Walker Branch Watershed (WBW)

Walker Branch Watershed (WBW) was established in 1967 on the Department of Energy's Oak Ridge Reservation to quantify land-water interactions in a forested landscape. The WBW project has three primary objectives: (1) provide base-line values for unpolluted natural waters within an urbanizing landscape, (2) contribute to our knowledge of cycling and loss of chemical elements in forest ecosystems, and (3) enable development of models for predicting the effects of human activities on the landscape (especially climate change, atmospheric deposition, and air quality). The initial focus of WBW research centered primarily on the geologic and hydrologic processes that govern the quantity and chemical composition of water moving through the watershed. In 1969 WBW was chosen as a site in the International Biological Program's Eastern Deciduous Biome Project, beginning a long history of ecological and biogeochemical research.

Over the years, WBW has been the site of many important research activities, including verifying the nutrient spiraling concept using experimental radioactive and stable tracer additions, identifying the importance of dry deposition in forests, identifying the role of macro-pores in hydrologic transport through forest soils, development of the eddy covariance method for determining water vapor and carbon exchange between the atmosphere and forest, and development of forest hydrology models such as TEHM (Terrestrial Ecosystem Hydrology Model), PROSPER (evapotranspiration by vegetation), and UTM (Unified Transport Model).

Support for WBW research has been provided primarily by the U.S. Department of Energy, Office of Science, Biological and Environmental Research, under contract DE-AC05-00OR22725 with the University of Tennessee-Battelle, LLC. Support has also been also provided by NSF, NOAA, and EPA, as well as the Electric Power Research Institute.

Site description and characteristics. The WBW (35.58 N, 84.17 W) is located approximately 40 km west of Knoxville in the Ridge and Valley Geophysical Province of eastern Tennessee. WBW is a 97.5 ha forested watershed ranging in elevation from 260 to 360 m a.s.l. and residing within the U.S. DOE Oak Ridge National Environmental Research Park, which encompasses over 8000 ha of protected and mostly forested land devoted to research and education in the environmental sciences. The climate is typical of the humid southern Appalachian region, with mean annual precipitation of 133.2 cm (almost all as rainfall with little seasonality) and mean annual temperature of 14.2ºC (monthly averages ranging from 4.4ºC in January to 25.1ºC in July) over the period 1969 to 2005. Annual evapotranspiration accounts for about 50% of annual precipitation.

WBW is underlain by the Knox group, a 610-m sequence of siliceous dolomite, divided into four formations characterized by minor variations in lithology and chert content. The soils are primarily Ultisols with small areas of Inceptisols in alluvial areas adjacent to streams. Soils

are generally well drained, have high infiltration capacity, and are acidic (pH 4.2-4.6) and low in exchangeable bases, nitrogen, and phosphorus. The vegetation is primarily chestnut oak (*Quercus prinus*), white oak (*Quercus alba*), tulip poplar (*Liriodendron tulipfera*), and red maple (*Acer rubrum*), which together account for about 70% of the total basal area. Hickory (*Carya* spp.) and shortleaf pine (*Pinus echinata*) were historically important minor components, but insect infestations have greatly reduced their abundance. The forest is of mixed age; the watershed was primarily in subsistence agriculture and open woodland prior to acquisition by the U.S. government in 1942. Periodic vegetation surveys of 296 long-term forest inventory plots indicate that the forest continues to increase in basal area. WBW is drained by two gauged, 1st-order streams, the West and East Forks, which are fed by several perennial springs.

Research Focus. WBW has been and continues to support a wide range of research. Long-term measurements include atmospheric inputs and stream outputs of water and chemicals, soil chemistry surveys (8-24 plots every 10 years), and forest vegetation inventories (296 plots every 5-10 years). Several plot-scale experiments are examining the response of vegetation and soils to sustained chronic alterations of the local precipitation regime (e.g., Throughfall Displacement Experiment). WBW is also the site of a ^{14}C-labelled litter transplant experiment to determine litter and soil C turnover rates (Enriched Background Isotope Study). WBW is a site in the AmeriFlux network using the eddy covariance technique for determining carbon dioxide, water vapor, and energy exchange between the atmosphere and forest. Stream studies continue to be a prominent component of WBW research, particularly the role of stream processes in controlling stream nutrient concentrations and catchment outputs. Several studies have investigated N cycling and retention using tracer ^{15}N addition experiments (e.g., Lotic Intersite Nitrogen eXperiment – LINX). Whole-stream rates of metabolism (gross primary production, ecosystem respiration) are being measured continuously since 2004.