WATER DEPENDENCY AND LIVELIHOODS OF RICE FARMERS IN DOUNG KHPOS COMMUNE, CAMBODIA

By

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A thesis submitted to the Victoria University of Wellington

in partial fulfillment of the requirements for the degree of Master of Development Studies

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Victoria University of Wellington

March 2016

Abstract

Although the livelihoods of the households in Doung Khpos commune are encompassed of different strategies, the dominant one is rice farming. The main water sources for rice farming in Doung Khpos commune are rainwater and canals, both of which are constrained by either seasonality or functionality. With unreliable water supplies for rice farming and frequent drought, water dependent livelihoods are exposed to higher threats.

Due to the non-availability and unpredictability of rainwater, the lack of water in the canals or the water commodification, some rice farmers were not able to grow rice all year round. The household income was reported to decrease; meanwhile some households had to borrow money to cover the household expenses. Some rice farmers coped with the household financial shortages by reducing the amount of food intake or asked the children to help with income generating activities which inevitably force them to skip or quit school. The growth and development of children could be impacted owing to the household economic insufficiency.

The majority of the rice farmers did not have solutions to cope with the water challenges for rice farming. With limited coping mechanism or capacity to deal with frequent flood and drought, in conjunction with no support in relation to water for rice farming from any stakeholders, the vulnerability of the rice farmers in Doung Khpos commune is high.

Improved water management, capacity building to the local community on climate change adaptation and disaster preparedness and water governance, are believed to enhance the livelihoods of the rice farmers in Doung Khpos commune.

Acknowledgements

Embarking on and completing academic life in New Zealand would be impossible without the scholarship provided by the NZAS Programme and academic and emotional support from many people whom I feel I have owed a great deal.

Firstly, I would like to express my sincere thanks and deep gratitude to the New Zealand government for granting me the scholarship. My acknowledgements to my programme director, professor John Overton for his initial support and constructive feedback in conducting my research. My special thanks to my supervisor, professor Warwick Murray who constantly provided me guidance and constructive criticisms to improve my research. I especially want to thank to Kirsten Reid who has provided me ongoing support academically and emotionally from the start and towards the end of my academic years. I would also thank and appreciate Linsell Richard, a NZAS Programme coordinator for his efforts in providing me the necessary support to thrive academically. All the lecturers were awesome and helpful. I do highly value their support.

My special thanks to World Vision Cambodia staff in Bourei Cholsar district for their support in every possible way to complete my mission and their guidance during my data collection period. I would also like to thank all local authorities, stakeholders and communities who allowed me access to data during my field work. My appreciation goes to my two assistants for their input and time devoted to collecting data.

Lastly, I would like to express my thanks and appreciation to my former managers, peers and friends who supported me to pursue my academic goals.

Dedication

This research is dedicated to my beloved parents, older sisters (Charya Cheng and Chankalyan Cheng), younger sister (Chansereiyao Cheng), brother in law (Chhay Ung) and my nephew (Ethan) and niece (Irene). I am exhilarated and grateful to be part of your life.

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Acronyms

ASSDP	Agricultural Sector Strategic Development Plan
CAVAC	Cambodia Agricultural Value Chain Program
CCDM	Communal Committee for Disaster Management
CDRI	Cambodia Development Resource Institute
CEDAC	Centre d'Etude et de Développement Agricole Cambodgien
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GRET	Groupe de Recherches et d'Echanges Technologiques
IWMI	International Water Management Institute
KII	Key Informant Interview
MAFF	Ministry of Agriculture, Forestry and Fisheries
MDGs	Millennium Development Goals
MoWRM	Ministry of Water Resources and Meteorology
NCDM	National Committee for Disaster Management
NGO	Non-Governmental Organization
NSDP	National Strategic Development Plan
OECD	Organization for Economic Cooperation and Development
SLF	Sustainable Livelihood Framework
WFP	World Food Program
WUFC	Water User Farmer Committee
WUFG	Water User Farmer Group
WVC	World Vision Cambodia

CHAPTER ONE: RESEARCH BACKGROUND

1.1 Research Rationale

Agriculture is a key contributing factor in global poverty reduction (Irz & Roe, 2000) and economic development (World Bank, 2005). It was crucial for achieving the first Millennium Development Goal (MDG) of eradicating extreme hunger and poverty (World Bank, 2005). It was especially vital for attaining the target of halving the proportion of people suffering from hunger and poverty by 2015 (World Bank, 2007b). Between 2012 and 2014, the estimated number of chronically undernourished people was 880 million (FAO, 2014b). These people live on less than US$ 1 a day while 2.1 billion live with less than US$ 2 (World Bank, 2007b). Seventy five percent of poor people in developing countries live in rural areas and their livelihoods (whether wholly or partly) depend on agriculture (World Bank, 2007b). Unfortunately, poverty is largely concentrated in Sub Saharan Africa and South Asia, where 70% of the world's poor live (Namara et al., 2010)

Cambodia is an agrarian country with an annual gross domestic product (GDP) growth of around 7% on average (FAO, 2014b). In 2012, It was reported that there was 7.3% growth in Cambodia's economic development (OECD, 2013b ; (FAO, 2014a). Agriculture contributed about 27% to the national gross domestic product (GDP) and employed around 67% of the workforce (FAO, 2014a). In comparison to the average gross domestic product (GDP) growth of the Association of Southeast Asian Nations (ASEAN) which was 5.5% (OECD, 2013a), the growth of Cambodia was higher. Thus, Cambodia's economies remain largely depend on agriculture (Bingxin & Xinshen, 2011) and according to the OECD (2013b), agriculture will increase its share to the country's economic development.

Promoting the agriculture sector is one component of the National Strategic Development Plan (NSDP) of Cambodia (Royal Government of Cambodia, 2014). Agriculture, especially rice production, is particularly identified as one crucial area to sustain the economic development growth of Cambodia (OECD, 2013b). Like most other countries in South Asia and Africa (Chapagain & Hoekstra, 2010), rice is

a staple crop for Cambodia and is regarded as food security (Nesbitt & International Rice Research Institute, 1998). It is Cambodia's most important agricultural product and export (Bingxin & Xinshen, 2011), contributing about 10% of the total agricultural products to the national gross domestic product (GDP) in 2012 (OECD, 2013b). About 33% of the total land area of Cambodia is agricultural land (World Bank, 2015), of which 75% is devoted to rice cultivation (FAO, 2014a). Seventy five percent of the total rice crop is wet rice which comes from rain-fed paddy fields (Bingxin & Xinshen, 2011). Though Cambodia's agriculture is economically significant, it is mostly underdeveloped (National Institute of Statistics, 2014). With the endowment of water resources and arable land, Cambodia has a potential for increasing rice production (Bingxin & Xinshen, 2011).

Most paddy fields in Cambodia are rain-fed. However, due to climate change, rainwater has now become uncertain and unpredictable, which is concerning since rice is the dominant crop and staple food for Cambodians. Uncertain rainfall affects rice yield significantly (Richard & Sokchea, 2013) and when water affects people' livelihoods, water related poverty can happen (Benedict, Bharwani, Rosa, Krittasudthacheewa, & Matin, 2009). For example, lack of access, lack of availability, distance, flooding, drought, water quality, commodity or water borne diseases can all contribute to water poverty (Black & Hall, 2004).

Improving water management and irrigation is essential to enhance livelihoods of farmers. Less than 25% of Cambodia's agricultural land is irrigated (Ministry of Planning, 2014). The two provinces with the highest number of irrigation are Kandal and Takeo (National Institute of Statistics, 2014). In 2013, 85% of household farmers in these two provinces identified a lack of water in the irrigation system as their main problem for rice cultivation (Sothath & Sophal, 2010). About 48% and 39%, respectively, complained about the inadequate system distribution and the lack of water diversion systems in the existing irrigation infrastructure (Sothath & Sophal, 2010). Because of Cambodia's hydrology, some rivers have too much water in the rainy season, whereas in the dry season, many have limited water (de Silva, Johnston, & Sellamuttu, 2014). There is also a decline in downstream flow (Mekong River Commission, 2005). Consequently, some parts of Cambodia face water

scarcity which results in a decrease in crop production and water conflicts among users and farmers (de Silva et al., 2014). One major challenge for Cambodia's agricultural development is its dependency on nature and climate (Sothath & Sophal, 2010) as the country is highly prone to natural disasters such as floods, drought and typhoons (Davies et al., 2014).

Takeo province is the second largest national rice producer (Asian Development Bank, 2014) and is considered the country's rice bowl (Council for the Development of Cambodia, 2013). Its poverty rate is 23.2% (Ministry of Planning, 2013). Takeo province is composed of 10 districts. According to the poor household identification, Bourei Cholsar district is the second poorest district in Takeo province (Ministry of Planning, 2013). Bourei Cholsar district has a poverty rate of 25.5% (Ministry of Planning, 2013) which is more than 2% higher than the poverty rate at the provincial level. Nearly a 100% of households in Bourei Cholsar district are rice farmers (District Councils, 2011). The main agricultural water sources in Bourei Cholsar are rainwater and canals (Ly, 2011). In the 1990s, the government privatized one main canal in Bourei Cholsar district which resulted in farmers having to pay an access fee to pump water into their paddy fields. Kimvan, Ovensen, Sochoeun and Trankell (2012) stated that water is a common good and should be given to farmers for free, instead of being commodified. The production cost for growing dry rice is extremely high, ranging between 50 to 75% of the total harvest values (Kimvan et al., 2012). The cost includes water access and pumping fees which according to Kimvan et al, (2012) is the main expenditure. Rice farming is the primary income for the majority households in the Bourei Cholsar district. Therefore, agricultural water poses a constraint on the livelihoods of Bourei Cholsar farmers.

1.2 Research Purpose and Objectives

This research seeks to answer the central question of "how can the livelihoods of rice farmers in Doung Khpos commune be enhanced through improved water management?" Three secondary questions will support the aim of the research. The first question is "how does water scarcity and commodification impact the livelihoods of the rice farmers?" The second question is "what are the rice farmers doing to overcome the challenges of water scarcity and commodification?". These

two questions will demonstrate the water challenges for rice farming and how rice farmers are coping with them. The third question explores what water support the rice farmers are receiving by examining the implementation of the national policies in relation to agricultural water management, local development plan and development projects

1.3 Research Area and Map of Research Area

Figure 1 (on page 5) is a map of Cambodia. Takeo province is located in the southern part of Cambodia (Council for the Development of Cambodia, 2013). Figure 2 (on page 6) shows the map of Takeo province. Figure 3 (on page 6) is the map of Bourei Cholsar district. Bourei Cholsar district has five communes, three of which are seasonally flooded every year (Ly, 2011). The main water sources for agriculture in the area are rainwater and surface water (canals). Doung Khpos commune is selected for this study because it is located downstream and furthest from the river. Water in the canals is pumped from the river which is around seven Kilometers from Doung Khpos commune. Access to water for agriculture is a challenge, especially during the dry season. In the dry season, the water level in the river is low and pumping water from the river to the canals is difficult. People living upstream have the advantages of getting water from the canals first. Furthermore, they are dug canals which are highly likely to get shallow. Therefore people who are living downstream are exposed to water disadvantages. Farmers in Doung Khpos commune have to pay an access fee to pump water from the canals; meanwhile water is not always available for them.

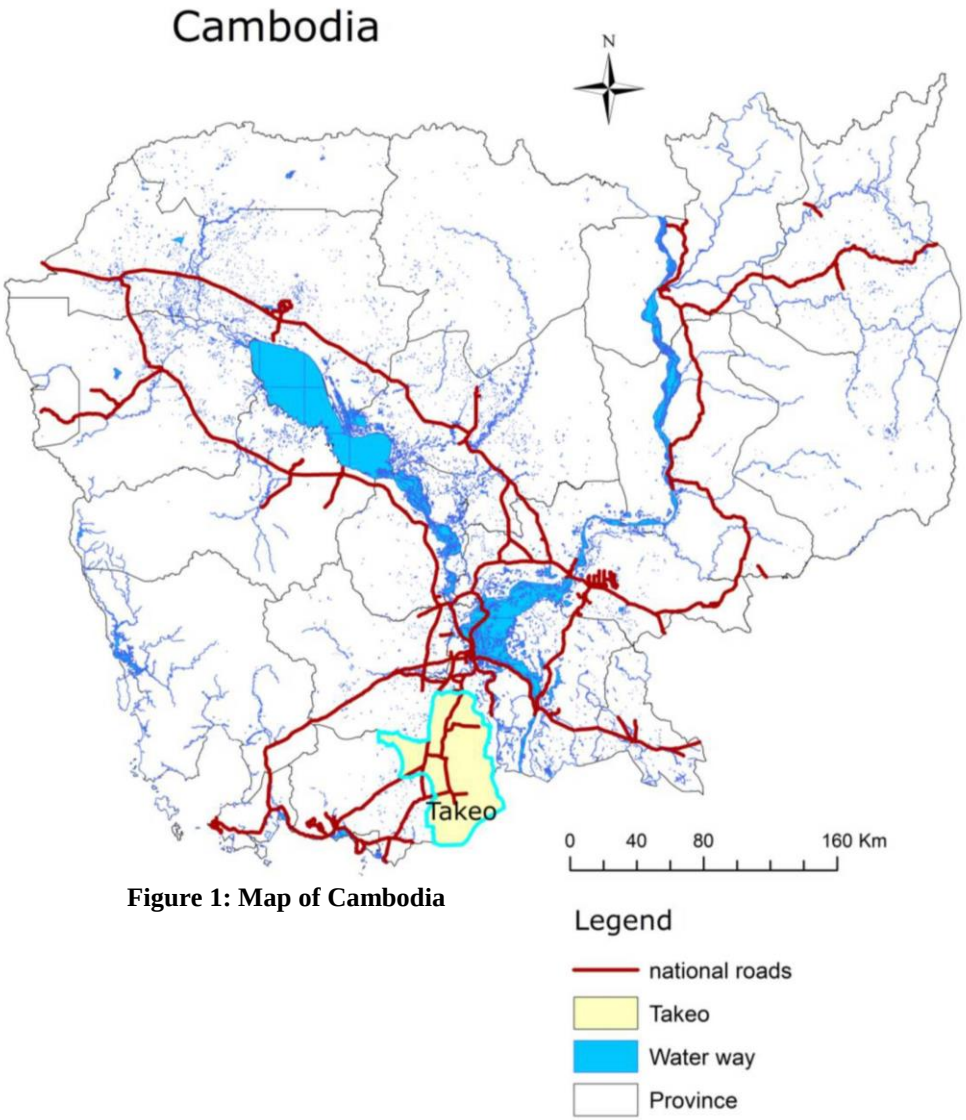

Figure 1: Map of Cambodia

Map Producer: Chansereiyut Cheng, with data for producing map from GIZ (2008), using ArcGIS 10.2

Figure 2: Map of Takeo Province

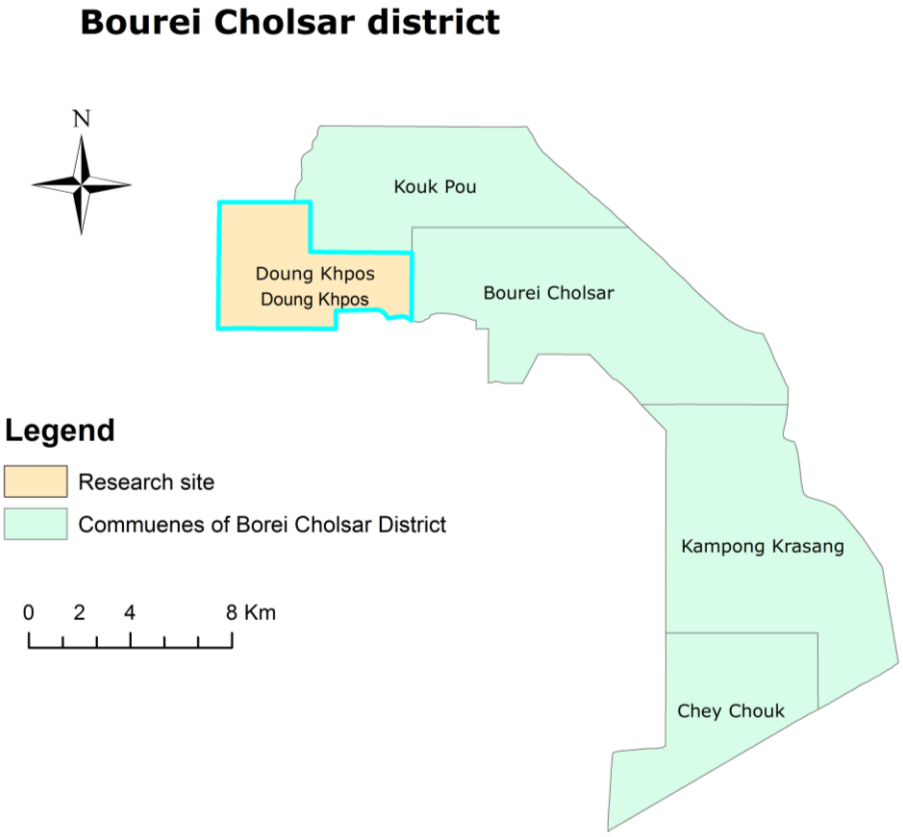

Figure 3: Map of Bourei Cholsar District

Map Producer: Chansereiyut Cheng, with data for producing map from GIZ (2008), using ArcGIS 10.2

1.4 Motives for conducting Research and Research Significance

Maxwell (1996) identified three types of purposes for undertaking research: personal, practical and research purposes. Conducting this research was my personal interest. I think this research has great possibility to result in changes in policies and program development, and hence changes in rural livelihoods. In turn, livelihood enhancement of households could potentially improve the education and health outcomes of children.

Before I came to study in New Zealand, I worked for World Vision Cambodia (WVC) as a design, monitoring and evaluation officer. I went for a field visit in Bourei Cholsar District and was shocked to see people facing such water challenges in relation to agriculture and household consumption. The lack of water sources, the salinization in the underground water, the privatization of the existing canals and the insufficiency of water in the privatized canals derail the livelihoods improvement of many households. Improving agricultural water management in this area will contribute to enhancing and sustaining the livelihoods of the rice farmers. I was wondering what I could do to contribute to improving or transforming rural livelihoods. If their livelihoods improved, children of rural communities could complete at least basic education and have enough nutritional food to eat.

The purpose of this research is to find out how livelihoods of the rice farmers could be enhanced through improved water management. Findings and recommendations from this research can contribute to development programs within non-governmental organizations (NGOs), in particularly World Vision Cambodia (WVC) whose vision is to improve the wellbeing of children. Their primary focus is education and health. There are strong connections between the income of the households and the education and health of children. The findings and recommendations from the research can be utilized for water privatization processes, access fees and water management. Additionally, they can be integrated into local development plans and can provide guidance for agricultural water related policies development and implementation. They can also be used as a document to support the evaluation of the national polices of agricultural water implementation.

1.5 Thesis Structure

This report consists of six chapters. The first chapter (the research background) presents the project's rationale including the selection of the research topic. I then explain the purpose and objectives of the research and identify the research site and the research significance, including my personal motives for undertaking this research. The second chapter (water, poverty and agriculture) focuses on reviewing and criticizing the existing research about water (consumption and agriculture), and its relationship with livelihoods and poverty. It highlights the uses of rainwater harvesting and irrigation for agriculture and their impacts on socioeconomic and environment, including the effects of water pricing and privatization. It also tackle the gap which previous research has not identified and why it is important to conduct this research. The research methodology chapter explains the analytical framework, data collection methods, sample selection for each method and data analysis procedures. It also highlights the difficulties during the fieldwork and explains the research ethics. The next chapter presents the main findings from the research. Chapter five discusses the findings from the research and weaves them with the literature in chapter two and assess the livelihoods of the rice farmers by using the Sustainable Livelihoods Framework related to water. The last chapter concludes the whole research and provides recommendations for improved agricultural water management and for further research in the future.

CHAPTER TWO: WATER, AGRICULTURE AND POVERTY

2.1 Introduction

Water resources are shrinking at a rapid rate (Forouzani & Karami, 2011). Water extraction for agricultural production has contributed to decreasing water quantity and degrading water quality rapidly (Forouzani & Karami, 2011). Research has been done on water, agriculture, livelihoods and poverty in many countries. Some of this research was to explore the relationships between water and poverty or finding out the socioeconomic impacts and some was conducted to propose solutions and to improve policies. The studies were focused at local, national, regional or global levels. In this section, a review on some studies was done.

Firstly, this chapter examines the relationship between water and poverty by reviewing previous studies about water (scarcity, pricing and privatization) for human consumption and agriculture and the impacts of these aspects on health, environment, livelihoods and poverty. It also examines relevant water policies concerning agriculture in Cambodia. Lastly, it provides critical evaluation of previous studies and identifies the gaps in previous research which my research attempts to address.

2.2 Water and Poverty

Water is vital for survival (Anand, 2007 ; Santos Pereira, Cordery, & Iacovides, 2009 ; Jain & Singh, 2010). Large amounts of water is withdrawn each day for agriculture, human consumption, industries and other purposes. The largest water user is agriculture (FAO, 2003a). Agriculture extracts around 70% of freshwater (de Fraiture & Wichelns, 2010 ; Wallace, 2000). Nearly half of the world water resources (47%) is in the American continent, while 5% is in Australia and Oceania and 6% is in Europe. Respectively, Asia and Africa share 32% and 10% of the world water resources (Demin, 2014). The country with the largest available water resources is Brazil (8,233Km3/year) and the country with the least available water resource is Kuwait (0.02 Km3/year) (Demin, 2014). Developing countries are the main water users, especially the countries in Asia. They withdraw around 70% of

annual water volume (Demin, 2014). About 97% of the world water is sea water and the remaining 3% is freshwater. More than 98% of freshwater is underground water and less than 2% is surface water (Qadir, Boers, Schubert, Ghafoor, & Murtaza, 2003). Only a very small amount of water on earth is consumable for humans and agriculture.

There is a relationship between water and poverty (Ahmad, 2003 ; Aderinwale & Ajayi, 2008; Kulindwa & Lein, 2008 ; Harrington et al., 2009b). The long distance to fetch water means people have to lose time for collecting water. Some family members are specifically need to be assigned to this job. For instance, in Sub Saharan Africa, time consumed to collect water is considered as a factor contributing to consumption poverty as people have less time to generate income (Bardasi & Wodon, 2010). Moreover, water scarcity means that people have to use water economically which inevitably leads to poor sanitation and unhealthy conditions. Additionally, the lack of water for agriculture purposes results in less yields, which in turn, impacts on food security and the livelihoods' of farmers. Other issues are the treating of water borne related diseases and spending money to buy water (for both consumption and cultivation), which increases household expenses, Hence, water crises can be considered as a major cause of poverty. There is also a relationship between national income per capita and the percentage of the population having access to water (Anand, 2007). Aderinwale and Ajayi (2008) also stated that a higher rate of the population without access to safe water, is related to a higher human poverty index (HPI). Access to sufficient amounts of safe water is vital for a healthy life, and obtaining water for agriculture is crucial for producing food (Kulindwa & Lein, 2008).

According to the World Water Development Report in 2003, a large contribution to poverty alleviation can be achieved by providing the poor with better access and better managed water (Hope & Gowing, 2003). In developing countries, the lack of water related services keeps undermining strategies for poverty reduction (Pérez-Foguet & Giné Garriga, 2011). In this section, the studies about the relationship between water (human consumption and agriculture) and poverty are examined.

2.2.1 Water for consumption and poverty

Poorer families tend to consume less water since they have less labour for fetching water, limited water transportation and fewer water storage facilities (Tucker, MacDonald, Coulter, & Calow, 2014). The lack of labour for collecting water makes nearer, unprotected water sources preferable to more distant protected water sources (Tucker et al., 2014). High expenses on water consumption, household economic constraints (Aderinwale & Ajayi, 2008) and gender inequality (Jain & Singh, 2010) contribute to trapping households into poverty cycle.

Aderinwale and Ajayi (2008) conducted a study on water and poverty in four cities in Nigeria. They found that water costs were too high for poor households. Water expenses per 25 liters were between 0.18 to US$ 0.35 and the average households needed around 240 liters for daily consumption. Therefore, people had to spend 1.80 to US$ 3.50 for their daily water needs. As many were living on US$ 1 income per day, this water cost was unaffordable for most poor households. A study by Jain and Singh (2010) showed that normally poor households in slum areas pay between five to ten times for a liter of water than the rich who live in the same city. The study of Aderinwale and Ajayi (2008) found that poor households in two cities of their four selected cities had to use water from unprotected and untreated water sources which are shared with animals.

Furthermore, industries around the cities (which the study was carried out) had caused water pollution and environmental degradation in the areas which forced surrounding families to use water that was polluted. The consumption of unsafe water and the poor living environment put people at a great risk of contracting many water related diseases and infections which inevitably decreased people's capacity for economic activities. Hemson (2008) argued that the intervention of public health by providing education and access to water, sanitation and hygiene vitally impacts on the well-being and health of poor people. Thus, improved access to water is one crucial strategy to reduce poverty (Hemson, 2008).

Aderinwale and Ajayi (2008) pointed out that the lack of a piped water system encouraged small water businesses which gave employment to water boys and

Almajiris in Kaban and Ibadan States. Almajiris is an Arabic derived word which means emigrant and they are sent off by their families to reduce the economic burden (Williams & Shenley, 2012). In the past, their presence in great numbers resulted in fundamental religious and ethnic crises. Economic opportunities in these two states were limited and hindered owing to the ethnic and religious crises.

A study conducted by Jain and Singh (2010) contended that gender inequality is also related to water poverty. Women are largely responsible for household water supply. Without available piped water at home, women have to access other water sources which may consume more time and decrease their economic activities. Finally, poverty persists due to the lack of water and sanitation supplies. One impact evaluation done in Nigeria showed that surrounding households can save US$ 8 a month if a collectively dug well is provided to the community.

Aderinwale and Ajayi (2008) and Jain and Singh, 2010) explained how the lack of safe water can lead to poor health conditions, economic crises and gender inequality, all of which contribute to poverty. The studies presented the relationship between water and poverty very well. The study of Aderinwale and Ajayi (2008) showed that even though Nigeria has abundant water resources, the country was still facing water issues relating to human consumption. This reflects ineffective water management. Though water for human consumption is minimal in comparison to water for agriculture, there is a strong need to manage it effectively. The findings from the studies are useful for developing a water management plan and can be also replicated for other countries. However, these studies focused on water for consumption, whereas my research focuses on how to improve water management for rice farming to enhance the livelihoods of the rice farmers.

2.2.2 Water for Agriculture, livelihoods and poverty

Agriculture remains a key instrument for poverty alleviation and sustainable development in the twenty-first century (World Bank, 2007b). It plays a vital role for development, especially in the least developed countries where the agricultural sector is large in terms of total income and labor force (Dethier & Effenberger, 2012). On average, in agricultural based countries, agriculture constitutes 29% of the gross

domestic product (GDP) (World Bank, 2007). Sixty five percent of the labor force is also employed in agriculture related activities. According to World Bank (2007b), agriculture contributes to development through economic activities, livelihoods and environmental services. In developing countries, poverty reduction can be reduced through the growth in agriculture. Agricultural growth improves the earnings of small farm holders, increases the wages of on farm workers and improves food production in terms of availability, accessibility and quality (World Bank, 2005). Two thirds of the world's poor live in rural areas while their means of earning a living are involved in agriculture related activities (World Bank, 2007). Therefore, growth within agriculture can improve the livelihoods of the poor.

It was estimated that around 7,100km3 of water per year is used globally for food production (Rockström et al., 2010a). Around 90% of water used for agricultural purposes is green (from precipitation) and the remaining 10% is blue (water from rivers, lakes, canals, streams, or underground) (Gerten, Heinke, Hoff, & Fader, 2010). Currently, the global population stands at 7.2 billion and it is projected to increase to 9.6 billion by the year 2050. More than half of the population growth will be in Africa (United Nation, 2013), where water is scarce (Rockström et al., 2010a). The total available freshwater produced by the hydrological cycle is adequate for the current population but the world water distribution is uneven due to countries' formation of physiographic and climate conditions (Demin, 2014). Most of the available water is in specific regions, leaving other areas facing water insufficiency (Qadir et al., 2003). By 2050, 1.8 billion people are anticipated to live in regions or countries with definite water scarcity (United Nations, 2014) and the amount of water needed to produce enough food will increase too. The estimated increase ranges between 8,500 and 11,000 km3. If the current food production and environmental trends continue, within the next 50 years there will not be enough food to feed the world's population (Molden, 2007).

As the population keeps increasing, in combination with the rises in incomes earning and the changes in food preferences (as people are better off, they tend to demand more manufactured goods), the demands for water for agriculture will increase globally (de Fraiture & Wichelns, 2010). The consequences of global climate change putting pressure on water resources (for instance, sea level rise has penetrated

underground water and freshwater sources) will result in an imbalance between fresh water supply and demand. It is globally accepted that not only water is crucial for livelihoods but it is also necessary for agricultural production (Cook et al. 2007 cited in Harrington et al., 2009, p. 149). Rural livelihoods can be affected by many factors, one of which is water (its availability, access and quality) (Harrington et al., 2009). The major constraining factor for agricultural production and income of the world's poor people is water (Namara et al., 2010). The first critical step to improve crop yields is water management because farmers intend to invest in other strategies to improve yields when the risks related to water are reduced (IWM & Sida, 2012). Improved water management can be achieved through water related interventions which can lead to the decrease in poverty through the rise in food production, the creation of more agricultural jobs and economic growth.

Rainwater and irrigation systems are two main water supplies for agriculture (Chapagain & Hoekstra, 2010). They are vital for growing rice because they help to maintain moisturizing the paddy soil (Chapagain & Hoekstra, 2010). Some farmers only grow rice in the rainy season, while others grow in both seasons. Growing rice in the rainy season reduces the water demand from irrigation systems because of the availability of rainwater. However, it also means that farmers have to find alternative sources of income in the dry season or they may have to depend totally on the income they generated from selling crops cultivating in the rainy season. Such financial dependence may have impacts on livelihoods of some farmers.

a. Rain-fed Agriculture

Many Asian countries have already reached the limits of their water resources (Chartres, 2014). A lot of river basins cannot supply enough water demands as they have also reached their capacity (Molden et al., 2007). While The contribution of precipitation to the underground water can be less than 2% in hot and dry regions (Tyle et al., 1996 ; Bouwer, 2002a, cited in Qadir et al., 2003, p. 166), the scale and intensity of extracting underground water has increased sharply (Turral, Svendsen, & Faures, 2010). To put it simply; underground water has been exploited at a higher rate than it can be replenished. Water is vital for agricultural production (Hussain, Giordano, & Hanjra, 2004). However, the possibility to expand irrigated areas and

exploit more underground water is limited. Sub Saharan Africa has total rain-fed agricultural land of more than 95% and Latin America has nearly 90%. East and North Africa have around 75% of rain-fed farmland, while South Asia and East Asia have respective rain-fed farmland of 60% and 65%. Almost 60% of the world food supplies are from rain-fed agriculture (Stockholm Environment Institute & United Nations Environment Programme, 2009). Rain-fed agriculture has played and will play a leading role for the provision of food and livelihoods for the world's increasing population (Rockström et al., 2010b). There is a need to increase the water productivity dramatically for rain-fed farms to provide enough food for the growing population (Rockström, Barron, & Fox, 2002). Improving rainwater harvesting system to increase water productivity and to increase agricultural production is crucial (Asresie & Reddy, 2014). In this section, research of the impacts of adopting rainwater harvesting system for agriculture is reviewed.

Harvesting rainwater for agriculture is considered as one crucial strategy to increase the production of agriculture (Asresie & Reddy, 2014) and increasing income of farmers in drought prone areas (Zingiro, Okello, & Guthiga, 2014). Amha, Gebremedhin, and ILRI (2008) found that rainwater harvesting ponds increase the income of rural farmers in Alaba Woreda, Ethiopia while the study of Zingiro et al. (2014) also mentioned that the households who adopted rainwater harvesting ponds have higher incomes than those who did not. Smith, Hildreth and Savadago (2011) conducted an evaluation of the economic impacts water harvesting in Burkina Faso, West Africa. The results from the evaluation revealed that rainwater harvesting increased crop yields and therefore increased the household income. He, Cao and Li (2007) pointed out that the adoption of rainwater harvesting and supplementary irrigation system (RHSIT) by farmers in Loess plateau of china increased crop yields significantly.

A study undertaken by Mutekwa and Kusangaya (2007) found that adopting rainwater harvesting technology systems for agriculture provided direct and indirect socioeconomic and environmental benefits to Zimbabwean farmers. For example, water availability from rainwater tanks enabled almost 90% of farmers to grow at least two crops per year. Mutekwa and Kusangaya (2007) also found that their household incomes rose due to the increase in crop production. Furthermore,

Mutekwa and Kusangaya pointed out that 29% of farmers could pay school fees of their children while 24% were in the process of connecting electricity to their houses as a result of their increased incomes. Others bought resources for farming and livestock, built new houses and connected to clean water supplies. It is clear that there was a socioeconomic improvement as a consequence of using rainwater harvesting technologies. Additionally, there was a sense of community created among these farmers as 31% formed a labor group to help each other with labor, equipment and tools for rainwater harvesting construction. Environmental benefits from adopting rainwater harvesting systems identified in the study were the reduction in soil erosion, maintenance of soil fertility and the conservation and recharging of underground water. Similar findings from the study of Asresie and Reddy (2014) also showed that rainwater harvesting systems could increase agro pastoral productions, decrease the impacts of drought and reduce soil erosion. Rockström et al. (2002) also pointed out that supplementary rainwater could decrease the risk of crop failures.

Using rainwater harvesting technologies is one solution for agricultural water management, as He et al.(2007), Mutekwa and Kusangaya (2007), Amha et al. (2008), Smith et al. (2011) and Zingiro et al.(2014) have shown. However, constructing rainwater harvesting systems needs space which may be a challenge for those who only have a small amount of land or who are landless farmers. Efficacy of such systems also depends on the condition of the rainwater. For example, these technologies may not be viable for seasonally flooded areas. Furthermore, the farmers who used rainwater harvesting technologies in the studies aforementioned grew crops which required less water than rice crops. My research investigates how water scarcity and commodification impacts on livelihoods of rice farmers. It examines the physical, social, human, natural and financial water assets which are related to livelihood outcomes. My research assesses all available water sources (rainwater and surface water. Underground water is salinized therefore it will not be included), then proposes how to manage and improve these water sources for rice farming to enhance the livelihoods of the rice farmers. Adopting a rainwater harvesting system could be proposed to improve water management for rice farming in Doung Khpos commune.

b. Irrigated Agriculture

Without the development and expansion of the irrigation system, the Green Revolution in Asia would not have occurred (ADB & IWMI, 2004) and the livelihoods of many Asian people would not have changed. Over the last half century, the expansion of irrigated areas (constructing more canals, building storage dams and exploiting underground water) has increased dramatically and now more than 60% of the world's irrigated areas are in Asia (Barker & Molle, 2004). Positive outcomes for food security, livelihoods and poverty alleviation have resulted from the investments in water (de Fraiture, Molden, & Wichelns, 2010), particularly from irrigation systems. These irrigation systems have improved world food production, which in turn, has improved food security and livelihoods (Molden et al., 2007). Because of the unpredictable and unreliable rainwater patterns, rain-fed agriculture has been no longer able to feed the growing population (Mwakalila, 2006). Forty percent of the worlds' crop production is from irrigated land (Bruinsma & Food and Agriculture Organization of the United Nations, 2003). One key strategy for the improvement of the rural livelihoods and the revitalization of rural economies is the access to irrigation systems to increase crop yields, household incomes and food security (Postel, Polak, Gonzales, & Keller, 2001)

Lipton, Litchfield and Faurès (2003) developed an analysis framework for the irrigation impacts on poverty. Their framework covers the direct impact on output (increased yields, employment and food prices), second round effects (for example, shifting crops, agricultural technology research) and socioeconomic and environmental impacts. This framework also takes into account the affecting factors on the impact of irrigation on poverty and more specifically, poor or vulnerable groups.

Irrigation is directly and indirectly linked to poverty (Hussain & Hanjra, 2004).The direct linkages occur at local and household levels via higher crop production, low risks (crop failure) year round production, and on and off farm employment (Hussain & Hanjra, 2004) which are similar to the framework (direct impacts) developed by Lipton et al. (2003).The indirect linkages happen at the national, and regional level and have wide- ranging economic effects (Hussain & Hanjra, 2004). Similar to

Lipton et al. (2003), (Namara et al., 2010) also explain that the improvement of agricultural water management contributes to poverty alleviation. Besides positive impacts, (Namara et al., 2010) also argued that irrigated agricultural water also has impacts on health and environment negatively. In this section, I present the studies of irrigated agriculture and its impacts on livelihoods and poverty alleviation positively and negatively, followed by my critical evaluation on these materials and how my research can potentially fulfil what is missing in those studies.

Research conducted by Hussain (2004), Hussain and Hanjra (2004), Mwakalila (2006), and Van Den Berg and Ruben (2006) reported that irrigated farm lands produce higher yields than rain-fed fields. Some studies showed that crop yields from irrigated farms can be twice as much as rain-fed farms. However, a study conducted by Ersado (2005) and Hussain (2004) explained that those who live close to irrigation schemes get greater benefits than those who live further away. Moreover, Senaratna Sellamuttu, Aida, Kasahara, Sawada and Wijerathna (2014) found that although some households have access to irrigated water, they remain poor. They emphasized that educational level and household size also determine the livelihoods of the households.

A study undertaken by Mwakalila (2006) focused on irrigated agriculture and its socioeconomic impacts in Tanzania by comparing rice production from rain-fed and irrigated land. Results showed that almost 50% of those who cultivated irrigated crops could grow rice two times per year. Therefore, they could harvest more crops a year than those who only cultivated once a year. On the other hand, thirty percent of rain-fed rice farmers were found to be highly exposed to crop loss due to unreliable rainwater. Specifically, the rice yield from irrigated paddy fields was 3,000kg per hectare which was twice as much as the yield from modern rain-fed land (1,500kg/hectare) and almost four times more than the yield from traditional rain-fed land (788kg/hectare). The analysis of the expenses and profits of the three rice production revealed that there was a marginal difference of US$ 0.02 for the returns per day between the traditional rain-fed rice production (US$ 0.48) and the modern rain-fed rice production (US$ 0.50). The returns per day for the irrigated rice production was US$2.50 which is five times more than the rain-fed rice production (both tradition and modern). The study also found that families who cultivated

irrigated rice produce enough surplus food to pay school fees for their children and other services. Moreover, with access to irrigated water, farmers can prepare for early planting which is good for their rice fields and contribute to good yields. Overall, the study concluded that irrigation systems have increased the food security and income of households and has helped to reduce poverty.

Kadigi, Kashaigili and Mdoe (2004) conducted a similar study on the economic impacts of irrigated paddies in Usanga Basin, Tanzania. Irrigated paddy land produces annual rice crops of around 105,000 tons which account for 14% of Tanzania's yearly rice production. 105,000 tons can be sold at a price of US$15.9 million. If the farmers in Usanga Basin stop growing irrigated paddies, Tanzania would stand to lose around US$15.9 million. Losses can be in the form of the decrease in the country's rice exports or in an increase in rice imports to supply consumer needs. It is estimated that about 30,000 households would be affected by these losses. On average, household farmers who cultivate irrigated rice can earn around US$ 530.90 yearly. Therefore, a daily earning from irrigated paddy cultivation for each household should be US$ 3.12. This daily return makes irrigated paddy crucial for poverty alleviation in Usanga Basin.

Van Den Berg and Ruben (2006) studied income distribution and small scale irrigation in Ethiopia. Their findings also showed that irrigation provided benefits to households who were involved in irrigation practices directly. For instance, irrigation decreased households' dependency on public funds and increased households' revenues. Higher labor intensity and crop productivity was found in irrigated lands. Interestingly, an evaluation report on the irrigation rehabilitation project in Peru done by Datar and Del Carpio (2009) found that poor farmers gained more benefits than rich farmers, with their annual income exceeding US$ 220 through an increase in crop production.

Senaratna Sellamuttu et al. (2014) conducted the study; 'How Access to Irrigation Influences Poverty and Livelihoods: A Case Study from Sri Lanka". Their research showed that average monthly consumption levels in adult households with irrigated land (US$ 8.20 in 2001 and US$ 13.65 in 2007) was higher than households with non-irrigated land (US$ 7.27 in 2001 and US$ 11.85 in 2007). Poverty has decreased

overtime. In 2001, 76% of households were categorized as poor (below the poverty line) while in 2007, the proportion of poor households reduced to 31%. A study undertaken by the IWMI (2004) also found that in an irrigated setting, poverty was 20% to 30% lower than rain-fed settings.

However, irrigation development can create favorable conditions for water borne diseases such as malaria and Japanese encephalitis (FAO, 2003b). Though many studies have found that agricultural irrigation increases household incomes and contributes to poverty reduction, there are also negative impacts on health. In Ethiopia, for example, Ersado (2005) stated that the construction of dams increases the incidence of diseases which leads to the loss of a labor force for farming, time to look after the sick people and income due to expenditure for health treatment.

The studies presented above mostly dealt with the impacts of irrigation and its impacts on economics, livelihoods or poverty reduction, whereas the study of Aderinwale & Ajayi (2008) analyzed thoroughly the linkages between water and poverty in Nigeria. However, this study was confined only to water consumption. Mwakalila (2006) compared rice production (impacts of water availability) from rain-fed land and irrigated land, including their returns value, whereas Kadigi, Kashaigili and Mdoe, (2004) analyzed the economic loss of Tanzania and the impacts on 30,000 households if people stop cultivating irrigated paddy crops. Both studies highlighted the importance of irrigation on livelihoods and economics, however they did not focus on how to improve water management to contribute to enhancing the livelihoods of the farmers.

Senaratna and Sellamuttu et al. (2014) compared the average consumption and poverty rate between households with irrigated land and households with non-irrigated land. They also analyzed the livelihoods beyond agricultural related activities and identified several factors (which were not related to the access to the irrigation such as education, household size, and vulnerable groups) that may cause poor households to remain poor. The writers used the Sustainable Livelihoods Framework of the Department for International Development (DFID), however they focused more on poverty reduction (households moving from being classified as poor to average or better off). Even though they proposed interventions for long term

benefits for the poor or vulnerable groups, those proposals were not related to agriculture.

The studies presented mostly dealt with the impacts of water (rainwater harvesting and irrigation) on the livelihoods and poverty. However, they did not examine how to manage and improve rainwater harvesting and irrigation functions for agriculture to result in the enhancement of the livelihoods of the farmers, in particularly when there is a growing concern that water supply will be less than the water demand, especially in the dry areas where irrigation systems are located (Water Management Institute, 2010). My research attempted to find out how to improve the livelihoods of rice farmers through improved water management for rice farming.

2.2.3 Water scarcity and its impacts

Water scarcity is one major problem faced by many countries in the 21st century (Santos Pereira, Cordery, & Iacovides, 2009). Water scarcity refers to the shortage of available water to supply water demand (Steduto, Faurès, Hoogeveen, Winpenny, & Burke, 2012). The estimated available water per capita per year for people in water scarce areas is less than 1,000m3 (Rijsberman, 2006). Water scarcity poses threats to livelihoods, food security and environment, therefore it is urgent to manage water resources more effectively (Vidal, Harrington, & Fisher, 2014).

In many parts of the world, water scarcity is a major constraint for agriculture (de Fraiture et al., 2010) and human health and the growth of the world population contributes to this problem . However, other factors such as ineffective water governance, lack of human capacity and inadequate water investments also lead to water scarcity (Molden et al., 2007). Water scarcity is divided into two categories (Molden et al., 2007). Economic scarcity refers to the lack of water investment, human resources to manage water effectively and limited functions of the relevant institutions (Molden et al., 2007). Physical scarcity happens when there is not adequate water to meet water demands, including environmental flows (Molden et al., 2007). In this section, I will review studies in relation to water scarcity (consumption and agriculture) and its impacts on health, poverty and livelihoods, followed by a critical evaluation.

Haddadin (2001) explained that at domestic level, water scarcity impacts on water expenses, sanitation, hygiene and public health which are believed to potentially dismantle governments. At an economic level, water scarcity impacts on the loss of agricultural products and on farm employment (Haddadin, 2001). For example, water scarcity in China studied by Jiang (2009) highlighted that water insufficiency and poor water quality are posing problems on China's economic development, food security and quality of life. China has the capacity to produce food to feed 21% of the worlds' population and has taken millions people out of poverty while continuing economic growth (Doczi, Calow, & Alançon, 2014). The study asserted that the economic and environmental connections between China and other countries are strengthening, therefore China's water shortage may have a global impact as China may no longer be able to produce food to feed the large and growing population (Brown and Halwei, 1998; Tso, 2004; Cai and Ringler 2007, cited in Jiang 2009, p. 3185). Moreover, Hofstedt (2010) affirmed that the water scarcity within China could potentially have extreme ramifications for security and international peace. Thus, tackling China's water scarcity will provide benefits to global sustainable development.

Seventy percent of community water supply was polluted by algae in the eastern regions of China in 2007. This algae pollution impacted 2 million people. It was estimated that the economic loss due to poor water quality equaled to 1.16% of annual gross domestic product (GDP) (WB, 2007a, cited in Jiang 2009, p.3189). Xie and the World Bank (2009) stated that the economic cost of the high incidences of cancer and diarrhea (treatment and death) in the rural area of China was about 0.49 percent of its gross domestic product (GDP). It was an underestimated cost since it did not include all associated costs. According to the World Bank (2007a), China has a higher mortality rate in relation to liver and stomach cancers which stem from the use of poor quality water than the world average. Additionally, water pollution in China has tremendous impacts on their marine, coastal and aquatic ecosystems (World Bank, 2007a). Effective management will reduce China's water vulnerability. Jiang (2009) pointed out three solutions to tackle China's water scarcity: 1) improve the institutional system that controls the amount of water extracted and utilized. 2) focus on market based approaches (water pricing and water rights) with clearly

defined rules and conditions and 3) policy decision making should be based on data driven research.

The study of Harrington et al. (2009) focused on cross basin comparisons (9 river basins) of water use and water scarcity and their present and future impacts on livelihoods. The 9 river basins were located across Africa, Asia and Latin America. The study attempted to find out to what extent water access and water scarcity result in poverty, how water related interventions (such as the changes in policies, institutional innovation and technologies) can improve livelihoods. The study found that there is more poverty in the areas where water is more abundant than the dry regions. For instance, Uganda which is a wet country is poorer than Egypt which is a dry country whereas the poverty in the dry Northeast Thailand is quite low. Hence, water scarcity does not really result in poverty. However, the study still stated that there is a relationship between water scarcity and poverty, even though the findings from the study did not support the assertion. The study pointed out that interventions for water and water management improvement can reduce poverty because water is a vital input for agricultural production and a vital part of livelihood systems (Cook et al., 2007). Harrington et al. emphasized that investment in water is a good intervention. Moreover, the study found out that good governance is required from local, state, regional and basin levels for water tradeoffs.

Marshall (2011) undertook a study on the water crisis in Kenya. Agriculture contributes to one third of Kenya's gross domestic product (GDP) while 75% of Kenyans depend on agriculture. An absence or the lack of water supply for agriculture has a profound impact on those who depend on it. It also affects the country's economic development. Forty three percent of Kenya's population have no access to clean water (World Bank, 2010 cited in Marshall, 2011, p. 31). In 1997, the livelihoods of two million people were affected by severe drought, whereas in 2000, 4 million Kenyans experienced famine. Between 2004 and 2005, drought impacted on agriculture causing millions people face severe food shortages.

The Demographic Health Survey (2003) showed that the adult mortality (per 1,000 lives) rate for males and females in Kenya was 6.19 and 6.57 respectively (Ministry of Health, 2004). Starvation and thirst have caused thousands of Kenyans to die each

year. The under-five mortality rate is considerably high (52) while the respective infant and child mortality rates are 39 and 13 (Ministry of Health, 2015). The utilization of contaminated water has put the health of millions of Kenya in danger. Malaria, cholera, typhoid and intestinal worms are prevalent water related diseases faced by Kenya. Around 2,600 of children who are under five died each year due to malaria, while approximately 3.5 million are at greater risk to contract malaria. Livelihoods (income) can be reduced owing to unhealthy conditions. The solutions to tackle Kenaya's water scarcity are renovating and protecting water towers in indigenous forests, promoting sustainable forest management, constructing dams to supply water for human consumption and agriculture and expanding the national water and sanitation project.

Though the findings from their study did not show the relationship between poverty and water scarcity, Harrington et al. (2009) believed there was. Jiang (2009) identified the causes of China's water scarcity and how water scarcity impacts locally, nationally and globally. The study of Jiang (2009) and Marshall (2011) explained the impacts of water scarcity on wellbeing and livelihoods and poverty very well. Both studies also proposed solutions to tackle water scarcity of each country. However, their solutions are country specific based and may not be appropriate for a Cambodian context. Additionally, both studies did not differentiate between the solutions for water human consumption and water for agriculture. Water consumption is negligible in comparison to water for agriculture. Hence, agricultural water management can be different from water management for human consumption. My research focused on how the livelihoods of the rice farmers in Doung Khpos commune could be enhanced through improved water management. It examined the water challenges for rice farming, the current water practices for rice farming of the rice farmers and the water support the rice farmers received. It also investigated irrigated water pricing which were missing in the studies presented above even though the solutions from Jiang and Marshall can be used to guide my research.

2.2.4 Water Pricing and Privatization

Over the last two decades, world water consumption has risen at twice the rate of the population rise in the 20th century (Diakité, Semenov, & Thomas, 2009; UN Water,

2013). In many regions, water withdrawal for food production and industries has impacted on ecosystems (Rijsberman, 2006). About 1.2 billion people, which, is around 20% of the world's population, live in areas with water scarcity while around 500 million people are reaching this challenge (UN Water, 2013). A water survey published in The Economist stated that water has been poorly governed, and especially extremely underpriced so charges on water with a sensible price is an ideal solution (Bond, 2004). Water trading is a good solution for farmers who use irrigation when they have to compete for water. Rates can be charged by using three approaches; the cost of irrigation provision, the benefits gained from irrigation and the ability of the beneficiaries to pay (Purohit, 2003). Bond (2004) argued that the charges should cover all related costs, including the environment. Water pricing maybe is the simplest concept, however it is politically difficult to implement (Rogers, 2002). Han and Zhao (2007) also stated that policies for water pricing are still controversial regarding the issues of water scarcity.

Molle and Berkoff (2007) stated that water pricing can be a financial tool for the recovery of establishment costs, maintenance and operation costs when public funds are not available. It is an economic tool developed to conserve water and it is also an environmental tool to minimize water degradation and to improve water quality. Though there are arguments on water pricing (impacts on the poor), the World Bank also considers the concepts of privatization, decentralization and participation within this approach (Finger & Allouche, 2003). Developing countries have challenges to fund water investment therefore privatization is an option (Diakité et al., 2009). Privatization is believed to be efficient and beneficial for environment (Molle & Berkoff, 2007) and can tackle the water needs of community (Baer, 2008). Privatizing water has many benefits such as less operating costs, higher productivity, better quality service, and larger covered areas (Svendsen, Gonzalez, & Johnson, 2003). However, many studies found out that pricing and privatizing water leads to environmental degradation and social conflicts. In this section, the studies of water pricing and privatization which led to disastrous effects are presented, followed by a critical evaluation.

Han and Zhao (2007) studied the impacts of irrigated water pricing in China. Three environmental effects stemming from rising water prices, were identified

underground water depletion, air and water pollution and the loss of irrigation facilities. Farmers reduced their rice cultivation and shifted to vegetable growing instead. During the rainy season, rice fields served as water storage facilities for both rainwater and irrigated water. Their seepage and runoff from rice growing contributed to the increase in the level of ground water (Han & Zhao, 2007). Furthermore, the farmers intensified pumping underground water for vegetable growing. Hence, the underground water level dropped. The farmers also intensified the use of chemical fertilizer and pesticides which degraded the water sources and polluted the air. Most irrigation required renovation as they were built with low standards. However there was insufficient funds to cover the cost as farmers switched to using underground water (Yang *et* al, 2003, cited in Han & Zhao, 2007b, p. 1477).

Baer (2008, 2015) argued how water privatization led to social and political chaos In Bolivia. The water system in Cochabamba was contracted to a private sector for 40 years. The impacts of privatization happened immediately and hugely. The private sector installed meters on communal wells which were constructed with donated and personal funds from the community. It charged the communities for meter installation and water consumption. There was a drastic decrease in water quantity for consumption and agriculture; meanwhile the rates were huge. The company also seized the private and communal water resources. There was a rise in water expenses between 200 to 300% which was equal to about a quarter of the low income workers. Prasad (2006) pointed out that expenses on water for consumption should not be more than 5% of households' income. Water connections were cut off from households who could not pay the fees. There was a protest primarily over a high rate and the seizure of privately owned water sources. Many protests relating to water privatization occurred. The protests were considered a battle between poor locals and an international company over water which is a basic human right (Baer, 2008). A few months later, there was a strike and blockade on many highways across Bolivia. Several protesters were sent to prison (Perreault, 2006) and one person died and many were injured. Consequently, the privatization contract was cancelled. After the contract cancellation, the water problems still persisted as around 40% of Cochabamba city's households did not have access to the city's water system (Perreault, 2006). They relied on unsafe water sold by vendors (Garcıá, Garcıá &

Quitń, 2003, cited in Perreault, 2006, p. 159). In the drought prone and semi-arid areas of Cochabamba city, water scarcity was not solved (Laurie & Marvin, 1999, cited in Perreault, 2006, p.159) and water rights for irrigated farmers were still not secure (Perreault 2005 , cited in Perreault, 2006, p.159). Several years later, the Bolivian government privatized water services again which provoked protests due to water tariffs and the lack of service (Baer, 2015). The water and sewage connection fee of US$ 445 which was more than eight times the average monthly earning of US$ 55 per person in Bolivia was beyond the financial capabilities of most households. Prasad (2006) contended that affordability is the utmost importance as water does not have a substitute and has direct effects on health and the environment. Similarly, Hailu, Osorio and Tsukada, (2012) reported that the water connection costs and water prices were too high for most Bolivian households.

Another water privatization scheme which resulted in water conflicts was shown in the evaluation project in Morocco by Houdret (2008). The project was designed to supply water to citrus farms. Before the project implementation, there were many water conflicts which were the consequences of water scarcity. The increase in competition over access to water resources sometimes caused violence and sabotage. Water scarcity also made the disparities of income and unequal distribution of land even worse. The situation was exacerbated once the project was implemented. The large number of farmers who were not the project beneficiaries were further impacted by the project implementation. They were marginalized by expensive fees. The project design did not focus on the sustainable water resource management such as water recycling, the economic use of water and the prohibition of expanding irrigated farms. Water conservation was not taken into the account. Moreover, the project implementation also led to the depletion of water resources

Violence over water resources occurred as a result of the water resources monopolizations and the construction of two dams upstream. People were forced to settle in other areas. The loss of their houses and farms were partly or not compensated. Some of the evicted farmers did not register their water rights. Therefore they had to rely wholly on the annual rainfall of 280mm for their farming livelihoods. Constructing and installing 90 kilometers of piping system also caused conflicts. The protest of the villagers over the destruction of olive trees along the

way suspended the works of the company for three months. Moreover, in the project implementation area, the decline in aquifer levels resulted in conflict upstream. Violence or conflict among poor farmers also occurred frequently due to wells drying up.

The studies presented above explained how pricing and privatization of water for human consumption and agriculture impacted on the environment, socioeconomics, conflicts, violence and social instability. However, livelihoods are not the main focus in their studies. For instance, the study of Han and Zhao (2007) focused on environmental impacts, whereas the study of Baer (2005, 2008, and 2015) and Houdret (2008) highlighted the impacts on livelihoods briefly. Their studies were more concerned about impacts. However, they did not propose or identify any solutions to tackle the problems which were found in their study. My research focuses on agricultural water management that positively contribute to enhancing the rice farmers' livelihoods. It also investigates the impacts of water pricing and privatization on rice farming and the income generation of rice farmers. Findings on the impacts of water pricing and privatization will contributes to a proposal for improved water management.

2.3 Water and Rice Farming in Cambodia

Cambodia is considered as a country with abundant water resources (MoWRM, 2004). In Cambodia, it is estimated that the available water volume per capita per annum is 8,750 cubic meters (Clausen, 2009) which is much higher than the water stress limit of 1,700 cubic meters defined by the United Nations (Clausen, 2009 ; Kumar, 2013). The average water volume required for food production per person per year is 1,000 cubic meters (FAO, 2003c). Therefore, water for food production in Cambodia should be ample. Owing to the geography of the country, in combination with the limited water infrastructure (irrigation and reservoir), many people face water shortages for agriculture during the dry season while during rainy season, the people face too much water (Clausen, 2009). As most paddy fields in Cambodia are rain-fed, rainwater dependency for rice farming poses great threats on the livelihoods of Cambodian farmers. In this section, I will first review the studies of agriculture, water and livelihoods in Cambodia. Then, I will examine the water related policies

for agriculture and rice policies which will be followed by an explanation as to why it is important to conduct this research.

2.3.1 Studies on Agricultural Water and Livelihoods in Cambodia

The study by Silva, Johnston and Sellamuttu (2013) showed that for the rice farmers in Pursat province, water shortages during the dry season for rice farming were an extreme challenge (Silva, Johnston, & Sellamuttu, 2013). During the rainy season in the last few years, the rice farmers in Pursat province experienced drought which now seem to be getting longer. This situation has forced them to pump water from the canals into their fields (Silva et al., 2013). Although pumping water is a solution to reduce crop loss, it decreased the profits considerably of the rice farmers due to the high cost of pumping water (Silva et al., 2013). The conversation between the farmers in Battambang and Preyveng provinces with the International Water Management Institute (IWMI) revealed that the farmers had serious concerns over the uncertainty of rainwater which affected their choice of crop selection and farming activities (Silva et al., 2013). Silva et al. also found that there were conflicts over water allocation and usage between farmers upstream and downstream since they needed water in different quantities at different times of the year (Silva, et al., 2013). Though the study conducted by Silva et al. revealed the challenges in relation to the changes in rainfall patterns, the lack of irrigation systems, the water scarcity and the higher fees for pumping water into the paddy fields, it did not link or provide a critical analysis of the cost of water for agricultural purposes to the livelihood of farmers.

A report from Phallika (2012) explained that the water fees that the farmers had to spend on the private sector to pump water into their fields was around 17 to 20 times higher than the fees charged by the Service Irrigation Service Committee (ISC) (Silva et al., 2013). Research done by the CDRI (2011) also pointed out that farmers might choose not to pay for water fees to pump water into their fields (Wokker, et al., 2011). However, the writers did not mention the alternatives to paying fees and the implications from such a decisions.

According to CDRI (2010), farmers around the Tonle Sap lake did not cultivate dry rice because of the insufficiency of the water as the irrigation systems were located

in lowland areas and the costs to pump water from the canal to their paddy fields were too high (Tong, Hem, & Santos, 2011). As a consequence, those farmers could only cultivate in the wet season. Therefore, some farmers had to migrate to other places such as cities or neighboring countries to look for seasonal jobs during the dry season (Tong et al., 2011). Analysis by Tong et al. (2011) argued that the availability of water in the dry season is critical for double cropping (cultivating rice on the same field twice a year). According to Phaloeun et al. (2003), mono cropping has been practiced over the years in some parts of Cambodia because of inadequate water availability and poor irrigation systems (Phaloeun, Basnayake, Kimgnoy, & Sarom, 2003). On the other hand, where there is supplementary water, farmers grow crops besides rice to earn more income (Phaloeun et al., 2003).

One study by CDRI (2012) showed that there was a sharp and sustained increase in the income from wet and dry rice for two communes in Preyveng province (Silva et al., 2013). The main factor to which contributed to the this increased income was the reliable supply of water for agriculture (Silva et al., 2013). However, this research also does not identify the impacts of water unavailability or water availability on the livelihood of the farmers.

2.3.2 Agricultural water related strategic plans and policies in Cambodia

About 80 percent of the Cambodian population live in rural areas (Council for Agricultural and Rural Development, 2011). Rural livelihoods are dominated by agricultural activities (de Silva et al., 2014). Recognizing that agriculture provides the potential for significant development, significantly (in terms of poverty alleviation at the household level and growth in gross domestic product at the country level), the Cambodian government positions the agricultural sector as central to the country's development strategy and policy making (de Silva et al., 2014). The promotion of the agriculture sector has been identified in the National Strategic Development Pan (NSDP) phase III of Cambodia for the period of 2014-2018 as one among four components for the country's sustainable development and poverty reduction (Royal Government of Cambodia, 2014).

Apart from the development plan at the national level (National Strategic Development Plan), there is an Agricultural Sector Strategic Development Plan

(ASSDP) for the period of 2014-2018 which supports and contributes to the National Strategic Development Plan (NSDP). Moreover, water for agriculture was also tackled in other sector strategic development plans such climate change, water management, food security and nutrition as they are interrelated. In this section, the main policies related to agriculture (rice crops) and water are examined.

a. Agricultural Sector Strategic Development Plan (ASSDP)

Agriculture sector enhancement is identified as one main component to reduce poverty and to boost economic growth. Four pillars one of which is "the enhancement of the agricultural productivity and diversification" (MAFF, 2015, p.30) are defined by the Ministry of Agriculture, Forestry and Fisheries (MAFF) to support and to achieve the objectives of the National Strategic Development Plan (NSDP).

The aim of the Agriculture Sector Strategic Development Plan (ASSDP) for the period of 2014-2018 is to make an increase of five percent in agricultural growth annually by enhancing and diversifying agricultural products and improving commercialization, including aquaculture and livestock farming while sustaining natural resources (MAFF, 2015). The Ministry of Agriculture, Forestry and Fisheries (MAFF) prioritizes five programmes, the first of which is the "Enhancement of Agricultural Productivity, Diversification and Commercializ- ation" (MAFF, 2015, p.31). Under the first programme, there are 21 sub programmes, one of which is the promotion of rice production development (MAFF, 2015). There are two indicators (percentage of farmers using pure seed and rice yield) with clear defined targets for each year (from 2014 to 2018) to measure the progress of the promotion of rice production development sub programme (MAFF, 2015). Rice yields are set to increase from 3.16 tons per hectare in 2013 to 3.25 tons per hectare in 2018. There are many activities set to achieve the targets of the sub programme of the promotion of rice production development, however none of them focus on improving irrigation systems. The improvement of irrigation systems with proper technical design to increase crop yields is identified in another sub program focused on strengthening the utilization and development of agricultural machinery and equipment.

b. Promotion of Rice Production and Export Milled Rice

In Cambodia, rice is the primary crop (Bingxin & Xinshen, 2011 ; International Finance Corporation, 2015). Rice production contributes about 15 percent to the agricultural value added economy while rice paddy fields take up around 75 percent of Cambodia's cultivated land (International Finance Corporation, 2015). Approximately, three million people (roughly 20 percent of the country's population) are estimated to be employed in the rice sector (production, processing and marketing) (International Finance Corporation, 2015). The government of Cambodia has a vision of transforming the country into a "rice basket" and a major milled rice exporter in the global market (MAFF, 2011, p.4). Rice policy was developed as part of the Agricultural Sector Strategic Development Plan (ASSDP). One out of four aspects of the rice policy is the enhancement of rice productivity (MAFF, 2015). Strategies for the short, medium and long term were developed to support rice production and rice exports, including activities. Rice is one of the largest water consumers in the agricultural sector (Chapagain & Hoekstra, 2010). Water is one crucial input for rice cultivation and rice yields. Yet, none of the activities or strategies developed to support the implementation of rice policy focus on the improvement of water access for agriculture. Where a focus of water for agricultural could be found, is in the document of the national water resource policy of the Kingdom of Cambodia.

c. Agricultural Water Policies and Plans

Cambodia is regarded as a country with abundant water resources (MoWRM, 2012b). However, the majority of Cambodian people experience water shortage during the dry season whereas during the rainy season, the water is in surplus (MoWRM, 2004). The irrigation systems in place in Cambodia are not enough, old and not functioning well which impact on water distribution and results in water shortage (MoWRM, 2004). According to the study done by the Centre Détude et de Dévelopment Agricol Cambodgien or the Cambodian Center for Study and Development in Agriculture (CEDAC), only 23 percent of Cambodian irrigation schemes are functioning during both dry and rainy seasons (de Silva et al., 2014). The lack of water has detrimental effects on food production and household water

supply (MoWRM, 2004). As most rural livelihoods largely depend on agriculture, the policies and planning for agricultural water, particularly irrigation are significant to improve the livelihoods of the large majority of rural people (de Silva et al., 2014). In this section, the agricultural water policies and plans are examined.

According to MoWRM (2004), five agricultural water policies were identified. The first policy is about water provision for farmers, for example, the amount of water needed, where and when they need it within the limits of water resources, and the technology which is available. The second agricultural water policy is about promoting the construction and rehabilitation of irrigation systems, drainage and reservoirs so as to provide adequate water for agricultural activities and to minimize the adverse impact of too much water. Promoting rainwater harvesting systems, which is appropriate for the rain-fed cultivated land, is also another policy relating to water for agricultural use. The fourth policy concerns the strengthening and expansion of Farmer Water User Communities (FWUCs) to enable them to participate in water resource management, including the maintenance of the irrigation system for sustainability. The final water policy is the minimization of the impacts on water resources resulting from chemical substances uses in agricultural by encouraging people to grow diversified crops.

d. Climate Change Strategic Plan for Water Resources and Meteorology

The impacts of climate change are perceived throughout the world to encompass an increase in global temperatures, a rise in sea levels and the melting of ice and snow (Lewis & Witham, 2012; Maharjan & Joshi, 2013). Agriculture is one of the sectors which are most affected by this changing climate (Maharjan & Joshi, 2013). The crisis of food production and food insecurity are also worsened by the effects of climate change (Ara Parvin & Reazul Ahsan, 2013).

Cambodia is one of the most susceptible nations within South East Asia to natural disasters , especially regarding, flood and drought (National Committee for Disaster Management, 2003). Since the 1990s, Cambodia experienced repeated floods and droughts which seemed to occur every two years (National Committee for Disaster Management, 2003). Cambodia's economy is mainly based on agriculture (Bingxin & Xinshen, 2011). Realizing that climate change poses a threat to the country's water

management, the Royal Government of Cambodia developed a Climate Change Strategic Plan for Water Resources and Meteorology (2013-2017) (MoWRM, 2012a).

Two climate change related strategic plans for water resources were identified (the strategies for adaptation and for mitigation) (MoWRM, 2012a). The most relevant adaptation strategy which is related to agriculture was the strengthening of the capacity of farmers and members of Farmer Water User Committee (FWUC) titled: "the selection of lower water crop varieties and the planning offer a lower water crop system for climate change adaption" (MoWRM, 2012b, p.23). The most relevant agricultural mitigation strategy is the introduction of technologies in water infrastructure construction and rehabilitation, to respond to the effects of climate change. Another relevant climate change strategic plan for meteorology is the management of flood and drought (MoWRM, 2012a).

2.3.3 Water for Rice Farming and Livelihoods

Sustainable water resource management contributes to sustainable livelihoods. The decrease in global fresh water resources has posed greater risks for millions of people. Water pricing and privatization was thought to be a mechanism tool to conserve water. However, privatizing and pricing water has had detrimental effects which even marginalized vulnerable and poor people even further. Many studies about water issues and agriculture or health, livelihoods or poverty have been conducted. Though some writers identified solutions in their study, their solutions were not specifically focused on irrigated water or rainwater for agriculture. They were also either generalized or based on countries' context. For instance, some studies were conducted in places such as China and Kenya where there was water scarcity. Cambodia is known to have abundant water resources. However, the lack of effective water management makes the country becomes an economic water scarcity country. Cambodia may need to intervene so it can deliver water to users more effectively and prevent the country from becoming a country with abundant water resources to a country with scarce water resources.

There has been a lot of research carried out about how improved agricultural water use (rainwater harvesting systems and irrigation) impacts on livelihoods and poverty.

However, there seems to be little research about how the lack of agricultural water (water unavailability, scarcity and pricing) impacts on livelihoods, particularly in Cambodia. There is even less research conducted in Takeo province (the nation's second rice producer). When there was research conducted in relation to water and agriculture in Takeo province however, Doung Khpos, the commune I researched was always overlooked. Difficult accessibility and seasonal floods could be the reason for other researchers not choosing to conduct their studies there. Water related policies, the management of water resources, the participation of the communities and relevant stakeholders are important factors in leading to effective water management. This research focuses on the enhancement of the rice farmers' livelihoods in Doung Khpos commune through improved water management. It focuses on how to improve the management of both rainwater and irrigation systems and identifies other determinant factors which contribute to the improvement of water sources.

2.4 Chapter Summary

No life could survive without water. Water is vital for a good health, food production and livelihoods of people. Compared to sea water, fresh water which is a necessity for human consumption and for food production is minimal. However, freshwater resources are under threat from ineffective water management and climate change (sea level rise, drought, sea water intrusion and so on). About one fifth of the world's population are facing water scarcity. With the projected growth of the world population and the impact of climate change, water scarcity will be getting worse. Without effective water management, the world may not be able to feed the growing population.

Two main water sources to supply water for agriculture are rainwater and irrigation systems. About 60 percent of the world food production comes from rain-fed fields and the remaining 40 percent is from irrigated lands. Adopting rainwater harvesting for farming was found to bring economic improvement for the farmers (rise in crop yields and income) by many studies. Moreover, some studies also conveyed that the adoption of rainwater harvesting also provides positive impacts for the environment. Many studies found that irrigation boosted crop yields, increased income of farmers,

and reduce poverty. However, some studies also mentioned that a high prevalence of diseases also occur as a result of dam construction. Some studies also pointed out that irrigated farms yield better than rain-fed farms and as a result gained higher incomes. Additionally, households who practiced irrigated agriculture produced adequate food for families.

Two categories of water scarcity are: economic water scarcity and physical water scarcity. Water scarcity reduces food production and has adverse impacts on food security. Water scarcity is found to have serious effects on agricultural dependent livelihoods. Though the growing population is one reason why there is water scarcity, other aspects such as poor water governance, ineffective water management and inadequate water infrastructure are also contributing factors. The world could be severely impacted by the water scarcity in China (as China produce 21% of the world food production).

Water is regarded as an economic goods. Pricing water is believed to bring economic recovery and environmental impacts. Water privatization is believed to ensure effective water management and to address water needs of communities. However, many studies showed that pricing and privatizing water in some countries (for instance, China, Bolivia and Morocco) caused social, economic and environmental conflicts.

There are a lot of policies developed by the Royal Government of Cambodia (RCG) to support agriculture sector, especially water resources management and climate change. However, many studies also emphasized the lack of water for agriculture during the dry season in Cambodia. My research examines how economic water scarcity and commodification impacts on livelihoods of rice farmers. It also explores solutions for rice farmers who had to tackle agricultural water problems, including an examination of water related policies for agriculture local development plans, and the support from others.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

The purpose of this research was to find out how to enhance the livelihoods of rice farmers in Doung Khpos commune through improved water management for rice farming. It attempted to explore the water challenges faced (water non-availability and commodification) by rice farmers, the practices of the rice farmers for coping with these issues as well as the support with respect to water for rice farming they were receiving (the implementation of the related policies for agricultural water, the local development plan and the program development run by related institutional stakeholders and non-governmental organizations).

This chapter has three purposes. The first purpose is to present the concept of sustainable livelihood and the analytical framework of Sustainable Livelihoods Water Asset Framework employed in this research. This chapter also explains the data collection methods, sample selection, sampling techniques and procedures for data analysis. Lastly, I will share my experiences in relation to the preparedness and administrative works for data collection and explain my positionality and reflexivity during fieldwork.

3.2 Research Methodology

3.2.1 Analytical Framework

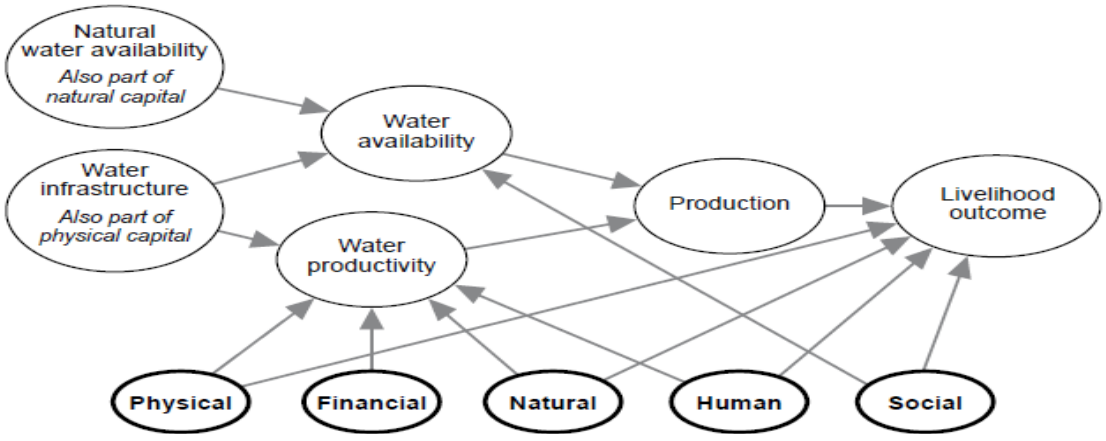

Figure 4: Sustainable Livelihood Framework related to water

(Benedict, Bharwani, Rosa, Krittasudthacheewa, & Matin, 2009, p.4)

This research was based on "the Sustainable Livelihoods Asset Framework related to water" as shown in Figure 4**.** As can be seen from Figure 4, water availability depends on water infrastructure and natural water availability which is also part of natural capital. Production depends on water availability and productivity which is affected by physical, financial, natural, human and social factors. Production, in combination with physical, financial, natural, human and social capital will affect the livelihoods of those involved.

This research also used the sustainable livelihood definition by Chambers and Conway (1991). Livelihoods are "the capabilities, assets and activities required for generating income and securing a means of living" (IFCRC, 2010, p. 15).. A livelihood is sustainable when it can deal with and recover from stress or unexpected situations and can maintain or improve its capabilities and assets in the present and in the future, while not compromising natural resources (Zoomers, 2008).

The Sustainable Livelihood Asset framework related to water and the sustainable livelihood definition were used as a guide to design a household questionnaire and semi structured questionnaires for key informants. They were also employed to analyze data and to assess the livelihoods of rice farmers in Doung Khpos commune.

3.2.2 Research Methods

This research used primary and secondary data. The primary data was acquired by using mixed methods. The secondary data were obtained by reviewing reports, policies and plans of relevant stakeholders (local authorities, ministries and NGOs) at local, district, provincial and national levels.

There were three reasons why mixed methods was employed in the study. Firstly, one method did not enable me to gather all information I wanted. Both quantitative and qualitative data were needed to address the central and secondary questions of this research. The information about water challenges, how rice farmers deal with them and the impacts of the solutions to the challenges could be gained by using a household survey. The information about current canal irrigation management and local development plan was obtained by interviewing relevant stakeholders.

The second reason I used mixed methods was to find out perspectives from different people on the same things (Laws, Harper, & Marcus, 2003; Matthews & Ross, 2010; Creswell, 2014) as their responses can be used to confirm or to contrast (Laws et al., 2003). For example, my research wanted to find out what support rice farmers received in relation to water for rice farming. Hence, I included questions asking about support in my survey questionnaires. I also asked three key informants questions about this kind of support to. Finally, the use of mixed methods can also result in good data validity as the methods take into account different sources (Bulsara, 2010).

This study applied a mixed method of "convergent parallel design". The quantitative and qualitative methods were equally prioritized (Creswell & Plano Clark, 2011). Both statistical and qualitative data were gathered concurrently (Creswell & Plano Clark, 2011). Data was analyzed separately and results were compared to confirm or to contrast (Creswell, 2014).

a. Data Collection Tools

i. Survey

A survey is defined as a systematic method for collecting data from a selected sample for building quantitative descriptors of the population of which the samples chosen are the members of that population (Groves, 2004). A household survey was conducted in Doung Khpos Commune by using a closed questionnaire. A questionnaire is a set of questions with given answers (Matthews & Ross, 2010). It is a format which enables structured and standardized data to be collected (Matthews & Ross, 2010). A closed questionnaire was designed and translated into Khmer (Cambodian language) so that the interviewees could understand it. The respondents felt more comfortable seeing the questions in the local language rather than the English language. Since there were issues around illiteracy and time, the questionnaires were filled by myself or my assistants. Firstly, a questionnaire was piloted involving several households to ensure the consistency of the questions and to check whether it was easily understood by people.

ii. Key Informant Interviews

Semi structured questionnaires were designed for key informants. Key informant interviews enable users to explore the answers from the interviewees in depth and allows the participants to voice their experiences in their own way (Matthews & Ross, 2010). Using Key Informant Interviews provides an opportunity for researchers to explore in detail the specific issues with the interviewees who are considered to be knowledgeable on a particular research topic (Dale, 2004).

Seven key Informant Interviews were undertaken with:

- *The officer of Bourei Cholsar District Office of Agriculture*: to examine the challenges for agriculture, natural disasters, the support provided to the farmers and agricultural development plans, including prioritized areas and actions.
- *The commune chief*: to identify water challenges, natural disasters which rice farmers are encountering, and the support given to the rice farmers. In particular, the interviews were designed to explore canal irrigation management and the impacts on the livelihoods of rice farmers as a result of pricing and privatization of the canals.
- *The Area Development Programme (ADP) manager of World Vision Cambodia (WVC)*: to investigate the implementation of their projects or activities related to livelihoods or water for agriculture and disaster risk reduction and how their project designs align with the district, commune development or investment plan and their prospective future project designs.
- *Two Water User Farmer Committees (WUFC)*: to explore access fees and canal irrigation management.
- *Two Water Village Representatives*: to identify their roles and responsibilities as Water Village Representatives and how the fees (rice or money) to access the irrigation system are collected and managed.

iii. Secondary Data

Primary data can be supplemented or triangulated by the secondary data (Overton & Diermen, 2013). Some quantitative data found in the research was compared to secondary data. For example, the average rice production per hectare found in this research was compared to the production at the national level. The primary and secondary data were woven together in the discussion chapter.

b. Sample selection and sampling technique

Dong Khpos commune consists of 12 villages which are scattered along the main road and village roads. There are two main canals (Sounmuay and So Hang). So Hang canal has much more water than Sounmuay canal. The main canal of So Hang has water during both dry and rainy seasons. So Hang canal covers five villages of Doung Khpos commune. Three of them are located upstream and two others are situated downstream. Sounmuay canal covers six villages. Some parts of Sounmuay canals are dried up during the dry season. One village does not have a canal.

A strata sampling technique was applied to select the samples according to their geographical situation (as can be seen in the figure 5) and the canal covering the villages. All villages in Doung Khpos commune were stratified into three:

- Group 1 was comprised of three villages and are covered by Sarhong canal. They are located upstream.
- Group 2 consisted of four villages and are covered by the tail of So Hang canal or Sounmuay canal.
- Group 3 has five villages, four of which are covered by Sounmuay canal and one village is not irrigated.

Stratifying the villages by using the canals the rice farmers access to obtain water for rice farming was practical to find out which groups faced more water challenges. The operation and maintenance of Sounmuay and So Hang canal could be compared as well.

A proportionate stratified sampling technique was used to select samples from each group. The proportionate stratified sampling technique enables users to select samples in proportion to their actual members in the overall population (Ruane,

2005). Ten percent of rice farmer households were selected from each group. The samples from each group were selected by using the probability sampling technique because it can provide better features to ensure the representativeness of the whole population (Groves, 2004)

Table 1: Stratified villages and sample selection

Strata	*Village*	*Number of Samples*	*Canal*
Group 1	3	38	So Hang
Group 2	4	44	Sounmuay or So Hang (tail)
Group 3	5	53	Sounmuay or None
Total:	12	135	

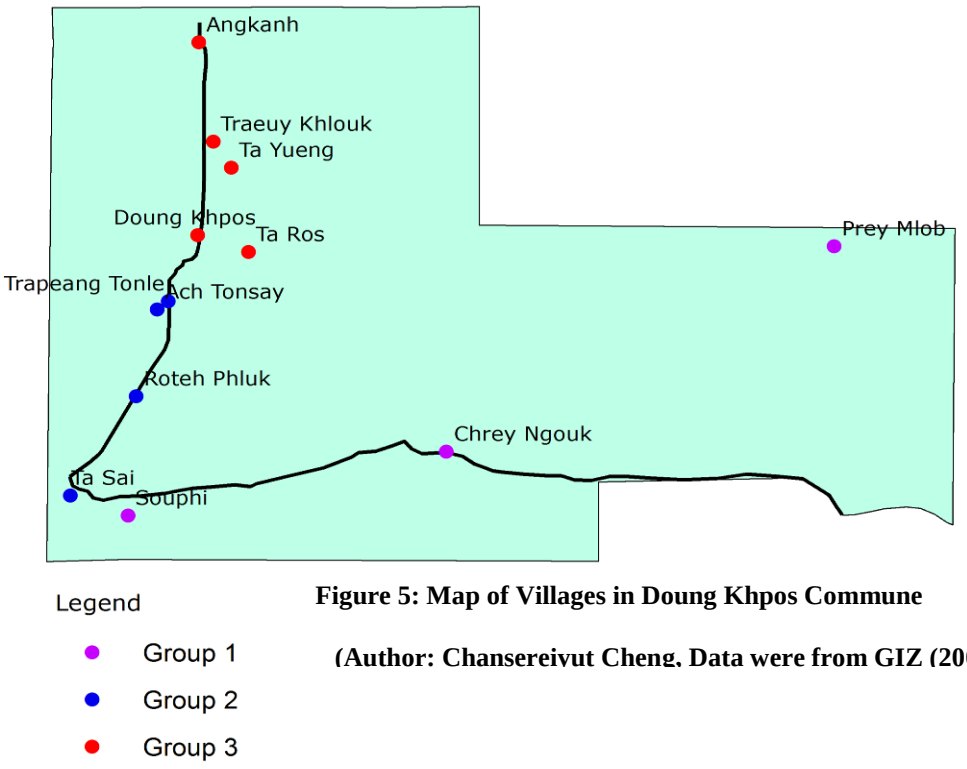

Figure 5: Map of Villages in Doung Khpos Commune

(Author: Chansereivut Cheng, Data were from GIZ (2008))

Key informants were selected by using a purposive sampling technique. This technique is the most effective (Tongco, Ma. Dolores C., 2007) because it enables

users to select respondents who are considered to have relevant knowledge about the topic (Tongco, Ma. Dolores C., 2007; Dale, 2004).

c. Data Analysis

The survey questionnaires (quantitative data) were coded using SPSS (Statistical Package for the Social Sciences). I adopted the statistical measurements suggested by Overton and Diermen (2013) and other statistics books for representing numerical data as follows:

- Measures of central tendency: are mean, mode and median. Mean is an average and mode is the most frequent cases (Chambliss & Schutt, 2006). Median is the point which divides the distribution in half (Chambliss & Schutt, 2006). These measures were used to analyze numerical data from the household surveys. Mean and mode, in particular, were frequently used.

- Frequency distribution: is used to show a single variable distribution across categories (Overton & Diermen, 2013). A frequency distribution can be displayed in histogram, pie chart or bar chart (Overton & Diermen, 2013). Frequency distribution was used in this study to display the sample from each group, educational level of the head of the households, types of rice that the farmers grow and disasters that rice farmers challenged.

- Measures of dispersion or measure of variation: "are descriptive statistics that indicate the spread or variety of scores in a distribution" (Argyrous, 2011, p.192). The most common measures of dispersion are range and standard deviation (Overton & Diermen, 2013). Range is the difference between the minimum and maximum values of the cases in a distribution (Overton & Diermen, 2013). The calculation of the difference between each case and the mean is called standard deviation (Chambliss & Schutt, 2016 ; Overton & Diermen, 2Sounmuay3). I used the measurements of range and standard deviation for data which I employed the central tendency measurement. The dispersion measurement gave more elaboration to interpret the data. While mean showed the average income of households, range illustrated the lowest and the highest amount of income. Mode informed readers the amount of

income with the highest frequency whereas the standard deviation explained the spread of each household income from the average.

- Cross tabulation: illustrates the relationship between two variables (Chambliss & Schutt, 2006 ; Overton & Diermen, 2013 ; Vanderstoep & Johnston, 2009). The measurement of central tendency (especially mean) and the dispersion (standard deviation) were used in combination with cross tabulation procedure in this study. The data of household incomes, rice yields, water challenges and others were crosstab with the sample groups. The procedure of cross tabulation showed whether there were similarities or differences among each group, which group complained about water challenges, which groups had the highest rice yield production and it also illustrated who had the highest income and what group they belonged to.

- Correlation coefficient: It is another way of describing the relationship between two variables (Overton & Diermen, 2013). The correlation coefficient is a single number ranging between the value of -1 and 1 (Field, 2009 ; Overton & Diermen, 2013 ; VanderStoep & Johnston, 2009). One of the uses of correlation coefficient procedure in my study was to examine the relationship between the household income and the educational level of the household heads.

- One Way-ANOVA: is employed to compare means among independent groups whether there are significant difference among them (Field, 2009). In this study, this procedure is used to compare the means among three stratified village groups to find out significant differences, for example the rice yields produced by each group. Villages in Group 1 are covered by So Hang canal. The villages Group 2 are covered by So Hang or Sounmuay canal while the villages in Group 3 are covered by Sounmuay canal or none.

Some data needed to be computed (household income, expenses on water, rice sales and so on). In conjunction with those statistical measurements, I also used other mathematical functions to compute data. One example was a breakdown of expenses on water within rice sales was done to find out how much (in percentage terms) rice sale was spent on water. Another example was the monthly income per capita was calculated monthly income per capita by dividing the household income and the

number of members in the households. The values of income per capita revealed the number of people living on less than US$1 a day.

Thematic analysis was used for qualitative data (from key informant interviews). A thematic analysis is defined as "a process of working with raw data to identify and interpret key ideas or themes" (Matthews, & Ross 2013, p. 373). Codes were developed to represent the themes which are identified and applied to raw data as a summary marker for later analysis (Guest, 2013). The information from the key informants was grouped into three main themes: water challenges, support (with regards to water for rice farming, livelihood activities and disaster reduction) and water access. Data in each theme was used to support or contrast the findings from the household survey.

Secondary data was also used to support, to complement or to contradict the findings from the household survey and the key informant interviews. Some findings and some secondary data were categorized into physical, financial, natural, human or social capital (See Figure 4**,** p.38). By examining each capital category, the livelihood outcomes (related to water) were assessed. Vulnerability and capacities of the rice farmers to cope and recover from natural disasters (flood and drought) were assessed as well. The assessment of the livelihood outcomes in relation to water and the sustainable livelihoods show the gaps in each capital category, including the capacities of rice farmers to cope and recover from the natural disasters. Based on the livelihood assessment and findings, solutions to improve water management for rice farming are proposed.

3.3 Research Scope and Limitations

The study was confined to one commune of Bourei Cholsar district. It mainly focused on agricultural water management and livelihoods by applying the Sustainable Livelihoods Framework (SLF) which is related to water developed by Stockholm Environment Institute (SEI) and the sustainable livelihoods defined by Chambers and Conway in 1991. Owing to the limited resources (finance and time), it was not possible to follow the statistical guideline of 95% confidential level and 5% confidential interval for sample selection. The samples selected was equivalent to

10% of the total households in Doung Khpos commune. Sample selection were ensured to represent the population.

3.4 Experiences from the 'field'

Planning for data collection is critical (Chacko, 2004). Contacting relevant stakeholders for the interview may take longer time than it was anticipated (Borovnik, Leslie, & Storey, 2013). Therefore establishing contacts with the stakeholders in advance is beneficial. Networking, personal and professional relationship enabled me to access some key informants easily. I worked for World Vision Cambodia. Seeking the approval from the Operational Manager (who is based in Takeo province) to interview his subordinate (who is an Area Development Programme Manager in Bourei Cholsar district) was not difficult. Furthermore, the staff of World Vision Cambodia showed me how to contact the key informants such as the officer of District Office of Agriculture, commune chief and village chiefs. I also approached a friend who has a friend working for CAVAC who in turn provided me with contacts from of the representatives of the Farmer Water User Committee (WUFC).

I found that organizing a meeting with the local authorities (the commune chief, clerk and commune councils) was helpful. They were gatekeepers who enable or hinder the access to participants for information in various ways (Bonnin, 2010). The aim of the meeting was to introduce myself and my assistants to the local authorities, to inform them about my research purpose and objectives and to seek their approval for conducting a survey. Furthermore, I asked for their recommendations in relation to the stratification of the villages (for sample selection) the safety in the commune. Seeking approval to undertake a survey from the commune chief was both obligatory and beneficial. I could be rejected by the village chief or villagers if I did not show them the approval letter from the commune chief when the survey was conducted.

When a study uses a household survey as a data collection method, seasonal consideration is necessary. In rural areas where infrastructure is poor, accessibility during the rainy season is difficult. Flood caused by rainwater also limits the access. Additionally, most farmers spend most of their time in paddy fields during harvesting and cultivation period. My data collection period was between the end of the dry

season (also the end of dry rice harvesting time) and the start of the rainy season (the wet rice cultivation time). It was good since the majority of people were at home and were able to participate in the survey.

Hiring local people (who are able to perform work) as research assistants was a good idea because there are no language or cultural barriers r. My assistants were from Takeo province and their families grow rice. Hence it was not difficult for me to explain the household questionnaires to them which mostly dealt with rice practices. Furthermore, they gave more input for my questions. Gender should be considered when it comes to recruiting research assistants. I anticipated that my interviewees for the household survey were likely to be female since males went to work. I understood that rural women tend to be shy so I recruited only female assistants as it was easier for women to be approached by same sex surveyors. As I lived and grew up in a rural area plus the development fieldwork experience I gained, positionality and reflexivity was applied throughout the data collection process.

Even with careful planning, researchers may face unexpected situations during fieldwork. Ability to adjust or adapt to unexpected situations, flexibility and competency to get along with diverse people in various situations are required (Chacko, 2004). When I interviewed one key informant, he briefly introduced me to the overall situation of rice farming in Doung Khpos commune. Then, he told me to expand what he was just shared which was up to me. I was shocked, however, I replied him sincerely that it was unethical to add up the answers on one's behalf and it would lead to bias views.

While conducting household surveys, I and my assistants wore casual clothes which were appropriate for the rural context. I and my assistants sat at the same level as the rice farmers to ensure that they did not feel inferior to us. . For the key informant meetings and interviews, I chose to wear formal clothes. There was no issues of being an outsider during the data collection period.

During my fieldwork, I also encountered some challenges. The supporting letter from my programme director was written in English. When I handed it to one key informant which I believed he understood English, he requested for a Khmer language document. I replied that I did not have one and requested that he wait and I would have the document translated. He was fine to proceed with the interview

because he used to be a student and understood my situation. Some key informants cancelled the meeting a few times which delayed my planning.

3.5 Research Ethics, Health and Safety

This research was undertaken with great consideration for the ethics, health and safety of the researcher, research assistants and participants.

3.5.1 Research Ethics

This research was approved by the Human Ethics Committee (HEC) of Victoria University of Wellington. I requested my programme director to issue a letter to support my data collection process.

I hired two assistants who are studying at the university in Takeo province to help with the survey. Research ethics was explained to them and they were given training on using household questionnaires. A contract for data collection was made between me and them. Confidentiality, morality and honesty were written in the contract. A trial survey was done to ensure that they both understood the questionnaire and to familiarize them with it before they went into the field. Before conducting the household survey, I and my assistants arranged a meeting with the commune chief to inform him about my research and its purpose, as well as to seek his approval. I was given a letter of approval to conduct a survey. Each village chief was informed about the household survey and my research and was shown the approval letter from the commune chief. They were introduced to my assistants as well. Each interviewee (household survey) was asked for their consent, including their right not to answer or to withdraw from the study before proceeding to answer.

A request for a meeting with the managers of the key informants was done to inform them about my research and to seek approval to interview their subordinates. A letter from my programme director was shown to their managers. Telephone calls were made with the key informants to inform them about my research and to request an interview. Before starting the interview, the consent form was read to the informant. Each key informant was asked about his consent in participating in the study. Recordings were not made as the key informants did not feel comfortable with this.

At the end of the interview, their responses were summarized to ensure that each point was recorded accurately.

3.5.2 Health and Safety Issues

Since I was concerned about our safety during the night, I and my assistants did not stay in Doung Khpos commune. I stayed at the hotel in the provincial town and my assistants stayed at their homes. We left the provincial town in the morning by motorbike and made sure that we arrived back in the provincial town before 4 pm. I and my assistants always wore a helmet when riding a motorbike. Wearing a helmet was also written clearly in the contract made between me and my assistants as a mandatory practice. We had raincoats, first aid kits and sanitizers to bring along every day. We brought our own bottle of water and lunch because it was hard to find food to eat in Doung Khpos commune.

The household survey was conducted at individual home. My assistants were well informed about prioritizing safety. I and my assistants made sure that we could be seen from a distance while we were interviewing the households. The key informants chose the place and time which was convenient for them.

3.6 Chapter Summary

How the livelihoods of the rice farmers in Doung Khpos commune can be improved through water management for rice farming is the aim of the research. The Livelihoods Water Asset Framework, the definition of sustainable livelihood and the livelihood assets were used as a guide to develop questionnaires and to analyze data. Mixed methods were used. Quantitative data were gathered through the use of the household question. The villages in Doung Khpos communes were grouped into three according to their shared border and the canal which the rice farmers accessed water. A proportionate stratified sampling technique was applied. The household survey was conducted with 135 rice farmers. Qualitative data were obtained through the interviews with seven key informants. Numerical data was coded and analyzed by using SPSS. Qualitative data was analyzed by using thematic analysis. Findings from the household surveys and key informant interviews were categorized into livelihood assets and were assessed for the livelihood outcomes of the rice farmers.

Careful planning for field work is crucial. Personal, academic and professional relationships are beneficial for approaching people. Seeking approval for undertaking a household survey from the local authorities is a must. Hiring local people to assist with data collection is an advantage as they speak the same language and culture. Health, safety and attention to ethics was adhered to throughout the entire process of data collection. Consents from research participants were sought before the interviews. The relevant stakeholders were informed and explained about the objectives of the research.

CHAPTER FOUR: WATER, RICE FARMING AND LIVELIHOODS

4.1 Introduction

Doung Khpos commune is comprised of twelve villages. The commune has a total of 1, 378 households (District Councils, 2011). Data was gathered by using a household survey with 135 rice farmers and interviewing seven key informants. The survey aimed to explore the socioeconomic status of households, rice farming practices, challenges in relation to water and natural disasters for rice farming and solutions rice farmers employed to tackle those challenges. The objectives of conducting the key informant interviews (KII) were to find out how the canals were managed, the challenges related to water for rice farming, development plans and support the rice farmers received from relevant stakeholders.

The purpose of this chapter is to present the findings from the household survey and key informant interviews (KII). Some analysis was conducted separately for each village group and then the results were compared among the different groups. The relationship between water for rice farming (water availability, pricing and privatization) and livelihoods was also examined.

For this study, all villages of Doung Khpos commune were stratified into three groups according to their close geographical areas and the canal irrigation which the rice farmers access for rice farming (see Table 2). Ten percent of the total households in each group were selected for the household survey. The findings from the household survey and key informant interviews (KII) were divided into six main sections of socioeconomic characteristics, rice production and income from rice sales, water for rice farming, canal management, natural disasters and support for agricultural water or livelihood activities.

Table 2: Village Groups

	Village	*Sampled Number*	*Total households*	*Canal access*
Group 1:	Souphie, Chrey Ngouk and Prey Mlob	38	381	So Hang
Group 2:	Tasai, Rotes Phluk, Ach Tonsay, Trapeang Tonle	44	447	Sounmuay or So Hang
Group 3:	Ta Ros, Doung Khpos, Ta Yeung, Treuy Klouk, Angkanh	53	544	Sounmuay or None

4.2 Findings

4.2.1 Socioeconomic features

a. Household size and Characteristics

There are 1,378 households in Doung Kphos commune. 1,270 persons were recorded by the commune councils to migrate seasonally to other places for work (Bourei Cholsar District Councils, 2014). On average, almost one person from each household migrated. According to the key informants I interviewed, the migration generally took place during the dry season when people did not grow rice. The majority of the migrants went to Thailand to work as laborers.

Table 3: Household size

Household Size	*Number of Adults*	*Number of Children*	*Number of members earning income*
4.53	3.59	0.94	2.40 = 52%

Table 3 above presents the household size and the number of household members earning incomes. Results from the household survey show that the average household size was 4.53 persons of which 3.59 and 0.94 were adult and children below 15 years old respectively. The average household size of 4.53 was close to the national average household size of 4.6 for rural areas (National Institute of Statistics,

2013). The percentage of the household members who could earn income was 52%, meaning that at least two members in the household generated income. Nearly 70% of the interviewees were women because in rural Cambodia, women tend to stay at home to take care children and perform household chores. Thus, they were able to participate in the survey.

b. Educational Level of Household Heads

With respect to the educational level of the household heads, 21% were illiterate which was relatively high in comparison to the national illiteracy rate of 13.6% (National Institute of Statistics, 2013). It was almost twice the national illiteracy level. The percentage of household heads who reached lower secondary class was 21% while 19% could attain higher secondary class. Primary schooling accounted for 39% which was slightly higher than the national level of 37.50% (National Institute of Statistics, 2013).

c. Household Incomes

Besides rice farming, 75% of the households had alternative sources of income through livestock, business, services provision or working. Earnings from off farm activities are critical pathways to poverty alleviation because they augment and provide alternatives to the incomes of the households (OECD, 2007). Income from rice made up around more than two thirds (70%) of the total household incomes. Therefore, rice farming and resources which are necessary for rice farming play a critical role in providing the livelihoods of the rice farmers in Doung Khpos commune.

Table 4: Correlation between the education of the household heads and household income

		Educational level of HH head	Approximate average monthly income of HH
Educational level of HH head	Pearson Correlation	1	.010
	Sig. (2-tailed)		.913
	N	125	125
Approximate average monthly income of HH	Pearson Correlation	.010	1
	Sig. (2-tailed)	.913	
	N	125	125

As can be seen from Table 4, the Pearson Correlation of 0.01 indicates that there is almost no relationship between the household income and the educational level of the household heads. Though the total samples were 135, the sample presented in Table 4 and 5 were 125 as 10 respondents chose not to answer about their income.

Table 5: Correlation between the number of members earning incomes and household income

		Number of members earning income	Approximate average monthly income of HH
Number of members earning income	Pearson Correlation	1	.12
	Sig. (2-tailed)		.18
	N	125	125
Approximate average monthly income of HH	Pearson Correlation	.12	1
	Sig. (2-tailed)	.18	
	N	125	125

Table 5 also signifies that there was a weak relationship between the monthly income of the households and the number of people who could generate income in the household as the Pearson Correlation is only 0.12.

It was normal practice for rice farmers who cultivated wet rice, to always keep some rice for the household supply. Therefore they sold less rice than they farmed, lowering their overall income generated from rice sales. Some households also raised livestock for their household supplies. Hence, the interviewers requested the household to calculate their kept wet rice and livestock into a cash equivalent even if they were only used for household consumption. Revenues from rice sales were seasonal and dynamic. Some households were reluctant to answer when asked about their household income. Additionally, though it was found that nearly one person from each household seasonally migrated to work in other countries, none of the respondents reported the income from remittance sent from overseas. Therefore, the monthly household income and income per capita presented here were an estimation only. Since ten interviewees chose not to answer a question regarding their household incomes, the calculation for the average monthly incomes did not include their responses. To ensure the best estimation of the average monthly incomes per

household and per capita, seven responses were not included as they had much higher income than others (more than US$ 500 a month).

The size of the paddy fields, the rice yields and the number of times rice was cultivated per year all influenced the incomes of those higher earning respondents. However, the value of the respondent with the highest income was recorded in the maximum column of Table 6.

Table 6: Average Monthly Household Income and Income per Capita in US$

	Mean	*Mode*	*Minimum*	*Maximum*	*Standard Deviation*
Household Income:	145.32	125	20.75	1,150	105.18
Income per capita:	37.12	31.25	2.78	285	33.68

According to Table 6, on average, the monthly household income was US$ 145.32 while mode equaled to US$ 125. Respectively, the minimum and maximum income was 20.75 and US$ 1,150. The standard deviation of 105.18 explains that there was a wide discrepancy of income among households.

The calculation of income per capita was devised by dividing the household income and the number of members in those households. The monthly income per capita was between US$ 2.78 and US$ 285. There was a wide discrepancy between the lowest and the highest value. The average monthly income per capita was US$ 37.15. The standard deviation of 33.68 shows that the distribution of the average income per person was highly dispersed.

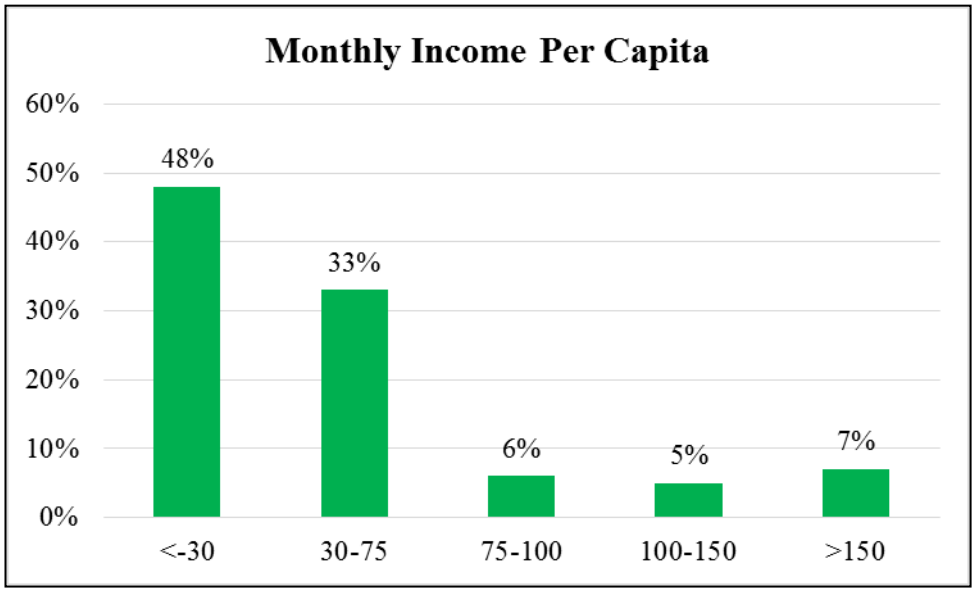

Figure 6: Monthly Income Per Person in US$

The bar chart (Figure 6) indicates that 48% people in Doung Khpos commune were living on less than US$ 1 a day. The people who received an income of US$ 1 or less a day came from various villages. However, Group 1 constituted the lowest proportion (about 8%). About 33% had a daily income of between US$ 1 and US$ 2.50. Less than 10% gained the income between US$ 2.50 and US$ 5 while 7% earned more than US$ 5 a day.

The main household income was from the sales of rice crops. The size of the paddy fields, the yields and the number of harvesting times in a year all influenced total annual rice production. Understandably, this production greatly affected the income of rice farmers. The paddy fields continued to be cultivated if rice farmers were able to plant wet rice once and dry rice twice within a year. However, some farmers cultivated only wet rice and left the paddy fields uncultivated for the rest of the year (approximately six months before the new wet rice season started).

60% of the rice farmers reported that the monthly household income varied while 40% said it was stable. Nearly half of those who had stable income came from Group 3 while Group 1 constituted the lowest proportion (22%) and Group 2 represented 35%. The months which farmers had the highest income were December, January and February. May and June were quoted as the lowest income period. Normally,

farmers harvest the wet rice between December and January. It was the sale of wet rice crops in particular, that increased the household income the most.

4.2.2 Rice Production and Income from Rice Sales

a. Rice Types, Rice Yields and Number of Cultivating times

The average paddy land per household was 1.56 hectares which is just a little lower than the average at the national level of 1.63 hectares (National Institute of Statistics, 2014). The minimum sized paddy land was 0.50 hectares while the maximum was 7 hectares. 65% of the respondents had paddy land between 1 to 2 hectares.

i. Rice Types and Cultivating Times per Year

Table 7: Cross Tabulation between Village Groups and Rice Types

Types of Rice cultivated	***Village Groups***			***Total***
	Group 1	**Group 2**	**Group 3**	
Wet Rice:	1 (3%)	21 (48%)	26 (49%)	48 (36%)
Dry Rice:	11 (29%)	1 (2%)	0	12 (9%)
Both:	26 (68%)	22 (50%)	27 (51%)	75 (56%)
Total:	38	44	53	135

According to table 7 (above), about 56% of farmers cultivated both types of rice while less than 9% grew only dry rice and 36% planted only wet rice. Most of those who only grew dry rice were in Group 1 (those who accessed So Hang canal), whereas those who cultivated only wet rice belonged to group 2 and 3. Nearly 70% of the respondents from Group 1 grew both types of rice while around 50% from Group 2 and 3 cultivated both kinds of rice.

Table 8: Cross Tabulation between Village Groups and Number of Cultivating Times a Year

		Village Group			Total
		Group 1	Group 2	Group 3	
Cultivation time for dry rice:	One	5	8	15	***28***
	Two	14	13	11	***38***
	Three	18	4	1	***23***
Cultivation time for wet rice:	One	27	39	49	***115***
	Two	0	2	4	***6***

The more times rice farmers cultivated rice, the higher the income they received. From the table 8, most people could grew wet rice once and dry rice two times a year. Less than 50% of the interviewees could grow rice all year round and half of them were in Group 1. Group 2 constituted around 30% and Group 3 made up about 20%. Water availability in So Hang or Sounmuay canal was the main factor that allowed the farmers the possibility of growing rice year round.

More than 50% (70 out of 135) of the rice farmers who were surveyed, left their paddy fields uncultivated from 3 to 6 months. The largest proportion (90%) of those who did not grow rice all year round were in Group 2 and 3. According to the key informants that were interviewed, the soils in the area were less suitable for growing alternative crops other than rice. In addition, the absence of rainwater was most quoted as the main reason for not cultivating dry rice and not being able to grow rice all year round. December or January to June (the dry season) was commonly stated as a period which people could not grow rice. So Hang canal might play a vital role enabling rice farmers in Group 1 (as they are located upstream of So Hang canal) to grow rice year round. Though some rice farmers in Group 2 also accessed So Hang canal, they were located downstream. Key informants pointed out that those who were located upstream received advantages with regards to obtaining water from the canal, compared to those who were located downstream.

ii. Rice Yields and Yield Differences among Groups

Table 9: Rice Production per Hectare

Type of Rice	*Mean*	*Mode*	*Minimum*	*Maximum*	*Standard Deviation*
Wet Rice:	2.35	2	0.50	5	0.86
Dry Rice:	4.89	5	2	8	1.26

Table 9 shows that the average wet rice yield and dry rice yield was 2.35 and 4.89 respectively. Wet rice yields were between 0.50 and 5 tons per hectare. The wet rice production of 2 tons per hectare was most quoted. The standard deviation of 0.86 means that the wet rice yields of the respondents were close to the mean of 2.35 tons per hectare.

Dry rice yields ranged between 2 and 8 tons per hectare while the mode was 5. The standard deviation stands at 1.26 which means that most respondents gained the rice yields which were not much different from the average wet rice yield of 4.89.

Table 10: Average of Dry Rice Yields among Three Groups

	N	Mean	Standard Deviation
Group 1:	37	5.37	0.97
Group 2:	23	4.56	1.28
Group 3:	27	4.50	1.40
Total:	87	4.89	1.26

Table 10 and 11 compare the average dry and wet rice yield respectively among the three Groups. According to table 10, Group 1 received the highest average dry rice yields of 5.37 tons per hectare. There is a slight difference of average dry rice yields per hectare between Group 2 (4.56 tons) and Group 3 (4.50 tons). Water is a vital input for agricultural production (Hussain et al., 2004). Group 1 comprised of five

villages which are covered by So Hang canal. Therefore, So Hang canal could be the contributing factor which enables Group1 to gain higher dry rice yields than Group 2 and Group 3. Group 1 has the lowest standard deviation which means that the values of the rice yield among the samples in Group 1 are less dispersed compared to the samples in Group 2 and 3.

Table 11: Wet Rice Yields Averages among the Three Groups

	N	Mean	Std. Deviation
Group 1:	27	2.20	0.90
Group 2:	43	2.51	0.88
Group 3:	53	2.31	0.82
Total:	123	2.35	0.86

With regards to the average wet rice yield per hectare, there are no significant differences among the three groups. However, the values of the standard deviation of the three Groups are slightly different.

b. Rice Crops Prices

The average price per kilogram for wet rice and dry rice was US$ 0.18 and US$ 0.23 respectively. The wet rice crops per kilogram could be sold from US$ 0.17 to US$ 0.30. The prices of the dry rice crops per kilogram were sold between US$ 0.17 and US$ 0.20 Riels. The standard deviation values of both wet rice and dry rice yields was close to zero, meaning that the distribution was very close to the mean values.

c. Income from Rice Sales per Harvesting Season

The duration for growing rice varied, depending on the types (wet or dry rice) and variety of each type (there are many types of wet and dry rice). On average, the duration for growing rice (from land preparation until the harvesting time) was 3 months for dry rice and 6 months for wet rice. The formula for calculating the income from rice sales per harvesting season in US$ currency (roughly US$ 1 is equal to 4,000 Cambodian Riels) is:

Total Income from Rice Sales = (Yield per hectare x size of land x Price per Kg) / 4000

Table 12: Income from Rice Sales per Harvesting Time in US$ (at the rate of US$ 1=4,000 Riels)

Income	*Mean*	*Mode*	*Minimum*	*Maximum*	*Standard Deviation*
Wet Rice Sales:	910	1500	100	7000	682
Dry Rice Sales:	1,485	844	277	14,700	715

Income from farmers' rice sales varied hugely. Two reasons for this variation were the size of the paddy fields that the rice farmers had and the yield they received per hectare. Though some rice farmers grew wet and dry rice on the same size plot, the income was different as the yield of wet rice (2.35 tons/hectare) was lower than that of dry rice (4.89 tons/hectare). The standard deviation of 682 for the total income from wet rice sales informs that there was a wide distribution among the income of the rice farmers. Similarly, the standard deviation of 715 for the total income from dry rice sales was highly dispersed.

To get the best estimation of the averaged calculations, those who got the income from selling rice exceeding US$ 3,000 were not included. However the maximum values were recorded in table 12 above. Respectively, 2 cases and 10 cases were not included in the analysis of the total income from wet rice and dry rice sales per harvesting season.

The income from wet rice sale was between US$ 100 and US$ 7,000 and the average was US$ 954. The income from dry rice sales ranged between US$ 277 and US$ 14,700 while the average was US$ 2,095. The income from selling the dry rice had a wider distribution than wet rice.

d. Supplementary Income and Solutions for the decline in Income

93% of those who did not grow rice all year round has supplementary income sources via livestock, working in others people's paddy fields and migrating to other places to work. During the period which the rice farmers did not grow rice, around

81% stated that their household income decreased while about 20% said that their income remained stable. Less than 20% of those with a decline in income reported that they had enough to cover household expenses whereas more than 80% did not have enough money.

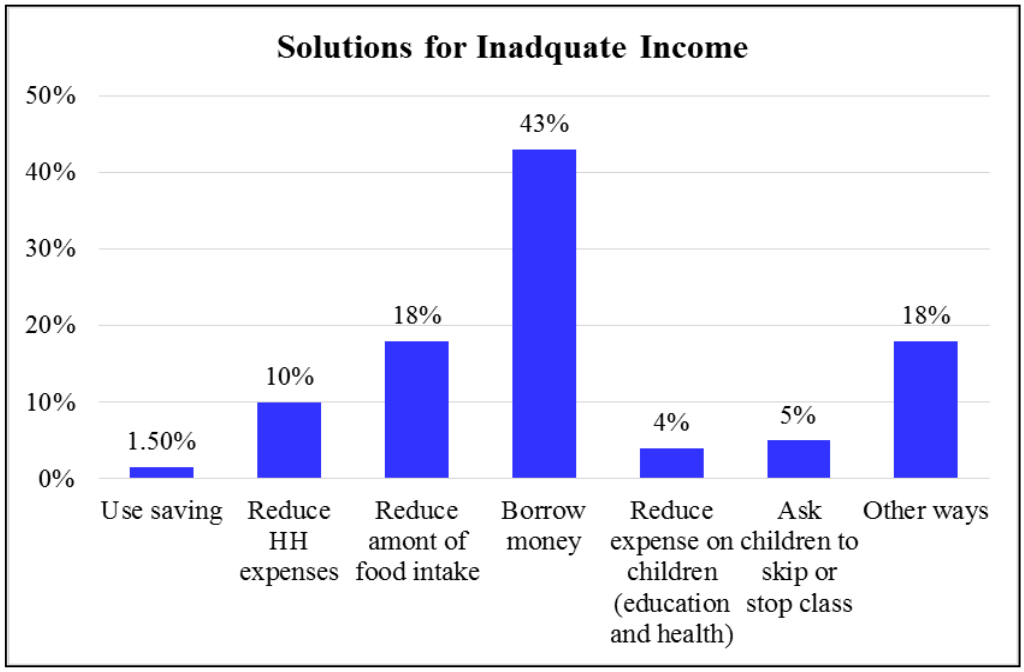

Figure 7: How People Deal with a Decline in Household Income

Figure 7 above illustrates that more than 40% of those who had inadequate income borrowed money from others (mainly through microfinance institutions). Less than 2% used savings. Other ways such as (the sales of livestock and other liquid assets) accounted for almost 20%. About 18% reduced the amount of daily food intake. Reducing household expenses on utilities such as water and electricity was reported by 10%. Five percent mentioned that they asked or forced children to quit or stay home from school so that they could partake in household income generation activities. Another 5% also said that they reduced expenditure s on education and health for their children. The solutions to cope with insufficient income during the period which people did not grow rice of almost 30% directly impacted on the wellbeing of children: decreasing food provision, reducing expenses on education and health and preventing them from going to school. According to Shariff et al. (2015), household income also influenced the dietary intakes of children. Thus, this research argues that there is a relationship between water for rice farming and the nutrition provision and overall development of children.

4.2.3 Water for Rice Farming

a. Water Sources for rice farming

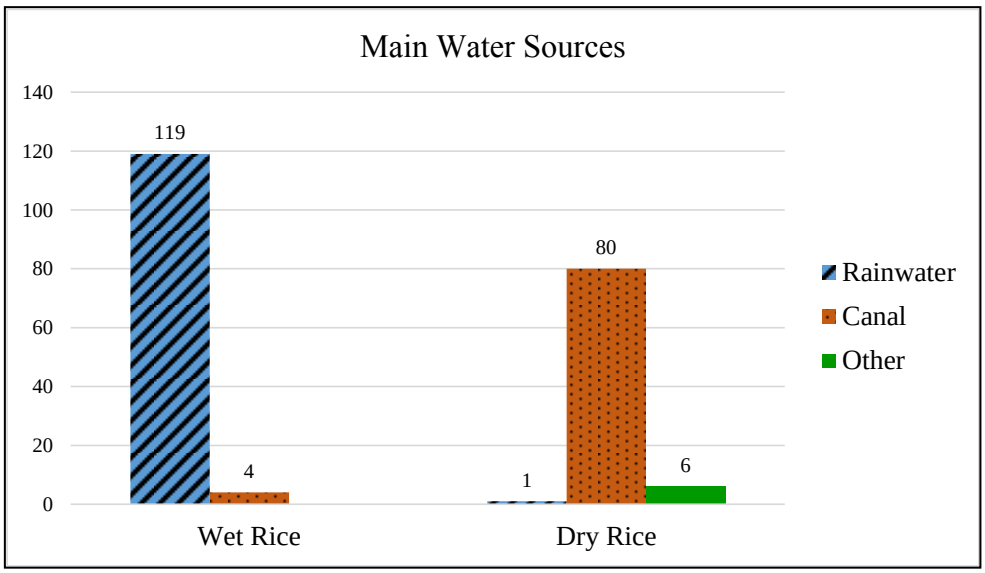

Figure 8: Primary Water Sources for Wet and Dry Rice Cultivation

According to the household survey and the key informants, the main water sources for rice farming were rainwater and canal irrigation (Sounmuay and So Hang). Although, a small number of households had small private ponds but were often dried up during the dry season. Underground water could not be used for human consumption or agriculture because it was salinized. According to figure 8, 119 interviewees responded that rainwater was the main water sources for growing wet rice. Canals were reported as the primary water source for growing wet rice by 4 persons. 80 respondents mentioned that canals were the main water source for growing dry rice while 6 said that private ponds or streams were their primary water source. Rice cannot live without water. Therefore, rainwater and Sounmuay and So Hang canals are very important for the livelihoods of the rice farmers in Doung Khpos commune.

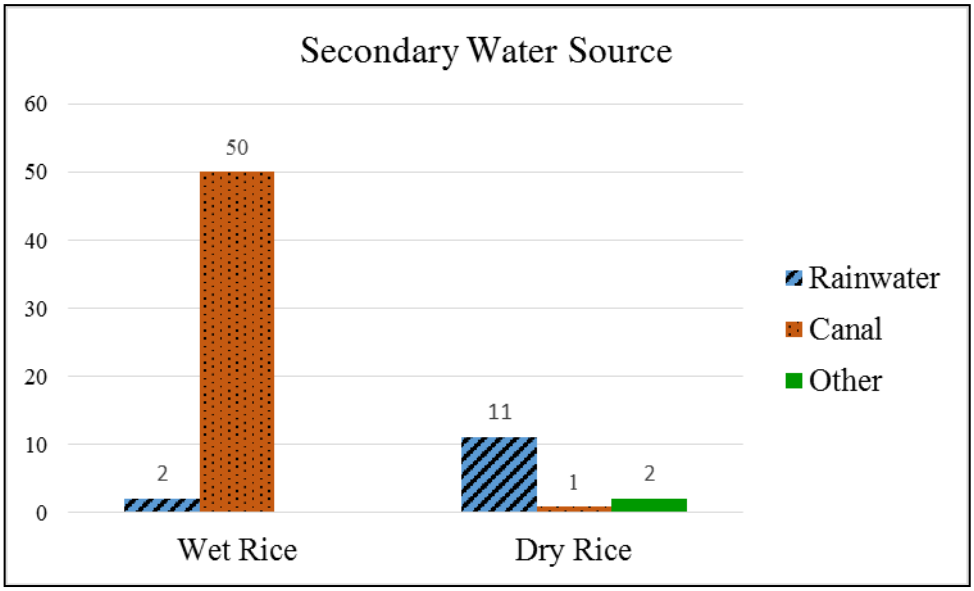

Figure 9: Secondary Water Sources for Dry and Wet Rice

The secondary water sources for wet rice farming were canal (mentioned by 50 respondents) and rainwater (reported by 2 interviewees). 11 rice farmers reported that they used rainwater as the secondary water sources for growing dry rice, while one said they accessed canals and two said they accessed private ponds. Paying fees to access water in the canals during the rainy season showed that depending on rainwater for rice farming alone was not enough. The high numbers of rice farmers that relied on the canals primarily or secondarily for growing rice suggest how important and indispensable canals are. The minimum and maximum distance from the paddy fields were 1 and 7,000 meters and the average was 458 meters. Up to 38% of the interviewees responded that their rice fields were 500 meters from their water sources.

b. Water Challenges for Rice Farming

Seventy six percent of the respondents reported that they faced water challenges concerning rice farming. It is noteworthy that those who experienced water challenges were from all groups. According to figure 10, the lack of water in the irrigation during the dry season was quoted by 59 interviewees as the main water challenge. This was similar to the responses from the key informant interviews that some parts of the canals were dried up during the dry season.

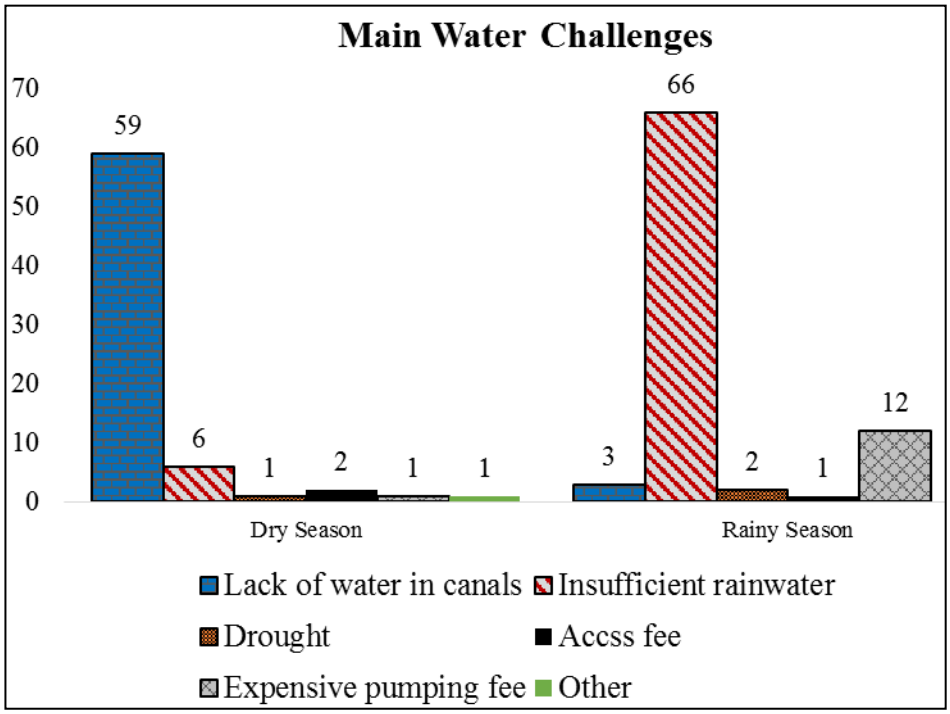

Figure 10: Main water challenges for Rice farming in both Seasons

Farmers' complaints implied that even those who could access So Hang canal, still faced water insufficiency. One key informant said that So Hang canal directly linked to the river so the canal's water relied on the water river level which usually rose during the afternoon. However, the water distribution was uneven. So Hang canal has many sub canals. The water in the sub canals was pumped from the main canal. Therefore those who were located upstream could pump more water than those who were downstream. Inadequate rainwater was said to be the main water challenge during the rainy season by 67 (about 50%) respondents. It seems that paying a fee to access water was not a challenge for the majority of farmers as only 2 interviewees mentioned this issue.

c. Fees for Water Access and Pumping

71% (96 out of 135) of the interviewees chose to pay the fee to access water for rice farming. Nearly 100% from Group 1 paid to access water and about 60% of those from Group 2 and 3 did. Since the majority of the interviewees paid to access water from So Hang canal and they are located upstream, they are able to grow rice three times a year. Furthermore, their dry rice yields were also higher then Group 2 and 3's rice yields.

Around 48% thought that they had to pay an access fee because the canals were privatized while 21% said that they paid a fee because of canal construction or renovation. 31% mentioned that businessmen had to buy fuel to pump water from the river into the canals or sub canals and so they could not access the water if farmers they did not pay.

Around one third of farmers chose to rely on rainwater (or private ponds or streams) wholly rather than pay the fee to access get water. Other reasons for choosing not to pay for water access were: the long distance from the canal to the paddy fields (26%), unavailability of water in the canals (24%), the expensive access fee (20%) and the marginal difference between the income from rice sales and access fee (13%). Other reasons for not paying to access water were made up about 17% and included, the pumping fee, adequate rainwater and the canals belonging to other villages)

According to the surveys and the key informant interviews, there were two types of expenses concerning water and rice farming: canal access fees which had to be paid to private businessmen or the chief of the Water User Groups (WUGs), and the pumping expenses fees (buying fuel or renting a pumping machine) to get water from the canal to farmers' paddy fields. Irrigation access fees were to be paid in half at the beginning of the cultivation period and the remaining half was to be paid during the harvesting season. The access fee was calculated according to the number of hectares in each paddy fields.

i. Water Access Fee

Table 13: Water Access Fee per Hectare in US$ Currency (at a rate of US$ 1 = 4,000 Riels)

	Mean	*Mode*	*Minimum*	*Maximum*	*Standard Deviation*
Access Fee:	68	75	45	100	13

The water access fees ranged between US$ 45 and US$ 100. The average access fee per hectare was US$ 68 which is almost equal to the value of 300 kilograms of wet rice (US$ 0.23/kilogram). 300 kilograms of wet rice was equivalent to almost 13% of the average wet rice yield of 2.35 tons per hectare. Approximately, 5% had to pay up

to US$ 100 (427 Kilogram of wet rice) which was around 18% of the average wet rice yield. The standard deviation of 13 shows that the distribution of the access fee were a bit dispersed from the mean.

ii. Pumping Fee per Harvesting Season

In relation to pumping machine 77% reported that they own it while 22% did not .Most of the rice farmers who did not have a pumping machine grew only wet rice. Two thirds of those without the pumping machine rented or borrowed one while the other third relied on rainwater. On average, the pumping hours were 10 while the number of pumping times per harvesting season was 8.

The calculations for the total expenses on pumping and renting a pumping machine for those who paid the access fees and those who did not were calculated separately. There were wide differences between the pumping and renting fee between those who accessed water from the canals and those who did not.

Table 14: Expenses on Pumping and Renting Fee per Harvesting Season in US$ Currency (at a rate of US$ 1 = 4,000 Riels)

	Access Canal?	*Mean*	*Mode*	*Minimum*	*Maximum*	*Standard Deviation*
Pumping and Renting Fee:	Yes	141	100	10	600	129
Pumping and Renting Fee:	No	24.5	7.5	2.50	100	24.5

As can be seen from Table 14, the average expenses of pumping water from the canals (for those who paid the access fee) to the paddy fields was US$ 141, whereas the lowest and highest expenses were US$ 10 and US$ 600. There was much variation among the expenses of pumping water as the standard deviation was 129. On average, the rice farmers who fetched water from the private ponds or streams (those who did not access the canals) spent around US$ 24.5 for pumping water into the paddy fields. Respectively, the minimum and maximum expenses were US$ 2.50 and US$ 100. There was less dispersions among the expenses of the rice farmers who pumped water from the canals and from privately owned ponds or streams.

The total water expenses per harvesting season was the result of adding the total access fees and the pumping fees. The total access fee was worked out by multiplying the access fee per hectare and the hectare of land. Total water expenses presented in table 15 were only for the rice farmers who paid access fees.

Table 15: Total Water Expenses on Both Rice in US$ (US$ = 4,000 Riels)

Total Water Expenses	*Mean*	*Mode*	*Minimum*	*Maximum*	*Standard Deviation*
For Wet Rice:	236	105	51	791	148
For Dry Rice:	303	150	51	1,227	192

Per harvesting season on average, rice farmers had to pay around US$ 236 for water to grow wet rice and US$ 303 for planting dry rice. If it takes three months to grow dry rice, it means that the rice farmers in Doung Khpos commune have to pay about US$3.30 a day for water expenses. The rice farmers had to pay around US$ 1.30 on daily water expense for growing wet rice, assuming that it takes six months to grow wet rice. As there is rainwater during the rainy season, the daily water expense to grow wet rice is lower than in the dry season. The results found from this study was not much different from the assessment report of Bourei Cholsar district in 2011 done by World Vision Cambodia, conveying that on average, rice farmers paid about US$ 250 for water expense to grow rice (Ly, 2011).

Table 16: Water Expense and Income from Rice Sales

	Average total water expense	*Average total income sales*	*Percentage*
Wet Rice	236	910	26%
Dry Rice	303	1485	20.40%

Table 16 presents and compares the total water expense and income from rice crop sales per harvesting season on average. In comparison to the total income from rice sales per harvesting season, about 26% went towards paying for water to grow wet rice and 20.40% for dry rice. Almost 30% of rice farmers paid 50 percent or more of

their income from selling wet rice. There were also a small number of people who paid more than their income from rice sales on water.

4.2.4 Canal Irrigation Management and challenges

a. Sounmuay Canal

Sounmuay canal covers three villages within the Bourei Cholsar district (two of which are located on the head and the middle of the canal) and Doung Khpos commune is located on the tail of Sounmuay canal. Sounmuay canal consists of two lines, each of which is about seven kilometers long and their widths range between 1 to 2.5 meters (Ly, 2011). They are located on the left and on the right of the main road of Bourei Cholsar district. The key informants I interviewed mentioned that Sounmuay canal is a hand dug irrigation which was left over from the Khmer Rouge Regime. There is also a pumping station to pump water from the vessel of the river into the Sounmuay canal.

According to the key informants for this research, Sounmuay Canal has been solely managed by the private sector. The informants pointed out that there were no Farmer Water User Committee (FWUC) and Farmer Water User Groups (FWUGs) for Sounmuay canal. Usually, the village chiefs were responsible for registering the households who wanted to access water from Sounmuay canal for rice growing. However, in this case, water payments were paid to the private sector. Half of the access fee payments had to be paid before the rice growing started. The remaining half was collected during the harvesting season. Research informants also stated that the full access fee amount had to be paid even if there was a lack of water in the canal or rice yields were low. However, it is hard for the rice farmers to pay half of their access fees prior to the rice growing season as they have to purchase fertilizers or other chemical substances as well.

Those who paid for water access fees were given an access card. The private sector hired a team to measure the width and length of the paddy fields of the rice farmers. Those who did not have access rights could not pump the water from the canal.

> *"If we did not pay for the access fee and we pumped water from the canal, the team of the businessman would take our pumping machine and we needed to*

pay a fine of a minimum of US$ 50 to get the pumping machine back", said one rice farmers in Ta Ros Village, 15 June 2915, Doung Khpos commune.

During the survey collection, I tried to ask many interviewees if I could see their water access cards. However, none of them kept it. This shows that documenting these materials is not necessary for them. Before the construction of So Hang canal, the fee to access Sounmuay canal was 400kg in rice per hectare. Now it has decreased to 375Kg. According to key informants, the privatization of Sounmuay canal was done without the participation from the local communities or local authorities and whether, a written contract for the Sounmuay canal privatization was completed or not, was unknown to the local authorities.

According to interviews with key informants there were challenges in relation to the management of Sounmuay canal. During the dry season, the water in the river is low which makes it hard to pump water from the river into Sounmuay canal. Hence, some parts of Sounmuay canal have dried up. Many households and major business stores are located along the main road. They built bridges (made from wood or brick) across Sounmuay canal to access their houses. Hence it is difficult for water to flow downstream, particularly in the dry season when water level is low. Key informants also added that a small amount of household rubbish has been discarded into the canal which has caused the canal to get even shallower and also blocks the canal's flow. This was also observed by the researcher and was also highlighted in an assessment report of Bourei Cholsar district of World Vision Cambodia (WVC)(Ly, 2011). Key informants also disclosed that in 2005, the main road of Bourei Cholsar district was renovated. This road renovation disrupted the pumping process of the Sounmuay canal. In fact, the construction workers needed the canal to be dry so they could collect soils from the canal for the road rehabilitation. One key informant said that:

"*This year will be worse for rice farmers because there was scarce water in Sounmuay canal due to the road construction and rice plants in some paddy fields are already dried out"*, 21 May, 2015, Doung Khpos commune.

One key informant and three survey respondents stated that although there was enough water in Sounmuay canal, it was not really useful as it did not come at the right time when rice was critically in need of water.

b. So Hang Canal

So Hang canal covers two districts of Takeo province. So Hang canal covers two communes (Kouk Po and Doung Khpos) of Bourei Cholsar district. The main canal of So Hang canal has a total length of 8.7 kilometers (CAVAC, 2014). So Hang canal consists of 12 sub canals. The main canal of So Hang was built by CAVAC (Cambodia Agricultural Value Chain Program) with the financial support from Australian Aid in 2011, according to the interview with the key informants.

The main canal has a direct link to the river (the river is about seven kilometers from Doung Khpos commune). There was an establishment of Farmer Water User Committee (FWUC) which was registered with the Provincial Department of Water Resources and Meteorology (PDWRM). So Hang canal has many sub canals to provide water for rice farming. The sub canals were renovated or constructed by the businessmen which were contracted to run the sub canals. Research informants stated that before the construction of the main canal and the sub canals, there was an environmental impact assessment undertaken by the staff of CAVAC. The communities participated in the selection of the Farmer Water User Committee and the businessmen (to manage the sub canals). Twelve Farmer Water User Groups (FWUGs) were created.

The businessmen pump water from the main canal into their sub canals. The rice farmers pump water from the sub canals into their rice fields. The rice farmers can pump water from the main canal without paying fees, according to one key informant interview. However, as the main canal is deep, pumping water by using small pumping machines is not possible. Moreover, most paddy fields are located far from the main canal. Hence there is no choice except to access water from the sub canals run by the businessmen. The access fee to So Hang canal was 350Kg in rice per hectare which is a bit lower than the Sounmuay canal. The businessmen (only So Hang canal) have to give 50 kg of rice (in cash) to Farmer Water User Committee (FWUC) for the operation and maintenance of the main canal.

Key informants mentioned that one of the main challenges of So Hang canal was that it could not cover all the villages in Doung Khpos commune. Since the main canal depends on the level and flow of water in the river, the water distribution from the

main canal into the sub canals was a challenge. Some sub canals were dried up during the dry season. Furthermore, the businessmen who manage the sub canals upstream can pump water better than those who are responsible for the sub canals downstream.

4.2.5 Natural Disasters

The large majority of rice farmers (96%) that were interviewed experienced natural disasters. Drought was quoted by more than 77% while flood was stated by 22% and strong winds were reported by 1 interviewee. According to the key informants, drought was the most common natural disaster in Bourei Cholsar district. In fact, they occurred almost every year and impacted on rice production severely. Flood or strong winds occurred occasionally. According to the household survey, almost 20% of those who faced natural disasters said that rice crops were destroyed completely. 68% stated that the rice crops were partly destroyed and another 12% expressed that the rice crops did not yield or they could not grow rice.

a. Frequency of Natural Disasters

As can be seen from figure 11 below, the highest frequency of drought and flood occur every two to three years (drought was reported by 68 (50%) respondents while flood was quoted by 17 (13%) interviewees). 29 (21%) said that drought happens every four years or more, while 11 respondents mentioned that droughts occurred every year. A small number of interviewees mentioned that drought and flood occur two to three times a year. 4 respondents stated that floods struck Doung Khpos commune every year whereas 11 people reported that floods happen one in every four years or more.

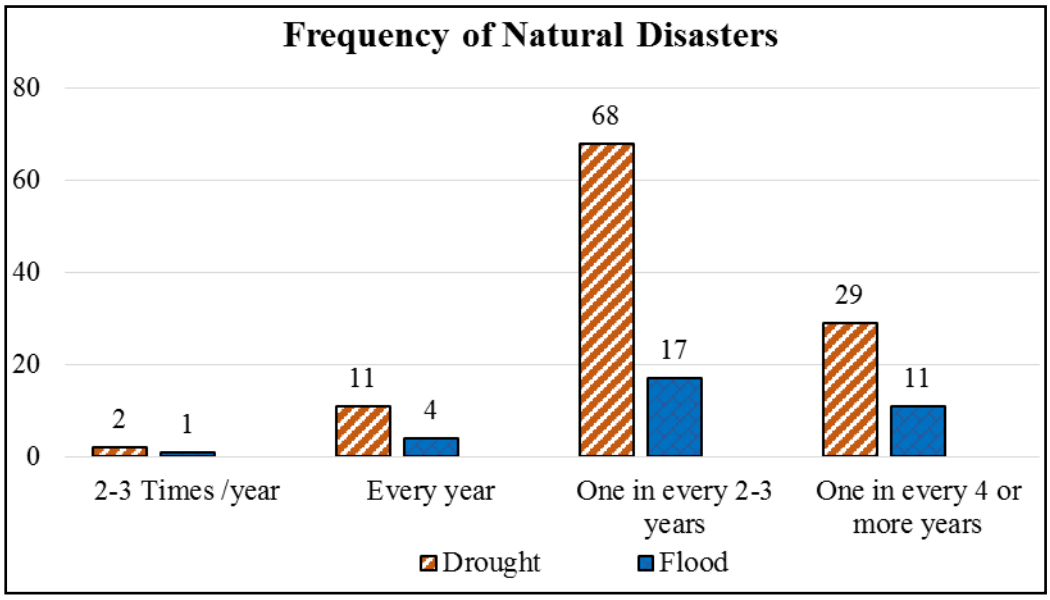

Figure 11: Flood and Drought Frequency

When questioned about the solutions to cope with natural disasters, the majority of rice farmers (around 80%) did not know what to do. In a drought, less than 5% reserved water for growing rice and less than 3% grew rice crops which needed less water. 12% opted to wait until rain came or the flooding had dissipated and some did not cultivate any rice at all.

The structure of Commune Committee for Disaster Management (CCDM) in Doung Khpos commune was established in 2011(Ly, 2011). According to key informants, the works of the Commune Committee for Disaster Management focused mainly on flood and sanitation during the flooding periods. The works did not focus on either natural disaster preparedness or climate change issues related to agriculture.

c. Recovery Period

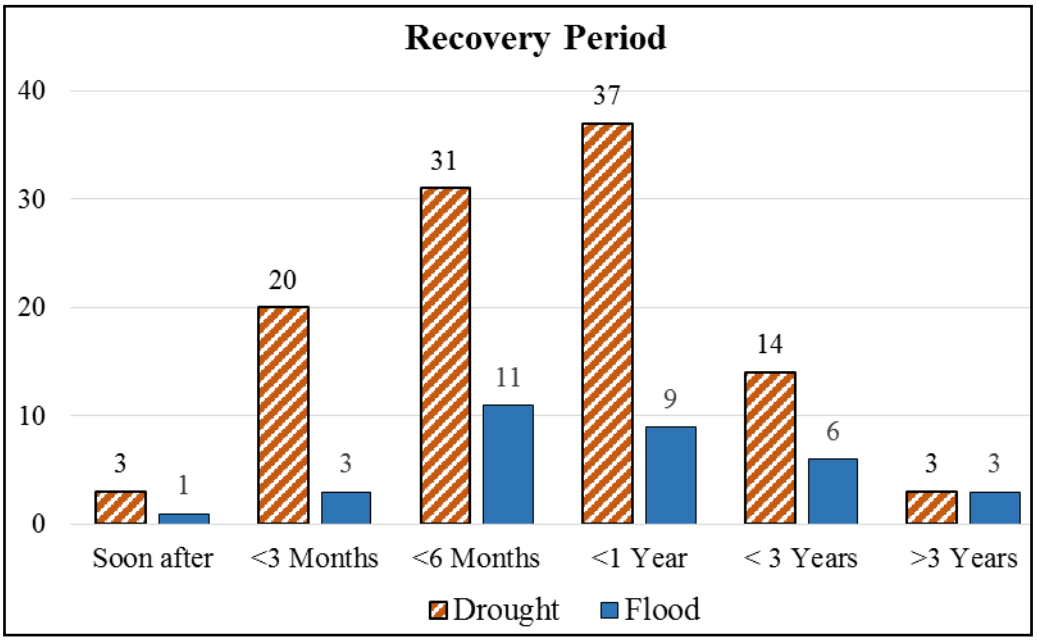

Figure 12: Timeframe to Recover from Natural Disasters

As shown in Figure 12 above, the number of affected people who can recover from flood or drought quickly is small, whereas up to 20 respondents said that their recovery periods last between one and three years. The common period for most victims to recover from flood and drought is between three months and less than one year. 6 respondents, which is about 5%, stated that it took them more than three years to recover from the effects of flood and drought.

4.2.6 Support for Agricultural Water or Livelihood Activities

All interviewees said that they did not receive any support in relation to water for rice farming from any sources. So Hang canal was just built in 2012. One key informant mentioned about the process before the construction of the So Hang canal. There were many village meetings and consultations to establish the Farmer Water User Groups (FWUGs), to select the Farmer Water User Committees (FWUCs), to discuss the price for access fees and to select the contractors (water businessmen were to be responsible to pump water from the main canal into the sub canals). There were possibilities that during the village meetings, the villagers were not well informed or the people themselves did not consider support which involved payment as support. One key informant mentioned that water for rice growing was not a

problem for the rice farmers since there were canals which were run by the private sectors.

Though World Vision Cambodia (WVC) is working in Doung Khpos commune, one staff member admitted that their development programs did not align with the local development plan. World Vision Cambodia (WVC) focuses on water for human consumption and sanitation. The current projects are not related to livelihood activities.

4.3 Chapter Summary

The household characteristics (household size, and educational level) found in the study is close to the national level. Educational level of the household heads and the number of members who are able to generate income has little relationship with the household income. Other findings such as paddy land size, rice yields, water challenges and natural disasters were also not significantly different from other studies.

More than two thirds of the households in Doung Khpos commune have alternative sources of income which are good for their livelihoods. The household income depended heavily on the size of the paddy field, the rice yields and the number of times that the rice farmers could grow rice. The number of harvesting times rely on the availability of water.

This study shows that there is a strong link between water and the income of rice farmers. The results from this research show that the rice farmers in Doung Khpos commune experienced many challenges with water shortages and expenses relating to rice farming. The main water sources for growing rice were rainwater and canals. However both water sources did not provide enough water for rice growing. Rainwater is the main water source for growing wet rice and it can be supplemented by water from the canals. However, during the dry season, rainwater is not available and some parts of the canals were dried up. Therefore growing dry rice meet with even more water challenges. As rice plays a critical role for rice production, the insufficient water supply for rice growing results in less yields, which in turn, means that farmers' household incomes are also negatively affected. The analysis of the

water expenses for rice farming shows that on average, the rice farmers had to spend more than 20 percent of their income from rice sales for water (access and pumping fees). In spite of paying the fees to get water, there was no assurance that rice farmers received the water that they needed for their rice farming activities in terms of quantity or timing. The current canals (Sounmuay and So Hang) do not cover all the villages and couldn't provide enough water for rice farming during the dry season. Access fees to both canals were not much different. Sounmuay canal has been managed by the private sector while So Hang canal has been contracted and managed by the private sector with the participation of the Farmer Water User Committee (FWUC).

In addition to the issues of water shortage and high prices for rice farming, natural disasters (flood and drought) also derailed farmer's rice production. Moreover, they occurred frequently and the majority of interviewed rice farmers needed at least six months to recover from these natural disasters. There was also no support or training in relation to flood and drought management for agriculture from either relevant institutions or Non-Governmental Organizations (NGOs).

The livelihoods of the rice farmers in Doung Khpos commune depended heavily on rice farming which is impacted severely by the absence or lack of water supply and issues related to climate change. The inadequacy of water infrastructure with its limited functioning, the lack of rainwater, water expenses and frequent natural disasters with limited coping mechanism all coalesce to make the livelihoods of the rice farmers in Doung Khpos commune very vulnerable.

CHAPTER FIVE: DISCUSSION

5.1 Introduction

Rice farming is the primary source of income generation for the large majority of households in Doung Khpos commune. Approximately, 70% of household income was generated through rice sales. Support for rice farming is crucial for improving the livelihoods of the households. The lack of water infrastructure, the unreliable nature of rainwater, the limited operation and maintenance of the existing canals, the high costs to get water from the canals (access fees and pumping fees) and the natural disasters contribute to hindering rice growing and reducing rice yields. Therefore improving water management will potentially enhance the livelihoods of the rice farmers in Doung Khpos commune.

In this section, findings from fieldwork and points made in the literature review are woven together. Rice production and water management for rice farming, natural disasters (flood and drought), privatization of canals, water related laws and policies for agriculture and the local development plans are discussed. Based on the Sustainable Livelihood Framework (SLF) related to water, the researcher will assess the livelihood outcomes of the rice farmers in Doung Khpos commune. From the discussion, recommendations for how to improve water management are highlighted and are presented in the following chapter.

5.2 Discussion

5.2.1 Rice Farming and Water Management for Rice Farming

a. Rice Production

The five year District Development Plan of Bourei Cholsar district was targeted to achieve 5 tons of yield for both dry and wet rice by 2015 (District Councils, 2011). This study found that the average dry rice yield in Doung Khpos commune was 4.89 tons per hectare which was close to the target of the district. With respect to the wet rice yield, it seems that a 5 tons per hectare cannot be achieved because it is more than two times the average wet rice yields of 2.35 tons found in this study. Another

study done by the Asian Development Bank (2014) found that the average wet rice yield in Takeo was 2.3 tons per hectare. Hence, targeting the wet rice yield of 5 tons per hectare by 2015 is ambitious for the district to attain.

At the country level, the average dry rice yields per hectare was 4.2 tons and the average rice yield was 2.6 tons (IWM & Sida, 2012). The study found that on average, rice farmers in Doung Khpos commune could gain dry rice yields of 4.89 tons per hectare which is more than half a ton higher. However, the average wet rice yields in Doung Khpos commune of 2.35 is lower than the national level. Nevertheless , in comparison with other countries in the greater Mekong sub region (Myanmar, Thailand and Vietnam), Cambodia received the lowest wet rice yields (Vietnam and Thailand can receive about 4 tons per hectare while Myanmar harvests about 3.4 tons) (IWM & Sida, 2012). Cambodia's high dependency on rainwater might be the reason of lower wet rice yields than other countries in greater Mekong sub region.

b. Water for Rice Farming

One third of the paddy fields were at least 500 meters from water sources and the average distance was 458 meters. The long distance suggested a lack of water in the distribution channels. The grievances of the rice farmers concerning the lack of water in the canals (Sounmuay and So Hang) during the dry and rainy season indicated that there was limited functioning within the operation and maintenance of both canals. Rice farmers in Doung Khpos commune did not just encounter the issues of limited water infrastructure (canals) but also limitation within existing canals. Paying access fees did not mean that the rice farmers overcame the challenges of water insufficiency for rice growing. As the water businessmen were getting paid via farmers' access fees, there ought to be an assurance that there is an availability and distribution of water in the canal for all users. The rice farmers in Doung Khpos commune and the rest of the country did not face physical water scarcity but economic water scarcity. Cambodia is endowed with abundant water resources and the yearly water volume per capita can be as high as 8,750 cubic meters. However, the country does not manage water resources effectively. For example there is inadequate water infrastructure, water governance, technologies and human resources.

According to FAO (2003), a person needs about 1,000 cubic meter per year for food production (FAO, 2003c). The available water per capita per year in Cambodia can be as high as 8,750 cubic meters. Despite of the topology of the country's geography, including the unevenly distributed water sources, experiencing water shortages during the dry season could be as a result of the country's ineffective water management (lack of water infrastructure such as tanks and reservoir, participation from relevant stakeholders and the implementation of water policies and plans). Thus, Cambodia faces economic water scarcity rather than physical water scarcity.

The absence of rainwater prevented over 50% of the rice farmers from growing rice all year round. Nonetheless, the large majority of the households reported to have other sources of income, as only a small number earned enough money to cover the daily household expenses. Insufficient income is one indicator of living in a lower socioeconomic status (Darmon & Drewnowski, 2008). Low socioeconomic status households potentially leads to the poor health and nutrition of children (Shariff et al., 2015). Rice farmers who did not earn enough to cover their expenses used different strategies to cope with their financial problems. Some solutions (asking or forcing children to skip classes and reducing the amount of food intake) had negative impacts on the development of children. The unavailability of water for rice farming not only prevents the development of children but also violates their rights to access education.

The findings from this study showed the strong relationship between water and rice farming. Additionally, the study also identified two impact levels one of which is direct and the one that remaining is indirect as pointed out by Lipton et al., (2003). The first impact (direct) is the rice yield and income. The lack of water for rice farming reduced the total annual rice production which negatively affects household incomes. The second impact found in this study was the impact on the development of children (the reduction of food intake and prohibiting children going to school temporarily or permanently) and the socioeconomic effects (for instance, borrowing money to cover household expenses during the period that rice farmers cannot grow rice). Ersado (2005) and Hussain (2004) emphasized that the households who are closer to irrigation gain more benefits than those who are live further away. This research also found that Group 1 (villages which are located at the head of So Hang

canal) could produce higher dry rice yields than Group 2 and Group 3. Although all groups mentioned the lack of water in So Hang canal, Group 1 had the advantage of getting water into their paddy fields first as they lived at the head of the canal.

Even though the five year District Development Plan was targeted at increasing the amount of irrigated land from 64 to 85% by 2015, this responsibility is likely to be taken up by the private sector (constructing or rehabilitating sub canals and pricing the access fees).

The study of Wokker et al. (2011) emphasized that some rice farmers decided not to pay access fees to get water for rice farming due to high water expenses (access and pumping) as it prevented them from making a profit. Similarly, Wokker et al. (2011) argued, as this research did, that one third of those who choose not to pay the access fee talked about the high price of the access fees and marginal profits they made after paying.

5.2.2 Natural Disasters, Rice Farming and Coping Mechanisms

Cambodia has a total number of 1,406 communes (Royal Government of Cambodia, 2014). It is regarded as one of the most natural disaster prone countries in South East Asia (National Committee for Disaster Management, 2003). About 500 communes (260 are prone to flood and 293 are susceptible to drought) were identified as the natural disasters prone areas (MAFF, 2013). Takeo province was mapped as the areas which is affected by both flood and drought (MAFF, 2013). The household survey from this research showed that nearly a 100% of rice farmers in Doung Khpos commune experienced flood and drought. Rice production and food security of rural communities are determined by the annual rainfall (National Committee for Disaster Management, 2003). Almost 100% of rice farmers depend on rainwater as either their main or secondary water source for rice farming. According to Redfern, Azzu and Binamira (2012), the most critical factor in limiting rice production is drought which is now increasingly becoming a severe problem. Therefore, the livelihoods of the rice farmers in Doung Khpos commune are potentially going to get worse in the future.

Drought occurred frequently in Doung Khpos commune and damaged rice crops. The large proportion of rice farmers did not know what to do. The lack of planned

water management reflected the limited capacities to cope with drought. Moreover, it took more than 6 months for most farmers to recover from the impacts of drought. With the high frequency of being exposed to the natural disasters and limited coping mechanisms, vulnerability within the rice farming commune in Doung Khpos is high. As a community that suffers from frequent drought, rice farmers are exposed to many of its consequences such as low crop productivity or less rice yields which negatively affects income. Moreover, with the high price for water (26% of the total income from the sales of wet rice and 20.40% of dry rice), rice farmers are at a great risk of losing profit. Seasonal floods also impacted on some parts of the commune. In sum, flood and drought have severe impacts on the rice dependent livelihoods of rice farmers in Doung Khpos commune.

5.2.3 Water Related Policies for Agriculture

Pérez-Foguet and Giné Garriga (2011) pointed out that in developing countries, poverty reduction strategies are undermined by the inadequacy of water related services provision. Cambodia also fails into this category since the country's economy is largely dependent on agriculture. Rice farming depends on rainwater heavily. Furthermore, the lack of irrigation, its limited functions and water shortages during the dry season are some of the main challenges faced by farmers. The royal government of Cambodia (RCG) has prioritized the enhancement of agriculture and the improvement of irrigation for poverty reduction. Therefore, to attain the goal of poverty reduction, Cambodia should ensure that farmers are supplied sufficiently with water services.

According to article 3 in the law of water resources management of the kingdom of Cambodia, water resources are the property of the country (Kingdom of Cambodia, 2007). Article 7 in this law also states that the collaboration and participation among private sectors, related institutions, beneficiary groups and Non-Governmental Organizations are related to the investment, exploitation, management, conservation and development of the water resources (Kingdom of Cambodia, 2007) and shall be encouraged. However, the privatization of Sounmuay canal was not done in consultation with the local communities and authorities. Business owners charged

access fees from the community for more than 15 years even when the supply of water was unreliable.

There are a lot of policies and strategic plans (water for agriculture, climate change strategic plan for water resources and meteorology, rice sector strategies) developed to support rice growing. "The selection of lower water crop varieties and planning offer a lower water crop system for climate change adaption" is one water resource strategy to address climate change issues (MoWRM, 2012b). According to the findings from the research household surveys, there were few farmers who had adopted rice crops which demanded less water. Owing to the interview with one key informant, the trainings provided to the rice farmers were about pest control and diseases for rice farming. The lack of support from the relevant government institutions reflects the limited implementation of the policies. Rice dependency is a primary livelihoods of the large majority of the people in Doung Khpos commune, however, there are many water challenges for rice farming.

The five year District Development Plan of Bourei Cholsar district addresses the issues of the natural disasters (flood and drought). However, it does not link specifically between natural disasters (flood and drought) with rice farming or agriculture.

5.2.4 The Privatization of the Canals

The privatization of the Sounmuay canal was done before the creation of the law on water resources management and meteorology. The law was created in 2003 while the privatization was has been implemented since 1990s. There was no Farmer Water User Committee (FWUC) for Sounmuay canal. The rice farmers or the local authorities do not have voices for the operation and maintenance of the Sounmuay canal. Theng and Koy (2011) pointed out that the critical factors which determine a success of irrigation management is the participation of the Farmer Water User Committee (FWUC) and communities in fee payment, operation and maintenance of the irrigation and water distribution. However, none of these factors exists for Sounmuay canal. It seems that Sounmuay canal is now the property of business owners rather than the property of the state (the law defines that all water resources belong to the state).

The same business owners have managed Sounmuay canal since the 1990s. Results from the household surveys revealed that rice farmers did not have adequate water to cultivate rice year round while they paid up to US$ 63 per harvesting season on average for water access. Meanwhile, there was no water related interventions from the local authorities or the government. Without supportive water governance from the national level, irrigation privatization is unlikely to flourish and could also potentially accrue too many advantages over weaker communities (Svendsen et al., 2003). This certainly seems to be the case regarding Sounmuay canal and the rice farmers who access it.

There was the creation of a Farmer Water User Committee for So Hang canal and the committee were registered formally with the Provincial Department of Water Resources and Meteorology (PDWRM). The Farmer Water User Committee for So Hang canal is functioning. Recruiting the Farmer Water User Committee the construction of the canal and the selection of the business owners (to manage the sub canals of So Hang canal) included the participation from the local communities. The challenge of the So Hang canal was that it could not provide enough water at the right time to all the rice farmers in its covered area. Research undertaken by Bandeth (2010) identified seven factors (five of which are internal and the remaining two are external) in determining the success of the Farmer Water User Committee The internal factors were the level of participation from local communities, the management and governance of the irrigation, the benefits that the irrigation provide, the quality of the irrigation systems and the characteristics of the farmer members within the irrigation scheme. The external factors include the level of external support and the market access. Based on the internal factors that the Farmer Water User Committee of So Hang canal has, it is highly likely that the committee is success.

The access fee was priced according to the size of land, not the number or the duration of the pumping times. Pricing the water without considering the amount of water extracted is ineffective and will also result in water scarcity in the future. Some rice farmers (especially those who are upstream) may pump more water than they actually need, leaving those downstream facing water inadequacy. This situation may

also create water conflicts among the rice farmers over the extraction of water. Excessive pumping may also lead to exhaustion and scarcity in the future.

5.2.5 Assessing livelihood outcomes

As the underground water in Doung Khpos commune cannot be utilized for agriculture, the only available water sources are canals and rainwater, including small owned ponds. Most of the respondents said that that the lack of rainwater was the main water challenges during the rainy season. Furthermore, rainwater is only available during the rainy season.

Limited water infrastructure leads to low water productivity. Insufficient rain and low water productivity results in the lack of water availability. The lack of water unavailability for rice growing has consequences for the number of harvesting times per year which leads to a low total annual rice production. According to key informants, the agricultural development plan of Bourei Cholsar district is not related to improving water for agriculture. Therefore, there are less possibilities that the local government take actions with respect to the improvement of water management for rice farming. High expenses of water for rice growing has effects on the livelihoods of rice farmers. Finally, the low total rice production within a year impacts on the livelihoods of the rice farmers in Doung Khpos commune.

Chambers and Convey (1991) defined "livelihoods are encompassed of capabilities, assets and activities required for generating income and securing a means of living" (IFCRC, 2010, p. 15). Besides rice farming, most households in Doung Khpos commune have diversified sources of income through livestock, business, services provision or working which increase the income. Chambers and Convey also added that the livelihoods could not be sustained if people cannot deal with and recover from unexpected or stress situation as well as retain or improve their assets and capabilities both in the present and future without compromising natural resources.

According to this definition, the rice farmers in Doung Khpos commune could not sustain their livelihoods because they have limited water assets for rice farming which is the main income generator. Furthermore, the rice farmers are lacking capacity to deal with water scarcity and natural disasters (floods and drought) for rice farming to sustain their living.

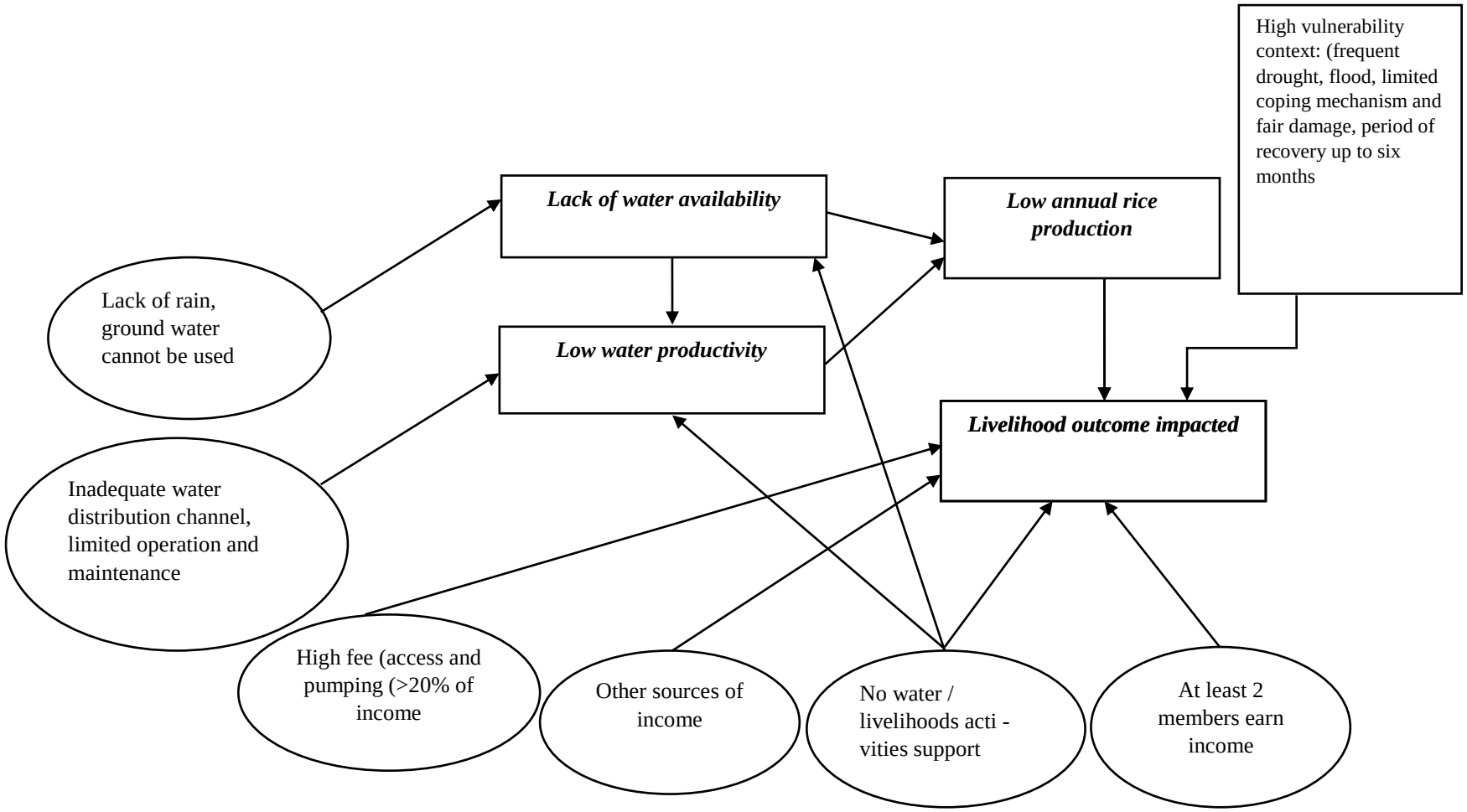

Figure 13: Framework to Assess the Livelihoods of Rice Farmers

Even though at least two people earned income in the interviewed households of Doung Khpos commune, almost 50% lived on less than US$ 1 a day. The higher number of people getting income in the household does not mean that the households get higher income because the Pearson Correlation between the number of people earning income and the household income is very weak (0.12).

Despite the fact that most rice farmers could earn an income from other sources during the period that they could not cultivate rice, the income is not sufficient for the household expenses for the majority of the interviewees. Frequent natural disasters and limited coping mechanism capacity expose the rice farmers to even higher vulnerability.

According to the analysis of the framework (Figure 13) the livelihoods of the rice farmers in Doung Khpos commune have been impacted profoundly by these many issues. Their livelihoods depend heavily on unreliable water sources and are exposed to the threats of natural disasters. Their livelihoods could be improved through better water management and the enhancement of rice famers' resilience capabilities so that they can more easily cope with the natural disasters.

5.3 Chapter Summary

Even though Cambodia is richly endowed with water resources, people are still encountering water shortages during the dry season which indicates that the country is ineffectively managing its water resources. In fact, Cambodia’s problem is more about economic water scarcity rather than physical water scarcity. Moreover, in spite of many related polices which support water for rice farming, the implementation of those policies remains limited.

At the commune level (Doung Khpos commune), the ineffective water management for agriculture can be seen in the local development plan of Bourei Cholsar district which does not seriously address water issues regarding rice farming, including strategies to cope with natural disasters for agriculture. Furthermore, the lack of participation from the community concerning privatization and management of Sounmuay canal also reflects ineffective management.

Similar to many writers such as Ahmad, (2003) , Aderinwale and Ajayi (2008) , Kulindwa and Lein (2008) and Harrington et al. (2009), the findings from the research show that there is a strong relationship between water and livelihoods (reflected in the rice crop production and household income). Furthermore, this research also found that there were direct and indirect impacts which have also been identified by other writers like Lipton and et al. (2003).

Despite high susceptibility and vulnerability to natural disasters, a large number of rice farmers do not have any coping mechanisms or solutions to be able to recover quickly once natural disasters hit. Meanwhile, there is no support provided to rice farmers (for example, capacity building of disaster preparedness). Thus, as rice farmers in Doung Khpos commune are dependent on rice for income, these issues, whether they be physical, financial or social, severely affect farmer's livelihoods

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter concludes this research and provides recommendations for improved water management for rice farming to enhance the livelihoods of rice farmers in Doung Khpos commune and for future research.

This research was undertaken to tackle how the livelihoods of rice farmers in Doung Khpos commune could be enhanced through improved water management for rice farming. The research also sought to answer three questions: 1) How does water scarcity and commodification impact on the livelihoods of rice farmers?, 2) What are the rice farmers doing to overcome the challenges of water unavailability and commodification? and 3) what agricultural water support do the rice farmers receive?. Firstly, this chapter provides the empirical findings, followed by the recommendations for the improvement of water management for rice farming and the recommendations for future research.

6.2 Empirical Findings

Data was gathered by using a household survey with a total rice farmers of 135 and by interviewing seven key informants by employing semi structured questionnaires. Samples for the household survey were selected by using a proportional stratified sampling technique while the samples for the key informant interviews (KII) were chosen by employing a purposeful technique.

Nearly all households in Doung Khpos commune are involved in rice farming. The income from rice sales makes up to two thirds of the total household income. The total annual income from rice sales are determined by the size of the paddy fields, the yields and the number of times that the rice farmers grow rice. The rice yields and the number of cultivating times mainly depend on water. Hence, water is one of the main determining factors concerning income for the rice farmers.

Water scarcity and commodification negatively affect the household income. The number of rice cultivating times in a year is constrained by the availability of water

and the high expense on water for rice farming. All villages (except Angkagn village) in Doung Khpos commune are covered by either Sounmuay or So Hang or both canals. The main water challenges for rice farming in Doung Khpos commune were the lack of a water distribution channel, inadequate water in the canals during the dry season and insufficient rainwater during the rainy season. The rice farmers in Angkagn village rely wholly on rainwater. The rice farmers have to pay the fee to access water from the canals, including the pumping fee. On average, more than 20% of the income from rice sales had to be spent on water for rice farming (access and pumping fees). Roughly, US$ 3.30 was spent each day on water to grow dry rice and about US$ 1.30 was spent on water to grow wet rice. Moreover, the rice farmers in Doung Khpos commune also experienced flood and drought frequently which also impacts] on their rice growing or rice production. During the period that the rice farmers could not grow rice, off farm activities, for most, did not provide enough income to cover the household expenses. Therefore, households had to borrow money from others, cut down the intake of food or involve school children in income generating activities. Natural disasters (flood and drought) were reported to occur often and impacted on rice farming in Doung Khpos commune while the communities had limited capacities to cope. Therefore, the livelihoods of the rice farmers are exposed to high vulnerability.

To tackle the challenge of water scarcity for rice farming, four solutions were identified (rainwater dependence, buying water, reserving water and not growing rice). In relation to water commodification, there was no solution mentioned by the rice farmers. During the rainy season, if rainwater was not enough, most rice farmers paid the access fee to pump water from the canals into the paddy fields. However, during the dry season, the rice farmers chose either to pay access fees for water so they could irrigate their paddy fields or they did not grow rice at all and waited until the next rainy season to grow rice again. Only a few rice farmers reserved water for rice farming during the dry season while the majority did not know what to do. In relation to the water commodification, some rice farmers thought that the canals were privatized while some expressed that the businessmen had to buy fuel to pump the water from the river into the canal (Sounmuay) or they had to pump water from the main canal into the sub canal (So Hang). Therefore, the rice farmers had to pay the access fees.

With respect to the agricultural water support for rice farming, the construction of So Hang canal to cover five villages of Doung Khpos commune was the main support identified. However, the communities did not perceive that they got the water support for rice farming as So Hang canal could only be accessed by paying the fees to the water contractors. Without So Hang canal, the rice farmers in five villages (Sophie, Tropaing Tonle, Treuy Klork, Prey Mlub and Chrey Ngourk) would still depend on rainwater for rice farming and for their livelihoods. Water management and natural disaster preparedness for agriculture were not integrated into the local development plan of Bourei Cholsar district. Additionally, the Communal Committee for Disaster Management did not address the natural disaster preparedness for agriculture while Doung Khpos commune was affected by flood and drought frequently. Moreover, the rice farmers lacked capacity to cope with the disasters or be prepared for them to mitigate crop losses. Though there are policies in relation to water for agriculture, the implementation of those policies in Doung Khpos commune is very limited.

Growing rice with unpredictable water sources, such as rainwater, limited functioning canals and high water expenses on accessing these canals impacts on the livelihoods of the rice farmers. Furthermore, the rice farmers lack the capacity to cope with natural disasters which makes their livelihoods even more vulnerable. Improved water management for rice farming is believed to contribute to improving the livelihoods of the rice farmers in Doung Khpos commune.

6.3 Recommendations

The section of the recommendations are divided into two, one of which focuses on how to improve water management for rice farming and another is the recommendations for future research.

Owing to the findings and discussion, the recommendations to improve water management for rice farming for the rice farmers in Doung Khpos commune are categorized into three: increased and improved water sources, capacity building and water governance.

a. Increased and improved water sources for Rice Farming

The water sources for rice farming in Doung Khpos commune are canals and rainwater. There is a need to improve the number and function of the canals, including the management of rainwater. With adequate water, rice farmers could cultivate wet rice once and dry rice twice in a year. Cultivating rice three times a year increases the annual income of the rice farmers substantially.

i. Canals

The two existing canals could not cover all the villages in Doung Khpos commune. Moreover, they could not supply enough water to the rice farmers at the required amount and at the right time. Angkagn village is not irrigated. Due to Angkagn village's location, So Hang canal should be extended to cover this village. If So Hang canal could not be extended to cover Angkagn village, other options such as reservoir and rainwater harvesting system should be considered. Soil erosion can make the canals and its sub canals getting shallow. Therefore, they should be often monitored and rehabilitated if needed.

The number of sub canals to provide water to all rice farmers should be increased. Minimizing the distance from the paddy fields and water sources also cuts down the cost of piping systems.

Since Sounmuay canal was constructed and left over from the Khmer Rouge regime, it should be rehabilitated followed a technical design. The construction of the small wooden or cement bridge and the installation of the cement ring block the flow of water from the head of Sounmuay canal to the end tail. Therefore, there should be control over this construction or installation. Reservoirs or tanks to store flooded water (as some parts of Doung Khpos commune are flooded) should be considered for later use during the dry season.

ii. Rainwater

Rainwater was mentioned as the primary water source for wet rice cultivation by many interviewees. Rainwater harvesting should be considered to save rainwater as surface water. Rainwater harvesting system can be tanks, reservoirs or ponds.

According to the policy of water resources management of Cambodia, promoting rainwater harvesting is one strategy for water for agriculture as well. However, technical design, location and annual rainfall need to be assessed before constructing the rainwater harvesting system.

b. Capacity Building

Flood and drought hit Doung Khpos commune almost every year. Therefore, improving capacities of the rice farmers to prepare or cope with the natural disasters for agriculture and building their resilience are very useful.

A local development plan is important. It serves as an instrument or tool for local development and identifies necessary projects or activities to be implemented. Local development plans are considered to reflect the community needs. Therefore, the local development plan of Bourei Cholsa district should address water management for rice farming and capacity building of disaster preparedness and coping mechanism to the rice farmers.

Water and sanitation management during flooded period is the main focus of the Communal Committee for Disaster Management (CCDM) in Doung Khpos commune. Livelihoods of most people in Doung Khpos commune are impacted by the water issues and natural disasters. Hence, extending the focus of the Communal Committee for Disaster Management (CCDM)'s work to water management and climate change adaptation for agriculture contributes to enhancing the livelihoods of the rice farmers.

Relevant institutional stakeholders (agriculture sectors, water resources management and meteorology and climate change sectors) at provincial and national level, including non-governmental organizations (NGOs) should provide training and capacity building of water management and climate change adaptation for agriculture to the communal committee for disaster management (CCDM). Then, the communal committee for disaster management (CCDM) could pass on the knowledge to the community. Moreover, as rainwater is becoming unpredictable and the dry season is prolonged, rice crops which demand less water should be introduced to the rice farmers in Doung Khpos commune as well. Wang et al., (2016) also emphasized that

global demand for water will be increased due to climate change, hence adaptation to rising pressure on water resources is necessary.

World Vision Cambodia has started implementing development projects in Doung Khpos commune since 2011. Overall, the timeframe for the development programme of World Vision Cambodia (WVC) can last up to 15 years (Ly, 2011). Improving the nutrition and education of children are the strategies of World Vision Cambodia (World Vision Cambodia, 2014). There are linkages between household income and the nutrition and the education of children. As disasters such as flood and drought impact on the livelihoods of rice farmers, World Vision Cambodia should consider either implementing projects or activities to improve the capacity of the Communal Committee for Disaster Management and the rice farmers for rice farming or design livelihoods projects to diversify and increase the income of the communities. World Vision Cambodia should also consider supporting water for rice farming to increase the income of households.

c. Water Governance – Participation from the communities

Cambodia has law, policies and strategic plans for water resources and meteorology, agricultural water and water resources for climate change. However, the compliance with the law and the implementation of the strategic plans and policies are still limited. Moreover, the local development plan and the plan of Agriculture Office should include water management and natural disaster preparedness for agriculture.

The management of Sounmuay canal should be reexamined by the relevant institutions. The success of the canal management requires the participation from the local communities, therefore a Farmer Water User Committee (FWUC) should be created for Sounmuay canal and the committee should be registered with the Provincial Department of Water Resource and Meteorology (PDWRM). Furthermore, local communities and local authorities should be empowered to express their voices and participate in any decision making regarding Sounmuay canal. The decision making includes the access fee, operation and maintenance and the water distribution. The privatization of Sounmuay canal should be reconsidered by the relevant institutions. Furthermore, the process of selecting the businessman for Sounmuay canal should be conducted like the selection process for So Hang canal

(consultation with and participation from the communities). The contract should be made between the selected businessman and the commune. Moreover, the contract should be within a limited timeframe.

6.3.1 Recommendations for Future Research

Water for rice farming is critical in Doung Khpos commune. Ros (2010) identified that the participation level of the Farmer Water User Groups (FWUGs) is one main factor in determining the success of the irrigation management. The research found that there is participation from the Farmer Water User Groups (FWUGs) in the management of So Hang canal. However, this research did not identify their level of participation. Future research can focus on how to improve the participation level of the Farmer Water User Groups (FWUG) in water management.

This research found that most rice farmers keep rice for household consumption. 95% of the rice farmers experienced the natural disasters (flood and drought). Natural disasters have negative consequences on the rice production which leads to a decrease in rice for household supplies and sales. Future research could explore the impacts of natural disasters as a result of climate change on household food security.

Besides rainwater and surface water, underground water is another main water source. This research did not include underground water because in Doung Khpos commune, it is salinized. Future research can study how underground water impacts on local livelihoods and economic development.

Additionally, the research found that nearly a person from each household migrates to neighboring countries, especially to become a laborer during the period which rice cannot be grown due to the unavailability of water. Future research can also explore how seasonal migration and remittances impact on local economics.

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List Appendices

Appendix 1: Questionnaires Survey

Household Questionnaire.

Q1. Questionnaire Number:

Q2. Date (dd/mm/yyyy):

Q3. Interviewer: [0]Sereiyut ☐ [1]Interview 1☐ [2]Interview 2☐

Q4. Village:

Q5. Household ID:

Q6. Categorization: [0]Poor 1 ☐ [1]Poor 2 ☐ [2]Non poor ☐

General Information

Q7. Name of Interviewee:……..

Q8. Sex: [0]Male ☐ [1]Female: ☐

Q9. Age:……

Q10. Relationship with the household head:

[0]Household head ☐ [1]Spouse ☐ [2]Child ☐ [3]Relative ☐

[4]Other ☐ (please specify……..)

Q11. What is the educational level of the household head?

[0]University or college ☐ [1]Higher secondary ☐ [2]Lower secondary ☐

[3]Primary ☐ [4]Vocational training ☐ [5]Illiterate ☐

[6]Other ☐ (Please specify…….)

Q12. What is the main occupation of the family? (Choose one which is the primary source of family's income)

[0]Rice farming ☐ [1]Fishing ☐ [2]Business ☐ [3]Service providing ☐

[4]Government staff ☐ [5]Worker ☐ [6]Other ☐ (please specify……)

Q13. What is the secondary occupation of the family?

[0]Rice farming ☐ [1]Fishing ☐ [2]Business ☐ [3]Service providing ☐

[4]Government staff ☐ [5]Worker ☐ [6]Other ☐ (please specify……)

Q14. How many members in the family?.....

Q14.1 Adults (>15):……

Q14.2 Children (<15):……

Q14.3 how many can earn an income?.....

Q15. What is the approximate monthly average income of the family?

Q15.1 Rice farming:	
Q15.2 Fishing	
Q15.3 Service providing	
Q15.4 Working	
Q 15.5Other……..	
Total:	……

Q16. Does your household income vary?

[1] Yes ☐ [0] No ☐ (If No, skip to Section: Rice farming)

Q17. If Yes, in which months of the year can the family get the most income? (Tick maximum 3)

[0]January ☐ [1]February ☐ [2] March ☐ [3]April ☐

[4]May ☐ [5]June ☐ [6]July ☐ [7]August ☐

[8]September ☐ [9]October ☐ [10]November ☐

[11]December ☐

Q18. In which months of the year the family get the lowest income? (Tick maximum 3)

0]January ☐ [1]February ☐ [2] March ☐ [3]April ☐

[4]May ☐ [5]June ☐ [6]July ☐ [7]August ☐

[8]September ☐ [9]October ☐ [10]November ☐

[11]December ☐

Rice farming

Rice productivity

Q19. What kind of rice do you cultivate?

[0]wet rice ☐ [1]dry rice ☐ [2]Both ☐

Q20. Usually, how many times per year can you cultivate? (please tick in the table)

	[0]One	[1]Two	[2]Three	[3]More than three (Specify……..)
Q20.1 Dried Rice				
Q20.2 Wet Rice				

Q21. How many hectares of rice land do you cultivate? …….

Q22. How many tons of rice can you harvest per hectare? (Please tick in the table)

	tons/hectare
Q22.1 Dry Rice	…….
Q22.2 Wet Rice	…….

Q23. How many members in your family engage in rice farming activities? (please Tick one)

[0]1 ☐ [1]2 ☐ [3]3☐ [4]4☐ [5]All ☐

Q24. What is the average price of rice per kilogram you receive?.....

Q25. Can you cultivate rice all year round? Yes ☐ No ☐ **(if Tick Yes, please go to Q29)**

Q26. If No, Why not? (Tick one main reason)

[0] No water in the irrigation system ☐

[1] No rainwater ☐

[2] Flood ☐

[3] Expenses on water is too much ☐

[4] Other ☐ (please specify…….)

Q27. Which period that you cannot cultivate rice?.....

Q28. What are your other alternative sources of income during this period ? (Tick 3 maximum)

Q28.1 Fishing ☐

Q28.2 Working in paddy field for other people ☐

Q28.3 Migrating to other place to work ☐

Q28.4 Rely wholly on saving left ☐

Q28.5 Other ☐ (please specify……)

Q29. Does your income increase or decrease during the period you cannot cultivate rice? **(If Tick decrease, go to Q 31, if Tick Increase or No change, go to Q32)**

[0]Decrease ☐ [1]Increase ☐ [2]No change ☐

Q30. If your income decreases, is it enough to cover your household expense?

[1]Yes ☐ [0]No ☐

Q31. If Yes, how do you cope with the income insufficiency? (tick all that apply)

[0] ☐ Use the saving

[1] ☐ Reduce household utility expenses (electricity, power, fuel etc…)

[2] ☐ Cut down the amount of food intake

[3] ☐ Borrow money from neighbors or money lenders.

[4] ☐ Reduce expenses on children such as education, health.

[5] ☐ Other (please specify……..)

Q32. If your income increase or stabilize, are you able to keep savings?

[1] Yes [0] No

Q33. If Yes, how much can you save?.....month

Water Challenges

Q34. What is your main water source for rice farming? (Please tick only one)

[0]Irrigation system ☐ [1]Rainwater ☐ [2]Underground water☐

[3]Other ☐ (please specify……)

Q35. What are other water sources for rice farming? (Tick all that apply)

[0]Irrigation system ☐ [1] Rainwater ☐ [2] Underground water☐

[3]Other ☐ (please specify……)

Q36. Do you encounter any challenges obtaining water for rice cultivation? (If No, go to Q….)

[1]Yes ☐ [0]No ☐

Q37. If Yes, when do water challenges happen? **(If tick In dry season, only fill in the Column Q38.1, if tick in Rainy season, fill in the column Q38.2, if tick Both, Fill in both *columns*)**

[0] In dry season ☐ [1] in Rainy season ☐ [2] Both ☐

Q38. What are the main water challenges do you face in both season? (Please tick maximum 3 for each season)

Q38.1 Dry Season	Q38.2 Rainy Season
Q38.1.1 ☐ Not enough water in the irrigation system	Q38.2.1 ☐ Not enough water in the irrigation system
Q38.1.2 ☐ Rainwater is insufficient	Q38.2.2 ☐ Rainwater is insufficient
Q38.1.3 ☐ Changes in rainwater patterns (dry season is getting longer)	Q38.2.3 ☐ Changes in rainwater patterns (dry season is getting longer)
Q38.1.4 ☐ lack of water from all water sources	Q38.2.4 ☐ Flood or too much water
Q38.1.5 ☐ Have to pay for the irrigation system to access water	Q38.2.5 ☐ Have to pay for the irrigation system to access water
Q38.1.6 ☐ Fee for pumping water from the irrigation system into paddy field is expensive	Q38.2.6 ☐ Fee for pumping water from the irrigation system into paddy field is expensive
Q38.1.7 ☐ The irrigation system is far from my paddy field	Q38.2.7 ☐ The irrigation system is far from my paddy field

Q38.1.8 ☐ Water becomes saltinised	Q38.2.6.8 ☐ Water becomes saltinised
Q38.1.9 ☐ Other (please specify……)	Q38.2.9 ☐ Other (please specify……)

Q39. Do you need to pay to access the irrigation system?

[1]Yes ☐ [0]No ☐

Q40. Do you choose to pay to access the irrigation system? **(If No, skip to Q45)**

[1]Yes ☐ [0]No ☐

Q41. If Yes, how do you pay?

[0]Cash☐ [1]Rice ☐ [2]Labor☐ [3]Materials ☐ [4] Other ☐ (specify……)

Q42. If you need to pay in cash, how much……./Riels per season

Q43. If you need to pay in rice, how many ……./kg per season

Q44. Who do you have to pay to?

[0]Village chief ☐ [1] Water representative in the village ☐ [2]Commune chief ☐

[3]Water merchandizers ☐ [4]Other ☐ (please specify……)

Q45. If No, why do you choose not to access the irrigation system? (tick 3 maximum)

Q45.1 ☐The fee to access is expensive

Q45.2 ☐The expenses on water and income from rice are marginalized

Q45.3 ☐ Besides the access fee, we have to pay for the pumping fee

Q45.4 ☐ Rainwater is enough for rice cultivation

Q45.5 ☐ My paddy field is far from the irrigation system

Q45.6 ☐ Water in the irrigation system is not always available

Q45.7 ☐The irrigation system belongs to other villages

Q45.8 ☐Only certain groups can access

Q45.9 ☐Other (please specify……)

Q46. Why do you have to pay? (Tick maximum 3)

Q46.1 ☐ The irrigation system is renovated and constructed more.

Q46.2 ☐ Water availability is ensured in the irrigation system

Q46.3 ☐ The irrigation system is privatized to businessmen

Q46.4 ☐ Other (Specify……)

Q47. In the past, did you have to pay to access the irrigation system? (If Yes, go to Q49)

[1]Yes ☐ [0]No ☐

Q48. If No, since which year do you have to pay to access the irrigation system?.....

Q49. Do you have pumping machine? **(If No, go to Q52)**

[1]Yes ☐ [0]No☐

Q50. If Yes, normally, how much do you spend on fuel for pumping per time?.....Riels

Q51. How can you pump water into your paddy field? (Tick one that applies to most situation)

If Tick Renting pumping machine, ask Q52, otherwise go to Q53

[0] Renting pumping machine ☐

[1] I rely wholly on rainwater ☐

[2] Borrowing other people's machine ☐

[3] Other (Please specify…….) ☐

Q52. If you need to rent a pumping machine, how much do you have to pay for the rent fee?.....Riels/time.

Q53. Do this amount above include the fuel fee? (If Yes, go to Q57)

[1]Yes ☐ [0]No ☐

Q54. If No, how much do you have to pay for the fuel fee each time?.....

Q55. How many hours do you normally pump water into your paddy field?.....hours

Q56. How many times do you need to pump per cultivation season?.....

Q57. Have you experienced natural disasters which affect your rice cultivation? **(If No, go to Section Support)**

[1]Yes ☐ [0]No ☐

Q58. What kind of disasters? (Tick maximum 3)

Q58.1 Drought ☐

Q58.2 Flood ☐

Q58.3 Storm ☐

Q58.4 Other (please specify…….) ☐

Q59. How did it affect your rice cultivation ? (Tick 3 maximum)

Q59.1 Crops were destroyed wholly ☐

Q59.2 Crops were partly destroyed ☐

Q59.3 Could not cultivate ☐

Q59.3 Crops did not yield ☐

Q59.4 Other (please specify…….) ☐

Q60. How often do you experience disasters? (Tick one only)

[0] One in every four or more years ☐

[1] One in every two - three years ☐

[2] Every year ☐

[3] Two – three times a year ☐

[4] More than three times a year ☐

Q61. How did you cope with natural disasters ? (Tick maximum 3)

Q61.1 Grow crops which are resistant to water ☐

Q61.2 Reserve water for rice farming ☐

Q61.3 No idea how to do ☐

Q61.4 Other (please specify…….) ☐

Support

Q62. Do you get any support for water for rice farming from NGOs or government? (If tick None, finish the survey)

[0]NGOs ☐ [1]Government ☐ [2]Other ☐ (please specify……..)

[3]None ☐

Q63. If there are supports from NGOs or Government or other, how do they help? (Tick all that apply)

Q63.1 Renovate the irrigation system ☐

Q63.2 Build more irrigation system ☐

Q63.3 Fund pumping machine ☐

Q63.4 Fund the fuel ☐

Q63.5 Ensure there's always water in the irrigation system ☐

Q63.6 Intervene with water merchandisers to ensure that water tariff is fair ☐

Q63.7 Other (please specify……..) ☐

Thanks so much for your valuable time taking part in this survey!

Appendix 2: Ethics Approval

TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI
VICTORIA
UNIVERSITY OF WELLINGTON

Phone
Fax
Email

MEMORANDUM

TO	
COPY TO	
FROM	
DATE	20 April 2015
PAGES	1
SUBJECT	**Ethics Approval: 21807** Water Dependency and Livelihoods of Rice Farmers

Thank you for your application for ethical approval, which has now been considered by the Standing Committee of the Human Ethics Committee.

Your application has been approved from the above date and this approval continues until 3 March 2016. If your data collection is not completed by this date you should apply to the Human Ethics Committee for an extension to this approval.

Best wishes with the research.

Appendix 3: Consent for Household Survey

TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI
VICTORIA
UNIVERSITY OF WELLINGTON

CONSENT TO PARTICIPATE IN RESEARCH FOR HOUSEHOLD SURVEY

Title of project: Water Dependency & Livelihoods of Rice Farmers.

I have been given and have understood an explanation of this research project. I have had an opportunity to ask questions and have them answered to my satisfaction. I understand that I may withdraw myself (or any information I have provided) from this project before *05/10/2015* without having to give reasons.

By signing on this consent form, I understand that:

- I consent to information or opinions which I have given being aggregated as group response on this research.
- I understand that the data I provide will not be used for any other purpose or released to others without my written consent.
- I understand that the questionnaire will be kept confidential
- I would like to receive a summary of the results of the research when it is completed.
- I agree to take part in this research.

Signed:

Name of Participant: **Date:**

Appendix 4: Consent for Key Informant Interview

TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI
VICTORIA
UNIVERSITY OF WELLINGTON

CONSENT TO PARTICIPATE IN RESEARCH FOR KEY INFORMANT INTERVEIW

Title of project: Water Dependency & Livelihoods of Rice Farmers.

I have been given and have understood an explanation of this research project. I have had an opportunity to ask questions and have them answered to my satisfaction. I understand that I may withdraw myself (or any information I have provided) from this project before *05/10/2015* without having to give reasons.

By signing on this consent form, I understand that:

- I consent to information or opinions which I have given being attributed to me in any reports on this research.
- I would like the tape recordings of my interview returned to me at the conclusion of the project.
- I consent to be photographed
- I understand that if I consent to my photographs to be put on the report, my identity is no longer confidential.
- I understand that the data I provide will not be used for any other purpose or released to others without my written consent.
- I would like to receive a summary of the results of the research when it is completed.
- I agree to take part in this research.

Signed:

Name of Participant: **Date:**

Appendix 5: Participant Informant Sheet for Household Survey

TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI
VICTORIA
UNIVERSITY OF WELLINGTON

INFORMATION SHEET FOR HOUSEHOLD SURVEY

Participant Information Sheet for a Study of Water Dependency & Livelihoods of Rice Farmers.

Researcher: *Chansereiyut Cheng*
School of Geography, Environment and Earth Sciences
Victoria University of Wellington, New Zealand

I am a Masters student in *Development Studies* at Victoria University of Wellington in New Zealand. As part of this degree I am undertaking a research project leading to a thesis. The project I am undertaking is to find out what can be done to improve the livelihood sustainability in terms of water management for rice farming. This research project has received approval from the Vicotria University Human Ethics Committee.

I am inviting households who are rice farmers to participate in this household survey. Participants will be asked about their challenges in relation to water they are encountering, how they are coping and how water challenges impact their livelihoods. Approximately, the survey will take around 40 minutes. Filling in the question will be done by researcher or surveyors.

You can choose not to take part in this survey if you do not want. During the interview, if you feel uncomfortable to answer or do not want to answer, you can tell the researcher to skip to other questions. If you would like to withdraw from the interview, the process will be terminated. If you want to withdraw yourself (or any information you have provided) from this project before *05/10/2015* without having to give reasons to the researcher.

Responses will form the basis of my research project and will be put into a written report on a confidential basis. It will not be possible for you to be identified personally. Only grouped responses will be presented in this report. The questionnaire and material collected will be kept confidential. No other person besides me and r. will see the questionnaires. The thesis will be submitted for marking to the School of *Geography, Environment and Earth Science*s and deposited in the University Library. It is intended that one or more articles will be submitted for publication in scholarly journals. Questionnaires will be destroyed two years after the end of the project.

If you have any further questions or would like to receive further information about the project, please contact me at

Appendix 6: Participant Informant Sheet for Key Informant Interview

INFORMATION SHEET FOR KEY INFOMRANT INTERVIEW

Participant Information Sheet for a Study of Water Dependency & Livelihoods of Rice Farmers

Researcher: *Chansereiyut Cheng*, School of Geography, Environment and Earth Sciences, Victoria University of Wellington, New Zealand

I am a Masters student in *Development Studies* at Victoria University of Wellington in New Zealand. As part of this degree I am undertaking a research project leading to a thesis. The project I am undertaking is to find out what can be done to improve the livelihood sustainability in terms of water management for rice farming. This research project has received approval from the Victoria University Human Ethics Committee.

I am going to interview

You are one of my interviewees and you will be interviewed individually. The place and time for the interview is at your own convenience. I want to find out the information in relation to the irrigation system, how it is managed, the challenges encountered, and any supports or policies related to water for agriculture. Approximately, the interview will take around 60 minutes.

Your answers will be noted by the researcher and recorded on the tape. However, if you want the researcher not to record your answers or take any photos, there will be neither recording nor photographing.

You can choose not to participate in this research if you do not want or feel uneasy. During the interview, if you feel uncomfortable to answer or do not want to answer, you can tell the researcher to skip to other questions. If you would like to withdraw from the interview, the process will be terminated. You can withdraw yourself (or any information you have provided) from this project before *05/10/2015* without having to give reasons to the researcher.

Responses will form the basis of my research project and will be put into a written report as the responses from the key informant interview. Your roles or position will not be written if you do not agree. It will not be possible for you to be identified personally unless you agree. Your photographs will not be put on the report without your consent. All material collected will be kept in a safe place. No other person besides me and will see the

questionnaires. The thesis will be submitted for marking to the School of *Geography, Environment and Earth Science*s and deposited in the University Library. It is intended that one or more articles will be submitted for publication in scholarly journals. Questionnaires will be destroyed two years after the end of the project.

If you have any further questions or would like to receive further information about the project, please contact me