Threatening Tonle Sap:

Challenges for Southeast Asia's largest Freshwater Lake

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Source: Michael Waibel 2009

Abstract: The Tonle Sap ecosystem in Cambodia is Southeast Asia's largest freshwater lake; strongly impacted by the Mekong river flood pulse. The lake is home to exceptional biodiversity, and rural communities living in free floating villages on the lake and on its shores. The fragile niche ecosystems as well as the rural livelihoods of Tonle Sap are under severe threat. Overfishing, illegal wood harvesting, further resource exploitation, and water quality deterioration all impact the stability of the socio-ecological system of Tonle Sap. At the same time, expected flood pulse changes due to regulatory measures in the context of hydropower development upstream on the Mekong are a severe threat for Tonle Sap's ecosystem stability. The area needs to shift into the focus of attention of national and international researchers, stakeholders, and decision makers, to find suitable pathways for a future sustainable development of this unique and pristine region.

Key words: Tonle Sap Lake, flood pulse ecosystem, floating villages, rural livelihoods, fisheries

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Introduction to Tonle Sap Lake's Socio-Ecological System: Tonle Sap Lake in Cambodia is the largest freshwater lake in Southeast Asia. The permanent water body of the Tonle Sap exceeds 2.500 km² in the dry season, and this area more than quadruples to 12.000 km² in the rainy season (August to November). In late June the monsoon waters of the Mekong river arriving from the North pour into Tonle Sap River, which then reverses its flow direction towards the North and feeds the lake from its southern tip. During this time the lake's surface expands four- to fivefold and the water volume multiplies up to 50 times, with water depths increasing from one to over 12 meters (Osmose, 2013).

Source of all other pictures: Claudia Kuenzer 2013

The Tonle Sap is unique in many ways. Not only the hydrologic regime with its vast fluctuations is exceptional in the world. The lake is one of the world's top fresh-water fisheries, as well as one of the world's largest habitats for snakes, and hosts the largest colonies of endangered water birds in Southeast Asia, among them 15 endangered species such as grey-headed fish eagles, spot billed Pelicans, black-headed Ibises, and Adjutants. Mammals include macaque monkeys, otters, fishing cats, flying foxes and bats, civets, lorises, as well as domestic animals living close to men. At the same time – due to high water level fluctuations – it is the largest seasonally flooded fresh-water swamp in Southeast Asia. Shrubs and trees withstand week-long flooding – a unique habitat of unique floristic composition consisting of gallery forest, short-tree shrub lands, and herbaceous aquatic vegetation. Most plants shed their leaves during submersion in the wet season. Leafs then sprout on the trees again from top to bottom (an uncommon oddity) after the flood waters recede (Osmose 2013).

About 100,000 people, of which most are Khmer, live in the over 150 floating villages scattered alongside the lake. Most of them live from the rich fisheries: as fishermen, fish traders, fish processing experts, or maintaining services (floating gas stations, schools, churches, police stations etc.). Some villages are fully floating villages perfectly adapted to the rise and fall of water levels. The location of those villages may shift for several tenths of kilometres between the dry and the wet season. Mixed villages contain fully floating homes as well as stilt homes built on 8-10 meter high stilts. Villagers have adapted their life perfectly to the water environment. Children are picked up by "school-boats" to visit their

floating schools, domestic animals such as pigs are kept in floating cages, people catch the daily dinner right in front of their floating house, and plants such as invasive water hyacinth or floating coconuts etc. are used to weave mats, baskets, or carve bowls. The floating communities of Tonle Sap Lake are outstanding in their adaptation to their natural environment. Many of them are located within the "Tonle Sap Biosphere Reserve", which was established in 2001 by the Cambodian government, after UNESCO had declared Tonle Sap an ecologic hot spot.

Major challenges

Some authors claim the Tonle Sap and the Mekong floodplains to be the most productive freshwater ecosystems in the world (Kummu et al. 2010), depicting the fish yield in the Tonle Sap (139-230 kg/ha/yr) to be 700-850 per cent higher than in the floodplains of e.g. the Amazon or the Brahmaputra (van Zalinge 2002). Migratory fish species (so called white fish) and residential fish of the lake itself (so called black fish) are differentiated. However, even though Baran and Myschwoda (2008) report that fish catches in the Tonle Sap and Lower Mekong Basin are (weight wise) greater now than in past decades (attributed to modern and partially illegal catch methods, such as the use of explosives, poison, and electrofishing, Valbo-Joergensen et al. 2009), they also find that there is a shift in catch characteristics (diminishing size and quality), from medium size and large fish towards an increasing amount of very small fish, which do not have a high market value (Kuenzer et al. 2012). Overfishing occurs due to the local fishery laws, which distributes part of the lake into different so called 'lots', in which lot operators fish as much as possible. Even though overfishing and coastal forest destruction is prohibited, the limitations are not specified (what IS overfishing), and law enforcement does not take place. In addition, migratory fishermen (e.g. from northern Thailand) as well as Cambodian rice farmers, which fish only during the rainy season, come into the area to fish. This overfishing as well as illegal wood harvesting has a direct impact on livelihoods and in the mid-term will aggravate poverty. At the same time, alternatives for income generation are rare: local fishermen need to overfish to survive as allowed catch amounts would simply not be enough to supply an income to the average rural household of seven people (5 children average). The decrease in fish has – in many areas – led to a drastic decline in migratory birds and disturbances in the food chain. On top of this, water pollution due to socio-economic development around the lake threatens local people's drinking water supply and lead to the explosive development of harmful invasive plant species, such as water hyacinth.

Rural livelihood of a coal fisher's family

These threats are further aggravated by upstream developments in the Mekong Basin. Hydropower developments along the main stem and its tributaries cause transboundary effects within the whole Basin (Kuenzer et al., 2012, Zhao et al. 2008). On the one hand, the provision of hydropower increases economic activity and meets the rising energy demand of Mekong riparian countries. On the other hand, the negative impacts of dam construction, mainly altered water flow and reduced sediment load, confirm downstream country's fears (Kuenzer et al., 2012). As the Tonle Sap is connected with the Mekong via the 100km long Tonle Sap River, the impact will be directly felt (Lamberts 2008). Only slightest changes in the flood pulse characteristics such as the timing and duration of the flood, the rate of rise and fall of the flood water as well as the height of dry and wet season water level may alter the complex ecologic niches and habitats and the associated processes that determine the Tonle Sap's ecosystem productivity (Valbo-Joergensen et al. 2009, Welcomme and Halls 2004, Lamberts 2008). Lamberts (2008) investigated the consequences of Mekong river flow alterations for the Tonle Sap ecosystem and compiled an impressive table of major flood pulse characteristics and their susceptibility to being affected by anthropogenic flow alterations in the Mekong River. For the lake, the timing of the flood is a crucial factor to allow the synchronisation between physiological readiness (for migration, spawning etc.) of the fish and the flood phase. Nesting species' reproductive cycle, for example, may be disrupted if water levels rise too fast, and eggs can become emerged if flood water falls too fast. According to a Cumulative Impact Assessment report, which was initiated by the World Bank and the Asian Development Bank and which aimed at examining the consequences of hydropower induced water level changes, dry season water levels are expected to rise up to 70 cm at Chaktomuk junction of the Tonle Sap and the Mekong River (Miyazawa et al. 2008). Such drastic changes would severely change the local ecosystem.

Conclusion and future needs

Summarizing, current threats to the Tonle Sap ecosystem are:

Floating stores and storage supplies

- regulatory measures (hydropower, but also water diversion projects and increasing irrigation) at the upper reaches of the Mekong and its tributaries, directly impacting the flood pulse and therefore sensitive niche-ecosystems,
- the loss of flooded forest due to wood consumption and clear cutting, leading to changes in the ecosystem (decreasing spawning and resting grounds for aquatic animals, decreased erosion and lake floor protection etc.),
- overfishing spurred by destructive and illegal fishing techniques (leading in the long run to alternative requests for protein, and thus landuse change in the Mekong Basin),
- water pollution through nearby cities, villages, and the use of agrochemicals (impacting biodiversity in and around the lakes, as well as food quality and finally human health),
- the spread of invasive water plant species (hindering transport and leading to further water quality deterioration),
- a lack of income alternatives for the local population and the need for extensive resource exploitation in the absence of law enforcement.

Although ecotourism is on-going at small scale, and although first non-governmental organizations have set foot into the area to support sustainable resource management, extended research, capacity-building, and awareness-raising on the complex relationships within this unique and pristine ecosystem is needed. It is crucial that the rural population of the floating villages of Tonle Sap can maintain their safe livelihoods in the future. Furthermore, incentive programmes for local communities to engage more in the protection of their own environmental resources are urgently needed to stress the value of biodiversity. Incentives and the development of new income sources, such as well-controlled and limited eco-tourism can also help to overcome the poverty of the rural people living near and on Tonle Sap. At local and national level in Cambodia most important is an improved law enforcement to mitigate activities of overfishing and resource destruction.

At regional, international level, the ecosystem of Tonle Sap deserves an even greater attention within the transboundary Mekong related dialogue of organisations and initiatives such as the Mekong River Commission, MRC, the Greater Mekong Subregion Initiative, GMS, and with further players such as governmental research agencies, non-governmental organisations, international research and development projects, as well as development aid implementation agencies.

References

Baran, E. and Myschwoda, C. (2008) Have fish catches been declining in the Mekong River Basin? In: Kummu, M. et al. (eds) Modern Myths of the Mekong. A critical review of water and development concepts, principles and policies. Water & Development Publications, Helsinki University of Technology, pp 55-64.

Kuenzer, C. et al. (2012) Understanding the Impacts of Hydropower Developments in the context of Upstream-Downstream Relations in the Mekong River Basin. Sustainability Science, Springer, DOI 10.1007/s11625-012-0195-z.

Kummu, M., et al. (2010) Basin-wide sediment trapping efficiency of emerging reservoirs along the Mekong. Geomorphology 119 (2010): pp 181-197.

Lamberts, D. (2008) Little impact, much damage: the consequences of Mekong River flow alterations for the Tonle Sap ecosystem. In: Kummu, M. et al. (eds.) Modern Myths of the Mekong. A critical review of water and development concepts, principles and policies. Water & Development Publications, Helsinki University of Technology, pp 3-18.

Miyazawa, N., Sunada, K., and Sokhem, P. (2008) Bank erosion in the Mekong River Basin: Is bank erosion in my town caused by the activities of my neighbours? In: Kummu, M. et al. (eds.) Modern Myths of the Mekong. A critical review of water and development concepts, principles and policies. Water & Development Publications, Helsinki University of Technology, pp 19-26.

Osmose (2013): The waterway: Between Battambang and Siem Reap – Introduction to the Tonle Sap great lake's ecosystem. 31pp.

Van Zalinge, N. (2002) Update on the status of the Cambodian inland capture fisheries sector with special reference to the Tonle Sap Great Lake. Catch and Culture 8 (2): 1-5.

Valbo-Joergensen, J. et. al. (2009) Fish Diversity in the Mekong River Basin. In: Campbell, I.C., (ed.): The Mekong – Biophysical Environment of an International River Basin, Elsevier, New York, pp 161-196.

Welcomme, R.L., and Halls, A.S. (2004) Dependence of tropical river fisheries on flow. In: Welcomme, R.L. and Petr, T. (eds) Proceedings of the second international symposium on the management of large rivers for fisheries, Volume II, RAP Publication 2004/16, FAO, Bangkok, pp 267-283.

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