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Title(English)	DISTRIBUTED MODELLING APPROACHES FOR BASIN SCALE SEDIMENT DYNAMICS AND THEIR APPLICATION TO MEKONG RIVER BASIN
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Thesis outline

Title: Distributed Modelling Approaches for Basin Scale Sediment Dynamics and Their Application to Mekong River Basin

Introduction

Soil erosion leads to environmental damage through sedimentation, pollution and increased flooding. The sediment produced by soil erosion process is transported into rivers, lakes, reservoirs, deltas and coastal zones resulting in high sediment deposition rates and frequent dredging operations (Verstraeten and Poesen, 1999). Basically, sufficient understanding of sediment transport dynamics must be demonstrated before the fate of contaminants can be reliably estimated. Therefore, a modelling is needed for adequate simulation of sediment dynamics for a prospective plan for basin development and management were undertaken or current plans are continued. Once constructed, such models are seen as useful tools for understanding particular catchments and for predicting the impact of land use and climate change on erosion and sediment transport for current and future plans.

Objectives of the research

The overall goal of this research is to develop and apply distributed models of sediment dynamics targeting for a large river basin (e.g., drainage area > 100 000 km^2) specifically the Mekong River basin. Specific objectives of this research are:

- To propose an integrated framework on spatio-temporal pattern of suspended sediment dynamics by combining RUSLE model with satellite images.
- To apply and validate the integrated framework in Mekong River Basin.
- To develop a process-based distributed model for soil erosion and sediment transport process for large river basins.
- To apply and validate the process-based distributed sediment transport on river basins including Mekong River Basin.
- To evaluate the potential impact of future climate and dams on sediment dynamics changes in Mekong River Basin.

Outline of this dissertation

Chapter 3

In this study, we proposed the integrated framework for sediment assessment which was applied to the Mekong River Basin. A conceptual modelling framework was developed based on monthly precipitation data, GIS, RUSLE-based to estimate surface erosion and sediment transport. This approach provides a reasonable solution to model SE and SSL in the Mekong River Basin as well as take into consideration a land use management practices. In addition, an effective combination of Landsat TM and ETM+ images with conventional in situ measurements in this framework was found to be useful to monitor SSC along the Mekong River Basin. The results indicate that the best wavelengths for satellite assessment of SSC was in the NIR range, band 4. Moreover, the framework was developed and succeed for delineating the severe SE, monitoring SSC, and estimating SSL in large basins like the Mekong River Basin. The spatial distribution of SE over the Mekong River Basin could help us to identify the severe SE areas, which deserve priority attention in basin management for soil and water conservation. Thus, it is possibly applied not only for the Mekong but also for other large basins which have a similar climate and hydrogeology.

The results of the application, we found that the severe SE area was highest close to upper (Lao PDR and China) and lower region (Vietnam) due to steep slope records around this area. The SSL in the downstream Mekong River Basin shows an increased pattern due to increasing drainage area, near Phnom Penh station, while the SSC decreased in this region due to the high deposition process in the lower region. Furthermore, the longitudinal profiles of seasonal SSL shows an increasing trend at distance 750 km (from upstream) until distance 900 km (between Vientiane and Nakhon Phanom station) due to high rainfall observed in this area. In addition, the highest SSC variation was close to Vientiane and Nakhon Phanom due to the maximum precipitation at these stations. Subsequently, intense soil erosion is occurred, carrying high sediment load to the river along this section. Moreover, the longitudinal profiles of SSC shows a decreasing trend from upstream to the downstream and due to decreasing the topography in the downstream Mekong River Basin.

Chapter 4

In this study, a physically-based model of sediment transport targeting for a large basin scale was developed and coupled with a distributed hydrological model. The model enables us to simulate rainfall-runoff processes and sediment transport on hillslope and within a river network. In its application to Chao Phraya River and Mekong River Basins, the sediment

dynamics (i.e., yield and erosion) were reasonably simulated in hillslope areas. As it is a grid-based model, it can identify locations of serious sediment dynamics by a fine grid scale. Moreover, the present model applications estimated soil cohesion (J) and detachability (k, Kf) in Chao Phraya and Mekong rivers, and revealed the high sensitivity of SSL to soil detachability (k, Kf) in both basins.

However, the presented model assumed a single SS size instead of a wide size range of SS, due to its limited information in both case studies. Thus, insufficient modelling of SS size distribution might be one of the reasons why the presented sediment model showed some limitations in the case studies. Therefore, the model performance is possibly further improved by incorporating multi-size sediment particles into the model. Moreover, uncertainties from the model input, parameters, and structure also potentially influence the simulation results. For example, the estimation of net sediment detachment (Eq. 4.9) can be improved by revising the equations. Currently, this equation (Eq. 4.9) was assumed that the soil particles are detached (limitation to deposition) and limited by factor such as soil cohesion. Thus, this equation should be improved by considering the reasonable balance between erosion and deposition, especially for river basins, which is highly concerned with both processes in terms of sediment management as in Mekong River Basin.

Nevertheless, the outputs from this model at basin scales may provide useful information to development planners, decision makers and other stakeholders when planning and implementing appropriate basin-wide sediment management strategies, which can be integrated also with water resource management. Moreover, our model could be used also to project the anthropogenic impacts on sediment dynamics under different scenarios in large river basins.

Chapter 5

This study assessed the impact of dams and climate change on sediment load and concentration in Mekong River Basin. In this study a multi-climate model, multi-emission scenarios and dam scenarios approach for the examination of this potential effect on suspended sediment load and concentration. The distributed process-based model is used as to simulate the present and future changes in sediment load and concentration in the study basin. Calibration and validation for both discharge and sediment from the distributed model were applied to simulate future changes in discharge, sediment load and concentration.

In general, sediment load and concentration are decreased due to increasing number of dam. While, higher discharge and sediment are expected when the rainfall is high, during wet season. The climate impact on sediment is larger than on river discharge, and the changes do

not always happen in the same direction. The results indicate that large uncertainties exist in all projected future hydrological variables (i.e., rainfall, discharge and sediment) due to differences between the climate model projections.

The results of this study may be helpful to development planners, decision makers and other stakeholders when planning and implementing appropriate basin-wide sediment management strategies as well as water management strategies to adapt to climate change and dams.

Conclusion

Nevertheless, the outputs from this study using both models approaches at the basin scale may provide useful information to developers, decision makers, and other stakeholders when planning and implementing appropriate basin-wide sediment management strategies, which can also be integrated with water resource management.