Geophysical Research Abstracts
Vol. 12, EGU2010-7150, 2010
EGU General Assembly 2010

Forest Ecosystem Processes at the Watershed Scale: Ecosystem services, feedback and evolution in developing mountainous catchments

Larry Band
United States (lband@email.unc.edu)

Mountain watersheds provide significant ecosystem services both locally and for surrounding regions, including the provision of freshwater, hydropower, carbon sequestration, habitat, forest products and recreational/aesthetic opportunities. The hydrologic connectivity along hillslopes in sloping terrain provides an upslope subsidy of water and nutrients to downslope ecosystem patches, producing characteristic ecosystem patterns of vegetation density and type, and soil biogeochemical cycling. Recent work suggests that optimal patterns of forest cover evolve along these flowpaths which maximize net primary productivity and carbon sequestration at the hillslope to catchment scale. These watersheds are under significant pressure from potential climate change, changes in forest management, increasing population and development, and increasing demand for water export. As water balance and flowpaths are altered by shifting weather patterns and new development, the spatial distribution and coupling of water, carbon and nutrient cycling will spur the evolution of different ecosystem patterns. These issues have both theoretical and practical implications for the coupling of water, carbon and nutrient cycling at the landscape level, and the potential to manage watersheds for bundled ecosystem services. If the spatial structure of the ecosystem spontaneously adjusts to maximize landscape level use of limiting resources, there may be trade-offs in the level of services provided. The well known carbon-for-water tradeoff reflects the growth of forests to maximize carbon uptake, but also transpiration which limits freshwater availability in many biomes.

We provide examples of the response of bundled ecosystem services to climate and land use change in the Southern Appalachian Mountains of the United States. These mountains have very high net primary productivity, biodiversity and water yields, and provide significant freshwater resources to surrounding regions. There has been a significant increase in population in the Southern Appalachians, with new building of second homes in steep headwaters, requiring significant expansion in high altitude roads, in contrast with traditional valley bottom development. With additional increases in hydrologic extremes (heavy precipitation and drought), and progressive changes in forest composition there has been increases in hazard from flash flooding, landslide activity and degraded water quality. The evaluation of integrated watershed impacts of the expected changes in climate and land management requires an interdisciplinary approach including direct feedbacks between ecological, hydrological, geomorphic and atmospheric processes within the framework of an adapting social system.

Advances in this type of interdisciplinary research require a network of ecohydrologic observatories generating long term, multi-dimensional data, and a science community working across the interface of multiple fields. Adding individual and institutional behavior as an input or interactive component of watershed ecosystems remains a challenge that spans ecological, hydrological and social science.