Ongoing Research

US Army Corps of Engineers®

Urban Flood Demonstration Program

Impact of Climate Uncertainties on In-stream and Riparian Vegetation

Products

The results of this work unit will be provided through a technical report and a technical note. The report will include models, data used for calibration, results, and future scenarios. The work will be closely coordinated with the USACE to ensure maximum benefit to USACE district offices and stakeholders.

Benefits

Vegetation in channels and floodplains is often scoured or washed out during high flow events or often giving ways to new and invasive species. Flood events also alter interactions between surface-subsurface waters which are complex and widespread. Water flows not only in the open water bodies but also through the interstices of boundary (streambed and streambank) materials, and creates a mixing zone with subsurface water. Possible increase in unsaturated zone thickness and decrease in residence time of subsurface water in the hyporheic zone and its temporal variability will affect the riparian and in-stream (particularly in ephemeral channels) vegetations. A notable impact of changing regime of surface-subsurface water interaction on ecosystems appears to be increased *Tamarisks* and *Russian Olives* in the western U.S. replacing native Cottonwoods and Willows. Researchers and managers are beginning to observe that invasive riparian species such as *Tamarisk*'s success in the entire western U.S. appears to be a function of its greater ability for drought and flood tolerance (Stevens and Waring 1985). Therefore, a study of coupled surface-subsurface water system and interaction between riparian vegetation particularly invasive species is urgently needed in the southwestern U.S., semi arid /arid area, in view of flood risks, river restoration and operations, especially in the wake of climate uncertainties.

Issue

Water resources and flood dynamics in semi arid and arid environments are becoming increasingly strained in all human, hydrological and ecological contexts. Continuous urban growth in the southwestern U.S., combined with the changing climate has forced regulators and land managers to make decisions that could have a significant impact on water resources and invasive vegetation management. Climate change has become an increasingly rigorous stressor to the environment. Recent studies have suggested continuous warming in the 21st century (IPCC 2007). The overall results of climate change are complex and uncertain. The changing climate will also modify hydrologic processes in this region (Christensen and Lettenmaier 2007) through a number of mechanisms including changes in evapotranspiration (ET), changes in type and distribution (spatial and temporal) of precipitation, and increase in frequency of extreme precipitation. The rain to snow ratio will increase and runoff peaks will be moved in the spring. Altered streamflow may reset the discharge/recharge pattern. Accordingly, the connection between surface and subsurface waters may be either enhanced or reduced in different seasons and at different locations. Such systematic changes in hydrology will likely affect the floodplain vegetation dynamics.

Description

The proposed work unit will study the surface-subsurface water interaction under climate change scenarios; and analyze the impact of surface-subsurface water interaction and the dynamics of in-stream and riparian vegetation with the following specific tasks:

Task 1. Topographic, meteorological, hydrologic, geologic and vegetation data will be collected for modeling. Supplementary data, such as ET, local groundwater table, and measured soil hydraulic properties will also be collected.

Task 2. Mathematical models will be constructed using the data collected in task 1 and calibrated. In the first stage, HydroGeoSphere model (Therrien et al. 2007), a fully integrated surface and subsurface flow and transport model developed in University of Waterloo (Sudicky et al. 2006), will be used to perform a smaller scale (a few hundred meters riparian lateral and a few miles longitudinal), but detailed 3-D analysis. In the second stage, a large watershed scale analysis will be done using GSSHA model developed and commonly used by USACE researchers.

Task 3. In this task, we will examine the effects of future climatic conditions on the surface-subsurface water interaction patterns. These conditions will be extracted from IPCC scenarios (IPCC 2007). Downscaling of climate data is currently ongoing at the University of Nevada, Las Vegas (UNLV). We will work closely with UNLV to incorporate this downscaled data into our models. The study will look at both the watershed scale and local (riparian zone) scale dynamics of the coupled surface and subsurface hydrology.

Task 4. The models will then be used to generate surface runoff and sediments to river for extreme precipitation scenarios. Change in land use and soil parameters will also be included in the analysis. Comparison with historical precipitation, runoff discharge and river stage will be made to predict the effect on future vegetation patterns e.g., extent and type such as invasive vs. native in extreme and altered scenarios. The modeling results for present and future climates will be analyzed to investigate if the local hydrology favors any invasive species such as Tamarisk in a long run. This task will focus on water budgets and Tamarisk biomass and population in the Lower Virgin River or a site in Southern California (San Louis Rey River). Published literature on threshold of water table depth favorable to Tamarisk invasion will be used to generate scenarios for invasion.

The proposed study area for this research effort is the Virgin River (Lower Virgin Valley Watershed; Nevada, Utah and Arizona) and/or the San Louis Rey River (California).

Sponsor

Urban Flood Damage Reduction and Channel Restoration Development and Demonstration Program for Arid and Semi-Arid Regions (UFDP)

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