Adaptive Strategies of Small-scale Farmers to Cope with Water Shortages due to Climate Change: a Comparative Study between the Tonle Sap Lake and the Mekong River Areas

In cooperation with Royal University of Phnom Penh (RUPP)
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Dr. Chheng Kimlong
President of AVI

About Centre for Governance Innovation and Democracy of Asian Vision Institute

Asian Vision Institution (AVI) is an independent think tank based in Phnom Penh, Cambodia, aiming at promoting peaceful, inclusive, adaptive, and sustainable societies in Asia. AVI holds the vision to generate positive changes through knowledge co-creation and multi-stakeholder partnerships, build peaceful, inclusive, adapting, resilient and sustainable communities in Asia, and promote Asian wisdom and perspective and the values of humanity, peace, and cultural diversity in Asia. AVI's missions are 1) to promote inclusive growth and people-centered development; 2) to conduct practical policy and program research; 3) to multi-stakeholder dialogue and strengthen cross-sectoral partnerships and collaboration; 4) to Advance knowledge sharing and build leadership and innovation capacity.

There are six main centers in AVI, namely Mekong Centre for Strategic Studies (MCSS), the Centre for Governance Innovation and Democracy (CGID), the Centre for Sustainable Development Studies (CSDS), the Centre for Culture and Peace Studies (CCPS), and Centre for Inclusive Digital Economy (CIDE), and Centre for Advance Research and Legal Studies (CALS).

Centre for Governance Innovation and Democracy (CGID) executes three main activities under the themes of 1) Public sector innovation; 2) Policy innovation for an inclusive society (with a focus on centrist democracy and social market economy); and 3) Young Political Leaders training programme.

Our Research areas focus on 1) Democratic governance, including the promotion of civic participation and responsible citizenry and the utilization of technology and artificial intelligence in the democratization process; 2) Innovations in government and institutional reforms, including the promotion of public leadership and public policy consultations and the integration of technology in policy research to provide concrete data for policy analysis; and 3) Dynamic City Development Initiatives, focusing particularly on the use of technology in both core and pilot projects in selected urban areas or major towns. The centre's flagship event is the annual Asia Think Tank Forum, which aims to promote dialogues and knowledge sharing about emerging governance issues and innovative solutions in Asia.

The Royal University of Phnom Penh (RUPP) is the largest public university in Cambodia. It hosts more than 12,000 scholarship and full-fee paying students across a diverse range of undergraduate and postgraduate programs. The university is a full member of the ASEAN University Network (AUN) and has a unique vision 'to become Cambodia's flagship university with a reputation in the region for teaching, learning, research, innovation, and social engagement.' The current strategic plan of the institution prioritizes the development of a strong research capacity incorporating peer-reviewed publications, as well as links to industry and community networks, which is well-aligned with Cambodia's National Education Strategic Plan (NESP) aimed at supporting the transition of the country from a lower-middle to upper-middle income country by 2030; and obtaining 'developed country' status by 2050. RUPP is widely considered to be the nation's leading higher education institution in terms of research output. For instance, a Scopus search of peer-reviewed research in international journals including a Cambodian institutional affiliation, shows that RUPP is the only Cambodian University in the top ten. Despite this, if RUPP, as the leading research institution in the country intends to be included in world university rankings, significant investment in the research capacity of the institution is required. If this were to be achieved, it would provide a clear indication that Cambodia has developed an improved capacity to generate local knowledge and innovation within the country. It would also demonstrate that the nation is better equipped to independently address the challenges faced in improving socio-economic development outcomes

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Ms. YANN is the Deputy Director of the Centre for Governance Innovation and Democracy of Asian Vision Institute. She holds a master's degree in Public Policy, majoring in policy analysis from Australian National University (ANU), and a master of Business Administration majoring in management from Pannasastra University of Cambodia. She was a former Youth Employability Specialist at UNDP with extensive experience in developing, implementing, managing, monitoring, and evaluating programs, projects, policies, and offices; and preparing and presenting policy papers, concept notes, background, speeches, articles, Pechakucha talks, videos, photo stories, magazine, and factsheets. She obtains a sound understanding of the roles of civil society, youth issues, macro and micro economic issues, public and private sector languages, and the national agenda for sustainable development.

2. **Dr. Serey Sok, Research Advisor**

Prof. Serey Sok is a Vice Head and Professor at the Research Office of the Royal University of Phnom Penh. Internationally, he has been appointed as a Senior Visiting Fellow or Associate Professor at Academy of Korea Studies, South Korea and a Visiting Scholar or Assistant Professor at University of Washington, USA. Also, he is a Visiting Scholar at Massachusetts Institute of Technology (MIT), USA, the University Technology Malaysia (UTM), Malaysia and the Central European University (CEU), Hungary. Serey completed his PhD in human geography at Hong Kong Baptist University (Hong Kong) in 2013 and MSC in regional and rural development at Asian Institute of Technology (Thailand) in 2015. Since 1999 Serey has worked with various national and international organizations, including Women Development Association (Cambodia), UN Refugee Agency, UNESCAP Building (Bangkok) and National AIDS Authority under UNIADS Project (Cambodia). He has conducted extensive, Cambodia-based research on agrarian communities' socio-economic development, migration, rural livelihood strategies, climate risk adaptation, and participatory river systems and fisheries co-management. He has also conducted fieldwork on Cambodians in the United States of America, France, South Korea, Malaysia, and Thailand. He is an author and co-author in top journals, including the Communications Medicine (Nature Group), Scientific Reports (Nature Group), Bulletin of the World Health Organization (IF= 13.831). His paper has also appeared in the International Journal of Disaster Risk Reduction, Asia Pacific Education Review,

World Development Prospective, International Journal of Water Resources Development, and Singapore Journal of Tropical Geography.

3. Mrs. Leakhena Thoeun, Research Officer

Leakhena is a research assistant at the Research Office of the Royal University of Phnom Penh, is an accomplished professional with over 10 years of experience in the NGO sector. Specializing in social work, climate change, disaster risk reduction, and rural development, she excels in research, team leadership, and innovative data collection methods. Her expertise also includes crafting compelling videos and case studies. Leakhena obtained her Master's in Biodiversity Conservation from the Royal University of Phnom Penh in 2024. Her academic thesis, focused on women's participation in wetland management, highlights her commitment to biodiversity conservation and community engagement. In recent years, Leakhena has actively participated in various qualitative and quantitative research projects and has provided technical support for both national and international initiatives.

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Mr. Punleu Thou is a researcher at the Research Office of the Royal University of Phnom Penh (RUPP). He is currently pursuing his Master of Science at the Center for Biodiversity Conservation (CBC) at RUPP. He earned his undergraduate degree from the Department of Economic Development, Faculty of Development Studies at RUPP. Punleu is a young researcher with significant contributions to the academic society through his active research engagement and publication. He has experience in managing fieldwork, data management, and analysis. He has authored and co-authored various scholarly and peer-reviewed publications, including studies on remittance and migrant workers in Thailand, financial education for primary school children in Cambodia, and community empowerment for sustainable natural resource management. Punleu's work reflects his commitment to advancing knowledge and addressing pressing societal issues, such as girls' leadership in school safety programming and promoting agricultural cooperatives for livelihood development among smallholder farmers in Cambodia.

Abstract

The paper analyzes the adaptive strategies of small-scale rice farmers in the Tonle Sap Lake and the Mekong River of Cambodia. The paper has addressed the following: dependency on water for income and poverty, access to the five livelihood assets, the impact of water shortage and local adaptation, and engagement in water management. The research was conducted in the Bakan district of Pursat Province, representing the Tonle Sap and Koh Sotin districts, and Kampong Cham, representing the Mekong River. The study collected quantitative data through surveys and qualitative data through social tools and participatory approaches. The surveys collected 300 households, 150 in the Tonle Sap Lake and 150 in the Mekong River. The study finds that (a) the farmers remain highly dependent on water resources, especially from the Tonle Sap Lake and the Mekong River, for their rice cultivation. However, rice farmers also have other alternative sources of consumption and income from non-farm activities; farm income is always significant. (b) The farmers were challenged to assess the five assets for tier livelihood development, especially limited access to human assets; (c) Farmers have sought means to cope with the negative impact of water shortage, but their local adaptation was insufficiently addressed to mitigate their risks and vulnerabilities; and (d) The existing support mechanism for water management was insufficient. While the residents had opportunities to participate in various events and activities for community development at the commune level, they were not involved much in the decision-making process. The findings of this research have improved the understanding of sustainable livelihood and local adaptive capacity to water shortage.

Keywords: sustainable livelihood framework, water shortage, adaptive capacity, the Tonle Sap Lake, and the Mekong River.

Introduction

Background

Climate change already exists in Cambodia, with variations in rainfall patterns (Thoeun, 2015), and it manifests as drought and flood (NCSD/MoE, 2020). A prediction by Eastham et al. (2008) suggests that while precipitation has remained stable or possibly decreased in the dry season, rainfall has increased over time in the wet season, resulting in more frequent flood events. The country has faced challenges with too little water in the dry season, causing drought, and too much water in the wet season, leading to floods (MoE, 2019). While floods have annually existed since 1999, drought recently brought even more concern in 2003 and 2004 (Sok et al., 2011). Both drought and flood severely impact socio-economic development (CNMC, 2010).

The abundant water availability in the wet season leads to frequent floods, damaging agricultural activities, and health-related issues, and negatively impacts the villagers' livelihoods along the riverine communities (NCDM, 2002). Since the 1960s, temperature has gradually increased by 0.8°C, and it was predicted to be more severe between December and June annually (McSweeney et al., 2008). Cambodia experienced the world's highest temperatures, averaging an estimated 64 days per year when the maximum temperature surpasses 35°C, positioning this nation in the top 23 countries with severe exposure to extreme heat (EPA, 2023). Temperature increases have put more pressure on ecosystems, livelihoods, and human health (World Bank and ADB, 2021).

Cambodia has abundant freshwater resources, which are essential for agriculture because more than 90% of the overall withdrawals have been used for this sector

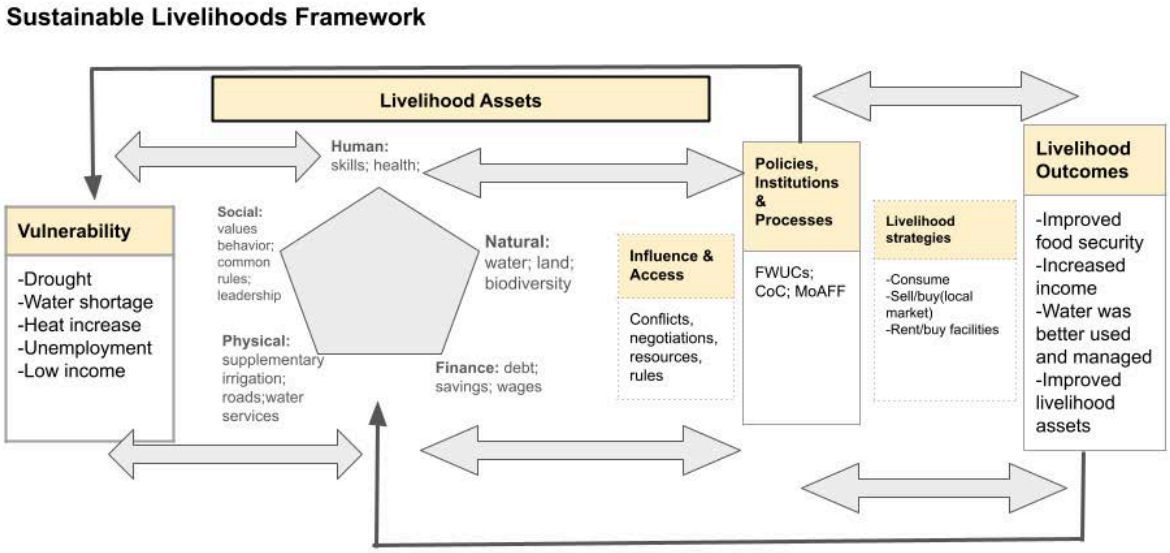
(UNWater, 2024). Moreover, water sources are important for daily food consumption and income generation activities, which most Cambodians have relied upon (Mak, 2003). The Tonle Sap Lake and the Mekong River are the two main sources of water-related resources for Cambodian people. The Mekong River brings a large volume of water flowing across its territories because it flows through Cambodia over a distance of 500 kilometers from the border of Laos to South Vietnam, which is called the Mekong Delta. At the same time, the Tonle Sap Lake is Southeast Asia's largest freshwater lake, which releases and takes millions of cubic meters of water to and from the Mekong River (MRC, 2010). Approximately 75,000 million m3 of surface water runs off Cambodian territory annually in the wet season (MRC, 2020). However, only 1% of the total water volume in Cambodia, equivalent to 750 million m^3, is essentially utilized by humans, and the majority (95%) is being supplied for agriculture-related activities (MoWRAM, 2012).

Agriculture is a catalyst for the national economy (MoP, 2013a, b), which contributed 21.5% of the Gross Domestic Product (GDP) in 2023 (World Bank, 2023) and employed 37.0% of the Cambodian population in 2022 (ILO, 2024). Moreover, the sector is essential for rural people's livelihoods and food security (McKenney & Tola, 2002). Nevertheless, climate change has significantly and negatively impacted the productivity of small-scale farmers (Keskinen et al., 2010). Chhinh et al. (2023) find that rainfall changes have experienced three conditions: early cessation, prolonged dry spells during the wet season, and late onset (Chhinh et al., 2023). For example, prolonged and severe droughts (Chann et al., 2020) negatively caused damages and rice production losses (Markert, 2021; Chhinh, 2019). Therefore, the Royal Government of Cambodia (RGoC) developed the Climate Change Action Plan (2016–2018) and identified agriculture as one of the most climate-sensitive sectors in Cambodia because the country remained dependent on rain-fed rice production systems (Poulton et al., 2016)

The paper examines the adaptative strategies of small-scale rice farmers to cope with water shortages due to climate change in the communities along Tonle Sap Lake and the

Mekong River. It has three main objectives: (1) dependency on water for income and poverty, (2) access to the five livelihood assets, (3) impact of water shortage and local adaptation, and (4) engagement in water management.

Sustainable livelihood framework in the face of climate change



Source: Authors' framework based on the context of Cambodia

The existing studies have associated the negative impacts of climate change on sustainable livelihood (Natarajan et al., 202; Tanner et al., 2015; Mobeen et al., 2023; Ullah et al., 2024; Tohidimoghadam et al., 2023, Fan, et al., 2022, Connolly-Boutin & Smit, 2026; Chuong et al., 2024). In Cambodia, scholars have investigated climate change in the context of rice production (Sok et al., 2021), agricultural cooperatives (Chhinh et al., 2022; Chhinh et al., 2023), productivity, damages, and losses of rice (Sok et al., 2022), food insecurity (Kheng, 2022), vulnerability (Sina, 2020), food consumption (Chen, 2022), local adaptive capacity (Prin, 2023). At the same time, a sustainable livelihoods

approach and program development in Cambodia (Turton, 2000) is an essential development agenda, and the extended research is closely associated with poverty (Bühler et al., 2015; Jiao et al., 2017), income sources (Jiao et al., 2017), nutritional security (Ader et al., 2024), livelihood assets (Key at al., 2020), natural resource management (McKenney et al., 2002), stresses and shocks (Marschke, & Berkes, 2006), adaptation, and resilience (Sok & Yu, 2015), a local institution, and decentralization (Marschke et al., 2014; Sok et al., 2014).

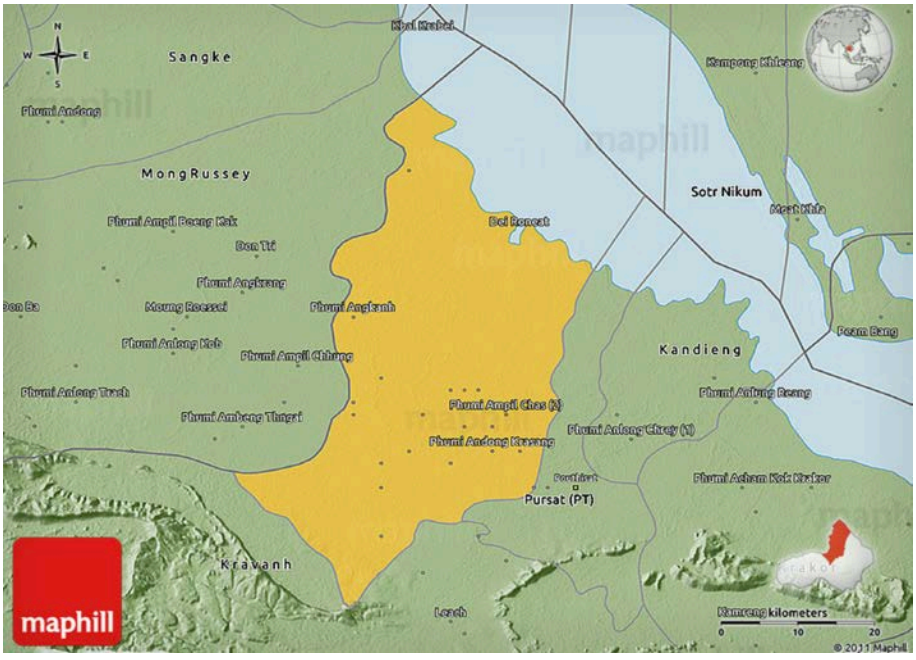
The sustainable livelihood framework, a pivotal approach in analyzing the adverse effects of climate change in developing nations like Cambodia, is important. This framework, as outlined in a working paper by Robert Chambers and Gordon Conway, "Sustainable Rural Livelihoods: Practical Concepts for the 21st Century," Has been widely acclaimed. Scoones (2015) has even gone as far as to consider this framework as an approach that can be applied to everything literally. The Brundtland's report Our Common Future and an advisory panel to the World Commission on Environment and Development (WCED) appeal for a shift in focus to sustainable livelihoods (WCED, 1987) but do not define what constitutes a livelihood. The First UNDP Human Development Report in 1980 was instrumental in setting out the agenda of sustainable livelihood (Solesbury, 2003). In 1998, sustainable livelihood was transformed from an approach into a framework based on a second IDS working paper by Ian Scoones (1998). Therefore, the sustainable livelihoods approach was first introduced, and it is now a backbone of applied and academic research in rural areas, especially in developing countries (DFID, 1999; UNDP, 2017).

The Department for International Development (DFID) adopted the sustainable livelihoods framework in 2001 to analyze livelihood assets and livelihood strategies/outcomes in the context of vulnerability. A resilient community is measured by the success or failure of a system to return to a normal or improved situation than the pre-hazard in the shortest period (DFID, 2011). de Haan & Zoomers (2005) suggest that

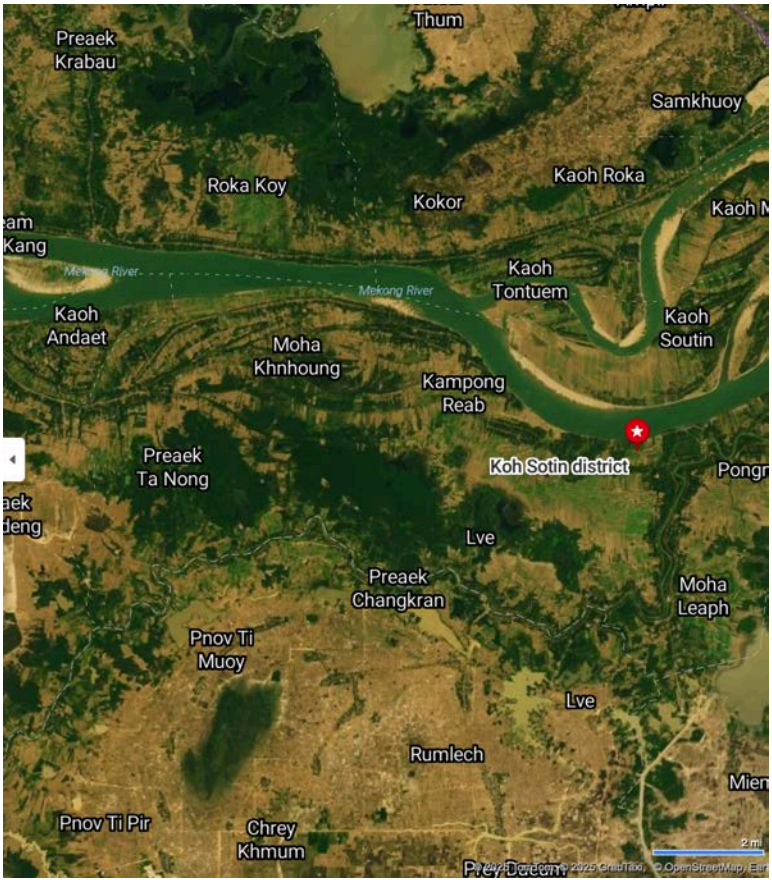
the framework is the notion of access to different types of assets focusing on long-term flexibility over time. Since the 1990s, Scoones (2009) has popularized the framework for individual development and capacities approach (Sen, 1985) . The framework has become a backbone of applied and academic research in rural areas in developing countries (DFID, 1999; UNDP, 2017). Chambers (1995: 174) and Conway (1992: 5) write in their working paper that a "livelihood in its simplest sense is a means of gaining a living." In their working paper, Chambers and Conway write (1992: 5, and see Chambers, 1995: 174, Scoones, 1998: 5) that a "livelihood in its simplest sense is a means of gaining a living." On the next page, they provide a fuller 'working definition':

> "A livelihood comprises the capabilities, assets (stores, resources, claims, and access) and activities required for a means of living: a living is sustainable which can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; and which contributes net benefits to other livelihoods at the local and global levels and in the short and long term."

Methodology and Study Areas



Source:Maphill website



Source: Maphil website

This is a comprehensive descriptive and explanatory type of research conducted to analyze the effect and cause of water shortage, local adaptive capacity, and support mechanisms to reduce the negative impacts of climate change. The study was a comparative study to explore if there was a significant difference between the Tonle Sap Lake riverine communities and the Mekong River. While the Bakan district of Pursat Province was selected as the riverine communities in the Tonle Sap, Koh Sotin district and Kampong Cham Province were recruited as in the Mekong River. The survey contacted 300 households from 150 households in the Tonle Sap Lake and 150 households in the Mekong River; the interviews were equally recruited males and females as representative households. The study considered both geographical areas and gender perspectives for comparisons and understanding of dependency on water-related resources.

Bakan is one of the districts in Pursat Province, located approximately 15 kilometers north of the provincial capital, Pursat, along National Highway 5. The district shares a border with the district of Veal Veaeng to the west, Battambang province to the north, Phnum Kravanh and Sampov Meas districts to the south, and the Kandieng district to the east. The northeast Bakan includes a portion of the Tonle Sap Lake, and three villages in this part of the district are Tonle Sap floating villages. Their location moves depending on the water level in the lake. Koh Sotin district is situated in Kampong Cham province, and it is about 42 kilometers by road but 10 kilometers south of the provincial capital of Kampong Cham by water. Koh Sotin borders the southern bank of the Mekong River and contains the islands of Koh Sothin and Koh Mitt. These details provide a clearer picture of the local conditions and the specific challenges the communities face in these areas.

Bakan and Kok Sotin districts were purposely selected for the survey and fieldwork. A systematic and stratified sampling design and procedure were applied to each household. The enumerators counted every three households for recruitment and were invited to participate in the survey. They also equally recruited male and female household representatives for the interview. Before starting the interview, the enumerators provided households with verbal consent. During the interview, all the respondents were informed to skip any question or leave the interview at any time. The respondents were mainly asked questions regarding the effect and cause of water shortage, local adaptive capacity, and support mechanisms to reduce the negative impacts of climate change. All the variables included in the structured survey questionnaires were based on available questions and scales used in past studies and discussions with practitioners, planners, and policymakers working on the impact of climate change on rural livelihood and local adaptive capacity to water shortage.

We also adopted social and participatory tools after getting preliminary findings from the survey to collect qualitative data; they include consultative meetings with rice

farmers and commune councils. We also conducted in-depth interviews with rice farmers and key informants with commune council members. In each district, we conducted eight in-depth interviews with rice farmers and four commune councils to collect qualitative data and information regarding their livelihood and adaptive capacity to water shortage. Field observations were also made to learn how the communities were accessible to the five assets and to assess the adaptive capacity to water shortage and the engagement in water resource management.

After the preliminary findings, we organized four consultative meetings among rice farmers and four among commune councils. We organized consultative meetings in the Bakan district's Trapeang Chorng and Svay Doun Kaev communes. In Koh Sotin, we also organized Moha Khnhoung and the Prek Ta Nong commune. In each commune, a consultative meeting for rice farmers and another for commune councils. The workshop started with a presentation of the preliminary results by the team leader, followed by discussion, questions, and feedback on the findings for the validation. The workshops were also organized as forums for interaction among researchers, commune councils, and rice farmers for capacity building, validation, clarification, feedback, planning, and policy implication. This research has several limitations: fieldwork was conducted in the Bakan district, represented in the Tonle Sap Lake, and in the Mekong River, which is representative of the Mekong River. However, this research involved rice farmers, village heads, and commune councils. Providing a large sample size has enabled its results and findings to be better generalized to the context of commune levels in Bakan and Koh Sotin districts.

The research used a desk review of the secondary source and a situational and problem analysis framework to analyze the qualitative data collected in the Bakan and Koh Sotin districts. Desk review was useful for the valuation in collecting, formulating, and synthesizing existing publications. Desk review increases understanding of the context and provides insights into the effect of water shortage and adaptive capacity in

the Mekong River and Tonle Sap Lake. For survey data, we used Statistical Package for Social Science (SPSS) software for quantitative data analysis; they included Weighted Average Index (WAI), t-test, and Chi-Square.

We used a t-test to test the perception of the rice farmers in the Mekong River and the Tonle Sap Lake about the effect and cause of water shortage, local adaptive capacity, and support mechanisms to reduce the negative impacts of climate change. For example, the Chi-Square test was also applied to investigate an association between access to livelihood assets and geographical location. We used to weight average index measured on a five-point scale, and they were recorded in the SPSS software by giving the highest weight of (1) 1.00 (5/5 = 1.00) to 'very high,' (2) 0.80 (4/5 = 0.80) weight to the 'high,' (3) 0.60 (3/5 = 0.60) weight to the 'neutral,' (2) 0.40 (2/5 = 0.40) weight to the 'low,' and (5) 0.20 (1/5 = 0.20) weight to the 'very low'. The overall assessment (OA) of WAI is based on "Mean" and interpreted as (1) very high (VH) = 0.81–1.00, (2) High (H) = 0.61–0.80, (3) Neutral (N) = 0.41–0.60, Low (L) = 0.21–0.40, and Very Low (VL) = 0.00–0.20.

Profile of the Respondents

Source: google image

Most respondents were married, followed by widow/widower (6.0%) and single (2.3%). While a higher proportion of the respondents were widows/widowers (7.3%), the figure shares 1.3% of divorced status. The average age of the respondents was 49.9 years; the average age of respondents in the Mekong River (53.6 years) was older than those in the Tonle Sap Lake (46.3) (P-value=0.000). The respondents could not complete a 6-year primary education (5.3 years); it was 5.5 years in the Tonle Sap Lake and 5.1 years in the Mekong River. The respondents reported 4.7 people as household members and 4.5 people as dependents. The respondents in the Mekong River shared a higher number of household members (4.9 people) than those in the Tonle Sap Lake (P-value=0.042).

Table 1. Gender and marital status of respondents by location.

Indicator	**Tonle Sap Lake**		**Mekong River**		**Overall**	
	n=150		n=150		n=300	
	f	**%**	**f**	**%**	**f**	**%**
Gender						
Female	74	49.3	73	48.7	147	49.0
Male	76	50.7	77	51.3	153	51.0
Overall	150	100.0	150	100.0	300	100.0
Marital status						
Single	4	2.7	3	2.0	7	2.3
Married	137	91.3	136	90.7	273	91.0
Divorced	2	1.3	0	0.0	2	0.7
Widow/Widower	7	4.7	11	7.3	18	6.0
Overall	150	100.0	150	100.0	300	100.0

The number of dependents in the two study regions was similar (P-value=0.051). The respondents reported an average land size for settlement of 1,213.8 square meters; it was larger (1,785.3 square meters) in the Tonle Sap Lake than in the Tonle Sap Lake (642.2 square meters) (P-value=0.0000). For agricultural land, the average size was 22,593.0-meter squares; it was a significantly larger size (33,336.7-meter squares) in the Tonle Sap Lake than in the riverine communities of the Mekong River (11849.3-meter squares).

Table 2. Demographic characteristics of respondents by location.

Indicator	Tonle Sap Lake	Mekong River	Overall	P-value
	n=150	n=150	n=300	
Age	46.3	53.6	49.9	***0.000****
Education	5.5	5.1	5.3	0.250
Family member	4.5	4.9	4.7	**0.042***
Dependent member	4.3	4.7	4.5	0.051
Land size for resettlement (meter square)	1785.3	642.2	1213.8	***0.000****
Land size for agriculture (meter square)	33336.7	11849.3	22593.0	***0.000****
Number of secondary occupations	1.3	1.7	1.5	***0.000****

Results and Findings

Dependency on water for income and poverty

All the respondents interviewed were involved in rice cultivation as their primary job, but 92.7% of the respondents were employed in multiple jobs simultaneously. On average, the respondents were employed by 1.5 jobs; the number of jobs in the Mekong River (1.7 jobs) was significantly higher in the Tonle Sap Lake (1.3 jobs). The study confirms that a single job could not support the family (**Table 3**). As a result, the survey finds that the respondents were employed in secondary jobs such as livestock raising (48.3%), gardening (32.3%), employed work (21.3%), self-employed work (19.0%), self-employed business (11.3%), and fisherfolk (1.7%). More than half of the respondents in the Tonle Sap Lake (56.0%) were likely to work as gardeners compared to those in the Mekong River (8.7%). Bakan district has been considered one of Cambodia's rice bowls. Half of the respondents in Koh Sotin district (56.0%) were also involved in gardening. The survey records that 53.3% of the Tonle Sap Lak and 43.3% of the Mekong River raised livestock for their living.

Table 3. Types of secondary jobs by geographical location.

Indicator	Tonle Sap Lake		Mekong River		Overall	
	n=150		n=150		n=300	
	f	%	f	%	f	%
Gardener	13	8.7	84	56.0	97	**32.3**
Fisherfolk	3	2.0	2	1.3	5	1.7
Livestock raiser	80	53.3	65	43.3	145	48.3
Self-employed worker	27	18.0	30	20.0	57	19.0
Employed worker	30	20.0	34	22.7	64	21.3
Self-employed businessmen	19	12.7	15	10.0	34	11.3
Employees (i.e., Private, Public, and NGOs)	20	13.3	18	12.0	38	12.7
Other	0	0.0	0	0.0	0	0.0
Overall	**132**	**88.0**	**146**	**97.3**	**278**	**92.7**
Number of secondary occupations	**1.3**		**1.7**		**1.5**[a]	

[a]P-value**=** 0.000***

According to the Trapeang Chorng commune head, rice cultivation was the primary source of the villagers in the commune, and few of them were involved in gardening. The rice farmers derived water sources from the rain in the wet season and the irrigation in the dry season. However, the access to water from irrigation was not widely accessible throughout the commune. For example, the residents in Kab Kralanh village owned agricultural lands and could cultivate for three or four times per year. The villagers owned between half and 20 hectares of agricultural land and were well accessible to water from an irrigation system to support their crops. In contrast, the residents of Thmei village could not access water from irrigation, so most of them cultivate it once a year. The residents who owned individual ponds could have sufficient water in the dry season for their crops, and they could grow more than one timer per year.

Table 4. finds that rice cultivation will remain the outstanding job for almost all respondents (94.0%) in the two study regions. Only a few respondents wished to shift to self-business operation (3.3%), especially those who resided in the Tonle Sap Lake (6.0%). During consultative meetings, rice farmers in Koh Sotin and Bakan districts

described how important rice cultivation was to their daily consumption and sources of annual incomes for rural livelihoods for hundreds of years. However, the young population has migrated for non-farm activities; the older generation still prefers to stay in the communities and cultivate rice, especially in the Bakan district. The residents of Angkor Chey Leu and Angkor Chey Kraom villages of Koh Sotin district described that some villagers have returned to get involved in rice cultivation in recent years, especially in 2024, because of increased rice prices.

Table 4. Primary job in the next decade by geographical location.

Indicator	**Tonle Sap Lake**		**Mekong River**		**Overall**	
	n=150		n=150		n=300	
	f	**%**	**f**	**%**	**F**	**%**
Rice Farmer	135	90.0	147	98.0	282	94.0
Gardener	0	0.0	0	0.0	0	0.0
Fishman	1	0.7	0	0.0	1	0.3
Animal Raising	0	0.0	0	0.0	0	0.0
Self Employed Worker	2	1.3	2	1.3	4	1.3
Employee	1	0.7	0	0.0	1	0.3
Business Owner	9	6.0	1	0.7	10	3.3
Staff (i.e., Private, Public, and NGOs)	2	1.3	0	0.0	2	0.7
Other	0	0.00	0	0.0	0	0.0
Overall	150	100.0	150	100.0	300	100.0

To supply sufficient water during the dry season, rice farmers use individual ponds to cultivate. At a consultative meeting among rice farmers in Svay Doun Kaev commune of Bakan district, rice prices in 2014 were highly satisfied, and it was as high as 1.1 million riels if compared to 80 thousand or 90 thousand riels in the past few years. The farmers must earn income from rice cultivation this year [2024]. For example, if they owned 10 hectares of agricultural land, crops from three of them could cover all the costs.

The survey finds that 62.7% of the respondents cultivated their crops in rainy and dry seasons, 85.3% in the Tonle Sap Lake, and 40.0% in the Mekong River. In the Mekong River, 60.0% of the respondents only cultivated their crops for rainy reasons, compared to 14.0% in the Tonle Sap Lake. The figure confirms that crop cultivation in the dry

season was not the only choice because access to sufficient water remained an issue for small-scale farmers. Farmers, during the consultative meetings organized in Koh Sotin and Bakan districts, were informed that between October and April is the dry season and May until September is the rainy season. The farmers noticed that the heaviest rain commonly falls between August and September. The consultative with commune councils (CoCs) in the two study districts also affirms that rice cultivation has been primarily rain-fed, so wet rice remained highly active. During the dry season, farmers who could afford access to water from supplementary irrigation, including irrigation systems, dykes, lakes, and ponds, were able to grow second crops of the year.

Table 5. Cultivating seasons by geographical location.

Indicator	**Tonle Sap Lake**		**Mekong River**		**Overall**	
	n=150		n=150		n=300	
	f	%	f	%	f	%
Rainy season only	21	14.0	90	60.0	111	37.0
Dry season only	1	0.7	0	0.0	1	0.3
Both seasons	128	85.3	60	40.0	188	62.7
Overall	150	100.0	150	100.0	300	100.0

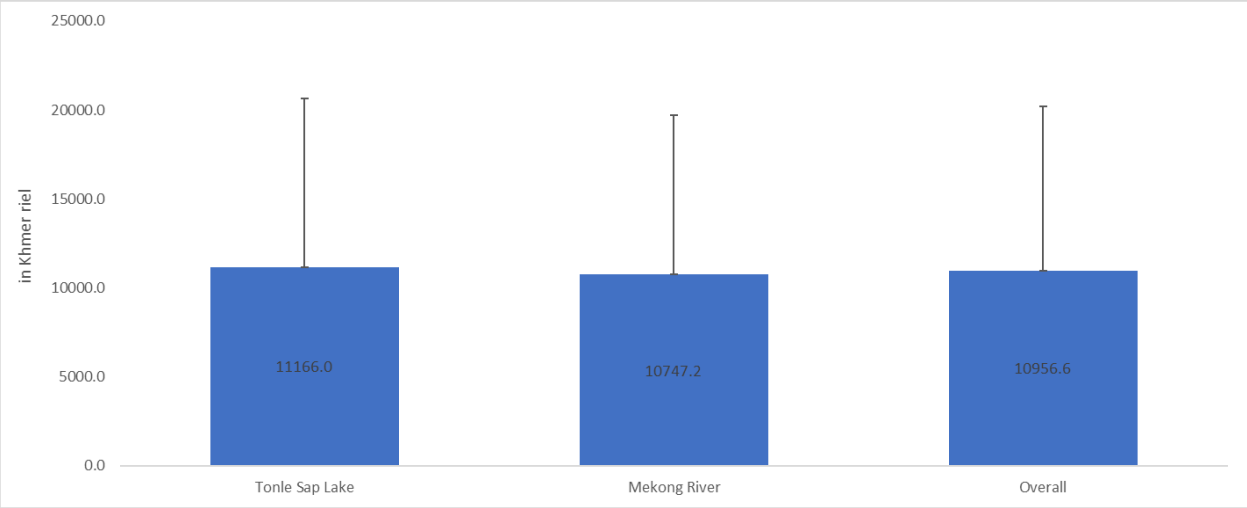
The consultative meeting will be held with residents in Kampout Ang village of Svay Doun Kaev in Bakan district. Short-term rice is cultivated for the first crop in May, and the yield is collected in August or September. Between September and November, paddy fields and Tonle Sap Lake were flooded by water from the streams. The residents started the second crop in November and collected yield in March. During consultative meetings in the two study districts, the residents and Commune Councils affirmed. that rice farmers could cultivate three crops if they were accessible to sufficient water. The survey recorded 63.7% of the residents involved in two crops derived from 86.7% in the Tonle Sap Lake and 40.7% in the Mekong River. During the consultative meeting, Commune Councils in Moha Khnhoung commune described alternative water sources for agriculture, such as hand pumps and ponds for use in the dry season.

ID-Poor has been widely granted to low-income households based on the national criteria the Ministry of Planning (MoP) implemented. **Table 6** records 8.7% of the respondents holding ID-Poor; it was 9.3% in the Mekong River and 8.0% in the Tonle Sap Lake. A commune council member in Trapeang Chorng commune pronounced that cardholders were eligible to access different types of social benefits such as free health services, cash payments, and subsidies. A head in Angkor Chey Kraom village claimed that ID-Poor households were always prioritized for donations and support during emergencies like floods, droughts, and storms. They were identified as a vulnerable group, so government agencies, Non-governmental Organizations, and private companies supported or provided donations based on the ID-Poor. If they did not have sufficient, ID-Poor 1 holders were prioritized and followed by ID-Poor II.

Table 6. ID Poor Status of respondents by geographical location**.**

Indicator	**Tonle Sap Lake**		**Mekong River**		**Overall**	
	n=150		n=150		n=300	
	f	%	f	%	f	%
Holding ID Poor						
Yes	12	8.0	14	9.3	26	8.7
No	138	92.0	136	90.7	274	91.3
Overall	150	100.0	150	100.0	300	100.0
Types of ID Poor						
ID Poor I	2	16.7	2	14.3	4	15.4
ID Poor II	10	83.3	12	85.7	22	84.6
Overall	12	100.0	14	100.0	26	100.0

Figure 1. Income per capita by geographical location.

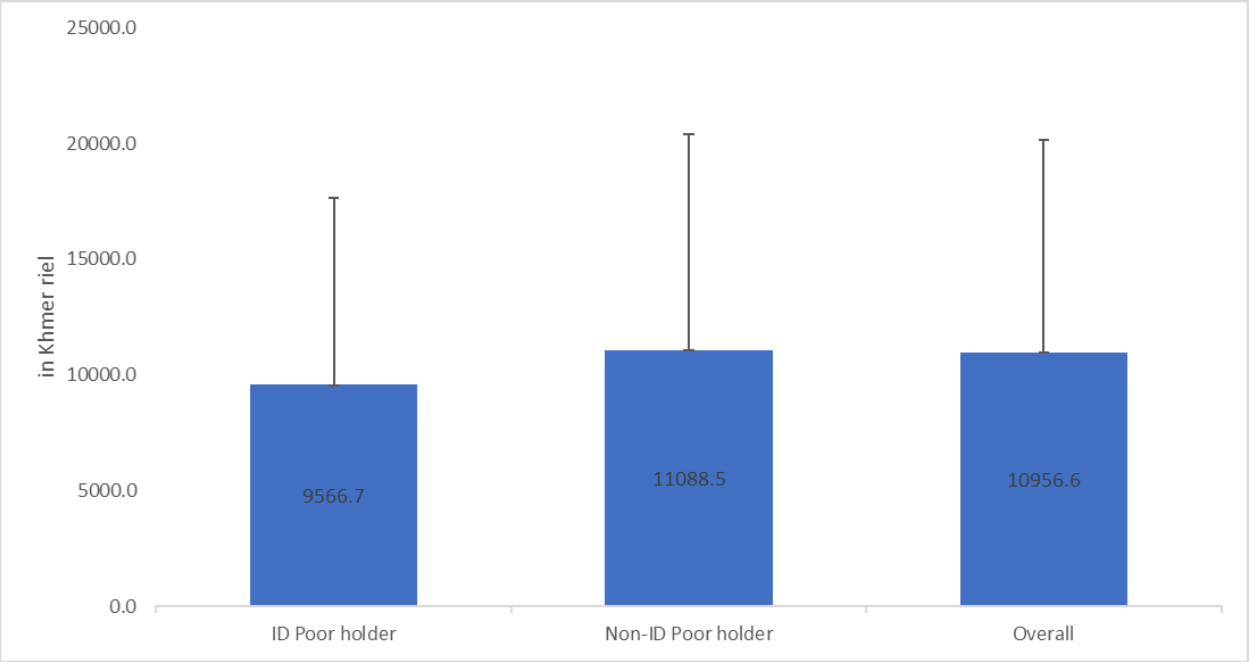


P-*value*: 0.695.

Every household was asked to report their income by listing all their incomes from farm and non-farm. On average, income per capita was 10956.6 Riel derived from 11166.0 Riel in Tonle Sap Lake and 10747.2 Riel in Mekong River. The average income per capita in Tonle Sap Lake and the Mekong River were not significantly different (P-value=0.695). The residents with ID Poor (9566.7 Riels) earned similarly to the residents with ID Poor (11088.5 Riels) (P-*value*: 0.279).

While monthly income per capita was not significantly different from the rural poverty line (P-value = 0.000), it was not significantly different from the national poverty line (P-value =0.992). In 2021, the Ministry of Planning (MoP) set 10926.6 riels per day per capita as the national poverty line and 8,908 Riels per day per capita as the rural poverty line.

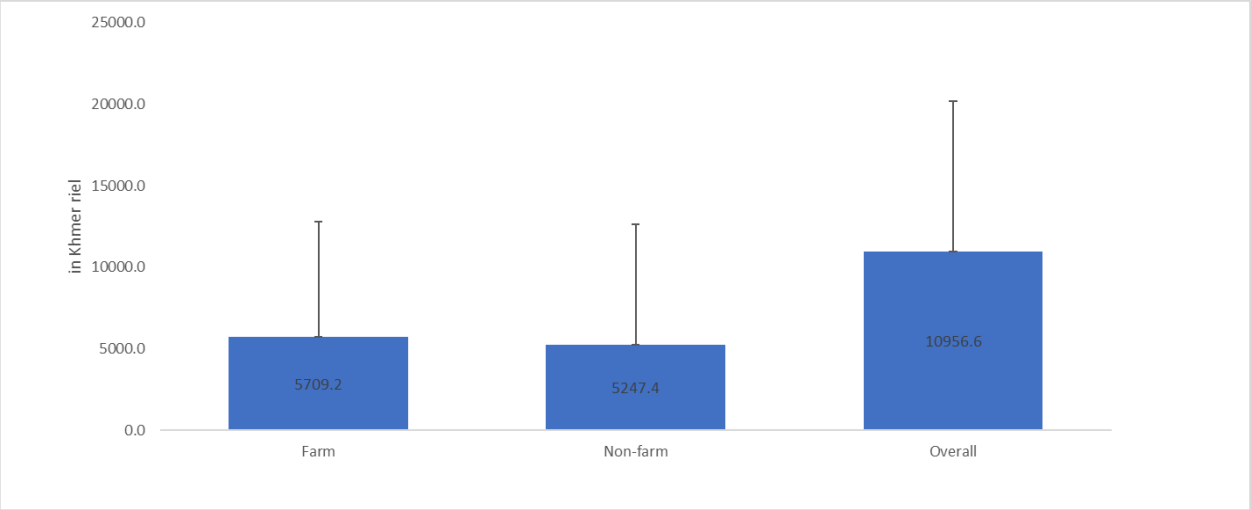
Figure 1. Incomer per capita by ID Poor holding.



P-*value*: 0.279.

In addition, the average income per capita from farms and non-farm farms was also not significantly different (P-value=0.474). Therefore, income sources from farms (5709.2 riels) and non-farm farms (52.47.2 riels) shared similar importance to rural livelihoods. During the household survey, the residents shared the roles and responsibilities of their households for income generation-related activities. Younger household members worked in nonfarm activities, and younger ones engaged in farm activities. In Thmei village of Rumlech commune in Bakan district, the residents opted for non-farm work and migrated to Phnom Penh, Thailand, or other provinces for jobs in construction and services. Young people also migrated to work in South Korea and Japan and sent remittances home for daily consumption and savings. The consultative meeting in Koh Sotin district shows that the communities did not have many jobs in the non-farm sector, so they had to migrate at least to Kampong Cham provincial town or Phnom Penh.

Figure 2. Incomer per capita by farm and non-farm.



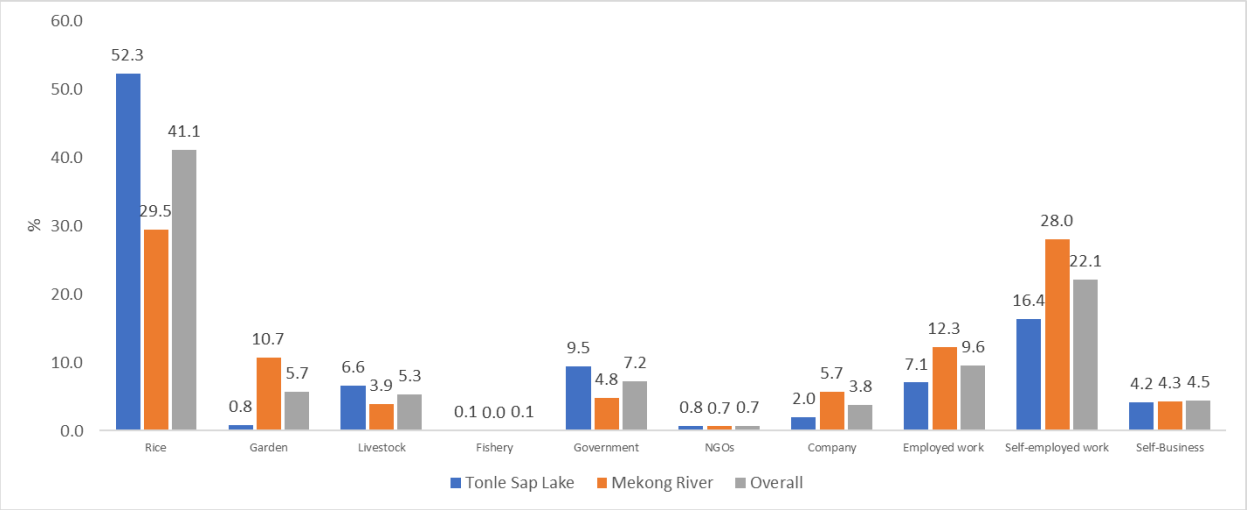
P-*value*=0.474.

The survey finds that household income was mainly derived from rice cultivation (41.1%), self-employed work (22.1%), employed work (9.6%), government (7.2%), gardening (5.7%), livestock raising (5.3%), and self-business (4.5%). Only a small proportion of the respondents were fisherfolk, especially in the Tonle Sap Lake. Comparatively, more than half of the respondents were rice farmers in Tonle Sap Lake (52.3%) and only 29.5% in the Mekong River. A high proportion of the respondents in the Tonle Sap Lake were employed as self-employed workers (28.0%), employed workers (12.3%), and gardeners (10.7%). In the riverine communities along the Mekong River, 28.0% of the respondents worked as self-employed workers, followed by 10.7% as gardeners and 12.3% as employed workers.

The consultative meeting in Bakan and Koh Sotin districts confirms that income sources are becoming more diversified. A breadwinner decides who is involved in the farm and non-farm work for their household income. In the past decades, rice farmers used machines for farming and reduced human and animal dependence, like cows and buffalo, for agriculture. Therefore, young people could be involved in non-farm work. The residents in Preaek Ta Nong commune of Koh Sotin district grow rice, crops, and

vegetables and raise livestock. The residents owned between half and three hectares. They preferred to grow short-term rice, including OM and 504, because they were easier and had markets from Vietnam.

Figure 3. Percentage of daily income per capita by sources and geographical location.



Access to the five livelihood assets

The Mekong River and the Tonle Sap Lake are the main water sources for Cambodian people. The Tonle Sap Lake respondents assessed high water accessibility for their daily consumption and agriculture-related activities (P-value=0.000). The residents rated it as having a high degree of accessibility, especially for bathing, drinking, cooking, and washing. However, the respondents rated a moderate degree of accessibility to water for rice cultivation and crop cultivation. T-test analysis confirms that the respondents in the Mekong River were more accessible to water for bathing (P-value=0.000), drinking (P-value=0.000), cooking (P-value=0.000), and washing (P-value=0.000).

However, the accessibility to water for rice cultivation was not significant (P-value=0.006); the respondents in the Tonle Sap Lake were more reachable to water for crop cultivation (P-value=0.002). Access to water depends upon the availability of

physical infrastructure and the affordability of individuals paying for services to bring water to their paddy fields. The residents agreed that water for their daily consumption was sufficient, but they faced challenges accessing water for agriculture-related activities. The residents in some of the Bakan and Koh Sotin districts had access to a water supply, so they used it for drinking, cooking, washing, and bathing.

Table 7. Access to water for consumption by geographical location.

Indicator	**Tonle Sap Lake**		**Mekong River**		**Overall**		**P-value**
	n=150		n=150		n=300		
	WAI	OA	WAI	OA	WAI	OA	
Water for bathing	0.71	H	0.79	H	0.75	H	***0.000****
Water for drinking	0.71	H	0.78	H	0.74	H	***0.000****
Water for cooking	0.71	H	0.78	H	0.74	H	***0.000****
Water for washing	0.70	H	0.78	H	0.74	H	***0.000****
Water for rice cultivation	0.52	M	0.50	M	0.51	M	0.066
Water for crop cultivation	0.53	M	0.47	M	0.50	M	***0.002****
Overall	0.65	H	0.68	H	0.66	H	***0.000****

Note: WAI = weight average index measured on a five-point scale [Very Low (VL) = 0.01–0.20, Low (L) = 0.21– 0.40, Moderate (M) = 0.41–0.60, High (H) = 0.61–0.80, Very High (VH) = 0.81–1.00]. OA = Overall assessment. Significance at the 0.05 level.

The respondents rated the degree of access to natural assets, including aquaculture, forests, wildlife, and birds, as low. The individual interviews with the residents confirmed that local markets are the main sources of their food; they could not access fish, aquaculture, forests, wildlife, and birds for their consumption and income-generation activities anymore. Water from the Tonle Sap Lake and the Mekong River were the main sources of their livelihood because they were involved in agriculture-related activities.

Table 8. Access to natural resources by geographical location.

Indicator	**Tonle Sap Lake**		**Mekong River**		**Overall**		**P-value**
	n=150		n=150		n=300		
	WAI	OA	WAI	OA	WAI	OA	

Fishery	0.37	L	0.34	L	0.36	L	0.100
Aquaculture	0.29	L	0.27	L	0.28	L	0.137
Forest	0.30	L	0.31	L	0.30	L	0.679
Wildlife	0.26	L	0.25	L	0.26	L	0.620
Bird	0.26	L	0.25	L	0.26	L	0.352
Overall	0.35	L	0.33	L	0.34	L	0.134

Note: WAI = weight average index measured on a five-point scale [Very Low (VL) = 0.01–0.20, Low (L) = 0.21– 0.40, Moderate (M) = 0.41–0.60, High (H) = 0.61–0.80, Very High (VH) = 0.81–1.00].
OA = Overall assessment. Significance at the 0.05 level.

The Tonle Sap Lake and the Mekong River respondents similarly assessed low accessibility to professional skills, such as gardening, small and medium enterprises, construction, and driving. The assessment was moderate for rice farming, moderate in the Tonle Sap Lake, and low in the Mekong River (P-value=0.001). The residents grow rice or crops by learning from one generation to another; they do not attend courses. The Provincial Department of Agriculture and Non-governmental Organizations (NGOs) raised some awareness, knowledge, and techniques to increase crop and livestock productivity. The residents also faced difficulty in seeking professional skills that were important for their careers, such as driving, construction, and small and medium enterprises.

Table 9. Access to professional skills by geographical location.

Indicator	**Tonle Sap Lake**		**Mekong River**		**Overall**		**P-value**
	n=150		n=150		n=300		
	WAI	**OA**	**WAI**	**OA**	**WAI**	**OA**	
Rice farming	0.45	M	0.39	L	0.42	M	***0.001****
Chamkar (i.e., vegetable and fruit)	0.36	L	0.40	L	0.38	L	***0.013****
Small and medium enterprise	0.29	L	0.30	L	0.30	L	0.782
Construction	0.30	L	0.29	L	0.30	L	0.844
Driving	0.33	L	0.32	L	0.33	L	0.347
Overall	0.35	L	0.34	L	0.34	L	0.615

Note: WAI = weight average index measured on a five-point scale [Very Low (VL) = 0.01–0.20, Low (L) = 0.21– 0.40, Moderate (M) = 0.41–0.60, High (H) = 0.61–0.80, Very High (VH) = 0.81–1.00].
OA = Overall assessment. Significance at the 0.05 level.

Overall, the respondents similarly rated high access to sufficient physical assets, including roads, local markets, health facilities, school facilities for children, transportation, and roads (P-value=0.244). The respondents assessed moderate degree of sufficient access to bridges and irrigation. The respondents in the Tonle Sap Lake rated a high degree of sufficient access to irrigation and a moderate degree of sufficient access in the Mekong River. T-test analysis finds that the respondents in the Tonle Sap Lake were likely to assess a higher degree of access to irrigation (P-value=0.000) and health facilities (P-value=0.042).

Table 10. Access to physical infrastructures by geographical location.

Indicator	**Tonle Sap Lake**		**Mekong River**		**Overall**		**P-value**
	n=150		n=150		n=300		
	WAI	OA	WAI	OA	WAI	OA	
Road	0.68	H	0.70	H	0.69	H	0.244
Bridge	0.58	M	0.58	M	0.58	M	0.786
Irrigation	0.61	H	0.51	M	0.56	M	***0.000******
Local market	0.61	H	0.63	H	0.62	H	0.255
Health facilities	0.71	H	0.68	H	0.69	H	***0.042****
School facilities for children	0.71	H	0.72	H	0.72	H	0.658
Transportation	0.66	H	0.67	H	0.67	H	0.329
Road	0.65	H	0.64	H	0.65	H	0.263
Overall	0.68	H	0.70	H	0.69	H	0.244

Note: WAI = weight average index measured on a five-point scale [Very Low (VL) = 0.01–0.20, Low (L) = 0.21– 0.40, Moderate (M) = 0.41–0.60, High (H) = 0.61–0.80, Very High (VH) = 0.81–1.00].
OA = Overall assessment. Significance at the 0.05 level.

The consultative meeting among commune councils in the two study regions shows that physical infrastructure is the top priority sector in the commune investment plan (CIP). Every year, the commune invests in constructing and improving physical infrastructure, especially roads and bridges. However, irrigation systems have also been listed as the top priority; the annual CIP funds were insufficient for constructing or improving irrigation systems. The residents in Preaek Ta Nong commune of Koh Sotin district describe their difficulty due to insufficient access to physical infrastructure, especially local markets, transportation, and road conditions.

Overall, the respondents rated moderate opportunities to participate in activities supporting community and social development. T-test analysis found that the respondents in the Tonle Sap Lake had sufficiently more opportunity to participate in community and social development activities. The respondents shared a similar moderate degree of raising concerns about community development, participating in Commune Council (CoC) activities, and involvement in community decision-making. However, the respondents rated a moderate degree of participation in activities organized by NGOs in the Tonle Sap Lake; it was a moderate degree of engagement in community and social development (P-value=0.008). The survey finds that the respondents rate a low degree of opportunities in activities carried out by government agencies. T-test analysis shows that the respondents in the Tonle Sap Lake shared a high degree of opportunities to engage in activities carried out by government agencies.

Table 11. Access to social participation by geographical location.

Indicator	**Tonle Sap Lake**		**Mekong River**		**Overall**		**P-value**
	n=150		n=150		n=300		
	WAI	OA	WAI	OA	WAI	OA	
Raised concerns about community development	0.46	M	0.43	M	0.45	M	0.207
Participate in activities of NGOs	0.41	M	0.35	L	0.38	L	***0.008****
Participate in activities of the Commune Council	0.55	M	0.54	M	0.55	M	0.574
Participate in activities of government agencies	0.39	L	0.34	L	0.36	L	***0.020****
Involve in community decision-making	0.45	M	0.41	M	0.43	M	0.051
Overall	0.45	M	0.42	M	0.43	M	***0.026****

Note: WAI = weight average index measured on a five-point scale [Very Low (VL) = 0.01–0.20, Low (L) = 0.21– 0.40, Moderate (M) = 0.41–0.60, High (H) = 0.61–0.80, Very High (VH) = 0.81–1.00].
OA = Overall assessment. Significance at the 0.05 level.

Local authorities in Trapeang Chorng commune in the two study districts explained the importance of Non-governmental Organizations (NGOs) in promoting social participation, including community meetings, outreach programs, and campaigns. The consultative meetings in both regions find roles of commune councils to allow the

residents to participate in the development of CIP. The residents also had the opportunity to raise their concerns and make some decisions about development projects to be included in the annual CIP. At the same time, the residents did not have much chance to work directly with the villagers, and they had some work with district and commune officers.

Overall, the respondents rated a moderate degree of accessibility to financial assets, a higher degree in the Tonle Sap Lake (P-value=0.041). In the Tonle Sap Lake, the respondents were highly accessible to microfinance for loans; it was moderately accessible to the Mekong River (P-value=0.044). The respondents in the Tonle Sap Lake also rated a significantly higher degree of accessibility to Commercial banks for loans (P-value=0.000) and Local lenders for loans (Value=0.048).

Table 12. Access to financial resources for investment by geographical location.

Indicator	**Tonle Sap Lake**		**Mekong River**		**Overall**		**P-value**
	n=150		n=150		n=300		
	WAI	**OA**	**WAI**	**OA**	**WAI**	**OA**	
Microfinance for loan	0.61	H	0.58	M	0.60	M	***0.044****
Commercial bank for a loan	0.52	M	0.45	M	0.49	M	***0.000*****
Local lander for loans	0.59	M	0.56	M	0.57	M	***0.048****
Saving group	0.48	M	0.46	M	0.47	M	0.328
Income generation activities	0.46	M	0.46	M	0.46	M	0.948
Overall	0.53	M	0.50	M	0.52	M	***0.041****

Note: WAI = weight average index measured on a five-point scale [Very Low (VL) = 0.01–0.20, Low (L) = 0.21– 0.40, Moderate (M) = 0.41–0.60, High (H) = 0.61–0.80, Very High (VH) = 0.81–1.00].
OA = Overall assessment. Significance at the 0.05 level.

Overall, the residents of Koh Sotin district could access commercial banks and microfinance for loans in Kampong Cham provincial town. Some officers from Microfinance also traveled to the commune for clients. In the Bankan district, some microfinance is located along the national highways where the residents can request loans. The residents claimed during the consultative meeting in Moha Khnhoung commune that financial assets were widely accessible for investment and expansion of

commercial activities and agricultural activities, but the interest rate is relatively high. The residents of the Bakan district also raised concerns about high interest rates and cheap and unstable paddy rice prices. Many rice farmers were in debt when they took loans from commercial banks or microfinance, and their crops were destroyed by floods or drought.

Impact of water shortage and local adaptation

Overall, the Tonle Sap Lake respondents rated a higher degree of impact of climatic hazard on crop cultivation (P-value=0.000). The respondents assessed a moderate degree of the impact of natural hazards on crop cultivation by natural hazards. They rated a high degree of drought, a moderate degree of flood, and a low degree of storm. While the respondents rated a moderate degree of flood impact in the Tonle Sap Lake, it was rated low in the Mekong River. The consultative meetings in the two regions confirmed that drought had the most effects on crops because of the alternative water sources for agriculture; for example, irrigation systems, ponds, and pumps could not supply sufficient water. The residents complained that if they started to grow rice or crops and then water shortage and drought existed, they faced great losses. A resident of Kampout Ang, a villager of Svay Doun Kaev commune, observed that flood and drought similarly affected the communities of the Tonle Sap Lake. While there was more water in some years from the rain and the Lake, the residents faced less water in some years.

Table 13. Impact of climatic hazard on crop cultivation by geographical location.

Indicator	**Tonle Sap Lake**		**Mekong River**		**Overall**		**P-value**
	n=150		n=150		n=300		
	WAI	OA	WAI	OA	WAI	OA	
Flood	0.48	M	0.36	L	0.42	M	***0.000******
Droughts	0.68	H	0.69	H	0.69	H	0.616
Storms	0.39	L	0.35	L	0.37	L	***0.019****
Overall	0.52	M	0.47	M	0.49	M	***0.000******

Note: WAI = weight average index measured on a five-point scale [Very Low (VL) = 0.01–0.20, Low (L) = 0.21– 0.40, Moderate (M) = 0.41–0.60, High (H) = 0.61–0.80, Very High (VH) = 0.81–1.00].
OA = Overall assessment. Significance at the 0.05 level.

Almost all the respondents (99.3%) agreed that there is sufficient access to water for cultivation and insufficient water for crops in the dry season (91.3%), especially in Tonle Sap Lake (98.7%). The commune head in Moha Khnhoung declared that rainwater was not certain anymore, and rice farmers found it hard to plan cropping. Rice farmers expected little from constructing irrigation systems to support their agriculture-related activities. Still, they chose supplementary irrigation for individual ponds, wells, and pumping machines. In the rainy season, the rice farmers are deeply dependent on water from the rain and water from wetlands, including rivers, lakes, swamps, dyke, and ponds. The residents in Moha Khnhoung commune of Koh Sotin district used water from the Mekong River between August and October for the first crop.

The residents depended on rain for the second crop for their rice cultivation. The residents may alternatively use water from the well if rain is insufficient. In Bakan district, Preaek Ta Nong commune residents cultivate the first crop between October and January and the second between January and March. Few of them could cultivate the third crop between March and May. Water from the well was the main source of this commune's third crop. In Bakan, the residents of Svay Doun Kaev commune cultivated between May and September for the first crop and from November to March for the second crop. In 2023, the rice of most of the households in Kampout Ang village was damaged by water shortage during the second crop.

Table 14. Damage of crops due to water sufficiency by geographical location.

Indicator	**Tonle Sap Lake**		**Mekong River**		**Overall**	
	n=150		n=150		n=300	
	f	%	f	%	f	%
Which season has sufficient water for your crop?						
Wet season	150	100.00	148	98.67	298	99.33
Dry season	0	0.00	2	1.33	2	0.67
Overall	150	100.00	150	100.00	300	100.00

Which season has insufficient water for your crop?						
Wet season	2	1.33	24	16.00	26	8.67
Dry season	148	98.67	126	84.00	274	91.33
Overall	150	100.00	150	100.00	300	100.00

Overall, the respondents strongly agreed with the negative impacts of water shortages; both study regions were similarly affected (P-value=0.199). They strongly agreed that water shortages threatened household food scarcity, caused conflict over water scarcity, affected health, caused malnutrition, caused debts, and caused spending on festivals. They also agreed that water shortages caused no choice in food preference and affected children's schooling. The consultative meetings organized in the two regions reveal the significance of water for rural livelihoods. Water is life because more water signifies more availability of consumption and sources of income. Rice has provided rural livelihoods with seasonal and annual incomes to support their livelihoods and daily consumption.

The residents in Svay Doun Kaev commune described the importance of water for livelihoods in the Bakan district, so the villagers were fighting for water to supply their paddy fields, especially during the dry season. In 2019, rice farmers in the Bakan district faced serious water shortages and conflict among farmers to access water. The villagers, who stayed near water sources, grasped water and did not release it for further part. In the Koh Sotin district, the residents felt similarly hard to access water if they were away from water sources. The residents mainly controlled water, which was adjunct to the water sources.

Table 15. Perception towards the effects of water shortages by location.

Indicator	**Tonle Sap Lake**		**Mekong River**		**Overall**		**P-value**
	n=150		n=150		n=300		
	WAI	OA	WAI	OA	WAI	OA	
Water shortage threatened household food scarcity	0.86	SA	0.89	SA	0.87	SA	***0.033****

Water shortage caused conflict for water scarcity	0.91	SA	0.85	SA	0.88	SA	***0.000******
Water shortage caused no choice in food preference	0.80	A	0.78	A	0.79	A	0.275
Water shortage affects the health	0.87	SA	0.88	SA	0.88	SA	0.670
Water shortage causes malnutrition	0.83	SA	0.81	SA	0.82	SA	0.106
Water shortage affected the schooling of children	0.76	A	0.77	A	0.76	A	0.756
Water shortage caused population migration	0.83	SA	0.79	A	0.81	SA	***0.002****
Water shortage caused debts	0.81	SA	0.80	A	0.81	SA	0.346
Water shortage caused unemployment	0.79	A	0.78	A	0.78	A	0.647
Water shortage caused in spending on festivals	0.83	SA	0.84	SA	0.84	SA	0.398
Overall	0.83	SA	0.82	SA	0.82	SA	0.199

Note: WAI = weight average index measured on a five-point scale [Strongly Disagree (SD) = 0.01–0.20, Disagree (D) = 0.21– 0.40, Undecided (U) = 0.41–0.60, Agree (A) = 0.61–0.80, Strongly Agree (SA) = 0.81–1.00]. OA = Overall assessment. Significance at the 0.05 level.

Water shortage has affected the socio-economics of rural people, including rice production and health. The respondents shared their views and insights regarding the negative impacts of water shortage; most identified disease attacks (77.7%) and the inability to farm (60.0%). Half of the respondents also confirmed that water shortage has reduced production, delayed crop harvest, and hampered rice production. Most respondents (93.3%) were worried about disease attacks in the Mekong River.

Table 16. Impact of water shortage on rural livelihood by geographical location.

Indicator	**Tonle Sap Lake**		**Mekong River**		**Overall**	
	n=150		n=150		n=300	
	f	%	f	%	F	%
Reduce crop production	83	55.3	90	60.0	173	57.7
Delay in crop harvest	79	52.7	83	55.3	162	54.0
Disease attack	93	62.0	140	93.3	233	77.7
Unable to agriculture	97	64.7	83	55.3	180	60.0
Hamper rice production	75	50.0	85	56.7	160	53.3

Table 16 shows that water shortages caused skin problems (93.0%), fewer (79.3%), dysentery (44.0%), Diarrhea (27.0%), and typhoid (3.7%). The consultative meetings with residents and commune heads in the two study regions did not provide clear and scientific reasons for why those diseases affected them. Further and in-depth studies are required to prove scientifically what diseases are caused by water shortage. The experts described some common diseases caused by A lack of clean water that increases the risk of diarrhoeal diseases, such as cholera, typhoid fever, dysentery, and other water-borne tropical diseases. Moreover, water scarcity also leads to diseases such as trachoma, plague, and typhus.

Table 17. Impact of water shortage on human health by geographical location.

Indicator	**Tonle Sap Lake**		**Mekong River**		**Overall**	
	n=150		n=150		n=300	
	f	%	f	%	F	%
Diarrhea	51	34.0	30	20.0	81	27.0
Typhoid	9	6.0	2	1.3	11	3.7
Skin Problems	133	88.7	146	97.3	279	93.0
Dysentery	53	35.3	79	52.7	132	44.0
Fever	135	90.0	103	68.7	238	79.3

In adapting to changes in water shortage and scarcity, the respondents changed their crop calendar, switched to less water-consuming crops, kept unsown after the possibility of drought, changed traditional irrigation practices to modern ones (e.g., sprinkler, drip irrigation, etc.), Used water harvesting through farm ponds, and used in-situ conservation practices. The survey shows that the respondents assessed a moderate degree of change in attitudes towards water shortage.

Table 18. Change in attitudes towards water shortage by geographical location. Changes in attitudes towards water shortage were similarly assessed by the respondents in the Tonle Sap Lake and the Mekong River (P-value=0.135).

Table 18. Attitudes towards water shortage in the Tonle Sap Lake and the Mekong River.

Indicator	Tonle Sap Lake		Mekong River		Overall		P-value
	n=150		n=150		n=300		
	WAI	OA	WAI	OA	WAI	OA	
Change crop calendar	0.57	M	0.56	M	0.57	M	0.425
Change to less water-consuming crop	0.61	H	0.60	M	0.60	M	0.714
Keep using unsown after the possibility of drought	0.51	M	0.56	M	0.53	M	***0.004****
Change traditional irrigation practices to modern ones	0.55	M	0.50	M	0.53	M	***0.005****
Use water harvesting through farm ponds, in-situ conservation practice	0.49	M	0.61	M	0.55	M	***0.000*****
Overall	0.55	M	0.56	M	0.56	M	0.135

Note: WAI = weight average index measured on a five-point scale [Very Low (VL) = 0.01–0.20, Low (L) = 0.21– 0.40, Moderate (M) = 0.41–0.60, High (H) = 0.61–0.80, Very High (VH) = 0.81–1.00].
OA = Overall assessment. Significance at the 0.05 level.

In Trapeang Chorng commune of Bakan district, the residents in Kab Kralanh village shifted from long-term to short-term rice cultivation, for example, OM and 504. Short-term rice crops require less water for cultivation, and the farmers can grow them multiple times yearly. Moreover, short-term rice has a good market in Vietnam and provides a high yield of between four and five tons per hectare. The Bakan and Koh Sotin district residents similarly adopted water shortage using supplementary irrigations, including individual pump machines, wells, and ponds for agriculture-related activities. Rice farmers in Moha Khnhoung commune of Koh Sotin district faced difficulty getting the wells because of the high cost and lack of underground water. The consultative meeting in the two study regions also recorded migration from the communities as the alternative to reduce the impact of water shortage on their livelihoods. The respondent rated a high degree of their ability to adapt to unexpected drought; they rated a low degree of an increasing saltwater intrusion.

The respondent assessed a moderate degree of their ability to adapt to water shortage; those in the Mekong River shared a higher degree (P-value=0.000). In general, the residents did not know what an increase in saltwater intrusion is, and they could not identify it except the provincial officers. The respondents assessed a moderate degree of their ability to withstand shocks and stress, changes in water level, Temperature–getting hotter, Water level–getting lower, unexpected flooding incidents, violent storms, and thunders leading to death.

Table 19. Ability to adapt to changes in water resources by geographical location.

Indicator	**Tonle Sap Lake**		**Mekong River**		**Overall**		**P-value**
	n=150		n=150		n=300		
	WAI	OA	WAI	OA	WAI	OA	
Shocks, Stress	0.45	M	0.49	M	0.47	M	0.064
Change in water level	0.42	M	0.48	M	0.45	M	***0.010****
Temperature–getting hotter	0.49	M	0.59	M	0.54	M	***0.000*****
Water level–getting lower	0.44	M	0.49	M	0.46	M	***0.039****
Increasing saltwater intrusion	0.29	L	0.31	L	0.30	L	0.240
Unexpected flooding incident	0.53	M	0.64	H	0.59	M	***0.000*****
Unexpected drought	0.58	M	0.65	H	0.61	H	***0.000*****
Violate storm	0.51	M	0.64	H	0.58	M	***0.000*****
Thundering	0.44	M	0.46	M	0.45	M	0.319
Overall	0.46	M	0.53	M	0.49	M	***0.000*****

Note: WAI = weight average index measured on a five-point scale [Very Low (VL) = 0.01–0.20, Low (L) = 0.21– 0.40, Moderate (M) = 0.41–0.60, High (H) = 0.61–0.80, Very High (VH) = 0.81–1.00].
OA = Overall assessment. Significance at the 0.05 level.

The commune councils in the Bakan district explained that residents' ability to cope with the water change is low because they require physical infrastructure to reduce their vulnerability. In the communities, some NGOs have worked to raise awareness and information among the residents regarding water management and climate change. Knowledge earned from NGOs has helped the residents to cope with the impact of climate change and water shortage to some extent. However, the residents require better physical infrastructure, for example, irrigation systems, roads, bridges, and safety

hills, to reduce the impact of water change. The residents also claim they were familiar with extreme events such as floods, droughts, and storms. The more frequently they happen, the higher their ability to cope with them.

The respondents applied various Indigenous knowledge to reduce the negative impact of water shortage; the respondents in the two study regions similarly assessed a moderate degree of their ability to change practice toward the negative impact of water shortage (P-value=0.068). The respondents assessed the high degree of changing crops, improving the number of herbicides and pesticides, and increasing the amount of fertilizer. The respondents rated their ability to change practices toward the negative impact of water shortage, for example, reducing cultivation area, diversifying crops, improving cultivation, advancing technique, improving cultivation facilities, and improving irrigation system. The respondent rated a low degree of their ability to buy agricultural insurance. The residents of Khnar Totueng village in Boeng Khnar commune of Bakan district have started using advanced technology, such as tractors, fertilizer, and chemicals, to increase their productivity. During the consultative meeting in Trapeang Chorng commune, some residents were involved in the insurance scheme with NGOs to cover losses and damage from floods and droughts. The residents also confirmed that no private companies could provide agricultural insurance yet, and NGOs have operated in small schemes. In the Koh Sotin district, the residents diversified crops by cultivating rice and growing crops and vegetables to increase their sources of consumption and income.

Table 20. Ability to change practice toward the negative impact of water shortage.

Indicator	**Tonle Sap Lake**		**Mekong River**		**Overall**		**P-value**
	n=150		n=150		n=300		
	WAI	OA	WAI	OA	WAI	OA	
Reduce cultivation area	0.51	M	0.54	M	0.52	M	0.164
Change crops	0.63	H	0.63	H	0.63	H	0.847

Diversify crops	0.39	L	0.48	M	0.43	M	***0.000****
Improve cultivation	0.52	M	0.58	M	0.55	M	***0.000****
Advance technique	0.51	M	0.54	M	0.52	M	0.154
Improve cultivation facilities	0.45	M	0.52	M	0.49	M	***0.001****
Improve the number of herbicides and pesticides	0.66	H	0.63	H	0.64	H	***0.032****
Increase the amount of fertilizer	0.65	H	0.63	H	0.64	H	0.297
Improve irrigation system	0.49	M	0.50	M	0.50	M	0.545
Buy agricultural insurance	0.38	L	0.38	L	0.38	L	0.849
Overall	0.52	M	0.54	M	0.53	M	0.068

Note: WAI = weight average index measured on a five-point scale [Very Low (VL) = 0.01–0.20, Low (L) = 0.21– 0.40, Moderate (M) = 0.41–0.60, High (H) = 0.61–0.80, Very High (VH) = 0.81–1.00]. OA = Overall assessment. Significance at the 0.05 level.

During the dry season, the respondents supplied water for their agriculture-related activities; they included diesel machines (87.3%), hand pumps (59.7%), and wells (31.3%). In the Tonle Sap Lake, the hand pump recorded a higher percentage of 70.7%; it was 48.7% in the Mekong River. In contrast, wells were more popular among the residents of the Mekong River (59.3%). Similarly, the residents' views in the Bakan and Koh Sotin districts reveal that the communities are surrounded by water sources from the Tonle Sap Lake, the Mekong River, and wetlands. However, there is a lack of physical infrastructure. Similarly, the residents used diesel machines, hand pumps, and wells to supply water to agricultural activities. The residents also complained about high expenditures on gasoline and diesel.

Table 21. Access to equipment or facilities to reduce the negative impact of water shortage.

Indicator	Tonle Sap Lake		Mekong River		Overall	
	n=150		n=150		n=300	
	f	%	f	%	F	%
Irrigation method	1	0.7	0	0.0	1	0.3
Electric motor	4	2.7	0	0.0	4	1.3
Diesel machine	128	85.3	134	89.3	262	87.3
Hand pump	106	70.7	73	48.7	179	59.7
Well	5	3.3	89	59.3	94	31.3
No equipment or facilities at all	3	2.0	4	2.7	7	2.3
Overall	150	100.0	150	100.0	300	100.0

Chi-square analysis explored a relationship between geographical location and the effect of water shortage. Was there a relationship between geographical location and the ability to cope with the negative impacts of water shortage (P-value=0.002)? Out of the total, 57.7% of the respondents could cope with the negative impacts of water shortage, 48.7% in the Tonle Sap Lake, and 66.7% in the Tonle Sap Lake. The analysis did not reveal a relationship between geographical location and water shortage affecting your agricultural yield (P-value=0.274) and a relationship between the effect of water shortage on agricultural yield and the ability to cope with the negative impacts of water shortage (P-value=0.552). Overall, 95.3% of the respondents claimed that water shortages affected agricultural yields, deriving from 96.7% in the Tonle Sap Lake and 94.0% in the Mekong River. In contrast, only 57.7% of the respondents could cope with the negative impacts of water shortage.

Table 22. Relationship between geographical location and water shortage.

Indicator		Geographical Location			X^2	***P-value***
		N	Tonle Sap Lake	Mekong River		
Is water shortage affecting your agricultural yield?	Yes	95.3	96.7	94.0	1.199[a]	0.274
	No	4.7	3.3	6.0		
	Total	100.0	100.0	100.0		
Are you able to cope with the negative impacts of water shortage?	Yes	57.7	48.7	66.7	9.954[a]	***0.002****
	No	42.3	51.3	33.3		
	Total	100.0	100.0	100.0		
		Is water shortage affecting your agricultural yield?				
Are you able to cope with the negative impacts of water shortage?		**N**	**Yes**	**No**		
	Yes	57.7	55.3	2.3	0.354[a]	0.552
	No	42.3	40.0	2.3		
	Total	100.0	95.3	4.7		

Engagement in water management

Of the total, 34.3% of the respondents participated in activities promoting water management, 47.3% in the Tonle Sap Lake, and 21.3% in the Mekong River. The Chi-square test reveals a relationship between participation in activities promoting water management and geographical location. NGOs have played very important roles in supporting rural communities by raising awareness and knowledge to support water resource management. The commune heads in the Bakan and Koh Sotin districts appreciated the work of the provincial departments and NGOs to support water management. The commune councilors and villagers worked to disseminate information and mobilize people for voluntary work to restore rivers, lakes, swamps, and dykes to ensure that water supply for agriculture was sufficiently supplied.

Table 23. Relationship between location and the involvement in water management activities.

Indicator		Geographical location			X^2	*P-value*
		N	Tonle Sap Lake	Mekong River		
Have you ever been involved in or participated in activities promoting water management?	Yes	34.3	47.3	21.3	22.488[a]	***0.000****
	No	65.7	52.7	78.7		
	Total	100.0	100.0	100.0		

The respondents also reported reasons for not participating in activities promoting water management. The main reason was not being invited; it was 97.5% in the Mekong River and 74.7% in the Tonle Sap Lake. In the Tonle Sap Lake, one-quarter of the respondents (25.3%) could not participate because they did not have time. At the consultative meeting in the Bakan district, the residents mentioned that they could participate in the meeting for one whole morning, but they could join voluntary work. The commune heads also raised similar issues about the local participation in restoring ponds and dykes when they were shallow. The residents did not have time for the restoration however they were using them for their agriculture activities.

Table 24. Reason for not being able to participate by geographic location.

Indicator	Tonle Sap Lake		Mekong River		Overall	
	n=79		n=118		n=197	
	f	%	f	%	f	%
Not being invited	59	74.7	115	97.5	174	88.3
Time is not allowed	20	25.3	3	2.5	23	11.7
Overall	79	100.0	118	100.0	197	100.0

Table 25 reported the respondents' involvement in water management activities; they participated as household representatives (96.1%), especially in the Mekong River. Almost all of the respondents (98.1%) were invited by Commune Councils; the respondents played roles in listening (96.1%) and discussion (45.6%). Comparatively, 34.4% of the respondents in the Mekong River participated as household

representatives, and only 21.1% of the respondents in the Tonle Sap Lake participated as household representatives. In the Tonle Sap Lake, 21.1% of the respondents were invited by the Provincial office, and the District office invited 15.5%. In contrast, 15.6% of the respondents played roles as decision-makers, but more than half of them (54.9%) played roles in being discussant. The residents revealed that they were open and allowed local participation in events organized to support community development and resource management.

Table 25. Involvement in water management activities by geographical location.

Indicator	**Tonle Sap Lake**		**Mekong River**		**Overall**	
	n=71		n=32		n=103	
	f	%	f	%	f	%
How did you participate in an event/activity regarding natural resources management?						
Household representative	67	94.4	32	100.0	99	96.1
Community representative	15	21.1	11	34.4	26	25.2
Overall	71	100.0	32	100.0	103	100.0
Which organization have you participated in the activity or event with?						
Central government	6	8.5	1	3.1	7	6.8
Provincial office	15	21.1	1	3.1	16	15.5
District office	11	15.5	2	6.3	13	12.6
Commune Council	69	97.2	32	100.0	101	98.1
NGOs	5	7.0	1	3.1	6	5.8
Overall	71	100.0	32	100.0	103	100.0
What are your main roles in the above involvement?						
Decision maker	9.0	12.7	5.0	15.6	14.0	13.6
Discussant	39.0	54.9	8.0	25.0	47.0	45.6
Listening	68.0	95.8	31.0	96.9	99.0	96.1
Overall	71.0	100.0	32.0	100.0	103.0	100.0

The head of Moha Khnhoung commune of Koh Sotin district suggests that local authorities, including the district office and commune councils, did not have sufficient budgets for organizing events and activities to promote water resource management. Events and activities to promote water resource management were mainly initiated and operated by the Ministries, provincial offices, and NGOs. Local authorities, including the district office and commune councils, supported the implementation of activities and

the organization of the events. Therefore, without activities from the Ministries, provincial offices, and NGOs, the residents could not be involved in water resource management in the communities.

The respondents' experiences about types of residents' engagement in water management; their participation resulted in the issues being discussed (62.1%), followed by actions taken (51.7%) and planning purposes (29.9%). Approximately one-fifth of the respondents (16.1%) claimed their participation came out with no action; it was as high as 24.0% in the Mekong River. In the Tonle Sap Lake, more than half of the respondents (59.7%) reported actions after participating in meetings and discussions with relevant organizations about water resource management. The respondents also shared several events and activities they participated in; all of them experienced participation in the meeting, followed by training (21.8%) and volunteering work (23.6%).

Table 26. Decision in water resource management by geographical location.

Indicator	**Tonle Sap Lake**		**Mekong River**		**Overall**	
	n=62		n=25		n=87	
	f	%	f	%	F	%
How did you participate in an event/activity regarding water management?						
Planning purpose	21	33.9	5	20.0	26	29.9
Taking into action	37	59.7	8	32.0	45	51.7
Being discussed	41	66.1	13	52.0	54	62.1
Nothing happens	8	12.9	6	24.0	14	16.1
Overall	62	100.0	25	100.0	87	100.0
The outcome of concerns raised						
Workshop	7.0	11.3	2.0	8.0	9.0	10.3
Meeting	62.0	100.0	25.0	100.0	87.0	100.0
Advocacy	3.0	4.8	0.0	0.0	3.0	3.5
Volunteering work	11.0	17.7	0.0	0.0	11.0	12.6
Training	16.0	25.8	3.0	12.0	19.0	21.8
Information sharing	5.0	8.1	1.0	4.0	6.0	6.9
Overall	62.0	100.0	25.0	100.0	87.0	100.0

Only 10.3 of the respondents experienced participating in workshops, especially in the Tonle Sap Lake (11.3%). At the same time, a higher proportion of the respondents in

Tonle Sap Lake participated in Volunteering work (17.8%), Information sharing (8.1%), and advocacy (4.8%). In the Mekong River, the residents had fewer opportunities for social and community development related to water resource management. The consultative meetings in the two study regions have recognized local participation because the residents had opportunities to raise their concerns and issues to promote water resource management. In particular, the workshop is mainly organized at regional or national levels; the residents could participate in planning and policy development.

The residents were invited to participate in developing the commune investment plan (CIP) every year, and the commune councils asked them to prioritize interventions in the planning. **Table 27** shows that more than 54.7% of the respondents did not know the priority. Almost all of the respondents in the Mekong River (920%) had no idea about the priority, and it was only 48.0% in the Tonle Sap Lake. In the Tonle Sap Lake, more than half of the respondents (61.0%) prioritized water resource management, but only 8.7% of those in the Mekong River did so. During the consultative meeting in Moha Khnhoung and Preaek Ta Nong commune, the residents and commune councils agreed that water resource management was also a priority because they were farmers. They suggest a more in-depth investigation of the findings, especially qualitative analysis, to ensure water resource management for agriculture or water supply for daily consumption. The respondents may refer to the priority of water supply rather than water resources for agriculture. The residents in Moha Khnhoung and Preaek Ta Nong communes were widely accessible to water supply for daily consumption, so the service was no longer their priority.

Table 27. Priority of water resource management in the CIP by geographical location.

Indicator	**Tonle Sap Lake**		**Mekong River**		**Overall**	
	n=150		**n=150**		**n=300**	
	f	**%**	**f**	**%**	**f**	**%**
The first priority	61.0	40.7	13.0	8.7	74.0	24.7
The second priority	8.0	5.3	6.0	4.0	14.0	4.7
The third priority	9.0	6.0	1.0	0.7	10.0	3.3

Not priority	0.0	0.0	38.0	25.3	38.0	12.7
No Idea	72.0	48.0	92.0	61.3	164.0	54.7
Overall	150.0	100.0	150.0	100.0	300.0	100.0

Chi-square analysis shows relationships among geographical location and (1) activities implemented by the commune council to support natural resources (P-value=0.000), (2) member of water resource management (P-value=0.001), (3) participation in the restoration of water infrastructure to promote water management financially (P-value=0.000) and (4) participation in the restoration of water infrastructure to promote water management physically (P-value=0.000). Nevertheless, there was no relationship between geographical location and the requirement to pay for water for agricultural activities (P-value=1.000).

Table 28. Relationship between water resources management and geographical location.

Indicator		**Geographical Location**			**X^2**	***P-value***
		n	Tonle Sap Lake	Mekong River		
Does the commune council do any activity to support natural resources?	Yes	80.7	98.0	63.3	57.794[a]	***0.000****
	No	19.3	2.0	36.7		
	Total	100.0	100.0	100.0		
Are you a member of water resource management?	Yes	8.0	13.3	2.7	11.594[a]	***0.001****
	No	92.0	86.7	97.3		
	Total	100.0	100.0	100.0		
Have you ever participated in the restoration of water infrastructure to promote water management financially?	Yes	53.7	78.7	28.7	75.406[a]	***0.000****
	No	46.3	21.3	71.3		
	Total	100.0	100.0	100.0		
Have you ever participated in the restoration of water infrastructure to promote water management physically?	Yes	47.3	70.7	24.0	65.520[a]	***0.000****
	No	52.7	29.3	76.0		
	Total	100.0	100.0	100.0		
Are you required to pay for water for agricultural activities?	Yes	0.7	0.7	0.7	0.000[a]	1.000
	No	99.3	99.3	99.3		
	Total	100.0	100.0	100.0		

Out of the total, 80.7% of the respondents reported that commune councils carried out activities based on the resources available to support natural resource management; a higher proportion existed in the Tonle Sap Lake (98.0%). Unfortunately, 92.3% of the respondents were not members of any community-based organization to support water resources management, and almost all of them in the Mekong River (97.3%) were not members. In the Tonle Sap Lake, the respondents contributed to the restoration of water infrastructure to promote water management financially (78.7%) and physically (70.7%). In the Mekong, only around one-quarter of the respondents contribute financially (28.7%) and physically (24.4%). The respondents suggest that community-based organizations or CBOs may not request their members for any contribution because they mainly operate with NGO support. The residents or members of any CBOs may be involved in activities implemented and actively support environmental conservation and water resource management.

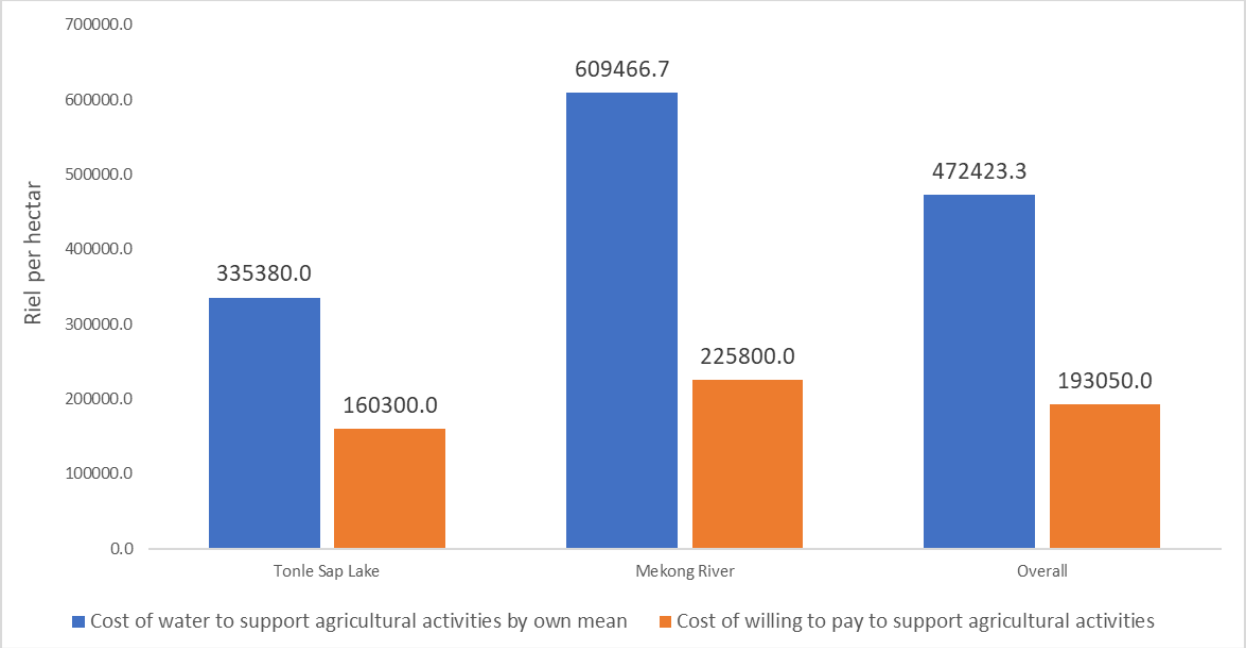
Table 29. Relationship between membership and water resources management activity.

Indicator		**Are you a member of water resource management?**			**X^2**	***P-value***
		n	**Yes**	**No**		
Have you ever participated in the restoration of water infrastructure to promote water management financially?	Yes	161	19	142	6.822[a]	***0.009***
	No	139	5	134		
	Total	300	24	276		
Have you ever participated in the restoration of water infrastructure to promote water management physically?	Yes	142	22	120	20.567[a]	***0.000****
	No	158	2	156		
	Total	300	24	276		
Are you required to pay for water for agricultural activities?	Yes	2	0	2	0.175[a]	0.676
	No	298	24	274		
	Total	300	24	276		

The respondents spent 477223 riels to supply water for agricultural activities; it was 609466.7 riels and 335380.0 riels. T-test analysis confirms that the respondents paid a similar amount for water to support agriculture (P-value=0.352). The survey shows respondents agreed that 193050.0 riels per hectare to support their agriculture was affordable; it was 225800.0 riels in the Mekong River and 160300.0 riels in the Tonle Sap

Lake. T-test analysis showed that the Mekong River respondents wished to pay significantly more than those in the Tonle Sap Lake (P-value=0.000). The analysis also shows that the cost of water support agriculture (472423,3 riels per hectare) was significantly higher than the cost of willingness to pay to support agriculture (160300.0 riels per hectare) (P-value=0.000).

Figure 4. Cost of water to supply agriculture by geographical location.



Note: P-value for the cost of water to support agriculture =0.352, P-value for the cost of willingness to pay for support agriculture=0.000.

The farmers in the two districts raised the issue of the high cost of water for supporting their agriculture, and the expenditure was beyond their ability to pay. The commune head in Trapeang Chorng reveals that the farmers pump water into their paddy fields individually; they bought pumps, pipes, electric motors, and diesel machines separately. Their practice has increased the cost because they did not cooperate. The rice farmers fought for water and were unwilling to share even though they already had enough. In a similar situation in the Moha Leap commune, the rice

farmers preferred to apply their means of collecting water rather than jointly among their peers in the communities. The head also mentioned that it was the best option to avoid conflicts and issues related to benefit sharing.

Conclusion and Suggestions

Conclusion

The key findings at previous levels and approaches in the Bank and Koh Sothin districts conclude that the rice farmers in the Tonle Sap Lake and the Mekong River have sought ways to cope with the impact of water shortage. However, their local adaptation was insufficiently addressed to mitigate their risks and vulnerabilities. The research has found the main findings as follows:

The rice farmers remain highly dependent on water resources from the Tonle Sap Lake and the Mekong River for their cultivation. However, rice farmers also have alternative sources of consumption and income from non-farm activities; farm income is always significant. Rice cultivation will remain the primary and future daily consumption and income sources in the next decade. The survey records that multiple tasks employed 92.7% of the residents; those in the Mekong River shared a higher number than those in the Tonle Sap Lake (1.3 jobs). Their secondary jobs included livestock raisers (48.3%), gardeners (32.3%), employed workers (21.3%), self-employed workers (19.0%), and self-employed businessmen (11.3%). In the Mekong River, gardening (56.0%) was the most common secondary source of income, but it was a low proportion in the Tonle Sap Lake (8.7%). Over half of the residents (62.7%) cultivated their crops in rainy and dry seasons, constituting 85.3% in the Tonle Sap Lake and 40.0% in the Mekong River. In the Mekong River, 60.0% of the residents only cultivated their crops in the rainy season, compared to 14.0% in the Tonle Sap Lake.

The survey finds 9.3% of the residents in the Mekong River and 8.0% in the Tonle Sap Lake held ID-Poor. On average, income per capita was 10,956.6 riels, similarly derived from 11,166.0 Riel in Tonle Sap Lake and 10,747.2 Riel in the Mekong River. Moreover, the residents with ID Poor earned equal to those with ID Poor. While monthly income per capita was not significantly different from the rural poverty line of 8,908 riels per day, it was lower than the national poverty line of 10,926.6 riels per day per person. Daily income per capita consisted of rice cultivation (41.1%), self-employed work (22.1%), employed work (9.6%), government (7.2%), gardening (5.7%), livestock raising (5.3%), and self-business (4.5%).

The rice farmers were challenged to assess the five assets for their livelihood development, especially with limited access to human assets. Overall, the residents in the two study regions were similarly accessible, with moderate access to water for their agriculture. Regarding human assets, the residents assessed low access to professional skills in the two study regions. At the same time, the residents in the two areas rated high access to sufficient physical assets. The residents of the Tonle Sap Lake rated it as having a high degree of sufficient access to irrigation, and it was only moderately accessible to the residents in the Mekong River. The survey also shows that the residents rated moderate opportunities to participate in activities supporting community and social development. The residents of the Tonle Sap Lake had more opportunities than those in the Mekong River. Concerning financial assets, the residents rated a moderate degree of accessibility to financial assets, a higher degree in the Tonle Sap Lake. In the Tonle Sap Lake, the residents were highly accessible to microfinance for loans, commercial banks, and local lenders.

Rice farmers have sought means to cope with the impact of water shortage, but their local adaptation has not been addressed sufficiently to mitigate their risks and vulnerabilities. Overall, the residents of Tonle Sap Lake rated a higher degree of impact of climatic hazard on crop cultivation. They rated a high degree of drought and a

moderate degree of flood. The residents were insufficiently accessible to water for crops in the dry season (91.3%), especially in Tonle Sap Lake (98.7%). The residents experienced the negative impacts of water shortages; the two study regions were similarly affected. Water shortages threatened household food scarcity, caused conflict over water scarcity, affected health, caused malnutrition, caused debts, and caused spending on festivals. Moreover, water shortages caused no choice in food preferences and affected children's schooling.

In addition, water shortage has affected the socio-economics of the rural people, including rice production and health. The residents shared their views and insights regarding the negative impacts of water shortage; most identified disease attacks (77.7%) and inability to farm (60.0%). Half the residents confirmed that water shortage has reduced production, delayed crop harvest, and hampered rice production. Residents were worried about disease attacks in the Mekong River. Water shortages caused skin problems (93.0%), fewer (79.3%), dysentery (44.0%), diarrhea (27.0%), and typhoid (3.7%).

The residents in the two regions similarly assessed changes in attitudes towards water shortage. The residents assessed a moderate degree of their ability to adapt to water shortage; those in the Mekong River shared a higher degree. In particular, the residents assessed a moderate degree of their ability to withstand shocks and stress, changes in water level, Temperature–getting hotter, Water level–getting lower, unexpected flooding incidents, violent storms, and thunderstorms leading to death. During the dry season, the residents collected water from diesel machines, hand pumps, and pumps for cultivation. In the Tonle Sap Lake, the hand pump recorded a higher percentage of 70.7%. In contrast, wells were more popular among the residents of the Mekong River (59.3%).

More than half of the residents (57.7%) could cope with the negative impacts of water shortage, 48.7% in the Tonle Sap Lake and 66.7% in the Tonle Sap Lake. The

analysis did not reveal a relationship between geographical location and water shortage affecting agricultural yield, and a relationship between the effect of water shortage on agricultural yield and the ability to cope with the negative impacts of water shortage. Overall, 95.3% of the residents claimed that water shortages affected agricultural yields, from 96.7% in the Tonle Sap Lake and 94.0% in the Mekong River. In contrast, only 57.7% of the residents could cope with the negative impacts of water shortage.

Support mechanisms for water management were insufficient. While the residents had opportunities to participate in various events and activities at the commune level, they were not involved much in the decision-making process. The survey shows 34.3% of the residents participating in activities to promote water management, deriving from 47.3% in the Tonle Sap Lake and 21.3% in the Mekong River. The analysis also reveals a relationship between participation in activities promoting water management and geographical location. They participated as household representatives (96.1%), especially in the Mekong River. Commune Councils invited most respondents; most played roles in listening and discussion. Out of the total, 15.6% of the residents played roles as decision-makers, but more than half of them (54.9%) played roles in being discussants.

Almost all of the residents in the Mekong River (920%) had no idea about the priority, and it was only 48.0% in the Tonle Sap Lake. In the Tonle Sap Lake, more than half of the residents (61.0%) prioritized water resource management, but only 8.7% of those in the Mekong River did so. The analysis shows relationships among geographical locations and activities implemented by the commune council to support natural resources, members of water resource management, participation in the restoration of water infrastructure to promote water management financially, and participation in the restoration of water infrastructure to encourage management water physically. Nevertheless, there was no relationship between geographical location and the requirement to pay for water for agricultural activities.

The survey records that 80.7% of the residents reported that commune councils carried out activities based on the resources available to support natural resource management; a higher proportion existed in the Tonle Sap Lake (98.0%). Unfortunately, 92.3% of the residents were not members of any community-based organization to support water resources management, and almost all of them in the Mekong River were not members. In the Tonle Sap Lake, the residents contributed to the restoration of water infrastructure to promote water management financially (78.7%) and physically (70.7%). In the Mekong River, one-quarter of the residents contributed financially (28.7%) and physically (24.4%). Overall, the residents spent 477,223 riels to supply water for agricultural activities. The analysis also shows that the cost of water to support agriculture (472423,3 riels per hectare) was higher than the cost of willingness to pay to support agriculture (160,300.0 riels per hectare).

Suggestions

The findings of this research should benefit several of Cambodia's Ministries, including the Ministry of Interior, Ministry of Rural Development, Ministry of Agriculture, Forestry and Fisheries, and Ministry of Water Resources and Meteorology, for policy implication, planning process, and program interventions. Under the Decentralization and Deconcentration (D&D) reform of the Ministry of Interior (MoI), the commune councils have supported rural livelihoods in response to local needs. Every year, the MoI provides a budget for the commune council to implement development projects, but the budgets are mainly used for infrastructure development, especially road construction. The MoI should increase the annual budget for CIP implementation, and the commune councils can allocate the annual funds for other activities to promote water resource management. However, the construction is a large project beyond the scope of the commune councils; the MoI should consider increasing the annual budget and enable the commune councils to construct supplementary irrigations, including ponds and hand

pumps, and to increase the access to sufficient water for agriculture, especially in the dry season.

The Ministry of Water Resources and Meteorology plays a very important role in promoting farmers' access to water by constructing irrigation systems for agriculture. The Ministry should work with the Royal Government of Cambodia (RGoC) to mobilize resources from the national budgets and bilateral and multilateral donors to construct and improve irrigation systems. International cooperation and support from development partners support mega projects for road construction and irrigation systems to make rural livelihoods more resilient to climate change. Therefore, the development partners should continue supporting the RGoC in improving physical infrastructures, including roads, bridges, and irrigation systems. Physical infrastructures are very important to promote sustainable livelihood development and resilience systems to the impacts of water shortage in the communities.

Relevant government agencies working from national to subnational levels should establish the local adaptive capacity to withstand water change by working closely with the district office and commune councils through the provincial office. The Ministry of Water Resources and Meteorology may consider small-scale and medium-scale irrigation systems for the short term from the national budget and large-scale irrigation systems for long-term investment and resource mobilization from development partners. The Ministry of Rural Development, Ministry of Agriculture, and Forestry and Fisheries should work to support the farmers in promoting community development and agriculture development by operating saving groups, water management groups, and market support. It is very important to work closely with rice farmers to promote their livelihood development through income-generation activities.

The NGOs and community-based organizations (CBOs) should continue their work to support the rice farmers to participate in community meetings to identify their needs and raise their concerns to improve their rice productivity and to participate in

decision-making for their sustainable livelihoods. Moreover, the NGOs and CBOs should work with farmers to provide them with the necessary skills and technical support to ensure that their livelihoods are sustainable. Water management groups are working well with support from NGOs to more effectively manage water for their agriculture and share equally among their peers. The study reveals that the rice farmers do not share the water for everyone in the communities.

Sustainable livelihood is a framework that can be applied to any analysis (Scoones, 2015) based on the capacity to access the five livelihood assets (DFID, 1999), focusing on long-term flexibility over time (de Haan & Zoomers, 2005). In applied and academic research, a sustainable livelihood framework is appropriate for rural socio-economic analysis (UNDP, 2017) in developing countries like Cambodia. The study has confirmed that the residents of the Tonle Sap Lake and the Mekong River have moderate access to natural, physical, social, and financial assets. The residents were challenged to access human assets, the heart of sustainable development. Since the residents' livelihoods in the two regions depend highly on agriculture, water shortages directly affect their consumption and income sources. The study shows that the residents have a moderate adaptive capacity but face risks and vulnerabilities when extreme climatic events occur. Improved access to the five livelihood assets helps improve local adaptive capacity and strategies to minimize the impacts of water shortage. The research calls for support from government and non-governmental agencies to promote access to the five livelihood assets, especially human assets. Access to the five livelihood assets proves significantly to increase the adaptive strategies of rice farmers in the Tonle Sap Lake and the Mekong River to cope with water shortage in the face of climate change.

Policy Recommendations

Improved Sustainable livelihood development is crucial to support the implementation of the National Strategic Development Plan 2019-2028 and UN's Sustainable Development Goals (SDGs) in the context of vulnerability and adaptive capacity to climate change. The study shows that the livelihood of the residents of the Mekong River and the Tonle Sap Lake is not yet sustainable; therefore, poverty and food insecurity are promoted to ensure that they can cope with long-term and short-term extreme climatic events, including flood, drought, and storm. The access to the five assets, especially human assets, promotes local adaptation to cope with the extreme climatic events for their rice cultivation.

In the Tonle Sap and the Mekong River region, small-scale rice cultivation will remain a source of daily food consumption and income; therefore, access to water through irrigation is a long-term investment. In addition, a support mechanism should be established to provide farmers with skills to cultivate rice and be resilient to climate extreme events, especially food and drought. At the same time, a stable price of rice and a wider market should be accessible to rice farmers. In recent years, rice has not provided farmers with a subsistence livelihood; extreme climatic events have also affected them with losses and damage. Therefore, improved local adaptive capacity to climatic extreme events is crucial for promoting livelihoods of the rice farmers in the Tonle Sap Lake and the Mekong River. The farmers should also provide some social welfare schemes and agricultural loans, and emergency support during the face of extreme climatic events beyond ID-Poor.

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Appendix

Appendix 1. Reliability Test and Cronbach's Alpha

Item-Total Statistics				
Q30	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Degree of sufficient access to water for (Bathing)	16.17	4.839	0.785	0.761
Degree of sufficient access to water for (Drinking)	16.21	5.181	0.751	0.774
Degree of sufficient access to water for (Cooking)	16.20	5.128	0.761	0.771
Degree of sufficient access to water for (Washing)	16.22	4.946	0.746	0.769
Degree of sufficiently accessible to water for (Rice cultivation)	17.37	5.685	0.377	0.844
Degree of sufficiently accessible to water for (Crop cultivation)	17.42	5.315	0.353	0.869

Item-Total Statistics				
Q34	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Water	19.36	86.765	0.579	0.833
Fishery	19.27	86.631	0.580	0.833
Aquaculture	19.03	88.178	0.531	0.837
Forest	19.08	91.706	0.473	0.842
Wildlife	20.22	91.082	0.465	0.843
Bird	18.89	89.451	0.535	0.837

Item-Total Statistics

Q36	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Training Rice farming	19.36	86.765	0.579	0.833
Training on Chamkar (i.e., vegetable and fruit)	19.27	86.631	0.580	0.833
Training on Small and medium business	19.03	88.178	0.531	0.837
Training on Construction	19.08	91.706	0.473	0.842
Training on Driving	20.22	91.082	0.465	0.843

Item-Total Statistics				
Q38	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Road	19.36	86.765	0.579	0.833
Bridge	19.27	86.631	0.580	0.833
Irrigation	19.03	88.178	0.531	0.837
Local market	19.08	91.706	0.473	0.842
Health facilities	20.22	91.082	0.465	0.843
School facilities for children	18.89	89.451	0.535	0.837
Transportation	19.22	87.860	0.588	0.832

Item-Total Statistics				
Q40	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Raised concerns about community development	19.36	86.765	0.579	0.833
Participate in activities of NGOs	19.27	86.631	0.580	0.833
Participate in activities of the Commune Council	19.03	88.178	0.531	0.837
Participate in activities of government officer	19.08	91.706	0.473	0.842
Involve in community decision-making	20.22	91.082	0.465	0.843

Item-Total Statistics				
Q42	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Access to microfinance for loan	19.36	86.765	0.579	0.833
Access to a commercial bank for a loan	19.27	86.631	0.580	0.833
Access to local lander for loans	19.03	88.178	0.531	0.837
Participate in saving group	19.08	91.706	0.473	0.842
Access to income-generation activities	20.22	91.082	0.465	0.843

Item-Total Statistics				
Q44	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Flood	19.36	86.765	0.579	0.833
Droughts	19.27	86.631	0.580	0.833
Storms	19.03	88.178	0.531	0.837

Item-Total Statistics				
Q48	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Water shortage threatened household food scarcity	19.36	86.765	0.579	0.833
Water shortage caused conflict for water in scarcity	19.27	86.631	0.580	0.833
Water shortage caused no choice in food preference	19.03	88.178	0.531	0.837
Water shortage affected on health	19.08	91.706	0.473	0.842
Water shortage caused malnutrition	20.22	91.082	0.465	0.843

Water shortage affected schooling of children	18.89	89.451	0.535	0.837
Water shortage caused population migration	19.22	87.860	0.588	0.832
Water shortage caused debts	19.33	89.336	0.561	0.835
Water shortage caused unemployment	18.37	85.430	0.558	0.835
Water shortage caused in spending on festivals	19.30	84.288	0.628	0.828

Item-Total Statistics				
Q51	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Change crop calendar	19.36	86.765	0.579	0.833
Change to less water-consuming crop	19.27	86.631	0.580	0.833
Keep using unsown after the possibility of drought	19.03	88.178	0.531	0.837
Change traditional irrigation practices to modern ones (i.e., sprinkler, drip irrigation, etc.)	19.08	91.706	0.473	0.842
Use water harvesting through farm ponds, in-situ conservation practice	20.22	91.082	0.465	0.843

Item-Total Statistics				
Q52	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Shocks, Stress	19.36	86.765	0.579	0.833
Change in water level	19.27	86.631	0.580	0.833
Temperature–getting hotter	19.03	88.178	0.531	0.837
Water level–getting lower	19.08	91.706	0.473	0.842

Increasing salt water intrusion	20.22	91.082	0.465	0.843
Unexpected flooding incident	18.89	89.451	0.535	0.837
Unexpected drought	19.22	87.860	0.588	0.832
Violate storm	19.33	89.336	0.561	0.835
Thundering (leading to death)	18.37	85.430	0.558	0.835

Item-Total Statistics				
Q53	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Reduce cultivation area	19.36	86.765	0.579	0.833
Change crops	19.27	86.631	0.580	0.833
Diversify crops	19.03	88.178	0.531	0.837
Improve cultivation	19.08	91.706	0.473	0.842
Advance technique	20.22	91.082	0.465	0.843
Improve cultivation facilities	18.89	89.451	0.535	0.837
Improve the number of herbicides and pesticides	19.22	87.860	0.588	0.832
Increase the amount of fertilizer	19.33	89.336	0.561	0.835
Improve irrigation system	18.37	85.430	0.558	0.835
Buy agricultural insurance	19.30	84.288	0.628	0.828

Appendix 2. Structured questionnaire

កម្រងសំនួរស្ទង់មតិ
សមត្ថភាពសម្របខ្លួនរបស់គ្រួសារកសិករលើបញ្ហាកង្វះខាតទឹកដោយសារការប្រែប្រួលអាកាសធាតុ

ព័ត៌មានលម្អិតនៃអ្នកសម្ភាសន៍

PROVINCE CODE កូដខេត្ត	
☐1- ស្រុកបាកាន ខេត្តពោធិ៍សាត់	☐1-ស្រុកកោះសូទិន ខេត្តកំពង់ចាម

ហត្ថលេខាអ្នកដឹកនាំក្រុម
កាលបរិច្ឆេទ:_____

កំណត់សម្គាល់ការយល់ព្រមសម្ភាសន៍
ការយល់ព្រមសម្ភាសន៍ចាប់ផ្តើម: បាទ ទេ
ការយល់ព្រមសម្ភាសន៍បញ្ចប់: បាទ ទេ

សេចក្តីណែនាំទូទៅ និងគោលបំណងនៃការស្រាវជ្រាវ (សេចក្តីថ្លែងការការសុំអនុញ្ញាត្តិសម្ភាសន៍)
អរុណសួស្តី / រសៀល /ជម្រាប់សួរ
ខ្ញុំឈ្មោះ .....ខ្ញុំធ្វើការអោយស្រាវជ្រាវអោយ ការិយាល័យស្រាវជ្រាវនៃសាកលវិទ្យាល័យភូមិន្ទភ្នំពេញ ពី“សមត្ថភាពសម្របខ្លួនរបស់គ្រួសារកសិករលើបញ្ហាកង្វះខាតទឹកដោយសារការប្រែប្រួលអាកាសធាតុ”។
គម្រោងស្រាវជ្រាវនេះដឹកនាំដោយ កញ្ញា យ៉ាន់ សុភ័ណ្ឌ និងលោកសាស្ត្រាចារ្យបណ្ឌិត សុខ សិរី អនុប្រធានការិយាល័យស្រាវជ្រាវនៃសាកលវិទ្យាល័យភូមិន្ទភ្នំពេញ។
ការស្រាវជ្រាវមានគោលបំណងក្នុងការស្វែងយល់ពីតំរូវការទឹកសម្រាប់កសិកម្ម
និសមត្ថភាពសម្របខ្លួនរបស់គ្រួសារកសិករលើ បញ្ហាកង្វះខាតទឹកដោយសារ ការប្រែប្រួលអាកាសធាតុ។
វាអាស្រ័យលើអ្នកថាតើអ្នកចូលរួមឬអត់ - អ្នកអាចបដិសេដ ប្រសិនបើអ្នកមិនចង់ចូលរួម បើអ្នកឆ្លើយថាបាទ/ចាស យើងនឹងធ្វើកំណត់ចំណាំអំពីការយល់ព្រមរបស់អ្នកដើម្បីចូលរួមក្នុងគម្រោងស្រាវជ្រាវ។
អ្នកអាចសម្រេចចិត្តមិនឆ្លើយសំណួរមួយចំនួន។ អ្នកគ្រាន់តែត្រូវប្រាប់យើងថាអ្នកមិនចង់ឆ្លើយសំណួរនោះទេ។
នៅចុងបញ្ចប់នៃការសម្ភាសន៍
យើងនឹងពិនិត្យមើលម្តងទៀតថាតើអ្នកសប្បាយចិត្តដែលមានចម្លើយរបស់អ្នករួមបញ្ចូលនៅក្នុងសំណុំទិន្នន័យរបស់យើងដែរឬទេ។ ប្រសិនបើអ្នកសម្រេចចិត្តថាអ្នកមិនចង់ចូលរួម យើងនឹងបំផ្លាញទិន្នន័យរបស់អ្នក។ខ្ញុំនឹងសរសេររបាយការណ៍អំពីអ្វីដែលអ្នក និងមនុស្សផ្សេងទៀតបាននិយាយ។ ខ្ញុំនឹងមិនប្រើឈ្មោះរបស់អ្នក និងព័ត៌មានផ្ទាល់ខ្លួនផ្សេងទៀតនៅក្នុងរបាយការណ៍ទេ។ មិនមានចម្លើយត្រឹមត្រូវ ឬខុសទេ យើងគ្រាន់តែចង់ស្តាប់នូវអ្វីដែលអ្នកគិតប៉ុណ្ណោះ។ ការសន្ទនារបស់យើងនឹងចំណាយពេលមិនលើសពី ៣០ នាទី។

តើអ្នកមានសំណួរអំពីការស្រាវជ្រាវ និងវិធីសាស្ត្ររបស់យើងទេ?
ប្រសិនបើអ្នកមានសំណួរទាក់ទងនឹងការស្រាវជ្រាវនេះសូមទាក់ទង បណ្ឌិត សុខសិរីទូរស័ព្ទលេខ ០១៦ ៥២១ ៥៧៥ ។
តើអ្នកសប្បាយចិត្តចូលរួមក្នុងការស្រាវជ្រាវនេះទេ? (ផ្តល់ជូននូវជម្រើសឆ្លើយតប - បាទឬចាស/ ទេ)

Demographic Information

00	Name (operational)	_____

01	Gender	☐0-Female	☐1-Male
02	Age	_____years	
03	Marital status	☐1-Single	☐2-Married
		☐3-Divorced	☐4-Widow/widower
		☐4-Others	
04	Education	_____years	
05	Household member	_____people	
06	Dependents	_____people	
07	Land size for resettlement	_____meter square	
08	Land size for agriculture	_____meter square	
09	What is your primary job?	☐1-Rice farmer	☐2-Gardener
		☐3-Fisherman	☐4-Livestock raiser
		☐5-Self-employed worker	☐6-Employed worker
		☐7-Self-businessmen	☐8-Employee
	SA	☐9-Other	
10	What are your secondary jobs? (If there is no any secondary job, "**q11=0**"	☐1-Rice farmer	☐2-Gardener
		☐3-Fisherman	☐4-Livestock raiser
		☐5-Self-employed worker	☐6-Employed worker
		☐7-Self-businessmen	☐8-Employee
	MA	☐9-Other	
11	How many secondary jobs do you have?	_____job(s)	
12	Are you holding ID Poor?	☐0-Yes	☐1-No
13	If yes, which category are you holding	☐0-ID Poor 1	☐1-ID Poor 2
14	Are you planning to change a new job in the next 10 year? (If there is no change, please tick same as in **q10**)	☐0-Yes	☐1-No
15	If yes, what primary job are you planning to change in the next 10 years?	☐1-Rice farmer	☐2-Gardener
		☐3-Fisherman	☐4-Livestock raiser
		☐5-Self-employed worker	☐6-Employed worker
		☐7-Self-businessmen	☐8-Employee
	SA	☐9-Other	

Household Income Analysis

16	How many jobs are employed by your household members?	_____job(s)	
Annual incomes [Last year]			
17	*-Rice farmer: paddy rice*	1_____tons/year	2_____riels/ton
18	*-Gardener: vegetables, maize, cassava, etc.*	1_____times/year	2_____riels/time
19	*-Livestock raiser: cow, buffo, chicken, duck, etc.*	1_____times/year	2_____riels/time
20	*-Fishermen: fishing activities*	1_____kg/day in open season	2_____riels/kg in open season
		3_____months/ open season	
21		1_____kg/day in close season	2_____riels/kg in close season
22		3_____months/ close season	
23	*-Other sources from agriculture*	1_____times/year	2_____riels/time
Monthly incomes [This year]			
24	*-Employee: government staff*	1_____riels/month	2_____month/year
25	*-Employee: NGOs staff*	1_____riels/month	2_____month/year
26	*-Employee: company staff*	1_____riels/month	2_____month/year
27	-Employed worker (factory, SME, waiter, guard, maid etc.)	1_____riels/month	2_____month/year
28	*-Other sources from employee*	1_____riels/month	2_____month/year
29	Bee collection	1_____riels/month	2_____month/year
Daily income [This month]			
30	-Self-employed worker: taxi driver, Tuk Tuk driver, farm worker, construction worker,	1_____riels/day	2_____moths/year
31	-Self-business: grocery, street vender, food seller, hawker, etc.	1_____riels/day	2_____moths/year
32	-Fish processing	1_____riels/month	2_____month/year
33	Eco-tourism	1_____riels/month	2_____month/year

Importance of water consumption

33	Indicators	To what degree are you sufficiently accessible to water for the following consumption?				
		Sever	Major	Moderate	Minor	Insufficient
-1	Bathing	☐1	☐2	☐3	☐4	☐5
-2	Drinking	☐1	☐2	☐3	☐4	☐5
-3	Cooking	☐1	☐2	☐3	☐4	☐5
-4	Washing	☐1	☐2	☐3	☐4	☐5
-5	Rice cultivation	☐1	☐2	☐3	☐4	☐5
-6	Crop cultivation	☐1	☐2	☐3	☐4	☐5

09	If you grow rice, which season are you growing rice?	☐1-Wet	☐2-Dry
		☐3-Both	☐0-Not relevant
34	How many times do you grow crop per year?		_____time(s)/year
-1	First crop	Start_____(month)	Finish_____(month)
-2	Second crop	Start_____(month)	Finish_____(month)
-3	Third crop	Start_____(month)	Finish_____(month)

11	Are you accessible to the following sources of water for your agriculture?			
-1	Access to river	☐0-Yes	☐0-Yes	Distance from home_____meters
-2	Access to lake	☐0-Yes	☐0-Yes	Distance from home_____meters
-3	Access to pond	☐0-Yes	☐0-Yes	Distance from home_____meters
-4	Access to cannel	☐0-Yes	☐0-Yes	Distance from home_____meters
-5	Access to reservoir	☐0-Yes	☐0-Yes	Distance from home_____meters

Access to natural assets

35	To what degree are you accessing to the following water related assets?					
		Very Low	Low	Moderate	High	Very High
-1	Water	☐1	☐2	☐3	☐4	☐5
-2	Fishery	☐1	☐2	☐3	☐4	☐5
-3	Aquaculture	☐1	☐2	☐3	☐4	☐5
-4	Forest	☐1	☐2	☐3	☐4	☐5
-5	Wildlife	☐1	☐2	☐3	☐4	☐5

-6	Bird	☐1	☐2	☐3	☐4	☐5
36	Is the access to water related resources assets above sufficient to your sustainable livelihood?					
				☐0 Yes	☐1 No	

Access to human assets

37	To what extend are you having the following skills through training?					
	Attributes	Very Low	Low	Moderate	High	Very High
-1	Rice farming	☐1	☐2	☐3	☐4	☐5
-2	Chamkar (i.e., vegetable and fruit)	☐1	☐2	☐3	☐4	☐5
-3	Small and medium business	☐1	☐2	☐3	☐4	☐5
-4	Construction	☐1	☐2	☐3	☐4	☐5
-5	Driving	☐1	☐2	☐3	☐4	☐5
-6	Technical work (ecotourism, factory,)	☐1	☐2	☐3	☐4	☐5
-7	Processing (fish, bee collection)	☐1	☐2	☐3	☐4	☐5
38	Is the access to human asset above sufficient to your sustainable livelihood?					
				☐0 Yes	☐1 No	

Access to physical assets

39	To what extend are you accessible to the following physical assets?					
	Attributes	Very Low	Low	Moderate	High	Very High
-1	Road	☐1	☐2	☐3	☐4	☐5
-2	Bridge	☐1	☐2	☐3	☐4	☐5
-3	River port	☐1	☐2	☐3	☐4	☐5
-4	Irrigation	☐1	☐2	☐3	☐4	☐5
-5	Boat for fishing	☐1	☐2	☐3	☐4	☐5
-6	Fishing gears	☐1	☐2	☐3	☐4	☐5
-7	Local market	☐1	☐2	☐3	☐4	☐5
-8	Health facilities	☐1	☐2	☐3	☐4	☐5
-9	School facilities for children	☐1	☐2	☐3	☐4	☐5
-10	Transportation	☐1	☐2	☐3	☐4	☐5
40	Is the access to physical asset above sufficient to your sustainable livelihood?					
				☐0 Yes	☐1 No	

Access to social assets

41	To what degree are you accessing the following social asset?					
	Attribute	Very high	High	Moderate	Low	Very low
-1	Raised concerns about community development	☐1	☐2	☐3	☐4	☐5
-2	Participate in activities of NGOs	☐1	☐2	☐3	☐4	☐5
-3	Participate in activities of Commune Council	☐1	☐2	☐3	☐4	☐5

-4	Participate in activities of government officer	☐1	☐2	☐3	☐4	☐5
-5	Participate in activities of community fishery	☐1	☐2	☐3	☐4	☐5
-6	Involve in community decision making	☐1	☐2	☐3	☐4	☐5
42	Is the access to social asset above sufficient to your sustainable livelihood?					
				☐0 Yes		☐1 No

Access to financial assets

43	To what degree are you accessing the following financial asset?					
	Attribute	Very high	High	Moderate	Low	Very low
-1	Access to microfinance for loan	☐1	☐2	☐3	☐4	☐5
-2	Access to commercial bank for loan	☐1	☐2	☐3	☐4	☐5
-3	Access to local lander for loans	☐1	☐2	☐3	☐4	☐5
-4	Participate in saving group	☐1	☐2	☐3	☐4	☐5
-5	Access to income generation activities	☐1	☐2	☐3	☐4	☐5
-6	Participate in revolving funds	☐1	☐2	☐3	☐4	☐5
44	Is the access to financial asset above sufficient to your sustainable livelihood?					
				☐0 Yes		☐1 No

Negative impact of water shortage on farmers

45	To what degree are the following hazards affecting your crop?					
	Attribute	Very high	High	Moderate	Low	Very low
-1	Flood	☐1	☐2	☐3	☐4	☐5
-2	Droughts	☐1	☐2	☐3	☐4	☐5
-3	Storms	☐1	☐2	☐3	☐4	☐5
-4	Lightning strikes	☐1	☐2	☐3	☐4	☐5
46	Which season has the sufficient water for your crop?		☐1-Wet season		☐2-Dry Season	
		SA	☐3-Other			
46	Which season has insufficient water for your crop?		☐1-Wet season		☐2-Dry Season	
		SA	☐3-Other			
46	Which season are the most affecting on your crop?		☐1-Wet season		☐2-Dry Season	
		SA	☐3-Other			

47	**Statement**	To what degree do you agree or disagree with the following statements about the impact of water shortage?				
		Strongly disagree	Disagree	Undecided	Agree	Strongly Agree
-1	Water shortage threatened household food scarcity	☐1	☐2	☐3	☐4	☐5

-2	Water shortage caused conflict for water in scarcity	☐1	☐2	☐3	☐4	☐5
-3	Water shortage caused no choice in food preference	☐1	☐2	☐3	☐4	☐5
-4	Water shortage affected on health	☐1	☐2	☐3	☐4	☐5
-5	Water shortage caused malnutrition	☐1	☐2	☐3	☐4	☐5
-6	Water shortage affected schooling of children	☐1	☐2	☐3	☐4	☐5
-7	Water shortage caused population migration	☐1	☐2	☐3	☐4	☐5
-8	Water shortage caused debts	☐1	☐2	☐3	☐4	☐5
-9	Water shortage caused unemployment	☐1	☐2	☐3	☐4	☐5
-10	Water shortage caused in spending on festivals	☐1	☐2	☐3	☐4	☐5

48	What are the negative impacts from water shortage?		☐1- Reduce production	☐2- Delay to crop harvest
			☐3-Disease attack	☐4- Unable to agriculture
		MA	☐5- Hamper fish culture	☐6-Other
49	What are the negative impacts from water shortage on health?		☐1-Diarrhoea	☐2-Typhoid
			☐3-Skin Problems	☐4-Dysentery
			☐5-Fewer	☐6-Malaria
		MA	☐7-Other	

Local adaptive capacity to water shortage

50	**Attribute**	To what degree are you able to change your attitude toward the negative impact from water shortage?				
		Very Low	Low	Moderate	High	Very High
-1	Change crop calendar	☐1	☐2	☐3	☐4	☐5
-2	Change to less water consuming crop	☐1	☐2	☐3	☐4	☐5
-3	Keep using unsown after possibility of drought	☐1	☐2	☐3	☐4	☐5
-4	Change traditional irrigation practice to modern one (i.e., sprinkler, drip irrigation etc.)	☐1	☐2	☐3	☐4	☐5
-5	Use water harvesting through farm pond, in-situ conservation practice	☐1	☐2	☐3	☐4	☐5

51	**Attribute**	To what degree are able to reduce the loss of your crop due to change in water resources?

		Very Low	Low	Moderate	High	Very High
-1	**Shocks, Stress**					
-2	Water level	☐1	☐2	☐3	☐4	☐5
-3	Temperature–getting hotter	☐1	☐2	☐3	☐4	☐5
-4	Water level–getting lower	☐1	☐2	☐3	☐4	☐5
-5	Increasing salt water intrusion	☐1	☐2	☐3	☐4	☐5
-6	Unexpected flooding incident	☐1	☐2	☐3	☐4	☐5
-7	Unexpected drought	☐1	☐2	☐3	☐4	☐5
-8	Violate storm	☐1	☐2	☐3	☐4	☐5
-9	Thundering (leading to death)	☐1	☐2	☐3	☐4	☐5

52	**Attribute**	To what degree are you changing your practice toward the negative impact from water shortage?				
		Very Low	**Low**	**Moderate**	**High**	**Very High**
-1	Reduce cultivation area	☐1	☐2	☐3	☐4	☐5
-2	Change crops	☐1	☐2	☐3	☐4	☐5
-3	Diversify crops	☐1	☐2	☐3	☐4	☐5
-4	Improve cultivation	☐1	☐2	☐3	☐4	☐5
-5	Advance technique	☐1	☐2	☐3	☐4	☐5
-6	Improve cultivation facilities	☐1	☐2	☐3	☐4	☐5
-7	Improve amount of herbicides and pesticides	☐1	☐2	☐3	☐4	☐5
-8	Increase amount of fertilizer	☐1	☐2	☐3	☐4	☐5
-9	Improve irrigation system	☐1	☐2	☐3	☐4	☐5
-10	Buy agricultural insurance	☐1	☐2	☐3	☐4	☐5

53	Are you accessible to the following equipment or facilities to reduce the negative impact from water shortage?		☐1-Irrigation method	☐2- Electric motor
			☐3- Diesel machine	☐4- Hand pump
		MA	☐5-Other	
54	Is water shortage affecting on your agricultural yield?		☐0-Yes	☐1-No
55	Are you able to cope with the negative impacts from water shortage?		☐0-Yes	☐1-No

Participation in fishery management

56	Have you ever involved in any activity or participated in activities to promote water management?	☐0-Yes	☐1-No
57	If not why?	☐1-Not being invited	☐2-Time is not allowed
		☐3-It is a waste of time	☐3-Other

58	How did you participate in an event/activity regarding natural resources management? **(MA)**	☐1-Household representative	☐2-Communiy representative
		☐3-Fisherfolk representative	☐4-Male representative
		☐5-Female representative	☐6-NGOs focal point
59	Did you raise any concern about natural resources during the events/activity?	☐0-Yes	☐1-No
60	If, yes what purposes were your concerns using for?	☐1-Policy purpose	☐2-Planning purpose
		☐3-Taking into action	☐4- Being discussed
	MA	☐5-Nothing happen	☐6-Other
61	If yes, what kind of activity or event?	☐1-Workshop	☐2-Meeting
		☐3-Advocacy	☐4-Volunteering work
		☐5-Training	☐6-Information sharing
	MA	☐7-Public forum	☐7-Other
62	Which organization have you participated in the activity or event with?	☐1-Central gov't	☐2-Provincial office
		☐3-District office	☐4-Commune Council
	MA	☐5-NGOs	☐6-Other
63	What are your main roles in the above involvement?	☐1-Decision maker	☐2-Discussant
	MA	☐3-Observer	☐4-Other
64	How does your community prioritize water resource management in commune investment plan (CIP)?	☐1-First priority	☐2-Second priority
		☐3-Third priority	☐4-Not priority
65	Is there any activity done by commune council to support natural resources?	☐0-Yes	☐1-No
66	Are you a member of water resource management?	☐0-Yes	☐1-No
67	Have you ever participated in restoration of water infrastructure to promote water management financially?	☐0-Yes	☐1-No
68	Have you ever participated in restoration of water infrastructure to promote water management physically?	☐0-Yes	☐1-No
69	Are you required to pay for water for agricultural activities?	☐0-Yes	☐1-No
70	If yes, how much per year for water to support agricultural activities per hectare?		_____Khmer Riel/hectare
		☐0-Yes	☐1-No
71	How much per year are you willing to pay to support agricultural activities per hectare?		_____Khmer Riel/hectare

72	Please additional comments and issues regarding to water in Cambodia

Appendix 3. Checklist for qualitative data

Questions for consultative meetings and interview

1. Please give a short description of agriculture activities in the commune.
2. What are the main sources for agriculture in this commune?
3. What are the factors causing water shortage in your commune?
4. How are the communes addressing water shortage?
5. Are water shortages included in the commune investment plan (CIP) and is the commune including a budget in the plan?
6. What are the key activities to address water shortage by commune?
7. What are the impacts of water shortage on small-scale farmers?
8. To what degree are farmers able to adapt to water shortage?
9. What are your suggestions to reduce the negative impacts from water shortage?