American Water Resources Association
2013 ANNUAL WATER RESOURCES CONFERENCE
November 4-7, 2013
Portland, OR

Tuesday, Nov. 5
8:30 AM – 10:00 AM
SESSION 22: Climate Change and Land-Use Impacts

Spatial-Temporal Optimization of Conservation Practices Affected by Future Climate Scenarios in the Eagle Creek Watershed, IN - Kelli Walters, Oregon State University, Corvallis, OR (co-author: M. Babbar-Sebens)

Long-term changes in climate can greatly affect the hydrologic response of a watershed and may reduce the effectiveness of conservation practices over time. The Eagle Creek Watershed is an agricultural watershed in the Midwest that has experienced urban growth and more extreme climate events, such as increased temperatures, earlier snow-melt runoff events, and lower late-summer flows. These land use and climate drivers have caused modifications to the hydrologic cycle, resulting in changed flood and drought patterns and water quality issues. In the past, structural solutions like dams and dykes were implemented to reduce upland flooding. While these structures have helped pass excess flows through upstream areas, they have separated rivers from their floodplains, leading to less natural water storage, increased flooding downstream, and greater sediment and contaminant transport through the system. An alternative solution is to improve the upland storage of runoff by installing a distribution of conservation practices, such as wetlands, riparian buffers, grassed waterways, etc., across the watershed. Where and how this network of conservation practices should be installed is a challenge to land-use planners due to the large number of possible practices and locations. Modeled watershed management plans are an effective way to evaluate the impacts of conservation practices and can be used to develop optimized management plans. However, these management plans offer benefits using current climate patterns, and it is important to study the long-term effectiveness of the conservation practices based on projected climate change. This study develops a simulation-optimization model to evaluate the long-term effects of conservation practices on river flow and water quality. This study uses a watershed flow and sediment transport model based on the Soil and Water Assessment Tool (SWAT) to simulate multiple scenarios of conservation practices. The long-term hydrologic impacts of these practices are modeled using current and future climate scenarios from the North American Regional Climate Change Assessment Program (NARCCAP). The model is used to create an optimized long-term management plan for the Eagle Creek Watershed and provides an adaptive decision-making tool for managing extreme runoff affected by climate change.

Climate-Smart Water Resources: Managing Natural and Built Systems in a Changing World - Rachel Gregg, EcoAdapt, Bainbridge Island, WA (co-author: J. Kershner)

Climate change is one of the most pressing issues facing water resources; it is a global problem that threatens the success and longevity of conservation and management actions. Climate-induced effects on the water cycle will alter hydrologic systems, which will have implications for ecosystems and human communities. In turn, these changes will affect how managers and planners approach sustainable water resources management. Practitioners are now faced with the challenge of developing and implementing strategies that support natural resources and human communities under changing climate conditions.

The field of adaptation is key to overcoming the challenge as it deals with attempts to minimize the negative effects or exploit potential opportunities of climate change by either decreasing a system's vulnerability or increasing its resilience. The field of climate change adaptation is in a period of transition. Practitioners must now move from generalities to concrete actions, including implementation, monitoring, and evaluation efforts. Key resource needs are the availability of relevant adaptation examples and knowledge-sharing networks. EcoAdapt, a non-profit organization based in Washington State, aims to fill these gaps through two of our core programs - the State of Adaptation, in which we survey practitioners, assess adaptation activities, and create case studies and synthesis reports, and the Climate Adaptation Knowledge Exchange (CAKE; www.cakex.org), a website that supports open access information exchange between practitioners. The State of Adaptation Program has surveyed over 2000 practitioners and resulted in over 350 case studies over the last three years. Our survey work to date has included the coasts of North America, the Great Lakes, and an ongoing effort in the western United States and Canada. In the course of our work in these other regions and in related projects, we have noted several strategies in use to support climate-smart water resources management, including increasing water supplies and protecting ecosystems, increasing water resource use efficiency, improving flood protection, and incorporating climate change into Integrated Water Resources Management. This presentation will focus on the outcomes of our survey efforts in the western United States and introduce participants to the CAKE interface. In addition, it will include discussion of a special project wherein scenarios of future terrestrial and freshwater climate changes in Washington State were mapped to identify areas likely to be most impacted in order to develop targeted adaptation strategies for implementation.

Hydrologic Sensitivity to Changes in Climate and Land Use in the Santiam River Basin, Oregon - Cristina Mateus, Oregon State University, Bend, OR (co-authors: D. Tullos, C. Surfleet)

Water supply and demand are likely to vary across river basins and across water users in the future as the climate and land use change. Some areas will be more sensitive to these changes than others. In order to explore how patterns in hydrologic responses vary with sub-basin characteristics that contribute to hydrologic sensitivity to climate and land use change, we apply streamflow projections to estimate water supply and demand, and explore how elevation, intensity of water demands, and intensity of groundwater interactions relate to vulnerability to water scarcity in the Santiam River Basin (SRB), in Oregon. Our results highlight how, for the Santiam River, water demand exerts the strongest influence on basin�TMs vulnerability to water scarcity, regardless of sub-basin hydrogeology. More vulnerable areas are found at the lower reaches of the basin where demands for water are higher. In addition, sub-basins characterized by higher permeability, with greater groundwater recharge, storage, and discharge (North Santiam), are less sensitive to changes in climate and land use compared to sub-basins characterized by a mixed surface-groundwater system (South Santiam). Furthermore, annual runoff variability is projected to increase in the future; however, the degree of increase is sensitive to basin geology and elevation. Improving our understanding of the increased uncertainty caused by climate and land use projections and thus its effect in water resources, as well as basins responses to future changes will provide a good insight to make managing more adaptive and flexible to changes.

Hydrological Responses to Future Climate and Land-Use Changes in the Elbow River Watershed in Southern Alberta, Canada - Babak Farjad, University of Calgary, Calgary, AB, Canada (co-authors: A. Gupta , D. J. Marceau)

The Elbow River watershed in southern Alberta, Canada is located in a semi-arid area which lies in the rain shadow of the Rocky Mountains. Climate change and rapid urbanization have raised concerns about the long-term sustainability of water resources in the watershed, which provides drinking water to the fast growing City of Calgary, in addition to meeting the considerable demands of industry and agriculture. In order to investigate the sustainability of water resources in the watershed, this research attempts to assess how future changes in climate and land use might translate into changes in hydrological processes in the watershed for the periods of 2010-2039 and 2040-2069. The methodology includes the following major steps. The first one is determining an appropriate temperature-based evapotranspiration model that can be applied for estimating future evapotranspiration (ET) rates in the watershed. The most commonly temperature based models, namely Hargreaves-Samani, Thornthwaite, and Blaney-Criddle were compared with the Priestley-Taylor model, which has been used and validated for the watershed by Alberta Agriculture and Food. Second, a cellular automata (CA) model calibrated and validated with historical land-use maps covering the period 1985-2010 was used to predict future land-use changes. Third, the physically-based, distributed MIKE-SHE/MIKE 11 model was applied to simulate the surface and groundwater hydrological processes in the watershed. The model incorporated precipitation and temperature from five climate change scenarios (NCARPCM-A1B, CGCM2-B2(3), HadCM3-A2(a), CCSRNIES-A1FI, and HadCM3-B2(b)) along with the forecasted ET rates and land-use parameters to obtain a full range of hydrological responses to both land-use and climate change, for the periods of 2010-2039 and 2040-2069, relative to the baseline period of 1961-1990. The Hargreaves-Samani model showed a superior performance relative to the other evapotranspiration models. For the five GCMs used in this study, the simulations of the impact of climate and land-use changes on the hydrological processes revealed a slight reduction in baseflow, infiltration, and evapotranspiration. However, the major change was observed in overland flow, which is a consequence of considerable urbanization and reduction of forested areas in the watershed. This research provides a comprehensive understanding of the impact of both climate and land-use change on the hydrological responses in the watershed, and could become a powerful analytical tool for decision makers to guide infrastructure management and ensure the sustainability of water resources.