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Research Article

The Spatial Politics of the Tonle Sap: A Multi-Scale Analysis of Conservation and Development Challenges

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Key resources of Tonle Sap Lake are fish, biodiversity, and natural resources. Its governance has been cast as a central pillar in the development of Cambodia. Although there is considerable literature and documents supporting the protection and conservation of the lake, there are also policies and development frameworks promoting hydropower investments and infrastructure developments that affect the TSL. Accordingly, this study questions how the water, fishery, biodiversity, and infrastructure developments are embedded in the conservation and development of TSL. In answering this question, the study conducts literature reviews and case studies in the Tonle Sap Biosphere Reserves, employing the political ecology approach. It concludes that TSL is a food-producing engine of Cambodia, the heartbeat of the Mekong River Basin, and a global biodiversity hotspot. The protection and conservation of the lake bring benefits to all at national, regional, and global levels, but the complex interplay of actors, arranged at various scales and levels, has collectively created the challenges facing the lake, giving rise to confrontation between conservation and hydropower, and raising questions about the long-term sustainability of its resources and the livelihoods that depend upon it.

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1. Introduction

Key resources of Tonle Sap Lake are fish, biodiversity, and natural resources. Its governance has been cast as a central pillar in the development of Cambodia. Although there are considerable literatures and documents supporting the protection and conservation of the lake, there are also policies and development frameworks promoting hydropower investments and infrastructure developments, affecting the TSL. Accordingly, this study questions how the water, fishery, biodiversity, and infrastructure developments are embedded in the conservation and development of TSL. In answering this question, the study conducts literature reviews and case studies in the Tonle Sap Biosphere Reserves, employing the political ecology approach.

TSL is the largest freshwater lake in Southeast Asia and the MRB, covering 2500 km^2 in the dry season, but it increases to 10,000-13,000 million km^2 in the wet season. The lake is connected to the Mekong River via the Tonle Sap River (Kummu and Sarkkula, 2008; Kummu et al., 2014) and has an exceptional water regime. In the wet season, an estimated 83 km^3 of water flows into TSL, of which the Mekong River contributes 54%, the lake's tributaries 34%, and the precipitation 13%. 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 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, the lake outflows its water to the Mekong mainstream through the Tonle Sap River, estimated at 82km^3, of which 84% flows via the 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 species that need protection under international conventions (Davidson, 2006; IUCN, 2016).

The 1995 MRC (write out abbreviation at first mention) Agreement protects the TSL via three important protocols; 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. Thus, one can ask how we can ensure the 'acceptable' dry and wet season flow under the scenarios of hydropower dam development. Consequently, this paper examines the governance of TSL from a political ecology perspective (Sithirith, 2021).

2. Conceptual Framework of Political Ecology

This paper examines the conservation of TSL on the one hand, and the developments of infrastructures and their impacts on the other hand, from the political ecology approach. Middleton (2022) reviewed the concept of political ecology on large hydropower dams. He pinpoints that political ecology is an interdisciplinary field that has grown rapidly since the late 1980s. It has evolved from the merging of human ecology / cultural ecology, development geography, and political economy, to include anthropology, human geography, political science, and environmental science, as well as fields such as political ecology on narratives and political ecology on scales. He finally highlights key concepts of political ecology on the large hydropower dams in the Mekong, focusing on hydro political ecology, rational hydrological approaches, the ontological politics of water, political economy and governance of large dams, knowledge production, and power relations, livelihoods, the commons, and water justice.

As this study looked into the Mekong River and Tonle Sap Lake, the researcher therefore draws on the concepts of political ecology, particularly the political ecology on scales and narratives, to analyze the political ecology of the Tonle Sap. In the Mekong, political ecology on narratives is often employed by politicians, industry, or NGOs to frame problems and orient actions. In the Mekong Basin hydropower debate, narratives have been employed by various actors as a disguise for their agendas and to legitimise their activities (Watts and Peet 2004). Geheb and Sahardiman (2019) discuss the political ecology of hydropower development in the Mekong River Basin, highlighting that hydropower development is occurring at a rapid, though controversial, pace, pitting a variety of stakeholder groups against each other at both local and international scales, and affecting state relations across scales. It is the process of socio-political construction of nature, viewing water as a medium that conveys power, and thus as a source of both collaboration and conflict. While the Mekong hydropower narratives do, indeed, attempt to conflate the massive regulation of hydrological systems with large-scale social and economic ambitions, they are also intended to obscure a widespread and systemic effort to control and alienate the region's waters via engineering at multiple scales.

Political ecology is concerned with how geographic scale is constructed and how actors use it to legitimize or delegitimize environmental change (Zimmerman and Bassett, 2003). Environmental and social changes in one location happen as the result of action; the processes and mechanisms take place at local, national, and international levels. Political ecology can help to illuminate how actors at one scale can construct and disseminate a version of scale that advances their agendas. Political ecology can help to highlight how powerful actors define the scale of environmental change and use these definitions to legitimize their actions (Marston and Smith, 2001; Rangan and Kull, 2009). In the Mekong Basin hydropower debate, hydropower developers and states often claim that the scalar benefits of hydropower, which are often measured at meso or national scales, are larger than the costs, which are often measured at local scales. In TSL, geographical space has been territorialized and reterritorialized into global, regional, and national levels, scales, and spaces (Sithirith, 2011 & 2022). As Jan Penrose (2002: 280) put it: "Through territoriality, specific places (including territories) are constructed, and it is this process that allows people to harness the material and emotional potential of space." In Penrose's terminology, territoriality helps harness 'the latent powers of space'. The production of space relates to its valorisation, commercialization, and the vital role that space plays in the processes of capital accumulation. Thus, space becomes at once a product and part of a process, serving various productive roles that help to generate revenue and profits for different agents (Lefebvre, 1991). Space holds two sources of latent power. First, a latent material power, and second, a latent emotional power (Penrose, 2002). Space comprises a substance fundamental to human life. Through its constitution of land, water, and atmosphere, space encompasses the basic prerequisites of human survival: the food that we eat, the water that we drink, the air that 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 have the capacity to invoke or release an emotional response. This is the latent emotional power of space (Penrose, 2002).

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 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). Resource politics is a politics of 'access' (Ribot and Peluso, 2003) and about issues of state centralization and decentralization, 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 (Wittayapak and Vandergeest, 2010).

3. Materials and Methods

The conceptual framework above is utilized to analyse the political ecology of the Tonle Sap. To do this, the study selected three sites in three Core Areas in the Tonle Sap Biosphere Reserve—Prek Toal, Boeung Tonle Chmar, and Stung Sen—to undertake the data collection. Prek Toal is the first TSBR Core Area, located on the northwest side of TSL in Battambang Province, which is rich in fishery, birds, and biodiversity. Boeung Tonle Chmar is a second TSBR Core Area located in Kampong Thom Province. The third Core Area is Stung Sen, located at the southern end of TSL, in Kampong Svay District, Kampong Thom Province (see Figure 1).

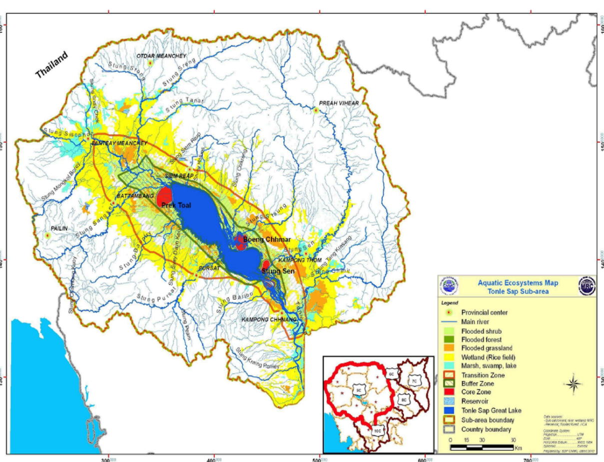

Figure 1. The studied areas in Tonle Sap Lake (Adopted from MRC, 2017).

The investigation gathered data from structured interviews with stakeholders at national and community levels. The research was conducted in three phases. First, between 2007 and 2011, information was collected 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, a study was conducted that focused on the aquatic and agricultural system in Tonle Sap, the linking between fisheries, agriculture, livelihoods, governance, and policy frameworks (Johnston et al., 2013). Additional data and information that were collected focused on fisheries, agriculture, water, and livelihood activities of fishing communities in TSL. The participants involved in the study included: (i) villagers selected from thirteen villages, including water-based, water-land-based, and land-based communities around TSL; (ii) officials from government agencies at the national, provincial, and local levels concerning fisheries and agriculture in TSL; and (iii) NGOs and researchers who worked in TSL. The study asked the participants about fish catch, agricultural activities, alternative livelihoods, water management, agricultural markets, and other related livelihood activities.

Third, between August 2022 and March 2023, in collaboration with the Mekong River Commission (MRC), a gap analysis, using the IUCN Green List Framework, was undertaken to assess whether the current management of the Tonle Sap Multiple Use Area (TS-MUA) meets the IUCN Criteria or not; focused on good governance of biodiversity conservation in three Core Zones of the TSBR, sound design and planning, effective management, and successful conservation outcomes. During the study period, first, a stakeholder meeting was held with representatives from MAFF, FiA, MOWRAM, TSA, and IUCN to discuss the management of three Core Zones of TSL prior to the fieldwork. Second, the fieldwork conducted during November 2022 involved consultations with site managers, park rangers, NGOs, and meetings with local communities. Key informant interviews (KIIs) with site managers, park rangers, NGOs, and village chiefs were conducted in three Ramsar sites—Prek Toal, Boeung Tonle Chhmar, and Stung Sen, focusing on the governance of the sites, the design and planning, the management, the outcomes of the conservation, livelihoods, and the participation of local communities. After the KIIs, three focus group discussions (FGDs) were organized, one FGD in each Ramsar Site, participated in by 12-15 rangers and officers in charge of the Ramsar site and villagers from the surrounding villages. Some questions related to indicators of the IUCN Green List were asked during the FGDs. In addition, participants in the KIIs and FGDs volunteered and gave informed consent. The information collected was kept highly confidential and anonymous. The participants were protected from any harmful effects.

Data and information collected were entered into the Excel sheet of the IUCN Green List indicators, including: (1) good governance, (2) sound design and planning, (3) effective management, and (4) conservation outcomes. The Excel sheet was analysed using tables, percentages, and graphs to explain the governance, livelihoods, and conservation in TSL. In addition, the political ecology framework was employed to analyze the territorialization of fisheries resources in TSL, to examine the spatial politics in the lake, to 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 finally, the changing environment.

4. Results

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). The 'flood pulse' submerges vast areas of TSL and its floodplains 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. (Lambert 2006 & 2013)

TSL naturally comprises three ecologically 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 humans in TSL have organized their settlements into 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 members are 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 floats 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 is physically 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.

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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 for paddy rice with '*neak leu*' or highlanders 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 date. 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 other. These have created a dependency and reciprocal system between *neak leu* and *neak tonle* to share their resources for their livelihoods (Sithirith, 2016).

Villagers living in a land-based community around TSL are named '*neak leu*' (highlanders), 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 cultivated 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 rainfall 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 from this floodplain and flows into the Mekong River with no use, as there are no storage systems, reservoirs, or basins that could extract water out of a 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 (Sithirith, 2015; Keskien, 2006). 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; Lebel, Garden & Imamura, 2005).

4.2.1. *Biodiversity Hotspots*

TSL is highly productive. The annual fish catch from the lake is estimated at between 180,000–250,000 tons, while the dai fishery on the 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% comes 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 species, including more than 200-370 species of plants, 197 species of phytoplankton, 46 species of zooplankton, 210-225 species of birds, 20-46 species of mammals, 30-42 species of reptiles, 300 species of invertebrates, and 05 species of amphibians. At least 44 species are globally threatened or endangered (MRC, 2010). Fish are 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 the 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 during the dry and rainy seasons, and doing 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 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 the 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 is a Core Zone of Biosphere Reserves issued by a Sub-decree in 2001, covering 21,342ha. In October 2015, RGC and IUCN granted Prek Toal status as a 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 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 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 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). The 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 the 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 was 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.

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

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

Source: MoE, 2022

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

TSL is a national space. The state has '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 competing 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 the 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, the 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. Prek Toal was under fishing lot no.2 in TSL in Battambang Province, which covers 50,134ha. Boeung Tonle Chmar was under fishing lot no.6 in TSL in Kampong Thom Province, which covers 8.325ha. Also, Stung Sen was under fishing lot no.2 in TSL in Kampong Thom Province, which covers 921ha. These areas were rich in 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 overlap 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, the 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 the 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 the 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 the BTC Ramsar Site (BTC-RS), covering 2,883ha. These CFis are located in the floating villages of Pov Veuy, covering 2,676 ha, and Peam Bang, covering 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 the 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 the 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 the 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 season[1] (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 have been 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 were 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 China, 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 the 11 mainstream dams in the LMB, 9 are in Laos, and two are in Cambodia. In Laos, the Xayabuiri Dam was completed and became 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 a 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 rest 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.

Dams would release water in the dry season to maintain their hydroelectricity outputs and release 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 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.

Hydropower dams alter the flow and the volume in TSL. According to MRC, in 2018, the wet season flow had 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 affect 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 of 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 144,635 tons in 2020—a 50% reduction. The decline in 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.

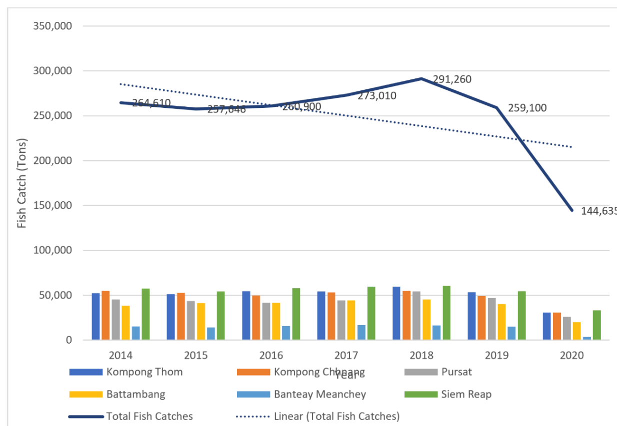

Figure 2. Inland fish production in TSL by years and by provinces in TSL (FiA, 2021)

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)**.

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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

Table 2. The decline in the fishing population in TSL

Source: FiA, 2021

At the Core Areas (Prek Toal, BTC & Stung Sen), various actors have engaged in TSL-MUA's conservation and protection of global species such as birds, Mekong Catfish, and other species. UNESCO has been a leading UN organization in conserving the globally 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 a 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 the national level, 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 for landscape protection and biodiversity and improve the livelihood of local conservation communities dependent on the wetland and lake resources. In addition, the 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 of both sites.

Also, FiA has received financial support from the 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; and practice the wise use of wetland resources. In the Prek Toal Ramsar Site, WCS and MoE/PDoE have supported the establishment of the Community Based Ecotourism (CBE). So far, the CBE at Prek Toal has received many tourists who have visited Prek Toal annually, around 2 million tourists.

However, there is no private sector involvement (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 to purchase, process, and trade NTFPs (aquatic and vegetable products).

5. Discussion and Conclusion

TSL possesses three scales—national, regional, and global (Sithirith, 2021). At the national scale, fishery is a key resource for the national economy and the livelihoods of its people. At the regional scale (the Mekong River Basin), TSL is the heart of the Mekong, where the flood pulse plays a critical role in absorbing the floods in the wet season and releasing them in the dry season (Campbell, Say & Beardall, 2009). At the global scale, TSL is a hotspot of global species. Concerted efforts have been organized around these scales to protect and conserve TSL, such as UN Biosphere Reserves, the Ramsar Convention, the 1995 MRC Agreement, and the national conservation program such as the flooded forest zoning. While these bring support to TSL, they also influence the governance and conservation of TSL from institutional, technical, and financial capacities from different scales and levels—global, regional, and national.

At each scale, TSL is a space. The TSL space encompasses land, water, fishery, biodiversity, and natural resources. For local communities, these resources form the dependent space for their living (Cox, 1998), a latent material and a latent emotional power (Penrose, 2002), and a representational space (Lefebvre, 1991). For the Government agencies, these resources are sectoral, institutional, technical specializations, and power defined by the legal frameworks. They are institutionalized with mandates, roles, and responsibilities to manage these resources (Keskinen, & Sithirith, 2009). Different institutions compete for different spaces, such as resources, powers, and influences, and so, spaces in TSL are territorialized, deterritorialized, and reterritorialized, as Peluso (2005a: 6) has stressed: "territorialisation produces places in relation to claimants," and there are numerous territories and places in and around the TSL. In addition, problems exist over overlapping claims, multiple functions in the same zones, boundary disputes between commercial, middle-scale, and family fishers, and there is great ambiguity over the specific territorial and resource access rights afforded to different communities. These have implicated the governance and conservation of TSL (Sithirith, 2022).

Space has been constructed and reconstructed by different actors at different levels. Fishery as a space has been organized into CFis, public fishing areas (open access), and conservation areas, after the abolishment of the commercial fishing lot system. The conservation area has been reconstructed into the fishery conservation area (FCA) and fishery sanctuary, under the responsibility of the Fishery Administration. As for biodiversity conservation, TSL is managed as a conservation area under the Ministry of Environment, reinforced by the Royal Decree in 2001. Furthermore, UNESCO has reconstructed the TSL as a Biosphere Reserve for conserving globally endangered species, and IUCN has granted the three Core Areas of TSBR as Ramsar Sites for wetland conservation. In the Core Areas and Ramsar Sites, MOE has established the CPAs to engage local communities in conservation activities. There are overlapping spaces, producing implications for the governance and conservation of resources in the lake. One space, zone, or territory may be managed by two or three institutions with different policies, legal frameworks, and technicalities, inducing the complexities of space, zones, and territories and causing hardship for local people's adaptation. These bring more competition than cooperation between concerned institutions and with local communities.

On the other hand, the states in the Mekong region view the Mekong as a resource for economic growth and modernization. The intensification of economic activity in the basin precedes plans for large hydropower dams. In Laos, hydropower was envisioned as a means of generating foreign exchange and state revenue through electricity export, first to Thailand and later to Vietnam and China. Many private hydropower proponents were from Europe, Australia, and the US, with an influential financing and policy role for Western bilateral donors and multilateral development banks, namely the World Bank and the ADB (Bakker, 1999). Later in Laos, private project developers and commercial financiers have primarily been from Thailand, Vietnam, and China, although actors from other countries, including Japan, Malaysia, and Korea, are also present (Middleton et al., 2009). In Cambodia, investment in both electricity generation and transmission comes primarily from the private sector and, in the case of large hydropower dams, has primarily come from Chinese developers and financiers (Siciliano et al., 2016). Although there are impacts of hydropower dams on TSL and tensions over hydropower dams, riparian states compete, cooperate, and share the benefits from hydropower dams. The regional and bilateral cooperation over the Mekong, the regional politics, and the national interests have shed more light on hydropower developments than on the conservation of TSL.

On the geographical scale of the MRB, as indicated by Zimmerman and Bassett (2003), the development elsewhere in the MRB, such as hydropower dams, would cause hydrological changes and impacts on TSL, biodiversity, and livelihoods. Although the 1995 MRC Agreement ensures the maintenance of the reverse flows and dry season flow to TSL, this is only rhetoric, and it will never happen in the context of increasing hydropower development and climate change. As Mekong riparian states struggle to graduate to middle-income countries and reduce poverty, more hydropower dams are being built to generate electricity to boost their economies. 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 on TSL. These have further impacted the water, fisheries, natural resources, and livelihoods of local communities dependent on the lake's resources. Despite these and breaching international agreements, Cambodia may not choose the way in which to complain about its neighbors who cause the impacts on TSL. Instead, Cambodia may empower itself in the Mekong cooperation by also building dams and infrastructures. Thus, more development projects, including hydropower dams and navigation projects, have been built and have made impacts on the conservation and management of the lake.

The only way to address the above challenges and impacts is through improving coordination across scales and levels and reinforcing global, regional, and national agreements and commitments for TSL. Also, the conservation of global species has benefited TSL, the Mekong Region, and the Mekong countries. At the same time, development in the region has to be balanced and avoid the consequences following the commitments assured by the regional agreement. Coordination and cooperation between government agencies are the second level of importance. Coordinated policy, planning, implementation, and management over spaces, zones, and territories bring significant outcomes for the sustainability of TSL.

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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.

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