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Sustainable livelihoods analysis in the Tonle Sap Lake and its floodplain, Cambodia

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សង្ខិត្តន័យ

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ABSTRACT

Tonle Sap Lake is the largest body of freshwater in Southeast Asia, benefiting millions of Cambodians. Yet, the lake is under increasing pressure, causing great concern for hundreds of communities depending on the bounty of its natural resources. This research analyzed types of employment, sustainable livelihood, and provision mechanisms in the fishing communities in Tonle Sap Lake. Household surveys were deployed to collect quantitative data from 505 households, and participatory approaches were applied to collect qualitative data through key informants and group discussions. The research findings supported four main conclusions. First, agricultural jobs remained the dominant mode of employment for the villagers in the communities surrounding the Tonle Sap, followed by fishing. For example, fishing was the mode of work for (33.7%), rice farming for (24.2%), and horticulture for (11.7%). Fishery and rice farming played an essential role in daily livelihoods. Second, however, the villagers' livelihoods were not yet fully sustainable. Their daily income per capita (9,199.7 Khmer Riels) was not significantly lower or higher than the rural poverty line (8,908 Khmer Riels), at t (504) = 0.499, P = 0.618. Moreover, their daily income was significantly lower than the national poverty line (10,951 Khmer Riels) set by the Ministry of Planning in 2021, at t (504) = -2.997, P = 0.003. Third, the villagers' livelihoods were constrained by limited access to the five livelihood assets, specifically, professional skills and social assets, support mechanisms to create alternative livelihoods, and local livelihood strategies. Fourth, the existing support mechanisms do not function to improve access to the five assets and engender local strategies for reducing vulnerabilities. Some suggestions are given to enhance sustainable livelihoods related to increased access to the five assets. Access to the five assets for sustainable livelihoods is required to establish robust support mechanisms for all the key stakeholders, which include government agencies, NGOs, and communities. Alternative livelihoods were found to be a viable option to decrease the burden on natural resources and improve sustainable livelihoods.

1. Introduction

The Tonle Sap area in Cambodia includes three separate wetland sites of regional and international significance, entailing the core zone of the Tonle Sap Biosphere Reserve (TBSR) in Prek Toal of Battambang province (Zalinge *et al.*, 2008). The government officially designated Boeng Chmar in 1999, followed by the Stung Sen Ramsar site in 2018 in Kampong Thom province (MoE, 2018). It contains an impressive amount of biodiversity, including more than 225 fish species, 370 plant species, 57 reptile species, 225 bird species, and 46 mammal species (Uk *et al.*, 2018). Tonle Sap Lake is the largest freshwater lake in Southeast Asia. Bonheur (2001) describes the Tonle Sap Lake as the heart of the Mekong River, and forming a unique hydrological system, as almost half of all Cambodians benefit from its water-related resources that, include fish, aquatic plants, birds, reptiles. When the water level of the Mekong River is high between May and October, water flows upstream into the Tonle Sap Lake, which enlarges in size from 2,600 km^2 to 13,000 km^2. The primary water sources include 53.5% from the Mekong mainstream, 34% from the lake's tributaries, and 12.5% from precipitation (Kummu et al., 2014). In the peak flood season, large areas of forests and grassland are inundated, and flooded zones provide sanctuary and breeding grounds for migratory fish, aquatic organisms, and terrestrial wildlife such as birds, reptiles, and mammals. The water flow reverses in November (Kummu & Sarkkula, 2008), and the reverse flow brings a large amount of water, sediments, nutrients, and migratory fish (Shivakoti *et al.*, 2020). The lake provides tremendous fishery resources which has been one of the most vital sources of food and of revenue for Cambodians (MAFF, 2015). As a result, it has been described as the world's most productive inland fishery (Thoun & Chambers, 2006). The annual catch has been conservatively estimated at 400,000 tons in 2007, roughly two-thirds of which came from the Tonle Sap Lake (Hortle, 2007), and the estimate increased to 910.153 tons in 2018 (FiA, 2018). The lake and wetlands have also created employment for millions of Cambodians, enabling them to increase their income, and contributing to poverty alleviation, food security, and economic development (MoP, 2019). Overall, the fishery

sector plays a vital role in the country's economy, with around 6 million people employed in both full-time and part-time fishery-related activities. With a value of approximately US$1.5 billion annually, fisheries contribute 8-12% to Cambodia's Gross Domestic Product (GDP). Furthermore, fishery harvests have provided a vital daily food source for Cambodians, making up an essential source of protein that accounts for 81.5% of the total protein intake. The annual fish consumption per capita is 63 kilograms, comprised of 44.2 kg of inland fish; 17.3 kg of marine fish; and 1.3 kg of aquaculture (FiA, 2014). Due to its significant freshwater ecosystems, the Tonle Sap Lake is enormously productive and sustains massive fish production (van Zalinge, 2002).

Approximately 1.7 million Cambodians live in the 1,555 villages of the Tonle Sap Lake and floodplains areas (Keskinen et at., 2013). Most households in the Tonle Sap can be accurately categorised as low-income and highly dependent on fishing. It was estimated in 2021 that 22.8% of the rural population remained below the poverty line (MoP, 2021) because their livelihood development was challenged as a result of in declining in fishery resources in terms of both the quantity and quality of outputs of fishers (Niras, 2020). Still, the degree of dependency differs between types of villages and the proximity of villages to the water (Hap et al., 2006). Of the total population, around 5% that live close to the lake were engaged in fishing as their main source of livelihood, while 60% that resided in the floodplain were involved mainly in agriculture, and 35% that lived in the urban zone were primarily employed in diversified jobs (Keskinen et at., 2013).

Fishing communities include small-scale, medium-scale, and large-scale fishing operations. Small-scale or subsistence fishing, which involves 90% of the local population, was a significant source of livelihood at the local level, as well as food security and national income (Hap et al., 2006). To sustainably preserve fishery resources, the two-step reform process in 2001 and 2012 entailed a strong policy commitment by the government to abolish all fishing lots and hand over fishing grounds to Community Fisheries (CFis) (Bann & Lieng, 2020). Before these fishery reforms in the 2000s, fishery management in Cambodia was highly centralised, and based on a system of fishing lots and specific fishing units. Since 2012, local rights and the decentralised management of CFis have been increasingly practiced (Sok et al., 2021).

Fishery remains important for rural communities, especially in the Tonle Sap Lake area. A recent study found around 70% of the population had engaged in fishing as a primary occupation, contributing to 78% of income sources; and around 95% of families comprised at least one member involved in fishing (Niras, 2020). Despite its significant value, the Tonle Sap Lake and wetlands have been increasingly threatened by pollution, land-use changes, abnormal fluctuation, climate change, and development projects. In addition, unsustainable fishing practices and overexploitation, which violate fisheries law and involve illegal fishing gear, have led to a decline in fishery resources. This has impacted livelihoods and increased vulnerability to environmental change which is becoming cause of great concern (Shivakoti et al., 2020). A decrease in the vitality of the fishery has made it more difficult for communities to retain their livelihood (Kusakabe et al., 2020). While, climate change predictably increases the obstacles for those whose livelihoods heavily rely on natural resources in the long-term, in the short-term there are limited opportunities for livelihood diversification (Nuorteva et al., 2010).

The impact of climate change results in reduced water flow for both wet and dry reasons, leading to frequent droughts (Oeurng et al., 2019). It is projected that flows will reduce by 9-29% by the 2030s, threatening the ecosystem and the population's livelihood (Shivakoti et al., 2020). Moreover, it has been argued that livelihood resilience measures could address challenges holistically to realise the sustainability and resilience of local livelihoods (Shivakoti et al., 2022).

This research aims to investigate and assess the prospects for the fishery-dependent communities through the application of a sustainable livelihood framework and to examine support mechanisms for the vulnerable fishing communities in the western Tonle Sap Lake, which

are located in the provinces of Banteay Meanchey, Battambang, and Siem Reap.

1.1 Conceptual framework: sustainable livelihoods

The sustainable livelihood framework was developed during the 1990s to examine and analyse livelihoods, particularly the living conditions of the rural poor, and elucidate potential development support or interventions (Scoones, 1998). In this research, the application of a sustainable livelihood framework aims for a comprehensive understanding of the degree of accessibility to various types of livelihood assets, support mechanisms, and livelihood strategies of the fishing communities in Tonle Sap Lake, in the context of the deterioration of the environment and increased scarcity of natural resources. To do this, the sustainable livelihoods framework introduced by the Department for International Development (DFID) was adopted (**Fig.1**). Cambodia provides a suitable case for the application of the framework in order to evaluate the contribution of the five main livelihood assets which are human, natural, financial, physical, and social (DFID, 1999). People define "livelihood" in different ways, but generally, it denotes the ways and means of making a living, and is considered to be sustainable if those means are able to cope with and recover from vulnerability. Scholars have produced substantial literature and extensive discussion on sustainable livelihoods, mainly with regard to rural development (Ellis, 1998; Helmore & Singh, 2001). Chambers and Conway (1992:7) point out: "A livelihood comprises the capabilities, assets (stores, resources, claims, and access), and activities required for a means of living; a livelihood 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." Despite its significant value, Tonle Sap has been increasingly threatened, becoming a cause of serious concern (Shivakoti et al., 2020). A number of studies have been carried out, pertaining to topics such as: the co-management of small-scale fisheries (Sok & Yu, 2021); the effects of environmental degradation on income deriving from small-scale fishing (Hartje et al., 2018); the role of CFi's in reducing livelihood vulnerability resulting from climate change (Wessling, 2020); impediments to community fishery management (Sok et al., 2012); how fishing communities in the Tonle Sap Lake make their living in the context of declining stocks of resources, increased competition between fishers, resource politics, and increased trade around the Lake (Sithirith, 2016); political participation and small-scale fishery management (Sok et al., 2021); lake and livelihoods (Bao et al., 2022); and, the importance of and challenges to fishery resources (Seingheng, 2022).

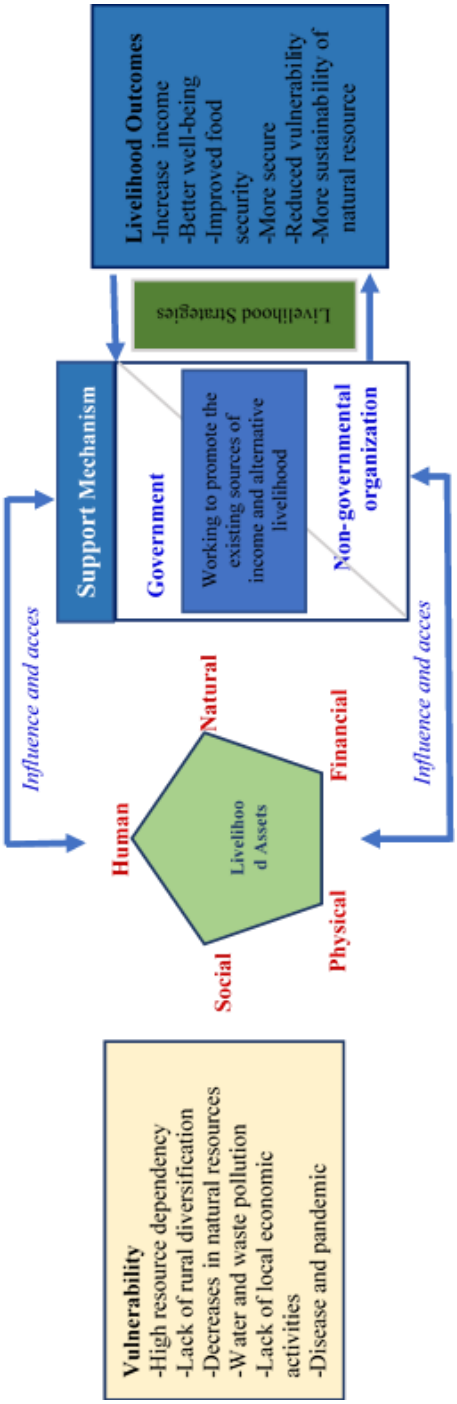

Fig. 1. Conceptualising a sustainable livelihood framework. Adopted: DFID (1999).

In addition, other scholars analysed the governance in the communities around the Tonle Sap Lake (Sithirith, 2022), to examine the strategies that fishing communities use to cope with environmental change. Any substantial changes that have an adverse effect on access to fish supplies would threaten millions of people whose livelihoods and food security directly or indirectly depend upon the fishery resources (Vuthy & Kong, 2015). In the context of environmental change and declining fishery resources, it was crucial to understand how fishing communities have been accessing livelihood capital to be put toward sustainability for present and future generations, as well as to explain what the enabling mechanisms and strategies are for coping with and responding to the unprecedented changes.

2. Materials and methods

The research design was comprised of a household survey for quantitative data and participatory approaches (i.e., key informants and group discussions) for qualitative data. The fieldwork was undertaken between November-December 2021 in three provinces at the western end of Tonle Sap Lake, namely Banteay Meanchey, Battambang, and Siem Reap. The inhabitants of these regions include 13,109 families (MoP, 2020), most of whom live in rural areas. Geographically, the seven communes (sangkats) of the study area were purposively selected based on their uniqueness. Prey Chas and Koh Chiveang communes in Battambang were identified as water-based communes which were situated on the floodplain and/or floating areas (**Fig. 2**). The people mainly rely on fishing for their livelihood due to being physically divided from the mainland. Kampong Phluk and Kampong Khlaing communes in Siem Reap were both land-based and water-based depending on the season (people spent half of the year on land during the dry season and half of the year on the water throughout the wet season), and the seasonal changes in the water level of the lake. Villagers engage in fishing as well as other occupations to supplement their income, such as small-scale farming or aquaculture. Prek Luong commune in Battambang, Sangkat Phniet in Banteay Meanchey, and Sangkat Chreav in Siem Reap are land-based communes, allowing people to

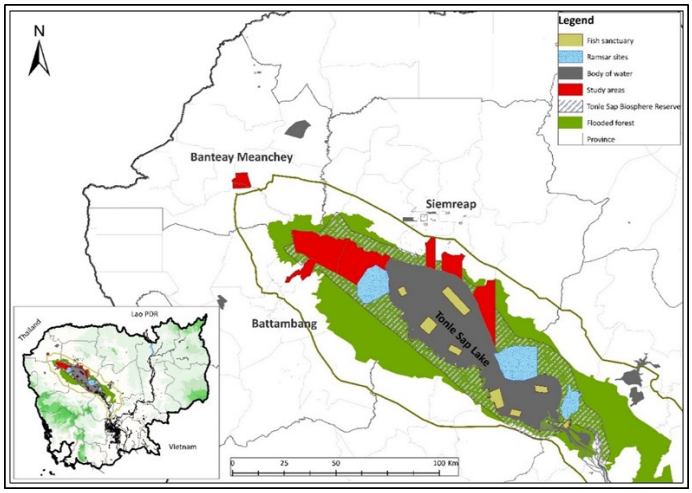

Fig. 2. Location of study communes and provinces.

engage in farming and occasional fishing, depending on the water level. In addition, agriculture, i.e., rice farming, offered more potential to communities and eco-tourism activities for additional income generation.

Consequently, the sampling combined both purposive and systematic approaches to select study locations and to contact households to be interviewed. From the provincial level to the commune level, the researchers applied purposive sampling based on three main criteria: (1) the target area of the Capfish Capture lot number one project at the western Tonle Sap Lake financed by the European Union (EU); (2) diversified livelihood intervention programs and potential for diversified livelihoods; and (3) high dependency on agriculture and fishery for subsistence income with a need to overcome the adverse effects of environmental changes. At the household level, a systematic sampling method was utilized for selecting the households based on a five-household interval, starting with the edge of the village. The research sample size totaled 505 households, including 182 in Battambang province, 183 in Banteay Meanchey and 140 in Siem Reap province, by applying Yamane's (1967) calculation with a 7% level of precision or error in each province.

Triangulation was used as a data collection method. An unstructured questionnaire for group discussion was employed with community fisheries committees actively involved in fishery management. This was done to collect information needed to understand livelihood dependency,

vulnerabilities, support mechanisms, and livelihood strategies to cope with a potential crisis. A semi-structured questionnaire was used for key informant interviews which were conducted with Commune Councillors (CoCs), representatives of the Provincial Fisheries Administration Cantonment, representatives of the Department of Agriculture, Forestry and Fisheries, and representatives of the Department of Environment. The interviews focused on government program supports and policies to enhance the villagers' livelihoods. A structured questionnaire was applied to interview villagers residing in the selected communes, aimed at collecting information pertaining to demographics, occupations, income sources, access to livelihood capital, livelihood strategies, constraints, and involvement in natural resource management. Field observations centred on understanding livelihood activities were also carried out during the fieldwork.

Regarding quantitative data analysis, the researchers employed both descriptive and inferential statistics. The descriptive data was utilized to investigate types of occupation and income sources in order to understand central tendencies and percentages. In addition to this, a weight average index (WAI) was applied to examine the degree of villagers' access to five livelihood assets, measured on a five-point scale, i.e., very low (VL) = 0.00–0.20, 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. Inferential statistics were used for analysis--the one-sample t-test compared the mean of household and national income per capita set by the Ministry of Planning (MoP) in 2021, while an ANOVA test was used to examine the income among the three study provinces and determine whether there was a significant difference. Moreover, multiple linear regressions were applied to predict key factors (e.g., livelihood assets) influencing the secondary jobs employed. Logistic regressions analyzed gender in relation to access to the five assets, and the predicted factors that influenced gender-related access included livelihood asset sufficiency. Eventually, qualitative data was applied in the course of content analysis in order to more deeply understand vulnerability, access to the five assets, support mechanisms, and livelihood strategies.

3. Results and discussions

3.1 Types of employment and incomes

At the western area of the Tonle Sap Lake, the respondents were employed in different types of jobs in farming and outside of agriculture (**Table 1**). Types of jobs included: fishermen (33.7%), rice farmers (24.2%), horticulture (11.7%), wage employment (10.5%), and self-owned businesses (9.7%). In Battambang, more than half of the respondents (54.3%) were primarily fishermen, and in Siem Reap the amount was 32.1%. Comparatively, a higher proportion of the respondents were employed as rice farmers (37.2%) and workers (15.3%) in Banteay Meanchey. In recent years, rural people have been gradually shifting from agricultural to non-agricultural jobs because they could earn on a fixed-schedule and short-term periodic basis. Employment in agriculture, such as rice cultivation, livestock, and horticulture, was found to provide income annually or seasonally.

Having more jobs provides household members with both benefits and costs. Households at Chreav were found to be involved in rice cultivation during rainy and dry seasons. In addition, they grew cash crops to generate additional income. The households in floating communes such as Prey Chas and Koh Chiveang engaged in fishing, crocodile raising, and chilli planting in the dry season. Field observation illustrated that the households faced issues related to their fish, chilli, and crocodile markets during the Covid-19 pandemic. The households tended to invest substantial time and finance during the survey period, although they received little income from those activities. Household income was derived from different members of the household. They were found to share their incomes in order to pay for daily costs such as food, transportation, and social activities [Group Discussion].

The rural village dwellers in water-based communes such as Kampong Phluk and Kampong Khlaing have been constrained by a decline in fishery resources due to climate change, hydrology variations, overfishing, and unsustainable fishing practices. The villagers residing in land-based communes faced water shortages and overuse of chemical substances in agriculture and limited

access to markets. The floating communes have been negatively affected by deleterious impacts of climate change, including decrease fishery resources and flooded forests, as well as the impacts of overfishing, illegal fishing gear practices, lack of access to markets, and poor environmental and waste management, which created hardships for livelihoods and diminished their quality of life [Group Discussion].

On average, a person earned 9,199.7 Khmer Riels per day. The primary sources were self-owned business (8,637.7 Khmer Riels), fishing (8,154.1 Khmer Riels), fish processing (5,929.2 Khmer Riels), and self-employed work (5,360.5 Khmer Riels). The survey found that daily incomes derived from rice farming (3,912.2 Khmer Riels), horticulture (3,523.6 Khmer Riels), and raising livestock (2,168.3 Khmer Riels) were small if compared to self-owned business (Grocery shop and vendor), fishing, fish processing, and self-employed work (Tuk Tuk driver and construction worker). The daily income derived from work in the government, in NGOs, and in companies remained minor because there is a lack of diversification in the rural areas studied. In recent years, daily incomes from rice farming, crop farming, and raising livestock gradually reduced due to decreased agricultural land size, the labor involved, and climate change (Table 2).

According to the Ministry of Planning (2021), the poverty line of rural people was 8,908 Khmer Riels per day per person. One Sample t-test confirms that the daily income of the study provinces (9,199.7 Khmer Riels per day) was not significantly lower or higher than the national poverty line set by the Ministry of Planning (MoP), at t (504) = 0.499, P = 0. 618. Households with more than one member engaged in income-generating activities were more likely to have a more secure income. However, the daily income per capita of the surveyed provinces was significantly lower than the national poverty line of 10,951 Khmer Riels per day per capita, at t (504) = -2.997, P = 0.003.

(Table .2) **Note:** ANOVA (P-value: Rice = 0.526, Crops = 0.000, Livestock = 0.099, Fishing = 0.000, Government = 0.049, NGOs = 0.255, Company = 0.013, Employed workers = 0.018, Bee Keeping = 0.391, Self-employed = 0.000, Self-owned business = 0.936, Fish processing = 0.22, Water hyacinth processing = 0.188, Eco-tourism = 0.124, Total income = 0.006, Income per capita = 0.003). The poverty line in rural areas (Ministry of Planning, 2021) was 8,908 Khmer Riels per day per person, P-value = 0.618. Significant variables are shown in Bold: *P < 0.05 [significant]; **P < 0.02 [very significant]; ***P = 0.000 [perfectly significant].

Table 1. Types of employment of respondents (n = 505).

Types	Battambang	Banteay Meanchey	Siem Reap	Overall
Rice Farmer	17.6	37.2	15.7	24.2
Horticulture	9.3	5.5	22.9	11.7
Fisherman	54.4	14.2	32.1	33.7
Livestock husbandry	0.5	5.5	2.1	2.8
Self-employed (Tuk Tuk driver)	3.8	2.7	5.0	3.8
Employed worker (Factory)	7.1	15.3	8.6	10.5
Self-owned business (Grocery)	4.9	13.1	11.4	9.7
Employee (Company, NGO,)	1.6	5.5	2.1	3.2
Other	0.5	1.1	0.0	0.6

Table 2. Income sources and amounts for the respondents (n = 505)

Sources (Khmer Riels)	Mean	Std. Deviation
Rice farming	3,912.2	9,325.4
Horticulture (Crops plantation)	**3,523.6*** **	9,780.0
Livestock husbandry	2,168.3	8,725.6
Fishing	**8,154.1*** **	11,802.1
Employee (Government official)	2,285.9	12,982.5
Employee (NGOs staff)	4,43.4	4,497.2
Employee (Companies)	**2,365.2** **	13,054.8
Employed worker (Factory)	3,034.6	13,083.9
Bee keeping	202.9	4,391.1
Self-employed (*Tuk Tuk* driver)	**5,360.5** **	11,654.9
Self-owned business (Grocery)	**8,637.7*** **	23,429.2
Fish processing	5,929.2	44,810.7
Water hyacinth processing	104.2	1,704.6
Eco-tourism	2,009.7	35,791.7
Total income	**44,219.0** **	67,157.6
Income per capita	9,199.7	13,130.9

The field survey also reveals that homeowners that earned income less than the poverty line lived in tiny houses and had less property. ANOVA testing found that the daily income of the respondents in Siem Reap (11,946.8 Khmer Riels) was perfectly significantly higher than in Banteay Meanchey (9,354.5 Khmer Riels) and Battambang (6,931.0 Khmer Riels), at F (502, 2) = 5.901, *P-value = 0.003*. Household incomes in Siem Reap were more diversified with various sources that included rice cultivation, fishing, eco-tourism, and horticulture.

Further ANOVA testing resulted in the findings that the daily income of the study provinces was significantly different among different types of employment: horticulture or crop cultivation *(P-value = 0.000)*, fishing *(P-value = 0.000)*, government work *(P-value = 0.049)*, company work *(P-value = 0.013)*, employed workers *(P-value = 0.018)*, and self-employed worker *(P-value = 0.000)*. While the incomes of the respondents in Siem Reap were significantly derived from fish processing, the respondents in Banteay Meanchey were highly derived from self-employment and self-owned businesses. In Battambang, a higher proportion of their daily income was derived from crops cultivation and fishing. It was observed that in fishing communities, the incomes and livelihoods were primarily derived from fishing. In contrast, three out of seven study areas were land-based communities; therefore, rice farming was one of the primary sources of income. In the two water-based (floating) communities studied in Battambang, fish were undeniably one of the primary sources of daily consumption and income.

3.2 Access to livelihood assets in fishing communities

Generally, households faced challenges in accessing the five key assets to sustain their livelihoods, especially human and social assets. Overall, the respondents had moderate access to natural and physical supports. The respondents were found to have substantial or high levels of access to water and moderate levels of access to fisheries. The respondents experienced low levels of access to aquacultures, forests, wildlife, and birds. With regard to human assets, the respondents were found to have moderate levels of access to information regarding fishing gear limitations, the opening of the fishing season, and the closing of the fishing season. Simultaneously, the respondents received little information concerning fishery laws and the time period of the waxing moon. Overall, the respondents agreed that they had a low degree of professional skills, and were engaged in rice farming, horticulture, small and medium-sized business, construction, driving, technical work (eco-tourism or factory), and processing (fish or honey collection) (**Fig. 3 & 4**).

Concerning physical assets, the respondents had (1) a high degree of access to roads, local markets, health facilities, school facilities for children, and land transportation; (2) a moderate degree of access to bridges, river ports, irrigation, boats for fishing, fishing gear, and water transportation; and (3) a low degree of access to homestays and bird watchtowers (**Fig. 5, 6,7 & 8**).

With regard to access to social assets, the respondents had little opportunity to raise concerns about community development and to participate in activities implemented by NGOs, Commune Councils, government agencies, and community fisheries. With regard to financial assets, the respondents had more access to loans from the bank, microfinance, and local lenders. However, they did not have enough opportunity to participate in savings groups and sufficient access to income generation activities. The respondents were empowered to make a good decision-making for access to a commercial bank and microfinance institutions for loans.

3.3 Factors influencing livelihood development

Multiple linear regression was applied to predict key factors influencing the number of secondary jobs employed in terms of the five types of assets (Table 3). The model predicts 10 out of 42 attributes influencing the number of secondary jobs employed, R^2 = 0.313; F (42, 404) = 4.377, $P < 0.05$. The characteristics of the five assets

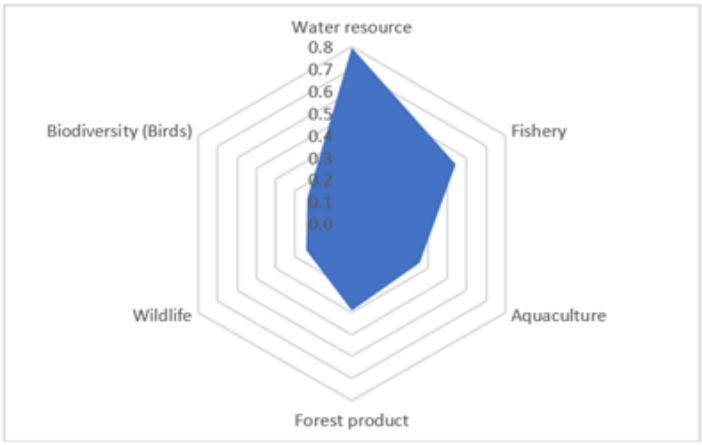

Fig. 3. Natural assets.

Fig. 4. Social assets.

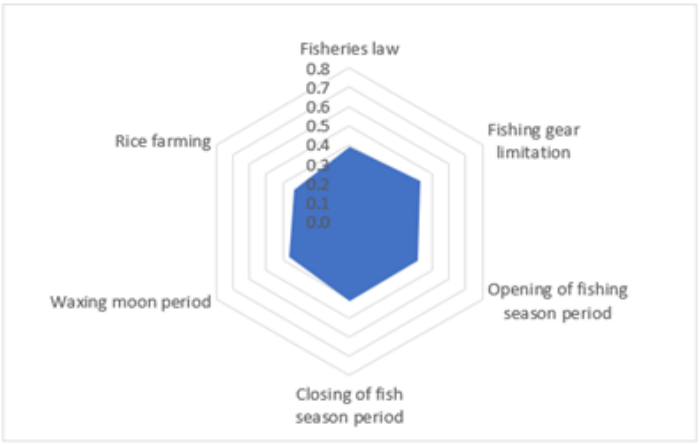

Fig. 5. Human assets.

Fig. 6. Professional skills.

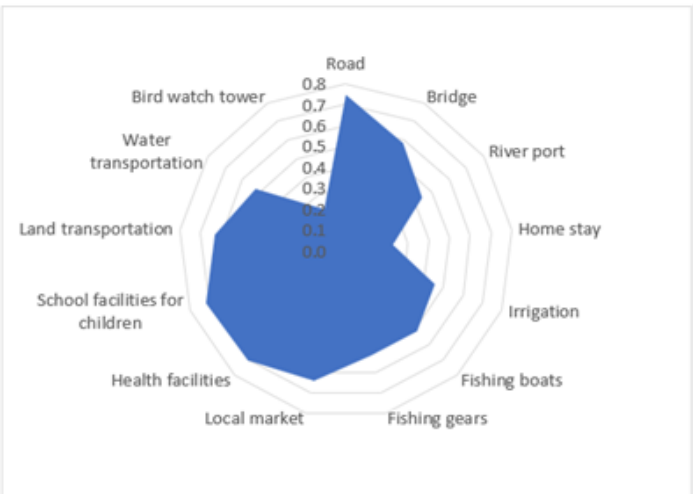

Fig. 7. Physical assets.

Fig. 8. Financial assets.

Note: WAI = Weight Average Index measured on a five-point scale [very low (VL) = 0.00–0.20, 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].

included water, fishery, aquaculture, technical work (eco-tourism, factory), fishing gear, land transportation, homestay, raising concerns about community development, access to local lenders, and access to income generation activities. The analysis reveals that attributes (fishery and technical work, raising concerns about community development, access to local lenders, and access to income generation activities) were negatively associated with number of secondary jobs.

The model suggests that the greater extent the respondents were involved in fishing and

technical work (eco-tourism and factory), the lower their chances to apply for more than one job. Those two types of jobs made people busy for most of the day, and they had no extra time to get involved in other positions. During the discussion, the villagers mentioned the importance of raising concerns during commune council meetings, access to local lenders for loans, and access to income generation activities. Although income generation was small for each household, their members faced challenges when seeking supplementary income or secondary jobs. The villagers admitted that one job could not sustain a household anymore. Therefore, a family requires more than one job to sustain their livelihood [Group Discussion].

The finding indicates there is more opportunity to access more than one job when the respondents had access to water, aquaculture, land transportation, homestays, and fishing gear. Focus group discussions describe the necessity of access to water because all types of jobs were associated with such access. Thus, water is a natural resource that is essential to creating employment. Source of incomes from aquaculture and the homestay were considered to result from medium and long-term strategies of local governments, NGOs, and villagers to diversify sources of livelihood. Aquaculture and homestay were found to be valuable sources of income by creating more jobs and reducing high dependency on natural resources. At the same time, improved access to land transportation and fishing gear increased the opportunity for more sources of income [Group Discussion].

Table 4 describes Logistic Regressions that examined the factors which influenced the relationship between gender and access to the five assets, including the sufficiency of the physical assets and social assets (X^2 (5) = 9.25, P < 0.05). The survey shows that a higher proportion of female respondents (43.6%) were able to access physical assets. In contrast, more male respondents (25.7%) participated in social events, as only 18.5% of female respondents did so. Key informants with commune councillors (CoCs) described that women were recently active in the community's work because men travelled or migrated far from the communities for their jobs for long periods of time. Necessary physical infrastructures inside the communes, such as roads, bridges, and irrigation, were highly used by women for income generation activities. Therefore, women, whose husbands migrated from the communities, represented their households during the events organised by CoCs, NGOs, and government agencies, in order to discuss or raise issues related to community development [Key Informant].

3.4 Support mechanism and sources for livelihood development

Supporting mechanisms were found to be very important for increasing access to livelihood assets of the households. In the communities, NGOs and the Provincial Office of Agriculture, Forestry, and Fisheries (PoAFF) provided social services, awareness-raising and capacity-building to improve human assets (knowledge and professional skills) for promoting natural and social assets. The fieldwork shows that access to financial assets was not the issue anymore. The widespread presence of micro-finance and commercial banks across the country has allowed people to access financial support for their initial investments and expand their current business and income generation activities (IGAs). At the same time, CoCs were working with the line Ministries, including the Ministry of Public Works and Transport (MoPWT), Ministry of Rural Development (MoRD), and Ministry of Water Resources and Meteorology (MoWRM), in order to advance physical infrastructure, including national roads, rural roads, and irrigation systems [Key Informant]. Group discussion with local people also identified the significant contribution of government agencies (from the national to the sub-national levels), NGOs, and the private sector in supporting the access to the five assets [Group Discussion].

At the household level, the villagers had various de facto investment supports in place to improve and develop their livelihoods (Fig. 9). Overall, four main supports were utilised to enhance livelihoods. These included: self-financing, borrowing from microfinance, support from relatives, and loans from a local tender. Most villagers preferred utilising their available financial resources as much as possible before borrowing from other sources. Such sources include microfinance, relatives, and local loan

Table 3. Factors influencing secondary job employment.

Attributes	Unstandardised Coefficients		Standardised Coefficients	*P*-value
	B	Std. Error	Beta	
(Constant)	0.574	0.375		0.127
Water resource	0.797	0.367	0.115	**0.030***
Fishery	-0.634	0.321	-0.150	**0.049***
Aquaculture	0.978	0.256	0.180	**0.000*****
Forest	0.033	0.279	0.007	0.906
Wildlife	-0.118	0.867	-0.012	0.892
Biodiversity (Birds and aquatic resources)	-1.145	0.900	-0.105	0.204
Fisheries law	-0.529	0.459	-0.091	0.249
Fishing gear limitations	0.496	0.476	0.093	0.298
Opening of fishing season period	-1.293	0.920	-0.261	0.160
Closing of fish season period	0.811	0.931	0.167	0.384
Period of waxing moon	0.335	0.388	0.062	0.389
Rice farming	0.513	0.313	0.091	0.102
Gardening *(Chamkar)*	0.000	0.323	0.000	1.000
Small and medium-sized business	-0.131	0.441	-0.016	0.767
Construction	0.481	0.391	0.061	0.220
Driving	0.518	0.399	0.072	0.194
Technical work (eco-tourism, factory)	-1.411	0.648	-0.129	**0.030***
Processing (fish, honey)	0.934	0.495	0.104	0.060
Roads	-0.220	0.339	-0.035	0.517
Bridges	-0.621	0.324	-0.144	0.056
River ports	-0.479	0.333	-0.113	0.151
Irrigation	-0.158	0.211	-0.039	0.453
Fishing boats	-0.267	0.375	-0.070	0.476
Fishing gear	1.292	0.351	0.327	**0.000*****
Local market	0.153	0.260	0.031	0.557
Health facilities	-0.280	0.373	-0.050	0.453
School facilities for children	0.363	0.355	0.068	0.307
Land transportation	0.918	0.332	0.184	**0.006****
Water transportation	-0.319	0.295	-0.082	0.280
Homestay	2.750	1.178	0.216	**.020****
Bird watch tower	-1.505	1.145	-0.118	0.190
Raising concerns about community development	-0.654	0.330	-0.117	0.048
Participation in activities of NGOs	0.564	0.373	0.096	0.131
Participation in activities of Commune Council	0.721	0.384	0.123	0.061
Participation in activities of government offices	0.342	0.439	0.049	0.436
Participation in activities of community fishery	-0.232	0.431	-0.040	0.591
Involvement in community decision-making	0.576	0.546	0.079	0.292
Access to microfinance loans	0.105	0.221	0.023	0.636
Access to commercial bank loans	-0.101	0.267	-0.020	0.704
Access to local lender	-1.113	0.241	-0.213	**0.000*****

Note: R^2 = 0.313; F (42, 404) = 4.377. Significant variables are shown in Bold: *P < 0.05 [significant]; **P < 0.03 [very significant]; ***P = 0.000 [perfectly significant]

Table 4. Gender and access to the five assets.

Livelihood asset	B	S.E.	Wald	P-value.	Exp(B)
Natural	-0.201	0.290	0.483	0.487	.818
Human	0.036	0.303	0.014	0.906	1.037
Physical	0.570	0.275	4.302	**0.038***	1.768
Financial	-0.009	0.283	0.001	0.975	0.991
Social	-0.660	0.280	5.564	**0.018****	0.517
Constant	-0.108	0.244	0.195	0.659	0.898

Note: $X^2(5)$ = 9.25. Significant variables are shown in Bold: *P < 0.05 [significant]; **P < 0.03 [very significant]; ***P = 0.000 [perfectly significant].

providers.

In comparison, 64.8% of the Battambang villagers utilised their financial capital, while 60.7% relied on local money lenders. Local loan providers were popular in the floating commune of Battambang province because borrowers were less likely to be required to use the property as collateral to obtain the loan. However, loans involve a relatively high interest rate. In Battambang, a few villagers obtained support from government and NGO projects for agricultural ventures, i.e., greenhouse gardens and poultry. Banteay Meanchey villagers mostly found investment through self-financing (79.2%), microfinance (44.6%) and relatives (25.4%). The livelihood support strategies in Siem Reap included self-financing (66.1%), microfinance (40.3%) and local loan providers (37.1%). Borrowing money from commercial banks was less popular across the communes studied because it requires villagers to use collateral and property (land titles), while most of the villagers have not legally obtained land ownership.

Similar to Battambang and Banteay Meanchey, in Siem Reap only a small proportion of villagers had been provided support by government and NGO projects. Some projects focused on small villages or some parts of the commune. Consequently, a limited number of locals could get involved in the project because of budget limitations. Other projects have criteria to select the participants which limit involvement, for example, the project to strengthen the capacity of the community fisheries committee and its members to improve the management of fisheries resources. This project is principally focused on the CFi committee and its members, some of which are utilised as key informants. Some government and NGO projects basically focused on awareness-raising about agriculture and natural resource protection.

The research found that the percent of the respondents that participated in activities varied, including: participation in meetings (20.4%), involvement in information sharing (5.5%), involvement in workshops (4.4%), engagement in volunteer work (3.8%), participation in training (3.4%), and participation in workshops (2.4%).

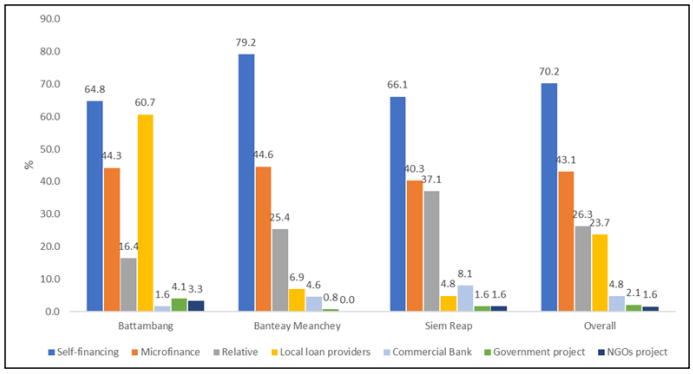

Fig. 9. Source of investment to improve income-generating activities.

In Battambang, the respondents were more actively involved in meetings (30.8%), than involved in volunteer work (6.6%), workshops (4.4%), and advocacy (3.3%). In Siem Reap, the respondents played more of a role in sharing information. These activities are generally organised at the village level by NGOs and the government, making it possible that villagers will join the meetings. During the village meetings, the people participated and raised their concerns about community development and natural resource issues. The commune councillors considered their concerns and promised to support conservation activities.

Commune Councils (26.1%) and NGOs (25.0%) have played significant roles in creating space for people to raise their concerns through event participation. The respondents also participated in events organised by: the central government (8.3%), the district office (7.5%), and the provincial office (2.4%). In Battambang, the respondent had more opportunities to participate in events organised by NGOs, CoCs, district offices, regional offices, and the central government. Out of the total, 17.8% of the respondents played a role as discussants, followed by 2.6% as observers, and 1.8% as decision-makers. In Battambang, 25.3% of the respondent were invited to participate as discussants. They discussed issues happening in their villages for and informed the CoCs. Sometimes, they also joined group discussions with NGOs to study community development.

Considering how villagers either succeed or fail to sustain their livelihoods in the face of shocks, trends and seasonality, can assist the introduction of policies and interventions for

coping with said shocks and stresses, and facilitate adaptive strategies (Allison & Horemans, 2006). Moreover, individuals and households often diversify their livelihood strategies (Moser, 1998). Utilising a sustainable livelihood framework could thus extend the notion of access to different types of capital over time with the focus on long-term flexibility (de Haan & Zoomers, 2005).

The survey result shows that the households had limited access to professional skills and social assets. Also, they tended to have a moderate degree of access to natural assets, physical assets, financial assets, information, and awareness regarding community development. The idea of livelihood assets is central to the sustainable livelihood framework. Rather than understanding poverty as purely a lack of household income, the sustainable livelihood approach considers the assets that poor people require to sustain an adequate income. In general, the more assets a household has access to, the less vulnerable it would be to the harmful effects of shocks and stress (DFID, 1999).

Sok and Yu (2015) claimed that riverine communities of the lower Mekong Basin in Cambodia had limited access to the five assets needed for sustaining livelihoods. At the same time, their capacity to adjust to vulnerabilities, such as disasters and economic crises, was low (Sok & Yu, 2025). The survey results show that the livelihood of the studied households was vulnerable because of high resource dependency, lack of rural diversification, declines in resources, water and waste pollution, lack of local economic activities, and the impacts of disease/pandemics. Based on the five assets, shaped by the context of vulnerability and transformations in structures and processes, underprivileged people can undertake a range of livelihood strategies (activities and choices) that eventually shape their livelihood outcomes.

Moreover, disadvantaged people are usually obliged to combine various approaches to survive. For example, individuals get involved in different activities, and household members may live and work in other places. The outcomes that they achieve could include more income, increased well -being, reduced vulnerability, and better food security. Occasionally, one product can negatively affect another, for instance, when poor people engage in less dangerous, and therefore lower-income activities, they are less vulnerable to shocks and stress (DFID, 1999) because poor people are generally unable to invest in larger income activity.

An increase in the five livelihood assets is beneficial to reducing household vulnerability. For example, improved access to financial assets helps to increase local economic activities. However, improved human assets, especially skills, are the key to rural development. Professional skills and infrastructure help to improve productivity and enable alternative livelihoods which reduces high resource dependency. Professional skill development is also crucial for diversifying sources of rural livelihoods. Moreover, households' access to information and awareness regarding community development and resource management may reduce the negative impacts of disease and pandemics as well as water and waste pollution.

The access to social assets has created dialogue on development among local people and key stakeholders, which is essential for achieving consensus and joint decision-making related to community development and resource management. Unfortunately, the households in the study provinces did not have sufficient access to all of the five livelihood assets, particularly human and social assets. The limited access to skills and local empowerment is the main constraint on effective use of the available natural, financial, and physical assets.

During group discussions, the respondents admitted they did not have sufficient skills, and that, in their work, they utilised techniques shared among their peers. For example, households grew vegetables without professional skills obtained through formal training or clear market strategies. Key informant interviews with local authorities found that they were invited to participate in developing the annual commune investment plan (CIP). Physical infrastructure has always been prioritised, and the budget is allocated. However, the available budget is not sufficient to provide fully for local resource requests.

Each year, a commune has funding for road

construction, and communities are also required to restore ponds, irrigation, and dykes. The households studied indicated that they could access loans and credit from microfinance and commercial banks, but most households did not have sufficient professional skills and knowledge of risk management. As a result, they could not use the available financial resources effectively and efficiently. The group discussion confirmed that natural resources, especially water and fishery, were relatively available and largely contributed to their livelihoods. However, the households did not have sufficient professional skills based on proper training to use the natural resources economically. Meanwhile, the households did not have adequate authority in the decision-making processes related to the use natural resources.

Alternative livelihoods are the best option to reduce the burden of natural resources and improve livelihood sustainability. In this research, eco-tourism was found to be the most effective option for the diversification of livelihood strategies. Senglong & Doeur (2022) claimed that 65.3% of the respondents in that research agreed their communities are good enough to develop eco-tourism sites. A few respondents already earned income from boat rentals (6.4%), selling meals (4.3%), and guiding tours (3.6%). However, the respondents claim that their livelihood gains from eco-tourism development are not sustainable - the average income generated was 200.1US$, compared to their average investment of 159.6US$. Their communities have an abundance of natural assets, including tourist attractions (43.8%), good environment (19.6%), ecosystem support (15.4%), cultural value (9.9%), and other (1.0%). Additionally, 70.1% of the respondents wish to generate income from eco-tourism.

The transforming structures and processes' box (**Fig. 1**) refers to the institutions and policies that affect poor peoples' lives, from public and private entities to national policies and local culture. These can change the vulnerability context and the assets to which poor people have access. The communities studied, local governments, CoCs, and NGOs each play an essential role in supporting eco-tourism development. Unfortunately, the survey shows that the respondents did not fully participate in the implementation of CBOs-related programs, such as Community Fisheries (40.1%), eco-tourism (2.6%), Community Protected Areas (0.2%), and saving groups (0.2%). At the same time, 70.3% of the respondent claimed that they were not invited to participate in any events related to community development. A limited number reported participating in the events organised by Commune Councils (26.1%), NGOs (25.0%), the central government (8.3%), district offices (7.5%), and provincial offices (2.4%). The survey also confirms the households did not receive sufficient support for accessing markets and finance. The households were found to depend on middlemen (66.7%), neighbours (48.9%), local markets (46.5%), and regional demand (14.3%) for their products. The households did not have enough power to negotiate prices with intermediaries or local merchants.

3.5 Policy Implications

Increase access to the five assets through improved human and social assets. The survey results clearly show that the households did not have sufficient access to human and social assets. The main issues for households were constraints in accessing professional skills (proper training) through their current mode of employment. Most of them work based on skills and knowledge passed from one generation to another. The survey shows that the respondents worked in primary jobs as fisherfolk (33.7%), rice farmers (24.2%), gardeners (11.7%), employed workers (10.5%), and self-businessmen (9.7%). Therefore, a feasibility study of specific professional skills required by each primary job should be conducted. This feasibility study would help to ensure that skills are provided in response to local and individual needs. The provincial government and NGOs should complete this feasibility study and disseminate it widely. The findings of this feasibility study should also be circulated among the key stakeholders, especially the Ministry of Labour and Vocational Training, because that ministry manages vocational training centres across the country. When specific skills are identified, the professionalism of the local people is improved through proper training by experienced coaches.

Regarding social assets, increased opportunity for decision-making among the

participants at the events organised by local government, CoCs, and NGOs are crucial to improving local livelihoods. In particular, an increase in budgets for the implementation of district investment plans and commune investment plans (CIP) is more effectively utilised by local decision-making. For example, income generation activity is one of the activities prioritized by the villagers for the implementation of commune investment plans, but the budget has not yet been provided for action in the study communities. Essentially, advocacy for an increase in budget allocation of the district investment plan and commune investment plans entails engagement with the Ministry of Interior (MoI). Local needs can be met when only the district office and CoCs have sufficient budget to implement their annual plans. At the same time, the district office and CoCs should be authorised to generate revenues through local tax collection. The district office and CoCs could then appropriately increase their budget to invest in development.

The access to the five assets for sustainable livelihood requires robust support mechanisms from the Ministry of Interior, Ministry of Labour and Vocational Training, Ministry of Information, Ministry of Tourism, Ministry of Agriculture, Forestry and Fisheries, Fishery Administration, CoCs, NGOs, and the private sector. The fishing communities cannot successfully establish and fortify eco-tourism services without support for the first three to five years. Human and social assets could probably be improved through projects implemented by NGOs, and physical infrastructure could be enhanced if the Ministry of Interior increases the annual budget for the Commune Investment Plans (CIP) of CoCs. Natural assets are central to rural development in Cambodia. All key stakeholders, including the abovementioned ministries, CoCs and NGOs, should jointly work to promote natural resource management.

The increase in the annual budget for CIP implementation also empowers local participation and decision-making in response to local demands. Loans and borrowing are widely accessible because of the scope of private sector lenders, such as microfinance organisations and commercial banks. NGOs should also increase their assistance in the establishment of savings groups and the access to small loans for local people to initiate income-generation activities. Access to the five assets requires a joint effort and commitment by all the key stakeholders.

4. Conclusion

Based on the findings, the researchers concluded that the villagers' livelihoods in the study communes of Siem Reap, Battambang, and Banteay Meanchey, were not yet fully sustainable. The daily income per person was 9,199.7 Khmer Riels which was not significantly lower or higher than the rural poverty level set by the MoP in 2021 (8,908 Khmer Riels per day). However, their daily income was significantly lower than the national poverty line, at t (504) = -2.997, P = 0.003. Limited access to the five livelihood assets, an insufficient support mechanism to create alternative livelihoods, and a lack of local livelihood strategies were the leading causes of lack of sustainability as well as the key constraints on improvement. The available livelihood assets of local people and the existing support mechanisms provided by the government, NGOs, and fishing communities were found to be insufficient for reducing vulnerabilities.

Vulnerabilities were caused by high resource dependency, a lack of rural diversification, declines in resources, water and waste pollution, a lack of local economic activities, and disease and pandemics. In addition, the local villagers did not have clear livelihood strategies for the effective and efficient use of natural resources due to a lack of human and social assets. When villagers did not have much opportunity to decide on their community development, they only participated in activities implemented by the government and NGOs. The resulting support mechanisms were not strong enough to enable local, sustainable livelihoods. The primary source of their products are middlemen (66.7%), and IGA investment is derived from self-financing (52.3%).

The research confirmed that access to livelihood assets remains challenging and does not provide for professional skill development and fomenting social assets. The villagers still obtain moderate degrees of natural assets, physical assets, financial assets, information, and

awareness on the topic of community development. Non-agricultural jobs such as employment as workers (10.5%) and self-owned businesses (9.7%) are increasing, but agricultural jobs remain dominant. The villagers were highly engaged in areas of work dependent upon the water-related resources of the Tonle Sap Lake, including: fisherfolk (33.7%), rice farmers (24.2%), and horticulturalists (11.7%). The villagers, especially in Siem Reap, were also involved boat rentals (6.4%), selling meals (4.3%), and guided tours (3.6%). In Battambang, the villagers manage water hyacinth processing, particularly the people in Koh Chiveang. The analysis showed that the daily income of the three provinces was different for different areas of employment, such as crop cultivation, fishing, government work, company work, employed workers (Factory), and self-employed workers (Tuk Tuk driver). While a share of the villagers' income in Siem Reap derived from fish processing, Banteay Meanchey respondents mainly earned from self-employed work and self-owned businesses. A higher proportion of the daily income in Battambang came from crops and fishing.

Alternative livelihoods approaches are the best option to reduce the burden on natural resources and improve the sustainability of their way and quality of life. In the future, the villagers' livelihoods can be improved by establishing well-functioning support mechanisms to increase the five livelihood assets and improve local strategies for reducing vulnerabilities and creating alternative livelihoods. All the key stakeholders, including government agencies, NGOs and communities, should work together to improve the sustainability of the villagers' livelihoods. For improving sustainable livelihoods, it is necessary to increase access to the five assets through improved human and social assets. The access to the five assets for sustainable livelihood requires the establishment of a robust support mechanism by the Ministry of Interior, Ministry of Labour and Vocational Training, Ministry of Information, Ministry of Tourism, Ministry of Agriculture, Forestry and Fisheries, Fishery Administration, CoC, NGOs, and the private sector.

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Declaration of competing interest

The authors declare that they have no competing interests.

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