ECOHYDROLOGIC IMPACTS OF CLIMATE AND LAND USE CHANGES ON WATERSHED SYSTEMS

Maintaining flows and quality of water resources is critical to support ecosystem services and consumptive needs. Understanding impacts of changes in climate and land use on ecohydrologic processes in a watershed is vital to sustaining water resources for multiple uses. This study completes a continental and regional scale assessment using statistical and simulation modeling to investigate ecohydrologic impacts within watershed systems.

Watersheds across the continental United States have diverse hydrogeomorphic characters, mean temperatures, soil moistures, precipitation and evaporation patterns that influence runoff processes. Changes in climate affect runoff by impacting available soil moisture, evaporation, precipitation and vegetative patterns. A one percent increase in annual soil moisture may cause a five percent increase in runoff in watersheds across the continent. Low soil moisture and high temperatures influence runoff patterns in specific regions. Spring runoff is increased by the influence Spring soil moisture, Winter and Spring evaporation, and Winter and Spring evaporation.

Spring runoff is decreased by increases in winter and spring temperatures and increases in the vegetation index. Winter runoff is affected by maximum vegetative index, temperature, soil moisture, evaporation and precipitation. Contributing factors to runoff are influenced by geomorphic and seasonal variations requiring strategies that are site-specific and use system-wide information.

Regional scale watershed analysis investigates the influence of landscape metrics on temporal streamflow processes in multiple gauged watersheds in Massachusetts, U.S.A. Time of concentration, recession coefficient, base flow index, and peak flow are hydrologic metrics used to relate to landscape metrics derived using FRAGSTAT software. Peak flow increases with increasing perimeter-area fractal dimensions, and Contagion index and decreases as Landscape Shape Index increases. There was an increasing trend in the fractal dimension over time indicative of more complex shape of patches in watershed. Base flow index and recession coefficient fluctuated from low to high decreasing recently. This could be indicative of open space legislation, conservation efforts and reforestation within the state in the last ten years.

Coastal systems provide valuable ecosystem services and are vulnerable to impacts of changes in climate and continental land use patterns. Effects of land use and climate change on runoff, suspended sediments, total nitrogen and total phosphorus are simulated for coastal watersheds around the Boston Bay ecosystem.

The SWAT (Soil and Water Assessment Tool) model, a continuous-time, semi distributed, process-based model, is used to simulate the watershed ecohydrologic process affecting coastal bodies. Urbanization in watersheds increased runoff by as much as 80% from the baseline. Land use change poses a major threat to water quality impacts affecting coastal ecosystems. Total nitrogen increased average of 53.8% with conservative changes in climate and land use. Total phosphorus increased an average of 57.3% with conservative changes in land use and climate change. Climate change alone causes up to 40% increase in runoff and when combined with a 3.25% increase in urban development runoff increased an average of 114%. Coastal ecosystems are impacted by nutrient runoff from watersheds. Continued urbanization and changes in climate will increase total nitrogen, total phosphorus and suspended sediments in coastal ecosystems.

Continental scale runoff is affected by soil moisture and vegetative cover. Cover crops, low tillage farm practices and natural vegetation contribute to less runoff. Developing policies that encourage protection of soil structure could minimize runoff and aid in maintaining sustainable water resources. Best Management Practices and Low impact development at the national level with continued stormwater legislation directed towards sustainable land use policy will improve water quantity and quality. Fragmentation observed in Massachusetts increases the number of urban parcels and decreases the size of forested areas.

Faster runoff patterns are observed but recent land management may be changing this runoff pattern. Municipal and state zoning ordinance to preserve open space and large forest patches will restrict urban growth to specific regions of a watershed. This could improve quantities of water available to ecosystems. Increases in total nitrogen, phosphorus and suspended sediments to coastal ecosystems can be minimized with use of riparian buffers and Best Management Practices within coastal watersheds. Urbanization and climate change threatens coastal ecosystems and national policy to preserve and restrict development of coastal areas will preserve coastal ecosystem services.

Source:
http://www.iwawaterwiki.org/xwiki/bin/view/Articles/EcohydrologicImpactsofClimateandLandUseChangesonWatershedSystemsAMulti-ScaleAssessmentforPolicy