AWRA 2011 ANNUAL WATER RESOURCES CONFERENCE
Albuquerque, New Mexico
November 7-10, 2011

NONLINEAR INTERACTION BETWEEN HYDROLOGY, GEOMORPHOLOGY, AND ECOLOGY IN MIRE

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ABSTRACT: Because anthropogenic stressors have caused mire degradations in subarctic northern Japan such as drying and invasion of alder-dominant shrub forest, the Japanese governments recently started a new project to restore meandering former river channel in the catchment to diminish invasive forest and to recover the original ecosystem. The author has so far developed the process-based National Integrated Catchment-based Eco-hydrology (NICE) model, which includes complex interactions between canopy, surface water, unsaturated water, aquifer, lake, and rivers. In this study, the author developed further the model to include nonlinear interaction and feedback of hydro-geomorphic and vegetation dynamics in the mire. Because NICE simulated the hydrologic cycle, elevation change, and vegetation succession processes iteratively including competition between native reed-sedge vegetation and invasive alder, it could reproduce reasonably the heterogeneous drying and alder invasion so far. This indicates some progress in the understanding of positive feedback between geomorphology and eco-hydrology in heterogeneous topography and vegetation beyond previous researches about regular slope and its relation to string or maze pattern. Simulation also projected that restoring meanders to river channel could be effective for decrease in discharge and sedimentation, increase in groundwater level, and the mire recovery more or less in the future. Furthermore, the author gave some evaluation to this phenomenon in relation to stability and regime shift. In particular, he evaluated local heterogeneity of groundwater and surface water in both horizontal and vertical directions, and clarified relationship between microtopography about ridge-depression and hydrologic cycle about divergence-convergence in short-term period. This mechanism is also related to interaction between groundwater and inundated flow, scaled dependence of hydrologic cycle, and its effect on sediment deposition and vegetation change. These results will throw some light on two conflicting conceptualizations of peatland hydrology, so-called, shallow-flow and groundwater-flow models, and bring out importance of the process-based model to clarify the linkage of hydrogeological and vegetation changes in long-term period.

References;
Nakayama, Ecol. Model., doi:10.1016/j.ecolmodel.2008.02.017, 2008a.
Nakayama, Forest Ecol. Manag., doi:10.1016/j.foreco.2008.07.017, 2008b.
Nakayama, River Res. Appl., doi:10.1002/rra.1253, 2010.
Nakayama, Hydrol. Process., doi:10.1002/hyp.8009, 2011a.
Nakayama, Agr. Forest Meteorol., doi: 10.1016/j.agrformet.2010.11.006, 2011b.
Nakayama & Fujita, Landscape Urban Plan., doi:10.1016/j.landurbplan.2010.02.003, 2010.
Nakayama & Hashimoto, Environ. Pollut., doi: 10.1016/j.envpol.2010.11.016, 2011.
Nakayama & Watanabe, Water Resour. Res., doi:10.1029/2004WR003174, 2004.
Nakayama & Watanabe, Hydrol. Earth Syst. Sci. Discuss., 3, 2101-2144, 2006.
Nakayama & Watanabe, Hydrol. Process., doi:10.1002/hyp.6684, 2008a.
Nakayama & Watanabe, Global Planet. Change, doi:10.1016/j.gloplacha.2008.04.002, 2008b.
Nakayama, et al., Hydrol. Process., doi:10.1002/hyp.6142, 2006.
Nakayama, et al., Sci. Total Environ., doi:10.1016/j.scitotenv.2006.11.033, 2007.
Nakayama, et al., Global Planet. Change, doi:10.1016/j.gloplacha.2010.06.001, 2010.
Nakayama, et al., Hydrol. Process., 2011 (in press).

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