms for the affected people throughout the basin, especially downstream communities should be implemented at the same time as those in upstream communities in order to sustain their standard of living and wellbeing.
- Data and information relating to the advantages of the development of hydropower in Lao PDR, especially the social and environmental mitigation mechanism, should be published and further resourced for future public research.
- Policymaker should motivate and encourage the hydropower development in Lao PDR to promote human wellbeing and achieve rapid economic development and graduate from poverty status. Apart from development of hydropower project to boost economy and eradicate poverty, the improvement of human wellbeing in Lao PDR is another vital aspect of development that the government of Lao PDR should promote and publish to other regional and international organisations for wider support and analysis.

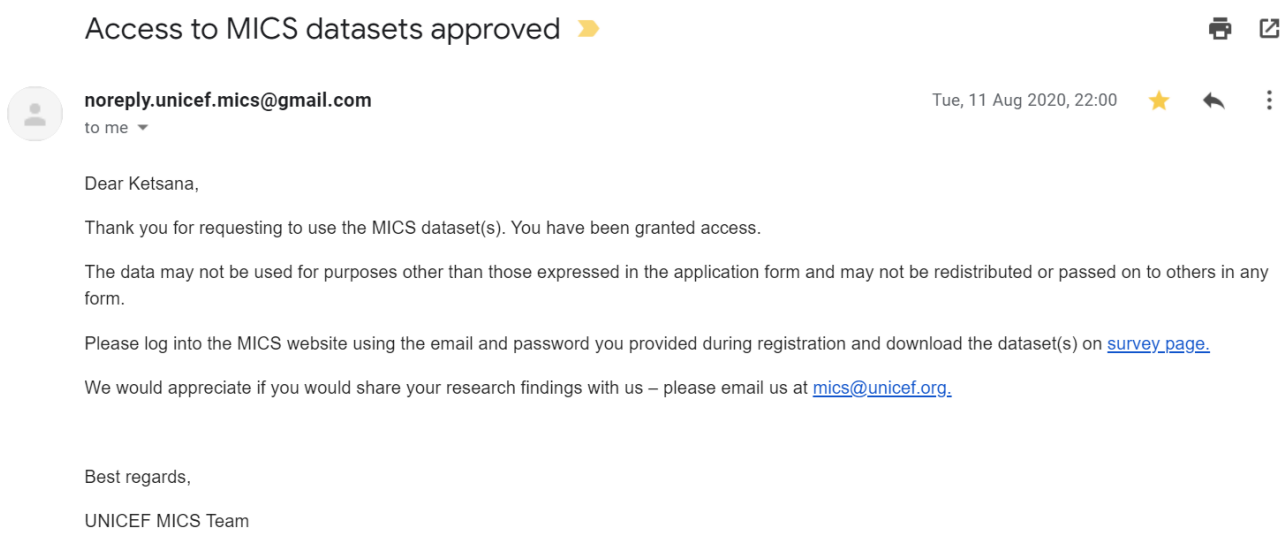
Future research implications are identified below:

- This thesis reflects only some aspects of wellbeing; other wellbeing domains need to be further explored, such as ecology, psychology, community, and governance. Other methods of assessing wellbeing should be applied in Lao PDR. Apart from using Alkire-Foster and Bhutan Gross National Happiness Index (as identified in this study).
- Field data collection and interviews should be conducted in Lao PDR. Further research should conduct surveys with the displaced and local people who live close to the project area and those in further locations for comparison and investigation of the benefit of hydropower development in Lao PDR.
- Different kinds of development project, other than hydropower dams, should also be investigated. There are various other development projects in Lao PDR that also support human wellbeing and social development like mining projects, agricultural projects, road and other infrastructure projects. Those projects have similar environmental and social resettlement mechanisms. Hence, assessing how those projects impact on social and human wellbeing should also be further researched.

This study provides a valuable research tool to assess wellbeing impacted by the hydropower development projects in Lao PDR and identifies future needs to ensure that development projects benefit all peoples.

APPENDICES

Appendix 1: The email from UNICEF for the grant of using LSIS/MICS dataset



Access to MICS datasets approved

noreply.unicef.mics@gmail.com Tue, 11 Aug 2020, 22:00

to me

Dear Ketsana,

Thank you for requesting to use the MICS dataset(s). You have been granted access.

The data may not be used for purposes other than those expressed in the application form and may not be redistributed or passed on to others in any form.

Please log into the MICS website using the email and password you provided during registration and download the dataset(s) on survey page.

We would appreciate if you would share your research findings with us – please email us at mics@unicef.org.

Best regards,

UNICEF MICS Team

Appendix 2: Process of recode by using IBM SPSS 27 Statistics to quantify levels of wellbeing in Lao PDR

This process employed the function ‘Transform’ (Recode into difference variables) in the IBM SPSS 27. There are only binary codes in this process (0&1) which 0 means ‘Not achieve wellbeing’, while 1 mean ‘achieved wellbeing’. Details are described below.

1. **Recoding data in the standard of living variables**

The standard of living domain is comprised of 10 variables which extracted from the same questions in the LSIS surveys in 2006, 2012 and 2017.

- The first variable is related to the permanent house which includes three questions: having permanent floor, roof, and wall which are extracted from questions HC3, 4, 5 in the LSIS asking household head ‘what is the main material of dwelling floor, roof and wall’. The code was ‘0’ for the responses of floor, roof and wall material are earth, sand, dung, wood planks, palm/bamboo, which mean the walls, roof and floor are not permanent and will code"0" (zero). However, the recode value was ‘1’ for the response if the main material of the floor, roof and walls are furnished such as: parquet or polished wood, vinyl or asphalt strips, ceramic tiles, cement, or carpet.
- Variables 2 to 9 are binary questions related to having electricity, television, mobile phone, washing machine, fridge, air conditioner, fan, and own toilet, which are extracted from questions HC8 and HC9 in the LSIS. The codes for these questions were ‘1’ for yes and ‘0’ for no.
- Variable 10 is related to having clean drinking water which are extracted from LSIS questions HC8 and HC9 asking ‘what is the main source of drinking water for members of your household? The codes for these questions was ‘1’ for response pipe into dwelling, piped into yard / plot, pipe into neighbour, public tap / stand piped, tube well / borehole, bottled water, sachet water, protect well; pond, stream, cannel, irrigation channel. However, the code was ‘0’ for the response, unprotected well, unprotected spring, rainwater, tanker-truck, card with small tank; and surface water (river, dam, lake)

2. **Recoding data in the health wellbeing variables**

Measuring the Wellbeing of health is similar with measuring the standard of living domain that comprise of 8 variables extracted from the same questions in the LSIS surveys in 2006, 2012 and 2017.

- The first variable is concerned with having iodised salt for consumption in the household, which is extracted from question SA1 for LSIS 2017 and SI 1 for LSIS 2010 and 2006, which asks ‘would you like us to check whether the salt used in your household contains iodine? May I see a sample of the salt used to cook the main meal eaten by your household members last night?' The code was ‘1' if the test result revealed that the household consumed iodised salt, but ‘0' if the response was “there is no iodised salt or if the testing colour of salt has not changed” or “no salt at home”.
- Variable 2 is about sanitation, and it is based on the questions WS7 for LSIS 2006, WS8 for LSIS 2012, and WS11 for LSIS 2017. The code was ‘1' if the response was flush to: piped, sewer, system, septic tank, pit latrine, unknown place or not sure, don't know where, ventilating improved pit latrine, pit latrine with slab, or composting toilet. The code was '0' if the response was "flush/pour flush to somewhere else, pit latrine without slab/open pit, bucket and other."
- Variable 3 aims to identify women who are free from domestic violence. The values for this variable were derived from the question DV1 for LSIS 2006, 2010 and 2017 asking “Sometimes a husband is annoyed or angered by things that his wife does. In your opinion, is a husband justified in hitting or beating his wife in this situation”. If the response is "yes" to any following answer (i) if she goes out without telling him; (ii) if she neglects the children; (iii) if she argues with him; (iv) if she refused sex with him; (v) if she burns the food, it was code ‘0’, meaning that women are violated, however, if the response is ‘no’ for all response, the code was “1”.
- Variable 4 is related to pregnant women received professional birth delivery assistance, which are extracted from questions MN7 for LSIS 2006, MN17 for LSIS 2012 and MN19 for LSIS 2017 asking ‘who assisted with the delivery of your last child?. The code was ‘1’ for the response, doctor, nurse/midwife, auxiliary nurse. However, the code was ‘0’ for the response, traditional birth attendant, community healthcare worker, relative/friend; and other/ no one
- Variable 5 is related to pregnant women received antenatal care. The response is derived from the questions HA12 of LSIS survey asking women od they received

antenatal care during pregnancy period. If the response was ‘yes’ the code was ‘1’, however, if the response was ‘0’ the code was ‘0’

- Variable 6 is about tetanus toxoid for pregnant women which derived from the question IM15 for LSIS 2006, IM2 for LSIS 2012 and 2017 asking pregnant women to show their immunization cards and check whether they have received tetanus toxoid protection or not. If the card mentioned receiving tetanus toxoid protection the code was ‘1’ of not, the code was ‘0’
- Variable 7 is about HIV/AIDS which derived from questions HA1-8 for LSIS 2012 and 2017 and question MN4 in the LSIS 2006 by asking pregnant women whether they were given any information about HIV/AIDS during the antenatal visit doctors. The new codes are outlined below.

Choices of response	Response choices in LSIS	Recode in SPSS
HA1. Now I would like to talk with you about something else. Have you ever heard of HIV or AIDS?	Yes/No/DK	Yes = 1 / No/DK = 0
HA2. HIV is the virus that can lead to AIDS. Can people reduce their chance of getting HIV by having just one uninfected sex partner who has no other sex partners?	Yes/No/DK	Yes = 1 / No/DK = 0
HA3. Can people get HIV from mosquito bites?	Yes/No/DK	Yes = 1 / No/DK = 0
HA4. Can people reduce their chance of getting HIV by using a condom every time they have sex?	Yes/No/DK	Yes = 1 / No/DK = 0
HA5. Can people get HIV by sharing food with a person who has HIV?	Yes/No/DK	Yes/DK = 0 / No = 1
HA6. Can people get HIV because of witchcraft or other supernatural means?	Yes/No/DK	Yes = 1 / No/DK = 0
HA7. Is it possible for a healthy-looking person to have HIV?	Yes/No/DK	Yes = 1 / No/DK = 0

HA8. Can HIV be transmitted from a mother to her baby	Yes/No/DK	Yes = 1 / No/DK = 0

- Variable 8 is about women immunisation. Questions response to this variable is derived from questions ‘MN7 for LSIS 2017, MN5 for LSIS 2012 and IM1 for the LSIS 2006. Asking women ‘Do you have a card or other document’ with which If the response is ‘yes’ and the card has mentioned any vaccination the code is “1”, however if the responses are “no”, then code is “0” meaning they are not achieving wellbeing.

3. **Recoding data in the education wellbeing variables**

Measuring the education wellbeing is similar with measuring other wellbeing domain in this thesis that comprise of 7 variables which extracted from the same questions in the LSIS surveys in 2006, 2012 and 2017.

- The first variable is concerning to education level of the household completion primary school, which derived from question WB6 for LSIS 2017, WB5 for LSISI 2012 and ED3 in LSIS 2006 asking ‘What is the highest level and grade or year of school you have attended’ if the response is complete, at least, primary school, the code was “1”, however if the response is ‘no school’ or ‘incomplete primary school’, the code was “0”.
- The second variable is about early childhood education for children aged between 3 to 5 years old which derived from the question UB6, 2017 and 2012 and BR6 for LSIS 2006 asking the parent or caregiver of their child aged 3 to 5 years old if their children attend early childhood education or not. The code was ‘1’ if the response is yes, if the response is ‘no’, the code was ‘1’.
- Variable 3 concerns women’s education and ask if women attending secondary school which derived from the question WM11 for 2006, WB4 for LSIS 2012 and WB6A for LSIS 2017 asking highest grade of your school attendance. The code was ‘1’ if the response is above secondary school and ‘0’ for the response below secondary school ‘no’
- Variable 4 concerned child aged between fifteen to forty-nine years old attend primary school which derived from the question WM11 for 2006, WB4 for LSIS 2012 and WB6A for LSIS 2017 asking highest grade of your school attendance. The code was ‘1’ if the response is above primary school and above, and the code was ‘0’ for the response said any grade of below primary school

- Variable 5 is concerned with literacy of women who have not attend primary school or never attend school and asked if women could read a particular sentence. The code was ‘1’ for the respondent that they can read whole sentences and the code was ‘0’ if they cannot read or read only part of the sentences.
- Variable 6 measures completion of primary school by women (grade 5) which derived from the question WM12 for 2006, WB4 for LSIS 2012 and WB7 for LSIS 2017 asking “what is the highest grade you completed at that level?”. If the response is above grade 15, the code was ‘1’ though if the response is below grade 15 (11-14), the code was ‘0’.
- The last variable is testing if women have knowledge about time or media. This is crucial for women’s planning and development when they know the time, they can manage times for any work like chores or playing with their family, which derived from question HC10A for LSIS 2006, WT4-5 for LSIS 2012; and MT3-4 for LSIS 2017 asking whether the respondent have watch/clock/mobile phone or something that can give you access to media such as live TV or radio?. The code was ‘1’ for the response ‘Yes’ at least one of the above variables, but the code was ‘0’ if the response is none mentioned above.

4. Recoding data in the child wellbeing variables

Measuring the wellbeing of child is similar with measuring other domains in this master thesis that comprise of six variables extracted from the same questions in the LSIS surveys in 2006, 2012 and 2017.

- The first variable is about child registration and protection which derived from the question BR1 of the LSIS 2006, 2012 and 2017 asking “does your child have a birth certificate? The code was ‘1’ if the response is yes and ‘0’ for the response ‘no’
- The second variable is about learning materials for early learning which derived from the question BR8 of the LSIS 2006 and EC5 for LSIS 2012 and asking parents or caregiver if children are offered some toys for playing. The code was ‘1’ if the response is yes and ‘0’ for the response ‘no’
- Variable 3 is also about learning materials especially books with pictures for children at early learning and development which derived from the question CE2 for LSIS 2006, EC1 for LSIS 2012 and 2017 asking parents or caregivers “how many

children's picture books do you have for your child? The code was '1' if the response is more than 1 and '0' for the response '0'

- The fourth variable is about adequate care for children which derived from the question BR8 for LSIS 2006, EC5 for LSIS 2012 and 2017 asking parents or caregivers "In the past three days, did you or any household member over 15 years old engage in the following activities: (1) reading a book and looking at pictures, (2) sang songs including lullabies, (3) took a child outside home, (4) compound, (5) yard or enclosure, (6) play with parents; and (7) name, count or draw things. The code was '1' if the response is 'yes' and '0' for the response 'no'
- Variable 5 concerns the health functioning and immunisation system for children which derived from the question VA1 for LSIS 2006, IM29 for LSIS 2012 and 2017 "has the child received any vitamin A dose within the last 6 months?" The code was '1' if the response is 'yes' and '0' for the response 'no'
- Variable 6 is about child vaccination which derived from the question IM1 for LSIS 2006, IM2 for LSIS 2012 and 2017 asking (1) do you have vaccination cards, and (2) in addition to what is recorded, has your child received any other vaccination including the vaccination received in a campaign or immunisation days". The code was '1' if the response is 'yes' and '0' for the response 'no'

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