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Impact Study of Tonle Sap Lake's Tributary Functions

THE NGO FORUM ON CAMBODIA
FUNDED BY ROSA LUXEMBURG STIFTUNG

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Sok Somith
Team Leader

List of Abbreviations

ADB	Asian Development Bank
ANKO	Akphiwat Neary Khmer Organization
CCCSP	Cambodia Climate Change Strategic Plan
CNMC	The Cambodia National Mekong Committee
CDRI	Cambodia Development Resource Institute
DRR	Disaster Risk Reduction
FGD	Focus Group Discussion
FWUC	Farmer Water User Community
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GHG	Green House Gas
KII	Key Informant Interview
MRC	The Mekong River Committee
MOWRAM	Ministry of Water Resources and Meteorology
MoE	Ministry of Environment
MAFF	Ministry of Agriculture, Forestry, and Fisheries
NGO	Non-Governmental Organization
NECA	Network on Climate Change Adaptation
NGOF	NGO Forum on Cambodia
NAPA	National Adaptation Programme of Action of Climate Change
NSDP	National Strategic Development Plan
NTFP	Non-Timber Forest Product
PCDRM	Provincial Committee on Disaster, Risk Reduction Management
PDAFF	Provincial Department of Agriculture, Forestry, and Fisheries
PDE	Provincial Department of Environment
PDWRAM	Provincial Department of Water Resource and Meteorology
PDH	Provincial Department of Health
RS	Rectangular Strategy
RLS	Rosa Luxemburg Stiftung
RGC	Royal Government of Cambodia
ToR	Term of Reference
TSBMO	Tonle Sap Basin Management Organization
TSA	Tonle Sap Authority
TSL	Tonle Sap Lake
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
UNICEF	The United Nations International Children's Emergency Fund
UNFPA	The United Nations Population Fund
UNFCCC	The United Nations Framework Convention on Climate Change
WFP	World Food Programme

List of Glossaries

Name of Tree Species in Khmer	Scientific Name of Tree Species	Name of Tree Species in English
Daem Raing	Barringtonia acutangula/asiatica	Cannonball tree
Daem Phnom Pheng	Hymnocardia wallichii	
Daem Borbuoy	Croton caudatus	
Daem Anhchanh	Gmelina asiatica	
Daem Phtuol	Diospyrus bejaudii	
Daem Ta Uo	Terminalia cambodiana	
Daem Chrakaeng	Mallotus anisoponus	
Daem Tros	Compretum triforiatum	
Daeum Krachork Andeuk	Ixora cuneifolia	
Daem Ponlea		Pavilion
Daem Thnong	Kino tree	
Daem Trasek	Peltrophorum pterocarpum	Yellow poinciana/flamboyant
Daem Sandan	Garcinia loureiri + G. merguensis	Garcinia loureiri
Daem Av Krapeu	Stixis obtusifolia	
Daem Romdenh	Planchonella obovata	Planchonella obovata
Daem Tromoung	Garcinia oliveri	Garcinia oliveri
Daem Dai Khla	Galbergia oliveri	
Daem Nhor Teuk	Morinda tomentosa	
Daem Kambasprey	N/A	N/A
Daem Chhaoh	N/A	N/A
Daem Sdei	N/A	N/A
Daem Ptol	Diospyrus bejaudii	
Daem Lngieng		Dandelion
Daem Kantouy Phe	N/A	N/A
Daem Tasiev	N/A	N/A
Daem Krabaw	N/A	N/A
Daem Chanhchas	N/A	N/A
Daem Dangkeap Kdam		Verbena
Daem Sdoksdav	N/A	N/A
Daem Sortei	N/A	N/A
Daem Khtum		Cactus
Daem Sbauv		Thatch
Daem Achsath		Animal cane

Name of wildlife in Khmer	Scientific Name of Wildlife	Name of Wildlife in English
Klatrey		Fishing cat
Chhmardav		Leopard cat
Andoek		Turtle
Sva		Monkey
Phe		Eurasian Otter
Teaprey		Dollarbird or wild duck
Sva Kdam		Long-tailed Macaque
Khdann		Deer
Sampouch		Large-spotted Civet Cat
Chorchok		Wolf
Chlous		Red Muntjac,
Trakuot		Bengal Monitor
Staing		Basra
Tradok Thom		Greater Adjutant
Kok		Cinnamon Bittern

Tradok Touch		Lesser Adjutant
Khaek Teuk		Great-Cormorant
Krasa		Grey Heron
Moanteuk		Common Moorhen
Chroukprey		Wild pig
Broveuk		Lesser Whistling Duck
Travdevich		Green Bee-Eater
Tonsay		Rabbit
Kngauk		Peacock
Kambrok		Pallas's Squirrel
Tetoy		Owl
Roneal		Milky Stork
Troyang		Glossy lbis
Kengkong		Hornbill
Tmart		Vulture
Tong		Great White Pelican
Kreal		Crane
Skar		Crab-eating mongoose
Ansorng		Water monitor
Kantheay		Softshell turtle
Kampuon	N/A	N/A
Bangkuoy trong		Moustached lizard

Name of Fish Species in Khmer	Scientific Name of Fish Species	Name of Fish Species in English
Kolraing	*Carcharhinus leucas*	
Prathom	*Pangasianodon hypophthalmus*	
Trasork Krahorm	*Systomus rubripinnis*	
Pruol	Cirrhinus microlepis	
Chhdr	*Channa micropeltes*	
Kies	*Phalacronotus apogon*	
Real	Amblyrhyn chiclithys truncatus	
Krum	*Osteochilus melanopleura*	
Sanday	*Wallago attu*	
Kray	*Chitala blanci*	
Domrei	*Oxyeleotris marmorata*	
Chhlaing	*Carcharhinus leucas*	
Kampot	*Dichotomyctere fluviatilis*	
Dangkteanh	N/A	N/A
Klar	*Datnioides polota*	
Kbork	N/A	N/A
Krahae	*Barbonymus gonionotus*	
Kantrop	*Pristolepis fasciata*	
Srakakdam	*Anematichthys repasson*	
Klang Hay	*Belodontichthys truncatus*	
Kanthor	*Trichopodus pectoralis*	
Reach	*Pangasianodon gigas*	
Trey Kla	*Datnioides microlepis*	
Trey Kbalpuos		snake head fish
Ach Kok	*Labiobarbus siamensis*	
Bobel	*Urogymnus polylepis*	

Executive Summary

Tonle Sap Lake is the largest freshwater lake in Southeast Asia, and directly supports over 1 million people in Cambodia. It provides the single largest source of protein for Cambodia's young and increasing population. However, the Tonle Sap basin has recently been under pressure due to severe threats to the lake's ecosystem, including overfishing, overexploitation of wildlife resources, dry-season encroachment, and land clearance of the flooded forest. This study aims to identify and document the main factors contributing to the changes of Tonle Sap Lake's tributaries, as well as the livelihoods of people and biodiversity along the tributaries. It also generates recommendations for key stakeholders to ensure sustainable livelihood and biodiversity.

The study was conducted in five provinces with tributaries including Steung Sen, Steung Sraeng, Steung Moung (Dauntri), Steung Pursat, and Steung Boribou, based on various selection criteria including their water contribution in and out of the Tonle Sap Lake, using the livelihood and biodiversity conceptual framework. The study engaged 17 provincial departments; 10 districts; 14 communes; and 14 villages in all 5 provinces with total **379** respondents of which **235** were women. Methodological approaches were employed including, literature reviews, key informant interviews, focus group discussions, case studies, and validation workshop.

Surface air temperature in the Southeast Asian region increased between 0.1 and 0.3 °C per decade between 1951 and 2000 (ADB, 2009). Sea levels have been rising at the rate of 1 to 3mm per year over the last 50 years. Events of heavy rainfall have increased significantly between 1900 and 2005, while tropical cyclones occurred more frequently between 1990 and 2003 (ADB, 2009). The increasing change in rainfall patterns since the 1920s have been unpredictable, and intense rainfall greatly impacts the livelihood of farmers. The country is projected to experience an increase in surface temperature up to 3.1°C by the 2090s, against the baseline conditions over 1986–2005 under the highest emissions pathway.

Another factor is climate change which is threatening the natural flow patterns of 11 river sub-basins contributing to the Tonle Sap Lake. The tributaries in Kampong Thom, Siem Reap, Battambang, Pursat, and Kampong Chhnang have already experienced the impact caused by the change in water flow patterns, inadequate and unpredictable rainfall, irregular flood pulse, and the lack of reverse discharge from the Tonle Sap Lake during the dry season. Flash floods and protracted droughts have continued to drain food sources and income of many people that depend on the rainfed river regimes for agricultural production. This indirectly drives up the price of agricultural inputs while the selling price for agricultural produce remains the same.

There have been extensive incidents of illegal poaching, land clearance and burning of flooded plants, disposal of toxic residues, landslides, and landfills, which are rampant in Tonle Sap Lake area and along the five studied tributaries. There has been a significant loss of trees, and the loss of aquatic and terrestrial wildlife species has been rising and the livelihood of fishing and agricultural communities has been greatly affected.

The above factors are forcing more people to find alternative occupations to sustain their household food and income. Some have already sent their family members to work in garment factories, construction, and other temporary paid work outside their communities. Others have migrated to

either bigger cities in Cambodia or traveled to Thailand in search of jobs. Older people are therefore shouldered with the care of grand children whose parents have migrated to work far from home. At the same time, migrated families have often been unable to keep their children in school. Many children had dropped out of primary level of education to engage in income generating activities to help support their families.

Rural women are becoming increasingly active in economic activities due to the demand for formal and informal employment opportunities locally or externally. Gender roles have also been changing as both men and women work to improve their livelihood and cover their household's needs, or to pay off any debts if there are any. The change of men's role in supporting their partners has therefore been crucial.

Some existing initiatives that have been effective include raising the awareness of concerned communities on water pollution, waste management, environment protection, and preventing illegal fishing and deforestation. Facilitation was provided to relocate floating households to inland areas and land possession was processed for agricultural production in wetlands to abate the current pressure on natural resources. NGOs have been actively involved in raising awareness of the local residents by providing agricultural skills trainings, institutional capacity building of community-based organizations, agricultural inputs, and other facilitation support including increased market access for farm produce.

However, there are issues that could be better addressed to rejuvenate the natural resources and sustain the local biodiversity and ecosystem in the area. The following are five key recommendations presented for further discussions:

- The allocation of sufficient budget, and capacity building of concerned stakeholders involved in the law enforcement should be a top priority to effectively contextualize the sustainability of natural resources management.

- The introduction of systemic approaches, as opposed to project based, should be considered to raise awareness of local residents on applicable laws, legal frameworks, and good practices concerning the protection and conservation of the local natural resources, including biodiversity and ecosystem of the concerned areas.

- Wherever possible, rehabilitation of the flooded forest covers should be considered as a pre-requisite by all relevant stakeholders for present and future design of interventions given the importance to protect the local biodiversity and ecosystem.

- As much as possible, consideration to sustain the local biodiversity and ecosystem should be integrated in socio-economic cost analysis to determine the feasibility of hydroelectric dam constructions. The engagement of wider stakeholders including civil society organizations, local communities, private sector etc., is therefore central in the assessment process prior to the construction of dams to ensure the benefits from the irrigation scheme are fairly distributed.

- The intervention on livelihood development for affected communities along the rivers should be strategically sound, and socio-economically feasible and scalable to ensure decent work and livelihood for local residents on their land.

1. Background and Context

1.1 Rationale for the Impact Study

Tonle Sap Lake is the main source of fish for villagers who depend on subsistence fishing to support their livelihood. The lake provides food during the harsh dry season when agricultural production can be negatively impacted by frequent droughts. Water sources nearby the Tonle Sap drain the amount left over from the wet season into the lake increasing fish supplies providing food stability for villagers. (Rainboth, 1996) The flood plains and forest habitats in the areas surrounding the lake also generate feed for fish. (Sverdrup-Jensen, 2002). Unfortunately, these areas are being threatened by wildfires from recurring droughts caused by climate change and are destroying the surrounding wetlands. Climate change is also threatening the natural flow and sedimentation patterns in Tonle Sap Lake which affects the rich biodiversity in the wetland ecosystem.

The region surrounding Tonle Sap Lake includes an important floodplain that supports people's livelihood and sustains numerous ecosystems in the area. According to Bahadur, the "floodplain ecosystem in Cambodia is expected to be affected by changes in economic conditions, social circumstances, environmental perturbations, demographic shifts and political climates." One of these components includes the construction of dams which directly affects fish supplies. As result, those who rely on subsistence fishing will not have the same benefits as before and will be forced to leave their lands. Fishing will no longer be sustainable, and people will have to look for work opportunities elsewhere. This is a major concern as fish is a dominant source of food and protein for many inhabitants of Southeast Asia.

The 2021 study report on people migration and climate change funded by RLS-Hanoi Office revealed that, while climate change seriously threatens natural resources and the environment, suitable measures shall be considered to protect and rehabilitate resources that the majority of local communities rely on for their livelihoods. Building the capacity of local people on the protection and conservation of natural resources is therefore important. Increased engagement and participation in forest and flooded forest management, reforestation, fisheries and aquaculture development and management etc., to ensure the protection and sustainability of the people and the environment. This requires the engagement of key stakeholders including public and private sectors as well as civil societies, NGOs, and development partners.

1.2 Purpose of the Impact Study

The NGO Forum on Cambodia (NGOF) will continue working with RLS regional office in Hanoi, Vietnam, to engage with key influencing actors in addressing climate change related issues in 2022. It aims to see the influence of its NECA members and youth on key decision makers towards adopting environmental policies and ensure responsiveness to climate change. In this regard, NGOF has conducted a research study on "Impact of Tonle Sap Lake's tributary functions and climate change on people livelihood and biodiversity" to complement the study report on people migration linked climate change funded by RLS in 2021. The study is produced as evidence based for policy dialogue and engagement with key influencing actors to address climate change related issues in Cambodia.

The main objectives of the research are:

i. To Identify and document the main factors which contribute to changes of Tonle Sap tributary functions and livelihood of people, and biodiversity along Tonle Sap Lake.
ii. To generate recommendations for key stakeholders to ensure sustainable livelihood and biodiversity along the Tonle Sap Lake.

Key questions include:

i. What are the main factors which contribute to changes of Tonle Sap Lake's tributary function and livelihood of people and biodiversity?
ii. What should be done by key stakeholders to ensure sustainable livelihood and biodiversity along the tributaries?
iii. What should be done by the regulators to ensure sustainable livelihood and biodiversity along the tributaries?

1.3 Scope and Clients of the Impact Study

The impact study was conducted in five provinces that were selected based on several criteria, including water contribution of the tributaries to and from the Tonle Sap Lake, in the conceptual framework of livelihood and biodiversity. The study engaged key stakeholders who have experience and knowledge about the study topic such as national experts, local government officials, line departments, NGOs, local community people, and other stakeholders who were identified and selected from the affected areas. The final findings, conclusions and recommendations are addressed to the NGO Forum on Cambodia and its NGO network members, policy makers, donors, other relevant stakeholders.

1.4 Methodology

1.4.1 Sampling

There are two main hydrological systems in Cambodia. The first is the Tonle Sap/Mekong system where the Tonle Sap lake is connected to the Mekong river. The Tonle Sap is the largest freshwater lake in Southeast Asia and covers around 250,000ha during the dry season and 1.6 million ha during the rainy season. The water level of the lake is 1-2 meters in the dry season and 8-11 meters in the wet season and is directly linked to 11 Rivers (Steung). The second water system called the 'The Upper Mekong delta' is the most densely populated and most intensively cultivated region of the country and includes Kandal, Takeo, and Prey Veng provinces in Cambodia, and some provinces in Vietnam. Both systems face recurrent floods in the rainy season, and droughts during the dry season. Over the last few decades, they have witnessed modifications largely due to uncoordinated development of reservoirs mainly used for irrigation and hydroelectricity purposes, both in Cambodia and neighboring countries[1].

This study has also included two other rivers, Steung Praek Tnoat and Takeo River, into the total **13 samples**[2] **as they** indirectly contribute water into the Tonle Sap. As suggested by the ToR, the consultant team conformed with 30% of the13 selected tributaries, 5 on the right and 8 on the left side, of Tonle Sap Lake for this study. Several selection criteria were developed by the consultant team and endorsed by the NGOF Management Committee as follows:

- Tributaries that cover a long distance.
- Tributaries which directly contribute to the Tonle Sap Lake, and vice vera.
- Densely populated areas along the rivers.
- Villagers whose livelihood depends on fishing, vegetable growing and cash crop production.
- Effects of climate change such as floods, drought, windstorms etc., that happen frequently along

[1] Source: Technical Report on Cambodia Irrigation Performance Benchmarking Framework, Australian Water Partnership: Blackwatch Counsulting Pty Ltd: 11 September 2020.
[2] Number of Tonle Sap Lake's Tributaries is counted inconsistently by researchers. At the validation workshop held on 9 September 2022, one of the participants had counted up to 27 tributaries as result of his research and other research did count 11 tributaries. MOWRAM has taken into account of 16 tributaries. However, Mr. Tek Vannara, (PhD), Executive of the NGOF confirmed that 11 tributaries are in Cambodia's historical record. For this particular research, the ToR took into account of 13 tributaries.

the tributaries.

- Tendency of out-migrants keeps increasing especially youth groups in the area.
- Existence of intervention projects of NGOs and or the government.
- Existence of more community-based organizations, i.e., women groups, youth groups, agricultural cooperatives, self-help groups, etc., in the area.
- Convenient accessibility by road or water way during the field data collection period.

During the technical proposal development phase, the consultant team consulted with local authorities such as the provincial department of agriculture, department of water resources and meteorology, district governors and others to verify information against the above criteria on such selection of the tributaries for participating in the study in Battambang, Pursat, Banteay Meanchey, Siem Reap, Kampong Thom, and Kampong Chhnang provinces. In addition, the consultant team shared knowledge and experience regarding conditions and contexts of the geographical area around Tonle Sap lake. The final selection of samples was further affirmed by the NGOF Project team to accentuate the above selection criteria was reasonably representative in terms of quantitative and qualitative sampling. The consultant team therefore selected 5 out of 13 tributaries including (i) Steung Saen (Kampong Thom), (ii) Steung Sraeng (Siem Reap), (iii) Steung Moung - Dauntri (Battambang), (iv) Steung Pursat (Pursat), and (v) Steung Boribou (Kampong Chhnanag).

Moreover, the consultant team selected communes and villages at the upper stream, middle stream, and lower stream areas for in-depth focus group interviews. There were engagements with **17** provincial departments (department of agriculture, forestry and fisheries, department of environment, department of water resources and meteorology, and provincial committee on disaster and risks reduction management); **10** districts; **14** communes; and **14** villages in all 5 provinces with a total of **379** respondents, of which **235** were women. The consultant team selected two households to develop separate case studies, one for impact orientation on livelihoods in Kampong Thom province and another for biodiversity in Battambang province. The details are shown below;

Table 1.4.1: Participation of Male and Female Key Informants

Tonle Sap's Tributary	**Total KII**		**Total FGD**		**Total**		
	Men	Women	Men	Women	Men	Women	Total
(i) Steung Sraeng (Siem Reap)	16	2	16	36	32	38	70
(ii) Steung Saen (K. Thom)	13	3	27	31	40	34	74
(iii) Steung Moung (Batt.)	12	3	19	61	31	64	95
(iv) Steung Pursat (Pursat)	13	7	15	65	28	72	100
(v) Steung Boribou (K.Chhnang)	8	2	5	25	13	27	40
Grand Total	**62**	**17**	**82**	**218**	**144**	**235**	**379**

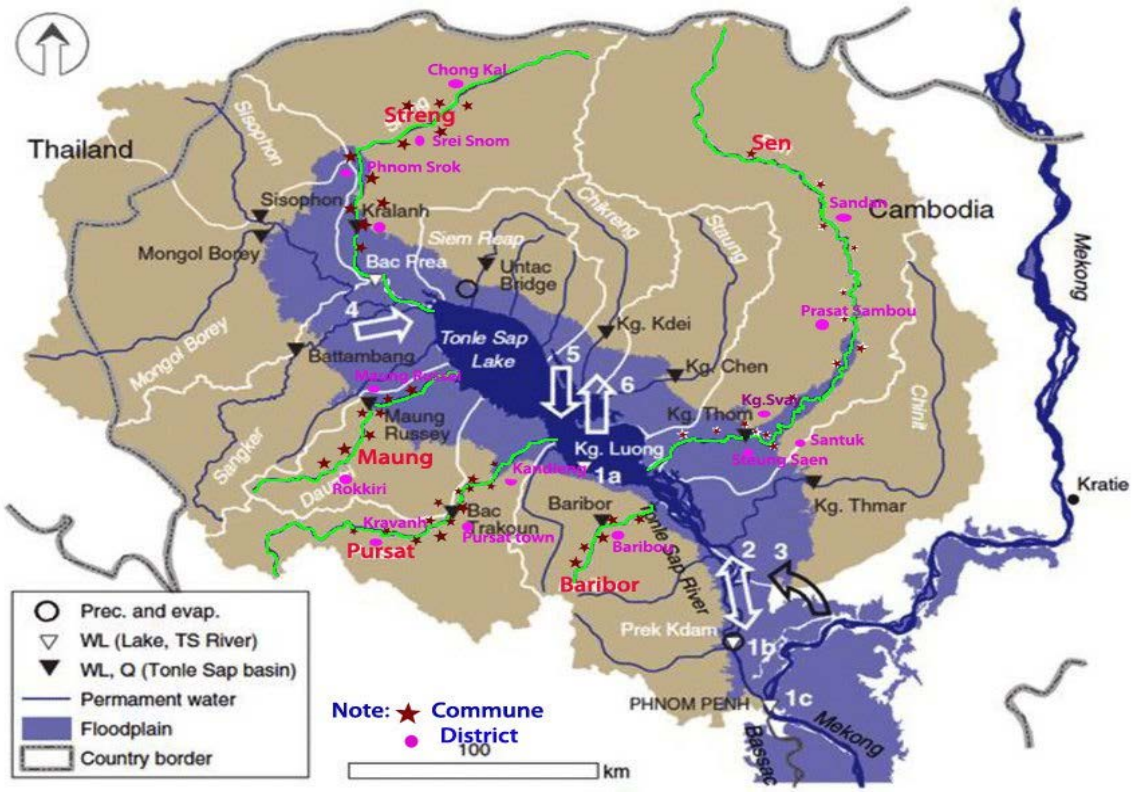
Source: Author

Table 1.4.2: 13 Target Tributaries of Tonle Sap Lake

No	Tributaries	Length	Descriptions	Other	Priority
1	Steung Sraeng	>200Km	Kralanh district, Beng communes, Siem Reap province. Steung Sraeng Kandal located on the border of Banteay Meanchey and Siem Reap provinces. It originates from Dangrek mountain and intersects with Steung Sangkae.	Estimate Distance	?
2	Stueng Siem Reap and Rolous	<100Km	Siem Reap town, Banteay Srei commune, Siem Reap province. Steung Siem Reap flows near the temples of Angkor and fills the resrvoirs (Baray)	Estimate Distance	
3	Steug Chikraeng and Steung Stong	<200Km	Chikraeng commune, Siem Reap province. It brings water into the swampy areas and Boeng Tonle Chhmar.	Estimate Distance	
4	Steung Saen	450Km	Sandan,Taben,Ngon, Roneam,Kok Krok, Tbong Krapeu, Prek sbov communes and Steung Saen districts, Kampong Thom province. It brings water from Dangrek mountain. There are many small streamsthat flow into this river.		?
5	Steung Chinit	264Km	Baksna, kampong Thmar and Thnot Chum communes, Kampong Thom province. It takes water from Steung Taing Krasaing and Steung Pongrong and brings the current flow into swampy areas through Steung Kampong Thmor.		
6	Steung Sereisophorn	>150Km	Sereisophoin town, Bros Lao commune, Banteay Meanchey province. It brings water from the Steung Mongkul Borei (which originates at 1,470m in Phnom Khao Khao, Thailand) and Steung Sangkae (which originates in Phnom Talor, at 700m in Cambodia) before flowing into the Tonle Sap Lake.	Estimate Distance	
7	Steung Moung (Dauntri)	>100Km	Ang Krang, Moung, Kralaompluk and Daun Try communes, Battambang province. It originates from Phnom Teuk Snow (1,425m) through Moung Russei and Rokkakiri districts.	Estimate Distance	?
8	Steung Svay Daunkeo	>150Km	Svay Daunkeo,Anlong Svay, and Beung Brei communes, Pursat province. Flows through Svay Daun Keo village.	Estimate Distance	
9	Steung Pursat	150Km	Damnak Ampil commune, Pursat town, Kandieng and Kravanh districts, Pursat province. It originates in Phnom Khmoch (1,425m), a river that is similar to a waterfall regime that causes floods.		?
10	Steung Boribou	<100Km & Shallow	Kdol commune, Boribou district, Kampong Chhnang province. Crossing Boribou and flows to Kampong Chhnang Province.	Estimate Distance	?
11	Steung Chreav	<100Km	Udong district, Kampong Speu province. The water flows through Udong.	Estimate Distance	
12	Steung Praek Thnaot	>250Km	Trapeangkong, Ang Chork, Kraheng, Haong Samnor communes, and Oral district, Kampong Speu province. It originates from many streams that flow from the Oral Mountains and from O'Mlou mountain range. This river flows through Kampong Speu province and Takhmao city.	Estimate Distance	
13	**Steung Takeo**	**>120Km**	**Boreicholsa, Angkor Chey commune, Donkeo town, Takeo province. flows into the Bassac River at Moat Chrouk province.**	**Estimate Distance**	

Source: Author

Diagram 1.5.1: Mapping of Tonle Sap Lake's Direct Tributaries



Source:https://www.researchgate.net/figure/Tonle-Sap-Basin-and-its-sub-catchments-with-the-main-rivers-including-flood-plains_fig6_327693253

At the commune level, the consultant team met with the commune chief, vice chief, and other officials who were available for focus group discussions, and applied key informant interview techniques with commune councillors. At the district levels, the consultant team met with district governors and/or other officials who were available to discuss similar sets of questions. All district members living on both sides of the tributaries were invited to participate in the study.

At the provincial level, the consultant team met with the Department of Water Resources and Meteorology, Department of Agriculture, Department of Environment, and the Provincial Committee on Disaster Risks Reduction Management. However, the Provincial Committee on Disaster and Risks Reduction management in Kampong Chhnang and Kampong Thom provinces were not available to meet. Five NGOs who are working on similar thematic issues as this study were also involved. The list of participants is provided in **Annex 8**.

At the national level, the consultant team discussed with the Tonle Sap Authority, UNDP, and NECA members. Even though the NGOF approached the Ministry of Agriculture, Forestry and Fisheries, Ministry of Water Resources Management and Meteorology, Ministry of Rural Development, and Ministry of Environment, it was not possible to secure their confirmation to participate in this study.

1.4.2 Methodological Approach

The study embedded purposeful sampling and exclusively relied on qualitative data sources. Quantitative data sources were possibly reachable through secondary and/or internet search engines. The quantitative data from these sources (**Annex 7**) was triangulated and verified with the primary data obtained from direct interviews. The study employed the following methodological approaches:

Literature Review. A desk review of relevant materials was conducted to identify the main factors contributing to the changes of Tonle Sap Lake's tributary functions, the livelihoods of people and biodiversity of the area. The titles of reviewed documents and references are provided in **Annex 7**.

Key Informant Interview (KII). The KII consisted of semi-structured and in-depth interviews. The KII was selected as research method because it could clarify or rectify data obtained from the documentation review. The method allowed for information to be collected either face-to-face or virtually, for both factual and content-related issues, and to address sensitive issues where applicable.

Focus Group Discussion (FGD). The consultant team facilitated discussions with 5 or more key community members including women groups, youth groups, village chiefs and other community-based organizations to solicit inputs following the guiding questions. Two case studies were developed to demonstrate the baseline situation in relation to biodiversity, and the livelihood of people.

Workshop. NGOF Project team organised a workshop to solicit additional information and verify inputs from different stakeholders to ensure the collected data is inclusive, appropriate and applicable. The study team presented the *preliminary findings* using detailed Power point slides. The presentation was followed by a participatory Question & Answer session and discussions of the findings and key recommendations.

Analysis of qualitative and quantitative data. The study team collected and analysed qualitative data through a deductive approach to form the basis for preparing the conclusions. The data collected from the KIIs and FGDs were subject to thematic content analysis (i.e., determining patterns, categories and themes) and organised and interpreted to determine any links with the study´s objectives. The steps in this process involved transcription, organisation, validation of the data and final presentation of the conclusions. The quantitative data was mainly drawn from secondary sources that are indicated with clear references. They were organised and presented in a logical way in the study report and descriptive and/or inferential statistics were used as appropriate.

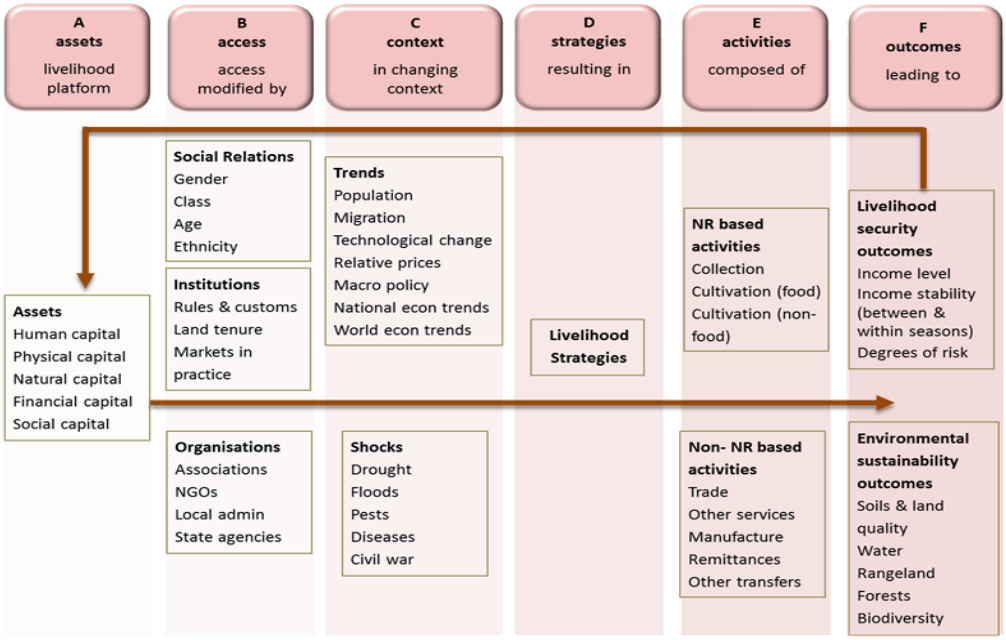
Quality Assurance. To ensure credibility and validity of the results, methodological triangulation of the data/information was applied by cross checking the information received from more than one source. The methods described above were relevant to answer the specific research questions, and the team made efforts to retain data quality and evidence to ensure reliable assessments contributing to the conclusions. In the final validation workshop towards the end of the study, the consultant team asked for reactions/comments and the draft study report was circulated to **54** NGOF members[3], NECA and national stakeholders. This provided another opportunity for clarifications and corrections as NGOF, NECA members, and national stakeholders also provided quality assurance of all deliverables.

1.4.3 Conceptual Frameworks

This study looks deeply into factors and conditions which have impacted on livelihood of local residents and biodiversity along the above selected tributaries. Whilst analysing the livelihood domain, the conceptual framework that was adapted by Ellis (2000) was utilized to the large extent. The field data collection was delved into essential livelihood dimensions such as, assets, access, context, strategies, activities, and the outcomes. The framework was further adapted to maintain flexibilities in varied contexts, i.e., demographic conditions, local knowledge on contents of the study. The consultants might not therefore utilize all the dimensions and elements in this framework as to keep the focus group discussions went healthily given a limit of time.

[3] Source: Minutes of the Validation Workshop held on 9 September 2022.

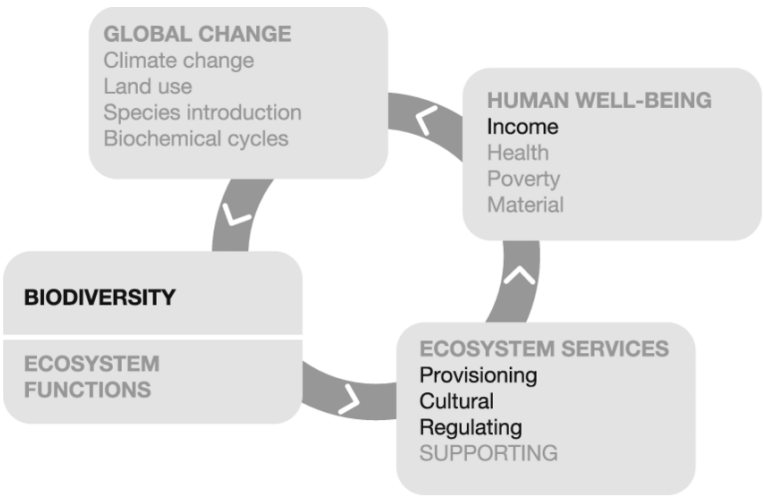
Diagram 1.4.1 Livelihood Conceptual Framework



Source: Ellis (2000): https://www.soas.ac.uk/cedep-demos/000_P516_EID_K3736-Demo/unit1/page_15.htm

The conceptual framework for biodiversity and global change effects on welfare under the ecosystem services approach guided the literature review and steered field data collection. But the framework was curtailed to local circumstances and the availability of data collected and or supplied by the relevant stakeholders.

Diagram 1.4.2: Conceptual Framework for Biodiversity and Global Change Effects



Source: adapted from MA 2005 (by Simboloxico):
https://www.researchgate.net/figure/Conceptual-framework-for-biodiversity-and-global-change-effects-on-welfare-under-the_fig1_227358388

1.5 Limitations

Road Access. The study was commissioned during the rainy season which made it difficult for the study team to access the downstream areas of the selected tributaries, an adjacent area of the Tonle Sap Lake. The consultant team used motorcycles and/or boats to meet with the community members and other key informants. The rainy season also limited access to directly observe the real-life situation in some villages where the case studies and focus group discussions were held.

Condensed Scheduled. The local people have been busy during the rainy season, especially those whose livelihood depends on fisheries, vegetable farming, and rice production. The consultant team had therefore arranged the meetings ahead of time to allow flexibility to the local residents to confirm their availability. The team had received coordination and support from the local government, district and commune councils to arrange the meetings with members of the community.

Scope and Quality of Data. The study has utilized evidence-based factors and conditions which rely more on qualitative data. However, whilst examining the livelihoods of people as well as the biodiversity dependent on the selected tributaries, scientific data should be meticulously applied for measuring. The quality of primary data might therefore be limited, and the consultants reviewed the secondary data available to verify and triangulate as much as possible. The quality of the assessment is dependent on the access to participants and pre-existing documents that are of high quality and up to date.

2. Findings

2.1 Results of the Literature Reviews

2.1.1 The Tonle Sap Lake and Biodiversity

The Tonle Sap Lake (TSL) is an integral part of the Mekong River Basin which originates in the Himalayas and flows through six riparian countries in East and Southeast Asia: Cambodia, China, Lao PDR, Myanmar, Thailand, and Vietnam [Annex 6: 10]. The TSL forms a natural floodplain reservoir in the depression of the Cambodian plains [Annex 6:2]. It is fed by three main perennial and numerous erratic tributaries and is drained by the Tonle Sap River into the Mekong River near Phnom Penh [Annex 6:2].

The hydrological cycle of the lake is unique due to the reverse flows during the peak flood season which expands the water surface (May–June) (Uk, et al., 2018; TSA 2015). When the level of the Mekong River is high, the flow of the Tonle Sap River is reversed and pushed into the lake raising its level by up to 8-11 meters and increasing its area from 2,500–3,000km^2 in the dry season to 10,000–16,000 km^2 in the rainy season[4]. This reverse flow brings in huge amounts of water, sediments, nutrients and migratory fish. The discharge from the lake is virtually blocked by the flood pulse until the flow in the Mekong River subsides (September-October) [Annex 6:10].

During the seasonal expansion of the lake surface, vast forests (i.e., flooded forests), wetlands, grasslands and fields are inundated. This provides sanctuary and breeding grounds for migratory fish and other aquatic organisms as well as terrestrial wildlife such as birds, reptiles and mammals. The normal discharge from the Tonle Sap River into the Mekong River restarts during September or October when the water level in the Mekong River starts receding. This gradual discharge from TSL in the dry season is vital for maintaining the environment in the downstream areas of the Mekong River.

Fishing activities directly support more than 1 million people and provide the single largest source of protein for Cambodia's young and increasing population [Annex 6:2]. The flooded areas offer seasonal breeding grounds and forage areas for fish that subsequently migrate to the Mekong River, thereby providing a regionally vital resource. The lake was nominated as a biosphere reserve in October 1997 by UNESCO under the Biosphere Program. Its catchments include large areas that have also been designated as globally important in terms of biodiversity, as well as offering potential for the storage of water for irrigation, domestic consumption, and hydropower.

The Tonle Sap basin is under severe pressure, and the exploitation of its resources is intense as it has never been called upon to supply so much to so many. Even so, there are many threats to the lake's ecosystem including the overexploitation of fishing and wildlife resources, dry-season encroachment, and land clearance of the flooded forest. Degradation of the watershed natural vegetation destroys natural habitats and results in deterioration of water and soil quality with increased silt. Despite the lake's inherent richness, most poverty indicators in the basin are worse than those that characterize other rural areas in Cambodia, and the national population as a whole [Annex 6:2].

The hydrological and environmental conditions of TSL and its basins is crucial for sustainable development in Cambodia and the lower Mekong Region as it covers more than 47% of the country's surface area. The productivity of TSL and the health of the ecosystem are critical for a number of people who depend on fishing for their livelihood. People living in floating villages are especially impacted by changes in the environmental conditions of the lake as they highly rely on the lake for their life and

[4]Source: https://www.adb.org/sites/default/files/institutional-document/33050/files/tonle-sap-basin-strategy.pdf

livelihood. Similarly, the fertile floodplains in the TSL basin are important for farming communities that grow rice, vegetables, and crop fruits. Maintaining the healthy environmental conditions of the lake, flooded forests, and farmland is therefore indispensable to sustain a harmonious balance among aquatic ecosystem, rich biodiversity, and livelihood of the local residents.

Cambodia reached a population of 16.5 million in 2019, with an annual growth rate of 1.6% (UNFPA, 2019). 80% of the population live in rural areas, and the country's population is expected to increase between 20 and 24 million by 2050 (UN, 2019). A broader geodemography shows approximately 52% of the population live in the central plains, 30% around the Tonle Sap Lake, 11% in the highland areas and 7% in coastal areas (MoE, 2015). There are approximately 1.7 million people that live in 1037 villages around TSL and the surrounding floodplains.

Fishing villages in TSL can be classified into three based on their location: water-based village (53 villages), land-based village (948 villages), and water-land based village (36 villages). In the water-based villages, often referred to as floating villages, local people primarily rely on fishing for their livelihood due to their physical disconnection from land. Their principal mode of transportation and livelihood are boats that are used for living, fishing, business, and access to public and private facilities (health care, markets, schools etc.). Floating villages are mobile throughout the year as the communities depend on the lake for their daily needs such as drinking water, cooking, washing, cleaning and waste disposal. They have learned to adapt to the hydrological changes in the area (Sithirith, 2011).

Human activities are also speeding up the changes in the hydrological and ecological conditions of TSL. Construction of water storage dams in the upstream area and climate change are transboundary issues which affect TSL (Uk, et al., 2018). A cascade of hydrological dams is planned or under construction in the upstream Mekong countries in addition to the existing dams that are operational in Lao PDR and China. Climate change influences seasonal flow patterns in the Mekong River directly affecting the water level in the lake (Uk, et al., 2018; Oeurng, et al., 2019). This threatens the hydrological cycle of the usual reverse flow which is crucial for the lake's productivity, inflow of sediment, nutrients, and fish catch.

2.1.2 Livelihood Dynamics

In Cambodia, fish and fishing activities on the Tonle Sap Lake are primary sources of nutrition and income. The lake contributes directly or indirectly to the livelihood needs of at least 15% of the total population [Annex 6: 11]. It is also home to a diverse array of flora and fauna, including one of the richest fish supplies in the world.

Despite the wealth of natural resources and the country's impressive economic growth over the last decades, the Tonle Sap area features some of the highest levels of poverty in Cambodia, reaching 80% in some areas[5]. Problems associated with increasing population pressures, increased market penetration due to improved infrastructure, a widening gap between rural and urban communities and rich and poor households threatens both ecological and social stability throughout the region. The situation will worsen in the absence of policies and programmes specifically designed to ensure a more sustainable pace of development and better distribution of benefits that reach the poor and most affected people.

Specific attributive factors that have exacerbated poverty incidences include:

- The poor depend on access to natural resource assets for their livelihood, and a social safety net in times of shock and distress. To meet the needs of the growing population, people resort to daily labor collecting NTFP or cutting wood in the absence of feasible employment alternatives. The scope

[5]Source: https://www.adb.org/sites/default/files/project-document/66288/37250-cam-tacr.pdf

and scale of conflicts over access to natural resources is escalating as local villagers struggle with increasing control of the environmental resources by outsiders. Tonle Sap Lake is rapidly diminishing in the face of weak regulations against exploitation by outside investors operating in collusion with powerful government officials.

- The decline of natural resources causes migration of people to other locations inside Cambodia, or across the border in search of labor. The pull factors associated with increased migration includes the rapid growth of manufacturing sector, tourism and construction sector, as well as a general trend towards a private market-led economy and integration with regional and world markets. Regarding the push factors, high population growth, low productivity in agriculture, and a series of annual crop failures from drought and floods have increased poverty in rural areas. The rapid decline of natural resources, especially timber and fish, and the gradual elimination of traditional rights to natural resources have generated acute pressures on young people to move out in search of work.

  Over a third of Cambodians have lived in more than one province in their lifetime, and almost 10% of the population have to work outside the country. (UNESCO 2018 see Parsons & Nielsen 2021). Migration rates vary significantly across the three agro-ecological zones. Whereas migration rates in the Tonle Sap and lakeside zone are well below the national average, the flood-prone riverside zone and drought prone east zones demonstrate higher levels of migrants per household. (Parsons & Nielsen 2021).

- Even though gender relations are complex, gender roles are changing and women around the Tonle Sap are taking on a wide variety of tasks in primary production and employment locally or in neighboring countries. Out of necessity, gender roles are most flexible toward impoverished women who often undertake so-called male tasks, while families that are better off can easily afford to preserve traditional gender roles. women from the poorest households typically experience ongoing health problems due to a lack of affordable health care, unhygienic living conditions, and reluctance to seek help. Domestic violence was observed and reported to occur primarily in poor and destitute households. Although women's labour, including domestic work, is of central importance to households and communities, their contribution is generally valued to be less than that of men. Gender inequality and poverty continue to constrain women's access to land and other assets, as well as to social services such as health and education.

According to the ADB Assessment Report (CDRI 2007), there are four distinct livelihood clusters associating with resource dependency:

(i) crops and livestock
(ii) dominated by crops and a mixture of forestry, fishery and livestock
(iii) dominated by forestry and a mixture of fishery, livestock and crops
(iv) nonfarm and livestock.

Over the past decades, there has been significant contribution of the primary sector (crops, livestock, fishery and forestry) to the livelihoods of Cambodians despite some variations of dependency within this sector. There has been a shift from crops and livestock in the 1990s to diversification into natural resource strategies at present. The motives relate to both the push and pull factors. The push factor associates with decreased arable land per capita. The pull factor is motivated by improved resource accessibility through landmine clearance and increasing demand from development of the market economy. Lastly, nonfarm activities remained minimal or static over the past decades because agriculture-based households are more attracted by daily wage employment instead of self-employment opportunities.

2.1.3 Climate Change Implications

Climate change is one of the most significant global environmental challenges. Recent and future changes in extreme weather and climate events will likely create substantial impacts and serious problems for society (Karl et al., 2008). They pose various threats to socioeconomic development such as decreasing agricultural productivity, increasing food insecurity and malnutrition, and increasing water-borne diseases – all of which affect the livelihoods of indigenous people (ADB, 2013; Dhar & Mazumdar, 2009). Climate change affects populations in areas where the levels of climate-sensitive diseases are high, including the urban poor in low and middle-income countries (Akhtar, 2016). All these issues are challenges to sustainable development in developing countries and are uncertainties the world is facing today.

The Earth's climate system has been significantly changing over the past few decades, and this phenomenon has been widely accepted in the scientific community (McCracken & Phillips, 2016). Sound evidence from the AR5 of the IPCC (Intergovernmental Panel on Climate Change) (2014) indicates that global mean sea level has risen approximately 0.19 m since the start of the twentieth century, and surface temperature has increased by 0.8 °C since the immediate pre-industrial time. These changes have been scientifically explained as the result of increasing anthropogenic emissions of greenhouse gases (GHGs) in the Earth's atmosphere (Akhtar, 2016). Industrialization, agricultural expansion, burning of fossil fuel, and transportation are the main causes for the increase of GHGs in the atmosphere (Shrestha, 2014). Concentrations of GHGs in the atmosphere influence the Earth's ability to reflect and absorb energy from the sun. As the level of GHGs increases, more heat is trapped in the atmosphere, causing the average surface temperature to increase (MoE & UNDP, 2011). With the ongoing emissions of GHGs, the climate system is projected to continue changing, however, the scale of such emissions remains unclear, and this uncertainty makes it difficult to forecast future climate change (McCracken & Phillips, 2016).

Southeast Asia has already been affected by climate change. Surface air temperature in the region increased between 0.1 and 0.3 °C per decade between 1951 and 2000 (ADB, 2009), and the sea level has been rising at the rate of 1 to 3mm per year over the last 50 years. Events of heavy rainfall increased significantly between 1900 and 2005, while tropical cyclones occurred more frequently between 1990 and 2003 (ADB, 2009).

Cambodia was ranked the world's second most vulnerable country to climate change in 2014 (Kreft et al, 2014). The country is projected to experience a temperature rise of 3.1°C by the 2090s, against the baseline conditions over 1986–2005 under the highest emissions pathway, RCP8 (The World Bank Group and Asian Development Bank 2021). Historical records indicate significant changes in rainfall patterns since the 1920s which are becoming increasingly sporadic and intense directly affecting the livelihood of farmers (Diepart 2015). Unpredictable rainfalls have transformed irrigation from agricultural luxury to a basic necessity for many farmers resulting in a growing need for capital investment (International Bank for Reconstruction and Development and World Bank 2015). The number of people exposed to extreme river floods is also estimated to grow by around 4 million by the 2040s.

Economic growth in Cambodia over the last decade has helped lower the poverty rate from 48% in 2007 to 14% in 2014. However, many of these gains are being threatened by the country's vulnerability to climate change as Cambodia is likely to experience an increase in temperature, longer droughts, and more frequent tropical storms (USAID 2018). Cambodia is highly vulnerable to the impacts due to its dependency on climate-sensitive sectors such as agriculture, water resources, forestry, and fishery for economic growth and supporting the majority of its population (World Bank 2020). Projected climate change trends indicate that the the countrys GDP will be affected by nearly 10% by 2050 (World Bank and Asian Development Bank 2021). Climate change is now routinely described as "a major threat" to the economy and society of Cambodia (Khut 2017).

Tonle Sap Lake (TSL), the largest lake in Southeast Asia, is under increasing pressure from pollution, land-use change, climate change, and development activities in the lake, its basin and the Mekong Basin [Annex 6:5]. Recent changes in the lakes hydrological system and its floodplains are becoming a great concern for hundreds of communities relying on the lake resources for their livelihoods. The lake has been experiencing abnormal fluctuations in its unique reverse cycle affecting the inflow of water, sediments, nutrients and migratory aquatic animals which are essential for the ecosystem, productivity, and fishery-based livelihoods. The reduced fish catch directly impacts the economic profile of the low-income fishing communities in the floating villages and increases their vulnerability. Pollution from point and non-point sources, eutrophication, poor sanitation, and disposal of wastewater has caused deterioration of water quality in certain parts of the lake. This has also led to an increase in water-borne diseases.

Cambodia has the highest consumption of inland fish per-capita in the world (Fiorella et al 2021). In a study in the Tonle Sap Lake basin, Fiorella et al (2021) found that households caught an average of 4.96 kg of fish/week, while average harvest of other aquatic animals and plants reached 1.26 and 1.58 kg/week, respectively. Over 70% of fish and 87% of other aquatic animals caught were used for household consumption. The low number of fish and aquatic animals caught, either because of altered efforts or ecological conditions, reduces the nutritional quality of the local diet.

The surrounding areas of the Tonle Sap Lake are amongst the most populated regions in Cambodia. However, the satellite-derived normalized difference vegetation index (NDVI) analysis between 2000 and 2016 indicates that the area is drying up. (Jacobson et al, 2019). Rural communities that are closely tied to agricultural systems and the harvest of natural resources are among the first and most severely affected by rising temperatures. For example, 29% of households in the Tonle Sap region experienced rice paddy loss and 19% experienced income loss due to the 2015/6 El Nino drought (FAO, WFP, and UNICEF 2016).

Climate change is threatening the natural flow patterns of 11 river sub-basins contributing to the Tonle Sap Lake. Climate change will reduce the annual projected flow from 9 to 29%, 10 to 35% and 7 to 41% in the 2030s, 2060s and 2090s respectively (Oeurng et al, 2019) [Annex 6:10]. There will be a decline in flood magnitudes and drought will increase throughout the basin resulting in serious impacts on biodiversity (Oeurng et al, 2019).

In a study on interactions between climate and food security in the North-Western region of Cambodia, Jacobson et al (2019) show that migration occurs in up to 45% of households, half of which is climate related. The biggest impacts of migration are labour shortages at the village level, followed by child welfare-related concerns, and safety of women and girls. However, migration does not improve food security (Jacobson et al, 2019).

Cambodia is already experiencing more flooding in its wet season and longer droughts in the dry season, threatening the livelihood of 80% of the population who rely on subsistence crop production, where 70% of the rice paddies were lost to floods and 20% from drought. The Ministry of Environment spokesman, Neth Pheaktra said, “not only do the figures provide evidence of the impact of climate change in the Kingdom, but also the risk global warming poses to its future.” According to Pheaktra, Cambodia witnessed 3,681 floods, 1,375 droughts and 1,917 hurricanes between 1996 and 2020, all of which killed 1,292 people and destroyed 14,761 houses and 1,875 hospitals”. Three million hectares of crops and around 1,000 schools were damaged. In 2013, floods alone led to a national loss of $350 million. Around 300,000 hectares of farmland and 200,000 homes were damaged, with 150 human fatalities. According to the Cambodia Climate Economic Growth Impact Model report, it is estimated Cambodia’s gross domestic product (GDP) loss is significantly higher than previous modelling work done in Southeast Asia.

In response, the government has quadrupled the budget for climate change to around $900 million spread across 14 ministries and institutions working together under the Climate Change Adaptation Project, which is set to run until 2030.

2.1.4 The Governance of Tonle Sap

The management of Tonle Sap's wetlands is centered on three main sectors: biodiversity, fishery and agricultural water management. However, it does not adequately consider the social and environmental importance of the wetlands. The management is segmented, and the governance is weak due to poor coordination among different agencies. In response to these issues, the Tonle Sap Authority (TSA) was established to improve coordination and strengthen the lake's governance.

Geographically, the majority of Cambodia lies within the Lower Mekong Delta making the MRC Agreement highly relevant for the natural and political environment of the country. Improved relations and cooperation with MRC countries is crucial in resolving issues and reducing future conflict, such as those that arise around hydroelectric dams in Vietnam and Laos. The Cambodia National Mekong Committee (CNMC) is the coordinating body for all types of works related to the Mekong development. However, despite the vast wetland areas around the Mekong, they do not work with wetland issues.

To improve coordination and effective governance, the ADB proposed to set up Tonle Sap Basin Management Organization (TSBMO), parallel with CNMC. However, in 2009, the RGC established the TSA which is chaired by the Minister of Water Resources and Meteorology (MORAM). The Minister of MOWRAM also chairs the CNMC thereby bringing the MOWRAM, TSA and CNMC under one umbrella at a national level. The Minister is also a regional council member of MRC on improving water governance coordination in the Mekong and Tonle Sap regions. However, the mandate of MOWRAM only addresses water issues and not wetlands. Thirty-one high level representatives from government ministries and institutions are appointed as members of the TSA. This improves stakeholder representation and contributes towards an inclusive and deliberative decision-making process. However, the decision-making process is largely the domain of government agencies and lacks civil society representation[6]. Even though the government has recently involved communities and CSOs in the management of Tonle Sap, the top-down approach to decision making remains in resolving conflicts over determining access to fishery groups.

The Provincial Department of Water Resources and Meteorology acts as a secretariat to the TSA. TSA commands are passed to the provincial department, which then implements the action. The Department of Wetlands, within the MoE, is the state agency responsible for coordinating wetland management and ensures the integration of wetland issues into the management of fisheries, biodiversity, water and agriculture. The Department of Wetlands is working collaboratively with other government agencies and NGOs to promote the wetland institutionalization and community participation in wetland governance. At present, the lack of an overarching legal definition leaves each sector to decide on their own. Wetlands are yet to be clearly defined under Cambodian law and the lack of coherency is leading to confusion within sectors which are left to either develop their own wetland definition or none at all.

The RGC has taken strong measures to combat illegal fishing activities and the lower-level government institutions have taken responsibility following the pressure from higher levels of government. The government has used the court system to combat illegal fishing and those found guilty including small fishing operators were imprisoned. Although this is a strong start by the Head of State, it is doubtful that this level of momentum will continue. Natural resource authority is segregated between territories

[6]Source:
https://www.researchgate.net/publication/282978187_The_Governance_of_Wetlands_in_the_Tonle_Sap_Lake_Cambodia

and the legal ambiguity aggravates institutional conflicts and frustrates integrated management. The Fisheries Law leaves out many non-fish resources unaccounted for and does not provide a framework for ecosystem-based management beyond its role in fishery production. Institutional coordination for wetland management is weak, leading to competition among different institutions having mandates, roles and responsibly in Tonle Sap and overlapped initiatives. Although MoE leads wetland management decisions, many areas overlap with fisheries management. There is no clear coordination mechanism in place to facilitate this conflict and each agency will only work within their sectoral mandate.

The Governance of Tonle Sap and fisheries management is continuously changing from the focus on commercial fisheries exploitation to community-based fishery management and biodiversity conservation. There needs to be a legal mandate for the overall management and planning for wetlands at the national, regional and local level. Ramsar experience and guidance highlights the need to take a multi-sectoral approach that involves civil society as well as the public and private sectors. A multi-institutional technical secretariat with decision-making authority, such as the one established under the sub-decree on Economic Land (industrial agriculture) Concessions 2005, is needed to effectively coordinate the management of wetlands.

2.1.5 The Policy Coverage on Climate Change

Considered one of the most vulnerable countries in the world to the effects of climate change, the Royal Government of Cambodia is taking major steps to improve its resilience and reduce its disaster risk with support from the UN Office for Disaster Risk Reduction. Several policies exist that include the reduction of risks from climate change and promote resilience amongst all concerned stakeholders. However, as elaborated in the governance section, there is no specific policy and law that has been regulated on the management of biodiversity, fishery and agricultural water.

Policies	Priority Areas
Rectangular Strategy Phase IV	The Rectangular Strategy IV is a clear blueprint to strengthen long-term sustainable development aimed at promoting economic growth, creating jobs, equitably distributing the fruits of growth, and ensuring effectiveness of public institutions and management of resources.
Second National Communication to the UNFCCC (2016)	Cambodia's Second National Communication to the UNFCCC (NC2) (2016) identifies the impacts of climate change on human lives and the expected damage to economic development and natural resources. These include intensified floods, droughts, saline intrusion and extreme weather events. It also contains the necessary mitigation measures that were implemented, and will continue implementing to adapt to climate change impacts and to further contribute to global efforts to reduce greenhouse gas emissions.
National Strategic Development Plan (NSDP) 2019-2023	The National Strategic Development Plan (NSDP) 2019-2023 outlines policies and priority actions for 2019-2023 that relevant ministry shall carry out, and presents estimated values, including expenses, resources and expenditure program. The key cross-cutting issues in the NSDP 2019-2023 are gender, environment, natural resources and green growth, disaster management, and public financial management reform.
Green Growth Road Map	The National Green Growth Roadmap focuses on addressing seven "A"' Access to clean water and sanitation Access to renewable energy Access to information and knowledge Access to means for better mobility Access to finance and investment

	Access to food security (agriculture) and nonchemical products Access to sustainable land-use
National Policy on Green Growth	The policy aims at enhancing the well-being and livelihood of all people in harmonization with ecological safety through green development growth, basing on green economy, blue economy, environment protection, social safety nets system and uphold of national cultural identity.
National Strategic Plan on Green Growth 2013-2030	Today, Cambodia takes the lead and is a role model in terms of green growth in the ASEAN countries, Asia-Pacific countries and member countries of the Global Green Growth Institute (GGGI). Green Growth principles focus on four pillars, namely economy, environment, society and culture to promote green growth, public health, quality of environment, people's livelihoods, and uphold of a national cultural identity. The Plan includes the following strategic focuses: ▪ Green Investment and Green Jobs Creation ▪ Green Economy Management in balance with Environment ▪ Blue Economy Development with Sustainability ▪ Green Environment and Natural Resources Management ▪ Human Resources Development and Green Education ▪ Effective Green Technology Management ▪ Promotion of a Green Social Safety System ▪ Uphold and Protection of Green Cultural Heritage and National Identity ▪ Good Governance on Green Growth
Cambodia Climate Change Strategic Plan 2014 – 2023	The CCCSP covers 8 strategic objectives, as follows: ▪ Promote climate resilience through improving food, water and energy security, ▪ Reduce vulnerability of sectors, regions, gender and health to climate change impacts, ▪ Ensure climate resilience of critical ecosystems (Tonle Sap Lake, Mekong River, coastal ecosystems, highlands etc.), biodiversity, protected areas and cultural heritage sites, ▪ Promote low-carbon planning and technologies to support sustainable development of the country, ▪ Improve capacities, knowledge and awareness for climate change responses, ▪ Promote adaptive social protection and participatory approaches in reducing loss and damage, ▪ Strengthen institutions and coordination frameworks for national climate change responses and ▪ Strengthen collaboration and active participation in regional and global climate change processes
National adaptation programme of action to climate change (NAPA) 2006	Cambodia's NAPA presents priority projects to address the urgent and immediate needs and concerns of people at the grassroots level for adaptation to the adverse effects of climate change in key sectors such as agriculture, water resources, coastal zone and human health.
Strategic National Action Plan for Disaster Risk Reduction 2019 – 2023	The primary motivation of the Royal Government of Cambodia in the formulation of an Action Plan for Disaster Risk Reduction (DRR) is to reduce the vulnerability of its people, especially the poor, to the effects of natural, environmental and human-induced hazards. The action plan has the following specific objectives:

	▪ Contribute to a common understanding, knowledge and awareness of disaster risk reduction ▪ Provide a comprehensive framework to guide and monitor the implementation of disaster risk reduction initiatives in the country ▪ Create a conducive environment for the mainstreaming of disaster risk reduction into development plans, policies and projects of the government ▪ Enhance coordination and cooperation between disaster management and development stakeholders ▪ Improve the efficiency of resource allocation and utilisation in disaster reduction ▪ Orient donor support in disaster risk reduction to government-identified priorities

2.2 Results of Primary Data Analysis

2.2.1 Impact on Biodiversity, Livelihood, and Gender Role

Two critical factors were identified by key informants in all the provinces as contributing to the change of sustainable biodiversity and livelihood along Tonle Sap tributaries. These include "human and natural factors".

2.2.1.1 Steung Sen

Biodiversity

Human factor. The local residents tend to intensively overconsume natural resources to meet their needs and increasing demand for livelihood. ***Population growth*** has accelerated local employment in the natural environment in parallel with the ***termination of fishing lot concession*** in Tonle Sap Lake by the government. The ***increase in market demand*** has simultaneously amplified the overexploitation of natural resources in face of ***weak law enforcement***, and ***lack of coordinated and concerted efforts*** of local government to cushion pressure on the overextraction this also causes illegal poaching, land clearance and burning of flooded areas. The ***increasing need for agricultural land*** has subsequently swept away the flooded plants and wetland areas which were feeding grounds for many wildlife and fish species.

As confirmed by the key informants, the forest covers including flooded forests areas have drastically decreased in the past five years. Only 50% of the forest cover remains along the Steung Sen compared to five years ago as local residents had cleared the flooded forest for rice field preparation and cut down the trees for making fishing traps. In Kampong Svay district, the decline of flooded forest is estimated at 90%, 50%-70% for Phatsandai commune, and 60%-80% of the forest cover in Sandan commune had decreased. In some places such as Taing Krang village in Taing Krasao commune, the forest cover has completely disappeared. The forest cover around Pro Heuch Lake (4 km^2 of water surface) in Sambo district is fully depleted.

As revealed, many tree species were diminished or are already lost such as Barringtonia asiatica, Hymnocardia wallichii, Croton caudatus, Gmelina asiatica, Diospyrus bejaudii, Terminalia cambodiana, Mallotus anisoponus, Compretum triforiatum, Ixora cuneifolia, Ponlea[7], Thong, Trasek, Sandan, Stixis

[7] Khmer name. Could not find scientific name or English name

obtusifolia, Romdenh, Tromoung, Galbergia oliveri, Morinda tomentosa, Kbas Prey, Chhors, Sdei, Diospyrus bejaudii, Longeang, and Hantuyphe.

Presently forest cover and precious trees only exist in Prey Lang province, and Community Forestry areas. Even though around 50% of the conservation forest area was destroyed by wildfire in the past five years, it has almost fully recovered by 90%. Some of the wildlife species that remained in Prey Lang and Community Forestry area are, the Fishing Cat, Leopard Cat, Turtle, Monkey, Eurasian Otter, Dollarbird, Long-tailed Macaque, Deer, Large-spotted Civet Cat, Wolf, Red Muntjac, Bengal Monitor, Basra, Greater Adjutant, Cinnamon Bittern, Lesser Adjutant, Great-Cormorant, Grey Heron, common Moorhen, and Wild Pig, Lesser Whistling Duck, Green Bee-Eater, Rabbit, Peacock, Pallas's Squirrel, Owl, Milky Stork, Glossy lbis, Hornbill, Vulture, and Great White Pelican are the lucky few survivors.

Local residents travel 5 to 20km from their villages to collect Non-Timber Forest Products (NTFPs) in forest areas. It's even farther for people that travel 40-50km from the provincial towns. For instance, villagers in Sambo district could collect wild vegetables such as Sandan and mushroom near their homes in the past five years, but now they must go over 3km to find them. NTFPs which remain accessible include, vine, rattan, bamboo, resin, mushroom and wild fruits like Rol, Kuy, and Romduol. The villagers consume most of their find, and the remainder always goes to the market. However, the market demand for NTFPs has gone down un the past five years.

The ***construction of hydroelectric dams*** at upper stream of the Mekong River has directly changed the current water inflows and outflows in Tonle Sap basin and subsequently caused the erratic water discharge to Steun Sen. Other dams that are under constructing in Putrea village of Putrea commune, Roveang district in Preah Vihear province, Dang Kambet village in Ngon commune, Sandan district and in Kampong Kor commune, Kampong Svay district, Kampong Thom province[8] will accentuate the potential gravity of change on the water regime in Steung Sen.

The low water level in both the Tonle Sap basin and Steung Sen has greatly affected fishery and agricultural livelihoods of many. The ***overuse of chemical fertilizers and pesticides*** during the dry season for rice production on wetlands is affecting the biodiversity both on land and in water. As evidenced, there are many fish species that are showing red marks on their skin and ulcer in their body.

Steung Sen serves as a water way for transportation and supplies water for commercial and household needs including irrigation systems for thousands of hectares of rice production along its length. For example, the community people in Taing Krasao commune use 80% of the river water for agriculture and 20% from natural lakes and ponds in the local area. The landscape of the area has great aesthetic value that can proliferate eco-tourism services in the locality.

Landslides on Steung Sen's riverbanks are increasing because of ***commercial sand extracting activities*** along the river. There is intense use of water to irrigate rice production yields two to three times a year as some parts of the river easily dry up during the dry season. According to the key informants, Steung Sen is drying up for longer periods in the last 5 years during the dry season in Sre Chong, Sre Veal, and Chheu Teal of Sandan district. In 2019, the river dried up in Kampong Ko commune which is around 8km west of Kampong Thom town which caused disruption of fish migration from Tonle Sap Lake.

Natural factors. ***Climate change*** has been affecting rainfall patterns and increasing water temperatures. The water level in both theTonle Sap basin and Steung Sen is relatively low. The ***change***

[8] Source: Mr. Vanny, the provincial department of water resources and meteorology, Kampong Thom province.

of water regime in the last ten years has inevitably retarded the cyclical floods in the floodplain areas. For example, local residents in Neang Sao village can no longer see the seasonally flooded plains in their village as they did in the past. During July 2022 this year, the floodplains along Steung Sen were still dry as the cyclical floods have been erratic. Flash floods occurred at the beginning of the rainy season in May 2022 which was also an unusual event that badly affected 2208 hectares of paddy rice fields in Kampong Svay district.

The regular floods provide feeding and spawning grounds to many fish species and terrestrial wildlife in wetland areas and brings productive sediments for agricultural activities during the dry season. The flooding period has become shorter from 5 to 6 months to less than 3 months, while drought period as become longer. Such changes have tremendously affected fish habitats and other wildlife species in the wetland areas. Some fish species have already disappreared in Steun Sen such as Carcharhinus leucas, Pangasianodon hypophthalmus, Systomus rubripinnis, Cirrhinus microlepis, Channa micropeltes, Phalacronotus apogon, Amblyrhynchichthys truncatus, Osteochilus melanopleura, Wallago attu, Chitala blanci, Oxyeleotris marmorata, Carcharhinus leucas, Dichotomyctere fluviatilis, Datnioides polota, Barbonymus gonionotus, Pristolepis fasciata, Anematichthys repasson, Belodontichthys truncatus, Trichopodus pectoralis, Pangasianodon gigas, Datnioides microlepis, snakehead fish, Labiobarbus siamensis, turtles, Urogymnus polylepis, softshell turtle, and snakes.

Livelihood

The termination of fishing lot concessions in the Tonle Sap basin had spurred an increase in fish population where people could catch up to 10kg per day using traditional fishing tools. However, this has currently changed, and the catch has fallen to 2kg per day. The same is true in Taing Krasao and Sandan communes where the fish catch decreased from 10kg to 2-3kg per day. In Bachey village, Sandan commune, the daily catch is 0.50-1kg compared to 5-6kg in the past five years. In Kampong Svay district, local residents could catch around 40-50 kg of fish per day a few years ago, compared to 4-5kg at present. Similarly, each household in Phatsandai commune now catch around 5-20kg of fish compared to around 50kgs per day five years ago. In Taing Kraing village, Taing Krasaing commune fish catch has decreased to 1 or 2kgs per day from about 10kg during the same time. This decrease in fish supplies triggered an increase of price from USD2.5 to USD7.5/kg for fresh fish.

The ***decline of fish supplies*** obviously impacts the lives and livelihood of many people who heavily rely on fishing activities. The key informants confirmed that many of people owed debts to banks or micro financial institutions. Some of them are forced to migrate in search of temporary jobs or move their household to other locations. Others have stayed in the villages and started to grow subsistence farms and cash crops instead of fishing. Local estimates show that around 50% of households that depend on fishing have shifted their occupation to grow cash crops such as cashew nuts, cassava, etc.

In the past, the local residents of Steung Sen in Sandan and Sambo districts were dependent on primarily rice production in the wet season, cash crop and vegetable cultivation, NTFP collection and fishing for food consumption. However, they now concentrate on dry season rice production 2-3 times per year using intensified seeds for commercial scale. This shift is visible in nearly 99% of the community in Kampong Svay district where the increasing cost of agricultural production and low fish supplies have forced some of them to migrate outside their community.

Over 90% of the people living in zone 3 of the floodplain area (i.e., Phatsandai commune) depend on fishing and only a few are engaged in agricultural activities (crop and cattle raising) and small business.

Some people are currently raising chicken and ducks to support their livelihood. The local residents are aware of, and fully abide by the applicable laws on the environment.

The lesser majority of people upstream of the river have only been moderately affected by the decline of fish catch because fishery is not their main source of livelihood. The income of community people in middle stream and downstream has been 'very' affected by the decline of fish catch. Their income is 'very' affected in the past three years for Bachey and Taing Krang villages, except Neang Sao village where people's income was moderately affected last year.

Table 2.1.3: Income being affected by the current change of Steung Sen's functions

Rating Value	Bachey Village (upstream)			Taing Krang Village (middle stream)			Neang Sao Village (downstream)		
	This year	Last year	Last 3 years	This year	Last year	Last 3 years	This year	Last year	Last 3 years
Not at all									
Slightly									
Moderately									
Very									
Extremely									

Gender Role

The current pressure on fishery livelihood has forced more women to take up men's roles in either usual fishing or shifting occupations. However, men use heavier fishing gear to catch more fish, while women use lighter equipment which is not as productive because of the decline of fishery resources. They spend hours making fishing nets or fixing them which takes most of their time in addition to household's chores. Families that have migrated have often been unable to keep their children in school. Many children have dropped out of primary levels and are engaged in income generating activities to help support their families. Many women in Taing Krang commune have migrated to different provinces or districts in search of jobs and left their husbands to produce seasonal rice and take care of their children. Often, domestic violence prevails around migration, poverty issues and the regular payment of loans. The frustration sometimes leads to increased consumption of alcohol drinks that worsens the situation.

Both men and women work together particularly in farming activities. Where the men have migrated, women have taken up their husband's role in ploughing the land using the hand tractors. Women in Sandan district do heavy labour work in cassava plantations to earn USD6.25 per day to secure an income. An increasing number of women are also currently involved in small business operations to supplement fishing and secure their food and income security.

2.2.1.2 Steung Sraeng

Biodiversity

Human factor. There are two ***dam constructions*** on Steung Sraeng (A Tao dam construction in Oddar Meanchey and Spean Sreng dam in Kralanh district, Siem Reap province) to store water all year around. According to Kampong Thkov commune chief, this has resulted in increased amounts of fish in Steung

Sraeng river. There are also Fishpond Conservation Communities in the area to ensure sustainability of the fish species. Other four irrigation schemes have been under construction in Ta An commune, Oddar Meanchey, Phnom Srok district, Banteay Meanchey province which can keep full water in the river throughout the year. These schemes are managed by the Farmer Water User Communities.

However, after completion of the constructions, flash floods and flood pulse have occurred unseasonably, according to the key informants. The schemes have eventually impeded the water inflows downstream from the reservoir and disrupted its normal current which can endanger the river's biodiversity. Water in the river dried up for a longer period during the dry season. Despite the fact that the river had received heavy rainfalls in the upland area – Oddor Meanchey province, the water inflows towards the lower stream in Siem Reap was limited. Low water level in Tonle Sap occurs every year and without the reverse discharge, the water quality in the river is easily degraded.

There are significant incidences of ***deforestation*** along the river and floodplain areas. The forest cover including flooded plants has dwindled in the past five years. There was a total of 3,100 ha of flooded forest area along Steung Sraeng located between the edge of the river and Tonle Sap Lake. Which had declined by approximately 1,079 ha in 2012, with an additional 40 ha lost at present. In Kralanh district, only small forest areas exist including flooded forests. In Tram Sorsor commune, there is a small-flooded forest area, and wider upland forests where three Forestry Communities were established and are in good shape. Around 10% of the flooded plains were lost in the past five years in Pong Ro village, Tram Sorsor commune. According to the key informants, only 2% of the forest cover remains in Srei Snom district whereas the community people in Kampong Tkov commune can no longer see the forest cover nearby their home village, and it has completely disappeared in Taing Krang village. Fortunately, the forest in Damnak Kchas village is not affected.

Tree species are less visible or completely lost including Barringtonia asiatica, Ixora cuneifolia, Hymnocardia wallichii, Gmelina asiatica, Cactus, Compretum triforiatum, Chomleuy, Khsan and Dandelion, Croton caudatus, Tasiev, Sandan, Krabao, Kanhchas, Romdenh, Dangkeap Kdam, Sdoksdav, and Sortei. The community people could no longer find wild honey, wolves, large-spotted Civet Cat, Eurasian Otter, crab-eating mongoose, water monitor, Fishing Cat, wild pig, turtle, snake, monkey, softshell turtle, Kampuon, Moustached Lizard, and rabbits in the area.

The overexploitation of natural resources is triggered by the fast ***population growth*** and an increase in agriculture investments. ***Illegal*** fishing/poaching and land encroachment are rampant. The increase in dry season agricultural production puts pressure on irrigation water and threatens to ruin local biodiversity in the river. Moreover, the ***overuse of agri-chemicals*** (fertilizers, pesticides/herbicides) to increase yields has been raising concerns of their harmful effect to the biodiversity and ecosystems in the river and wetland areas.

Natural factor. The river is a critical source of water supply for agriculture and household consumption, fish habitats, transportation, and an aesthetic landscape which could inspire ecotourists. The construction of dams has slowed down water inflows and outflows, disrupted waterways, and changed the patterns of flood pulse. The floods always bring nutrients, sediments, and forage enriching the biodiversity in the wetland areas to feed fish and terrestrial wildlife species and support agricultural activities during the dry season.

The ***change of water regime*** in the river endangers the seasonal migration of fish and sustainable ecosystem in the wetland areas. This results in sporadic ***landslides*** that cause some parts of the river to dry up earlier during the dry season and cause pollution of the water in Steung Sraeng.

Fish species have been less visible or disappeared such as *Channa micropeltes*, *Chitala blanci*, *Phalacronotus apogon*, *Labeo chrysophekadion*, *Anabas testudineus*, *Amblyrhynchichthys truncatus*, *Carcharhinus leucas*, Taneil, T*enualosa toli*, S*yncrossus helodes*, X*enentodon cancila*, Thnang Ampov, *Macrognathus taeniagaster*, *Wallago attu*, *Parambassis wolffii*, *Channa micropeltes*, Kuol prik, *Barbonymus gonionotus*, *Thynnichthys thynnoides*, *Pangasius larnaudii*, *Macrognathus siamensis*, *Osteochilus melanopleura*, Snake-head Fish, Softshell Turtle, and *Plotosus canius*.

Livelihood

The change of biodiversity in Steung Sraeng has deeply impacted the livelihood of local communities. The fish catch continues to decline and is concerning to people who mainly depend on fishing such as the communities in Sambuo commune. The local residents use traditional fishing tools such as small hole nets to catch fish for household consumption. Other villagers highly rely on seasonal rice production, vegetables and cash crops growing. The increase in price of agricultural inputs together with the decline of fish catch has forced some villagers to migrate in search of jobs, or shifting their livelihood occupations to running small businesses, or raising livestock.

However, the impact is relatively less on local residents that mainly largely relied on other agricultural occupations, as emphasized by the Provincial Committee on Disaster and Risk Reduction Committee in Siem Reap and echoed by the district officers from Kralanh district, Tram Sorsor, and Kampong Thkov communes. The situation is similar in Srey Snam district where the majority of people do not reply on fishing for their livelihood. According to the district officer of Srey Snam, fish catch is estimated at 1kg compared to about 7kg/day five years ago. During the same time, fish catch has also decreased from 5kg to 2kg/day/household in Pong Ro village, from 30kg to 10kg/day in Damnak Kchas village, and from around 5kg down to 1-2kg/day in Phnom Trongbath village. The livelihoods of communities living upstream or in the upland areas are heavily dependent on wet season rice production and fishery activities.

Recently, the law enforcement has started to reactivate and inspire local residents to reduce overextraction of natural resources. They have presently expanded agricultural production such as growing of rice and aquaculture as conditions seem favorable with the expected water supply from the dams' construction. The local residents in Tram Sorsor commune have already taken up alternative livelihood options by growing of cash crops like cassava and cashew nuts to increase their income. Some of the local residents in Srey Snam district collect NTFPs such as Romdenh, Rattan, and Dangkeap Kdam to make extra income or for household consumption. However, they now have to travel about 9km from their village instead of just 4km five years ago. Others have increased dry seasonal rice production and started to plant cashew nuts as fish and NTFP resources are not enough. Unfortunately, the price of cashewnuts and other agricultural products have unpredictably dropped down and pushed many people to migrate.

Amongst the three communities in the upstream, middle stream, and downstream areas of the river, the change of functions of Steung Sraeng has "moderately" affected the income level of local residents in Pong Ro village and "very" affected the income of households in Phnom Trongbath and Damnak Kchas villages. The opposite was true the previous year where the income of the upstream villagers was badly affected while those in the middle and downstream areas were spared as the local residents were able to make their living from fishing during the same period. This was likely the impact of COVID-19 during 2020 and 2021 that contributed to the low-income level of people in the upstream region. The local

communities in Pong Ro and Damnak Kchas villages confirmed that their income was 'moderately' affected while villagers in Phnom Trongbath were 'very affected compared with the last three years.

Table 2.1.4: Income being affected by the current change of Steung Sraeng's functions

Rating Value	Pong Ro (upstream)			Phnom Trongbath (middle stream)			Damnak Kchas (downstream)		
	This year	Last year	Last 3 years	This year	Last year	Last 3 years	This year	Last year	Last 3 years
Not at all									
Slightly									
Moderately									
Very									
Extremely									

Gender Role

Both men and women work hard given the above livelihood circumstances. The current hardship has forced women to involve in laborious tasks that they didn't carry out in the past. For example, many women and men in Damnak Kchas village have migrated in search of daily labor in other provinces, cities, or even Thailand. Other women have to travel far distances to catch fish where their safety is at high risk. The children of migrant families are more likely to drop out of school and involve in paid labour. Domestic violence usually occurs in households who are deeply afflicted by poverty.

2.2.1.3 Steung Moung (Dauntri)

Biodiversity

Steung Moung has potential to make contributions in improving the livelihood of rural residents. This river connects 2 main districts: Rokakiri and Muong Reussey, where many families use the river for rice and other crops production, and animal raising for food and income security. Communities in 7 villages of Bassac commune can easily access the river for rice and other crops cultivation. Basa dam (irrigation scheme) can serve as a tourist attraction for local visitors to enjoy the sight and mountainous forest landscape. The river proliferates with fish, wildlife species, and flooded plants, and facilitates transportation connected to the Tonle Sap basin. Local tourists can travel by boat to Siem Reap on this river and enjoy sightseeing along the river before crossing the Tonle Sap basin during the wet season.

Human factor: ***Population growth*** is the main driver for the exploitation of natural resources. As local demand for food soars up, agricultural production correspondingly needs to expand which inevitably leads to ***encroachment of*** the flooded forest areas. The ***privatization*** of state land has also reduced the forest cover in the past five years. Wildlife species such as birds, snakes, turtles, Greater Adjutant, Crane, Tougan, monkeys, and vultures have been less visible or have completely disappeared. The loss of flooded forest cover and wildlife species is more apparent in Chrey commune in Moung Reussey district and in Rokkiri district.

Illegal fishing and poaching activities have damaged the sustainability of biodiversity and ecosystem in the localities. In addition, the ***overuse of agri-chemicals*** such as fertilizers and pesticides for rice

production and other cash crops, disposal of plastic waste and toxic residues into the river have significantly endangered aquatic organisms, and also the villagers that depend on the river.

On the positive side, the ***dam constructed*** in Bassac commune, Rokakiri district upstream of Steung Moung brings back a slight increase of fish catch during the rainy season. The dam also creates the opportunity for farmers to grow rice and other cash crops in both seasons. The level of water during dry seasons is however too low in the reservoir to provide safe breeding-ground for fish species and disrupts fish migration. ***Landfills*** are also increasing for housing on the riverbanks which narrows the waterways used for transportation especially in the wet season. This leads to soil erosion in some parts of the river.

Natural factor: As agreed by the key informants, ***climate change*** is one of the major drivers for changes of the biodiversity in locality. The change of water regime, irregular rainfall patterns, and low rainfall has directly prolonged the drought period and caused unpredictable flash floods. The low level of water ***tends to increase the temperature*** and dries up some parts of the river and causes the death of many fish species. For example, the river across Moreah Prov village, Chhrey commune, Moung Roessey district, was dry between March and May. This has caused the death of many fish species and damaged the biodiversity and ecosystem in the river. The river also received delayed water inflows in July and August or even September in some years that is ***unusual regime*** as it used to regularly happen in May or June.

During 2019-2020, the flash flood affected the livelihoods of people living along the river and prolonged the drought period causing water shortage for farming. For example, flash floods occurred twice during 2019 and 2020 in Moung Reussey commune. Households in Chrey commune can easily the river for farming and household needs during the wet season but have been facing water shortage for farming during the dry season.

In Am Reng village, Bassac commune, around 50 out of 223 families had sporadically used water from Steung Moung to irrigate their farms during the dry season. But, after a 9km dam was constructed by the government in 2019, they have lost access to the river. During the rainy season, the water inflows from Tonle Sap basin have been unable fill the floodplain areas which in turn affects the lives of the migratory fish and terrestrial wildlife. The typical fish species, Great white sheatfish, Catlocarpio Siamesis, Pangasianodon Gisga, Brachirus orientalis, Twisted jaw sheatfish, Red tailed tinfoil fish, Clown featherback fish, and Brown featherback fish are less visible or have completely disappeared.

Livelihood

The communities used to enjoy their fishery livelihood along Steung Moung in the past five to ten years when their catch was high. About 95% of households in zone 2 and 3 of the Tonle Sap Biosphere Reserve heavily depended on fishing and farming activities such as rice cultivation and animal raising to make a living. Livelihoods of people living along the riverbanks and floating villages of Koh Chiveang commune, Ek Phnom district, were also dependent on fishing during the rainy season and farming during the dry season when the water recedes. The majority of households in Moung Reussey district had to the river for irrigating their farms and raising animals in both seasons.

Presently, their livelihood has been critically threatened with the decline of fish supplies. For instance, the fish catch per household has fallen from 2-3 tons to 1-2 tons per year in the past five years. In Bassac commune of Rokakiri district, local residents can catch 1-3 kg per day from the river which is low compared to the past five years. Similarly, people in Moung Reussey district catch only 1-

2kg/day/household compared to about 5kg in the past five years. The maximum quantity of fish caught annually per household in Moung Reussey is 500-1000kg showing a drastic decline in the past five years. Local residents in Moreah Prov village, Chrey commune catch around 2-3kg of fish per day per household, and people in Pralay village get 1-2kgs where both areas used to catch up to 5kg/day/household in the past few years.

As shown above, the amount of fish supplies has been relatively lower because of overfishing activities that give less chance for fish species to breed and grow before they are caught. The water regime has changed and the local demand for fish consumption has increased. The current lack of fishing for consumption in Moung Reussey and Chrey communes is indicated by the fact that 80% to 95% households had to buy fish from the local market.

During the dry season water from the river is insufficient for farming activities and raising animals for many households. The collection of NTFPs is no longer possible because the forest cover is lost as the local residents burn and clear it almost every year. However, some villagers in Am Reng village have been able to collect vines, mushroom and firewood for family use. In addition, the increasing in price of agricultural inputs and cyclical decline of selling price of farm produce are concerning to farmers. Some families had already shifted their livelihood occupation to run small business, sell labour, or migrate to other provinces or abroad in search of jobs on construction sites or on-farm works to secure an income. As evidenced, a total of 164 people from 85 families in Am Reng village have migrated to work in other provinces or find work Thailand.

When asked about their income being affected by current change of functions of the river, key informants from the upper and midstream communities stated that their income was only slightly affected since last year, while the downstream community were not at all affected in the last year. All key informants confirmed that the affect was generally moderate in the past three years. It is obvious that some people from the three area have migrated in search of jobs or have shifted their occupations in the past three years to secure their livelihood and deal with the extensive issues caused by the current change of river's functions.

Table 2.1.5: Income being affected by the current change of Steung Moung or Dauntri's functions

Rating Value	Am Reng Village (upstream)			Pralay Village (middle stream)			Moreah Prov Village (downstream)		
	This year	Last year	Last 3 years	This year	Last year	Last 3 years	This year	Last year	Last 3 years
Not at all									
Slightly									
Moderately									
Very									
Extremely									

Gender Role

The shift of livelihood occupations has involved women in income generating activities in addition to their traditional household chores. Women are increasingly engaged in on-and off-farm activities and some have migrated to other Cambodian provinces, or Thailand in search of jobs. Men have taken similar alternatives and mostly work on construction sites and on-farm labour. Older people have shouldered the care of children whose parents have migrated to work far from home.

2.2.1.4 Steung Pursat

Biodiversity

Human factor. The key informants firmly attested that the change of water regime is directly related to the ***construction of three dams*** in the upstream of Steung Pursat, in Phnom Kravanh district. This has created unpredictable patterns of floods in the last three years, causing frequent flash floods that are affecting crops, houses, and livestock. This has been greatly affecting the lives and livelihood of many local residents in Kandieng and Kravanh districts from May to September. The damage from the flash floods was worse in Kranvanh than other districts in Pursat.

The fast ***population growth*** is increasing the demand for consumable natural resources. Currently, wildlife species and flooded plains along Steung Pursat and in the Tonle Sap basin have been vastly depleted in the last five years due to the expansion of agricultural land and privatization which leads to forest clearance and land encroachment. The local residents in Kandieng district can no longer collect wild honey, vines, mushroom, wild fruit, rattan, etc., in the forest and or floodplain areas.

Simultaneously, the remarkable degradation of wildlife species and biodiversity in the area due to ***weak law enforcement*** has become a prime concern for the community and the government. A few tree species such as Barringtonia asiatica and Sandan are completely depleted. As revealed, the critical loss of wildlife species includes birds, snakes, turtle and monkeys that live in the flooded forest of Tonle Sap Lake. In 2019, the government called for strict law enforcement in the flooded forest and floodplain areas in zone 2 and 3 to save the biodiversity. This has resulted in some improvement in the forest cover and wildlife species in Samrong commune.

The water level during the dry season is insufficient for farming and animal raising activities and the drought period is getting longer causing some parts of the river in Kravanh district to dry up. On the other hand, the district officer of Kravanh confirmed that ***commercial sand extraction*** has deepened some parts of the river where fish and other aquatic species can find refuge for breeding. Landslides are also increasing where people transgress the legal settlement areas along the riverbanks and make landfills, dispose solid waste, and release toxic residues into the river. The amount of fish catch has therefore declined. Without promising alternative livelihood options, farmers are intensively using ***chemical fertilizers and pesticides*** to increase the yields in the floodplain areas and the chemical residues threaten aquatic organisms and biodiversity.

Natural factor. The change in rainfall patterns has influenced the water regime. Local residents living upstream near the dams have better access to water for crop cultivation, growing vegetables, animal raising and fishing in both seasons. 90% of families living upstream in Kravanh district are farmers whose livelihoods depends on the above livelihood occupations. For instance, the residents in Samroang commune, Kravanh district have enjoyed sufficient fishery during the rainy season. However, the access to water and fishery endowments are not equally distributed in the middle and downstream areas of Steung Pursat. Around 95% of households living along Pusat river located in Kandieng district have access to the river for cash crop production and animal raising. Some villagers have managed to grow rice twice a year.

Conversely, some other areas lack water for agriculture activities in dry season. Close to 95% of farmers in Kandieng commune had been affected by flash floods in recent years during the wet season. People living in Kanchor commune are more often affected by floods than the other places., however, they lack water for irrigation in the dry season.

Rainfalls are becoming inadequate, the wet season is getting shorter, and floods have become unpredictable causing a direct impact on sustainable biodiversity and ecosystem in the localities. The quantity of fish has declined. The average annual fish catch per households in the floating villages is around 1-2 tons er year compared to 2-3 tons caught in the last five years. The weight of fish caught in Kandieng district is anchored at 2 to 4 kg/day compared to 5 to 10kg/day in the past five years. Similarly, in Kanchor commune, the fish caught in Steung Pursat and Tonle Sap basin is around 2 to 4 kg/day, and sells for 20,000 to 40,000 Riel, as compared to 5 to 10 kg/day that cost 50,000 to 100,000 Riel in the past few years. In Por Andet, Samroang, and Bangkol villages, the villagers catch around 1 to 4 kg of fish per day compared to 4-10kg/day in the past five years. Meanwhile, some fish species have disappreared such as the great white sheatfish, red tailed tinfoil fish, clown featherback fish, brown featherback fish, Labeo chrysophekadion, and Cirrhinus microlepis.

Livelihood

The livelihood of local residents living along Steung Pursat depends on wet season and dry seasonal rice production, cash crop cultivation, animal raising and fishing activities. The low fish catch has severely affected families whose livelihood has a high reliance on fishing. In the past, fishing used to be the primary source of income for 80 to 90% of households in the floating villages, which is presently down to 30 to 40%. Most people in Kanchor commune, located 10km from Tonle Sap Lake used to catch fish in the basin for family consumption and making extra income in the past five years. But currently their fish catch is in predicament and most of them have abandoned this fishery livelihood.

Flash floods and drought have continued to drain the sustenance and income of many especially in Por Andeth and Samroang villages. 95% of households in Bangkol village have produced rice in both wet and dry seasons even though their crops were badly affected by flash floods and protracted droughts in the past two years. Meanwhile, the price of agricultural inputs has soared but the selling price for agricultural produce remained relatively lower. These factors have forced more local residents to find alternative livelihood occupations to sustain their income and livelihood. Some villagers have already left to work in garment factories in Krokor district, construction sites, and other temporary paid work outside their communities. Other have migrated to other towns in Cambodia or Thailand in search of jobs.

The significant shift of livelihood occupations however has eased the economic shock especially during the COVID-19 pandemic. The income of local residents in upstream, middle stream, and downstream villages has therefore been moderately or slightly affected by the current changes of Steung Pursat's functions.

Table 2.1.6: Income being affected by the current change of Steung Pursat's functions

Rating Value	Samroang Village (upstream)			Bangkol Village (middle stream)			Por Andeth Village (downstream)		
	This year	Last year	Last 3 years	This year	Last year	Last 3 years	This year	Last year	Last 3 years
Not at all									
Slightly									
Moderately									
Very									
Extremely									

Gender Role

The garment factories set up in Krokor district, Pursat province have provided convenient formal employment opportunities for rural women especially those whose livelihood has been affected by the current change of water regime in Steung Pursat. The increase of women in economic activities is directly related to the shift of occupations, and the high demand in formal and informal employment opportunities locally and in other provinces. Both men and women work harder to cover their household's needs and debts to banks or MFIs. Other women are taking more risks to their safety in search of jobs in Thailand.

2.2.1.5 Steung Boribou

Biodiversity

Human factor. The key informants pointed out that a disruption of water flow in Steung Boribou is mainly caused by the ***construction of two dams*** in upper stream, A Chang and Lomharch. The dams impede the regular waterway and block migratory fish and breeding grounds along the river and in the floodplains. Similarly, ***population growth*** in the above provinces has directly motivated an increased incidence of illegal poaching, land encroachment, forest clearance, and disposal of waste and toxic residues into the river. The landfills and commercial sand extraction in some parts of the riverbanks accelerate drying up in some parts of the river during the dry season. In addition, Steung Boribou is not the main water source for fishing, irrigation or household use[9]. The farmers along the river could not access the river in the past three years and therefore increased any agricultural production during the dry season.

The flooded forest covers in eleven communes in Boribou district and flood plants in Tonle Sap area are burned and cleared by local residents almost every year causing it to be depleted in the past five years. The try species, wildlife species, and the seasonal flooded plants have been lost including Barringtonia asiatica, Sandan, Gmelina asiatica, Romdenh, Thatch, Animal cane, and the like. Wild pig, rabbit, turtle, fishing cat, monkey, wild bees, and wolf have already dissapeared. For those who eke out a living on NTFPs, they now travel around 10km from their villages, however, they can no longer collect wild honey, vines, or mushroom as they had done in the past. For example, in Anchanh Roung commune, Boribou district, the flooded forest has been lost, and upland forests were entirely depleted in the past five years.

Natural factor: ***Rainfall*** has been unpredictable and inadequate to fill the river during the wet season. Local residents experience flash floods, and some of their crop and animals were destroyed. The rainy season has protracted with longer periods of drought. During the dry season, there is little or no water in some parts of river. The water level in Tonle Sap basin is too low for the reverse discharge to Steung Boribou. For several years, households along the river in Boribou district have faced shortage of water during the dry season for irrigation and household use.

Presently, fish species including Thynnichthys Thynnoides, Datnioides polota, Dicthotomyctere fluviatilis, Chramos, Labeo chrysophekadion, Cirrhinus microlepis are disappearing from the river. The fish catch by local residents has plummeted from 5 to 10kg/day/household to 1 to 3kg in the past five years. The same is true for the people of Meloum commune therefore fishing can no longer be a subsidiary source of income for the local residents along the river.

[9] Source: The Provincial Department of Environment

Livelihood

The ecological and socio-economic functions of Steung Boribou have contributed to improving the livelihood of many households residing in the rural areas. The river also supports communities against economic shock. Around 85 to 90% of households living along Steung Boribou in Boribou district have access to the river for growing rice, cash crops, vegetables, and raising animals. Agricultural production was the main source of food and income of around 90% of local residents in Meloum and Andoung Roveang villages. The livelihood of local residents in Anchanh Roung commune heavily relied on rice and cash crop cultivation and animal raising. However, it was observed that five villages located along the river in Anchanh Roung commune had no access to water for the whole year because the water level is too low.

The lack of irrigation water in Boribou district is critical to sustaining the surrounding biodiversity, ecosystem, and agricultural production. This factors into income diversification where many people have turned to construction work, garment factories, running micro businesses, and other off-farm occupations. Some people have also migrated to Thailand in search of jobs. Young people especially women are highly visible in the garment factories that are active in Kampong Chhnang province.

The change of functions of Steung Boribou has not significantly affected the income of local residents in either Andoung Roveang, Meloum, upstream, middle or downstream villages. Fishing has not been their primary source of livelihood and was only used for household consumption. Conversely, their agricultural livelihood which is the prominent source of food and income security has been threatened by cyclical flash floods and protracted droughts. Outside paid employment opportunities are on the rise where the garment sector in particular has absorbed women with low skills in the locality. More men are involved in construction work in the province or outside their area. This enables the villagers to cope with unexpected economic shocks such as the Covid-19 pandemic, where the income of local residents in the above two villages was only slightly or moderately affected in the last three years respectively.

Table 2.1.7: Income being affected by the current change of Steung Boribou's functions

Rating Value	Andoung Roveang Village (upstream)			Meloum Village (middle and downstream)		
	This year	Last year	Last 3 years	This year	Last year	Last 3 years
Not at all						
Slightly						
Moderately						
Very						
Extremely						

Gender Role

The local residents in Boribou district have a high reliance on agricultural livelihood and catch fish mainly for household consumption. The yields of agriculture investment notoriously continue to be less reliant while the current change of water regime in Steung Boribou has been insufficient during the dry season. Women therefore take up alterative livelihood occupations and increasingly work for garment factories in Kampong Chhnang. Others have migrated to other provinces or Thailand with their whole families in search of jobs. Men usually involve in farming activities and find temporary jobs on

construction sites. Similarly, young men also tend to migrate to other areas in search of jobs. Both men and women work hard to meet their household needs.

The change of men's role is preemptive in supporting women who make strenuous attempts to participate in paid work. As emphasized by the key informants, gender sensitivity is being lucratively pervasive within the community which has decreased incidences of domestic violence.

2.2.2 Governance of the Tonle Sap Lake's Tributaries

There are several policies in place to address climate change and promote the sustainability of natural resources management such as the Rectangular Strategic Plan Phase IV, Second National Communication to UNFCCC 2016, Green Growth Roadmap, Cambodia Climate Change Strategic Plan 2014-2023, National Adaptation Program of Action, and Strategic National Action Plan for Disaster and Risk Reduction 2019-2023 to name a few. The Tonle Sap Authority's role has been playing around the governance issues for the Tonle Sap Lake and its basin. There is not any mandatory role of such form of mechanism exists to govern the tributaries. However, at sub-national level the above policies have guided the implementation modalities which functional Departments and local authorities of each province have been working on each agenda. There are some interventions of the NGOs in place. But the coherence amongst all concerning stakeholders in implementing the policies remains a challenge in terms of budget allocation, technical capacity, and systemic approaches. Following implications of the management on natural resources for each tributary have underscored the best efforts made individually and collectively by the concerned institutions.

2.2.2.1 Steung Sen

There are several initiatives that exist to protect and promote sustainable biodiversity and livelihood of communities that are dependent on the Steung Sen:

The government. issued a guideline to allocate land for local people in the protected area - zone 2 to raise cattle and grow rice and reduce their dependency on fishing activities. The provincial authority plans to relocate communities from fish breeding areas in the Tonle Sap basin and resettle them inland, such as in Phatsanday commune. The commune and district authorities in collaboration with national line ministries had withdrawn state land in Tonle Sap's floodplain that was illegally occupied by local people. In addition, Phatsanday commune authority has planned to improve water quality in the river by applying water sanitation measures.

The Provincial Department of Water Resources and Meteorology (PDWRAM) has recently studied the possibility of dam construction at Trea commune, Rovieng district, Preah Vihear province, and other potential locations for dam construction in Dang Kambet and Mean Chey commune of Sadan district, and in Kampong Ko commune of Kampong Svay district, Kampong Thom province, to store deeper levels of water in the river providing favorable conditions for biodiversity conservation. The Department has also provided water pumps and fuel for emergency assistance to irrigate rice cultivation during the drought and flood periods.

The Provincial Department of Agriculture, Forestry and Fisheries (PDAFF) supports communities to conserve four big lakes in Sandan district, and to participate in preventing of illegal fishing activities. There are Community Fisheries and Deep-water Fishery Conservation Areas (2 sites) in Steung Sen river, as well as the protected fishing areas which were established by PDAFF in cooperation with the

Provincial Department of Environment (PDE). The PDAFF has actively promoted and technically supported the local communities to raise fish and provided rice and vegetable seeds including technical training on livestock and cattle raising. The Department through its district level office has facilitated market access for the community to sell their products. The Department also monitors and cracks down any illegal fishing activities in target locations. The district and commune authorities have disseminated fishery and forestry laws and have taken actions against illegal fishing methods during the last two mandates. Meanwhile, PDE plans to strengthen environmental law enforcement for natural resource protection, including education and awareness raising on illegal fishing and poaching activities, and the overuse of agro-chemicals that negatively impact the environment.

Kampong Svay district authority has also planted many palm tree-seedlings in the protected flooded forest areas of zone 3 in May 2022. The district authority has cooperated with the Rural Development Bank to provide soft loans with a low interest rate of 3% per year for agriculture investment purposes.

The NGOs. Some NGOs have supported local households with solar water pumps promoting renewable energy for vegetable production and to replace fossil fueled pumping generators. They have also provided capacity and skills enhancement, and other necessary facilities to the community members.

The communities have been able to conserve fish resources in three deep water holes in Steung Sen where fish species can easily migrate during the rainy season. Other support includes, drinking water facilities, water-way construction for agricultural irrigation, saving groups formation, establishment of farmer water user communities, home gardening techniques, livestock raising, and other diversified income generating skills.

2.22.2 Steung Sraeng

The Government. The Ministry of Agriculture, Forestry and Fisheries (MAFF) has been implementing the national plan to build fish cascades at the dike construction in Steung Sraeng. In the meantime, local attempts have further exasperated the clearing of flooded forest cover along the river and lakes to provide breeding-ground for fish and proliferate other terrestrial wildlife species. The provincial, commune and village authorities have jointly developed the fishery and bird conservation area at Ta Sao dike located along the river. The Provincial Department of Agriculture, Forestry, and Fisheries (PDAFF) has planned to replant trees on flooded plant areas with the local communes and establish the local committee to prevent illegal fishing activities. This Department has also provided technical assistance and input such as equipment, fingerlings, and feeds to local communities who have a high reliance on fishing.

The Provincial Department of Water Resources and Meteorology (PDWRAM) has established Farmer Water User Community (FWUC) in the local communities to maintain the irrigation schemes and ensure sufficient water supply to local farmers for irrigating rice production. Local authorities engaged local residents and members of the FWUC in maintaining public establishments such as irrigation schemes. During the last three years, PDWRM has provided water pumps, rice seeds and technical training to local communities who were badly affected by drought.

The Provincial Department of Environment (PDE) has disseminated the law on biodiversity management and conservation, and strengthened law enforcement to curb illegal fishing activities, and to rehabilitate and expand fish nurseries. As a result, the capacity of Fishery Conservation Committee in Tumnop Tasao and Anlong Treykranh areas in Tram Sorsor commune have improved. Local authorities conducted awareness raising on the benefits of biodiversity conservation and engaged local

residents in planting trees in the flooded forest protected area of zone 3. The main role of the Fishery Administration is to manage fisheries and fishery conservation zones, and to release fingerlings into the river. Lunhard and Tei Lakes and other community ponds in Sambuo commune were included under natural resource conservation. The local authorities have cooperated with the local communities to build Ta Sao dike, O'samnap dike, and other dams constructed on the mainstream of Steung Sraeng as fish conservation sites. The Water Pump Committee was also established in this commune to promote dry seasonal rice production in the area.

The NGOs. Various support is provided to local communities to grow vegetables, raise chicken, establish producer groups and saving groups, and access to market and financial services. For example, the Livelihood Enhancement Association of the Poor project run by the provincial authority in cooperation with an NGO has supported poor households with setting up their saving groups and providing technical skills on raising chicken and fish and setting up of fish hatcheries.

2.2.2.3 Steung Moung

The government. The national and local governments have increased their effort to protect and conserve local national resources and strengthening of both environmental and forest protections including illegal fishing and poaching. At the provincial level, the Department of Environment has played the greater role in strengthening capacity of the Community Fishery Association on forestry management and biodiversity conservation. The Department has also worked with local authorities and partners to raise awareness of communities on waste management, natural resources management, and environment protection so that they can take part in fighting illegal poaching, land encroachment and deforestation activities in the locality. In addition, the Provincial Department of Agriculture, Forestry, and Fisheries (PDAFF) has been providing trainings on agricultural skills like, seed selection, pest management, crop planting, and marketing of agricultural produce. Many fingerlings were released into Tonle Sap Lake with the concerted effort of the Provincial Department of Environment (PDE), PDAFF and other partners.

The provincial Department of Water Resources and Meteorology (PDWRAM) takes the lead in dam and canals construction and rehabilitation of the existing irrigation systems to improve agricultural productivity and sustainability of biodiversity and ecosystem in the rivers. PDWRAM has also supported the existing Farmer Water User Communities in cooperation with local authorities to sustainably maintain the irrigation schemes. The Provincial Committee on Disaster, Risk Reduction Management (PCDRM) has cooperated with village, commune, district, and provincial authorities, line departments, PDAFF, PDWRAM, PDE, and the Provincial Department of Health (PDH) in raising awareness and making disaster responses.

The NGOs. The role of NGOs has been more on raising awareness and capacity building of the community people and local organizations. For example, Village Support Group (a local NGO) has improved the capacity of 29 Community Fisheries in Battambang and Banteay Meanchey provinces on biodiversity conservation, leadership, and problem solving.

Other NGOs in the area have involved in protecting forest clearance, illegal poaching activities, excavating of community ponds, and promoting the sustainability of biodiversity and ecosystem. The project interventions in Steung Moung and Tonle Sap Lake have been to protect and promote the sustainability of biodiversity, strengthening law enforcement to protect flooded forest areas, and raise

awareness on the environment, waste management and hygiene in communities who are living along the riverbanks.

2.2.2.4 Steung Pursat

The government. There are some initiatives in place to curb the current pressure on natural resources. The Provincial Department of Agriculture, Forestry, and Fisheries (PDAFF) has constantly cooperated with the Provincial Department of Environment (PDE) to raise awareness and encourage participation of local residents in preventing illegal poaching, land encroachment, forest clearance, protecting of other environmental pollution, and promoting sustainable biodiversity. The Department has also beefed-up the capacity of Fishery Communities by providing agricultural inputs and conducting a series of agricultural livelihood training courses including fish keeping, animal raising, cash crop production, and vegetables growing in collaborating with other Departments and NGOs. The construction of hydroelectric dams and dikes is under the constitution of PDWRAM in coordination of other relevant provincial departments and local authorities. PDWRAM has supported the establishment of the Water Farmer User Communities and built their institutional capacities to sustainably maintain the irrigation schemes in their locality.

The NGOs. Support has been provided for capacity building of Fishing Communities on fish conservation, raising awareness on prevention of illegal fishing and deforestation, effects of toxic and chemical residues, and reforestation in the floodplain areas. A good example is Akphiwat Neary Khmer Organization (ANKO) that has supported the sustainability of community livelihoods along the river by providing small grants to the Community to excavate community ponds in their area, raise fish and animals, and grow vegetables in order to reduce pressure on fish resources in the river and Tonle Sap Lake.

2.2.2.5 Steung Boribou

The government. The national and provincial governments have facilitated the relocation of 95% of households from the floating villages in Tonle Sap basin to inland areas. A joint effort between PDAFF, PDE, PDWRAM has been made to raise awareness of communities on water pollution, waste management, environment protection, prevention of illegal fishing and deforestation. The above departments have worked in synergy with local authorities in the promotion of biodiversity protection. PDWRAM also provided support for the establishment of FWUC and building its capacity to sustainably manage the existing irrigation schemes in Steung Boribou. In cooperation with NGOs in the locality, PDAFF has provided a series of trainings on technical agricultural skills to the community people and facilitated the establishment of producer groups for vegetable and native chicken production.

The NGOs. World Vision International (WVI) and Phnom Neang Kangrei Association (PNKA) had supported the establishment of Agricultural Cooperatives, as well as develop the institutional capacity of previous farmer members to manage agricultural livelihoods. Recently, other NGOs have been jointly working on raising awareness of the community people on environment protection and natural resources management. NGOs also provide agricultural skill trainings such as home gardening, animal raising, etc.

3. Conclusion

Tonle Sap Lake in Cambodia is the largest freshwater body in Southeast Asia, that forms a natural floodplain reservoir in the depression of the Cambodian plain. It is fed by three main perennial and numerous erratic tributaries and is drained by the Tonle Sap River into the Mekong River near Phnom Penh. When the level of the Mekong River is high, the flow of the Tonle Sap River reverses. The water is pushed into the lake, raising its level by up to 8-11 meters and increasing its area from 2,500–3,000 square kilometres in the dry season to 10,000–16,000 square kilometres in the rainy season.

The lake's fisheries directly support more than 1 million people and provide the single largest source of protein for Cambodia's young and increasing population. The flooded areas offer seasonal breeding and nursery grounds and forage areas for fish that subsequently migrate to the Mekong River, thereby providing a regionally vital resource. Presently, the Tonle Sap basin is under severe pressure, and consumptive use of its resources is intense. There are many threats to the lake's ecosystem, including overexploitation of fisheries and wildlife resources, dry-season encroachment, and land clearance of the flooded forest. Degradation of the watersheds' natural vegetation destroys natural habitats and also results in deterioration of water and soil quality and increased siltation. These predicaments are being commingled with an increasing vulnerability to climate change of the country in Southeast Asia. Surface air temperature in the region increased between 0.1 and 0.3 °C per decade between 1951 and 2000 (ADB, 2009). Sea level has risen at the rate of 1 to 3 millimeters per year over the last 50 years. Heavy rainfall events increased significantly between 1900 and 2005, while tropical cyclones occurred more frequently between 1990 and 2003 (ADB, 2009).

The country is projected to experience warming of 3.1°C by the 2090s, against the baseline conditions over 1986–2005 under the highest emissions pathway. The change in rainfall patterns since the 1920s increasingly sporadic, unpredictable, and intense rains have badly affected farmers' livelihoods. The climate change is threatening natural flow patterns of 11 river sub-basins contributing to the Tonle Sap Lake. Climate change will reduce the annual projected flow from 9 to 29%, 10 to 35% and 7 to 41% for the 2030s, 2060s and 2090s projections, respectively (Oeurng et al, 2019). There will be a decline in flood magnitudes and an increase in drought occurrences throughout the basin resulting in the impacts on its biodiversity (Oeurng et al, 2019).

The tributary in Kampong Thom, Siem Reap, Battambang, Pursat, and Kampong Chhnang has already experienced with the change of flow patterns indulged by inadequate and unpredictable rainfall and irregular flood pulse, and an inactivity of reverse discharge from Tonle Sap during the dry season. Besides, human factor has tremendously influenced to such change. The population growth along the tributaries has also accelerated local owned account employment in the natural endowment in parallel with the termination of fishing lot concession in Tonle Sap Lake by the government. The increase in market demand has simultaneously amplified an overexploitation of the natural resources in momentum of weak law enforcement, lack of coordinated and concerted efforts of local government to cushion pressure on the overextraction. It is so obvious that the de facto human activities are being a driver for illegal poaching, clearance and firing of flooded plants, disposal of waste and toxic residues into the tributaries/rivers, and landfills in some parts of the riverbanks. The increasing need for agricultural land has subsequently swept away the flooded plants and wetland areas where they were feeding grounds of many wildlife and fish species. The present sand commercial collection is being attritive to the riverbanks and subsequently causes to dry up quickly in some parts of the river during the dry season.

These changes have a strong implication to disrupt sustainability of biodiversity and ecosystems in the rivers and floodplain areas. A significant loss of tree, aquatic, and terrestrial wildlife species has been on a rise as far as the five tributaries have concerned. Likewise, fishery livelihood is eventually diminished by an indication of a gradual decline of fish catch. The local residents whose livelihood is dependent on the fishery resource, in particular in downstream of the rivers of Kampong Thom, Siem Reap, Battambang, and Pursat has been vastly affected. This gravity is relatively less for those living along the river in Kampong Chhnang. The flash floods and protracted droughts have continued to drain food and income of many who have largely depended on water from the rainfed and river regimes for agricultural production. Some parts or a whole length of the river in all five studied areas are quickly dried during the dry season. Meanwhile, a price of agricultural inputs acutely sores up but the selling price for agricultural produce is significantly sliding down. These have forced more local residents to find alternative livelihood occupations to sustain household's food and income. Some have already sent their family members to work in garment, construction, and other temporary paid work outside the community. Other have migrated to other provinces or cities in Cambodia and or Thailand to search of job.

The current pressure on fishery and agricultural livelihoods has forced more women to take up men's roles in either usual fishing or shifting occupations in addition to their traditional household's choirs. The increase of rural women in economic activities is precisely related to shift of livelihood occupations and demand of the formal or informal employment opportunities locally or externally. The men and women work harder together in this present time to well cushion their household's needs and debts to the bank or MFI. The women have more engaged in on-and off-farm jobs and some migrated to search of jobs in other Cambodian provinces, cities or Thailand. Men have taken similar alternatives but the majority of them have involved in construction work, and on-farm labour. Older people have been shouldered by taking care of children whose parents migrated to work far from home. The migrated families have often been not able to keep their children in school. Many children had dropped out of school at their primary education. The children have more likely engaged in income generating activities to help their family.

The presence of garment factories in Pursat and Kampong Chhnang provinces has provided convenient formal employment for rural women especially those whose livelihoods are being affected by the current change of the tributary functions. More young women from the communities have increasingly grasped this opportunity in whilst their agricultural production gives little hope. The change of men's role is preemptive in supporting to their partner whilst women have strenuous attempt to participate in paid work. As emphasized by the key informants, gender sensitivity is being lucratively pervasive within the community. Obviously therefore the incidence of domestic violence is being less likely.

The local government has been struggling to enforce the applicable laws and good practices in line with the national policies for the course of national resources sustainability with the genuine guidance of the national government. The enforcement has come in to more strictly since 2019 pushed by the head of the national government. Some existing initiatives are being effective include, awareness raising of the concerned community people on water pollution, waste management, environment protection, preventing illegal fishing and deforesting activities. A facilitation in relocating of floating households to reside inland area and a process of providing land possession for agricultural production in wetland areas has been on a good move to cushion the current pressure on natural resources. The NGOs have also actively involved in raising awareness of the local residents on above thematic focus and providing agricultural skills training, institutional capacity to community-based organizations, agricultural inputs, and other facilitation support in market access for farm produce.

4. Recommendation

Recommendation 1: THE LAW ENFORCEMENT

The enforcement of relevant laws is crucial to sustain the governance of natural resources. Local governments have been trying to enforce the applicable laws however the efforts have been sporadic. Some of the reasons are insufficient budget allocation, lack of technical expertise amongst the concerned government officials, lack of robust coordination and cooperation amongst the technical provincial departments, local authorities, and civil society organizations. The support from the national sectoral ministries on the development of local aquaculture has been more on a project basis and often lacked coherence for scaling up.

In this respect, *the sufficient allocation of budget and capacity building to concerned stakeholders involving in the law enforcement should be on top of priorities to effectively contextualize the sustainability of natural resources management*. To achieve this further attention should shade the light on:

- Strategic engagement of wider stakeholders, the government, private sector, civil society organizations, and local community people in combating on illegal poaching/fishing activities, land encroachment, and clearance of flooded forests.

- The support to develop local aquaculture should be more strategic and the intervention modalities should be practical and feasible to take scale. In parallel, a promotion of fish raising is crucial in reducing current pressure on native fishery resource.

Recommendation 2: COMMUNITY AWARENESS RAISING

The local residents have basic awareness of applicable laws, legal frameworks, and good practices concerning environmental protection including fish conservation and protection. The local governments and civil society organizations have jointly been encouraging local participation in the protection and management of natural resources and the environment. The strategic implementation modalities will reinforce awareness creation amongst the local residents that can help to track behavioral changes at individual levels if applied. It requires a long-term endeavor with systemic approaches that can affect positive mindsets towards the love and care for nature as thousands of lives and various animal and plant species depend on a healthy ecosystem.

Consideration is therefore should be placed on, *an introduction of systemic approaches, as opposed to project based, to raise awareness of local residents on the applicable laws, legal frameworks, and good practices concerning the protection and conservation of natural resources including biodiversity and ecosystem available in their locality*. To achieve this further attention should shade the light on:

- Continuous capacity building to concerned key institutions (provincial, local authorities, NGOs) and community-based organizations (community fisheries, etc.,) on above relevant thematic focus to deepen the awareness of community residents and appropriately arrange for local monitoring mechanisms to be in place with properly capacitated. The training on leadership, management, and fundraising for the community fishery committee members is crucial to reactivate their functions.

- Awareness of and strictly abided by the local residents on legal demarcation for natural water bodies including riverbanks and lakes to avoid causing landslides and landfills. A monitoring mechanism should be in place locally to prevent soil erosion that is caused by commercial sand collection in the rivers.

- Feasible measures should be put up in particular floating villages and densely populated areas to demonstrate proper waste management practices in addition to awareness raising as to revitalize the water quality in rivers and Tonle Sap basin.

Recommendation 3: REHABILITATION OF FLOODED FOREST COVERS

The flooded forest covers were gradually being depleted with different degrees of gravity in the study areas because of rampant forest clearance and encroachment for expanding agricultural production, commercial purposes, and land privatization. As an example, the flooded forest covers in eleven communes in Boribou district and the Tonle Sap area are cleared and burned by local residents almost every year. The severe loss is apparent in Moung Reussey and Rokakiri districts, and along Steung Sraeng of which 1,079 ha in 2012 and additional 40 ha were lost out of total 31,00 ha available in the present time. The tree, fish, and wildlife species have been on a significant loss.

Where it is possible and given the priority of necessary existence of the local biodiversity and ecosystem, *"rehabilitation of the flooded forest covers is pre-requisite to attention of all relevant stakeholders for present and future design of interventions"*. The interventions should be prioritized in:

- Planting of suitable tree species in the flooded forest/floodplain area including riversides to provide back the feeding ground to fish species and other terrestrial wildlife species for breeding and reduce natural landslides. A feasible study should be conducted in full consultation of relevant stakeholders to identify areas to be rehabilitated in each of the studied locations.

Recommendation 4: IRRIGATION SYSTEMS MANAGEMENT

The Provincial Department of Water Resources and Meteorology (PDWRAM) takes a lead in constructing the dams/dikes across the tributaries. The Water Farmer User Community (FWUC) is established to sustainably maintain the irrigation scheme upon a completion of the construction. The dams have directly created irregular water inflows and outflows and more likely determined a level of water in downstream during the dry season. At the bright side, irrigation schemes can store water during the dry season to partly rejuvenate the biodiversity and ecosystems locally, i.e., at the upper steam of Steung Moung brings back a slight increase of fish catch during the rainy season. Other four irrigation schemes have been under the construction in Ta An commune, Oddar Meanchey, Phnom Srok district, Banteay Meanchey province can keep full water in the river throughout the year. At the negative side, local residents in the middle and downstream have faced water shortage for irrigating their crops during the dry season, i.e., the water level in Tonle Sap basin is too low to make it possible for the reverse discharge to Steung Boribou. Since several years ago, households residing along the river in Boribou district have always faced shortage of water during the dry season to irrigate their crops and fulfill household use. Water level during the dry season cannot sufficiently supply to farming and animal raising activities and the drought period is longer. There are some parts of the river dried up during the dry season in Kravanh district.

Sustainable consideration of the local biodiversity and ecosystem should be integral parts of the socio-economic cost analysis to determine the feasibility of hydroelectric dam construction. As such, *the engagement of wider stakeholders including the civil society organizations, local communities, private sector, and etc., in the assessment process prior a construction of the dam is therefore centrally important as an entry point to assure the benefit from the irrigation scheme is fairly distributed*. To achieve this further attention should shade the light on:

- Rehabilitate existing or build new secondary and or tertiary canals to adequately bring water for distributing to farmers who have their farming area far from the main water reservoirs. Private sector, where it is economically feasible, should be engaged in providing such service.

- Diversify water sources development to meet different needs of farmers such as, rice production, cash crops growing, fruit tree plantation, livestock and animal raising, etc.

- Further encourage local residents to actively participate in management of irrigation scheme through their existing or to be established organization, i.e., WFUC. Ongoing support of capacity building for WFUC is necessary to ensure viable operations for the scheme.

- Promote a role-model and knowledge management around good practices on the management of irrigation scheme and the sustainability of biodiversity and ecosystems through incentive policy support.

Recommendation 5: ALTERNATIVE LIVELIHOOD OPTIONS

The decline of fish catch is obviously impacted on survival magnitude of many who have a high reliance on fisheries. For people living in zone 3 of the floodplain area (i.e., Phatsandai commune), over 90 per cent of them make their living on fisheries and only a few have engaged in agricultural activities (crop and cow raising) and small business. The less majority of people in upstream of the river have been moderately affected by the decline of fish catch because most of them don't involve fisheries as their main livelihood. The income of community people in middle stream and downstream has been 'very' affected by the decline of fish catch (in Kampong, Siem Reap, Battambang, Pursat).

The lack of water in the rivers is so critical to sustaining the surrounding biodiversity, ecosystems, and agricultural production. Their agricultural livelihood which is a prominent source of food and income security has been threatening by cyclical flash floods and protracted droughts. In the meanwhile, with increasing cost of agricultural production and low price of their produce, local residents have little hope on their last resort. These have factored into income diversifications which many households have already demonstrated in construction work, garment factories, running micro business, and other off-farm occupations. Some of them have even migrated to Thailand for search of jobs as another way to keep household's survival and live with the current debt to banks or micro financial institutions. Young people especially women are highly visible in the garment factories established in Pursat and Kampong Chhnang provinces.

The intervention on livelihood development for those being affected along the rivers should be strategically sound, and socio-economically feasible and scalable to ensure decent work and livelihood for local communities on their land. Fine-tuning their agricultural skills and providing support to commercially demonstrate the application of the skills learned and market access for their farm produce are crucial. To achieve this further attention should shade the light on:

- Local consumers prefer to eat native fish rather than farmed fish because they believe that farmed fish is less flavor and being intoxicated by chemically processed feeds. Therefore, there is a need for support of value chain development of farmed fish commodity for better access to high value market. In this respect, private sector plays an important role in marketing and processing fish product, including a provision of technical support to fish farmers.
- Continuing to build capacity of producer groups and or community-based organizations and support in developing of contracted farming systems as to create viable market outlets for their produce. A feasible study on specific location should be arranged to contextualize interventions in each studied location.
- Where it is possible, legal landholding rights should be granted to local residents living in the floating villages, i.e., Phatsandai commune for having secured access to and control over their housing and cultivating land areas.