The main goal of this study is to use “top-down” approach to simulate catchment scale hydrologic processes, in terms of water partitioning, runoff generation, storage dynamics and human/water interaction, and therefore to obtain a comprehensive understanding on intra-annual water balance of watersheds. An evaporation model at seasonal scale is developed based on Budyko framework. A runoff generation model at seasonal scale is developed based on proportionality hypothesis. By combining the two models, a complete intra-annual water balance model is obtained in this study. In terms of storage dynamics, the feasibility of using base flow recession analysis to estimate evaporation and storage change in the watershed is evaluated and a conceptual model for contributing area estimation is developed.

Two case studies are conducted. The first one is Chipola River Watershed case study, which is mainly focus on using seasonal water balance model developed in this study to project future trend of evaporation, runoff and storage change, using precipitation and potential evaporation projection from Regional Climate Models (RCMs) as input. The second one is the Apalachicola River Basin case study, which is mainly focused on using Soil Water Assessment Tool (SWAT) model to simulate streamflow and sediment load in the river basin. The study also used RCMs for the future climate projection. By combining climate projection and SWAT hydrologic simulation, the future trend of streamflow and sediment load change of Apalachicola River is estimated.

For theoretical development, the results show a good performance of the models developed in this study. For the seasonal Budyko model, 250 out of 277 study watersheds have a Nash-Sutcliff efficiency (NSE) higher than 0.5. For the seasonal runoff model, 179 out of 203 study watersheds have a NSE higher than 0.5. For the storage dynamic model, a good agreement of estimated contributing area with observed streamflow and groundwater table depth is showed in the study. For practical applications, the combined seasonal water balance model in Chipola River Watershed case study showed good performance for seasonal runoff, evaporation and storage change. And for the SWAT model simulation in Apalachicola River Basin case study, a high NSE of 0.92 is achieved for runoff simulation and an acceptable NSE of 0.46 is obtained for sediment load simulation. Based on the model results, a significant seasonality of watershed behavior is revealed in the fundamental hydrologic processes: water partitioning, runoff generation and storage dynamics. The connection between seasonality and vegetation in the watershed is also discussed. The study successfully identified the key controlling factors in the hydrologic processes at seasonal time scale: long term climate, vegetation, soil property, topography and rainfall pattern.

To summary, this study investigated the climate and landscape controlling factors on the seasonal hydrologic cycle. The hydrologic system is an interconnected and integrated system that is affecting and being affected by a variety of elements. This study helps to point out some of the key elements that should be considered in the future studies on this complex system.

Major: Environmental Engineering

Educational Career:
Bachelor’s of Environmental Science, BS, 2007, Nankai University
Master's of Environmental Science, MS, 2009, University of Kansas

Committee in Charge:
Dingbao Wang, Chair, Civil, Environmental, & Construction Engineering
Scott C. Hagen, Civil, Environmental, & Construction Engineering
Manoj Chopra, Civil, Environmental, & Construction Engineering
David M. Sumner, U. S. Geological Survey

Approved for distribution by Dingbao Wang, Committee Chair, on June 19, 2014.
The public is welcome to attend.