Modelling the Impact of Changing Land-Use on Sediment Regime and Hydropower in the Tonle Sap Watershed, Cambodia

Mohit Kaura and Mauricio E. Arias
[1] Department of Civil & Environmental Engineering, University of South Florida, Tampa, FL, USA

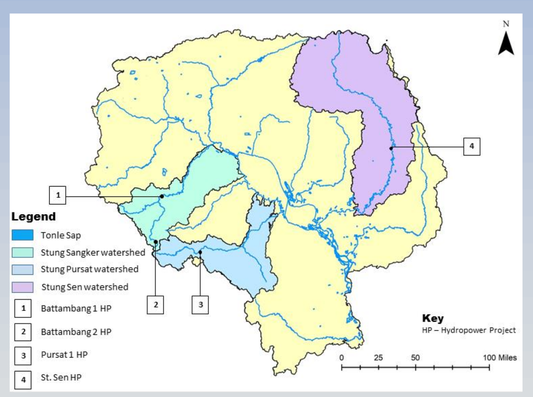
WATERSHED SUSTAINABILITY RESEARCH GROUP

MOTIVATION

- Sediment accumulation is a major factor that negatively impacts useful life-time and operation of hydropower dams.
- Decline in forest cover within a watershed accelerates the rate of soil erosion, increasing the amount of sediments carried in streams heading to reservoirs.
- This costs losses to both the ecosystem and hydropower industry.

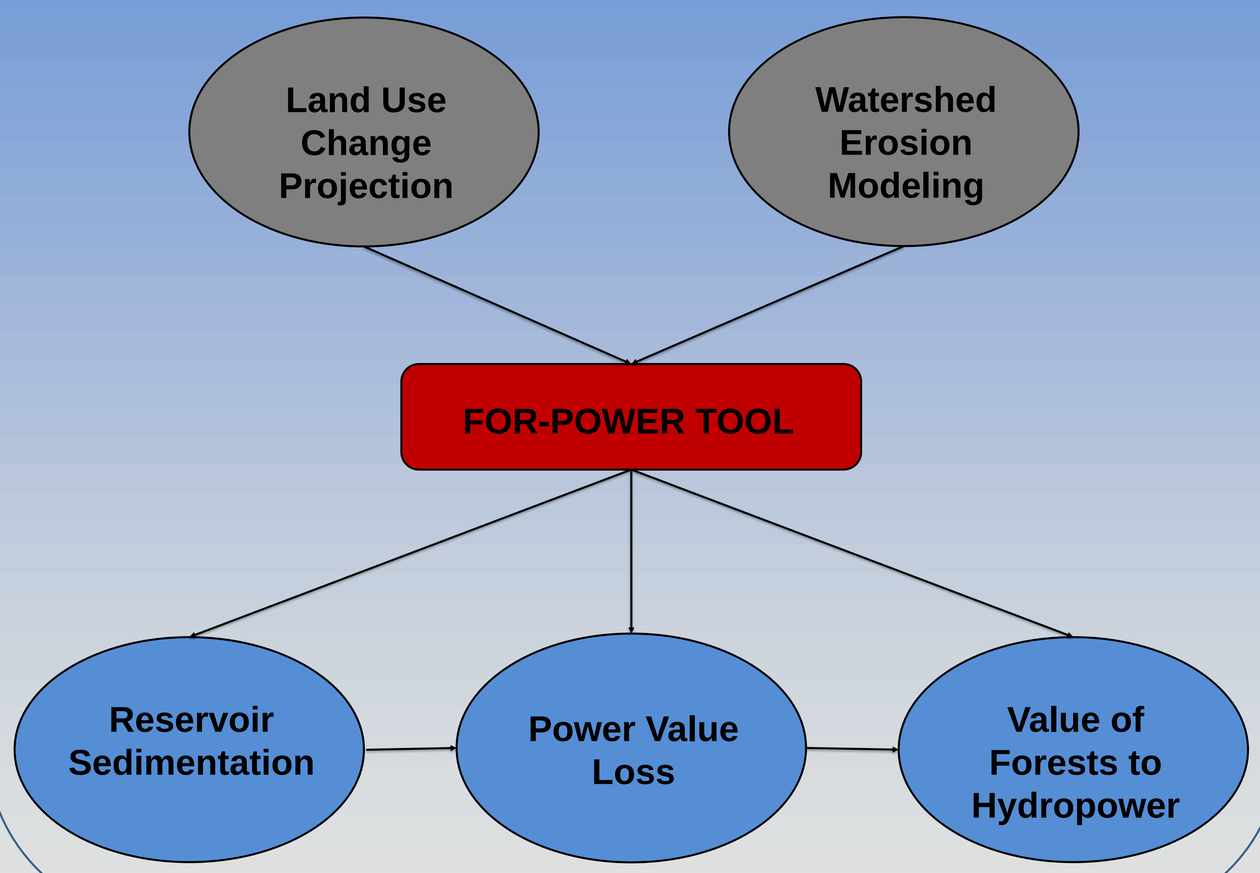
BACKGROUND

The largest freshwater flow reversal system in the world, Tonle Sap basin in Cambodia is facing rapid agricultural and hydropower development. An option to balance the tradeoffs between these activities and environmental protection is to estimate cost of reservoir sediment accumulation to hydropower.. By applying the framework to four proposed dams, economic benefits of forest conservation to the hydropower industry are derived.



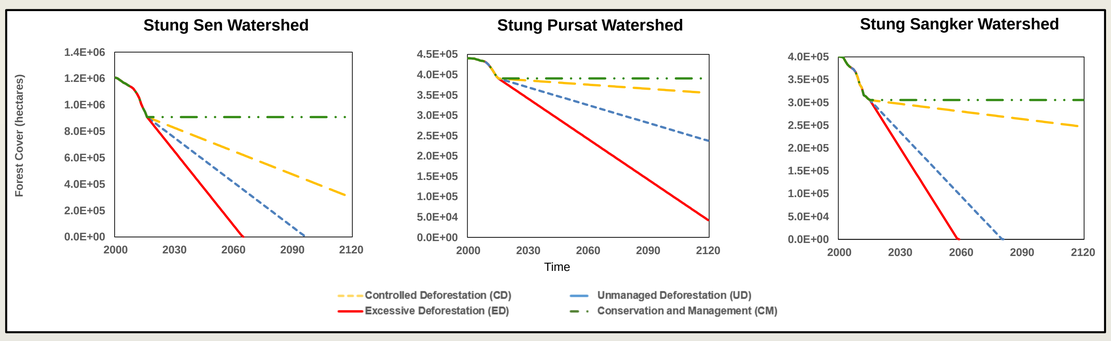
Study Watersheds in the Tonle Sap Basin

METHODOLOGY

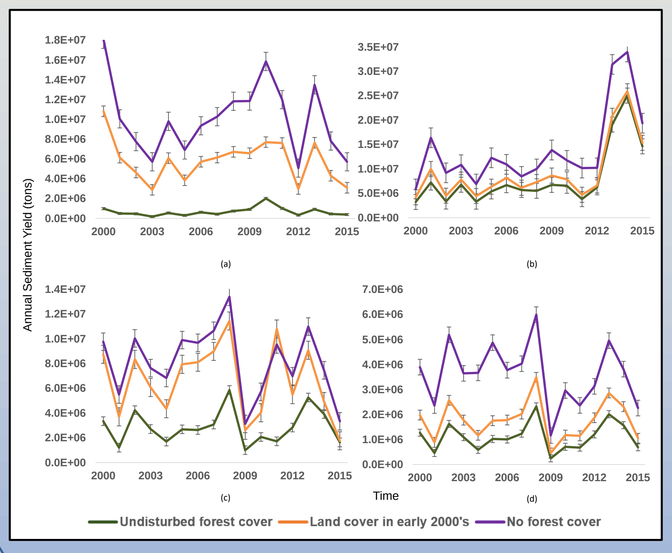


RESULTS

LAND COVER CHANGE AND WATERSHED EROSION MODELING



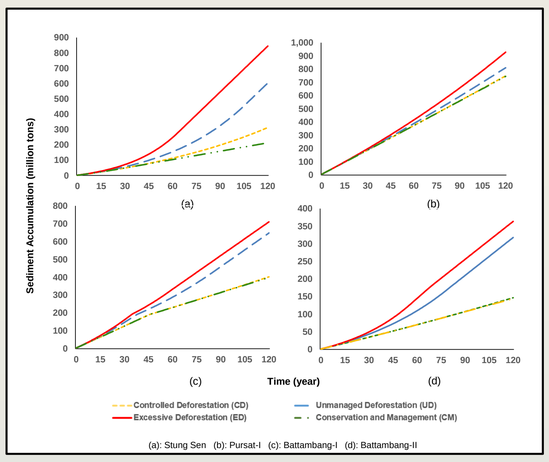
Based on ongoing deforestation rates in the Sen, Pursat and Sangker watersheds in the period 2000-2015, four scenarios of deforestation (Controlled, Unmanaged, Excessive and Conservation) were considered. The projection estimated absolute forest cover loss in Sen, Pursat and Sangker watersheds in the coming 50, 100, and 45 years respectively.



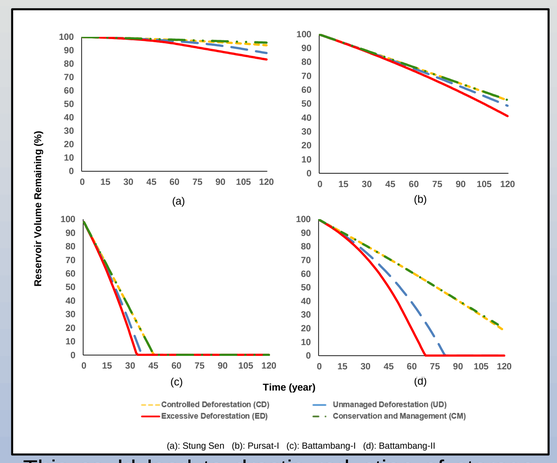
The sediment yield in the watersheds was estimated as a function of forest cover loss, keeping the loss rate constant in every scenario.
Three land-use scenarios were developed to estimate the relationship between forest cover and sediment yield in the watershed.

- Undisturbed Forest Cover
- Land Cover in early 2000's
- No Forest Cover

RESERVOIR SEDIMENTATION

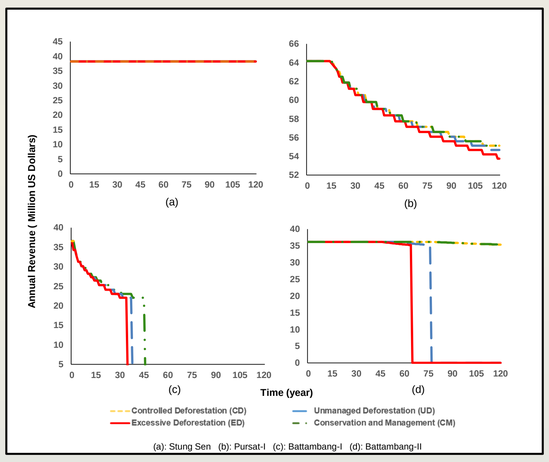


Depending on the extent of deforestation in the coming 100 years, each of Sen, Pursat, Battambang I and II dam catchments could be accumulating average annual sediment loads up to 6-10 million tons.

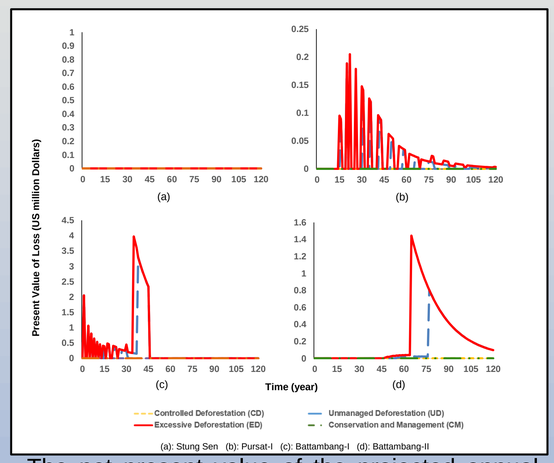


This could lead to drastic reduction of storage capacity of dam reservoirs, filling up to 10%, 50%, 100% of Sen, Pursat, Battambang I and II reservoirs respectively.

POWER VALUE LOSS



Due to the enormous size of Sen dam, it might not lose any revenue, however, the other dams could lose up to 50%-100% of their projected revenue over the next 100 years.



The net present value of the projected annual losses for Pursat, Battambang I and II reservoirs respectively could amount up to 2.6, 44.8 and 28.2 million dollars respectively.

CONCLUSIONS

FOR-POWER aims to demonstrate that losses suffered by hydropower operators after a certain timeline could be reduced by investing in the protection of forests. This framework estimates the value of forests to hydropower which could be used as an investment to protect these forests in the Cambodian watersheds, and potentially decelerate the filling of dam reservoirs with sediments. This modeling framework could be applicable to medium-scale dams worldwide where forest protection may be a good investment to sustain hydropower generation.

ACKNOWLEDGEMENT

Funding is provided by the John D. and Catherine T. MacArthur Foundation through a project entitled “Managing pressures from the development of dams, land use conversion, and climate change on riverine and ecosystems of the Mekong’s Tonle Sap basin”. We would like to acknowledge the support of Tom Cochrane, Chantha Oeurng and Miquel Arnaiz for provision of data.