The Political Ecologies of the Tonle Sap: Global, Regional and National Framework for Conservation and Development

Mak Sithirith

Funding: No specific funding was received for this work.
Potential competing interests: No potential competing interests to declare.

Abstract

Situated in Cambodia, the TSL (TSL) is the largest freshwater lake in Southeast Asia and the Mekong River Basin (MRB). It is a globally important biodiversity hotspot, while also displaying significant economic, livelihood, and food-production values. However, the lake and its resources are under significant pressure from over-fishing, and upstream development (particularly hydropower) has affected its hydrology and sediment supply to the lake. Many actors at local, national, regional, and global levels have sought to influence how the lake's resources are managed, utilized, and developed – although at this stage, without notable impact. This paper analyzes the political ecology of the TSL's demise. It seeks to show how the complex interplay of actors, arranged at various scales, has collectively created the challenges facing the lake, giving rise to questions about the long-term sustainability of its resources and the livelihoods that depend upon it.

Mak Sithirith

Post-Doctoral Fellow, WorldFish Center, Cambodia;

E-mail: maksithirith@gmail.com / m.sithirith@cgiar.org

Keywords: Tonle Sap, biodiversity conservation, fishing lot, ecological transformation.

1. Introduction

TSL is the largest freshwater lake in Southeast Asia and the MRB, covering 2500 km2 in the dry season, but it increases to 1.0-1.3 million km2 in the wet season. The lake is connected to the Mekong River via the Tonle Sap River (Matsui et al., 2005; Kummu and Sarkkula, 2008; Kummu et al., 2014) and has an exceptional water regime. In the wet season, water from the Mekong River flows into TSL, estimated at 83.1 km3, of which the Mekong River contributes 53.5%, the lake's tributaries 34%, and the precipitation 12.5%. The lake absorbs volumes of floodwaters and reduces flooding along the Mekong River (Kummu et al., 2014). The water flows from the Mekong River, bringing 72% of sediments to TSL, providing rich nutrients for fish and biodiversity, and fertilizing the agricultural lands along the Mekong River and Delta. In the dry season, from November to March, when the water level in the Mekong River is lower than that of the Tonle Sap Lake, TSL outflows its water to the Mekong mainstream through the Tonle Sap River, estimated at 82km3, of which 84% via Tonle Sap River and 13% via evaporation (Kummu et al., 2014).

The Mekong River, tributaries, hydrological processes, and the flows of TSL produce the Tonle Sap's flood pulse (timing, modality, speed, height, duration), which is of tremendous importance to fisheries productivity and biodiversity in the Lower Mekong Basin and Tonle Sap system (Poulsen et al., 2002). It is also a fact that the 'flood pulse' transforms both the physical and the human landscapes of the Lower MRB and TSL, submerging vast areas during the wet season, exposing those areas in the dry season, creating inundated forests with unique species adapted to the rhythms and cycles of the pulsing ecosystem, and providing a natural habitat for many species of flora and fauna. TSL is highly productive, and it is rich in fisheries. The lake is home to global biodiversity species that need protection under international conventions.

Also, the 1995 MRC Agreement protects TSL; first, the Mekong can be dammed and diverted; second, the average flows can be maintained; and third, maintaining average flows in the Mekong mainstream during the rainy season is a healthy optimum, which are: a) Of not less than the acceptable minimum monthly natural flow during each month of the dry season; b) To enable the acceptable natural reverse flow of the Tonle Sap to take place during the wet season (MRC,1995). Despite the assurance to protect TSL, it is very vague on protecting the dry season flow and the flow levels in general. How can we ensure the 'acceptable' dry and wet season flow under the scenarios of hydropower dam development? Thus, this paper examines the governance of TSL from a political ecology perspective.

2. Conceptual Framework of Political Ecology

The basis for a *political ecology analysis* has been the conviction that the ecology and the political spheres interact in governing society and the environment. It studies the relationships between political, economic, and social factors with environmental issues and changes. Political ecology differs from apolitical ecological studies by politicizing environmental issues and phenomena (Benjaminsen and Svarstad, 2018). A central element of political ecology is that understanding ecological changes cannot be done without consideration of the political and economic structures and institutions within which it is embedded (Neumann, 2009). Further, Escobar (2006) defines political ecology as a study of environmental conflicts, focusing on economic, ecological, and cultural aspects of the ecosystems. "Political economy is concerned with the structural and institutional features of a country or region and how these interact with politics and economics…" (Andreas, Fernie, and Dainty, 2022:868). It studies the economic distribution, political issues, and social power relations, and the valuation of natural resources is only subject to economic conditions.

On the contrary, ecological economics does not value nature only in economic terms but from a process, functions, and services. The ecosystem and political economy processes contribute to defining the value of natural resources, which does not reflected in market prices. Access and control of resources take on a complex ecological and political character.

In the process, it involves changes of complex ecosystems into modern forms of nature. It has changed place-based and local cultures into cultures that increasingly resemble dominant modern cultures. Social movements provide another insight into the simultaneous emphasis on economic, ecological, and cultural aspects of conflicts (Escobar, 2006).

The political ecology study analyzes structures, prevailing institutions, actors, interests, and their powers that influence the management of the exploitation of natural resources (Andreas, Fernie, and Dainty, 2022). *Structures* are slow-moving entrenched patterns that are hard to impact in the short run, typically historical circumstances, cultural traits, and natural phenomena. They may, or are likely to, be restrictive for policy change. *Institutions* are patterns in the society described as "…humanly devised constraints that structure political, economic, and social interaction." (North, 1991:97). Institutions are rules and norms, both formal and informal, that provide structure for behavior and relationships in society. *Actors/agents*, finally, are those taking initiatives and pursuing interests, acting individually, in groups, or cooperating spontaneously through shared norms and or strategically to achieve desired future outcomes. All actors have varieties of interests, and different interests manifest themselves within and between different categories of actors. While actors, interests, and powers are open-ended categories with no definitive single content, a simplified inventory – identifying the most significant actors and their respective powers and interests – can still serve as a basic framework for a political economy analysis.

Central to numerous discussions about political ecology is the concept of power, politics, and policies (Jones, Jones, and Woods, 2004). Power is the commodity that sustains politics and policy, and 'politics' is the whole set of processes that are involved in achieving, exercising, and resisting power' while policy relates to the 'intended outcome'—the things that power allows one to achieve and that politics is about being in a position to do (Jones, Jones and Woods, 2004: 3). Politics, power, and policy are related to spatial organization, in which power may be made more explicit, communicated, and reified through the creation of boundaries and the formation of different kinds of territories (Sack, 1986; Passi, 1996; Delaney, 2005). Formation of particular territories frequently requires rules, regulations, and disciplinary codes, attempting to enforce control, and certain groups may indeed draw political and economic advantages from such forms of territorialization. However, the power implications and ways power is mediated through multiple stakeholders, institutions, agencies, and individual actors may result in unintended outcomes, generate new conflicts, and produce a form of resistance. Resource politics is a politics of 'access' (Ribot and Peluso, 2003) and about issues of state centralization and decentralization (Wittayapak and Vandergeest, 2010) and within these essential political strategies and policies relating to allocating and distributing rights to ordinary people, there are both territorial and non-territorial aspects.

In the process, different actors from different levels are involved in environmental governance, dealing with many issues and influenced by individual interests and their shared contexts. These actors are engaged in multiple arenas to debate and influence the negotiation; or resist, reinforce, and reframe their agenda and issues. Different actors employ different tools, such as technical support, advocacy, and power to establish and legitimize their positions and to engage in deliberation. The decisions are primarily about framing, supply, and demand.

3. Materials and Methods

The paper examines the political ecology of TSL. It develops the framework to analyze the political ecology in TSL using literature, surveys, and fieldwork. The researcher gathered data from structured interviews with stakeholders at the national and community levels. Empirical studies were conducted between 2005 and September 2020 to collect primary and secondary data. The research was conducted in three phases. First, the researcher collected the data in TSL between 2007 and 2011 for doctoral research at the National University of Singapore. The data and information collected during this period concentrate on the geographical classification of TSL—the commercial fishing lot system, the zoning of TSL for environmental conservation, resource governance, and the politics of resources (Sithirith, 2011).

Second, between 2013 and 2013, the researcher conducted research work for WorldFish, focused on the aquatic and agricultural system in Tonle Sap, the linking between fisheries, agriculture, livelihoods, governance, and policy frameworks (Johnston et al., 2013). More data and information were collected, focused on fisheries, agriculture, water, and livelihood activities of fishing communities in TSL.

Third, between August 2022 and March 2023, the researcher worked with the Mekong River Commission (MRC) to conduct the gap analysis in the Tonle Sap Multiple Use Area, focusing on biodiversity conservation in three Core Zones of the Tonle Sap Biosphere Reserves. On 16 September 2022, the researcher participated in the stakeholder meeting with representatives from MAFF, FiA, MOWRAM, TSA, and IUCN to discuss the management of three Core Zones of TSL. The field works in TSL was conducted from 13 to 18 November 2022 with the involvement of two staff from TSA and the Department of Wetland/MoE. During the field works (13-18 November 2022), the researcher met the site managers, park rangers, NGOs, and local communities. These meetings were done across three Ramsar sites in Tonle Sap Lake—Stung Sen, Beung Tonle Chhmar, and Stung Sen. After the meetings, three FGDs were organized. One FGD in each Ramsar Site was participated by 12-15 rangers and staff of the Ramsar site (Figure 3). Some questions related to indicators of the IUCN Green List were asked during the FGDs. Data and information collected were entered into the Excel sheet of the IUCN Green List. The political ecology framework discussed above is employed to analyze the territorialization of fisheries resources in TSL, to examine the spatial politics in the lake, look into the overlapping spaces, actors' involvements in different spatial dimensions, and power relations of actors over spatial differences and to explore the impacts of hydropower developments on TSL, and last, but not least the changing environment.

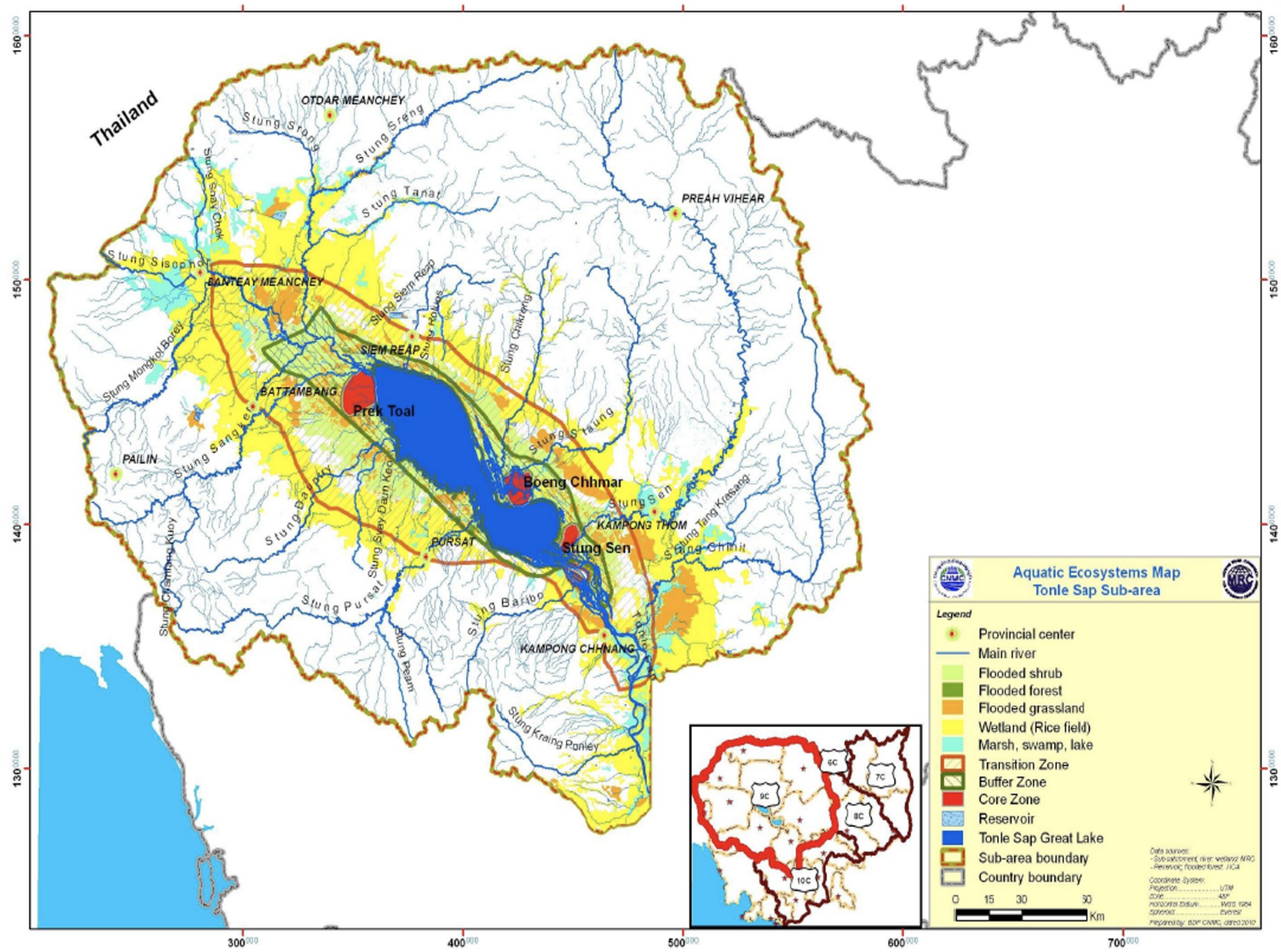

Figure 1. Map of studied areas in Tonle Sap Lake

4. Results and Discussion

4.1. *Tonle Sap Lake and Socio-Cultural Ecological System*

The Mekong River, tributaries, hydrological processes, and the flow of TSL produce numerous complex non-human and human spatial dynamics, which are never totally within or under 'human' control. TSL is characterized by a 'flood pulsed ecosystem'. The annual 'flood pulse' (timing, modality, speed, height, duration) is essential to fisheries productivity and fish migrations in the Lower Mekong Basin and Tonle Sap system (Rainboth, 1996; Poulsen et al., 2002). It is also a fact that the 'flood pulse' transforms both the physical and the human landscapes of the Lower MRB and TSL, submerging vast areas during the wet season, exposing those areas in the dry season, creating inundated forests with unique species adapted to the rhythms and cycles of the pulsing ecosystem, and providing a natural habitat for many species of flora and fauna.

TSL naturally comprises three ecological functioning zones—the terrestrial, the floodplain, and the aquatic. The terrestrial zone covers large areas—rice fields and flooded forest areas. The floodplain is an area where it is flooded for six months and dry for another six months. However, the aquatic zone is an area where it is covered year-round by water (Bailleux, 2003).

The natural ecological system of TSL influences how people live in the lake and use the lake resources to sustain their livelihoods. The human in TSL has organized their settlements in three different categories, located in three different ecological zones: land-based, water-based, and water–land-based communities. The land-based community (LBC) is a community that is situated on land for the entire year, whereby community member is engaged in farming and fishing, depending on the distance between the lake and the community. The water-based community (WBC) refers to a floating community, whereby the community is floated year-round on water, and fishing is a primary occupation of community members. The third is a water–land-based community (WLC), whereby the community physically is situated for six months on the water and six months on land. These communities are located in the ecological zone, affected by seasonal water levels (Sithirith, 2011).

People living in water-based and water-land-based communities are called '*neak tonle*' (river people). They are engaged in fishing as their main livelihood activity. The '*neak tonle'* lives adapting to the lake and river system; particularly to the hydrological regime of the lake between the dry and wet seasons including the rising and falling water; the vertical and horizontal motilities; seasonality; resources; and spaces.

Neak tonle catches fish for consumption but needs paddy rice to supplement their diets. Rice and fish are the backbones of household economies. The surplus of fish catches is thus bartered paddy rice with '*neak leu*' or highlander from the land-based community. The bartering of rice and fish between *neak leu* and *neak tonle* is similar to what James Scott (1976) describes as "equal exchange" in the moral economy of peasant society. More specifically, it means that "a gift or service received creates, for the recipients, a reciprocal obligation to return a gift or service of at least comparable value at some future dates. The notion of equal exchange was a general moral principle of peasant society" (Scott, 1976: 167). 'Reciprocity' is viewed as a moral principle underlying social action in the *neak leu* and *neak tonle* society.

The social relations of *neak tonle* and *neak leu* are deeply rooted in the rice-fish economy, allowing them to exchange different products such as fresh fish, dried and fermented fish for rice, and other agricultural products. This relationship enables the neak tonle and neak leu to complement one another and specialize in fishing and farming respectively. *Neak tonle* and *neak leu* live together as one system, where one respects the function and roles of the others. These have created a dependency and reciprocal system between *neak leu* and *neak tonle* to share their resources for their livelihoods (Sithirith, 2016).

Villager living in a land-based community around TSL is named '*neak leu*' (highlander), and they organize their farming fields in the Tonle Sap floodplain into S*releu (rainfed lowland ricefield)*, S*rekandal* (medium deep-water rice-field), and S*rekrom (Deep-water rice/floating rice field). Sreleu* is located in the upper area of the Tonle Sap floodplain between 8 and 10m above sea level (asl). *Srekandal* is located deeper inside the floodplain, *6 and 8m asl*, lower than S*releu* but higher than S*rekrom. Srekrom (Deep-water rice/floating rice field)* is located deeper inside the Tonle Sap floodplain area between 4 and 6m asl (Sithirith, 2016).

The rice cultivation in S*releu* has relied on rainfall, not the lake's hydrology. In *Srekandal,* farmers cultivate floating rice in the past but have changed to planting receding rice at present, after the receding water in the lake. *Srekrom (Deepwater rice/floating rice field)* is located deeper inside the Tonle Sap floodplain. The rising water in TSL influences the rice productivity of S*rekrom*. Thus, farmers cultivate rice varieties that grow following the rising and falling water levels, known as a *'Srove Leung Tuk'* translated as 'rising water rice' in English. In the dry season, farmers cultivate in this area a 'dry season rice.' However, farming is traditional, small-scale, and subsistent, largely dependent on rainfalls and sometimes on lake water (Sithirith, 2016).

Farming in *Sreleu, Srekandal*, and *Srekrom* has been affected by too much and too little water. During the wet season, there is too much water in the TSL floodplain, and the too-much water sometimes causes flooding and damages rice farming and people's properties. During the dry season, water from TSL recedes this floodplain and flows into the Mekong River with no uses, as there are no storage systems, reservoirs, or basins that could extract water out of too-much water situation and store it for use in the season of too-little water.

4.2. *The 'Global Space' of Biodiversity*

Space in TSL is constructed and re-constructed, and actors are involved in the process of spatial construction. Different actors, community, state, and non-state actors; from different levels—local, national, regional, and global—construct various spaces in the same geographical areas, and much of the spatial exercise involves power. First, space comprises the resources fundamental to human life on this planet. Space encompasses land, water, and the atmosphere that provide the resources for human survival, including the food we eat, the water we drink, the air we breathe, and the resources for protecting ourselves. Second, when the substantive qualities of space are filtered through human experiences of time and process, strong attachments to space can invoke or release an emotional response (Penrose, 2002).

4.2.1. *Biodiversity Hotspots*

TSL is highly productive. The annual fish catch from the lake is estimated at between 180,00–250,000 tons, while the dai fishery on Tonle Sap River annually harvests about 12,000 tons of fish migrating from the lake to the Mekong River early in the dry season (Campbell et al., 2006; van Zalinge et al., 2004). Cambodia ranks 5th globally in terms of inland fish production after China, India, Bangladesh, and Myanmar, estimated at around 500,000 tons annually, of which about 50% come from TSL. Fish and aquatic resources have been a source of food and protein for the Cambodian population. Also, fish production has been central to the Cambodian economy (Degen et al*.,* 2000; Degen and Thouk, 2000; Bruce and Yim, 2004).

Overall it is home to many biodiversity species, including more than 200-370 species of plant, 197 species of phytoplankton, 46 species of zooplankton, 210-225 species of bird, 20-46 species of mammal, 30-42 species of reptile, 300 species of invertebrates, and 05 species of amphibians. At least 44 species are globally threatened or endangered (Davidson, 2006; MRC, 2010). Fish is the largest group of vertebrates, which are abundant in the Tonle Sap ecosystem (Lamberts, 2006). Although the number of fish species in the Tonle Sap is unknown, it is estimated. Approximately 500 species of fish have habituated in the Mekong River system in Cambodia, and at least 143 species have been recorded in the Tonle Sap Lake and surrounding lowlands. Twenty-two of these species are known to be of international conservation concern (Davidson, 2006). For the above reasons, TSL was designated as Tonle Sap Biosphere Reserve (TSBR) under UNESCO auspices in 1997 for biodiversity conservation (RGC, 2001).

Given the biodiversity and some rare species in TSL, UNESCO has worked with RGC to designate the lake as a Biosphere Reserve. In 1997, TSL was declared a Biosphere Reserve. The Tonle Sap Biosphere Reserve was established by Cambodia and supported by the Royal Decree issued in April 2001. The 'Biosphere Reserve' classifies TSL into three zones—the Transitional, the Buffer, and the Core Zones. The transition zone covers an area of approximately 899,600 hectares, surrounded by 541,482 hectares of buffer zone of permanent and seasonal wetlands, including the lake water bodies. The Core Zone is classified into three Core Areas—Prek Toal, Boeung Tonle Chmar, and Stun Sen—covering an area of 58,635ha. Furthermore, since 1996, these three Core Areas have been designated as Ramsar sites to promote the value of biodiversity conservation in the region internationally. These include (1) Prek Toal covering 21,342ha, (2) Beung Tonle Chmar (BTC) covering 28,000ha, and (3) Stung Sen covering 9293ha (Table 1).

4.2.2. *Human Dimension*

The three Core Areas are also home to 5,426 households living in 19 water-based villages (floating communities) and dependent on fishing and lake resources for their livelihoods. Five villages are situated in Prek Toal with a total population of 12,424 people, equivalent to 2,704 families, most of whom live in water-based communities. Eight water-based villages are in the BTC Ramsar Site—five in Kampong Thom Province and three in Siem Reap Province—which is home to 1,222 households with a total population of 6,044 people living in floating houses, moving from one place to another place during the dry and rainy season and do fishing somewhere near the BTC for their living. There are no farmlands, only water bodies and wetlands, where fishing is the main livelihood activity. On average, poorer families spend 2-3 hours for fishing per day and can catch 5-10 kg of fish or more if they are lucky. Villagers keep some fish for their consumption and sell the rest of their catch immediately (Meynell et al., 2019). About 1,500 households live in Stung Sen Ramsar Site (SSRS), with a total population of about 7,500 people. The SSRS was under the fishing lot no.2 located in Kampong Thom Province, but in 2012, RGC canceled the fishing and returned it to the fishery conservation area (FCA), covering 921 ha (Herranz, Muñoz, and Vong, 2022).

4.2.3. *Biosphere Reserves and Ramsar Sites*

Prek Toal, BTC, and Stung Sen are the Core Areas of Tonle Sap Biosphere Reserves in 1997. Prek Toal, located on the northwest side of TSL, is a Core Zone of Biosphere Reserves issued by a Sub-decree in 2001, covering 21,342ha. In October 2015, RGC and IUCN granted the Prek Toal status as the Ramsar site by Sub-Decree No. 139, issued on October 2, 2015. It is the largest Ramsar site or the core area in the TSBR, which is considered a vital area for water bird breeding and foraging habitats and supports many endangered species of water birds. The site is an area for water bird breeding and foraging habitats, among other areas in Cambodia. Prek Toal supports endangered species of water birds, such as the Spot-billed Pelican, Painted Stork, Lesser Adjutant, Greater Adjutant, three species of cormorants, Asian

Openbill, Black-headed Ibis, Back-necked Stork, Oriental Darter, Grey-headed Fish-eagle, Glossy Ibis, and Masked Finfoot. Apart from the above, many water bird species, such as Great Egrets, Herons, etc., still nest, breed, and live here almost year-round. Mammals in the Prek Toal Ramsar Site are diverse, and many species that are listed as globally threatened, and those species' populations are of international importance (Davidson, 2006).

Beung Tonle Chma (BTC) is the second largest Core Area in TSL after the Prek Toal, covering 14,560ha. However, in 1996, it was designated as the largest Ramsar site in TSL, covering 28,000ha, including 3,800ha of a permanent water body known as a Boeung Tonle Chhmar, surrounded by a complex creek system, flood plains, and flooded forests. The maximum elevation of the site is 10 m above sea level (Meynell et al., 2019). BTC Ramsar Site supports a large assemblage of plant, fish, reptile, mammal, and water bird species, many of which are vulnerable or endangered. It regularly is home to more than 20,000 individuals of large water birds, being one of the feeding grounds for the breeding colonies of birds at Prek Toal, such as Asian open-bill, Oriental darter, spot-billed pelican, Indian cormorant, lesser adjutant, and greater adjutant. There are also 296 fish species in the Tonle Sap area (43% grey fish, 40% white fish, and 17% black fish species), of which 17 are threatened species. When inundated, the Boeung Tonle Chhmar site provides a rich habitat for fish feeding and breeding.

Stung Sen is the third Core Area in Tonle Sap Lake, covering an area of 6,365ha. It has been designated as a Ramsar Site in November 2018, covering an area of 9,293ha. It is home to six villages in Phat Sanday Commune in Kampong Thom Province.

Table 1. The Biosphere Reserves, Ramsar Sites, and Fishery Conservation Area

Site	Biosphere Reserves Core Area (ha)	Ramsar Area (ha)
Prek Toal	21,342	21,342
Beung Tonle Chmar	14,560	28,000
Stung Sen	6,365	9,293
Total	58,635	42,267

Source: MoE, 2022

4.3. *National Space—Fishing Lots and Fishery Conservation Areas*

TSL is a national space. The state has an 'absolute power' to manage that space. Indeed, it is concerned with how TSL could contribute to the national economy and local livelihoods. The French Protectorate Administration territorialized TSL into commercial fishing lots in 1908. The fishing lot system was maintained by various government regimes between 1954 and 2012 to generate revenues for the state following the departure of the French (Degen and Thouk, 2000; Cheyvy and Le Poulain, 1940; Degen et al., 2000). By the 2000s, 56 fishing lots, covering about 507,731ha, were operated in TSL (Bruce and Yim, 2004; Sithirith and Vikrom, 2008). While it brought benefits and revenues to the state, it also created conflicts and tensions. The fishing conflicts between fishing communities and fishing lot operators intensified following the

2000s, leading to its abolishment in the 2012s. The fishing lot system prevailed in Cambodia for about 150 years (Sithirith, 2011).

The abolishment of the commercial fishing lot system has released large fishing areas under the fishing lot management system into “open access’’, leading to over-exploitation of fisheries and conflicts between fishermen to compete for access and maximization of fisheries resources. Faced with such a challenging situation, the RGC has issued a decree to re-territorialize the open access area into a fishery conservation area and community fishery to reduce anarchic fishing activity in the TSL. About 222 community fisheries around the lake have been established in six provinces around the Tonle Sap, with 94,033 households as members. It covers about 538,739ha around the TSL. Most of CFis in TSL have registered with MAFF**.** At the same time, each community fishery (CFi) has demarcated a boundary and drawn the map to differentiate one CFi from the others. Members of the CFis are allowed to fish for subsistence only, using small-scale fishing gear.

4.3.1. *Fishery Conservation Area (FCA)*

After abolishing the fishing lot system in 2012, RGC has transformed 93,246ha, or 35 percent of abolished fishing lot areas into fishery conservation areas. The fishery conservation areas were further territorialized into 23 fishery conservation areas similar to fish sanctuaries. FiA is the sole agent responsible for the fish sanctuary and fishery conservation area management. Large canceled fishing lot areas in Battambang, Pursat, and Kampong Thom Provinces were converted into fishery conservation areas, accounting for 51 percent, 44 percent, and 26 percent respectively. These include the former fishing lot no.2 (50,134ha) in Prek Total in Battambang, the former fishing lot no.2 (7476ha) in Pursat, and the former fishing lot no.6 in BTC in Kampong Thom provinces.

Before the 2012s, three out of 37 fishing lots in TSL overlapped the Core Areas. FiA considered these fishing lots as the richest fishery areas in TSL. The Prek Toal was under the fishing lot no.2 in TSL in Battambang Province, which covers 50,134ha. The Boeung Tonle Chmar was under the fishing lot no.6 in TSL in Kampong Thom Province, which covers 8.325ha. Also, the Stung Sen was under the fishing lot no.2 in TSL in Kampong Thom Province, which covers 921ha. These areas were rich in the fishery and the most productive fishing lot areas in TSL.

FiA has a mandate to manage the fishery conservation areas (FCA). The Core Areas and the Ramsar Sites in TSBR overlaps with the FCAs in each site. In Prek Toal, the FCA covers 50,134ha, the BTC’s FCA covers 8,325ha, and Stung Seng’s FCA covers 921ha. The FCA areas were former fishing lot areas, rich in fisheries, abolished in 2012.

4.3.2. *Community Protected Areas (CPAs) and Community Fisheries (CFis)*

In the TSL, many CFis and CPAs were established. In 2001, RGC removed part of the fishing lot areas for community use, and in 2012, the entire fishing lot system was abolished and turned large fishing lot areas into open-access fishing areas and community fisheries (CFis). Five CFis were established in the Prek Toal area, covering 19,713ha.

Also, there is one Community Protected Area (CPA) in BTC Ramsar Site that was established in 2006-2007 through the

UNDP Tonle Sap Conservation Project (TSCP). The CPA covers 65ha, including 8ha of the Fishery Conservation Area (FCA). After a short period, the CPA was not functioning, and then it was revived by MoE with technical and financial support from the EU-NSA IUCN project (2013-2016) (IUCN, 2016). It is managed by the MoE/PDoE of Kampong Thom Province. In addition, in 2012, 37 fishing lots in TSL, including Fishing lot no.6 in BTC, were permanently abolished and handed back to fishermen's families for their daily livelihood. Following this decision, two Community Fisheries (CFis) (including small FCAs with strict protection) were established in Peam Bang Commune, inside BTC Ramsar Site (BTC-RS), covering 2,883ha. These CFis are located in the floating villages of Pov Veuy, covering 2676 ha and Peam Bang 208 ha. The CFis fall under the Ministry of Agriculture, Forests and Fisheries (MAFF) and are managed by elected CFi Committees under the Fisheries Administration (FiA).

Within Stung Sen Ramsar Site (SSRS), a Community Protected Area (CPA) was formed in Toul Neang Sav Plov village (Phat Sanday commune) in 2009, covering 1,495ha. NatureLife Cambodia / BirdLife International (NL/BL) works with Toul Neang Sav Plov CPA to strengthen CPA management and effectiveness. NL/BL also established one additional CPA in Phat Sanday commune and built their capacity and expertise for site management to support livelihoods and habitat conservation in SSRS. In addition, fisheries in SSRS are managed by the Phat Sanday Community Fishery (CFi), established by FiA in 2007, covering 8,810ha, and registered with MAFF in 2008. Five villages in Phat Sanday Commune are members of the Phat Sanday CFi. The Phat Sanday CFi is administered by the Fisheries Administration (FiA) under the jurisdiction of MAFF. SSRS also overlaps with Lower Stung Sen Key Biodiversity Area (KBA) and Important Bird Area (IBA). Fish Conservation Areas (FCAs) or fish sanctuaries have been established within the IBA and nearby open waters of TSL.

4.4. *The Regional Space and Hydropower*

The Tonle Sap River acts as a valve or artery connecting the Mekong River to TSL, and thus, the Tonle Sap's biophysical characteristics cannot be considered without reference to the Mekong hydrological regime. TSL owes its uniqueness to the natural phenomenon of reverse water flow, with approximately half of an annual pulse absorbed by the Lake area from the Mekong River during the wet season (May to October) and released back during the dry season1 (Nikula, 2005:13; Kammu *et al.*, 2008). Hence, the Tonle Sap is part of the Mekong River Basin, and the 1995 MRC Agreement recognizes TSL as a valuable area in the Lower Mekong River Basin. Further, four Lower Mekong Countries signed the 1995 MRC Agreement to protect it (MRC, 1995). Article 5 of the Agreement guarantees the equitable and reasonable utilization of the Mekong water. First, the Mekong can be dammed and diverted; second, the average flows can be maintained; and third, maintaining average flows in the Mekong during the rainy season is a healthy optimum. The question is how to protect TSL using this article given its vague meaning and confused terms (Ojendal, 2000; Sithirith, 2007). Article 6 also raises two concrete points in maintaining flows in the mainstream: a) Of not less than the acceptable minimum monthly natural flow during each month of the dry season; b) To enable the acceptable natural reverse flow of the Tonle Sap to take place during the wet season (MRC, 1995). Despite the assurance to protect TSL, it is very vague and unclear on protecting the dry season flow and the flow levels in general, but what is the dry season? How much is the acceptable low flow? How can we ensure the 'acceptable' dry and wet season flow under the scenarios of hydropower dam development? Hitherto, the real meaning of these terms is left out with no clarification or explanation (Sneddon, 2003).

However, hydropower is still possible under the 1995 MRC Agreement. These have put TSL under threat. Since the 1950s, nearly 6,000 large and small dams were built in the lower Mekong River Basin (FACT and EJF, 2001). Between 1965 and 2005, 22 major dams, hydropower, and irrigation schemes were built in four lower Mekong countries: Thailand, Laos, Vietnam, and China—About 40% of these dams were for irrigation and the rest for hydropower. The active storage capacity of these dams was 15,328 million cubic meters (mcm).

After the 1990s, 156 hydropower projects have existed in the Mekong Region—some built, some under construction, and some under planning. These dam projects could potentially produce a total capacity of 52,043 MW with a storage capacity of 126,890 MCM. Some 24 hydropower projects are being planned and built on the mainstream of the Mekong River, 13 dams in the Lancang River in Chinam, and 11 dams in the Lower Mekong River Basin (LMB). Eleven out of 13 Chinese hydropower dams were built between 1990 and 2020 and operated to generate electricity. Of 11 mainstream dams in the LMB, 9 nine are in Laos, and two are in Cambodia. In Laos, Xayabuiri Dam was completed and operational in 2019; Don Sahong was completed in 2020; Pak Beng Dam has completed the PNCA and is under planning; and two other Laos dams are under the PNCA.

Some 132 hydropower projects have been planned and built on the tributaries of the Mekong River in the LMB, of which 25 dams are operational, 13 are under construction, 23 are under license, and 74 dams are planned (MRC, 2017). In the 3S river basin, there are 42 dams--three major hydropower dams were completely built on the Sekong, eight on the Sesan and seven on the Srepok, and 23 are under planning (Constable, 2015; Piman et al., 2016; Piman et al., 2013).

Laos has planned to build 100 hydropower dams, of which 91 are on the tributaries and nine on the mainstreams of the Mekong River, with a total capacity of more than 20,000MW and the storage capacity of 57,477 MCM. Cambodia has planned 21 dams in the Mekong basin in Cambodia, of which two are on the mainstream (Sambo and Stung Treng), and the rests are in the 3S region and around TSL. Vietnam, a downstream country in the Mekong River, has planned for 20 dams, of which 15 are built in the 3S rivers2, while Thailand continues to finance the hydropower projects in Laos to import electricity to Thailand.

4.5. *Social and Ecological Transformation*

Dams would withhold water in the dry season to maintain their hydroelectricity outputs and release the water to protect dams during floods. In addition, dams possess flow regulation with a total regulation storage capacity. The flow regulation entails a few seasonal floods downstream during the usual years. A few seasonal floods, however, are likely to result in a decline in soil fertility over the large areas of rice cultivation in the Lower Mekong Basin. Fewer seasonal floods would also mean less natural capacity to constrain saltwater intrusion from the sea into the Mekong Delta. As a result, aquatic life long adapted to the Mekong ecosystems could be seriously jeopardized by a changing flow regime. Fish migration could be blocked by dam building. If the Mekong’s biodiversity dropped, this would likely be accompanied by falling productivity in the wild fisheries.

Between the 1990s and 2010, China completed four dams. The water storage capacity of these four dams was only 17,109 MCM. Although these dams hold back water, the water level in the Mekong River between 2001 and 2010 had not changed significantly. However, between 2010 and 2020, seven dams were built by the Chinese in the upper Mekong River Basin. In total, 11 Chinese dams were completed in the upper Mekong between the 1990s and the 2020s, with a total storage capacity of 47,644 MCM. Between the 1992s and the 2019s, China's Mekong Dams held back and thus made the water level in the Mekong River downstream of China relatively lower than the predicted level.

In the LMB, the proposed dams on the mainstream of the Mekong River and its tributary dams would subtract 81,192 MCM of water from the Mekong River, of which one is operational, the Xayaburi dam, one is under construction (Don Sahong dam), two are under the planning, and two are in the process of PNCA. In the 3S region, 42 dams have been planned, with a total storage capacity of 26,327 MCM. Combining the active storage capacities of the Chinese dams, the LMB dams, and the 3S dams, the total volumes held by hydropower dams would be equivalent to about 155,163 MCM. It will significantly alter the river flow downstream. In the Mekong River Basin, the hydropower dam operations have considerably modified the flow of the Mekong River (July-August) (Räsänen et al., 2016).

Hydropower dams alter the flow and the volume in TSL. According to MRC, in 2018, the wet season flow has reduced by 7%, and the dry season flow increased by 7% at all key stations, including the station in Kratie in Cambodia (MRC, 2018; Baran and Ratner, 2007; Halls and Kshatriya, 2009; Kirby and Mainuddin, 2009; Baird, 2009; Baran and Myschowoda, 2009). The flow at Kratie would reduce to 4,000m3/s in the wet season, and the dry season flow would increase to 2,200m3/s (Pinan et al., 2013). These will further alter the flow and volume of water in the TSL and affects fisheries productivity. In the 3S Basin, if all planned dams are built and operated, the dry season water flow is increased by 98% at the 3S outlet (Piman et al., 2016), and the wet season flow is decreased by 22% (Pinan et al., 2013).

The decline in water level significantly started in 2014. During 2014-2015, Cambodia experienced a severe drought, and the Tonle Sap water level was relatively low. In 2015, a forest fire in TSL occurred in Battambang Province due to the long and severe drought and the low water level. The severe drought in Cambodia continued in 2016, and the Royal Government of Cambodia declared a state emergency due to a lack of water for human consumption, and the State responded by distributing water to its populations across the country. In the Mekong Delta, more than 2 million Vietnamese and major Vietnamese rice production areas were impacted by low water levels and severe saline intrusion in 2016, resulting in over USD 670 million in losses. In March 2016, the Chinese government released water from upstream dams to relieve drought in the LMB and southern Vietnam.

The reverse flow from the MR to TSL occurs from mid-May to mid-October. The long-term average (LTA) annual Reverse Flow (RF) volume from the MR to TSL is about 40.38 km^3 between 1996 and 2015. However, the trend of the RF volume of TSL declined between 1997 and 2020. In the 2019s, the RF started until the first week of August, three months late. The total RF volume to TSL was estimated at 31.48 Km^3, critically lower than the LTA of TSL (40-42 Km^3). In the 2020s, the RF of TSL took place intermittently; the 1st RF started on 7 July and ended on 15 July, with a total volume of just 0.21 Km^3; the 2nd RF occurred in the last week of July, or early August 2020, resulting in an accumulated RF volume of 12 Km^3; the 3rd and 4th RF events occurred in late September and the third week of October 2020. The total volume of the

RF in 2020 was only 18.89 Km^3 or about 44% of the acceptable annual volume of 43 Km^3 (average condition for 1997–2005).

The changes in the RF from the MR to TSL between 2018 and 2020 and the reduction in the inundation around the lake degrade the lake's productivity. The Dai fishery production in TSR declined from 16,975 tons in 2018 to 9,900 tons in 2020. The decline in inundated areas around the lake, the low volumes of floodwaters entering the lake, the degradation of fish habitats due to lower water levels, and the destruction of flood forests between 2018 and 2020 contributed to changes in fish catches in TSL.

The annual fish catch from TSL accounts for 250,000 tons. However, between 2018 and 2020, it dropped from 291,260 tons in 2018 to 144635 tons in 2020—a 50% reduction. The decline of fish production in TSL is associated with the lowering water level, volume, inundated areas, and flood duration. Of course, it cannot deny other factors that contributed to the decline in fish catches in TSL, such as the destruction of flooded forests, illegal fishing, and the disappearance of some fish species (Figure 2). Figure 2 also demonstrates the decline in fish catch by provinces in TSL. In Siem Reap, Kampong Chhnang, and Kampong Thom provinces, fish catch has contributed significantly to the provincial economies and livelihoods of communities around TSL. However, they recently experienced a drop in fish catch. The reductions in fish catches have transformed the human connection with the lake.

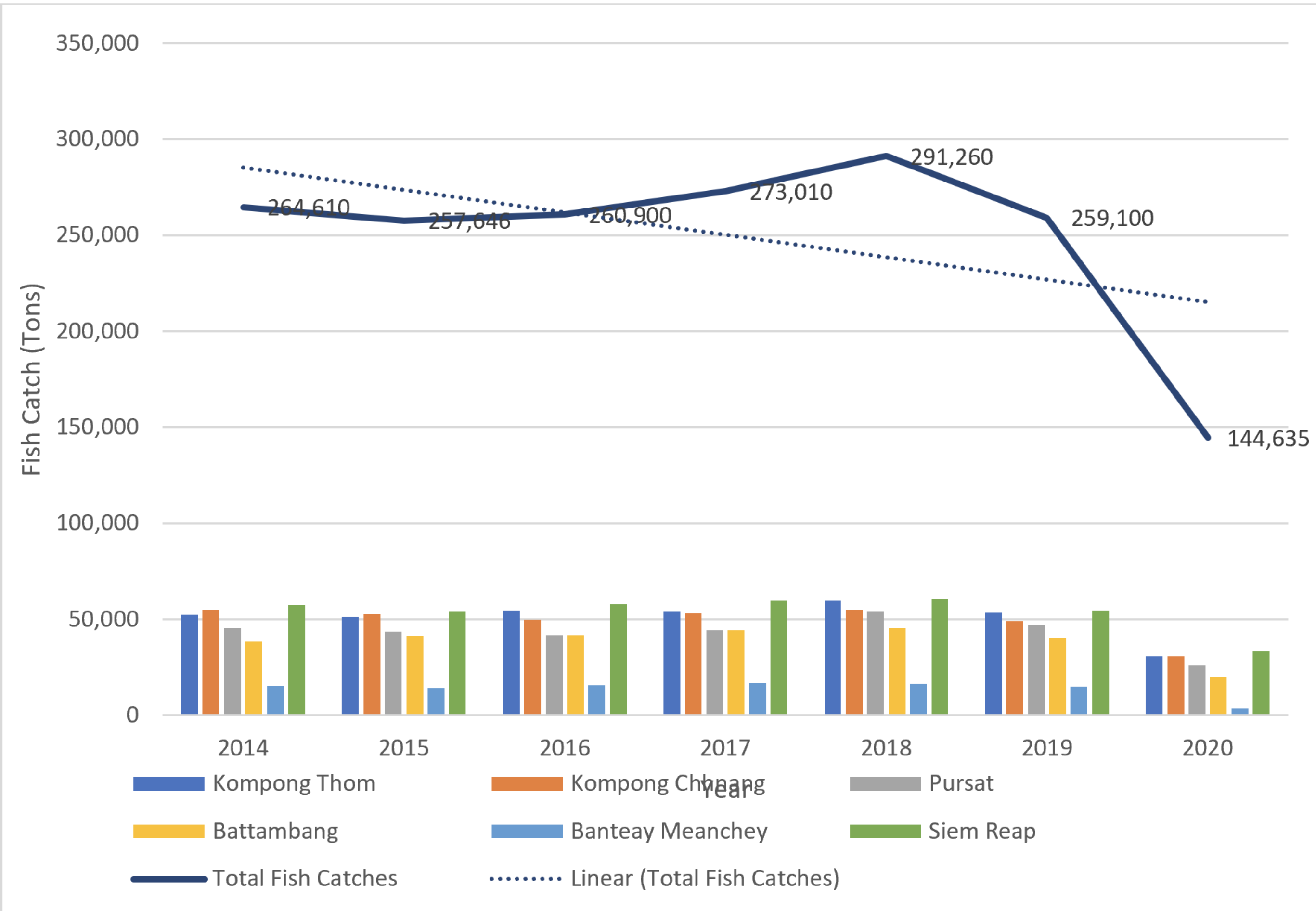

Figure 2. Inland fish production in TSL by years and by provinces in TSL (FiA, 2021)

The decline in inland fish production in TSL has affected fishing households and the fishing population. In the Tonle Sap provinces, fishing households declined by 10% between 2018 and 2019. Also, the fishing population by sex has dropped by 10% for male and 9% for female fishers. In total, the fishing population has declined by 10%. Banteay Meanchey has a high percentage of declining fishing households (25%) and fishing population (28%), followed by Kampong Thom and Kampong Chhnang Provinces **(Table 2)**.

Table 2. The decline in the fishing population in TSL

Province	No. of fishing households		Changes (%)	Male fisher		Changes (%)	Female fisher		Changes (%)
	2018	2019		2018	2019		2018	2019	
Kompong Chnang	51,760	41,516	-20	62,112	49,932	-20	93,168	74,898	-20
Pursat	35,338	35,338	0	67,700	67,700	0	66,357	66,357	0
Battambang	33,040	29,731	-10	46,565	41,908	-10	17,896	16,106	-10
Kompong Thom	45,466	44,466	-2	41,136	41,136	0	4,330	3,330	-23
Siem Reap	72,044	72,044	0	160,706	160,706	0	112,044	112,044	0
Banteay Meanchey	58,030	43,411	-25	120,100	86,500	-28	26,900	19,460	-28
Total	295,678	266,506	-10	498,319	447,882	-10	320,695	292,195	-9

Source: FiA, 2021

4.6. *Institutional Arrangements*

The TSL is complex, and the global, regional, and national dimensions shape its management. The international conventions, regional agreements, and national sectoral frameworks have all weights influenced the institutional arrangement and governance system of TSL. However, despite the diverse factors, the governance of TSL is still centered on three sectors: biodiversity, fishery, and water management. Thus, different institutions and actors nationally, regionally, and globally working on these sectors shape the governance of TSL, each with the mandates, roles, and responsibilities in the management. The coordination among different agencies is inadequate, and this causes the weak governance of TSL. In addressing these concerns, Tonle Sap Authority (TSA) was established to facilitate coordination and TSL governance.

4.6.1. *Institutional Framework for Tonle Sap Governance*

The CNMC is the coordinating body for all works related to the Mekong developments. It was established in line with the membership of Cambodia in the MRC and therefore acts as a national arm of the MRC, coordinating MRC works at the national level. On the other hand, the Asian Development Bank (ADB) has expanded its works in the Mekong region through the Greater Mekong Sub-region (GMS), and in Cambodia, the Tonle Sap Initiative was introduced in 2005, aiming at increasing the development and coordination in the TSL region. To address its needs, the ADB proposed to set up the Tonle Sap Basin Management Organization to improve the coordination and development work in TSL. However, in 2007, the RGC did not take the ADB proposal forward but established the Tonle Sap Authority (TSA) through a Royal Decree in September 2007 (RGC 2007), aiming at improving coordination, conservation, and development of TSL. Many representatives of various government agencies are members of the TSA, comprising 31 high-level representatives from ten different government ministries. It brings the coordination of concerned stakeholders closer.

The state agency responsible for fishery management in TSL is the Fisheries Administration (FiA). The Tonle Sap is the main fishing area where FiA is used to manage fisheries in TSL through a commercial fishing lot system to generate revenue for the national budget and the country's economy. In 2012, RGC reformed the fishery sectors, abolished the fishing lot system, and transformed large fishing lot areas into community fisheries (CFis) and the remaining areas into fishery conservation areas. Some fish conservation areas overlap with the Biosphere Reserve Areas and Ramsar Sites. These have contributed to overlapping roles and responsibilities between FiA and MoE in TSL.

MoE was established in 1993 with mandates to manage the Tonle Sap Biosphere Reserve and be the Cambodia focal point for the Ramsar Convention. Actors involved indirectly in Ramsar Site management include provincial/district authorities and different governmental departments, such as the Department of Agriculture, Forestry and Fishery (DoAFF), the Department of Planning (DoP), the Department of Health (DoH), the Department of Tourism (DoT), and the Department of Youth, Education, and Sport (DoYES). Secondary stakeholders include various NGOs and private sector actors such as NatureLife Cambodia / BirdLife International, IUCN, Fishing Cat Ecological Enterprise Co., Ltd, and the Ministry of Environment, the Government of Japan (Figure 3).

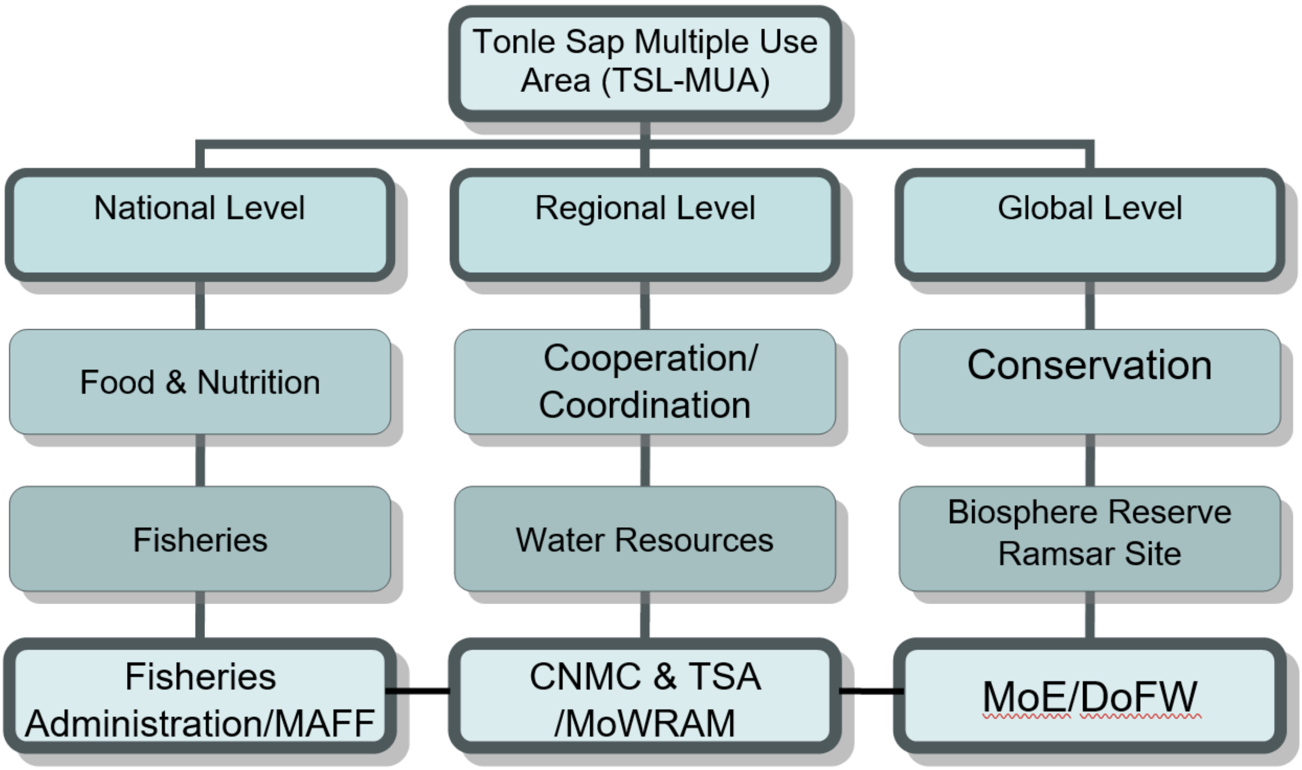

Figure 3. Institutional Framework for Tonle Sap Governance

4.6.2. *Actors and Intuitions in the Management of the Core Areas/Ramsar Site*

At the Core Areas (Prek Toal, BTC & Stung Sen), various actors have engaged in TSL-MUA's conservation and protection of global biodiversity species such as birds, Mekong Catfish, and other species. UNESCO has been a leading UN organization in conserving the global endangered and rare species in TSL. UNESCO and the Ministry of Environment are working together to strengthen the sustainable management of the Biosphere Reserve in TSL. On the other hand, IUCN is an active global organization in monitoring the implementation of the Ramsar Convention and promotes the conservation of wetland areas. IUCN has worked with MoE and NGOs such as FACT, CI, and others in Ramsar Sites in TSL to conserve wetland resources in Prek Toal, BTC, and Stung Sen sites.

At the regional level, TSL has been identified by MRC as Mekong regional environmental asset where MRC works with MRC's member countries to protect and conserve it for sustainable Mekong development. MRC has implemented the Mekong-Wetland Project in the Lower Mekong River Basin, financed by KfW. In Cambodia, the Mekong-Wetland Project is implemented by MRC, focusing on Prek Toal. WCS is a conservation NGO subcontracted by MRC/KfW to carry out conservation activities at the community level.

At national levels, MoE/PDoE is an agency responsible for managing the Biosphere Reserves and Ramsar sites in TSL. There is an Office in charge of Biosphere Reserve and Ramsar management with several rangers under the direct supervision of the PDoE. Also, NGOs such as IUCN, WCS, BirdLife, and others have supported each Office in carrying out conservation activities. IUCN, FAO, and other conservation NGOs may provide technical and financial support on landscape protection and biodiversity and improve the livelihood of local conservation communities dependent on the wetland and lake resources. In addition, World Bank has worked with MoE to implement a Cambodia Sustainable Landscape and Ecotourism Project (CSLEP) in the Cardamom Mountain and Tonle Sap Landscape (CMTS). It has implemented the project in BTC and Stung Sen and supported the management for both sites.

Also, FiA has received financial support from EU-CAPFISH Capture Project to manage the fishery conservation area and community fisheries in TSL-MUA. IUCN, WCS, and BirdLife have provided technical and financial support to CFis and CPAs in all three Ramsar sites in Tonle Sap Lake. Communities (local people in the buffer zone) participate in forest plantation, protection, and ecotourism development; cooperate on forest fire precaution and fighting; wise use of wetland resources. In Prek Toal Ramsar Site, WCS and MoE/PDoE have supported the establishment of the Community Based Ecotourism (CBE). So far, the CBE's Prek Toal has received many tourists who have visited Prek Toal annually, around 2 million tourists.

However, there is no private sector (Tourism/Private companies). There is potential to engage the private sector in resource management, such as fresh water, natural landscapes, and the environment to provide ecotourism services or purchasing, processing, and trading NTFPs (aquatic and vegetable products).

5. Conclusion

TSL has a complex space. Space has been territorialized, constructed, and reconstructed by different actors at different levels. Different actors possess different powers at different levels and scales, shaping TSL into different spaces and zone based on different specializations. Different actors claim different spaces, often overlapping and imposing different management systems, policies, legal frameworks, and institutional arrangements. Competing claims have created implications for resource governance.

Furthermore, different actors possess different agendas and intervening approaches for development and conservation in TSL. While TSL is conceived as a global space of biodiversity conservation, UNESCO has put TSL as a Biosphere Reserve for conserving globally endangered biodiversity species, and IUCN has granted the three Core Areas of TSBR as Ramsar Sites for wetland conservation. At the national level, FiA has established the FCAs and CFis, while MoE has organized the CPAs and MOWRAM has zoned TSL into three different zones. Also, while TSL is protected by the 1995 MRC Agreement signed by four lower Mekong Countries, these countries continue to build hydropower dams on the mainstream and tributaries of the Mekong River, which in turn undermine the security and the protection of TSL. These global, regional, and national frameworks have created overlapping spaces, legal frameworks, and management systems, which somehow compete and conflict with one another, implicating the governance of TSL.

The increased Chinese presence in the Mekong Cooperation and riparian states through Chinese investments has brought more development interventions in the Mekong River Basin, which has led to more development of hydropower dams, causing changing hydrological regimes and impacts downstream, particularly TSL. These have further impacted the water, fisheries, natural resources, and livelihoods of local communities dependent on the lake resources. At the same time, the development around TSL has made more challenges to the conservation and management of the lake.

Improving coordination across scales and levels is essential for implementing global, regional, and national commitments for TSL. Also, the conservation of global biodiversity species has benefited TSL, the Mekong Region, and the Mekong countries. At the same time, the development in the region has to be balanced and avoid the consequences following the commitments assured by the regional agreement.

Statements and Declarations

Acknowledgments

The author would like to extend his thanks to WorldFish and the Dean of the Faculty of Development Studies, Royal University of Phnom Penh for their support.

Author’s Note

Mak Sithirith is Post-Doctoral Fellow at WorldFish Center in Cambodia.

Declaration of Conflicting Interests

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author received no financial support for the research, authorship, and/or publication of this article.

Notes

[1] In the wet season, the surface area of the Lake increases from 250,000-300,000 ha to approximately 1.0-1.6 million ha, with depth increasing correspondingly from 1–2 m amsl to 9–11 m amsl, and storage capacity reaching a maximum of 80 million cubic meters. It absorbs 20 percent of the Mekong River's floodwaters and serves as a flood regulator (MRC, 2004; ADB, 2002). The drop in the water level in the Mekong in the dry season creates the “reverse flow” from the Lake into the Mekong.

[2] This report is taken from the CGIAR Report. The CGIAR Research Program on Water, Land, and Ecosystem. https://wle-mekong.cgiar.org/wp-content/uploads/unnamed-11.jpg. Accessed on 13 July 2018.

References

- Andreas B, Fernie S and Dainty A (2022) “Understanding Policy and Change: Using a Political Economy Analysis Framework.” *Construction Management and Economics* 40 (11–12): 865–83.
- Bailleux, Renaud. 2003. *The Tonle Sap: A Pulse of Life.* Bangkok: Asia Horizons Books.
- Baird I (2009) *The Don Sahong Dam: Potential Impacts on Regional Fish Migrations, Livelihoods and Human Health* POLIS Project on Ecological Governance, University of Victoria, Canada.
- Baran E and Myschowoda C (2009). Dams and Fisheries in the Mekong Basin.*Aquatic Ecosystem Health and Management,* 12 (3):227-234.
- Baran E and Ratner B (2007) *The Don Sahong dam and Mekong fisheries.* Available at: http://www.terraper.org/articles/DonSahong%20science%20brief.pdf.
- Benjaminsen T A and Svarstad H (2018) *Political Ecology. Reference Module in Earth Systems and Environmental Sciences.* doi:10.1016/b978-0-12-409548-9.10608-6.
- Bruce M and Yim C (2004) *Domestic* Fish Trade*: A Case Study of Fish Marketing from the Great Lake to Phnom Penh* Working Paper 29. Phnom Penh: Cambodia Development Resource Institute (CDRI).
- Campbell IC, Poole C, Giesen W, Valbo-Jorgensen J (2006) Species diversity and ecology of Tonle Sap Great Lake, Cambodia. *Aquatic Sciences* 68:355-373.
- Constable, D. (2015). Atlas of the 3S Basins. Bangkok: IUCN.
- Chevey P and F Le Poulain (1940) *La Pech Dans Les Eaux Douces du Cambodge* Travaux De L’institut

Oceanographique de L'indochine. Le Memoire, Gouvernement General de L'indochine. Saigon.

- Davidson P (2006) *The biodiversity of the Tonle Sap Biosphere Reserve*: 2005 status review. Prep. by Wildlife Conservation Society (WCS) for the Tonle Sap Conservation Project. Phnom Penh: WCS.
- Degen P, Van AF, Van Zalinge N, Thouk N and Vuthy L (2000).*Taken for Granted Conflict over Cambodia's Freshwater Fisheries Resources.* Written for the 8th IASCP Conference, Bloomington, Indiana, 31 May to 4 June, 2000. Phnom Penh: MRC, DoF and University of Antwerp, Belgium.
- Degen P and Thouk N (2000) Historical, Cultural and Legal Perspectives on the Fishing Lot System in Cambodia. In *Common Property in the Mekong: Issues of Sustainability and Subsistence,*eds. M. Ahmed & P. Hirsh, 49-60. Penang: Australian Mekong Resources Center, Sydney University, and World Fish Center.
- Delaney D (2005) *Territory: A Short Introduction*. UK: Blackwell.
- Escobar A (2006) Difference and conflict in the struggle over natural resources: a political ecology framework. *Development 49*(3): 6-13.
- Fisheries Action Coalition Team (FACT) & Environmental Justice Foundation (EJF). 2001.*Feast or Famine? A Solution to Cambodia Fisheries Conflict.* London: UK.
- Halls A S and Kshatriya M (2009) *Modelling the cumulative effects of mainstream hydropower dams on migratory fish populations in the lower Mekong basin*. MRC Technical Paper No.25, Vientiane: Mekong River Commission Secretariat.
- Herranz Muñoz V and Vong V (2022) *Climate Change Vulnerability Assessment Stung Sen Ramsar Site, Cambodia*. Bangkok, Thailand: IUCN.
- International Union for Conservation of Nature (IUCN) (2016) Strengthening Capacity of Fishing Communities in the Tonle Sap to Manage their Natural Resources Sustainably. EU-NSA Project Report (2013-2016). Phnom Penh: IUCN.
- Johnstone G, Puskur R, Declerck F, Mam K, Sithirith M, Pech B, Seak S, Chan S, Hak S (2013)*Tonle Sap Scoping Report-CGIAR Research Program on Aquatic Agricultural Systems*. Montpellier: Consultative Group for International Agricultural Research.
- Jones M, Jones R and Wood M (2004) *An Introduction to Political Geography: Space, Place and Politics.* London and New York: Rutledge.
- Kirby M and Mainuddin M (2009) Water and agricultural productivity in the Lower Mekong Basin: trends and future prospects. *Water International*, *34*(1): 134-143.
- Kummu M, Tes S, Yin S, Adamson P, Józsa J, Koponen J & Sarkkula J (2014) Water balance analysis for the Tonle Sap Lake–floodplain system. *Hydrological Processes*, *28*(4), 1722-1733.
- Kummu M, Lu X, Rasphone A, Sarkkula J & Koponen J (2008) Riverbank changes along the Mekong River: Remote sensing detection in the Vientiane–Nong Khai area. *Quaternary International*, *186*(1), 100-112.
- Lamberts D (2006) The Tonle Sap Lake as a productive ecosystem. International Journal of Water Resources Development *22*(3):481-495.
- Meynell PJ, Kong K, Sorn P and Lou V (2019) *Climate Change Vulnerability Assessment Boueng Chhmar Ramsar Site, Cambodia*. Bangkok, Thailand: IUCN.
- Mekong River Commission (MRC) (2018) THE COUNCIL STUDY: *The Study on the Sustainable Management and*

Development of the Mekong River Basin, including Impacts of Mainstream Hydropower Projects. Vientiane/Lao PDR: The Mekong River Commission.

- Mekong River Commission (MRC) (2010) *State of the Basin Report 2010 Summary*. Vientiane: Mekong River Commission.
- Mekong River Commission (MRC) (1995) *Agreement on the Cooperation for the Sustainable Development of the MR Basin*. MRC Secretariat. Available on https://www.mrcmekong.org/assets/Publications/95-agreement.pdf.
- Neumann R (2009) Political ecology: theorizing scale. *Progress in human geography* 33(3):398-406. DOI: 10.1177/0309132508096353.
- Nikkula J (2005) *The Lake and Its People—Review and Integration of Hydrological, Ecological and Socioeconomic Information in the Tonle Sap Lake*. Master's Thesis. Espoo: Helsinki University of Technology.
- North D (1991) "Institutions, Ideology, and Economic Performance." *Cato J.* 11: 477.
- Ojendal J (2000) *Sharing the Good: Mode of Managing Water Resources in the Lower Mekong River Basin.* Department of Peace and Development Research. Sweden: Goteborg University.
- Paasi A (1996) *Territories, Boundaries and Consciousness: The Changing Geographies of the Finnish-Russian Border.* Chichester, New York, Brisbane, Toronto and Singapore: John Wiley & Sons.
- Penrose J (2002) *Nations*, States, and Homeland: Territory and Territoriality in Nationalist Thought. *Journal of Nations and Nationalism,* 8 (3):277-297.
- Piman T, Cochrane T A and Arias M E (2016) Effect of proposed large dams on water flows and hydropower production in the Sekong, Sesan and Srepok rivers of the Mekong Basin. *River research and applications 32*(10):2095-2108.
- Piman T, Lennaerts T, and Southalack P (2013) Assessment of hydrological changes in the lower Mekong Basin from Basin-Wide development scenarios. *Hydrological Processes 27*(15): 2115-2125.
- Poulsen AF, Ouch P, Sintavong V, Ubolratana S and Nguyen T (2002) *Fish migrations of the Lower Mekong River Basin: implications for development, planning and environmental management*. MRC Technical Paper No. 8. Phnom Penh: Mekong River Commission.
- Rainboth WJ (1996) *FAO species identification field guide for fishery purpose*. Fish of the Cambodian Mekong*,* Rome: FAO, 265.
- Räsänen TA, Someth P, Lauri H, koponen J, Sarkkula J, Kummu M (2016) Observed river discharge changes due to hydropower operations in the Upper Mekong Basin. *Journal of Hydrology*. Doi: http://dx.doi.org/10.1016/j.jhydrol.2016.12
- Ribot J and Peluso N (2003) A Theory of Access. *Rural Sociology* 68:153-181.
- Royal Government of Cambodia (RGC) (2007) *Royal Decree on the Establishment of Tonle Sap Authority, Draft, Unofficial Translation*. Available Online At: http://www.foodsecurity.gov.kh/Otherdocs/Royal-Decree-tsba-Eng.pdf.
- Royal Government of Cambodia (RGC) (2001) *Royal Degree on the Establishment and Management of the Tonle Sap Biosphere Reserve*, Translation by Neou Bonheur, Available online at: http://www.tsbred.org/docs/law_and_regulation/Royal_Decree_On_creation_and_managemet_of_tsbr_Eng.Pdf.
- Sack R (1986) *Human Territoriality: Its Theory and History.* Cambridge: Cambridge University Press.

- Scott J (1976) *The Moral Economy of Peasant: Rebellion and Subsistence in Southeast Asia.* New Haven and London: Yale University Press.
- Sithirith M (2016) Political economy of fishing villages: A case study in the Tonle Sap Lake, Cambodia *Journal of Environmental Science and Engineering B* 5(6):299-313.
- Sithirith M (2011) Political geographies of the Tonle Sap: Power, space and resources (Doctoral Dissertation, National University of Singapore, Singapore).
- Sithirith M and Mathur V (2008) Entitlements and the Community Fishery in The Tonle Sap: Is the Fishing Lot System Still an Option for Inland Fisheries Management? In *Sustaining Tonle Sap: An Assessment of Development Challenges Facing The Great Lake,* eds. Chadwick, M., Juntopas, M., and Sithirith, M., 99-121. Bangkok: Stokholm Environment Institute (SEI).
- Sithirith M (2007) *Cooperation in the Mekong River Basin: A Reflection of Cambodia's Experiences in the Development of the Mekong Region*. Chiang Mai: Regional Center for Social Science and Sustainable Development (RCSD), Faculty of Social Science, Chiang Mai University, Thailand.
- Sneddon C (2003) Conservation Initiatives and Transnationalization in the Mekong River Basin. In *Globalization and New Geography of Conservation*, ed. K. Zimmerer, 191-212. The University of Chicago Press.
- Van Zalinge N, Degen P, Pongsri C, Nuov S, Jensen J, Nguyen VH, Choulamany X (2004) The Mekong River System. In *Proceedings of the Second International Symposium on the Management of Large Rivers for Fisheries*, eds. Welcomme, R.L., Petr, T., 1:333–355. Bangkok, Thailand: FAO Regional Office for Asia and the Pacific.
- Wittayapak C and Vandergeest P (2010) *The Politics of Decentralization: Natural Resource Management in Asia.* Silkworm: Combined Academic, Chiang Mai: Chesham.