Modelling Sediment and Ecosystem in Tonle Sap Lake for Impact Assessment

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Abstract: Tonle Sap Lake in Cambodia is the largest permanent freshwater body in Southeast Asia. The 3D hydrodynamic and water quality model has been set up for the lake and its floodplains to understand the ecosystem and geomorphological processes, and the possible changes caused by the Mekong upstream developments as dams and reservoirs.

Key words: Tonle Sap Lake, Mekong, sediment transportation modelling, impact assessment, upstream impacts

Introduction

The Tonle Sap Lake in Cambodia is the largest permanent freshwater body in Southeast Asia. The lake is a unique lacustrine-wetland ecosystem. It is Mekong's major natural reservoir with annual water level fluctuations of 8 to 10 meters. The area exceeds 12,000 km^2 during the monsoon floods, and shrinks below 2,000 km^2 in the dry season (Figure 1). A dominant feature of the Tonle Sap system is that the sediment flux to the Tonle Sap Lake in the flood season (June-September) is many times larger compared to the outflow flux in the dry season (October-May). This sediment is very important ecosystem processes. Mekong River is responsible for the main part (ca. 70 %) of the annual sediment load of average 7 million tons to Tonle Sap Lake (Figure 1).

It is hypothesized that sediments carried by the Mekong waters to the Tonle Sap Lake bring in the essential nutrients that feed into the lake's food webs (Sarkkula et al., 2004; Sarkkula et al., 2003; WUP-FIN, 2003). The higher the flood the more sediments and nutrients is brought in. The Mekong Upstream developments like construction of dams have already led to significant trapping of sediments (Kummu et al., 2004) and nutrients and may reduce the fertility of the Tonle Sap system.

The 3D mathematical model has been set up for the Tonle Sap Lake and its floodplains for simulating the hydrodynamics, inundation of the floodplain, suspended sediment transport and sedimentation to understand the ecosystem and geomorphological processes,

Short scientific paper

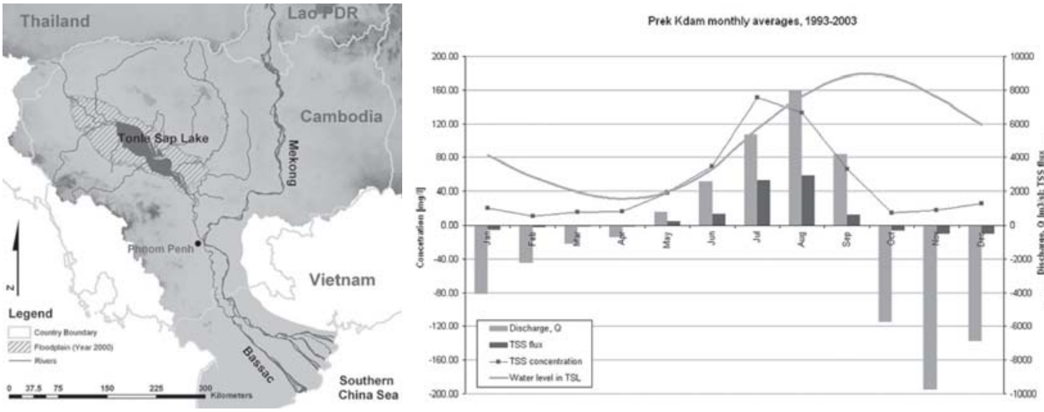

Figure 1. Left: Tonle Sap Lake and Lower Mekong Basin floodplains. Right: Monthly average flows, sediment fluxes and sediment concentrations in the lake outlet, Prek Kdam (1993-2003). Positive values into the Tonle Sap Lake and negative values from the lake.

and the possible changes caused by the upstream developments (WUP-FIN, 2003). The model is used e.g. for the scenario simulations and impact assessments to assist in the maintenance of sustainable conditions in the lake and its surroundings.

RESULTS AND DISCUSSION

The results of the WUP-FIN modeling work are showing that the main sedimentation areas are in the flooded forest and flood plains are in the Tonle Sap delta area and in the vicinity of the lake proper and the tributaries. These areas function effectively in trapping of sediments inside the vegetated habitats (WUP-FIN, 2003). Model results are supported by the water quality measurements, where a steep decline of suspended sediments concentrations is found when moving from lake to the flood plain and by the topographic features of the lake where a natural levee has formed on the lake edges. Also, the results from the sediment traps are supporting the modelling results.

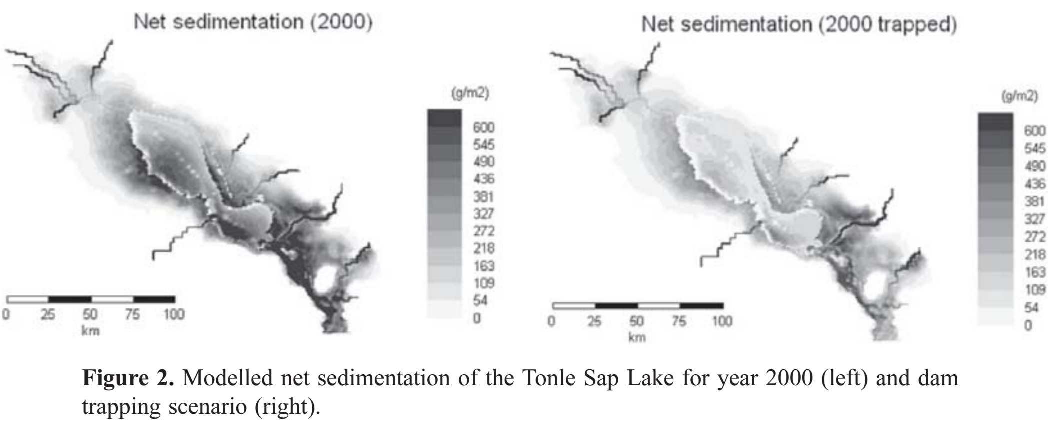

Figure 2. Modelled net sedimentation of the Tonle Sap Lake for year 2000 (left) and dam trapping scenario (right).

Figure 2 compares the results of the net sedimentation for the year 2000 and dam trapping scenario, where the sediment load from Mekong was halved illustrating the worst scenario for trapping impacts of reservoirs in Mekong upstream.

Conclusions

The common belief has been that the lake is filling up with the sediment but the recent studies (Penny, 2002; Tsukawaki, 1997) show the net sedimentation in the north-western part Tonle Sap lake proper has been in average 0.1 mm/year and 0.16 mm/year in the north-eastern part from 5500 years B.P. until present. The modelled net sedimentation rates fit well with the coring results of Tsukawaki and Penny. Conclusion of these results is that the lake is not filling up with sediments.

Upstream development could mean dramatic reduction of the net sedimentation in the Tonle Sap and consequently, in the supply of sediment bound nutrients to its floodplain for maintaining its biological productivity as shown in dam trapping scenario. This would directly have influence e.g. as reduced fish catches and thus, people around the lake. More research is urgently needed to be done to better understand the nutrient cycle of the lake and the impacts of the upstream and local developments on it.

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