Linking Forest Structure to Ecosystem Services Using a Forest Landscape Simulation Model: Water Issues, Soil Erosion, Woody Debris, and Biodiversity

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Motivation

Forests provide many ecosystem services (e.g. timber production, hydrological regulation, erosion control, biodiversity). However, the consequences of global climate change on forest ecosystems are insufficiently known. The main objective of this research is an improved understanding of the effect of climate change on forest ecosystem services through forest structure change.

Research questions

1. How will climate change influence forest structures in Korea?
2. What is the relationship between forest structure and important ecosystem functions (e.g. water flux, soil erosion, woody debris, and biodiversity)?
3. How will forest ecosystem services be altered by changes in forest structure?

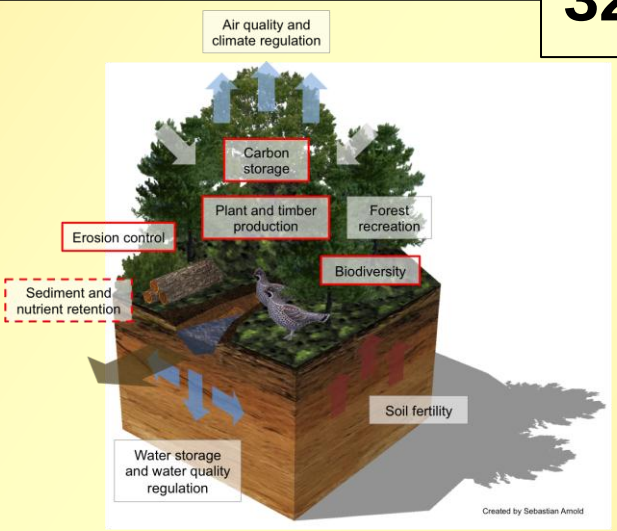

Fig. 1. Overview of the research interests

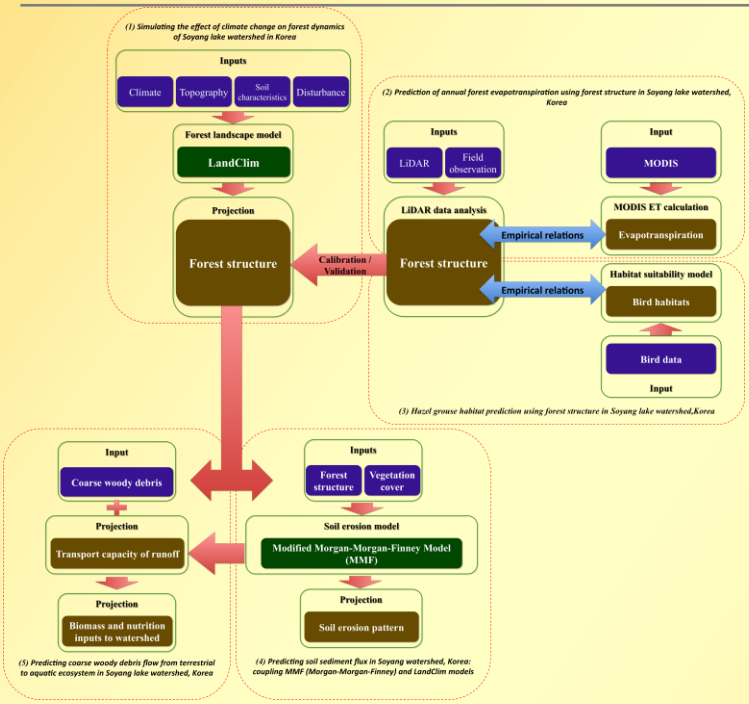

Fig. 2. Research concepts and approaches

Research concepts and approaches

(1) We will simulate forest dynamics to project forest structure using the dynamic forest landscape model LandClim [1].

(2) To quantify how water flux is regulated by forest, we will establish empirical relationships between forest structure and MODIS-based evapotranspiration (ET) [2].

(3) Using LiDAR data, we will quantify the relationship between forest structure and animal habitat (e.g. Hazel grouse) [3].

(4) Using the semi-physical soil erosion prediction model MMF and vegetation outcome from forest landscape model LandClim, we will project annual soil erosion from forests in Soyang Watershed [1], [4].

(5) With the coarse woody debris (CWD) output from LandClim and transport capacity of runoff from MMF, we will project annual CWD flow from the terrestrial to the aquatic ecosystem [1], [4], [5].

Model descriptions

LandClim [1]

1. Spatially explicit, process-based forest dynamics model
2. Produces quantitative description of forest structure based on individual tree cohorts
3. Simulates succession processes with respect to shifts in fire regime and other disturbance regimes, such as insect outbreaks, windthrow and drought

Modified Morgan-Morgan-Finney (MMF) [4]

1. Simplified semi-physical hydrology model that estimates annually-based soil erosion and surface runoff.
2. The model yields transport capacity of surface runoff.
3. Modified version considers the effects of vegetation cover in a more elaborated manner.

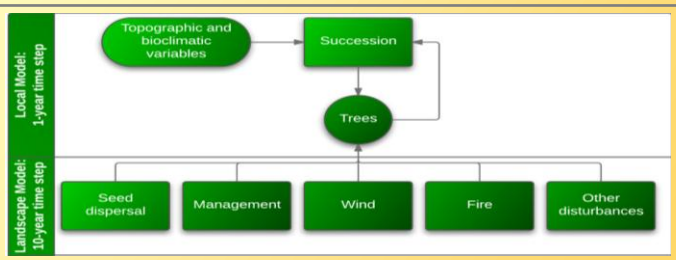

Fig. 3. Basic structure of LandClim [1]

References:

[1] Schumacher, S., Bugmann, H., Mladeoff, D. (2004) Improving the formulation of tree growth and succession in a spatially explicit landscape model. Ecol. Model. 180: 175-194
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[3] Mathys, L., Zimmermann, N. E., Zbinden, N., Suter, W. (2006) Identifying habitat suitability for hazel grouse Bonasa bonasia at the landscape scale. Wildlife Biol. 12: 357–366
[4] Morgan, R. P. C., Duzant, J. H. (2007) Modified MMF (Morgan--Morgan--Finney) model for evaluating effects of crops and vegetation cover on soil erosion. Earth Surf. Process. Landforms 33: 90–106
[5] Harmon, M.E. et al. (1986) Ecology of Coarse Woody Debris in Temperate Ecosystems. Adv. Ecol. Res. 15: 133-302