Climate Change Vulnerability Assessment Stung Treng Ramsar Site, Cambodia

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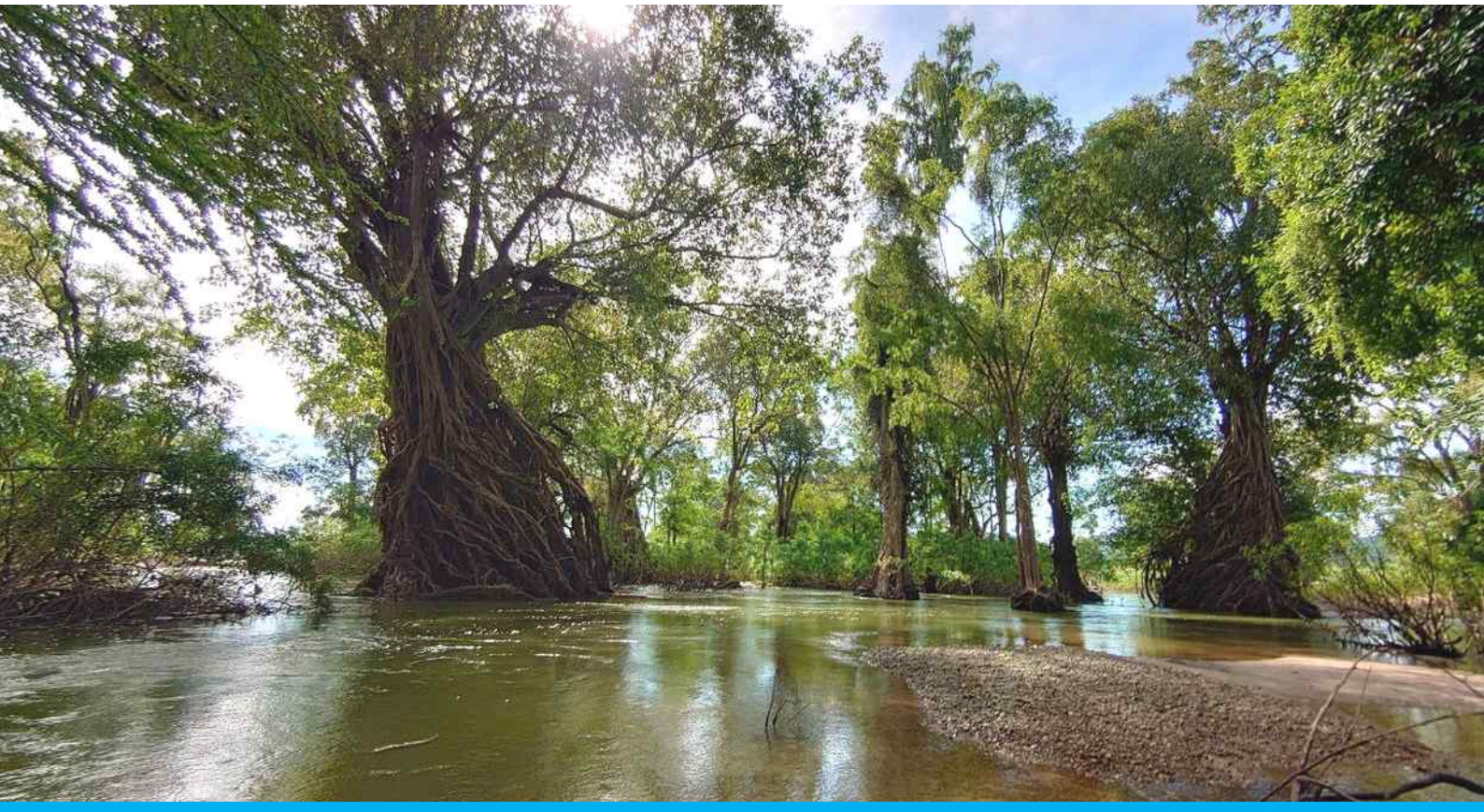

Mekong WET: Building Resilience of Wetlands in the Lower Mekong Region

Federal Ministry
for the Environment, Nature Conservation,
Building and Nuclear Safety

FISHING CAT
ECOLOGICAL ENTERPRISE

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TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS

BB/DF	Bamboo with deciduous, seasonal, hardwood forest
BMUB	German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety
CF	Community Forest
CFi	Community Fisheries
DDF	Deciduous, Dipterocarp, Seasonal, Hardwood Forest
DoAFF	Department of Agriculture, Forestry and Fishery
DoH	Department of Health
DoP	Department of Planning
DoT	Department of Tourism
DoYES	Department of Youth, Education and Sport
FCAs	Fish Conservation Areas
FiA	Fisheries Administration
GDNPA	General Directorate of Natural Protected Area
GHG	Greenhouse Gas
IBBRI	Indo-Burma Ramsar Regional Initiative
IKI	International Climate Initiative
ICEM	International Center for Environmental Management
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
LMB	Lower Mekong Basin
MAFF	Ministry of Agriculture, Forestry and Fisheries
MoE	Ministry of Environment
MXF	Mixed evergreen and deciduous, seasonal, hardwood forest
NGO	Non-Governmental Organization
NL/BL	NatureLife Cambodia / BirdLife International
NTFPs	Non-Timber Forest Products
PDoAFF	Provincial Department of Agriculture, Forestry and Fisheries
PDoE	Provincial Department of Environment
STRS	Stung Treng Ramsar Site
UNESCO	United Nation Education Scientific and Cultural Organization
VAs	Vulnerability Assessments
WA	Wildlife Alliance
WRRT	Wildlife Rapid Rescue Team of MAFF & WA

ACKNOWLEDGMENTS

The Climate Change Vulnerability Assessment (VA) was conducted within the context of the project “Mekong WET: Building Resilience of Wetlands in the Lower Mekong Region” (2017-2022). Stung Treng Ramsar Site (STRS) was chosen as one of the wetland sites for building climate resilience and conserving, managing, and restoring natural ecosystems in collaboration with local communities and stakeholders, with the VA being a first step towards adaptation planning. The authors are grateful to several indispensable people who contributed this report.

The assessment was carried out by the Fishing Cat Ecological Enterprise Co., Ltd. (FCEE) team including Ms. Vanessa Herranz Muñoz, Mr. Pablo Rafael Pedraza Indeguy, Ms. Sara Maria Fernandez Siles, Ms. Hem Sodane, Ms. Mom Pichsreyneang, Mr. Song Det, Mr. Sophatt Reaksmey and Mr. Vong Vutthy, who conducted field research, interviews and workshops for the CCVA.

Firstly, we would like to express our gratitude to provincial and local authorities from Stung Treng Province and the seven villages selected to contribute to the assessment Koh Sralau, Koh Kei, Ou Svay, Koh Hib, Koh Chheu Teal Touch, Anlong Svay and Krala Peas, and to the Ministry of Environment (MoE) authorities in particular: Mr. Sreng Cheaheng, Deputy Director of the Department of Environment of Stung Treng Province, Mr. Nen Pisey, Director of STRS and local MoE Rangers for their technical support and participation. We would also like to thank community participants for providing their valuable time and local knowledge.

We are also grateful to Mr. Pin Kakada (Wonders of the Mekong Project), Ms. Ny Naiky (NatureLife Cambodia / BirdLife International), and Ms. Nicole Leroux (Wildlife Alliance) who provided expert species knowledge. Finally, we would like to acknowledge the financial support from the International Climate Initiative (IKI) of the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) for Mekong WET.

EXECUTIVE SUMMARY

The “Middle stretches of the Mekong River north of Stung Treng” or “Stung Treng Ramsar Site” (STRS) was designated in 1999 in recognition of its unique diversity of wetland habitats, encompassing wide stretches of braided river, deep pools, a mosaic of forested channel islands, rocky outcrops, sandbars and flooded forests. STRS extends approximately 40km between Stung Treng town and the Lao PDR border and the total area of the site is estimated at 14,600ha. (Sunleang, 2012). The site harbors one of the least disturbed stretches of large river ecosystems in Southeast Asia (Timmins, 2006) and is considered one of the most valuable riverine wetlands for biodiversity conservation in Indochina, as well as one of the most important protected wetlands in the Mekong river system. In 2022, the Ministry of Environment announced plans to submit the area extending from the Lao PDR border (including STRS) to Kratie town, covering approximately 200km along the Mekong river, to UNESCO as Cambodia’s first Natural World Heritage Site.

Climate in Stung Treng is driven by the seasonal monsoon cycle: the dry season extends from November to April when the northeast monsoon winds are dry and cold; and the rainy season from May to October is characterized by the influence of the southwest monsoon (Bezuijen *et al.,* 2008). In recent years, onset of wet season has become unpredictable with late dry seasons between 2014 and 2016 and early rains in 2017 and 2018. Temperature anomalies and intense rainfall anomalies, swinging between unusually wet and unusually dry have been registered in recent years the entire Lower Mekong Basin (LMB) (MRC, 2022). Climate change, El Nino events and the impact of water storage on the flow of the Mekong are reported to have caused the intense drought experienced in the LMB in recent years (MRC, 2022 and references therein).

Due to seasonal variations in water flow both along the Mekong River and the Stung Treng Basin and its tributaries, in dry season STRS water levels drop drastically reaching a minimum level of 2 meters, and in wet season water levels increase by 10-12 meters. In dry season, deep pools and large tributaries, such as the O'Talash River, are essential for fish spawning and play a significant role as nursery grounds for juveniles. Water levels measured at Stung Treng show delayed peaks of reduced duration in 2018, 2019, 2020 and 2021. Dry season water levels, however, were higher than the historical and 2008-2017 averages, indicating that upstream dams are releasing water during dry periods (MRC, 2022).

STRS aquatic habitats include deep pools which are critical to hundreds of species of migrating fish, and beaches and sandbars only exposed in dry season providing vital nesting sites for birds and rare reptiles. In STRS, there is a unique type of flooded forest not found anywhere else along the Mekong, where flood resistant and fig trees often intertwine showing current swept semi-aerial roots, providing abundant resources for birds and fish, and creating the landscape that is distinctive of the site. Terrestrial habitats in STRS are found on islands and river banks and mainly represent mixed deciduous forests. Island and river bank slopes descending into the the river (or strand areas) also harbor a characteristic forest type adapted to withstand seasonal inundation.

The site’s aquatic habitats, critical for inordinate amounts of biodiversity, are completely dependent on the seasonal fluctuations of river water levels. Currently, the most severe impacts these habitats are suffering stem from the operation of dams upstream, gravely disrupting natural flooding patterns. Reduced flooding in the wet season diminishes the seasonal area of wetland habitats, and water releases during the dry season disrupt the natural dynamics of flooded forests, which has resulted in mass death of trees throughout the site (Baird, 2007; 2022). Terrestrial habitats, on the other hand, are also disturbed and degraded by agricultural encroachment, illegal logging and forest fires.

STRS provides vital habitats for a variety of key species, particularly migrant white fish and megafish, such as Critically Endangered giant barb (*Catlocarpio siamensis*). The site is also essential for many bird species, particularly regional endemic Mekong wagtail (*Motacilla samveasnae*). Irrawaddy dolphins (*Orcaella brevirostris*) of the Critically Endangered Mekong subpopulation used to occupy the transboundary deep pools north of STRS and were the most significant flagship species of the area, and the focus of local conservation and ecoturism activities. However, the group was decimated by illegal fishing over four decades, and construction and operation of the Don Sahong dam between 2019 and 2021 is suggested to have contributed to the death of the last few.

In February 2022, the last dolphin in the area was found dead. In the past, Irrawaddy dolphins traveled along the Mekong River and its tributaries when water levels were highest in the wet season (Baird and Mounsouphom, 1994). If protection and conservation measures for the remaining dolphin population along the entire stretch of the Mekong River between Kratie and the Lao PDR border were to radically improve in effectiveness, there is a possibility that the dolphins might return and perhaps settle again in the STRS area. Siamese crocodiles (*Crocodylus siamensis*) are locally extinct, however the site is still important for many threatened reptiles such as Critically Endangered giant softshell turtle (*Pelochelys cantorii*). Poaching, particularly using snares, guns and bird nets, was documented throughout the site and is the most severe threat to all vertebrate species.

Over 15,000 people live in the 20 villages located within STRS as of 2021 (STRS MoE Site Manager pers. comm.). Fishing used to be the main occupation and source of income in the past (e.g. Allen *et al.,* 2008) and is still important for local communities living on islands, however, during the current assessment, Community Fisheries (CFi) members reported that fish catch has declined dramatically in recent years and many fishers have abandoned the practice entirely. Farming rice, oranges, sesame and other crops, as well as keeping livestock currently sustains most households. In addition, non-timber forest products (NTFPs), particularly several species of mushrooms collected within the wetland forests are also a significant source of income. Some local community members reported that [illegal] logging, as well as production of wooden furniture, and use of timber for construction are also important sources of local income. Several communities throughout the site have Community-based Ecoturism (CBET) groups which organize activities, and provide food and accommodation in local “homestays”. CBET activities in and around STRS provide important additional incomes and help promote conservation values.

In recent years, Stung Treng has already experienced unprecedented fluctuation in temperatures, with annual maximum and minimum both becoming more extreme. Climate change projections to 2059 indicate that temperatures may rise between 1 and 3ºC, dependent on different scenarios. Precipitation projections present a high degree of uncertainty, and contemplate the possibility of increases of 100-150mm or reductions of 50-100mm per month in the wet season.

Both aquatic and terrestrial habitats in STRS are highly vulnerable to climate change impacts. Aquatic habitats are vulnerable due to their high specialization and dependence on hydrology and environmental conditions, while terrestrial habitats are already altered and degraded, making them increasingly vulnerable to climate change. Among key species, flagship megafish and regional endemic Mekong wagtail are highly vulnerable to climate change impacts. Climate change will exacerbate the impact of other anthropogenic threats to the site and could potentially push its habitats beyond ecological tipping points. The most pressing threats to habitats and species however, stem from dam operations upstream severely altering hydrology, and on-going intense illegal fishing, logging and poaching.

Local communities reported to have experienced drought, extreme storms and winds, and extremely high and low temperatures in recent years. These impacts have resulted in damages to homes, crops and in some cases, have affected the health of people and livestock, as well as hindering income generation. Adaptation and coping mechanisms reported by local communities hinge on ensuring safety, developing early warning systems and generating additional income. Increasing technical capacity and services of Community-based Ecotourism committees (CBETs) may provide good opportunities for increased local income generation connected to conservation objectives. Sustainable financing should ensure good living standards for local communities to minimize illegal activities and promote development of diversified livelihood opportunities, including tasks directly connected with conservation and restoration of habitats.

During 2022, the high number of deaths of Irrawaddy dolphins, the rescue and increasing concern over rare megafish, and the mass death of flooded forests trees in STRS due to dam releases have received considerable global and regional media attention due to the dire situation they face. These exceptional species and habitats, iconic of the Cambodian Mekong are under intense pressure from illegal activities and suffering extreme alterations of the life-giving water flow from upstream dams.

In January 2023, the Cambodian Prime Minister highlighted the urgent need to protect the Mekong dolphins and megafish, as well as their unique riverine habitats, establish no-take zones and energetically tackle illegal fishing, which perhaps the UNESCO World Heritage recognition may help accomplish. Conclusions of the current assessment show that only highly effective implementation of these actions, and more crucially, international cooperation for wise management of the Mekong River water flow, will ensure the survival of the STRS wetlands and biodiversity in the short term, considering that climate change will intensify impacts and further push ecological thresholds closer to their tipping points in the medium to long term.

1. GENERAL INFORMATION

1.1 Building resilience of wetlands to climate change in the Lower Mekong Region

Wetland areas, which refers to marshes, rivers, mangrove, coral reefs, and other coastal and inland habitats, play many important roles within ecosystems. Wetlands provide clean water, water flow regulation, carbon storage and perform as natural buffer against erosion, floods, landslides as well as storms and other extreme weather events. The Lower Mekong Basin (LMB) spans over a total area of 606,000 km^2, and covers four countries, Cambodia, Lao PDR, Thailand and Viet Nam, with more than 60 million inhabitants. The Lower Mekong Basin region harbors rich natural resources, particularly forests, rivers, and wetlands which support the livelihoods of millions of people who directly depend on natural resources. However, wetland area is decreasing and losing ecosystem functions due to human activities including population pressure, infrastructure development, agricultural intensification, deforestation, overexploitation and mismanagement. Climate change is set to intensify impacts on habitats, species and livelihoods.

"Mekong WET: Building Resilience of Wetlands in the Lower Mekong Region"[1] (2017-2022) aims to build climate resilience by harnessing the benefits of wetlands in Cambodia, Lao PDR, Thailand, and Viet Nam. The project is funded by the International Climate Initiative (IKI) of the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB). Mekong WET will help the four countries to address their commitments to the Ramsar Convention, an international treaty for the conservation and sustainable use of wetlands, and to achieve the Aichi Biodiversity Targets. Through its focus on wetland ecosystems, the project also supports governments in implementing National Biodiversity Strategies and Action Plans (NSBSAPs) under the Convention of Biological Diversity and pursuing their commitments on climate change adaptation and mitigation under the United Nations Framework on Climate Change.

Vulnerability Assessments (VAs) were conducted in eleven Ramsar sites/wetland sites in the four LMB countries as the first step of a participatory adaptation planning process. The approach combined scientific assessments with participatory appraisals and dialogues with communities living at the sites and the authorities in charge of site management. For Cambodia, five sites were selected: Koh Kapik Ramsar Site in Koh Kong Province (KKRS), Boeung Prek Lapouv Protected Landscape situated in Takeo Province (BPL), Boeung Tonle Chhmar Ramsar Site (BTCRS) and Stung Sen Ramsar Site (SSRS), located in Kampong Thom Province and Stung Treng Ramsar Site (STRS) in Stung Treng Province. This report presents the results of the vulnerability assessment for Stung Treng Ramsar Site.

1.2 Objectives and setup of the study

The main objectives of the assessment were:

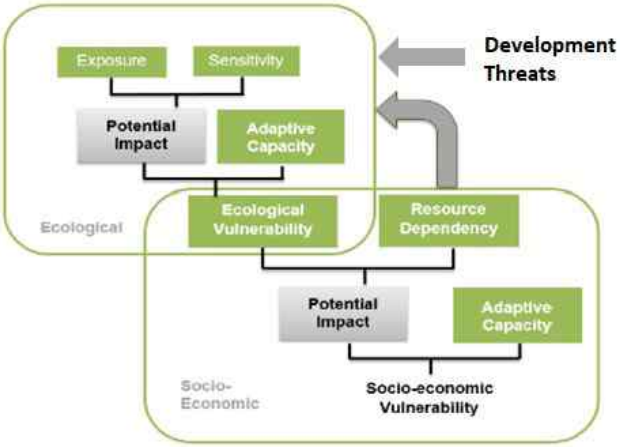
- To determine the vulnerability of ecosystems and livelihoods to the impacts of climate change.
- To identify options to address vulnerabilities and improve the resilience of wetlands and livelihoods to the impacts of climate change.

The assessment was carried out through two components: A description of the current situation and available knowledge of the wetland, and an assessment of climate change vulnerability of wetland habitats, species and livelihoods using the tools and methodologies developed by IUCN (IUCN, 2017) using a socio-ecological framework (Box 1). Livelihood vulnerability was assessed using the Village VA tool through a consultative process with key informants and local community members. The Habitat and Species VA tools were completed in consultation with experts as well as through primary research conducted by the STRS VA team including a camera-trap survey, a questionnaire on presence and threats to mammal species in STRS, and evaluation of habitats using remote sensing and ground-truthing. Finally, draft VA recommendations were validated through workshops run by members of a local Community Protected Area (CPA) group.

[1] See https://www.iucn.org/regions/asia/our-work/regional-projects/mekong-wet

Box 1: Conceptual framework Vulnerability Assessment (after Marshall, 2009; GIZ/ISPONRE/ICEM, 2016)

According to the Intergovernmental Panel on Climate Change (IPCC, 2007), **vulnerability** is defined as the degree to which something (a species, an ecosystem or habitat, a group of people, etc.) is susceptible to, or unable to cope with, the adverse effects of climate change, including climate variability and extremes. Vulnerability is further explained as a function of the character, magnitude, and rate of climate variation to which a system/species is exposed, the system/species' sensitivity, and the system/species' adaptive capacity.



Exposure is defined as the extent to which a region, resource or community experiences changes in climate. It is characterized by the magnitude, frequency, duration and/or spatial extent of a weather event or pattern.

Sensitivity is defined as the degree to which a system is affected by climate changes.

Together, exposure and sensitivity describe the **potential impact** of a climate event or change. This interaction of exposure and sensitivity is moderated by **adaptive capacity**, which refers to the ability of the system to change in a way that makes it better equipped to manage its exposure and/or sensitivity to a threat.

Within the context of Mekong WET, which is focused on wetlands, the **ecological system** consists of two elements: species and habitats. The **socio-economic system** refers to the socio-economic vulnerability (e.g., livelihoods etc.) of the villages or communities that are dependent on resources derived from the wetlands. Socio-economic and ecological information collected during the assessments evaluates how the ecological and socio-economic system interact to determine the overall potential climate change impact.

2. SITUATIONAL ANALYSIS

2. SITUATIONAL ANALYSIS

2.1 Description of the wetland

2.1.1 Location and site description

Stung Treng Ramsar Site is one of Cambodia's five protected wetland conservation areas and was designated as a Ramsar site in 1999 (Sunleang, 2012). It is considered one of the most valuable riverine wetlands for biodiversity conservation in Indochina as well as one of the most important protected wetlands in the Mekong River system. Only the Tonle Sap Biosphere Reserve surpasses it in size (Timmins, 2006 in Allen *et al.*, 2008). The site hosts more than 50 species of socioeconomically important fish and plays a major role in the migration of a multitude of species that migrate to the area to spawn and greatly contribute to the Tonle Sap fishery (Sunleang, 2012).

The Ramsar Site encompasses approximately 37 km of the Lower Mekong River Basin and the total area of the Site is estimated at 14,600 hectares (Sunleang, 2012). Located in north Cambodia, its northern boundary is approximately 3 km from the Lao PDR border, while the southern one is approximately 4 km from Stung Treng town (Allen *et al.,* 2008) (Fig. 1). Here, the Mekong River meets the Se Kong River which has two additional tributaries: Se San and Sre Pok. As a result of this confluence, vast natural resources are created, as well as a unique river ecosystem from Kratie City to Stung Treng, extending to the Cambodian-Lao border (Cuasay & Vaddhanaphuti, 2005; Sunleang, 2012).

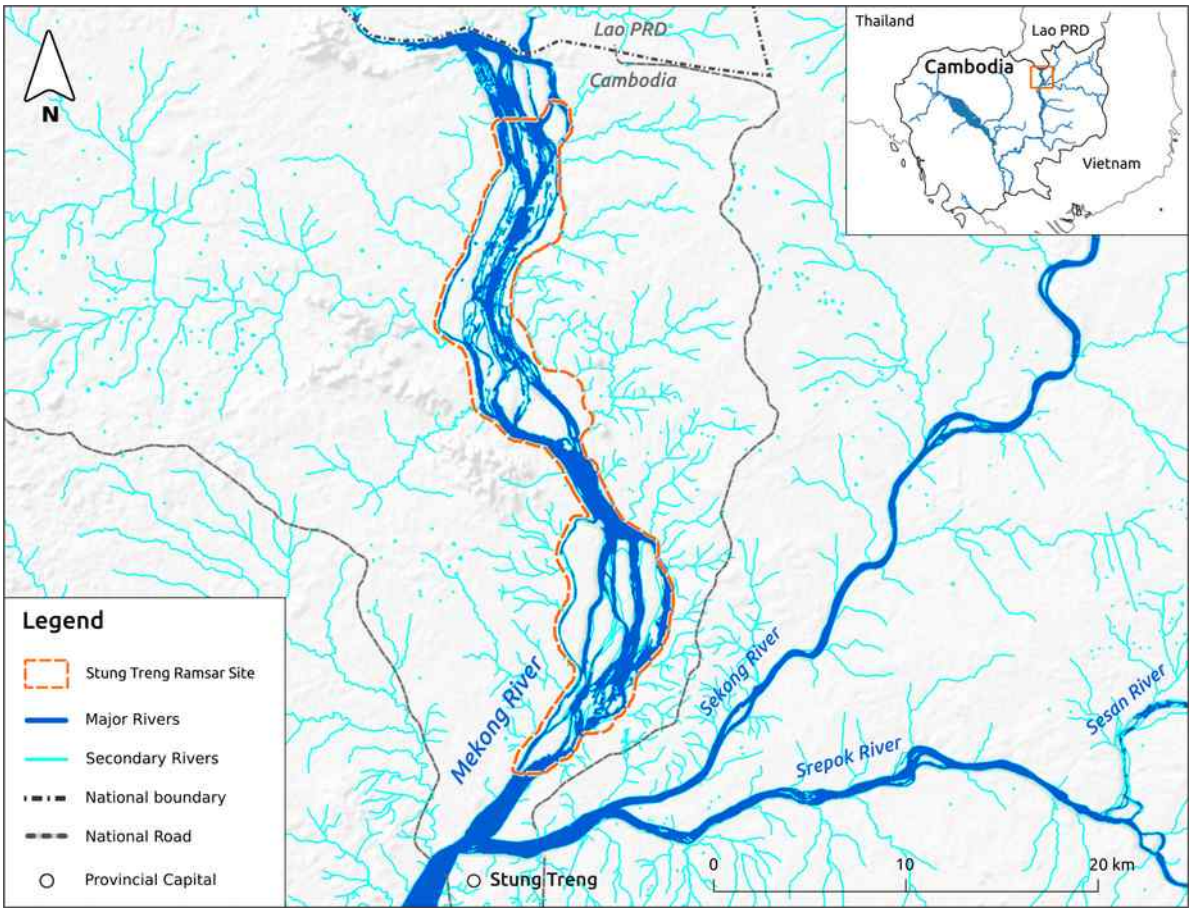


Figure 1. Stung Treng Ramsar Site location, rivers and national boundary.

The Ramsar Site is divided into two sections, separated by a single, wide, open waterway. Along the riverbanks, water flows into braided channels flowing among large islands, seasonal islets, sandbars and rocky outcrops. Some parts of the main channel have a width of up to 1 km, whereas others have nearly 4 km, if the large islands and secondary channels are included (ICEM, 2013).

Due to its diverse topography, the site has a unique diversity of wetlands. There is a mean elevation of 50 m with a variation of at least 10 m in elevation throughout the site (Allen *et al.*, 2008). In the upper area of the site, the river bed is shallow with several stretches of rapids. A mosaic of islands, channels, rocky outcrops, sandbars, mudflats, and seasonally inundated vegetation can be found here. In the lower part, the scattered rocky islets are covered with a distinct shrubby vegetation type and the flow of water is relatively slower. In this area, there are also pools up to 70 m deep, which represent a vital refuge for numerous fish species during the dry season (Sunleang, 2012).

In Stung Treng Ramsar Site, flooded forests and numerous islands with different types of vegetation provide habitat to a large number of local bird species. The channels flowing and surrounding the islands to join the main waterway, represent a vital refuge and food source for numerous species of fish (Sunleang, 2012). Long established villages are situated on some of the larger islands, mainly on the northern and southern stretches, and scattered settlements are found throughout the site on islands, islets and riverbanks (Fig. 2).

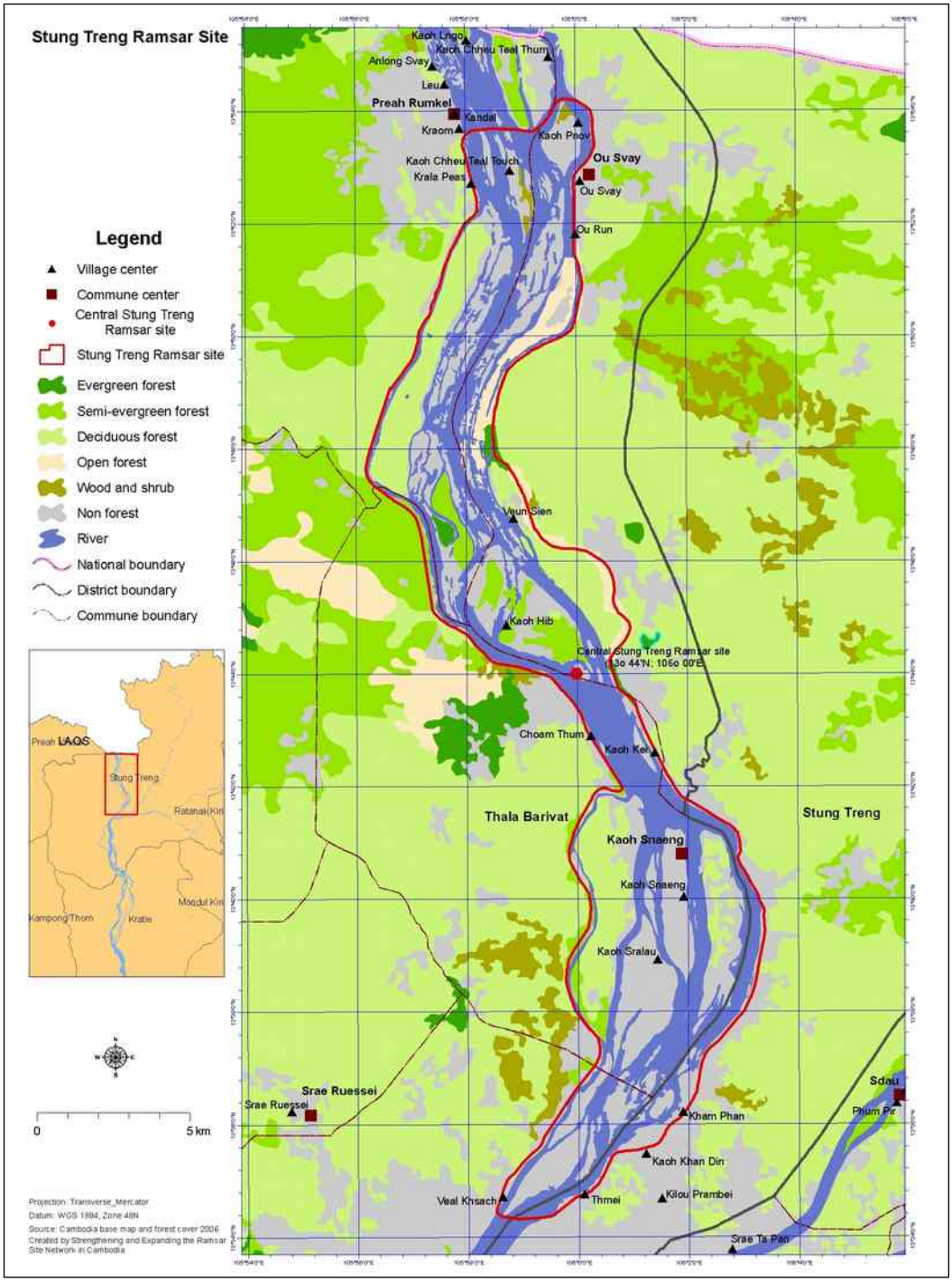


Figure 2: Map of Stung Treng Ramsar Site (source: Ramsar).

2.1.2 Current and historic climate

Stung Treng's climate is dominated by a pronounced seasonal monsoon cycle, with a dry season from November to April, when the northeast monsoon winds are dry and cold, followed by a rainy season from May to October characterized by the influence of the southwest monsoon (Bezuijen *et al*., 2008). On average, more than 75% of the region's annual rainfall can be attributed to the rainy season, from June to September (Fig.3a) (Fan & Luo, 2019). The mean annual precipitation in Stung Treng is about 1900 mm (ICEM, 2013), nevertheless, monsoon fluctuations, as well as the El Niño and La Niña phenomenon, profoundly impact rainfall distribution spatially and temporally, leading to high interannual variations, ranging from 1441.3mm (1996) to 2600.2mm (2000) or 2148.2mm (2016) (Try & Chambers, 2006; Sunleang, 2012; Ministry of Industry, Science, Technology and Innovation, 2021).

The mean monthly precipitation in the rainy season from 1920 to 2000 was 313 mm, taking only the data from June to September (ICEM, 2013). Throughout the year, monthly maximum peaks occurred in August and September, and minimum records in January and February (Fig.3b).

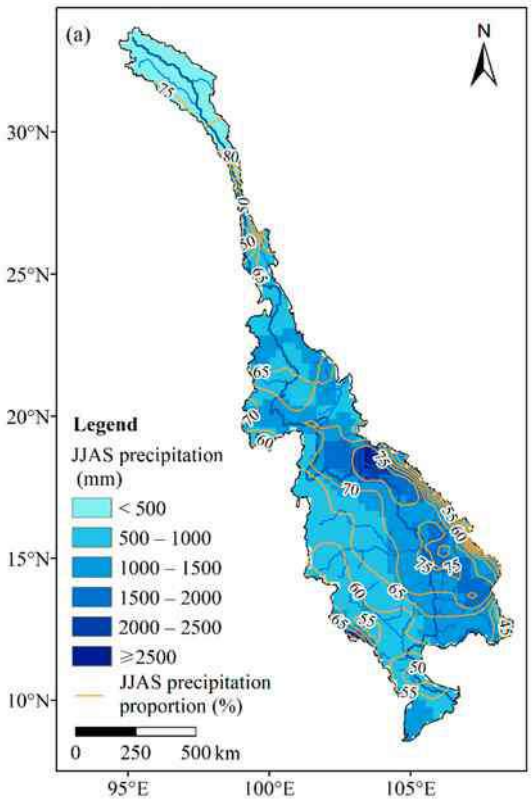


Figure 3a. Spatial distribution and proportion of precipitation during June, July, August and September in Lancang–Mekong River Basin, (source: Fan & Luo, 2019).

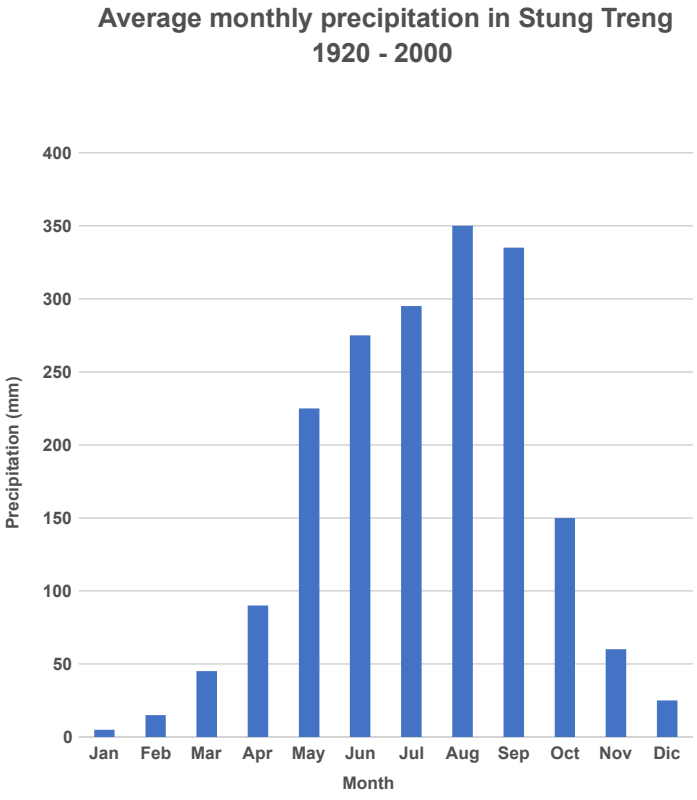


Figure 3b. Average monthly precipitation from 1920 to 2000 in Stung Treng. Average precipitation from June to September is 313mm (data source: ICEM, 2013).

As described above, rainfall occurring between the months of June and September accounts for 75% of the annual total (Fan & Luo, 2019). Consequently, only the annual averages obtained during these months are shown for the analysis of precipitation of the last decade (2000-2021). Figure 4 shows that these averages have minimum values in the years 2007, 2009, and 2010. During these years in the months of June and July the minimum values of the last two decades were recorded (33mm, 48mm, and 99mm during June; and in July 68mm, 149mm, and 173mm).

On the other hand, the maximum averages were observed in 2011, 2013, and 2014, with peaks occurring during July (526 mm in 2013 and 683 mm in 2014). Considering the whole data set, the average annual precipitation during the months of greater rainfall from 2015 fall below 300 mm, which reveals an important decrease compared to the average peak rainfall between 1920 and 2000. In the last two decades, the pattern of precipitation during these months has been markedly uneven, which makes it difficult to predict or plan actions in case of possible catastrophes such as unexpected floods from one year to another.

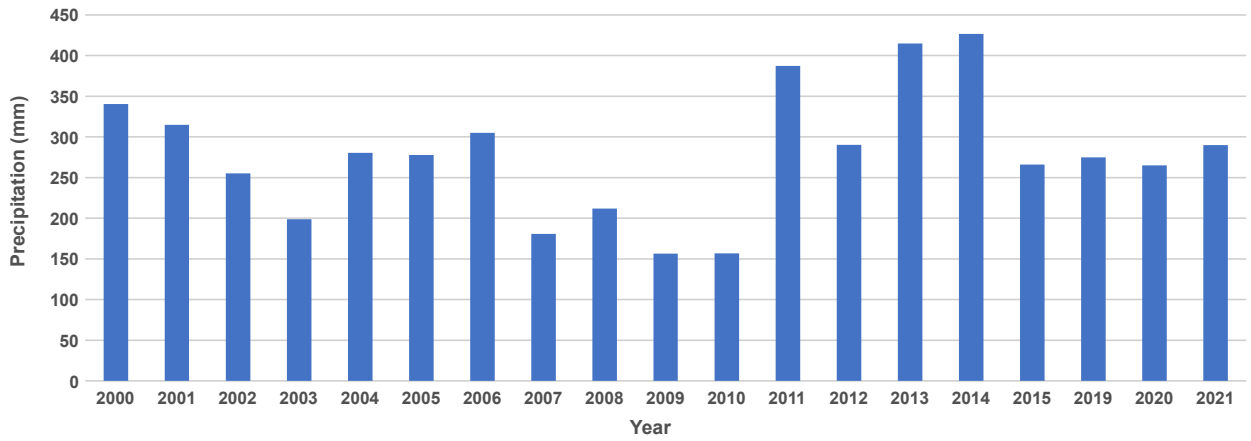


Figure 4. Average annual precipitation in rainy season (June, July, August and September) from 2000 to 2015 (data: MRC, 2016) and 2019, 2020 and 2021 (data: MRC, 2022) in Stung Treng (compiled by authors).

In recent years, the onset of the wet season has become unpredictable with late dry seasons between 2014 and 2016 and early rains in 2017 and 2018. Intense rainfall anomalies, swinging between unusually wet and unusually dry have been registered in recent years during the month of July in the entire LMB (MRC, 2022)(Figure 5.)

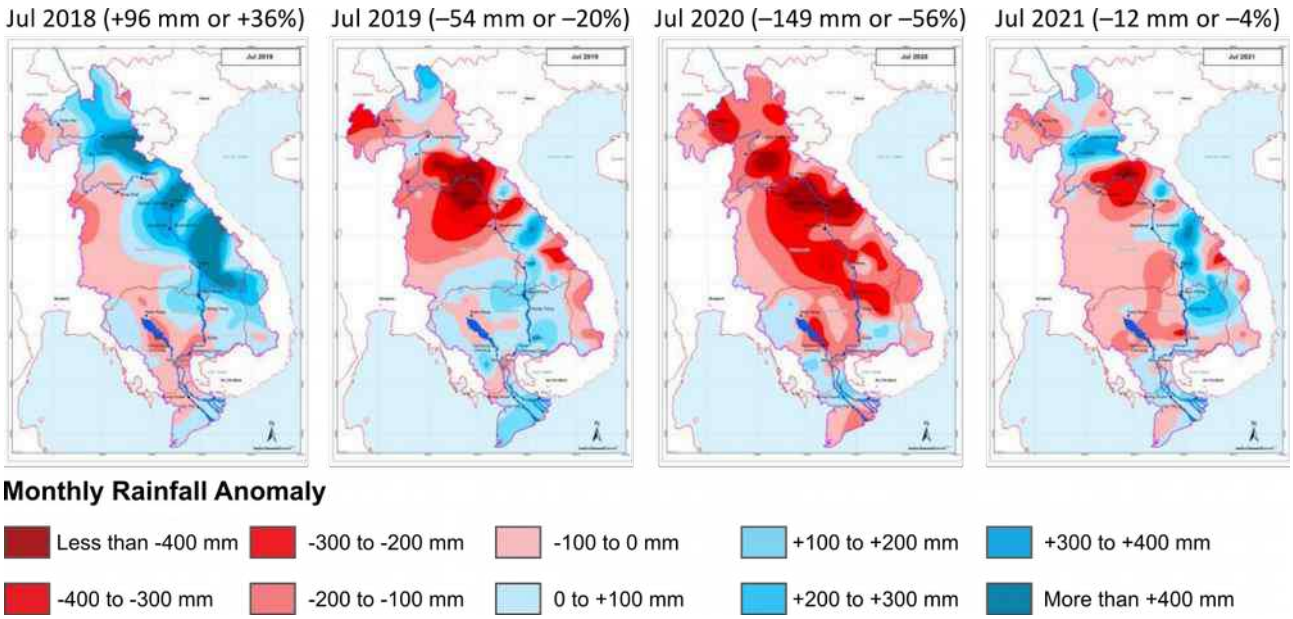


Figure 5. Monthly rainfall anomaly in the LMB in July 2018, 2019, 2020 and 2021. Amount of rainfall in mm and ratio in % (source: MRC, 2022)

Historically, maximum temperatures in Stung Treng peak in March, April and May, whereas November, December and January are the coldest months (Ministry of Industry, Science, Technology and Innovation, 2021) (Fig 6). Average annual temperatures in Stung Treng from 1990 to 2011 ranged between 26.4 and 27.3°C, averaging 26.96°C. During this period, only four out of twenty-two years had an average annual temperature exceeding 27.2°C, and only in 1998, temperature surpassed 27.5°C.

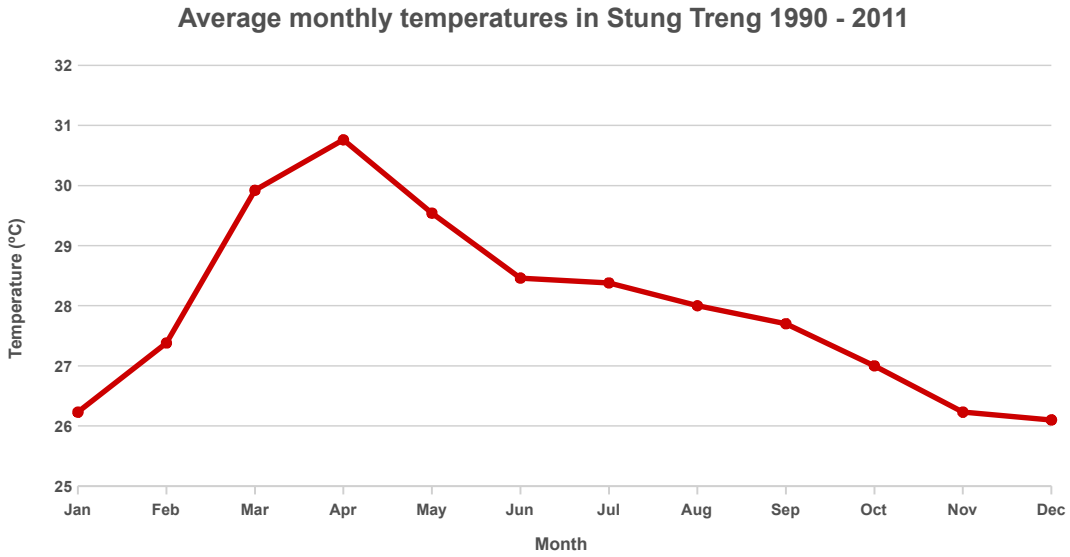


Figure 6. Average monthly temperatures between 1990 and 2011 in Stung Treng. Temperatures were recorded at the Stung Treng Province weather station (source: Ministry of Industry, Science, Technology and Innovation, 2021)

From 2012 to 2021, average annual temperatures ranged between 26.94 and 27.68°C, averaging 27.31°C. This represents an increase of 0.35°C in just ten years compared to the period from 1990 to 2011. It is important to underline that only one year between 2012 and 2021 had average temperatures below 27°C, and in four years the threshold of 27.5°C was exceeded. Figure 7 shows average annual temperatures during the last thirty years in Stung Treng.

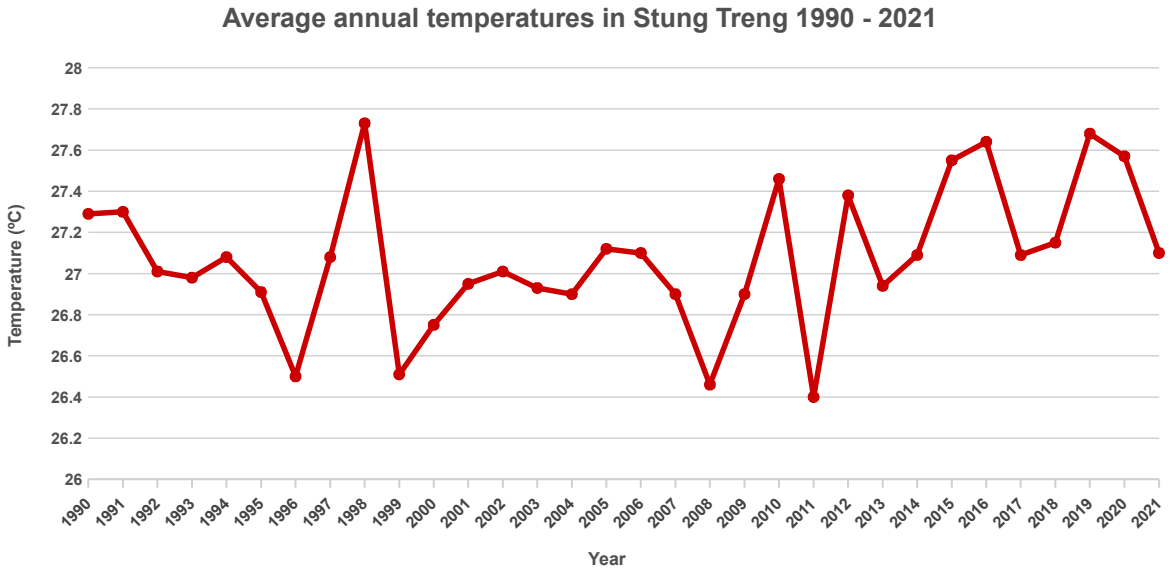


Figure 7. Average annual temperatures between 1990 and 2021 in Stung Treng Province (source: Climate Change Knowledge Portal, World Bank, 2022, https://climateknowledgeportal.worldbank.org).

The available literature states that the average maximum temperature in Stung Treng between 2003 and 2010 was 33 - 34ºC, and the minimum was 22 - 24ºC (Try & Chambers, 2006; ICEM, 2013). According to data from the Ministry of Industry, Science, Technology and Innovation, in recent years, the maximum temperatures in April and May were higher in 2015 and 2016 than in previous years, with peaks of 41 and 42ºC. These years also generally present lower minimum temperatures throughout the year, with lows between 15 and 17ºC in January and February (Figure 8). Extreme maximum and minimum temperatures have already been described in Stung Treng in the context of climate change impacts experienced in the last two decades (Try & Chambers, 2006; Bezuijen *et al.,* 2008). During the current assessment, inhabitants of Stung Treng Ramsar Site reported experiencing such extreme temperature peaks and lows in recent years. In addition, some of the predictions for the medium-long term specifically point to these changes.

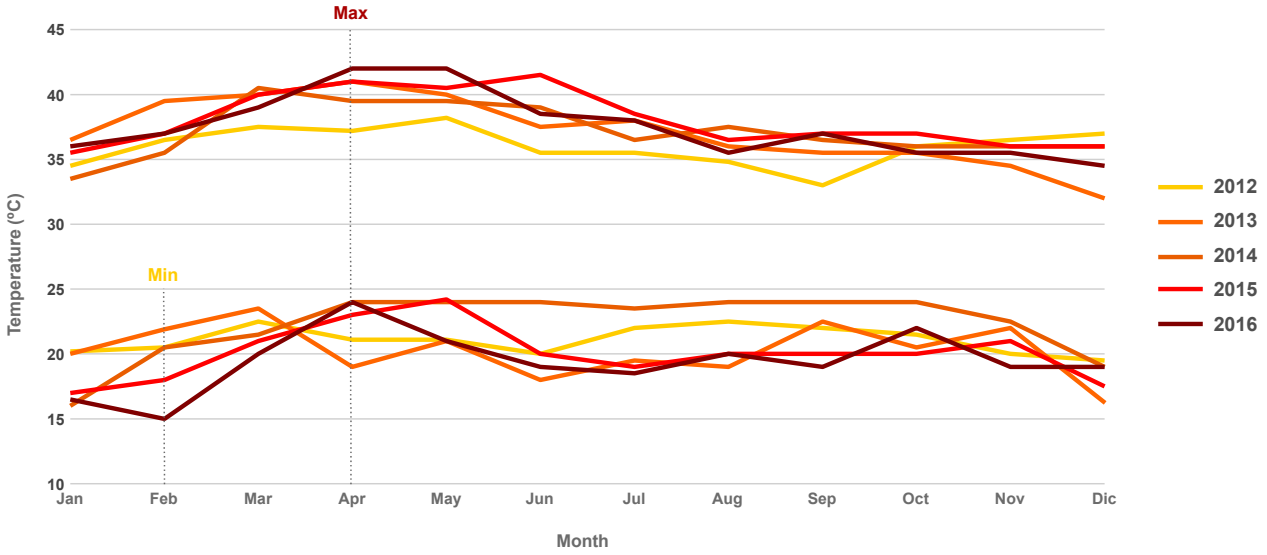


Figure 8. Monthly maximum and minimum temperatures in 2012, 2013, 2014, 2015, and 2016 in Stung Treng. Temperatures were recorded at the Stung Treng Province weather station (source: from data of Ministry of Industry, Science, Technology and Innovation, 2021).

Temperature anomalies and rainfall deficits due to climate change, *El Nino* events and the impact of water storage on the flow of the Mekong are reported to have caused the intense drought experienced in the Lower Mekong Basin (LMB) in recent years (MRC, 2022 and references therein) (Figure 9).

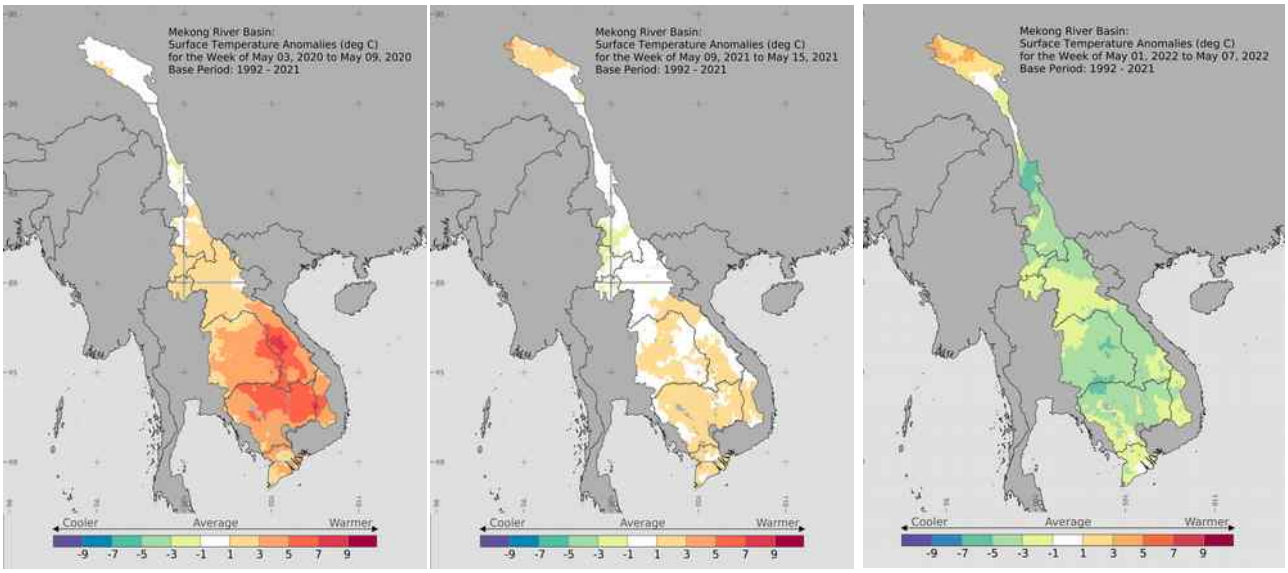


Figure 9. Temperature anomalies in the LMB in May 2020, 2021 and 2022 (Mekong Dam Monitor. Stimson Center, 2022. https://www.stimson.org/project/mekong-dam-monitor/)

2.1.3 Hydrological characteristics

The Mekong River flows into Stung Treng through the Khone Falls in Lao PDR, where the elevation drops 21m (Cuasay & Vaddhanaphuti, 2005). Near Stung Treng town and just outside the STRS boundary, the rivers Sesan, Sekong, and Sre Pork converge, contributing 22% to the flow of the Mekong (Sunleang, 2012). All four channels annually carry water into the Mekong mainstream flowing at an average rate of approximately 37,800 m^3/second (Try & Chambers, 2006).

As a result of seasonal variations in water levels both along the Mekong River and the Stung Treng Basin and its tributaries, STRS harbors unique aquatic and riverine habitats (Try & Chambers, 2006). During the dry season (November to April), water levels drop drastically reaching a minimum level of 2 meters (Fig. 10). Continuous drainage of the floodplain takes place during this time, and only the deepest pools and some channels remain. A large number of the approximately 40 small tributaries located within STRS dry up during these months. It is in this season when deep pools and the larger tributaries, such as the O'Talash River are essential for fish spawning and play a significant role as nursery grounds for juveniles (Try & Chambers, 2006; ICEM, 2013). As the monsoon arrives in May and June, the water level gradually rises, reaching its highest level between July and September. Each year, these maximum levels vary, reaching close to 12 meters (Fig. 10). In Stung Treng town, where the Mekong meets the larger tributaries and blocks their flow, river water backs up into the seasonal floodplains along the tributaries, flooding forests, wetlands, and rice fields (Cuasay & Vaddhanaphuti, 2005). Although annual flooding dominates the basin in some areas and is part of the seasonal cycle, heavy and long-lasting rains during the rainy season can exceed the capacity of the mainstream and numerous tributaries, putting the local population at risk (Fan & Luo, 2019).

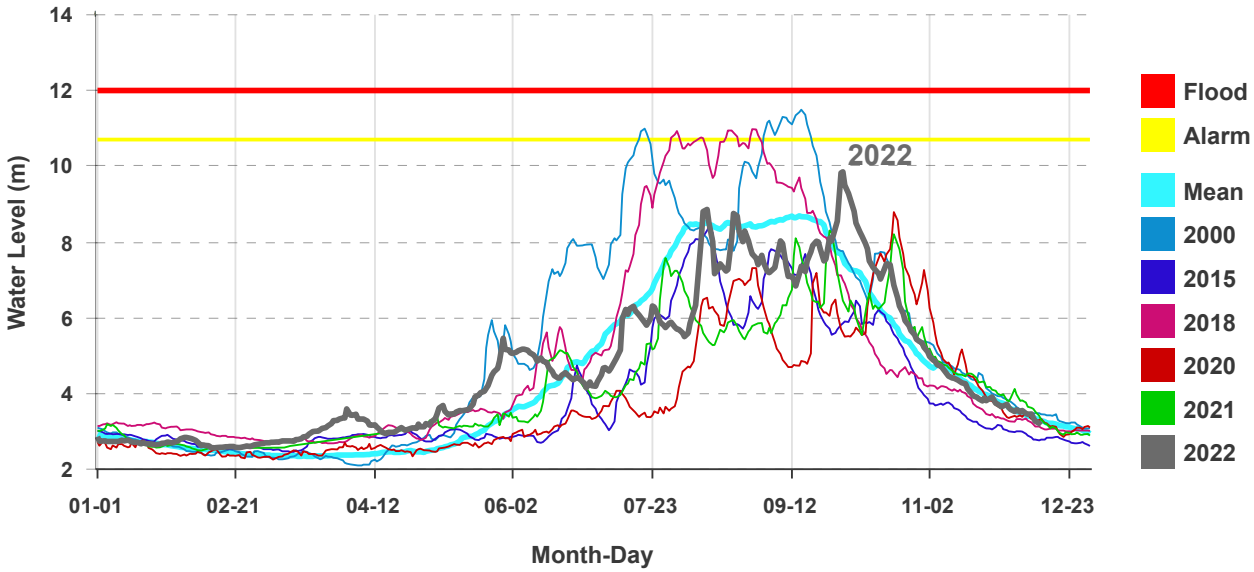


Figure 10. Water Level hydrograph of the Mekong River at Stung Treng for the years 2000, 2015, 2018, 2020, 2021 and 2022 (source: adapted from database Ministry of Water Resources and Meteorology, 2022, http://dhrw-cam.org).

In the Stung Treng basin, streamflow changes are influenced by three factors: anthropogenic activities, precipitation, and evapotranspiration. The latter is the least influential and is always related to a decrease in water level. The main cause of the uncertainty in hydrological processes and water resources is the spatial and temporal distribution of precipitation (Fan & Luo, 2019). As described above, the southwest monsoon rules the wet season (Bezuijen *et al.*, 2008). However, it is important to note that Stung Treng is also largely influenced by the Western North Pacific Summer Monsoon (WNPSM).

Figure 11 shows how the intensity of this climatic event has a high impact on the flow at Stung Treng, the sub-basin most affected by this monsoon of the six within the Lacang-Mekong River Basin (as partitioned according to the locations of six hydrological stations by Fan & Luo, 2019). Its consequences are positive flow variations up to 12.1%, and negative flow variations of 19.5% in strong and weak monsoon years respectively. These data are especially important given that climate change may alter the behavior of this monsoon events, increasing the uncertainty in flow level fluctuations.

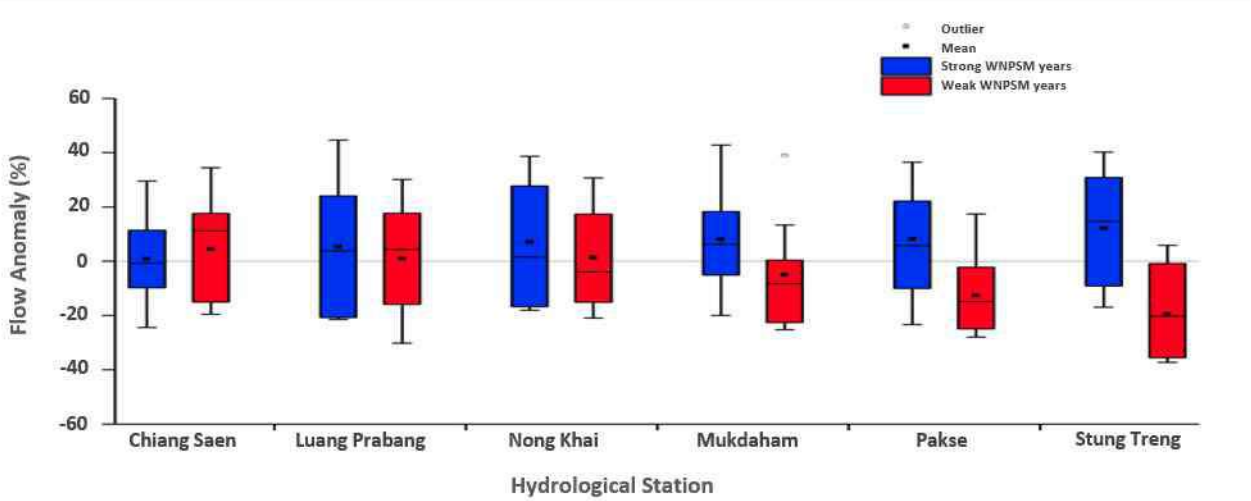


Figure 11 Flow anomalies associated with WNPSM during June, July, August and September at six hydrological stations. Time series at Chiang Saen, Luang Prabang and Nong Khai stations are 1970–2012, and those at Mukdahan, Pakse and Stung Treng stations are 1951–2015 (source: Fan & Luo, 2019).

During the 1970s and 1980s anthropogenic activities had a greater impact on the annual fluctuations of the streamflow levels than precipitation (Fig. 12a). This influence significantly decreased in the 1990s and 2000s. However, the contribution of anthropogenic activities to the mean annual streamflow change at Stung Treng in the 2010's is nearly 100%. This tendency is dominant in the recent period over all six sub-basins of the Mekong River, and is especially significant in the downstream sub-basins (Pakse and Stung Treng) (Fig. 12b) (Tang & Wang, 2020). A large part of this human influence can be attributed to the development of hydropower projects in the Upper and Lower Mekong Basins, as well as nearby tributaries, such as the Sesan River dam, which lies 25 kilometers from the Mekong's mainstream in Stung Treng (Sunleang, 2012). The development of dams for the generation of hydroelectric power and irrigation is now becoming a major issue in Cambodia and surrounding countries in the Lower Mekong, threatening major changes to the hydrological regime of the Mekong (Allen *et al.,* 2008).

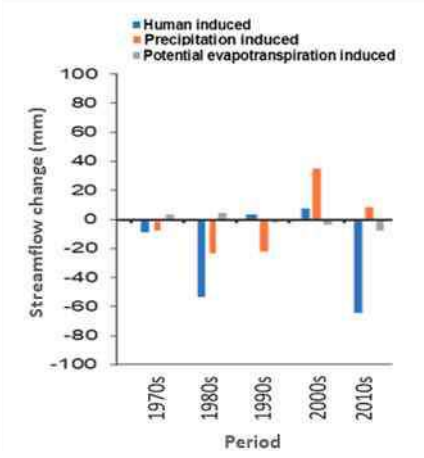


Figure 12a. The changes in streamflow in the Stung Treng sub-basin induced by precipitation, evapotranspiration and human (source: adapted from Tang & Wang, 2020).

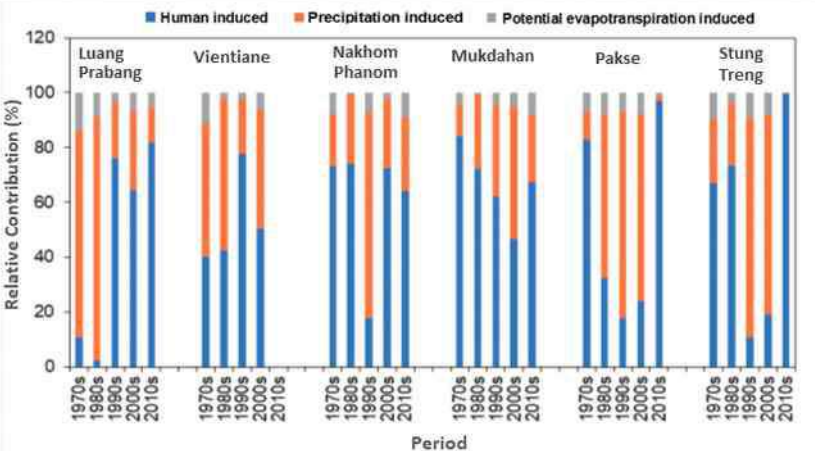


Figure 12b. Relative contributions to the mean annual streamflow change of anthropogenic activities, precipitation and potential evapotranspiration (source: Tang & Wang, 2020).

In recent years, water infrastructure operations had a significant impact of the flow of the Mekong River at Stung Treng, with the total volume of wet season flow at the site being considerably reduced in discharge and duration in 2019, 2020 and 2021. Wet season flow "deficits" compared to the average 2008 – 2017 were measured in the downstream LMB all three years, indicating that tributary in-flows were also lower than normal. For instance, over the 2019 wet season, the deficit at Stung Treng was 90.8km^3, and the pattern of deficits continued in 2020 and 2021 (Figure 13a) (MRC, 2022).

Water levels measured at Stung Treng show delayed peaks of reduced duration in 2018, 2019, 2020 and 2021. Dry season water levels, however, were higher than the historical and 2008 – 2017 averages, indicating that upstream dams are releasing water during dry periods (Figure 13b) (MRC, 2022).

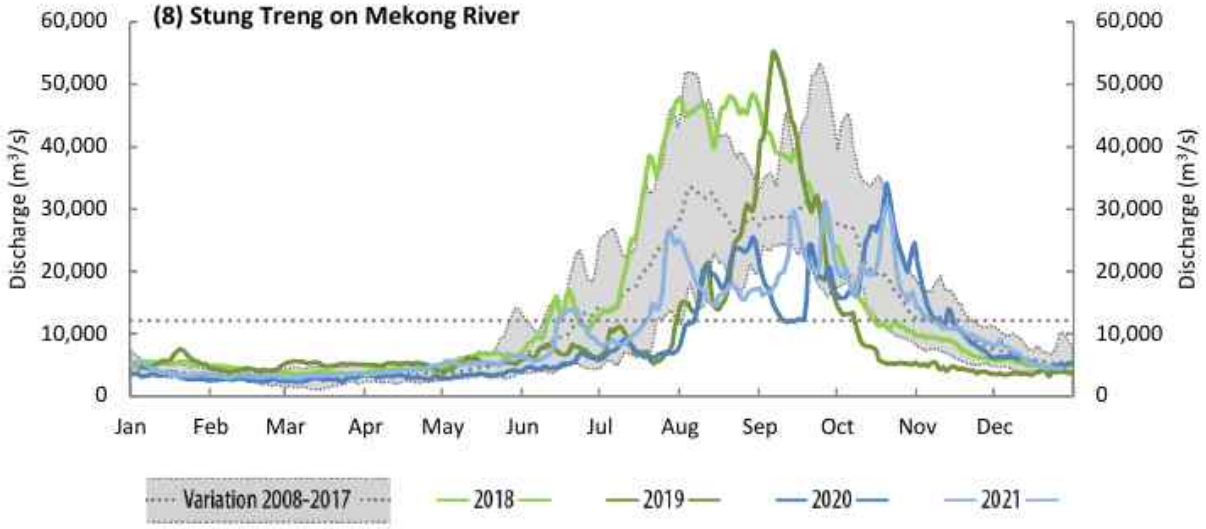


Figure 13a. Discharge of the Mekong mainstream at Stung Treng in 2018 – 2021, compared to conditions 2008 – 2017 (source: MRC, 2022).

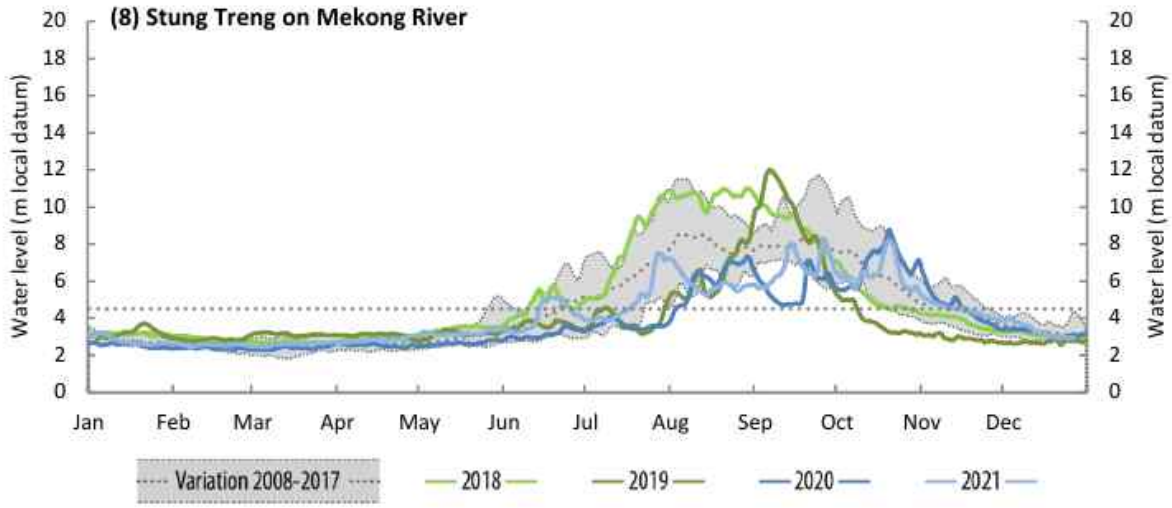


Figure 13b. Water level of the Mekong mainstream at Stung Treng in 2018 – 2021, compared to conditions 2008 – 2017 (source: MRC, 2022).

2.1.4 Wetland habitats

As a part of a biological survey conducted on the Mekong River in Stung Treng and Kratie provinces between 2006 and 2007, 683 species of vascular plants, as well as seven bryophytes were recorded from the highly diverse habitats found along the river. During this survey one new species was described and 23 new records for Cambodia were registered. The survey report includes an extensive annex with details of all records documented (Bezuijen *et al.*, 2008).

In STRS, there are two main ecosystem complexes comprising a variety of habitats along the river: the riverine zone, including aquatic habitats, flooded forests and seasonally inundated habitats below the river flood level; and the terrestrial zone, situated on islands and along river banks above the flood level. These zones are connected by steep riverbanks with specialized vegetation or "strand" areas (Figure 14).

Figure 14: Cross-section of the Mekong River at STRS from the mainstream (left) to the river banks (right) showing low water level (LW), high water level (HW), characteristic habitats and biodiversity information. Habitat and vegetation types adapted from Bezuijen *et al.* (2008). **Below**: Open water habitat leading to channel woodlands in STRS.

Riverine Zone

In STRS, the seasonal change of water level is quite significant (over 10 m), and this is reflected in the high diversity of habitats with specialized vegetation types found throughout the area. Several vegetation zones have been recognized by researchers along the gradient between the river mainstream and the lateral river banks. Some of these habitats are completely submerged during the wet season and appear only in the dry season between February and May. The bedrock and sandy river floor play important structural roles for this ecosystem, allowing for the establishment of riverine vegetation and the formation of the dry season, low water level seasonal habitats that are critical to many fish species as breeding grounds (Bezuijen *et al.*, 2008).

Deep pools and aquatic habitats

Deep pools in STRS (Figure 15) reach over 80m in depth and are remarkably important for the hundreds of migratory fish species traveling through the site every year, as well as for the Critically Endagered Mekong population of Irrawaddy dolphins (*Orcaella brevirotris*). River depth decreases sharply beyond the mainstream deep pools and in the aquatic habitats that get exposed first when water recedes, plants present are obligate aquatic herbs, found either floating or growing attached to the rocks at bottom of the stream, and only partially emerging during the dry season. These plants require water in order to survive through their whole life cycle, and are mainly monocots with only one dicot represented, while algae were also reported but not described (Bezuijen *et al.*, 2008). These areas provide microhabitats and for fishes during their growing stages (Try & Chambers 2006; RIS, 2012).

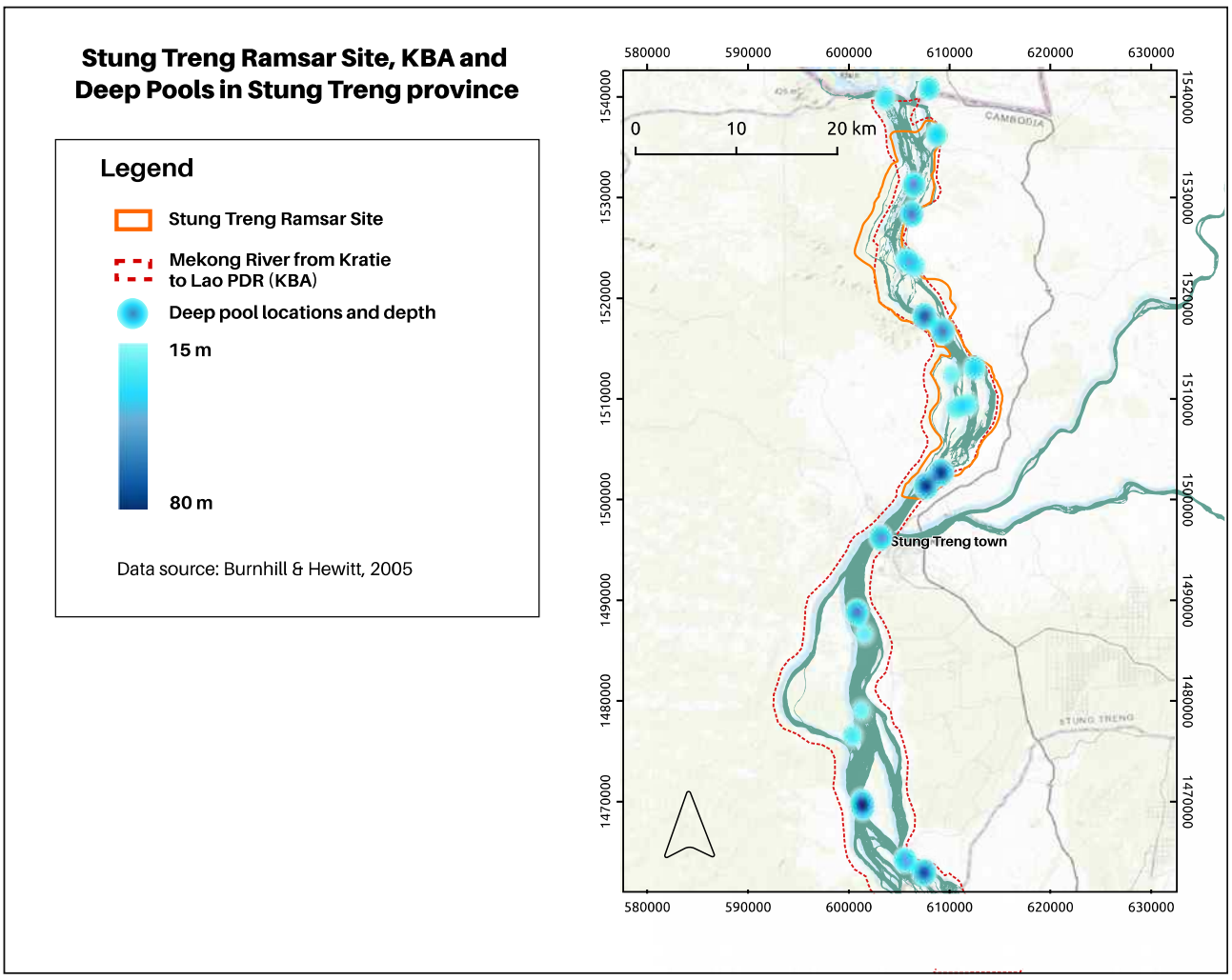


Figure 15. Location and depth of deep pools within and around STRS in Stung Treng province. Data source: Burnhill and Hewitt, 2005.

“Kai Kum” and flooded forests

In the rocky to sandy area immediately above the purely aquatic zone, water flows fast and shallow forming rapids and riffles, which act as a natural water purification system (ICEM 2014). This area is the first to get submerged and the last exposed during the annual cycle of the river. The vegetation here comprises scattered deciduous herbs and shrubs, generally lacking trees. Shrubs are all deciduous, amphibious rheophytes, mainly growing in dense clusters on rocky substrate. The contiguous zone, which is exposed for longer periods, has been labelled “Kai Kum”, the Lao name for the dominant plant *Phyllanthus jullienii*, and harbors more plant diversity and abundance. The first trees are found here and include *Barringtonia acutangula*, *Eugenia mekongensis* and occasionally *Crateva magna* (Bezuijen *et al.,* 2008). In a very unique type of flooded forests only found in Stung Treng RS (Allen *et al*., 2008), Acacia and other species host several species of ficus which provide food for birds, small mammals and fishes, mixed or alongside patches of Indian willows (*Salix tetrasperma*). These flooded forests teem with considerable flocks and colonies of small to medium birds (including mixed species colonies of parakeets and small corvids) observed during the rapid surveys conducted for the current assessment in wet season 2022.

Sand Features (Sandbar / Beach)

This habitat is characterized by open, seasonally inundated sandy areas found in isolated sandbars and beaches on islets and larger islands. Here, the bedrock is absent and soil conditions are poor, lacking enough organic nutrients for perennial vegetation to grow. Annual herb species are numerous but very sparse and include *Cleome viscosa*, *Dentella repens* and *Hedyotis pinifolia* as well as monocot grasses, especially Cyperaceae (sedges) and Gramineae (grasses). Both grasses and herbs are rooted, which contributes to protecting the river margins from erosion, and providing nesting grounds for bird species during their reproductive season (Bezuijen *et al.*, 2008).

Channel Woodlands (Acacia-Anogeissus)

This zone is dominated by two deciduous tree species commonly growing in rocky areas, *Acacia harmandiana* and *Anogeissus rivularis*. Both species reach up to 15m in height, and some individuals become partially submerged during the wet season between August and September, losing their leaves, which grow back when the water recedes. Many trees present crowns bent downstream due to the strong flow of the river, and loose logs and other organic matter dragged by the current accumulate on their branches. Roots develop thick fibrous mats in both species. This habitat is generally isolated, but occasionally appears to merge with terrestrial zones. At the merging point, often there are several woody climbing vines such as *Dalbergia volubilis*, *Paraderris elliptica*, *Derris scandens*, and *Hiptage triacantha* (Bezuijen *et al.*, 2008). In these areas, the invasive shrub *Mimosa pigra* is spreading fast and is considered to be the direct cause of decline of native flora (Tan Dang et al., 2012).

Strand

Strand areas are found on islands and riverbanks that have a pronounced slope, performing like a hill which connects the riverine zone and the terrestrial areas, receiving the floods last, and only when the water level is very high. Woody plants grow along this boundary, which has dense evergreen vegetation and high species diversity including the common creeping woody climber *Ficus heterophylla*, the shrub *Polyalthia modesta*, and the small trees *Flueggea virosa* and *Crateva magna*. Notably, some tree species are restricted to this area, for example *Homalium brevidens* and *H. caryophyllaceum*, *Pterospermum diversifolium*, *Quassia harmandiana, Crudia chrysantha, Combretum quadrangulare, Cordia dichotoma, Mallotus (Trewia) nudiflorus, Nauclea orientalis*, and *Salix tetrasperma* (Bezuijen *et al.,* 2008).

Terrestrial Zone

Several types of terrestrial forests are represented in the larger islands and river banks along the Mekong River. Island vegetation can be markedly different from the mainland, however, terrestrial forests in the area have been deeply and continuously modified by human activities over hundreds of years, and crops, invasive species, secondary growth and disturbed habitats dominate terrestrial zones. Besides terrestrial forests, islands often present grasslands and ponds ("viel" and "trapeang" in Khmer language) which provide important habitats for birds. The four basic forest types of these areas often appear merged together in the compositions described below:

Mixed evergreen and deciduous, seasonal, hardwood forest (MXF)

Most forests in the area pre-human impact would have been MXF but have been cleared or degraded into other types. MXF present more evergreen understory and ground flora than other types, while tree canopies reach up to 25m. Herb species in this terrestrial habitat include *Desmodium heterocarpon, Justicia ventricosa, Calcareoboea bonii* and *Carex indica.* Spiny shrubs and treelets such as *Polyalthia evecta and Desmos chinensis, Atalantia monophylla* (Rutaceae)*, Memecylon lilacinum, Ixora finlaysoniana* and *I. nigricans,* and *Streblus asper* complement the understory. Evergreen trees which were formerly common are now found sparsely, with main species including *Xylopia pierrei, Mammea siamensis, Acronychia pedunculata, Irvingia malayana, Lepisanthes tetraphylla, Carallia brachiate, Eugenia fruticosa* and *E. grandis, Diospyros bejaudii, Chaetocarpus castanocarpus* and *Drypetes roxburghii.* Common woody climbers are *Artabotrys hexapetalus, Celastrus paniculatus, Tetrastigma harmandii, and Dalbergia entadoides* (Bezuijen *et al*., 2008).

Bamboo with deciduous, seasonal, hardwood forest (BB/DF)

BB/DF is the most common forest type in the area. Degraded MXF areas often present in transition being replaced by rapid growth BB/DF. The bamboo component (mostly *Bambusa* species which are densely clumped and fire-resistant) can be the dominant component or entirely absent. BB/DF is generally more open and deciduous than MXF and includes much secondary growth and variation. Ground flora includes many annuals such as *Crotolaria acicularis, C. montana* and *Mecopus nidulans, Borreria brachystema and Hedyotis verticillata* (both Rubiaceae), *Lindernia ciliata* and *Torenia violacea* (both Scrophulariaceae), *Dipteracanthus repens* and *Justicia ventricosa* (both Acanthaceae) and deciduous herbs that revive during rainy season (July-September) such as: *Murdannia edulis, Halopegia brachystachys,* some gingers, *Curcuma aurantiaca, Globba schomburgkii* and *Zingiber zerumbet,* while orchids (terrestrial types) also grow during the same period. Woody climbers are deciduous and include *Uvaria hahnii, Capparis micracantha, Harrisonia perforata, Calycopteris floribunda* and *Combretum latifolium, Ziziphus cambodiana* and *Z. oenoplia*. Trees are mostly deciduous, up to 25m tall, and mainly represented by species severely exploited such as *Dipterocarpus alatus, Hopea odorata, Xylia xylocarpa, Sindora siamensis, Terminalia bellirica* and evergreen species *Irvigia malayana* (Bezuijen *et al.,* 2008).

Deciduous, Dipterocarp, Seasonal, Hardwood Forest (DDF)

Trees in DDF are almost all deciduous and generally scatered. The most abundant species are the designate *Dipterocarpaceae* family dominated by *Dipterocarpus intricatus* and *D. tuberculatus, Shorea obtusa* and *S. siamensis.* Other common trees in DDF are *Dillenia pentagyna, Bombax anceps, Berrya mollis, Buchanania glabra* and *B. lanzan, Pterocarpus macrocarpus, Terminalia alata, Careya arborea, Mitragyna rotundifolia* and *Morinda tomentosa, Diospyros ehretioides,* and *Aporosa octandra.* There are also densely growing ground plants, which can reach 1 – 2 m during the rainy season, and woody climbers found on termite mounds. Ground flora is mostly deciduous, peaking during flowering season between July and September and includes *Eriosema chinense, Knoxia brachycarpa, Euphorbia parviflora* and deciduous monocots which are far more abundant including *Costus speciosus, Curcuma gracillima, Kaempferia siamensis, Habenaria acuifera H. mandersii and, H. rumphii* (Orchidaceae) (Bezuijen *et al.*, 2008).

Viels (grasslands) and Trapeangs (ponds)

Viels and trapeangs appear throughout the flood plain areas in wet season, and are highly dependent on the water regime. The viel areas are sometimes formed by abandoned rice fields set at lower elevations. Trapeangs often dry out during the dry season and are generally less than 50m in radius with only 2m in deepth, and often artificially maintained for domestic cattle to use. Trapeang present abundant and diverse amphibious vegetation with more dicots than other aquatic habitats and vascular plants rooted in mud include more annuals than deciduous perennials (Bezuijen *et al.*, 2008).

2.1.5 Key species

Fish

The Mekong River is one of great rivers of the world and holds extraordinary fish diversity, surpassed only by the Amazon and the Congo, which have much larger watersheds. Researchers have recorded 890 freshwater fish species on the Mekong (Rainboth *et al.,* 2012). The central Mekong section between Lao PDR and Cambodia is considered one of the most diverse within the Indo-Burma region, where 16.9% of 1,178 fresh water fish species are considered threatened (Allen *et al.,* 2012).

The literature lists the fish diversity of the Cambodian Mekong between Khone Falls and Kratie at over 220 species (Bezuijen *et al*., 2008; Rainboth *et al*., 2010). In STRS, a fish catch monitoring study from 2007 to 2014 identified 196 species and highlighted the site as having one of the highest species richness within the Cambodian Mekong catchment including the 3S rivers (Ngor *et al.,* 2018). Fish in the Lower Mekong are categorized into three ecological groups: white fishes, which undertake long distance migrations, mainly between the lower floodplains and the mainstreams of the Mekong and its tributaries, and account for 37% of species; black fishes, which are floodplain residents undertaking lateral migrations between the floodplain and local streams, and comprise 13% of species; and grey fishes, which have ecologically intermediate traits between the white and black fishes and are known to undertake short-distance lateral migrations between local tributaries, and account for 50% of species (Baran *et al.,* 2013).

Significant species present in Stung Treng Ramsar Site include several megafishes, which are some of the most ecologically, economically and culturally important species in the world, as well as some of the most threatened, including: Critically Endangered Mekong giant catfish (*Pangasianodon gigas*), giant pangasius (*Pangasius sanitwongsei*), Mekong giant salmon carp (*Aaptosyax grypus*); giant barb (*Catlocarpio siamensis*) and Jullien's golden carp (*Probarbus jullieni*); Endangered giant freshwater whipray (*Urogymnus polylepis*) (Figure 16) and *Luciocyprinus striolatus;* and Data Deficient *Wallago micropogon* (Campbell *et al.,* 2020)(Figure 17). Most of these species are protected in Cambodia under Sub-decree No. 123 (2009). Other important species present in STRS include Endangered striped catfish (*Pangasianodon hypophthalmus*) and Vulnerable small-scaled mud carp (*Cirrhinus microlepis*). Economically important species for local livelihoods include the "snakehead" group Channa, including *C. striata* and *C. micropeltes*. The other group of fish that play a significant role as keystone species in the STRS ecosystem is Henicorhynchus; this ecologically important group is present beneath the Khone Falls between December and February, and from May to July each year. The Lower Mekong fisheries are estimated to be worth $17 billion and provide over 50% of the animal protein consumed by people in the region (Nam *et al.,* 2015).

Figure 16: A 2m wide giant freshwater whipray, one of several rescued and tagged by Wonders of the Mekong during 2022 south of STRS, which set the world record for largest freshwater fish (300 kg). Photo: Chhut Chheana / Wonders of the Mekong

Fish populations in northern Cambodia including STRS are threatened by the prevalent use of illegal fishing methods such as electrofishing, gill nets with a small mesh size, explosives, poison, illegal traps, and fishing at protected sites and during breeding season including at the deep pools (Campbell *et al.,* 2020). Recent studies show that hydropower dams may be causing severe and irreversible impacts to fish communities, and STRS, still retaining a relatively unaltered flow and particularly high species diversity, is one of the most vital sites for fish conservation in the LMB (Nuon *et al.,* 2020; Durant *et al.,* 2022)

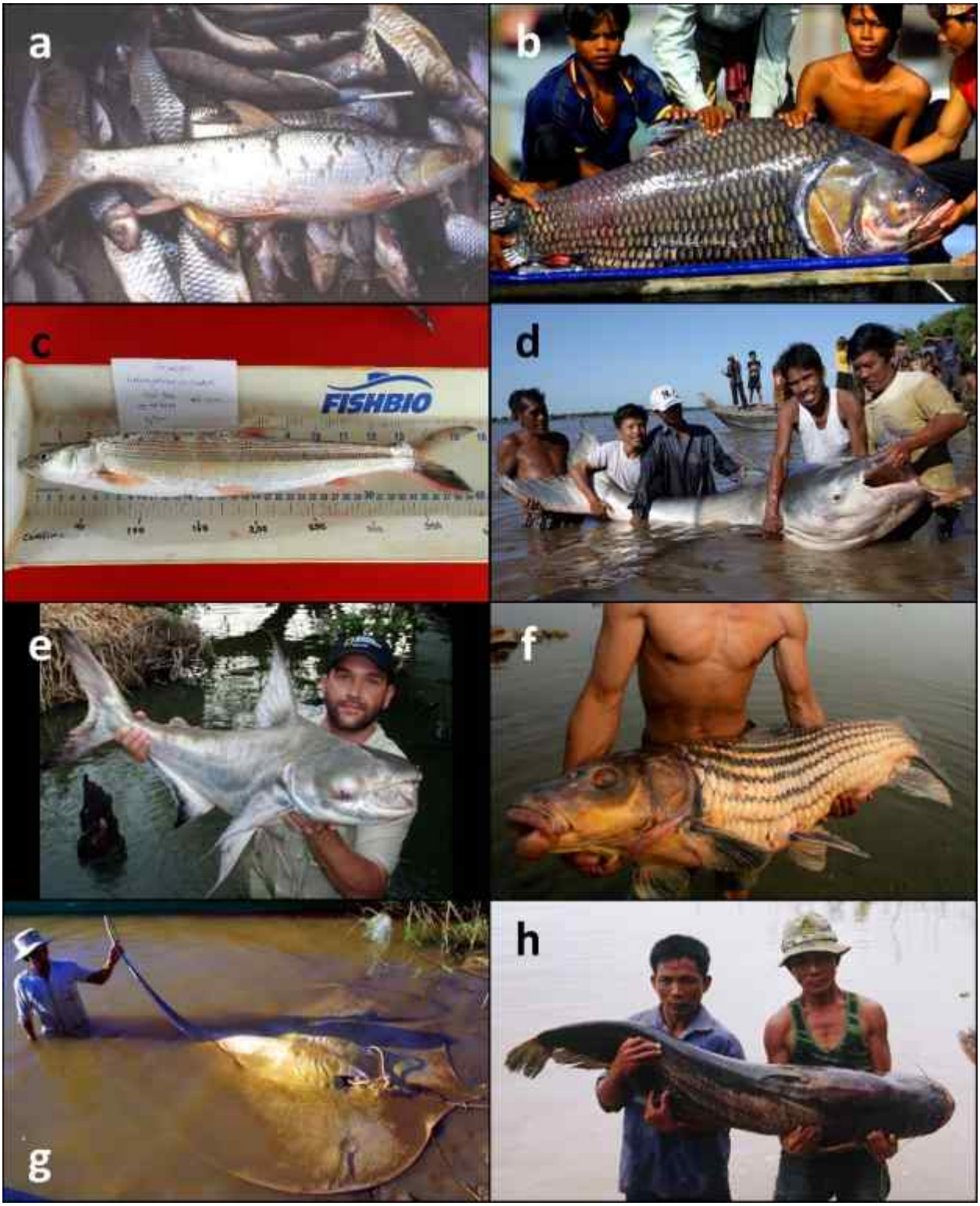


Figure 17. Photographs of the megafish species examined by Campbell et al., (2020). (a) *Aaptosyax grypus*, (b) *Catlocarpio siamensis*, (c) *Luciocyprinus striolatus*, (d) *Pangasianodon gigas*, (e) *Pangasius sanitwongsei*, (f) *Probarbus jullieni*,(g) *Urogymnus polylepis*, (h) *Wallago micropogon*. Photo credits: Peter Cunningham (a), Zeb Hogan (b,d,e-g), FISHBIO (c), Suthep Kritsanavarin (h) (source: Campbell et al., 2020).

Birds

STRS is recognized as an area of great significance for bird conservation in Cambodia, harboring over 200 species within the Ramsar site and adjacent forests (Vong 2004; Try *et al.,* 2006). The site supports a large proportion of the global population of Near Threatened Mekong wagtail (*Motacilla samveasnae*), a species endemic to a small area of the Mekong River and its major tributaries (Birdlife International, 2020). STRS also hosts riverine species that have seriously declined all over mainland South-east Asia, including Vulnerable river tern (*Sterna aurantia*), and Near Threatened great thick-knee (*Esacus recurvirostris*) and river lapwing (*Vanellus duvaucelii*), as well as Critically Endangered white-shoulder Ibis (*Pseudibis davisoni*) (Birdlife International, 2022). Other threatened species recorded at STRS include Endangered green peafowl (*Pavo muticus*), and Near Threatened grey-headed fish eagle (*Ichthyophaga ichthyaetus*), Oriental darter (*Anhinga melanogaster*), and Spot-billed pelican (*Pelecanus phillippensis*), as well as important populations of white-winged duck (*Cairina scutulata*), spot-billed duck (*Anas poecilorhyncha*), white-bellied woodpecker (*Dryocopus javensis*), Oriental pied hornbill (*Anthracoceros albirostris*), pied kingfisher (*Ceryle rudis*) and blue-tailed bee-eater (*Merops philippinus*) (Try *et al.,* 2006; Bezuijen *et al.,* 2008; RIS, 2012). Threatened vulture species residing in northern Cambodia range across thousands of kilometers and may also use the site (Clemmens *et al*., 2012). A total of 17 key Cambodian bird species have been recorded in or nearby the Ramsar site (Vong, 2004; Try *et al*., 2006)(Table 1).

Table 1: Bird species of conservation concern recorded in and around STRS (Adapted from Try *et al.,* 2006).

Species	Scientific Name	IUCN RL Status (2004)	IUCN RL Status (2022)
White-shouldered ibis	*Pseudibis davisoni*	**CR**	**CR**
White-rumped vulture	*Gyps bengalensis*	**CR**	**CR**
Red-headed vulture	*Sarcogyps calvus*	NT	**CR**
Greater adjutant	*Leptoptilos dubius*	**EN**	**EN**
White-winged duck	*Carina scutulata*	**EN**	**EN**
Green peafowl	*Pavo muticus*	**VU**	**EN**
Spot-billed pelican	*Pelecanus philippensis*	**VU**	**VU**
Lesser adjutant	*Leptoptilos javanicus*	**VU**	**VU**
Great hornbill	*Buceros bicornis*	NT	**VU**
Oriental darter	*Anhinga melanogaster*	NT	NT
Painted stork	*Mycteria leucocephala*	NT	NT
Lesser fish-eagle	*Ichthyophaga humilis*	NT	NT
Grey-headed fish-eagle	*Ichthyophaga ichthya*	NT	NT
Cinereous vulture	*Aegypius monachus*	NT	NT
White-rumped falcon	*Neohierax insignis*	NT	NT
Black-bellied tern	*Sterna acuticauda*	NT	EN - Possibly extinct in the region
Indian skimmer	*Rynchops albicollis*	EN – Record unconfirmed	EN - Possibly extinct in the region

Mekong wagtail (*Motacilla samveasnae*). Photo: Reaksmey Sophatt / FCEE

Reptiles

In the STRS, 43 species of reptiles have been recorded (Vong, 2004), of which 23 species are considered of conservation concern (Table 2) (Smith, 2001). The presence of Critically Endangered Siamese crocodile (*Crocodylus siamensis*) was detected in channels and islands of the central section of STRS up until the early 2000s (Timmins, 2006; ICEM, 2014), but the species is now most likely locally extinct. However, STRS is still likely to hold populations of Critically Endangered giant softshell turtle (*Pelochelys cantorii*) and Vulnerable Asiatic soft-shell turtle (*Amyda cartilaginea*). Python (*P. molurus / P. reticulatus*) tracks, as well as sightings were reported in the channels and along the O'Talas river. Bengal monitors (*Varanus bengalensis*) are likely to be relatively common in STRS (Timmins, 2006; ICEM, 2014). The great diversity of seasonal aquatic habitats in STRS is possibly important to many reptile species, particularly rare turtles which have become increasingly threatened in recent years (Table 2). Reptile species were reported to be the main target for hunters to sell in local markets and export to Lao PDR, Viet Nam and China, particularly for meat, skin and to use in traditional medicine (Singh *et al.,* 2006).

Table 2: Reptile species of conservation concern recorded in STRS in the early 2000s (adapted from Smith, 2001 and Vong, 2004), and current IUCN Red List status.

Species	Scientific Name	Historical status & Comments	IUCN RL Status (2022)
Siamese crocodile	*Crocodylus siamanesis*	Recorded from Koh Keo island and O'Talash.	**CR – locally extinct**
Asian giant softshell turtle	*Pelochelys cantorii*	Globally threatened-endangered. Hunted	**CR**
Yellow-headed temple turtle	*Hieremys annandalii*	Globally threatened-endangered. Hunted	**CR**
Giant Asian pond turtle	*Heosemys grandis*	Globally threatened –vulnerable. Hunted	**CR**
Elongated tortoise	*Indotestudo elongata*	Globally threatened-endangered. Hunted	**CR**
Southeast Asian Leaf Turtle	*Cyclemys oldhamii*	Globally near-threatened. Hunted	**EN**
Asian box turtle	*Cuora amboinensis*	Globally threatened-threatened. Hunted	**EN**
Chinese softshell turtle	*Pelodiscus sinensis*	On sale in Veun Sean village (Ramsar)	**VU**
Asiatic softshell turtle	*Amyda cartilaginea*	Globally threatened –vulnerable. Hunted	**VU**
Indo-Chinese water dragon	*Physignathus cocincinus*	Reported from Ramsar islands. Hunted	**VU**
Burmese python	*Python molurus*	CITES II	**VU**
King Cobra	*Ophiophagus hannah*	CITES II. Hunted	**VU**
Indochinese spitting cobra	*Naja siamensis*	CITES II. Hunted	**VU**
Cave racer	*Elaphe taeniura*	Reported to occur in Ramsar	**VU**
Indochinese water dragon	*Physignathus cocincinus*	Ramsar islands, tributaries. Hunted	**VU**
Malayan snail-eating turtle	*Malayemys subtrijuga*	Globally threatened-vulnerable. Hunted	NT
Bengal monitor	*Varanus bengalensis*	CITES I. Hunted	NT
Indochinese rat snake	*Ptyas korros*	Common along O'Talash. Hunted	NT
Water monitor	*Varanus salvator*	Reportedly common. CITES II. Hunted	LC
Changeable Lizard	*Calotes versicolor*	Very common in Ramsar	LC
Spotted gliding lizard	*Draco maculatus*	Widespread in Ramsar	LC
Common gliding lizard	*Draco volans*	Widespread in Ramsar	LC
Common butterfly lizard	*Leiolepis belliana*	Hunted	LC
Eastern butterfly lizard	*Leiolepis reevesii*	Hunted.	LC
Northern forest crested lizard	*Calotes emma*	Found in Ramsar villages	LC
Long-tailed lizard	*Takydromus sexlineatus*	Reportedly in Ramsar villages	LC
Reticulated python	*Python reticulatus*	Reportedly common. CITES II	LC
Monocled cobra	*Naja kaouthia*	CITES II. Hunted	LC
Banded krait	*Bungarus fasciatus*	Occurs in Ramsar	LC
Common mock viper	*Psammodynastes pulverulentus*	Common in dry forest near Ramsar	LC
Rainbow watersnake	*Enhydris enhydris*	Common in Mekong streams. Hunted	LC
Bocourt's watersnake	*Enhydris bocourti*	Mekong and tributary streams. Hunted	LC
Puff-faced watersnake	*Homalopsis buccata*	Mekong tributary streams	LC
Chequered keelback	*Xenochrophis piscator*	Occurs on Ramsar islands	LC
Radiated ratsnake	*Coelognathus radiatus*	Common in dry deciduous forest	LC
Striped kukri snake	*Oligodon taeniatus*	Common in Ramsar	LC
Ornate Flying Snake	*Chrysopelea ornata*	Occurs on Ramsar islands	LC
Viper	*Trimeresurus sp*	Occurs in Ramsar	-

Figure 18: Giant softshell turtle (*Pelochelys cantorii*). Photo: Chris Greenwood / WWF Cambodia

Mammals

A wide variety of mammal species were historically found at Stung Treng Ramsar Site. According to an assessment conducted in 2004, nineteen mammal species were known to be present with the Ramsar site or in the forests nearby. The study already describes an important decline of formerly present species such as the Asiatic black bear (*Ursus thibetanus*), sun bear (*Ursus malayanus*) and tiger (*Panthera tigris*) (Vong, 2004).

Subsequent studies conducted in the area only found a few large mammal species present in STRS. The species of conservation concern reported were Endangered Banteng (*Bos javanicus*), Eld's deer (*Cervus eldii*) (Timmins, 2006; Bambaradeniya *et al*., 2006 in Allen *et al*., 2008), hog deer (*Axis porcinus*) (Maxwell *et al*., 2006 in Bezuijen *et al*., 2008), long-tailed macaque (*Macaca fascicularis*) and Indochinese silvered langur (*Trachypithecus germaini*) (Bezuijen *et al.,* 2008); and Vulnerable gaur (*Bos gaurus*), smooth-coated otter (*Lutrogale perspicillata*)(Allen *et al*., 2008) and fishing cat (*Prionailurus viverrinus*) (Try & Chambers, 2006).

The Critically Endangered Mekong River subpopulation of Irrawaddy dolphin (*Orcaella brevirostris*) has been recently estimated at 89 individuals and relatively stable (Eam *et al.,* 2020). Irrawaddy dolphins were once of the flagship species of Stung Treng Ramsar Site. The dolphins were the focus of ecotourism in the area and their presence facilitated the involvement of the local community in biodiversity conservation. The population of these aquatic mammals had been progressively declining over forty years in STRS and nearby rivers due to the use of explosives and large mesh gillnets (Baird and Mounsouphom, 1994), widespread use other illegal fishing methods, decline of prey species caused by overfishing (Baird & Beasley, 2005, Try & Chambers, 2006) and chemical pollution (Schnitzler *et al.,* 2021). By 2016, only three Irrawaddy dolphins remained in the Anlong Cheuteal pool that straddles the Lao PDR/Cambodian border. Between 2019 and 2020, the Don Sahong dam was built and started operating in the Hou Sahong channel between Don Sahong and Don Sadam islands and local communities reported that the explosions during construction disoriented the dolphins and played a part in the death of some. Two more individuals were found dead in 2021. According to press and local communities the last Irrawaddy dolphin in the area died in February 2022 (Box 2. pg 37).

Figure 19: Irrawaddy dolphin (*Orcaella brevirostris*) at Kampi pool in Kratie province. Photo: Tan Somethbunwath / FiA / WWF Cambodia.

2.1.6 Land use

Terrestrial habitats in STRS are found in channel islands and along a narrow strip on the margins of the river mainstream. Larger channel islands on the north and south of STRS have long-established villages and extensive areas of rice fields and other crops such as oranges. Major islands and smaller sandy islets on the central portion of STRS do not support villages, but numerous scattered, relatively recent human habitations, small orchards and cleared patches for water buffalo grazing are located throughout. Domestic cattle grazing (both water buffaloes and cows) was recorded on several larger uninhabited islands.

The western riverbank has only a few villages close to the shore and is mainly covered by channel woodlands and mixed DDF; scattered households and clearings are also present. The eastern riverbank supports several villages, a road and many households along the shoreline, as well as rice fields and other crops.

On the land use / land cover map (Figure 20a), some sandy islets and beach formations within the river mainstream are wrongly classified as built up areas. Some areas classified as shrubland correspond to native marshlands and invasive *Mimosa pigra* stands, while others are regenerating clearings or burned areas for conversion to agricultural fields.

Satellite images (Figure 20b) and data from Global Forest Watch (2022) show that STRS lost 295ha of tree cover between 2015 and 2021, with an important peak of deforestation happening in 2021. Furthermore, the forests surrounding STRS, especially the older, denser forests to the west suffered significant deforestation and degradation during the same period.

2.1.7 Drivers of change

Several factors influence the structure of the wetland and drive alterations to wetland habitats in STRS:

- Dam development on the Mekong mainstream has had negative impacts on downstream ecosystems including STRS by changing the patterns of seasonal water flows, the sediment carried and the water quality. Furthermore, dams have contributed to declining fish catch downstream due to the reduction in seasonally flooded area and duration of floods (Burbano *et al.*, 2020; MRC, 2022). For instance, Don Sahong hydropower dam in Lao PDR has impacted fish migration patterns at the deep pools in the Ramsar Site due to decreased water flow and increased siltation rates (Burbano *et al.*, 2020).
- Population increase, levels of water demand arising from hydropower, agriculture, and industrial development put pressure on the wetlands and fisheries.
- Conversion of terrestrial forest and riverine vegetation into agricultural areas, including rice fields, impacts islands and riverbanks and was observed along with scattered human settlements during the current assessment in all areas of STRS.
- The invasive shrub *Mimosa pigra* is present along sandbars and beaches throughout STRS. This invasive species can spread rapidly and cover long distances transported by water as well as become quickly established on land within floodplain habitats. *M. pigra* has the potential to convert natural ecosystems into unproductive scrubland, displace native flora and alter important features of habitats, having a significant negative impact on biodiversity.
- The golden apple snail (Pomacea spp.) is also widespread throughout STRS and impacts growth of native vegetation and crop production in the surrounding rice field areas. Local villagers collect this snail species for family consumption and food for aquaculture fish.
- Climate change, in addition to global weather phenomena such as *El Niño*, are intensifying drought periods. Precipitation patterns are also showing important alterations in recent years (MRC, 2022).

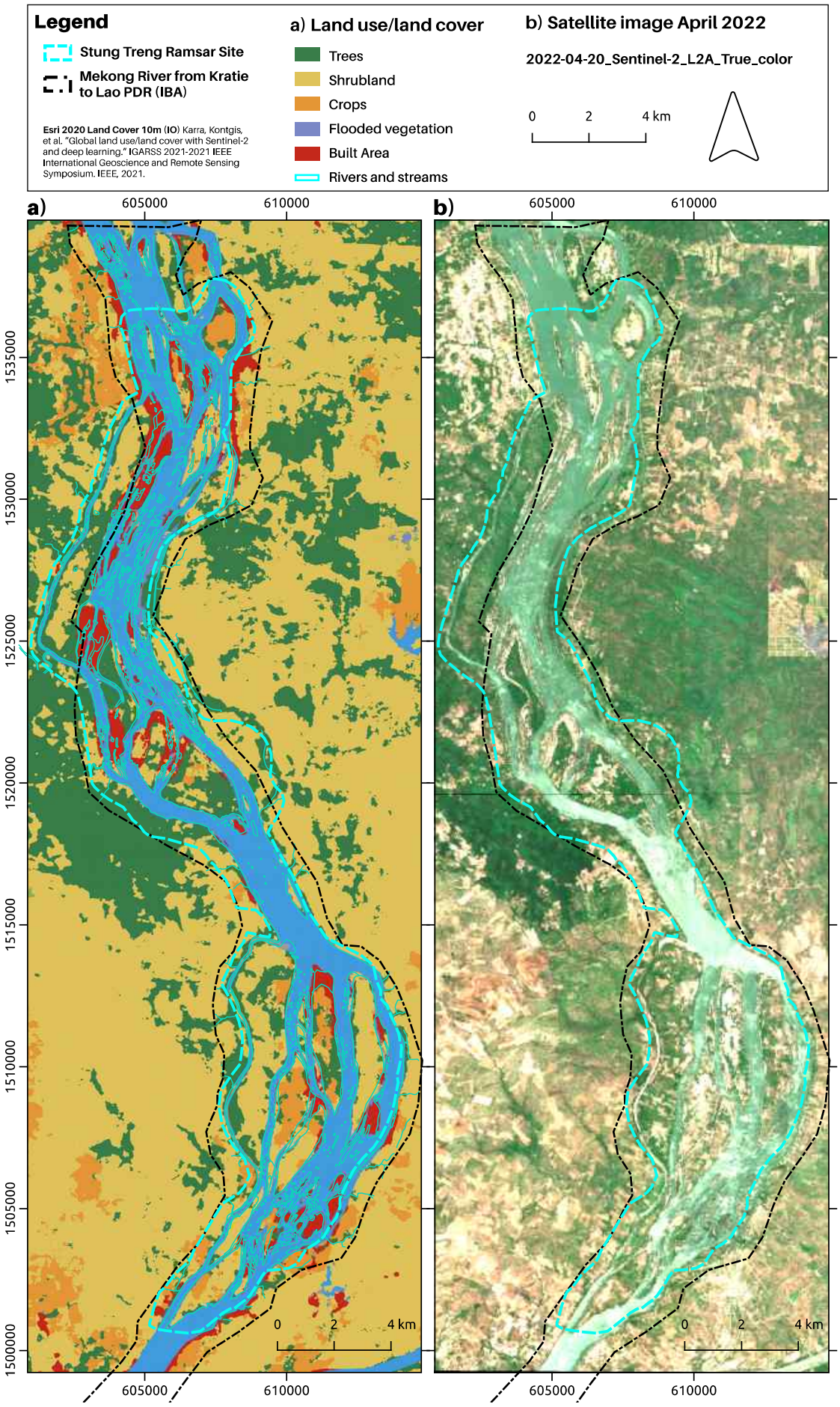


Figure 20a. Land cover map (source: Karra, Kontgis *et al.,* 2021) and boundaries of STRS and IBA/KBA. **Fig. 20b:** Sentinel 2 L2A satellite image of STRS in April 2022.

2.1.8 Conservation and Zoning

Since its designation as Ramsar site in 1999, many organizations have worked on biodiversity and livelihoods in the area, including zonation. In 2006, Timmins proposed several areas for demarcation as Core Zones and Fish Sanctuaries, and in 2008 The Darwin Project / IUCN (Allen *et al.*, 2008) presented a report including proposals for demarcation and zoning highlighting the following areas:

- Preah Sakhon Core Zone: covering 192 ha, centrally located in remote islands and with no permanent settlements, and the highest concentration of breeding river terns (Timmins, 2006). Preah Sakhon was also suitable to designate as Fish Core Zone because this area holds small pools, small channels and some larger pools during dry season.
- Anlong Rusei Core Zone: covered 468 ha and was the last know location of the local population of Critically Endangered Siamese crocodile, as well as the site providing the most suitable habitat for the species.
- Anlong Chheuteal Dolphin Protection Zone lays just outside the STRS northern boundary and provided the main habitat for Irrawaddy dolphins.
- The O'Talas river is a tributary adjacent to Koh Khan Kham and was reported to be highly significant for wetland biodiversity, and was suggested as a possible site for extension of the Core area.

There has been no official zoning, demarcation or management plan implemented in STRS since those recommendations were made. Conversely, fisheries conservation has been implemented in STRS, and every village has a Community Fisheries (CFi) zone and committee responsible for management, implementation of fisheries law and information sharing. STRS also falls within the Key Biodiversity Area (KBA) "Mekong River from Kratie to Lao PDR".

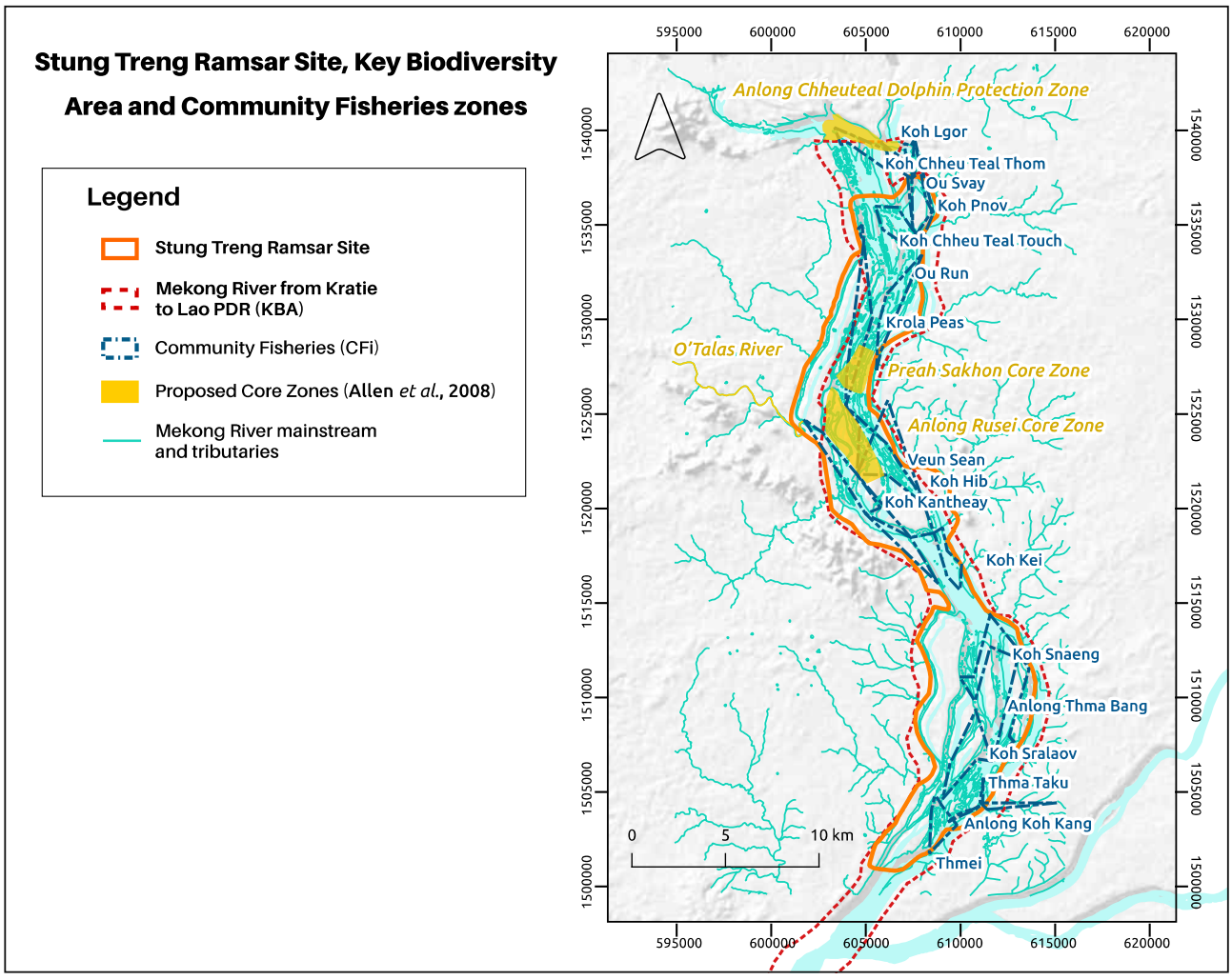


Figure 21. Community Fishery areas (CFi) and proposed Core Zones in STRS.

2.2.1 Communities and population

The Stung Treng Ramsar Site (STRS), in the middle stretches of the Mekong River, is located north of Stung Treng province, about 5km from Stung Treng town and 4km from the Lao PDR border (RIS, 2012). According to the data records provided by the Ministry Of Environment Deputy STRS Manager, within the site there are 20 villages, belonging to four communes, and two districts with total population of 15,549 people and 3,459 households as of 2021 (Table 3).

Table 3: Population within STRS, villages, corresponding districts and communes, and numbers of households and residents reported by local MoE officials.

District	Commune	Village	# Households
Stueng Traeng	**O'Svay**	O'Svay	331
		O'Run	285
		Koh Pnov	116
		Koh Heb	124
		Voeurn Soeurn	75
	Samaki	Phum Thmey	232
		Phum Koh Khorn Din	132
		Phum Kham Phann	316
Thala Barivat	**Preah Rumkel**	An Lung Svay	21
		Krola Peas	190
		Koh Cheu Teal Thom	127
		Koh Cheu Teal Touch	123
		Koh Langor	62
		Phum Kraom	258
		Phum Leu	167
		Phum Kandal	265
	Kaoh Snaeng	Koh Key	100
		Koh Snaeng	257
		Koh Sralau	146
		Phum Jorm Thom	132
Total Number of Households			**3459**
Total population			**15549**

Village residents in STRS live in fixed houses (not floating), usually on stilts to adapt to seasonal flooding which often reaches the base of the house. A few times a year, villagers may be asked to put businesses on hold to move to higher altitudes and settle there in temporary shelters due to extremely high water levels that occasionally reach the height of their roofs. Respondents reported that police officers, chiefs, and Red Cross always help with food, tents, and moving to a safer area.

Koh Snaeng commune has three villages located inside the Ramsar site. Koh Snaeng and Preah Rumkel have very similar demographics, everyone can speak Lao language well. Koh Snaeng has a Community Based Ecoturism committee (Somros Koh Han CBET), which provides accommodation and services, and receives national and international tourists mainly in the dry season. The committee reported that this village used to belong to Lao PDR until the French colonial era, which is why the majority of residents here are Lao PDR indigenous groups. Koh Snaeng village can only be reached by boat. Local students from Koh Snaeng have to travel by boat every day to get to schools on the mainland.

Koh Snaeng village

O S'vay is a commune with five villages accessible by roads. Residents of O S'vay were once from Kampong Cham; they reported that King Sihanouk asked them to move from Kampong Cham to O S'vay in the 1960s. They also added that during King Sihanouk's era, O S'vay was a city with good roads, electricity, markets, health center, and hospitals. People were given one house made of concrete and a piece of land when they settled there, in exchange for guarding the Cambodian border. Currently the markets, health centers and hospitals no longer exist, however, the government plans to build a health center in this commune again soon. A great majority of O S'vay residents are Khmer with no Lao language proficiency.

Preah Rumkel is also a commune that can be reached by roads, which used to be very popular with tourists attracted by the prospects of watching the Irrawaddy dolphins at Anlong Chheuteal pool. The local CBET committee organizes boat trips and homestays in collaboration with local villagers. The demise of the local dolphin population has brought about negative consequences for local ecotourism activities, but was also deeply saddening to the people who tried to protect the last remaining individuals for years (Box 2).

Box 2. The last Irrawaddy dolphins in Preah Rumkel

By 2016, there were only three Irrawaddy dolphins left at Anlong Chheuteal pool. Two of them died in 2021, and the skeleton of one of them (a female dolphin, weighing 180kg and 230cm long) (Fig. B2.1) was preserved and mounted on a exhibit in Anlong Svay village. The exhibit, which was intended to provide visitors with information about the local dolphin population, now serves as a shrine to mourn their loss (Fig. B2.2).

Figure B2.1. Female dolphin found dead in June 2021. Photo: Phnom Penh Post 15 June 2021.

Figure B2.2. Dolphin exhibit in Preah Rumkel.

"There used to be three Irrawaddy dolphins here [in recent years], the last one we named Ek Ka (Sanskrit word meaning lonely), died in 2022 by getting tangled in nets" - The head of the Community Based Ecoturism committee (CBET) at Preah Rumkel, Mr. Vanna recalls - "Ek Ka was a very clever and friendly dolphin. I used to dip my toes in the river and Ek Ka came to lift the toes up with his head." Whenever there had not been tourists for a couple days, Vanna's boat did not reach Ek Ka's core habitat (1km downstream from Don Sahong dam), and Ek Ka would come to check for Vanna's boat at his home port. "Ek Ka could typically avoid gillnets in the river well although there were many. Unless there was sudden explosion noise that caused Ek Ka to freak out, he could not get tangled that way." (Fig. B2.3)

Figure B2.3. Last dolphin (Ek Ka) found dead in February 2022. Photo: Phnom Penh Post 16 February 2022.

Before the passing of the last dolphin, Mr. Vanna claimed that tourists could come in ten vans, and all ten groups would want to take the boat tour. "Now, only one in ten groups may decide to take the boat tour to the flooded forest."

2.2.2 Key livelihood activities

Livelihoods of local communities around STRS vary widely depending on the geographical locations of villages. On the mainland, O'Svay residents are strongly dependent on livestock and crops such as bananas, limes, oranges, beans, cashews and vegetables. Occasionally, they collect mushrooms and firewood from the wetland for food and cooking fuel. Most respondents at O'Svay have stopped fishing recently because they had to travel farther to find fish. Even traveling considerably far, villagers reported that nowadays the catch is not sufficient to compensate the physical and economic effort fishing entails. Nonetheless, they still rely on other wetland resources such as water, firewood, mushrooms, and wild vegetables. Many households in O'Svay are members of the CBET, and they take turns to serve tourists: some offer accommodation in homestays, some operate restaurants, and some others work as committee members in administration and management duties.

Local communities in Koh Snaeng commune rely heavily on the wetland forests. Villagers reported that their sources of income include logging the forest for high value timber to make furniture and for construction. They also collect and sell rattan, bamboo, and firewood. Fishing, raising livestock and farming bananas and vegetables are livelihood activities that villagers engage on year round. Depending on the season, farmers tend to harvest different crops including sesame, red bean, cashews, oranges or rice. In addition, CBET members operate tourism activities in the dry season from January to May only. Residents of this commune reported they used to catch 5-10kg of fish per day in the wet season, and around 10kg per day in dry season ten years ago. From 2020 to 2022 however, the catch dropped to 3kg per day in the wet season and 1kg in the dry season.

In Preah Rumkel commune the CBET operates tourism activities including homestays, restaurants and boat tours. Other livelihood activities include carpentry, raising livestock and fishing all year round. Seasonally, villagers collect snails (including golden apple snail) and mushrooms such as earthstar mushroom (*Geastrum sp*), peacock mushroom (*Amanita hemibapha*) and termite mushroom (*Termitomyces sp*) mainly to sell locally. Earthstar mushroom makes up a large proportion of the local harvest, and is the most long-lasting, which allows for export to Thailand and Lao PDR. Local fishers reported fish catch 10 years ago was 5kg per day in the wet season and 10kg per day in the dry season. From 2020 to 2022, the catch dropped to 2kg per day in the wet season and 1kg in the dry season.

2.2.3 Use of wetland resources

Local communities within STRS are mainly dependent on raising livestock, farming and using forest timber for construction and furniture business. Few rely on fishing, and many have abandoned the practice completely due to the drastically reduced fish catch in recent years. Residents of villages in islands are substantially more dependent on wetland resources than those on the mainland. The most significant uses of wetland resources in STRS include:

- Honey collection for local sale and consumption.
- Firewood (for cooking), as well as wild vegetables for consumption and local sale.
- Several species of mushrooms from the STRS wetland are important sources of income for local villagers. Most are sold locally, but one species (earthstar mushrooms) is also sold nationally and exported internationally.
- Some people operate tourism activities through CBETs for visitors to visit the Mekong, explore the Ramsar wetlands and experience its unique landscapes and biodiversity.
- All year round, villagers rely on the Mekong River for transportation from one commune to another, including to be able to access basic services such as schools and hospitals.

2.2.4 Land tenure and land use rights

The government of Cambodia has not recognized land tenure rights for local people in Stueng Treng Ramsar site. Within STRS, there are 15 CFis established by the Fisheries Administration (FiA) of the Ministry of Agriculture, Forestry and Fisheries (MAFF), which manage fishing areas, implement fisheries regulations and often participate in NGO-led activities focusing on livelihoods and biodiversity. The MoE is working to establish (land-based) Community Protected Areas (CPAs) to support protection of STRS land habitats. The CBET groups also play an important role in protection and natural resource management of the wetland, by providing income, sharing information and raising awareness.

2.2.5 Governance

After being designated as Ramsar site in 1999, the Ministry of Environment (MoE) is solely responsible for managing the area to ensure biodiversity conservation and social, environmental, and economic sustainability. The FiA and the CFis are responsible for fisheries management and for combating illegal fishing through the design of fish conservation zones and the enforcement of the Fisheries Law.

Stung Treng Ramsar Site Management Unit, which consists of the Ramsar Site Manager and a team of environmental rangers, is directly under the Provincial Department of Environment (PDoE). In addition, PDoE and the Department of Agriculture, Forestry, and Fisheries (PDoAFF) cooperate closely.

The STRS management plan was updated and submitted to the provincial council in 2015, but no further progress has been made to date.

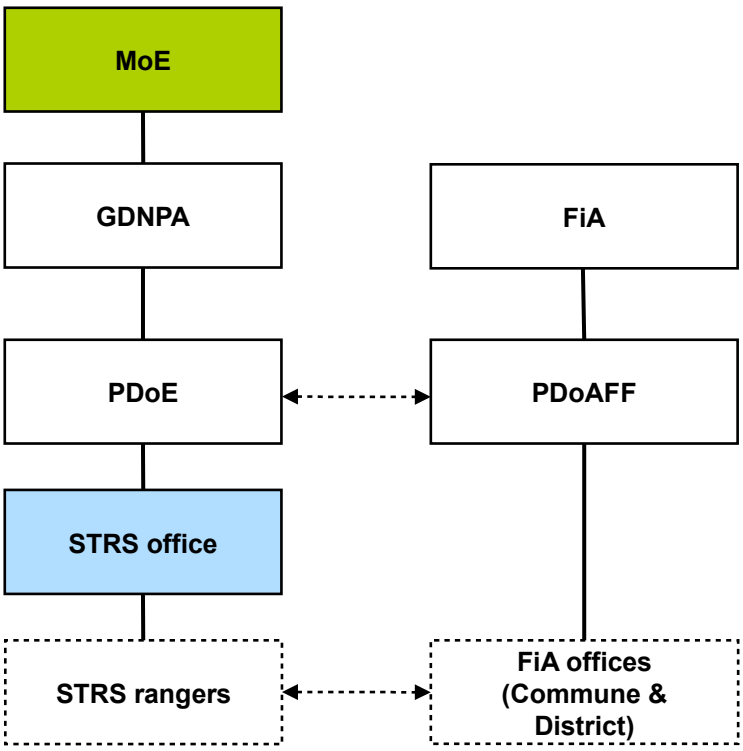


Figure 22: Governance structure of STRS. MoE (Ministry of Environment), GDNPA (General Directorate of Natural Protected Areas), FiA (Fisheries Administration), PDoE (Provincial Department of Environment), PDoAFF (Provincial Department of Agriculture, Forestry, and Fisheries).

2.2.6 Stakeholder analysis

Many stakeholders are working in STRS: major government agencies, provincial government agencies, local authorities and community groups. NGOs and private organizations also play an important role in site management and decision-making.

Primary stakeholders: There are three main bodies responsible for STRS administration: MoE (Ministry of Environment), PDoE (Provincial Department of Environment) and FiA (Fisheries Administration), which provide support and collaborate with other stakeholders. As one of the most prominent figures, the Community Fisheries (CFis) are responsible for the coordination and implementation of Fisheries Law. PDoE actively collaborates with CFis, sharing information during regular meetings, as well as coordinating patrols in fish conservation areas, situating them as important partners for law enforcement in the area. FiA also supports capacity development of CFi groups by providing training sessions on updates of fisheries and environmental regulations, often with the collaboration of the Department of Fisheries Conservation (DFC).

Secondary stakeholders: This group includes government departments such as the Department of Planning (DoP), the Department of Health (DoH), the Department of Tourism (DoT), and the Department of Youth, Education and Sport (DoYES). Additionally, a number of NGOs and private organizations are currently working on projects in the area, financially supporting and actively collaborating with some of the primary stakeholders. These are: Non-Timber Forest Products (NTFP) organization, Cambodian Center for Agricultural Studies and Development (CDAC); World Wide Fund for Nature (WWF); Cambodia Rural Development Team (CRDT); Culture and Environment Preservation Association (CEPA); Fishing Cat Ecological Enterprise (FCEE); Wildlife Alliance (WA) and International Union for Conservation of Nature (IUCN).

The cooperation and support of all these parties allows the execution of initiatives such as Community-based ecotourism (CBET) that strengthens social and economic development based on the conservation of biodiversity in Stung Treng Ramsar Site. (Figure 23).

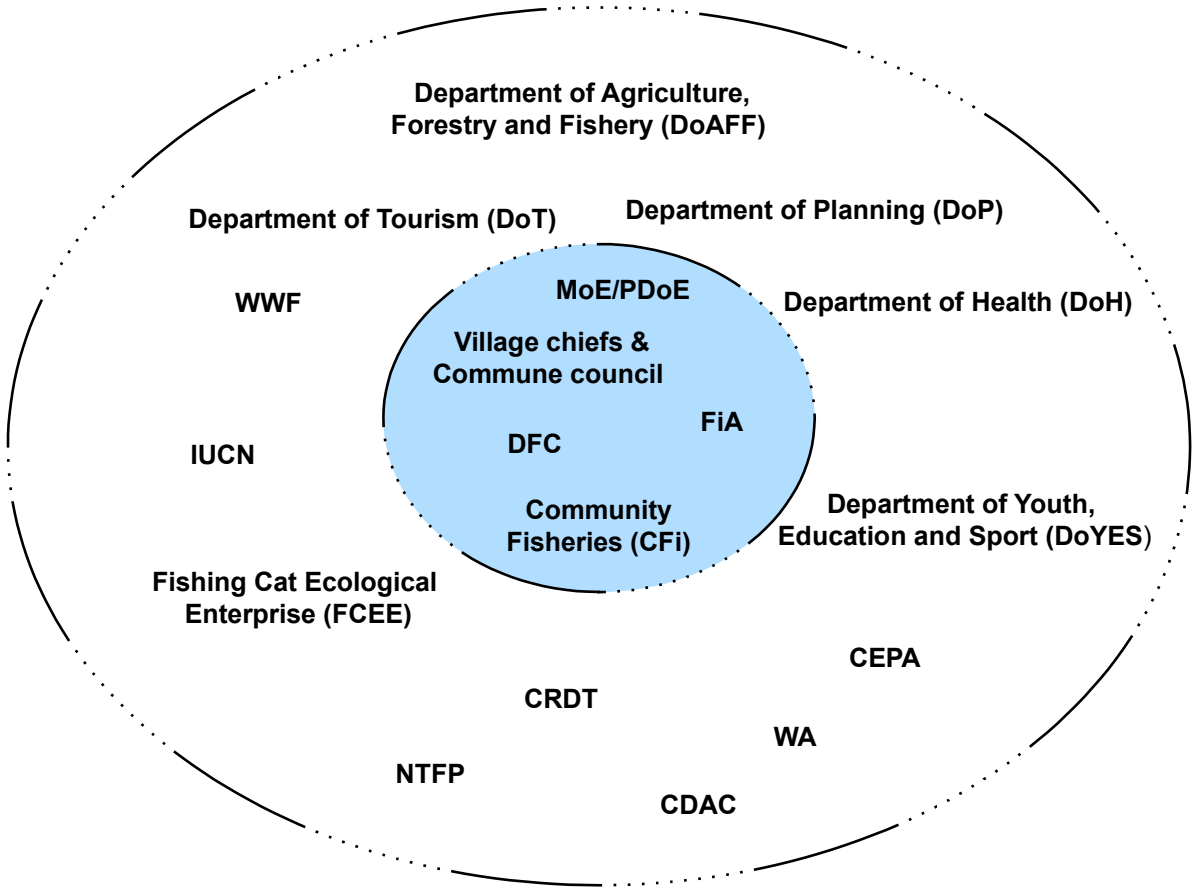


Figure 23. Overview of primary and secondary stakeholders relevant to decision making in STRS.

2.2.7 Gender and vulnerable groups

Agriculture, fisheries and collection of non- timber forest products (NTFPs) are the main sources of income and food consumption for women and men in Stung Treng Ramsar Site. Fishing and farming duties are often segregated and shared by men and women in the area, and both, as well as children and youth take part in NTFP collection. Women spend a long time on household roles and they are often responsible for making decisions about resource use and income. Female-headed households have more difficulties obtaining income, increased burdens of looking after young families, and have fewer opportunities for joining in community decision-making since Khmer tradition ascribes a passive role to women. For instance, all village chiefs, which are chosen by commune councilors, and commune chiefs are men, although this position could be filled by men or women (Johnstone *et al*., 2013). Essential fisheries activities, such as fish processing, are mainly carried out by women, however they have not been given enough consideration by the sector (FiA, 2015).

Because of its proximity to the Lao PDR border, in some areas of STRS, residents are Lao indigenous, speak Lao language and still retain other traditions, such as cooking Lao recipes. Lao indigenous residents and their customs have been integrated within the STRS local communities for many decades, and contribute to bestowing the area with a rich and unique culture.

2.2.8 Perceived threats to wetland habitats and livelihoods

Clearing of forests: The clearing of terrestrial and riverine forests for conversion to agricultural land has continued unabated since early reports (e.g. Allen *et al.,* 2008). In larger islands that accommodate villages, agricultural fields have been expanded until some of them only retain forest around the fringes. Scattered households are present in many smaller islands and along all parts of the riverbanks, alongside small crops or buffalo grazing patches often set by clearing sloped strands and riverine forests, not only destroying unique habitats but also contributing to land erosion. Fire has also played a part in forest destruction and degradation, and regenerating areas are also being cleared and settled in. Within STRS, 295ha of forest were lost between 2015 and 2021, and the surrounding forests have lost massive amounts of cover in recent years (Figure 24).

Figure 24. Tree cover loss between 2015 and 2021 in STRS. Source: Global Forest Watch.

Invasive species

- ***Mimosa pigra:*** The invasive plant *Mimosa pigra* is spreading along the riverbanks and islands, invading the seasonally inundated riverine forest and the fringes of sandbars. *M. pigra* in STRS also appears further inland, in and around areas converted for agriculture. The invasive species is transported by water, which has allowed it to reach all habitats and establish itself throughout the entire site, hindering growth and regeneration of native species. To control its spread would entail an active habitat restoration program, focused on uprooting the invasive plants and restoration with local native species, as suggested on strategies designed for other flooded sites, such as the Tonle Sap floodplain (Chan & Mihara, 2018).

- An invasive filamentous algae known as 'water net' (Hydrodictyon spp.) forming dense mats, was reported to be spreading in braided and shallow areas of the river within channel mosaic habitats, shrublands in the northern and central parts of the Stung Treng Ramsar Site in the early 2000s (Bambaradeniya *et al.* 2006). The species was not observed during the current assessment, carried out in wet season, but may still bloom and proliferate in the dry season, reducing water quality and oxygenation, particularly in shallow streams and ponds.
- Golden apple snails (*Pomacea* spp.) are also present in flooded habitats and rice fields in and around STRS. These snails proliferate quickly and damage native flooded habitats and crops. Local communities in STRS collect them for subsistence and to feed aquaculture fish.

Illegal fishing: The populations of fish and other aquatic species in Stung Treng Ramsar Site have been massively impacted by the use of illegal fishing methods including poisoning, use of explosives, electrofishing, using illegal mesh sizes, fishing out of season and at deep pools and other sensitive areas for decades (e.g. Allen *et al.,* 2008; Nuon and Gallardo, 2011). Migratory fish species have severely decreased due to overfishing as they migrate back from tributaries to the Mekong River. Overfishing and extensive use gillnets were not only a threat to fish populations, but also played a significant role in the local extinction of several species such as Siamese crocodiles and Irrawaddy dolphins, as well as heavily impacting turtles, other reptiles and water birds such as masked finfoot (*Heliopais personatus*) (Timmins, 2006). Furthermore, fish reproduction has been heavily impacted in STRS because of intensive fishing in the deep pools, where fish take shelter and breed during dry season (Allen *et al*., 2008). These illegal fishing practices (possibly with the exception of explosive use) have continued to be used extensively in STRS until the present, and in combination with the impacts of climate change and water infrastructure on the Mekong mainstream hindering migrations and altering water flows, have resulted in a steep decline in the local fish catch. This has led to many fishers in the area abandoning the practice entirely because it no longer provides a sufficient source of income for livelihoods.

Poaching for mammals, reptiles and birds using guns, traps, snares and nets is prevalent throughout STRS and the surrounding forests. Poaching for the wildlife trade is a severe long-standing threat to biodiversity in STRS (e.g. Singh, *et al.,* 2006; Allen *et al.,* 2008). During the current assessment, poachers using guns, slingshots, traps, bird nets and snares were observed throughout the site.

Figure 25. A yellow-footed green pigeon (*Treron phoenicoptera*) was rescued from a bird net during the current assessment activities.

Water infrastructure: The unique flooded habitats of STRS are highly vulnerable to changes in the volume and timing of water flow in the Mekong River. Water infrastructure in the Mekong River Basin has developed rapidly, impacting the water levels and duration of the peak monsoon season, leading to significant socio-ecological implications for the flooded habitats, riverine forests, and aquatic ecosystems as well as local livelihoods along the Cambodian Mekong (MRC, 2022). Recent projections predict flow reductions of 9 to 29% in the 2030s and of 7 to 41% by the 2060s, with a decrease in extreme flows and increased drought (Arias *et al.,* 2019). Water storage operations in the Upper Mekong Basin (UMB) have contributed significantly to the unprecedented low volume and short duration of the peak flood during 2019, 2020 and 2021 (MRC, 2022). Furthermore, since the early 2000s, several companies expressed interest and conducted at least partial feasibility studies with the prospects of building a Mekong mainstream dam inside STRS, which would destroy large proportions of the site, displace thousand of people and flood unique habitats vital to significant biodiversity (WWF, 2018). Concerns were raised by local communities and many conservation organizations, and early projects were scrapped, with Cambodia eventually setting a 10 year moratorium on the construction of any Mekong mainstream dams in 2020 (in general press). In 2022, a developer was again given permission to conduct a feasibility study in STRS, prompting alarm among local communities and NGOs (Flynn and Pry, 2022). However, in September 2022, the MoE circulated a letter informing the cancellation of the project.

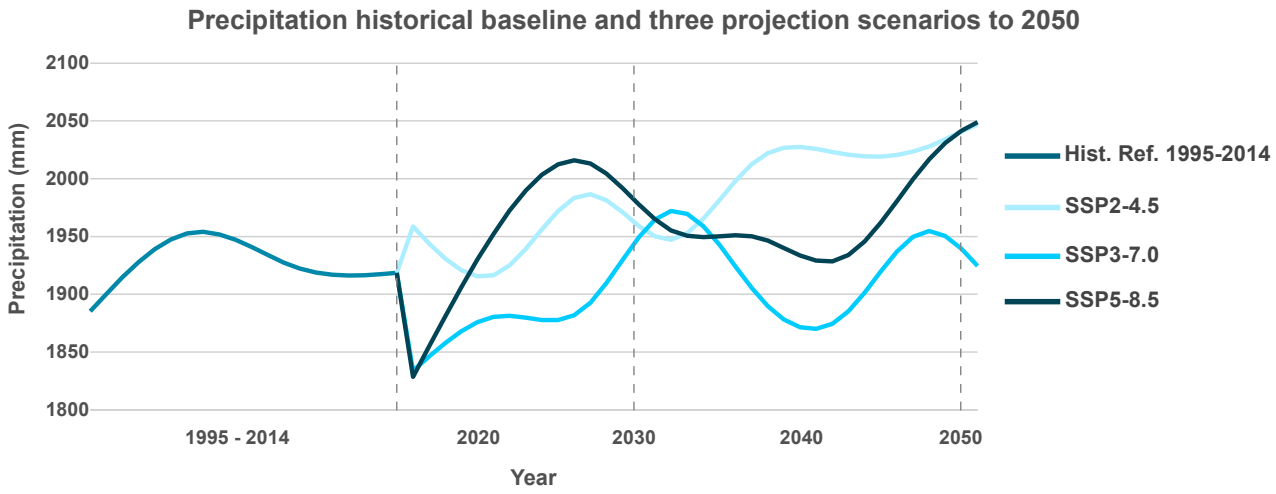
2.3 Climate projections for the site

This section examines the predictions of the IPCC Sixth Assessment Report for Stung Treng Province, using the 1995-2014 period as a baseline. The climate projections, which have been supervised by the World Climate Research Program, are presented at a resolution of 1.0° x 1.0° (100km x 100km) and are based on compilations of the Coupled Model Inter-comparison Projects version 6 (CMIP6) (database of CCKP World Bank Group). A multi-model approach has been used for the development of energy, land use, and emissions trajectories based on Shared Socioeconomic Pathways (SSPs). The SSPs describe five plausible scenarios (SSP1-SSP5) that are based on possible future demographic, technological, economic, and natural system trends during the 21st century. Each of these trends could lead to very different emissions and warming outcomes in the future (Riahi *et al.*, 2016). The data shown represent the range and distribution of the most plausible projected outcomes of climate system change for a selected SSP. In this report, the SSP-based scenarios are referred to as SSPx-y, where "SSPx" refers to the Shared Socioeconomic Pathway (SSP), and "y" refers to the level of radiative forcing (in watts per square meter, or W m $^{-2}$) resulting from the scenario in the year 2100 (Pörtner, *et al.* 2022).

This report uses average data from the comparison of different climate models. Many of these models greatly differ in their predictions, which makes it necessary to use an intermediate view that can be described and analyzed. It is important, however, to consider the values within the ranges corresponding to each model´s predictions, which may differ from the mean values. In the IPCC's Sixth Assessment Report, some scenarios have wide ranges that the report deems as "very likely" and therefore as possible future values for their scenario and time period. In order to provide a more complete analysis, this report also shows figures with annual mean values for the three most plausible scenarios (SSP2-4.5, SSP3-7.0) and the worst one (SSP5-8.5) (Hausfather & Peters 2020), with predictions for the year 2030 as the near future and 2050 as the medium-term future. Secondly, the figures are shown with predictions for the period 2040-2059 for the same scenarios with monthly mean values and these ranges added. By using this approach, the seasonal distribution of climate changes can be observed, along with possible changes in predictions if in the future the reality matches a particular model more closely than the average.

Figure 26 shows the mean precipitation predictions for 2030 and 2050 based on the baseline of 1927.48 mm (1995-2014). In the year 2030, an upward trend is observed in the three scenarios considered, ranging from 22.60 mm (SSP2-4.5) to 36.52 mm (SSP3-7.0 and SSP5-8.5). This represents an increase of 1.20% to 1.90%. By 2050, precipitation substantially increases for SSP2-4.5 and SSP5-8.5 with an increase of about 120 mm, which implies an increase of 6%. In contrast, SSP3-7.0 appears to have a new alignment with the baseline.

Given the overall predictions for the three scenarios, it is concluded that in the near future, precipitation fluctuations produced by the effects of climate change, will proceed along the projections described previously both in this report and by other authors for the historical and current climate of Stung Treng Ramsar Site (Try & Chambers, 2006; Sunleang, 2012; Ministry of Industry, Science, Technology and Innovation, 2021).



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In order to understand the seasonal distribution of rainfall variation, as well as the possible ranges of predictions for the period 2040-2059, the following figure is presented. The mean data obtained from the model comparison predicts an increase in precipitation during the rainy season with peaks in October of 50 mm. However, the ranges of the predictions indicate precipitation increases of between 100-150 mm per month during the rainy season, including November in the case of SSP3-7.0 and SSP5-8.5. These ranges of precipitation predictions present a lot of uncertainty because they also contemplate the possibility of a reduction in precipitation of between 50-100 mm during the rainy season for all three scenarios (Figure 27).

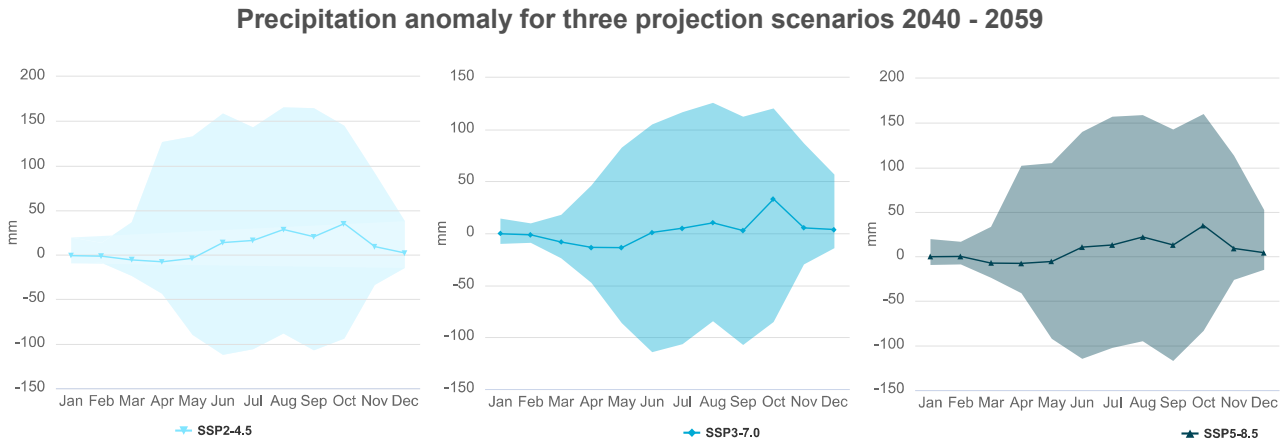


Figure 27. Projected precipitation anomaly in Stung Treng from Multi-Model Ensemble for scenarios SSP2-4.5, SSP3-7.0, and SSP5-8.5, with the reference period (baseline): 1995-2014. (source: adapted from database of CCKP World Bank Group https://climateknowledgeportal.worldbank.org).

Figure 28 shows the average temperature trend predictions for the years 2030 and 2050 concerning the baseline established at 27.51ºC (1995-2014). By 2030, a clear upward trend is observed in the three scenarios considered, ranging between 0.56ºC (SSP3-7.0), 0.74ºC (SSP2-4.5), and 0.82ºC (SSP5-8.5). By the year 2050, the predictions show a considerable increase of more than 1ºC for all scenarios, with 1.36ºC (SSP2-4.5), 1.40ºC (SSP3-7.0), and 1.68ºC (SSP5-8.5).

These data imply a significant and steady increase in temperatures at Stung Treng Ramsar Site. This increase was already described by some authors in the early 21st century (Try & Chambers, 2006) and corroborated by data recorded at the Stung Treng Province weather station, with historical maximum temperatures above 41ºC in some months (Figure 29). The consequences of such an increase in temperature could pose a severe threat to the lifecycle of many of the species inhabiting the site, as well as to the local community livelihoods relying on wetland natural resources.

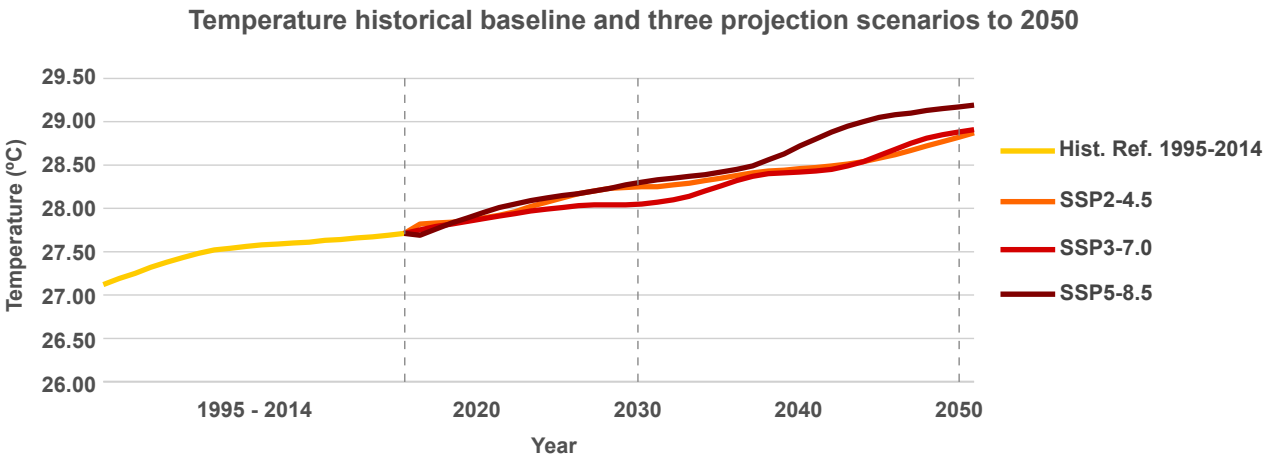


Figure 28. Projected mean temperature in Stung Treng from Multi-Model Ensemble for scenarios SSP2-4.5, SSP3-7.0, and SSP5-8.5, with the reference period (baseline): 1995-2014. (source: from database of CCKP World Bank Group https://climateknowledgeportal.worldbank.org)

To understand both the seasonal distribution of the temperature increase and the possible ranges of the predictions for the period 1940-1959, the following figure is presented. The three scenarios are consistent with a generalized increase in temperatures over 1°C for all the months. In SSP2-4.5 and SSP3-7.0 the ranges indicate rises above 2ºC for all the months with peaks of more than 3ºC in the month of May. This temperature rises of more than 3ºC is extended in time, from December to May for SSP5-8.5.

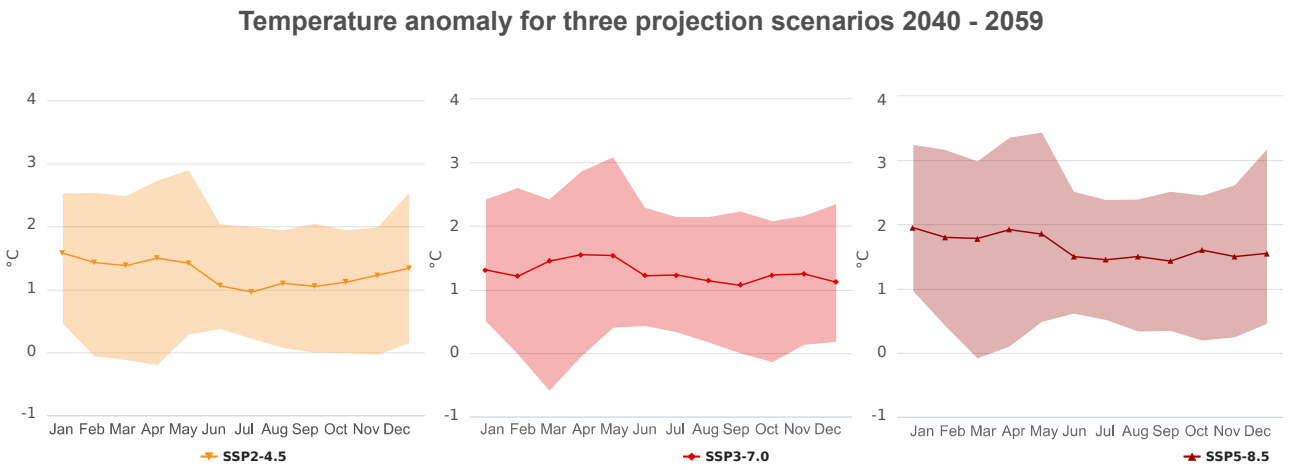


Figure 29. Projected temperature anomaly in Stung Treng from Multi-Model Ensemble for scenarios SSP2-4.5, SSP3-7.0, and SSP5-8.5, with the reference period (baseline): 1995-2014 (source: adapted from database of CCKP World Bank Group https://climateknowledgeportal.worldbank.org).

3. VULNERABILITY ASSESSMENT

3. VULNERABILITY ASSESSMENT

3.1 Habitat Vulnerability

Stung Treng Ramsar Site harbors a unique variety of wetland habitats which are grouped into two broad categories: aquatic habitats (Riverine Zone) including deep pools, sandbars and beaches and strand areas; and terrestrial habitats (Terrestrial Zone) including different forest types found on islands and river banks, as well as “viels” (grasslands) and “treapeangs” (ponds) located on the islands. Climate change is already producing alterations in STRS such as temperature extremes, irregular precipitation and extreme weather events, which in combination with the impact of water infrastructure operations, are leading to unpredictability of the seasonal water levels and duration of floods, causing severe impacts on the wetland habitats such as prolonged periods of exposure, drought and soil erosion. Anthropogenic pressures on STRS wetland habitats including clearing for agriculture, illegal logging and expansion of uncontrolled human settlements have continued unabated in recent decades (Try & Chambers, 2006), and even increased in recent years.

The habitat vulnerability assessment was conducted through consultation with local key informants, field observations and remote sensing information.

Following the IUCN Mekong WET Climate Change Vulnerability Assessment methodology, each habitat was assessed with regards to its baseline conservation status, including non-climate related threats, and level of exposure, sensitivity and adaptive capacity in relation to climate threats. The overall scores are presented in Figure 30. Climate change vulnerability matrices including specific threats to STRS and each habitat, and evaluation of the same elements, were also designed and completed.

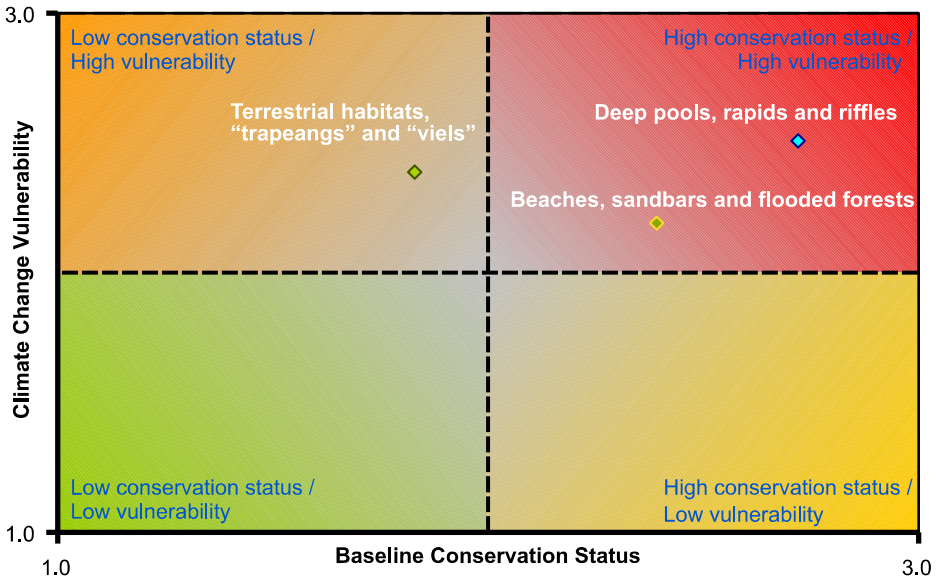


Figure 30: Baseline conservation status and climate change vulnerability of habitats in STRS.

Deep pools and rapids and riffles habitats scored considerably high both on conservation status and vulnerability, because of their huge significance at the most basic level of the entire ecosystem, and due to being highly exposed to all threats and having no adaptive capacity at all without human intervention. Beaches, sandbars and flooded forests scored high on conservation status due their importance for many species and the uniqueness of these habitats, which are also highly vulnerable to climate change as their structure is determined by hydrological conditions. Finally, terrestrial habitats have a medium conservation status due to being much more widespread in the region, but scored high on vulnerability due to being already degraded, lowering their adaptive capacity.

3.1.1 Riverine habitat

A. Deep pools: These habitats have a very high conservation significance both for ecological and economic reasons. There are several Endangered species of fish, in particular flagship species of megafish, and some endemic species for which deep pools are critical habitats for breeding and migration. Similarly, other aquatic habitats including rapids and riffles which form in the shallow parts of the mainstream, providing crucial habitats for keystone species such as *Henicorhynchus siamensis* and *Henicorhynchus entmema*. These habitats play a crucial role as nurseries for all migratory fish before they go downstream in the Mekong and its tributaries throughout the floodplain (ICEM 2013).

In the climate change context, aquatic habitats, including the deep pools and the rapids and riffles zones, have a very high vulnerability and a very low adaptive capacity, as they are completely dependent on water flows and timings. However, considering their vertical structure and depth, exposure and sensitivity to climate change impacts is considered to be medium. Additional impacts from climate change also include disturbances to the deep pool floor from flow change and soil erosion dragging logs, which get trapped and obstruct passages, affecting the activity of megafish (Campbell *et al.,* 2020). The other consequence identified was the inability for some individual trees and patches situated on the edge of rapids and riffles to survive due to unprecedented change of flow (ICEM 2013).

Table 4: Climate change vulnerability matrix for aquatic habitats in STRS.

Threat	Exposure	Sensitivity	Impact Level	Adaptive Capacity	Vulnerability
High temperatures	VH	VH	VH	VL	VH
Increased rainfall in wet season	H	H	H	VL	H
Irregular rainfall in dry season	VH	VH	VH	VL	VH
Longer period of dry season	VH	VH	VH	VL	VH
Invasive species	VH	VH	VH	VL	VH
Development threats					
Decreased flood level & duration	VH	VH	VH	VL	VH
Increased dry season flood	VH	VH	VH	VL	VH
Agricultural conversion	VL	VL	VL	VL	VL
Fire	VL	VL	VL	VL	VL

Note: Very High (VH); High (H), Medium (M), Low (L), Very Low (VL)

B. Beaches, sandbars and flooded forests: The presence of shrubs and trees on these zones, including *Anogeissus rivularis, Acacia harmandiana, Phyllanthus jullienii* and many species of herbs and grasses is vitally important to provide habitats for several ground nesting birds, such as Critically Endangered white-shoulder Ibis (*Pseudibis davisoni*) and for rare fresh water turtles such as Critically Endangered giant softshell turtle (*Pelochelys cantorii*) during the dry season. The impacts of climate change on flooded forest and sandbars stems from the hydrological changes caused by irregular precipitation, as well as their exposure to increased temperatures. Changes in rainfall patterns will cause some plant species to disappear from the habitat if the water level stays too high for longer periods of time and if the current is stronger than usual in wet season. In dry season water levels are too low, habitats will be exposed to high temperatures and drought for longer periods than they can survive.

Alterations to the sandbar and beach habitat structure will change plant species composition and lead to severe impacts on Critically Endangered fresh water turtles and ground nesting birds that use them during breeding season (ICEM 2013). The presence of invasive species, especially *Mimosa pigra*, raises concerns of displacement of the native species (Tan Dang *et al.,* 2012).

Some patches of the unique mixed species flooded forests found in STRS which are situated on very exposed areas close to the river mainstream are highly vulnerable to flow changes and drought, and clumps of dead trees were observed in such areas throughout the site (Box 3). Loss of these habitats would have a profound impact on biodiversity as they are vital feeding grounds for significant keystone fish species (Baird, 2007). These flooded forests also confer STRS with some of the unique landscapes that attract tourism, and therefore their loss and degradation will also have a severe impact on local livelihoods.

Box 3. Downstream Impacts of Dams on the Seasonally Inundated Riverine Forests of the Mekong River in Northeastern Cambodia

On the Mekong River, north of the town of Stung Treng in northeastern Cambodia, and below the border with Laos, lies an area of riverine seasonally flooded forest designated as a Ramsar wetland site because of its exceptional biodiversity and uniqueness. The cumulative impacts of numerous upstream hydropower dams in China and Laos are destroying this vital ecosystem due to the release of water during the dry season, eliminating the critical dry period for flooded forests. The damage being wrought on these flooded forests, and on the various species of aquatic life that depend on them has already been significant. Different species have been affected differently, but some have almost completely disappeared. Others are being increasing impacted. This loss of important habitat is having a significant impact on fisheries, especially for a number of Pangasiidae catfish and cyprinid carps. New upstream dams, and continued high dry-season water levels due to upriver water releases from existing dams, are likely to lead to the increased degradation and possibly the complete eradication of the flooded forests along the mainstream Mekong River in the coming years, unless serious measures are taken to address the problem (releasing less water from upstream dams during the dry season). The potential impacts of dams on the Mekong River are much more significant than the impacts that are likely to occur due to human-induced climate change, although climate change generally remains an important potential environmental threat.

Ian G. Baird[1] and Michael A.S. Thorne[2]. Personal communication, 22nd January 2023.

[1] Department of Geography, University of Wisconsin-Madison
[2] British Antarctic Survey

Sandbars are naturally dynamic systems that shift, dissolve and reform regularly with currents, sedimentation and deposition of coarse organic materials. Bare sandbars and beaches will have low adaptive capacity, and some may be lost, reducing their overall area. Sandbars bearing shrubs will have greater adaptive capacity, however, depending on the resilience of particular shrub species. These habitats are highly exposed to climate change impacts because of increasing erosion from water flow, and direct effects of high temperatures, however, their sensitivity is considered medium, as sandbars covered in vegetation will be more resilient than bare ones, which will experience faster and more profound shifts than usual.

Anthropogenic threats to the landscape, combined with climate change impacts, place these habitats under even further pressure. Operations of upstream dams, compounded by the increased degradation and fragmentation of the landscape, reduce sediment transport and deposition on sandbars, and increase dry season flow and inundation, increasing erosion. In flooded forests, hydropower dams will also reduce wet season inundation levels and periods, but increase dry season flooding and reduce exposure time (ICEM, 2013). The impacts of hydrodam operations have been felt intensely during the recent wet seasons 2019 – 2022, with delayed and reduced peak floods (MRC, 2022) affecting the entire LMB. In STRS, the consequences of the combined impacts of climate change and flood alterations are already leading to loss of sandbars and flooded forest patches.

Table 5: Climate change vulnerability matrix for beaches, sandbars, flooded forest habitats

Threat	Exposure	Sensitivity	Impact Level	Adaptive Capacity	Vulnerability
High temperature	VH	VH	VH	VL	VH
Increased rainfall in wet season	H	M	H	L	H
Irregular rainfall in dry season	VH	VH	VH	L	VH
Longer period of dry season	VH	VH	VH	VL	VH
Invasive species	VH	VH	VH	VL	VH
Development threats					
Decreased flood level & duration	VH	VH	VH	VL	VH
Agricultural conversion	VH	VH	VH	VL	VH
Fire	VL	VL	VL	VL	L

Note: Very High (VH); High (H), Medium (M), Low (L), Very Low (VL)

3.1.2 Terrestrial habitats, “trapeangs” and “viels”

Several new records of herbs were discovered in a detailed biological survey in STRS in 2007, which warrants further research on particular plant groups throughout the habitat, particularly on islands (Bezuijen *et al.,* 2008). Terrestrial habitats are used by a variety of mammal species, including threatened ungulates and primates. “Trapeangs” (ponds) in particular are critical areas for many water birds throughout the year, including Critically Endangered white-shoulder Ibis (*Pseudibis davisoni*). Their locations are relatively close to the river mainstream which put them at risk of being impacted by excessive flooding and exposure. These habitats also face the consequences of temperature increase and are at risk of drying out. “Viels” (grasslands) are covered up to 80% with grass, which increased temperatures will dry excessively, placing them at a high risk of being destroyed by wildfires during dry season (ICEM 2013). In the context of climate change, the terrestrial habitat as a whole is at high risk of climate change impacts. Soil erosion is considered a great threat to the habitat, especially the strand area which will lose the substrate that holds many specialist tree species. Another major threat is increasing temperatures, which increase chances and intensity of wildfires during dry season. Increased wet season water levels will also reduce the availability of terrestrial habitats on low-laying islands in STRS. Riparian vegetation is highly exposed to climate change, which will increase evapotranspiration, run-off, soil erosion and flooding. These habitats are also highly sensitive, due to being already highly degraded in some areas, which also reduces their adaptive capacity (ICEM 2013).

Destruction and degradation of the STRS terrestrial habitats has been on-going over the last two decades, and its intensity has increased in recent years due to the difficulties experienced by the local human population during the Covid-19 pandemic. Human settlements, accompanied by small orchards and cleared patches for buffalo grazing, as well as extensive presence of domestic cattle, are increasingly destroying and degrading terrestrial and riverine habitats throughout forested islands in STRS. Meanwhile, there is little evidence that livelihood activities damaging the habitat documented in recent decades (e.g. Bezuijen *et al*., 2008), such as timber logging and provoked fires have ceased. Alterations to water flows produced by upstream hydroelectric dam operations will also further impact riverine habitats exposed to floods.

Table 6: Climate change vulnerability matrix for terrestrial habitats, “trapeangs” and “viels”

Threat	Exposure	Sensitivity	Impact Level	Adaptive Capacity	Vulnerability
High temperature	H	VH	VH	M	VH
Increased rainfall in wet season	H	VH	VH	M	VH
Irregular rainfall in dry season	H	VH	VH	M	VH
Longer period of dry season	VH	VH	VH	VL	VH
Invasive species	VH	VH	VH	VL	VH
Development threats					
Decreased flood level & duration	M	M	M	VL	M
Agricultural conversion	VH	VH	VH	VL	VH
Fire	VH	VH	VH	VL	VH

Note: Very High (VH); High (H), Medium (M), Low (L), Very Low (VL)

3.2.1 Fish

Stung Treng Ramsar Site provides critical habitats for a great variety of fish species because it comprises several significant habitat types including deep pools, rapids and flooded forests, as well as over 40 small tributaries, receiving water both from their own watershed and Mekong backflows, which makes them extremely important for fish spawning and nursery areas (Try and Chambers, 2006). Over 200 fish species have been recorded in STRS, which is a vitally important site during the annual migration of white fish (ICEM, 2013). Fish vulnerability assessments were conducted through key informant interviews in STRS and further completed in collaboration with experts from Wonders of the Mekong project (Figure 31).

White Fish. The white fish group migrates long distances between the Tonle Sap floodplain and the upper Mekong, including tributaries within the Ramsar Site during the wet season (ICEM, 2013). White fish species favor habitats with higher levels of oxygen in the water. Some of the most significant white fish species found in STRS are fish in genus Channa (e.g. *Channa straita, Channa micropeltes*), and Boeseman (e.g. *Boesemania microlepis*) and several fish species in the genus Cyprinids, such as soldier river barb or “Chhkok” (*Cyclocheilichthys enoplos*) and small mud carp or “Prul/Kralang” (*Cirrhinus microlepis*), as well as the river catfishes in the family Pangasiidae (ICEM, 2013, Hawkins *et al.*,2018). Another significant group includes Henicorhynchus, particularly *H. siamensis* and *H. entmema*, which are keystone species in the lower Mekong ecosystems (Chan *et al.*, 2019). Migrating fish have been impacted by the Don Sahong hydropower dam (just outside of the northern STRS boundary) through changes to their December-February and May-July migration pathways below the Khone Falls (Fukushima *et al.,* 2014). White fish species have to cope with the stress of poor water quality conditions due to climate change impacts, such as floodplain water bodies becoming hot and oxygen depleted to the point of causing mass fish die outs, as well as insufficient food due many ponds drying out. White fish species particularly Henicorhynchus have a very high economic importance and are negatively impacted by mainstream hydropower dams on the Mekong which have contributed to severely reducing fish catch in Cambodia in recent years (Yoshida *et al.*, 2020; MRC, 2022). Other reported threats to migrating white fish species include illegal fishing and overfishing, aquaculture pollution, migratory channel blockage and impact of diseases (Kang and Huang, 2022).

STRS CFis reported particularly low fish catch levels between 2020 and 2022, likely influenced by the weak and short flood peaks experienced in recent years due to water storage for mainstream dams. CFi members throughout STRS are starting to abandon fishing activities altogether because they are no longer profitable. Illegal fishing in the area also continues unabated.

White fish species, including keystone species *Henicorhynchus siamensis* and *Henicorhynchus entmema* are negatively affected by increases in temperatures and irregular precipitation altering the dynamics of essential breeding habitats, and are therefore highly vulnerable to climate change and are under additional pressure from the impacts of hydropower dams and illegal fishing.

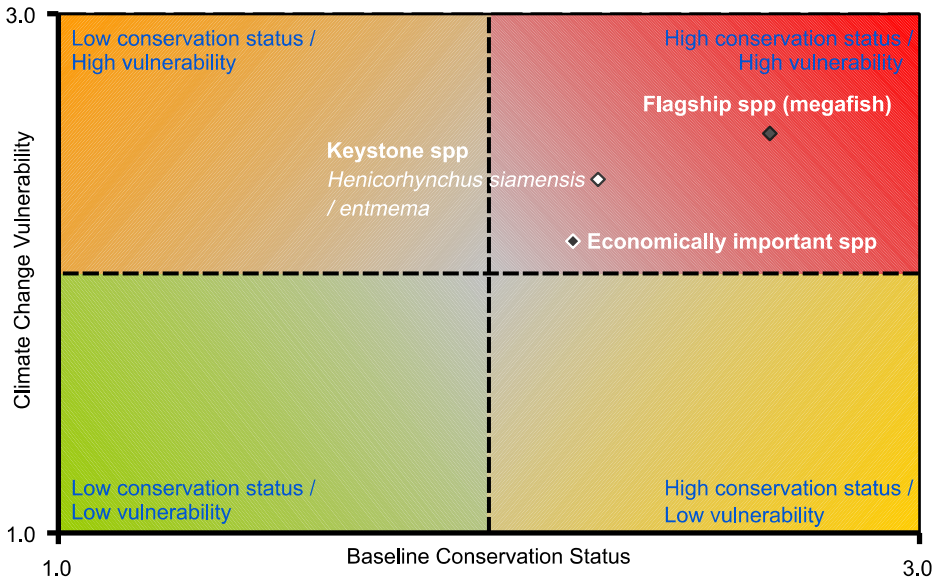


Figure 31: Baseline conservation status and climate change vulnerability of fish in STRS.

Economically important species in STRS include *Mekongina erythrospila, Incisilabeo behri, Labeo pierrei, Phalacronotus spp., Cyclocheilos enoplos, Albulichthys albuloides, Hemibagrus wyckioides* and *Bagarius yarrelli.* This group includes species still commonly encountered, and some that are potentially more resilient to climate change, however overexploitation, illegal fishing and dam disruptions have greatly depleted fish populations. These conditions confer them a high baseline conservation status and a medium to high vulnerability to climate change.

Flagship species: Stung Treng Ramsar Site hosts a highly complex ecosystem and supports aquatic habitats such as deep pools, which are critical for the conservation of flagship megafish species including Critically Endangered Mekong giant catfish (*Pangasianodon gigas*), giant pangasius (*Pangasius sanitwongsei*), Mekong giant salmon carp (*Aaptosyax grypus*), giant barb (*Catlocarpio siamensis*) and Jullien's golden carp (*Probarbus jullieni*); Endangered giant freshwater whipray (*Urogymnus polylepis*) and *Luciocyprinus striolatus;* and Data Deficient *Wallago micropogon* (Campbell *et al.,* 2020). In northern Cambodia, all megafish species have been reported to be in steep decline over the last 20 years, particularly *Pangasianodon gigas*. On the other hand, *Probarbus jullieni* is considered a more commonly recorded species. Over the last two decades, megafishes have become increasingly rare and their body sizes have declined sharply (Figure 32). Megafish species in northern Cambodia are severely threatened by illegal fishing, overexploitation, habitat degradation and the impact of water infrastructure on migration routes and water levels (Campbell *et al.,* 2020). Despite legal protection, megafish and other protected species can still be easily found for sale in local markets along the Mekong River and in Phnom Penh (Asnarith Tep pers. comm)(Box 4). Their large body size, long generation time and long range migratory behavior renders megafish species highly vulnerable to climate and non-climate related threats (Herranz Muñoz and Vong, 2022).

Box 4. Protected fish found in markets in December 2022 and January 2023

Protected fish and megafish species photographed at markets in Stung Treng, Kratie and Phnom Penh in December 2022 and January 2023: a) & e) EN *Pangasianodon hypophthalmus ;* b) VU *Datnoides undecimradiatus;* c) EN *Probarbus labeamajor*; d) CR *Probarbus jullieni*; f) Juvenile EN *Urogymnus polylepis;* g) VU *Bagarius yarrelli* . All of these species are protected in Cambodia under Sub-decree No. 123 (2009).

Photos and reports: Asnarith Tep

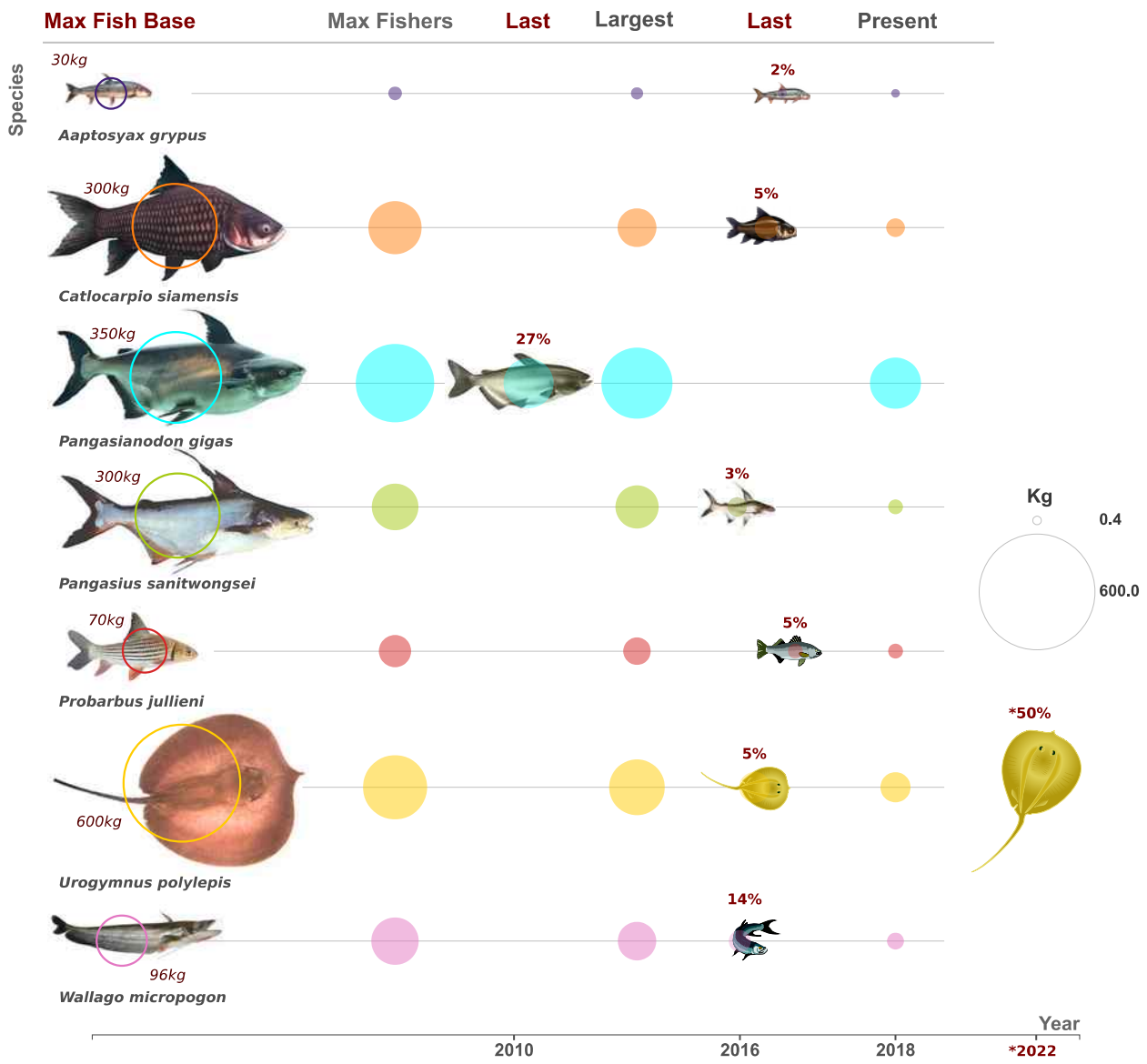


Figure 32. Maximum weight in Fish Base, and information obtained from fishers during interviews by Campbell *et al.* (2020). "Max fishers": maximum weigh fisher thought the species attained; "Last": weigh of the last specimen captured by the fishers; "Largest": weight of largest specimen they captured; and "Present": average weigh the fishers believed the species to be at the time of interviews (2018). Data source: Campbell *et al.,* 2020. **Urogymnus polylepis* rescued in 2022 weighted 300kg.

3.2.2 Birds

Stung Treng Ramsar Site is made up of riverine wetlands holding a variety of unique habitats that play important roles to support many bird species. Flooded forests and channel woodlands with large trees and are important for establishing colonies, nesting, feeding and breeding particularly during December-March. Beaches, sandbars, “trapeangs” and “viels” are particularly important for many water bird species (ICEM, 2013). According to early surveys, up to 17 species of conservation concern were recorded in STRS, including seven listed in threatened categories (Vulnerable to Critically Endangered) (Vong, 2004; Try and Chambers, 2006). Birds in STRS are threatened by habitat destruction and degradation, and poaching. During the current assessment, poachers were found to be using guns, slingshots and nets to target birds throughout STRS. using guns and slingshots to target birds throughout STRS.

FCEE conducted a rapid bird survey at selected locations within STRS and recorded a total of 58 species (Table 8). Species assessments were conducted in collaboration with experts from NatureLife Cambodia / BirdLife International. Additionally, the team conducted a camera-trap survey (see Section 3.2.3) and data was provided from another parallel camera-trap survey conducted in forests nearby by Wildlife Alliance (WA) (Table 7).

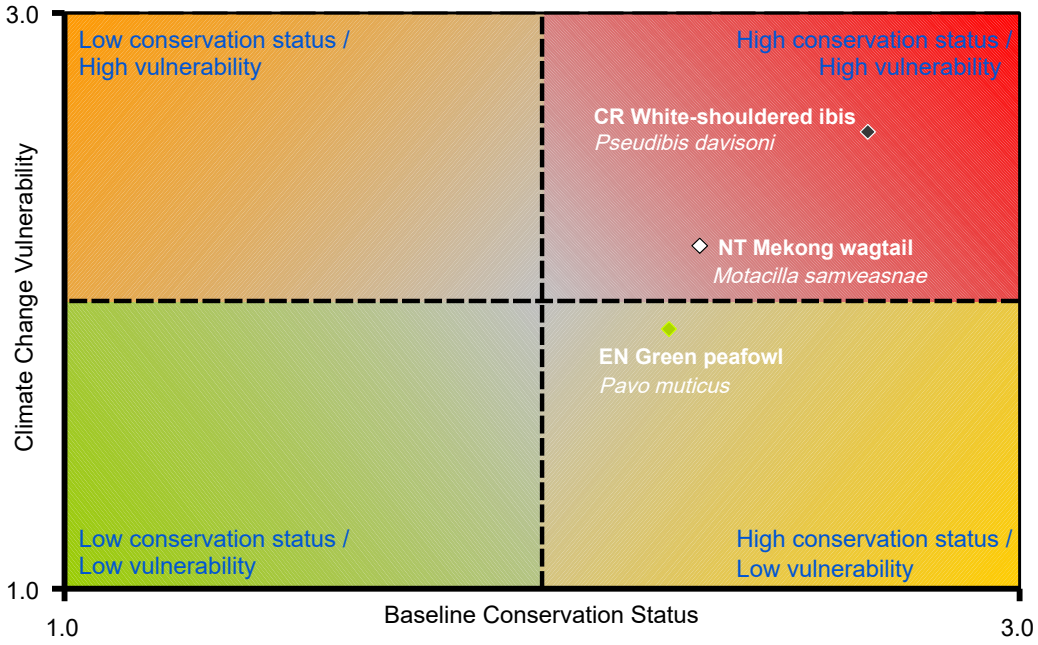


Figure 33: Baseline conservation status and climate change vulnerability of significant bird species in STRS.

Table 7. Species photographed, IUCN Red-List Status, percentage of sites, frequency per 100 camera-trap nights and WA records (*)

Species	Scientific name	IUCN Status	% Sites	Freq. /100CTN	WA
Birds					
Green Peafowl	*Pavo muticus*	**EN**	14.29%	0.52	*
Black Drongo	*Dicrurus macrocercus*	LC	4.76%	0.10	-
Blue-Winged Pitta	*Pitta moluccensis*	LC	4.76%	0.10	*
Brown Fish Owl	*Ketupa zeylonensis*	LC	4.76%	0.10	-
Greater Coucal	*Centropus sinensis*	LC	42.86%	4.69	-
Greater Racquet-Tailed Drongo	*Dicrurus paradiseus*	LC	9.52%	0.21	*
Indian Spot-Billed Duck	*Anas poecilorhyncha*	LC	4.76%	0.21	-
Malayan Night Heron	*Gorsachius melanolophus*	LC	9.52%	0.42	-
Oriental Magpie-Robin	*Copsychus saularis*	LC	4.76%	0.10	-
Red Jungle Fowl	*Gallus gallus*	LC	33.33%	1.98	*
Red-Billed Blue Magpie	*Urocissa erythroryncha*	LC	9.52%	0.31	-
Shikra	*Accipiter badius*	LC	9.52%	0.21	-
Spotted Dove	*Spilopelia chinensis*	LC	4.76%	0.10	-
Stork-Billed Kingfisher	*Pelargopsis capensis*	LC	4.76%	0.10	-
Striated Heron	*Butorides striata*	LC	4.76%	0.10	-
White-Crested Laughingthrush	*Garrulax leucolophus*	LC	28.57%	1.88	*
Crested serpent-eagle	*Spilornis cheela*	LC	-	-	*

Table 8. Bird species sighted during the rapid bird survey in STRS, Khmer name, English name, scientific name and IUCN RL status.

Khmer Name	English Name	Scientific Name	IUCN Status
ខ្ទប់ដីមេគង្គលើ	Mekong Wagtail	*Motacilla samveasnae*	**NT**
ស្មោញ	Oriental Dater	*Anhinga melanogaster*	**NT**
សេកក្បាលប្រជេះ	Grey-Headed Parakeet	*Psittacula finschii*	**NT**
សេកសក ឬ សេកយី	Red-Breasted Parakeet	*Psittacula alexandri*	**NT**
ចាបក្រចឬពរពេចក្រច	Yellow-vented Bulbul	*Pycunonotus finlaysoni*	LC
ពរពេចក្បាលខ្មៅចុងស្លាបស	Sooty-headed Bubul	*Pycunonotus aurigaster*	LC
ពរពេចត្រចៀកឆ្នូត	Streak-eared Bubul	*Pycunonotus blanfordi*	LC
ទៀវព្រៃ	Dollar Bird	*Eurystomus orientalis*	LC
ទៀវ	Indian Roller	*Coracias benghalensis*	LC
ខ្លែងឆាបល្មើងក្រមៅ	Brahminy Kite	*Haliastur indus*	LC
ស្វាំងស្លាបឆែក	Shikra	*Accipiter badius*	LC
ស្វាំងកំប៉ោយខ្មៅស	Black Baza	*Aviceda leuphotes*	LC
ស្វាំងលលក	Black-Shoulder Kite	*Elanus caeruleus*	LC
ប្រម៉ង	Osprey	*Pandion haliaetus*	LC
ចាបពូក	Baya Weaver	*Ploceus philippinus*	LC
ខ្លែ ងស្រោក	Barn Owl	*Tyto alba*	LC
ឆ្នងឆ្នតល្មើង	Rufous Treepie	*Dendrocitta vagabunda*	LC
ឆ្នងឆ្នតខ្ទៀវ	Red-billed Blue Magpie	*Urocissa erythrorhyncha*	LC
ទ្រមាក់ខ្លា	Racket-tailed Treepie	*Crypsirina temia*	LC
ឆ្នងឆ្នតខ្លួន ត្នោ ត	Eurasian Jay	*Garrulus glandarius*	LC
អន្ទេ បទងកន្ត្រែ	Greater Racket-tailed Drongo	*Dicrurus paradiseus*	LC
ត្រដេវក្បាលត្នោត	Chestnut-Headed Bee-Eater	*Merops leschenaulti*	LC
ត្រដេវតូច	Little Green Bee-eater	*Merops orientalis*	LC
ពពូលជើងល្មើង	Yellow-footed Green-pigeon	*Treron phoenicopterus*	LC
លលកបាយ	Spotted Dove	*Streptopelia chinensis*	LC
លលកទ្រាំង	Red-Collared Dove	*Streptopelia tranquebarica*	LC
ទាកាបព្រៃ	Indian Spot-Billed Duck	*Anas poecilorhyncha*	LC
កុកខ្មៅ ឬ ឆ្លើមអណ្តើក	Black Bittern	*Dupetor flavicollis*	LC
ក្រសាប្រជេះ	Grey Heron	*Ardea cinerea*	LC
ចាបដង្កូវពោះល្មើង	Yellow-bellied Prinia	*Prinia flaviventris*	LC
ងាវកក	Stork-billed Kingfisher	*Pelargopsis capensis*	LC
កដបខ្មៅស	Pied Kingfisher	*Ceryle rudis*	LC
សារិកាកែវក្របី ឬ រីកក្របី	White-vented Myna	*Acridotheres grandis*	LC
សារិកាកែវគោ ឬ រីកគោ	Common Myna	*Acridotheres tristis*	LC
	Chestnut-tailed Starling	*Sturnus malabaricus*	LC
ចាបតេត	Common Tailorbird	*Orthotomus sutorius*	LC
ចាបតេតព្រៃ	Dark-Neck Tailorbird	*Orthotomus atrogularis*	LC
ចាបព្រៃទ្រូងល្មើងឆ្នូត	Pin-striped Tit-Babbler	*Macronus gularis*	LC
សេកក្រិច	Vernal Hanging-Parrot	*Loriculus vernalis*	LC
ល្វាចេក	Oriental Magpie Robin	*Copsychus saularis*	LC
ចេកចុំក្បាលខ្មៅ	Black-headed Oriole	*Oriolus larvatus*	LC
ស្វិតទេចៅ	Common Iora	*Aegithina tiphia*	LC
កេងកងតូច	Oriental Pied Hornbill	*Anthracoceros albirostris*	LC
ចេកទេសតូច	Small minivet	*Pericrocotus cinnamomeus*	LC
ចេកទេសធំ	Scarlet Minivet	*Pericrocotus speciosus*	LC
ប៉ោលគោក	Lineated Barbet	*Megalaima lineata*	LC
ប៉ោលគោកអំបុក	Coppersmith barbet	*Psilopogon haemacephalus*	LC
ត្រសេះត្នោត	Rufous Woodpecker	*Micropternus brachyurus*	LC
ត្រសេះបៃតងក្បាលក្រហម	Lace Woodpecker	*Picus vittatus*	LC
ត្រសេះខ្នងភ្លើង	Common Flameback	*Dinopium javanense*	LC
បាគូ	Common Hoopoe	*Upupa epops*	LC
ចាបចង្រៃង់ចុងខ្នងស	White-rumped Munia	*Lonchura striata*	LC
	Greater coucal	*Centropus sinensis*	LC


Malayan Night Heron (*Gorsachius melanolophus*)


Coppersmith barbets (*Psilopogon haemacephalus*)

Species assessed

Mekong Wagtail. The Mekong wagtail (*Motacilla samveasnae*) was only recently described from the lower Mekong in north-east Cambodia and southern Lao PDR (Duckworth *et al.,* 2001). Within Stung Treng Ramsar Site this species uses particular habitats such as isolated trees on wide river channels and sandbars on channel mosaics (Duckworth *et al.,* 2001). Mekong wagtails in STRS were recorded as dispersed but widely present within wider channels in November, and in April-May in rocky woodlands or near permanent dry season water channels (ICEM, 2013). This small birds showed preference for wider channels (more than 100m across) and sandbars, rocky outcrops, bushes or dead trees sticking out of the water surface, and were rarely seen on the river banks or forested islands (Duckworth *et al.,* 2001). Breeding Mekong wagtails are strongly associated with fast-flowing, channels braided among sandbars, rocks and bushes adapted to long periods of submersion, mainly *Homonoia riparia* (Davidson *et al.,* 2001). Alterations to the seasonal levels of water flowing in channels produced by hydropower dam operations would have severe consequences on vital microhabitats for the Mekong wagtail. On the other hand, this species may not be as impacted by human disturbance and poaching as others in the area (Davidson *et al.,* 2001).

During the current assessment, individuals and pairs of Mekong wagtails were readily observed throughout STRS, suggesting that the local population is able to maintain healthy numbers. In contrast, during the rapid bird survey, the difference in general bird numbers between northern and southern areas of STRS was noticeable, with a lot fewer birds in the south where active bird nets were also found. Considering its highly localized and restricted geographical distribution and extremely high habitat specificity, Mekong wagtails are considered to by highly vulnerable to climate change impacts that will alter habitat structure in the region.


Mekong wagtail (*Motacilla samveasnae*). Photo: Senglim Suy / FCEE

Species assessed

Green peafowl: Endangered green peafowl (*Pavo muticus*) was reported to inhabit Koh Khon-kheo and other large islands in STRS (ICEM, 2013). Green peafowl were photographed by camera traps during the current assessment at several large islands and on the forest west of STRS between August and December 2022. Green peafowl is distributed widely over subtropical and tropical forests in south and Southeast Asia, and is considered to be extinct in Malaysia (Brickle, 2002; Kong *et al.,* 2018). Populations of the species have disappeared from southern China and are decreasing rapidly in both southwest China and Southeast Asia due to habitat conversion and poaching (Kong *et al*., 2018). Green peafowl prefers habitats with dry deciduous forest with acces to permanent water with low levels of human disturbance. Green peafowl populations have been severely impacted by human activities, including disturbance from nearby settlements and infrastructure development, as well as loss of access to permanent water, and most significantly poaching, resulting in the species currently suffering from low genetic diversity and high levels of inbreeding. Green peafowl however, seem to be moderately resilient to climate change impacts, and extensive suitable habitats still remain in Southeast Asia (Dong *et al.,* 2021). In Cambodia, habitat restoration activities, such as recovery of “trapeangs” (ponds) are crucial to maintain and increase the national population. Green peafowl in STRS are therefore considered to have a high conservation status and medium vulnerability to climate change.

White-shouldered ibis (*Pseudibis davisoni*). The white shouldered ibis is considered as the most threatened and most rapidly declining waterbird in Southeast Asia. It is estimated that there are 1,000 Critically Endangered white shouldered ibis in terms of global population, and 95% of white-shouldered ibises survive in northern Cambodia (Bird-Life International, 2018, Loveridge *et al.,* 2017). White-shouldered ibis prefer habitats comprising ponds with high vegetation cover on the bank substrate, large river channels and low levels of human disturbance (Wright *et al.,* 2010; 2012). Within STRS, habitats on river channels with large extents of exposed sand are highly suitable for white-shouldered ibis to forage, and breeding occurs between December and March (ICEM, 2013). White-shouldered ibis populations have declined dramatically due to conversion of wetlands, degradation of river channels, and poaching for adults, chicks and eggs (BirdLife International, 2018). According to local informants, white-shouldered ibis inhabit areas of little human disturbance on the central section of STRS. Dam operations leading to changes to channel structure and loss of sandbar habitats provoked by increased water flows during dry season will negatively impact the STRS population of white-shouldered ibis. Impacts of climate change on the species include irregular precipitation leading to loss of suitable habitats, and negative effects of temperature increase on the egg incubation period. These factors considered together render the white-shouldered ibis in STRS of a very high conservation status and highly vulnerable to climate change.

3.2.3 Mammals

The Stung Treng Ramsar Site mammal species assessment involved two research approaches: a rapid camera-trap survey, and a questionnaire to gather information on historical and current presence of target species, as well as to discern the threats that mammal species face in the area. Local key informants also provided significant information for the assessment. Wildlife Alliance (WA) also conducted a camera trap survey at Community Forests nearby, provided data and contributed to the assessments.

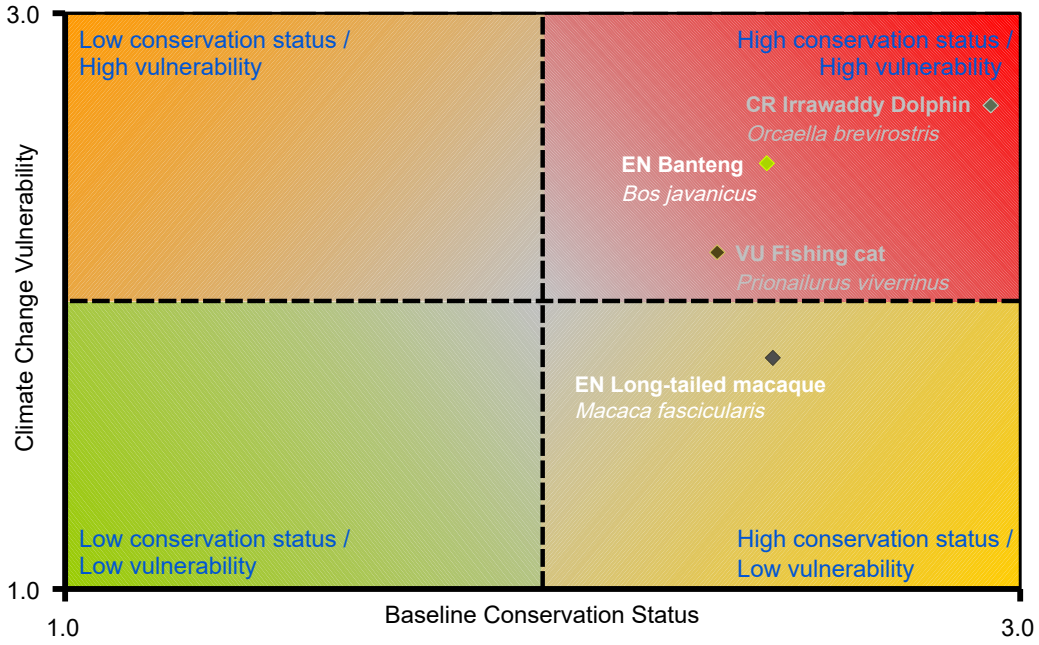


Figure 34: Baseline conservation status and climate change vulnerability of significant mammal species in STRS.

Critically Endangered Irrawaddy dolphins (*Orcaella brevirostris*) have recently disappeared from the area however, there is a chance the species may return one day. The dolphins were the most important flagship species at the site, and would have very high conservation status and climate change vulnerability. Endangered banteng (*Bos javanicus*) was detected in and around STRS and considering their reduced global population, the high incidence of threats in the area, and their dependence on terrestrial habitats which are being rapidly converted and degraded, the species has a high conservation status and is also highly vulnerable to climate change impacts. Endangered long-tailed macaque (*Macaca fascicularis*) populations are declining sharply due to being highly sought after by poachers, but they are highly adaptable to a variety of habitats and levels of degradation. The species has therefore a high conservation status and moderate vulnerability to climate change. It is unclear if Vulnerable fishing cats (*Prionailurus viverrinus*) are still present in STRS, but if they were, they would have a high conservation status due to how rare the specie is in the entire region, and moderate to high climate change vulnerability due to being highly associated with wetland habitats, but adaptable to some degree of degradation.

Camera-trap survey

Camera-trapping was used to primarily detect large and medium-sized mammals, focusing on detecting presence of Vulnerable fishing cat and smooth-coated otter. Camera locations were selected conducting a stratified random sampling, which covered all habitat types at the site, over a 2 x 2 km grid. In some instances, cameras were placed where villagers informed of potential recent sightings of fishing cat.

A total of 26 cameras were installed from August 2022 to December 2022, remaining at the same location for approximately two months. Results were obtained for 21 locations over 959 camera-trap days. Cameras recorded presence of 13 mammal species, including Endangered banteng (*Bos javanicus*), and long-tailed macaque (*Macaca fascicularis*); as well as 16 birds including Endangered green peafowl (*Pavo muticus*) (Table 9). Wildlife Alliance (WA) conducted a camera-trap survey simultaneously in and around Community Forests (CF) Chom Pich and Prochum Met, situated west of STRS. Additional species photographed by WA were incorporated in the results table below, and include detection of Endangered banteng and Vulnerable gaur (*Bos gaurus*).

Table 8. Species photographed, IUCN Red-List Status, percentage of sites, frequency per 100 camera-trap nights and WA records (*)

Species	Scientific name	IUCN Status	% Sites	Freq. /100CTN	WA
Mammals					
Banteng	*Bos javanicus*	**EN**	4.76%	0.10	*
Long-Tailed Macaque	*Macaca fascicularis*	**EN**	4.76%	0.10	*
Gaur	*Bos gaurus*	**VU**	-	-	*
Burmese Hare	*Lepus peguensis*	LC	9.52%	0.63	-
Common Palm Civet	*Paradoxurus hermaphroditus*	LC	4.76%	0.10	*
Greater Bandicoot Rat	*Bandicota indica*	LC	4.76%	1.04	-
Indochinese Ground Squirrel	*Menetes berdmorei*	LC	52.38%	4.80	-
Leopard Cat	*Prionailurus bengalensis*	LC	23.81%	0.63	-
Malayan Porcupine	*Hystrix brachyura*	LC	9.52%	0.42	*
Northern Treeshrew	*Tupaia belangeri*	LC	9.52%	0.21	-
Small Asian Mongoose	*Prionailurus bengalensis*	LC	23.81%	3.34	-
Small Indian Civet	*Viverricula indica*	LC	14.29%	0.31	*
Variable Squirrel	*Callosciurus finlaysonii*	LC	19.05%	0.83	*
Wild Boar	*Sus scrofa*	LC	4.76%	0.21	*
Northern Red Muntjac	*Muntiacus vaginalis*	LC	-	-	*
Lesser Oriental Chevrotain	*Tragulus kanchil*	LC	-	-	*
Crab-eating mongoose	*Herpestes urva*	LC	-	-	*
Bat Spp		NA	19.05%	0.63	
Rat		NA	33.33%	1.67	
Reptiles					
Common Water Monitor	*Varanus salvator*	LC	14.29%	0.31	-
Bengal Monitor Lizard	*Varanus bengalensis*	NT	-	-	*
Human and domestic					
Human		NA	71.43%	20.54	-
Cat		NA	4.76%	1.04	-
Chicken		NA	4.76%	0.10	-
Cow		NA	9.52%	0.52	-
Dog		NA	33.33%	1.88	-
Water Buffalo		NA	23.81%	1.67	-

Large, forested and mostly uninhabited islands in STRS represent essential habitats for the species detected. Koh Khan Kham and Koh Phone Kep islands host a high percentage of the mammal species detected by the cameras. The presence of hog deer (*Axis porcinus*) -listed as Endangered- on the island of Koh Phone Kep, was reported to by local MoE rangers. Bird species such as green peafowl (*Pavo mitucus*) -listed as Endangered- and great hornbill (*Buceros bicornis*) -listed as Vulnerable- are also present in these islands. Vulnerable fishing cat (*Prionailurus viverrinus*) and smooth-coated otter (*Lutrogale perspicillata*) were not detected during the survey, however local informants reported that both species tend to use STRS islands and sandbars in the dry season.

The only felid present was leopard cat (*Prionailurus bengalensis*) -listed as Least Concern-, photographed at five locations, on Koh Khan Kham, Koh Phone Kep, and in the forest to the west of STRS. This species is considered one of the most abundant felids in Southeast Asia (Mohamed *et al.,* 2016) and its presence in STRS had already been reported (Try & Chambers, 2006). The species reaches higher abundance in evergreen forests (Rostro-García *et al.,* 2021), likely due to this habitat harboring a higher biomass of small rodents, especially during the dry season (Petersen *et al.,* 2019). The leopard cat is an extraordinarily adaptable species, capable of living in human-modified landscapes (Mohamed *et al.,* 2013). This is a generalist carnivore, whose diet is largely based on small mammals, but also predates on lizards, birds, insects, and amphibians (Rabinowitz, 1990; Rajaratnam *et al.,* 2007). As a result of these characteristics, this species is an effective agricultural pest controller (Silmi *et al.,* 2021). This ecological role is especially important in the Stung Treng Ramsar Site, where the cultivation of corn or rice are increasingly widespread.

Domestic cattle, cats and dogs were photographed roaming freely on some of the larger islands without established villages, which poses an additional threat of disease transmission and wildlife depredation. The cameras also photographed several poachers with guns and others with slingshots (for birds), both within and nearby STRS. Poaching is a severe threat to wildlife in STRS, which has taken an incredibly high toll over decades, resulting in severely diminished diversity and abundance, particularly of medium to large mammal species.

Overall, considering the results from both the current assessment and the WA survey, it is highly positive for the conservation status of STRS and surrounding forests to confirm presence of threatened ungulates (banteng and gaur), however many species of large and medium sized mammals are already missing from the site and the abundance of the species recorded is alarmingly low.

Species Assessed

Banteng (*Bos javanicus*)

This bovine species is found throughout Southeast Asia, with populations throughout its range suffering rapid decline due to extensive habitat loss and hunting (Gardener *et al.,* 2016). Banteng is reported to be extinct in south Malaysia, Bangladesh, and India (Gardner *et al.,* 2016 and references therein). Bantengs show a preference for low elevation flat open areas (Chaiyarat *et al.,* 2019) and are reported to occur mainly in open deciduous dipterocarp forests and denser mixed deciduous forests (Gray, 2012). In Cambodia, the northeast and particularly the Eastern Plains Landscape, is considered a global stronghold, containing an estimated 60% of the remaining global population (Grey *et al.,* 2012; 2016). On the Northern Plains, a banteng population persists in Phnom Tnout Phnom Pok Wildlife Sanctuary (Our Future Organization pers. comm.). On the Eastern Plains Landscape, bantengs have been found to persist outside of protected areas, within an economic land concession in Kratie province (Chan *et al.,* 2020). A multi-year camera-trap survey in the southwest of the country concluded banteng had been extirpated from the area (Gray *et al.,* 2017), however, in 2018 a small population was found to persist in the Prambei Mum Community Forest, Kampong Speu (Gish *et al.,* 2021). Camera-trapping in Prochum Met and Chorm Pich Community Forests, situated northwest of STRS, detected a small population consistently at cameras within the former site over a six-month period. Small herds comprised of bachelor groups and adult females with juveniles were photographed in open grassland and in sparsely forested areas of bamboo near streams.

An individual banteng was also photographed on a camera located in one of the largest uninhabited islands within STRS (Koh Khan Kham).The banteng was photographed at a site 50m from the water and in mixed semi-evergreen forest. This detection is consistent with the species reported preferred habitats which are mixed deciduous / semi-evergreen forest or deciduous forest (Phan & Gray, 2010) and open canopy mosaic habitats with grassland (Duckworth *et al.,* 1999). Despite the fact that this species shows a negative spatial interaction with free-range livestock (Pudyatmoko, 2017 in Rahman *et al.,* 2019), livestock was also captured at this station. Due to the possibility of hybridization, some authors have warned that interaction between livestock and banteng can threaten the genetic integrity of the wild species. Furthermore, banteng appears to be particularly susceptible to several livestock diseases (Wharton, 1957; Tun Yin, 1967; Salter, 1983 in Gardner *et al.,* 2016).

Banteng's habitat preferences combined with the estimated range of a herd of over 40 km^2 (Prosser *et al.,* 2016) indicate that the patches of forests within and around STRS are of particular importance to provide quality habitat for this population. Terrestrial forests in STRS are highly vulnerable to climate change impacts, due to their already degraded state, increased risk of fires and on-going conversion and degradation.

The conservation status of Banteng in STRS is therefore very high, and the species is also considered highly vulnerable to climate change.

Long-tailed macaque (*Macaca fascicularis*)

Long-tailed macaques are distributed across southeast Asia, ranging east-west from Myanmar to the Philippines and north-south from Northern Thailand to the southern islands of Indonesia. This primate species is recognized to be widespread and rapidly declining, and they were only up listed to Endangered in 2022, from Vulnerable in 2021, and Least Concern previously, due to the severe impact of poaching throughout their range, particularly for their use in the biomedical industry, seeing its price quadrupled since 2019 (Hansen *et al.,* 2022).This species is extremely adaptable and can be found in a wide range of habitats such as primary and secondary forests, altered and humanized habitats, but are most characteristic in mangrove, swamp and wetland areas (Fauzi *et al.,* 2020). Long-tailed macaques are widespread throughout all of Cambodia, in areas such as the lowlands, evergreen, and dry dipterocarp forest of Samkos Wildlife Sanctuary in the Cardamom Mountains (Coundrat *et al.,* 2011), swamp forest in Prek Toal Core Area of Tonle Sap Lake (Campbell *et al.,* 2006), along the Mekong River in the Kratie Province (Bezuijen *et al.,* 2008), in the northeastern part of Cambodia (Fuentes, 2011), and in the mangroves of Peam Krasop Wildlife Sanctuary (Thaung *et al.,* 2018). By 2008, the population of long-tailed macaque along the Mekong River was reported to be in steep decline, due to large-scale harvesting for the wildlife trade (Bezuijen *et al.,* 2008).

Long tailed-macaques were detected at a location on the mainland, west of the river, in mixed DDF, near degraded areas. STRS hosts significant habitat for the conservation of the species, as it favors forested wetlands and the site retains large areas with only low disturbance levels. However, obtaining only one photo-capture throughout the entire survey is a highly concerning result, and suggests that poaching for macaques has been intense.

In Stung Treng Ramsar Site, long-tailed macaques were previously reported on some of the larger islands (Timmins, 2006). During the current assessment, only one record of the species was obtained, however, the species is likely still present within some the larger islands. The long-tailed macaque is a generalist and highly adaptable species that is likely to be resilient to climate change impacts. STRS hosts significant habitat for the species, however targeted poaching remains a severe threat. Therefore, STRS is of high conservation value for the species, which has a medium climate change vulnerability score.

Irrawaddy dolphin (*Orcaella brevirostris*)

Irrawaddy dolphins are found in coastal waters from the Bay of Bengal to Palawan (Philippines), and south to northern Austarlia. The also inhabit three major tropical river systems in Southeast Asia: the Ayerwady (Myanmar), the Mahakam (Indonesia) and the Mekong (southern Lao PDR, Cambodia and Vietnam). In Cambodia, Irrawaddy dolphins were historically present in the Tonle Sap great lake, throughout the entire Mekong River and along the 3S rivers (Baird and Beasley, 2005). The Mekong population of Irrawaddy dolphins is currently listed as Critically Endangered and its distribution is limited to the stretch between Kratie town and the border with Lao PDR. In the last two decades, despite conservation efforts, this population has declined rapidly due to human-induced mortality, mainly by gill net entanglement and electrocution (from illegal electro-fishing), but disease and severe habitat disturbance from dam construction have also played a role in fatalities. The last resident dolphin at the deep pool area between Cambodia and Lao PDR died in February 2022 .

In December 2022, three dolphins were found dead over a seven-day period, bringing the total number of dead dolphins to 29 since 2020 (WWF, 2022). Their plight has attracted the attention of international press during 2022, and in-depth articles were published in outlets such as The Third Pole[1] and Al Jazeera[2] . Reports since the late 1990s coincide in highlighting the need for more resources for patrolling, better management of dolphin areas and more effective law enforcement, however despite efforts by NGOs, government agencies and local communities, measures implemented to date have failed to protect the species (Khan and Willems, 2021). The situation is dire considering the number of deaths since 2020 (29), together with the decrease of overall population numbers (Figure 35).

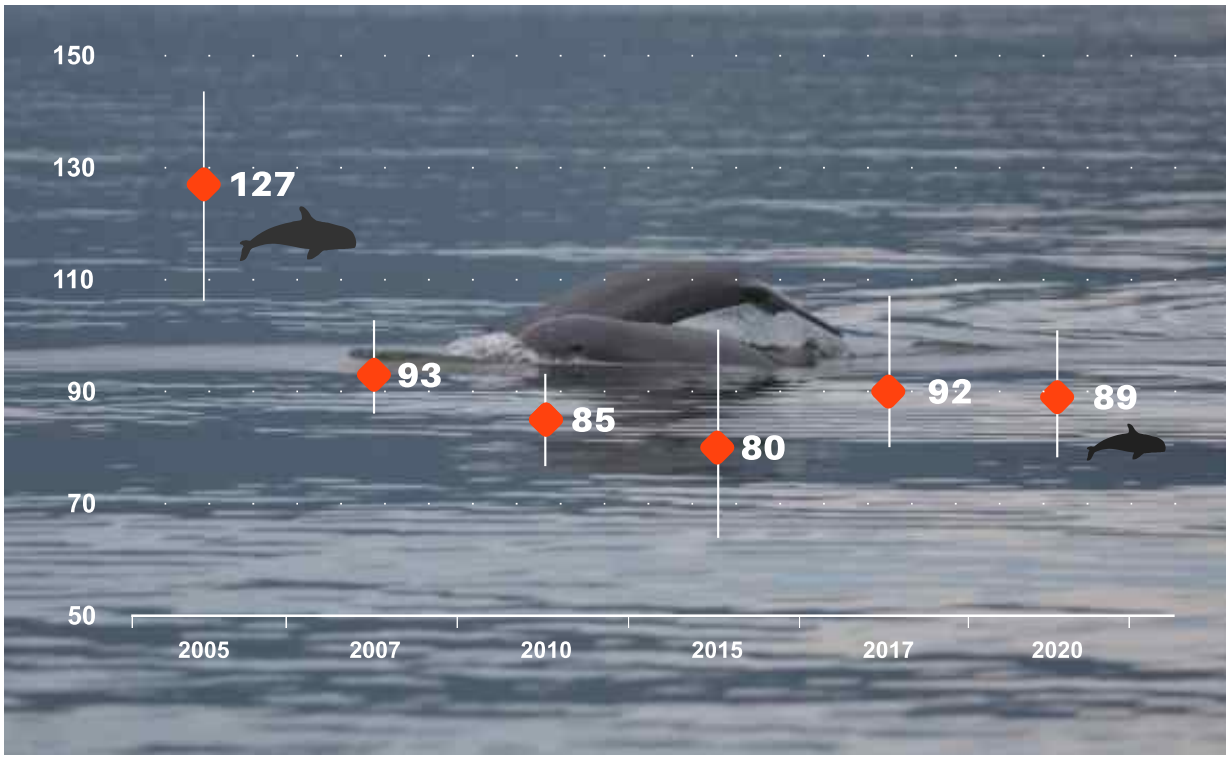


Figure 35. Mekong Irrawaddy dolphin population estimate 2020. Data source: Eam *et al.,* 2020

These shy dolphins are reported to swim throughout large stretches of the river during the wet season when the water levels are high, and retreat to the deep pools during the dry season. One of the dolphins recovered during December 2022 was found at a deep pool area just south of Stung Treng town. If conservation measures were to improve, dolphins could potentially return to use and perhaps settle again around STRS, where the species was a vital flagship for conservation activities and local community tourism enterprises, as well as a much revered icon of the Mekong River. It is therefore critical to continue to highlight the importance of STRS for Irrawaddy dolphins, even though the species is currently locally extinct.

1 https://www.thethirdpole.net/en/nature/cambodia-strives-to-protect-last-mekong-irrawaddy-dolphins/

2 https://www.aljazeera.com/news/2022/12/8/cambodias-mekong-dolphin-is-dying-despite-efforts-to-save-it

Fishing cat identification questionnaire

Fishing cats (*Prionailirus viverrinus*) are medium-sized, stocky and muscular, weighing from 7 to 16 kg, with body length of 65 – 85 cm and a relatively short tail of 20 – 30 cm. Their short, coarse fur is gray or olive brown with black lines on the face, neck and shoulders, small black spots and lines throughout the body, and white underparts. Fishing cats are the largest of the Prionailurus genus and are often confused with leopard cats (*Prionailurus bengalensis*), which are smaller (approximately the size of a domestic cat), more slender with a longer tail, and brighter fur with leopard-like rosettes.

Fishing cats range from South to Southeast Asia, closely following the patchy distribution of wetlands. Major strongholds are found in South Asia, but the Southeast Asian population is in a much more perilous situation. (Mukherjee *et al.,* 2016). Habitat loss, poaching, persecution and vehicle strikes are the main threat to their survival throughout their range. In Cambodia, a population of fishing cats persists in the coastal mangroves (Thaung *et al.,* 2017), and wetlands around the Tonle Sap and the Mekong River are priority areas for targeted surveys to search for other possible remaining populations (Adhya *et al.,* 2022).

The seizure of a dead individual near the Tonle Sap floodplain in 2018 suggested that fishing cats might still inhabit the area. In October 2022, a local MoE ranger obtained the first confirmed photograph of fishing cat in Boueng Chmmar Ramsar Site, within the Tonle Sap Biophere Reserve.

In Stung Treng Ramsar Site, reports mention presence of fishing cat as a rare species suffering hunting pressure (Smith, 2001 in Try & Chambers, 2006). In 2021, FCEE investigated a video in social media showing a dead fishing cat which may have come from Stung Treng, further suggesting that the area might of high priority to detect remaining populations of the species.

In Cambodia, most people use the term “kla trey” loosely to refer to both fishing cat (*Prionailirus viverrinus*) and leopard cat (*Prionailirus bengalensis*). Considering this, the authors designed a questionnaire with ten questions including photo identification questions, targeted to ascertain whether people could properly identify fishing cat. The questionnaire also included sections on threats to wildlife and wildlife conflict. A total of 25 people were interviewed at villages within STRS.

Results of the questionnaire showed that most people interviewed in STRS could correctly identify “kla trey” as fishing cat, with 56% giving six to ten correct answers. However, only 16% of participants recognized the correct name (“chmmar dav”) and description for leopard cat, and therefore results are likely to still hold a lot of uncertainty (Figure 36). Fishing cats were not detected during the camera-trap survey, however the high suitability of the STRS wetland habitats and surrounding forests, would make the area an important refuge for the potential remaining population.

Further questionnaire results showed that participants could also recognize Endangered large-spotted civet (*Viverra megaspila*) and jungle cat (*Felis chaus*), and most thought that these species as well as Vulnerable smooth-coated otters (*Lutrogale perspicillata*) are still present in STRS (Figure 36).

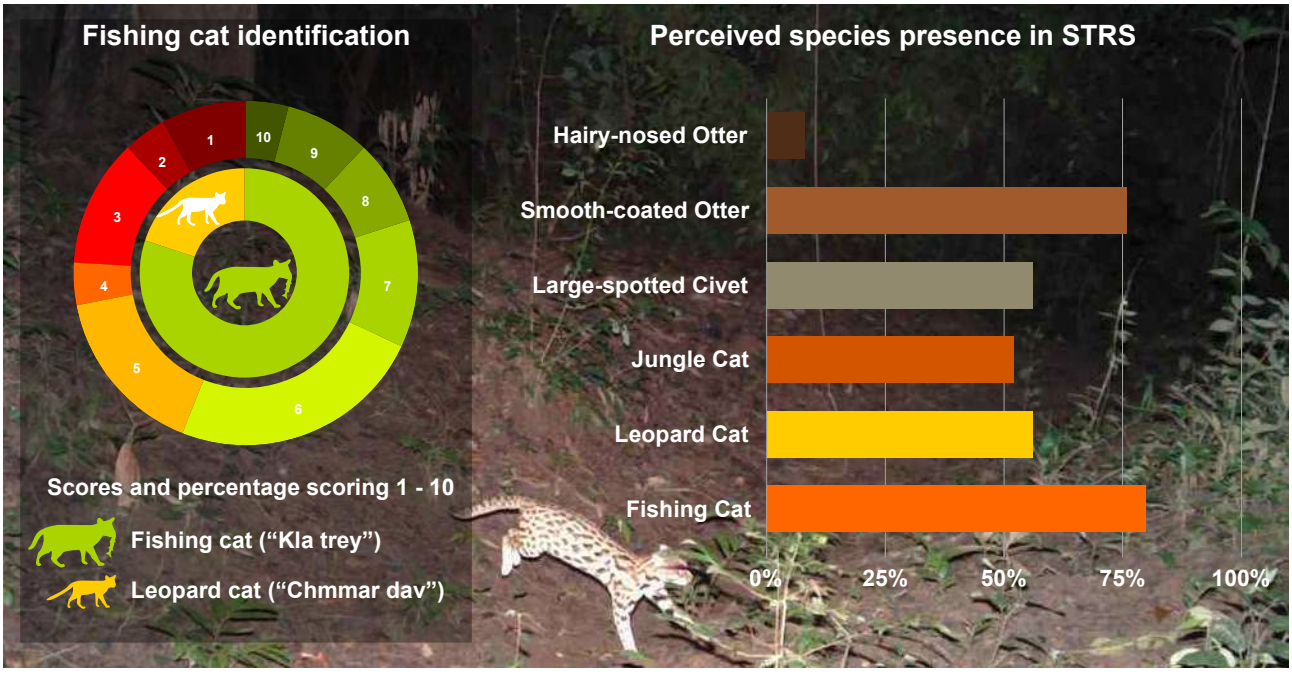


Figure 36. Left: Proportion of participants scoring 1 -10 on the fishing cat identification questionnaire (outside), and proportions giving appropriate descriptions of fishing cat (“kla trey”) and leopard cat (“chmmar dav”). Right: Percentage of participants who believed the listed species are still present in STRS.

Threats Questionnaire

Hunting/poaching is the largest threat mammal species STRS. This is the main reason why many large mammals were reported locally extinct or near extinction in the area (Bezuijen *et al.,* 2008). According to the threats questionnaire, otters, fishing cats and leopard cats may also face human-wildlife conflict. Vulnerable smooth-coated otters are likely to be still present in STRS, and villagers described a high incidence of conflict when otters or cats raid and break fishing nets, however the great majority of respondents reported that usually incidents do not prompt retaliation. These species are also targeted to some degree, however these results may correspond more to past times when skins would hold high economic value.

Participants reported most hunting is destined for household consumption, which is likely to correspond with targeting more nutritionally valuable species such as wild boar and muntjac. Wild meat consumption in the area is concerning, not just because of the damage to wildlife populations, but also due to being recognized as one of the main potential sources of zoonotic disease spread (IPBS, 2020).

Another concerning aspect revealed during the interviews was that 40% of respondents mentioned snares as the most popular hunting technique (Figure 37). This method is highly damaging as it is a non-selective capture method that can cause a highly negative impact on non-target species (Gray *et al.,* 2017). Furthermore, another 33% mentioned the use of guns or home-made guns (poachers with guns were also photographed by the camera-traps), which makes law enforcement activities even more complex and dangerous to conduct effectively.

Unless the pressure on wildlife and habitats is mitigated, the remaining large and medium sized mammal populations within STRS will continue to decline at an accelerated rate. Effective conservation measures, including strengthened law enforcement, improved management and zoning, support for alternative livelihoods, raised awareness and sustainable financing are urgently needed to ensure survival of key species in STRS.

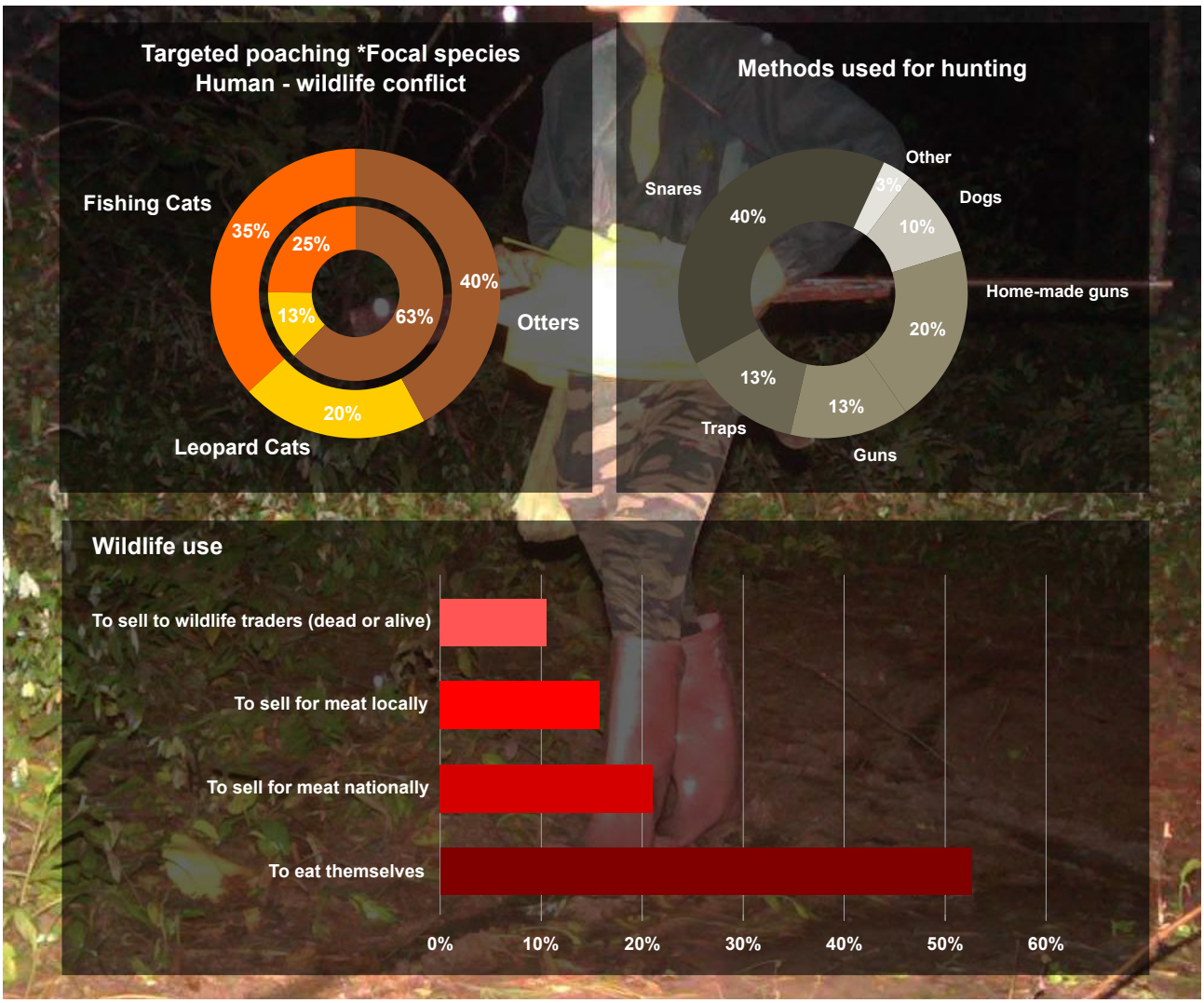


Figure 37. Percentage of participants reporting: top left outer: species targeted by poachers (out of focal species); top left inner: human-wildlife conflict; top right: methods used by poachers; bottom: purposes for hunting/poaching.

3.3 Community and livelihoods

The assessment of community and livelihood vulnerability was conducted in seven villages within STRS, focusing on local community reliance on wetland resources for livelihoods. Village chiefs, CFi (Community Fisheries) and CBET (Community-based ecotourism) committee members participated in focus discussion groups and identified the main wetland resources which are essential for local community livelihoods. Several participatory tools were used for the appraisal:

- Resource ranking: Women and men in villages identified the top 10 wetland resources which are essential to their livelihoods.
- Seasonal calendar: A seasonal resource calendar was produced to show wetland resource harvesting activities of local people over a 12-month period.

Climate change vulnerability was also assessed during discussions with key local community members and additional information was collected on fish catch details and trends in recent years.

3.3.1 Resource dependency

Table 10 indicates the 10 most important wetland resources that local residents living either within or near Stung Treng Ramsar Site use to support their livelihoods. Harvesting of several species of wild mushrooms and fishing are the most important sources of income for local livelihoods and household consumption from the perspectives of both women and men. Significant proportions of household income are obtained by selling different mushroom species including *Amanita hemibapha* and *Termitomyces* spp. at the local market. Women and men indicated that fishing provides an essential source of income sustaining local livelihoods, particularly during the flooding season, when large quantities of fish are present in the river and local people can sell both fresh fish or make processed fish products by drying or fermenting it. The river is considered an important resource for the provision of clean water for daily activities, growing vegetables and rice, boat transport and fishing. Local people residing on islands along the river in STRS, also generate income by growing rice, vegetables and keeping livestock, particularly cows and buffaloes. In addition, local people also plant crops such as red beans, oranges, limes, cassava, pumpkin and cashew that are dependent on the seasonal flooding of the river to irrigate them. The overall pattern of wetland resource collection and use indicates some differences between women and men due to role separation for certain tasks, such as men undertaking firewood collection, bamboo collection, and fishing, and women taking care of the housework, feeding livestock, cooking and processing fish.

Table 10. Ten most important wetland resources in STRS scored by men (M) and women (W).

Item	Score		Use	Local names of main species utilized
	M	W		
Mushrooms	10	8	For household consumption and sale	Piset Kngoak (*Amanita hemibapha*), Pist Rosy (*Dictyophora indusiata*), Pset Phork (*Geastrum* .spp)
Fish	8	8	Food and income. Sold fresh or processed as Prahoc, dried fish, etc.	Trey Chhpin (Mekong silver barb) *Hypsibarbus suvatti*, Trey Khya (Blacktail catfish) *Hemibagrus wyckii*, Trey Ka Ek (Sailfin shark carp) *Morulius chrysopheakdion*, Trey Tanel (Yellow catfish) *Hemibagrus filamentus*, Trey Kae (Snail eating catfish) *Pangasius conchophilus*, Trey Proul (Small scail mud carp) *Cirrhinus microlepis*
Bamboo	7	8	Eating, selling, building houses, making temporary shelters at rice fields, making baskets and traditional fishing gear	
River water	8	8	Daily use, irrigation and transport	
Rattan	8	6	Food and income	
Firewood	4	7	Cooking fuel	
Wild honey	7	7	Food and income	
Snails	6	4	Food and income	
Wild vegetables	4	4	Food and income	

Local villagers were asked to illustrate the seasonal calendar of wetland resource collection and identify livelihood activities over a 12-month time frame (Table 11). Local villagers reported that fishing in and around STRS is practiced year-round but the weight of the fish catch depends on the season: in dry season (February-April) fish yield is significantly lower than in wet season due to the low levels of water remaining in small streams and the characteristics of the life cycle of many fish species spawning and migrating during wet season. Fish caught in STRS are important for local food consumption and to sell at the local markets, as well as in some cases for export to Lao PDR. Local fishing activities have been negatively impacted over the last two decades by many factors such as overfishing and illegal fishing by resident and non-resident fishers, changes to river hydrology caused by climate change and dam operations upstream and habitat degradation. A small proportion of households also practice aquaculture from October-March. NTFP collection of resin, bamboo and mushrooms is conducted almost year-around for household consumption and to supply local market demand. Furthermore, another salient activity of local villagers is logging in the wetland's remaining terrestrial forests to use timber for the construction of homes, furniture and repairing boats. The collection of firewood is still important to fuel cooking stoves. Currently, local communities in STRS have additional opportunities to earn extra income in the dry season (January-May) by getting involved in tourism activities including forest trekking, camping, boat trips and providing accommodation in homestays. Regarding agricultural activities, local communities grow rice during the wet season and corn, pumpkin, green beans, watermelon and vegetables and fruits products are grown almost year-around.

Table 11. Seasonal calendar of wetland resource use/collection and livelihood activities in STRS. Darker gray denotes higher intensity of use.

Livelihood Activities	Month of year											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fishing												
Rice farming												
NTFP collection												
Tourism												
Snail collection												
Aquaculture												
Vegetable farming												
Construction labor												
Livestock farming												

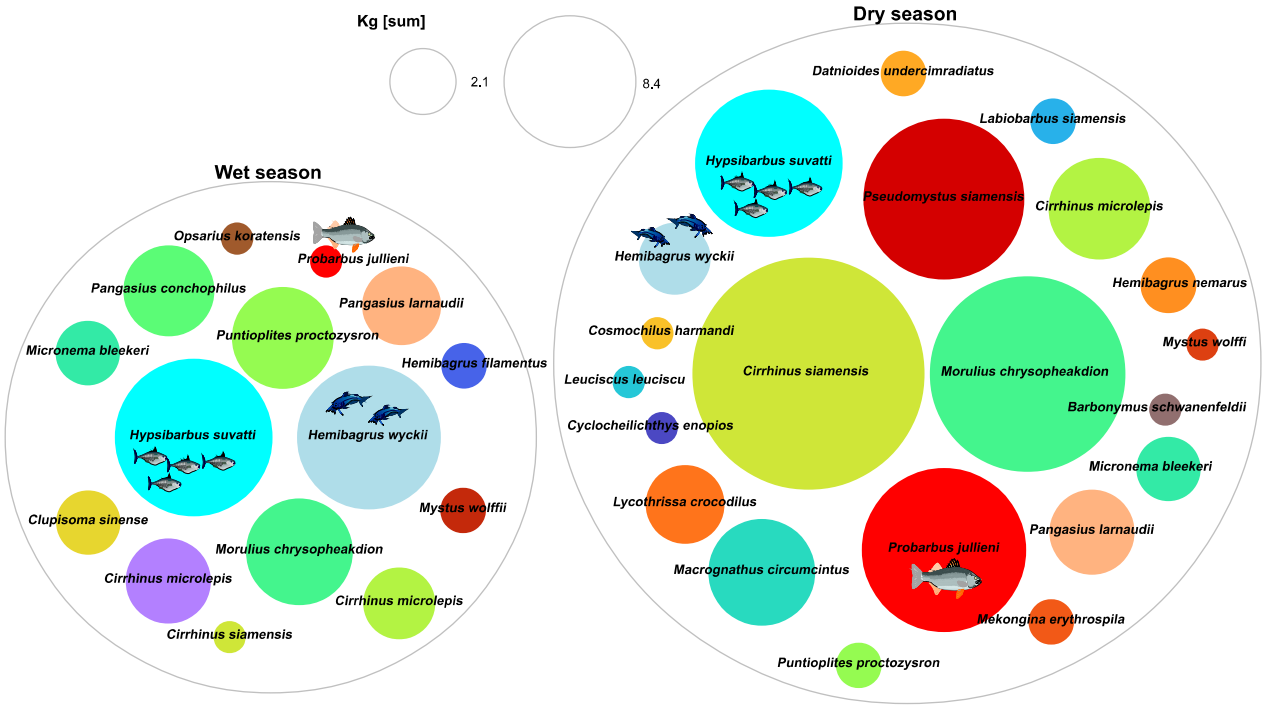
Additionally, during focus group discussions, CFi members and villagers provided rough estimates of the current fish catch in wet and dry seasons for the most significant species (Figure 38). According to local reports, fishers catch larger quantities of fish during wet season, however, catch estimates show that more species are captured and overall fish catch biomass is larger during the dry season. The most important species year round are *Hypsibarbus suvattii* and *Morulius chrysopheakdion*, followed in wet season by *Hemibagrus wyckii* and *Puntioplites proctozysron*, and in dry season the largest proportion is made up by *Cirrhinus siamensis* ("trey riel"), and *Pseudomystus siamensis*.

One concerning finding was that capture of Critically Endangered *Probarbus jullieni* was reported at two sites on the north and south of STRS, during wet and dry season, which coincides with the local perception of this species being relatively common, but highlights a lack of knowledge of protected species which are illegal to capture.

Groups also discussed fish catch trends in the last 20 years, and reported a massive decline (perceived as 80-90%), attributing it along the timeline to overfishing and illegal fishing using highly destructive methods between 2000 and the mid 2010s, followed by additional impacts from water infrastructure operation on the Mekong mainstream and possibly climate change in more recent years.

Regarding evaluation of the conservation state of the area and capacity to tackle illegal fishing, local community members highlighted the need for more resources for patrolling and law enforcement activities. Groups also reported that illegal fishing, especially using highly destructive methods such as explosives and poison has declined in recent years due to better fisheries management by the CFis, but electro-fishing, use of nets with illegal mesh sizes and fishing out of season and at sensitive sites (such as deep pools) still occur unabated throughout the site.

Figure 38. Wet and dry season fish catch summed over all sites surveyed in STRS. Bubble size represents size of fish catch (kg) of each species noted.



3.3.2 The impact of climate change on resources

Villagers from seven villages were asked to identify a timeline of memorable extreme climate events and extreme weather events that have impacted natural resources and livelihoods in Stung Treng Ramsar Site over the last 10 years. The main types of extreme events and their impact on the wetland habitat are summarized in Table 12. Extreme storm events in and around STRS were reported to occur with a higher frequency in recent years and their impacts significantly affected local people, mainly by making it too dangerous to go out fishing and therefore reducing household income, as well as damaging houses. Local people indicated that storms can cause significant damage to the wetland habitats by provoking landslides on island river banks as a consequence of trees falling down. Moreover, strong winds were also identified as becoming more extreme, leading to crop damages and destruction of chicken and duck coops. High temperatures and lightning were the main factors that increased the intensity of forest fires in recent years. Furthermore, people identified that unusual flooding events have occurred more often since 2017, and play an important role in reducing local incomes due to loss of livestock, damage to houses, and loss of crops.

Local community members in STRS also reported that in 2018, the failing of Saddle Dam D in Lao PDR caused floods that damaged crops, the felling of large trees, and the evacuation of many families due to the emergency flooding situation.

Table 12. Extreme weather events and impact over the last 10 years in STRS.

Extreme weather events	Year	Impact on livelihoods, wetland habitats and species
Storms and lightning	Recent years, particularly 2016 and 2022	Storms impact people's incomes due to difficulties to go out to fish. Extreme storms also destroy local boats and houses. Lightning ignited fires and killed cows and buffaloes.
Strong winds	Particularly since 2016	Strong winds provokes trees to collapse along the river, damages crops and chicken and duck coops.
Drought	2016, 2019, 2020, 2021	Low river water levels, reducing access to available fresh water, can contribute livestock deaths (buffalo, chicken and duck), fish death when dry season stream and ponds dry out, crop damage and health issues. Drought also contributes to forest fires.
Extreme heat	Recent years	Extreme heat contributes to low fish catch, crop damage, death of livestock, mass fish death and people's health problems, as well as fueling forest fires.
Forest fires	Intensity increasing in recent years	Loss of wetland habitats and wildlife. Conversion of burned habitats to agriculture. Increased hazard for people, villages and livestock. Forest fires are happening more often, with greater intensity and destructive consequences for wetland habitats and species.
Unusually low water levels	2019, 2020, 2021 and 2022	Unusually low water levels impact local people's income by reducing available areas and duration of the season for high yield fishing, and having a direct impact on fish populations.
Out of season and extreme floods	2017,2018,2019, 2022	Crop damage and loss, livestock loss and home damage and loss.

3.3.3 Current and future coping strategies

People living in the Stung Treng Ramsar Site use various mechanisms to cope with extreme weather events and climate change, which provide the essential indicators for estimating adaptive capacity of local communities. Men and women in villages were interviewed to gather strategies on how people cope with the impacts of extreme weather events and the strategies that will be used to cope in the future. Table 13 and Table 14 summarize current and future coping strategies.

In case of a storm, people generally store home supplies in a safe place and family members may move to other places such as a neighboring house that is strong enough to withstand the storm. Drought, floods, low water levels, and strong winds in recent years have led to crop damage, income loss, health issues and livestock death. Local community members try to prepare for drought and high temperatures by pumping more water in the crop fields and providing additional water sources to livestock. In recent years, more people feel the need to move to the city and or to neighboring countries to get temporary jobs to compensate for lost income. Most of the population however, still rely heavily on wetland natural resources.

Table 13 Impact of extreme events and current coping mechanisms of men and women.

Extreme event	Impact	Current coping activities (Men)	Current coping activities (Women)
Storms	Home collapse	Keep house supplies in a safe place during storms.	Move the family temporarily to a safe location
Strong wind	Crop damage	Replanting crops	Replanting crops
Drought	Crop damage	Pumping water from the river	
		People need to buy more food from town	
	Insufficient food for household		Getting a loan to buy supplies for replanting crops.
Forest fires	Fire happened near house	Helping each other to set up and use water to put out fires	Helping each other to set up and use water to put out fires
	Forest and wildlife loss		
Extreme heat	Crop damage/loss	Pumping river water for irrigation	Pumping water from rivers to make a cool environment for livestock.
	Livestock health issues and loss		
Unusually low water levels	Loss of income	Collect more NTFPs. Seek temporary jobs in Stung Treng city or Lao PDR. Get loans. Do construction or other jobs for money.	Collect more NTFPs.
			People buy drinking water from the town.
	Low water quality		
			People grow shifting crop types such as beans and peas.
	Impact on soil fertility		
Floods	Insufficient food for family	Collect more NTFPs and wild food from the wetland	People move to the city temporarily.
			People prefer to raise more livestock
	Loss of income		
	Home damage by landslide	People move to a safe place and some people move to the city to seek jobs.	People move to a safe place and some people move to the city to seek jobs.

Local community members were also asked to identify plans on how they would cope with extreme weather events in the future. Future strategies were proposed including developing clean water supply, irrigation systems for crops and rice fields, store rice seedlings, and plant shifting crops to improve soil fertility. In response to drought, people would like to build canals to support crops and rice fields using water pumps. People also proposed to keep improving the services for tourists to make more income and provide more opportunities for local community members to be engaged as guides, providing food and accommodation in homestays.

Table 14. Impact of extreme events and future coping mechanisms of men and women.

Extreme events	Impact	Future coping activities (Men)	Future coping activities (Women)
Storm	Home collapse	Build stronger houses in safer areas.	Keep house supplies in a safe place during storms.
Strong wind	Home damage	Construct new home	Seek safer place for the house and make it stronger.
Drought	Insufficient food for household	Migrate to nearby countries to seek temporary jobs	
	Crop damage		Dig canals and use water pumps for irrigation
Forest fire	Fire happened near house		Establish early warning/alarm system and fire risk protocols. Use water pump to fight fires near houses.
	Forest and wildlife loss	Build watch tower/s to observe forest fires early and to prepare equipment on time.	Restore wetland habitats.
Extreme heat	Health problems	People go to private clinics or hospitals to get medicines by selling properties.	
	Livestock health issues and loss		Make shelters and ponds using water pumps to fill them and ensure enough water and shade is available to livestock.
Unusually low water level	Reduced fish stocks	Find alternative sources of income such as tourism services	Keep more livestock and eat domestic meats (pork, beef, chicken, duck).
	Low quality water	Install water pumps and filtering systems	
	Crop damage/loss		Plant more resistant crops, use irrigation
Flood	Loss of income	Rely on NTFPs	Migrate to nearby cities or countries to seek temporary jobs
	Home damage	Move to safer areas	Raise more livestock
Forest fires	Forest loss	Set up early warning systems and collaborate to extinguish fires	Training to prevent fires.
	Risk to personal safety and homes		Develop emergency evacuation plans for villages.

4. CONCLUSIONS

4. CONCLUSIONS

4.1 Summary of vulnerabilities

STRS was designated as a Ramsar site in 1999 in recognition of its rich wetland habitats and biodiversity, which are uniquely adapted to the natural seasonal fluctuations in water level of the Mekong River. In 2022, the Ministry of Environment announced plans to submit the area extending from the Lao PDR border (including STRS) to Kratie town, covering approximately 200km along the Mekong River, to UNESCO as Cambodia's first Natural World Heritage Site.

Aquatic habitats in STRS include deep pools, which are vital for hundreds of migrating fish species, and a distinctive type of flooded forest combining flood resistant trees and fig trees, which provide essential resources and habitats for many bird and fish species.

The most severe threat to the STRS wetland habitats is the altered hydrology currently driven by upstream dam operations, which in recent years has altered the life cycle of the wetlands by releasing water during dry season, preventing habitats from being exposed for long enough (Baird 2007; 2022). This impact is apparent throughout the site, where mass dieouts of flooded forest trees can be readily observed. Terrestrial habitats on islands and along the river banks harbor relatively degraded mixed deciduous forests; agricultural encroachment, illegal logging and fires remain severe threats, and scattered human settlements, often accompanied by large livestock are found throughout the site.

Over 200 fish species inhabit STRS, which provides essential habitats for fish reproduction and growth stages, as well as during their migrations along the Mekong River. Deep pools are particularly important for increasingly rare, highly threatened megafish species. Illegal fishing, particularly electro-fishing, use of nets with illegal mesh sizes and fishing at sensitive sites such as deep pools and during closed season, is still prevalent throughout the site.

Irrawaddy dolphins (*Orcaella brevirostris*) were the most notable flagship species in the STRS area, occupying the deep pools stretching through the Cambodia-Lao PDR border, however the last individual died in early 2022. Illegal fishing has decimated the local population for over forty years and more recently, the construction of the Don Sahong dam contributed to the death of the last remaining individuals. Aquatic habitats are likely to still host Vulnerable smooth-coated otters and potentially fishing cats, and terrestrial habitats still retain a population of Endangered banteng and long-tailed macaque. STRS is a crucial site for many bird species and hosts a significant population of endemic Mekong wagtail, as well as Critically Endangered white-shouldered ibis and Endangered green peafowl. Siamese crocodiles are locally extinct, however the site is still important for many threatened reptiles such as the Critically Endangered giant softshell turtle (*Pelochelys cantorii*). Poaching, particularly using snares, guns and bird nets, was documented throughout the site and is the most severe threat to all vertebrate species.

In the past, local community livelihoods were highly dependent on fishing. Local Community Fisheries (CFis) work on the sustainable management of fishing areas designated for each village within STRS. CFis reported sharply declining fish catches, particularly in recent years, which they attribute to the combination of illegal fishing, overexploitation and the impact of water infrastructure, as suggested by recent reports (e.g. MRC, 2022). CFis recognized they lack appropriate resources to tackle illegal fishing and reported that many local fishers have felt forced to abandon fishing altogether. Most local community members nowadays generate income by farming rice, oranges and other crops, and also rely heavily on NTFPs, particularly several mushroom species.

Climate change has already impacted the site, increasing the frequency and intensity of destructive storms, which endanger people and homes. Temperature increases have exacerbated the effects of drought and and forest fires, and irregular precipitation is contributing to the altered hydrology of the wetland habitats. Climate change will exacerbate the impact of other anthropogenic threats to the site and could potentially push its habitats beyond ecological tipping points. The most pressing threats however, stem from dam operations upstream severely altering hydrology, and on-going intense illegal fishing, logging and poaching.

Only international cooperation working to benefit people and biodiversity can limit the impacts of upstream dam operations. Construction of additional mainstream dams would have substantial impacts on Stung Treng's wetlands. Increased long-term sustainable funding, cooperation between government agencies, NGOs and local communities, as well as further development of conservation minded livelihoods such as high quality ecotourism activities and services are urgently needed to tackle illegal activities in STRS.

4.2 Adaptation planning

Based on the results obtained during the Climate Change Vulnerability Assessment of Stung Treng Ramsar Site, three sets of recommendations, environmental, social and economic, were developed as potential adaptation measures to enhance resilience of wetland habitats, species and livelihoods.

Table 15. CCVA recommendations and adaptation measures.

Climate Change Vulnerability Assessment Recommendations
Environmental
- Improve patrolling/law enforcement capacity of community organizations and rangers for both illegal forest activities and illegal fishing activities. Build capacity of CFis to prevent illegal fishing and protect important sites such as deep pools.
- Raise community awareness to stop poaching and consumption of wildlife.
- Develop zoning. River banks, and large and small islands without established villages should be managed to minimize impact of human activities and prevent access of livestock and domestic animals. Scattered households should receive support to move to established villages.
- Fire prevention and mitigation actions such as capacity building for community organizations and rangers, provision of equipment, building watch towers, developing early warning systems and action plans.
- Removal of invasive plant species, mainly *Mimosa pigra*, coordinated with corresponding habitat restoration with native plants. Protect and restore terrestrial habitats.
- Develop strategies and raise awareness to prevent and mitigate conflicts between fishers and smooth-coated otters.
- Support international cooperation for wise management of the Mekong river water flow. Prevent development of dams in STRS.
Social
- Promote sustainable farming and prevent further land conversion
- Create NTFP management groups to ensure sustainable harvesting
- Improve access to clean energy (e.g. solar) and improve waste management
Economic
- Build capacity of CBETs to enhance knowledge of local biodiversity, provide better income and services, and connect their activities to conservation objectives.
- Sustainable financing of PAs should ensure good living standards for local communities to minimize illegal activities and promote development of diversified livelihood opportunities including tasks directly connected with conservation and restoration of habitats.

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