The Influence of Land Use Projection Uncertainty on Flow and Sediment Estimations: A Case Study from the Mekong Basin

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Quantitative understanding of potential changes of flow and sediment is complicated by uncertainty related to land use change projections. Without accessing uncertainty, it can be difficult for policymakers and resource managers to develop effective land use policies and management programs. This study aims to investigate the implication of uncertainty in land use change projections on flow and sediment estimations using the Soil and Water Assessment Tool (SWAT) model. We applied SWAT to the Sesan, Srepok, and Sekong Rivers (3S) (Figure 1) in the Mekong (the most important tributaries of the lower Mekong containing valuable protected areas) as our test basin, but lessons learned from this research can be useful globally.

The Land Change Modeler (LCM) (Eastman, 2009) was used to project multiple land use transitions of the 3S basin. The uncertainty in land use projection was addressed using an *ensemble forecasting approach* as suggested by Santini and Valentini (2011). Potential future land use changes were computed by combining three different model configurations/inputs: (1) three land demand scenarios, (2) two transition potential modeling approaches and (3) constraints on and off i.e., retaining (or not) current protected areas, which generated 12 different land use change scenarios (Table 1). The uncertainty was analyzed for the medium-term future (2051-2070 or 2060s) time horizon.

Table 1. Land change scenarios and resulting changes as compared to current baseline.

Scenario	Scenario Description			Results	
				Percent change as compared to baseline	
	Transition potential model	Land use demand based on historical period	Constraints (retain or not protected areas)	Flows	Sediment load
LR_A1	Logistic Regression (LR)	1993 - 1997	No	-3.9	25.9
LR_A2		1993 - 1997	Yes	-2.7	-7.9
LR_B1		1993 - 2010	No	-19.2	154.3
LR_B2		1993 - 2010	Yes	-11.8	48.0
LR_C1		1997 - 2010	No	-21.5	206.6
LR_C2		1997 - 2010	Yes	-12.1	49.8
SW_A1	SimWeight (SW)	1993 - 1997	No	-4.2	69.2
SW_A2		1993 - 1997	Yes	-2.6	18.3
SW_B1		1993 - 2010	No	-17.6	218.4
SW_B2		1993 - 2010	Yes	-11.4	71.3
SW_C1		1997 - 2010	No	-21.0	249.0
SW_C2		1997 - 2010	Yes	-12.3	75.3

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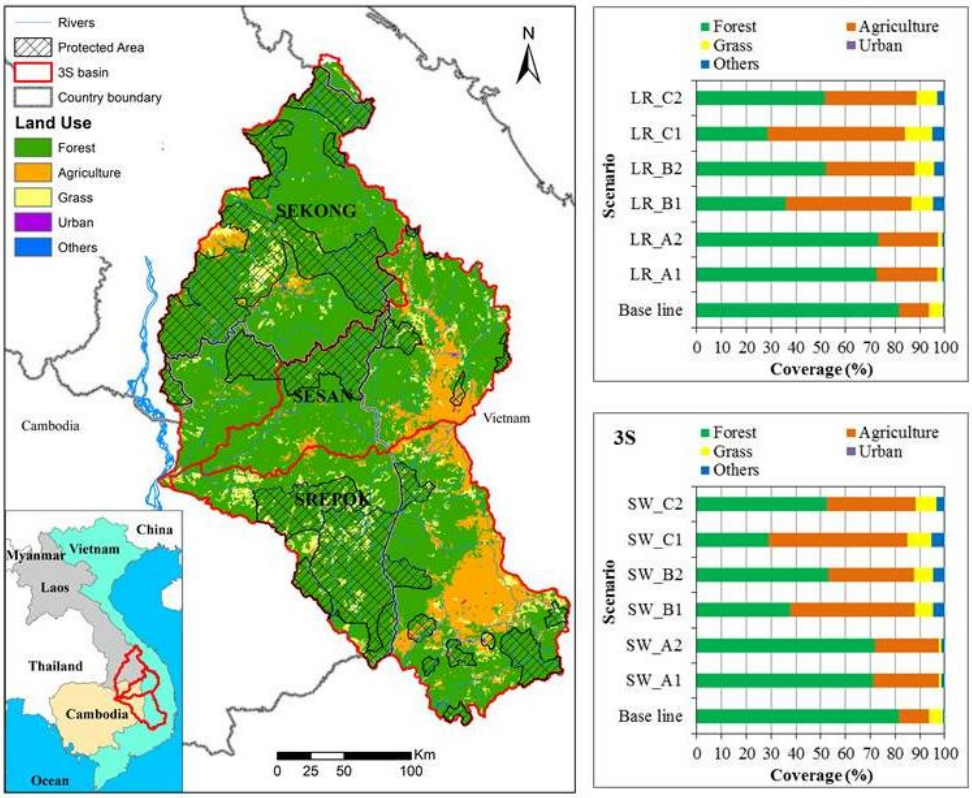

Figure 1. Location of the study area with land use for baseline period and percentage of total coverage change for different land change scenarios.

The analysis of land use change showed that land demand leads to the greatest uncertainty in land use change projections (Figure 1). Modeling approaches do not make much difference in the total change, but can result in spatial variations of change. Retaining (or not) protected areas to constrain the land use allocation can also contribute significantly to uncertainty in land use change projections. All scenarios showed decreases in annual flow of the 3S basin varying from 3 – 21 %. In contrast, the changes in annual sediment losses from the basin ranged from -8% to 249% (Table 1).

The results indicate high uncertainties in magnitude of changes of flows as well as sediment yields due to uncertainty in land change projection, with greater uncertainty in sediment loads than flow projections. In addition to the assessment of uncertainty related to land use projections, climatic change and model parameter estimation uncertainties should be considered when modelling water and sediment in watersheds around the world (Shrestha et al., 2016).

References

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