Walnut Gulch Experimental Watershed (WGEW)

The Walnut Gulch Experimental Watershed (WGEW) was established by the U.S. Department of Agriculture (USDA) in the early 1950s to develop knowledge and technology to conserve water and soil in semiarid lands. The watershed is representative of brush- and grass-covered rangeland found in the transition zone between the Chihuahuan and Sonoran Deserts of the U.S.A. and Mexico. WGEW is the most highly instrumented semiarid experimental watershed in the world and serves as a model for conducting watershed hydrology studies. The USDA Southwest Watershed Research Center (SWRC) was created in 1961 to administer and operate WGEW as an "outdoor laboratory" with detailed experiments and observations to improve our basic understanding of semiarid rangeland. The 50-year continuous record of precipitation and runoff at WGEW has been key to development and validation of many hydrology and erosion models, including the KINEROS runoff model and the USLE/RUSLE conservation planning technology. The 100-year photographic record and near-50-year record of vegetation composition and soil erosion has led to better understanding and prediction of the changes associated with increasing population and climatic variation. The WGEW and SWRC facilities have attracted national and international scientists to study semiarid hydrology and overland flow.

Large flumes at WGEW automatically measure storm runoff and are used to improve flood plain management.

Site Description and Characteristics: The WGEW encompasses the 150 square kilometers in southeastern Arizona, U.S.A. that surrounds the historical western town of Tombstone. Elevation of WGEW ranges from 1220 m to 1950 m MSL. The climate is classified as semiarid, with mean annual temperature at Tombstone of 17.7°C and mean annual precipitation of 312 mm. The precipitation regime is dominated by the North American Monsoon with more than 60% of the annual total coming during July, August and September, and about 30% coming during the six months October through March. Virtually all runoff is generated by summer thunderstorm precipitation and peak flow rates vary greatly with area and on an annual basis. Cattle grazing is the primary land use with mining, limited urbanization, and recreation making up the remaining uses.

The WGEW is located primarily in a high foothill alluvial fan portion of the larger San Pedro River watershed. Depth to ground water varies greatly in the watershed ranging from 50 m at the lower end to 145 m in the central parts of the watershed. Upland slopes can be as great as 65% while slopes in the lower lying areas can be as small as 2 to 3%. Soils on WGEW are generally well-drained, calcareous, gravelly loams with large percentages of rock and gravel at the soil surface. Soil surface rock fragment cover (erosion pavement) can range from nearly 0% on shallow slopes to over 70% on the very steep slopes.

Traversing slot sediment sampler collects sediment during a flow event to quantify rangeland erosion rates.

Shrubs dominate the lower two-thirds of WGEW, including creosotebush (*Larrea divaricata*), whitethorn Acacia (*Acacia constricta*), mariola (*Parthenium incanum*), and tarbush (*Flourensia Cernua*). Grass species dominate the upper one-third of WGEW, including black grama (*Bouteloua eriopoda*), sideoats

grama (*Bouteloua curtipendula*), three-awn (*Aristida sp.)* and Lehmann lovegrass (*Eragrostis lehmanniana*).

Hydro-meteorologic and soil erosion/ sedimentation data are collected from 125 instrumented installations on WGEW. Precipitation is measured with a network of 88 weighing-type recording raingauges arranged in a grid throughout the watershed. Various runoff and sediment measuring structures are used to monitor 11 large watersheds (227 – 14,933 ha), 8 medium watersheds (35 – 160 ha), 11 small watersheds (0.2 – 5.9 ha) and 10 stock pond watersheds. Meteorological, soil moisture and temperature and energy flux measurements are made at two vegetation/soil complexes. Permanent vegetation plots and transects have been established to evaluate the impacts of management practices and global change on vegetation. SWRC recently reinstrumented WGEW with electronic sensors and digital data-logging capability combined with radio telemetry to allow remote data transmission and monitoring. This reinstrumentation greatly enhanced our research and cooperative capabilities as well as maintaining the viability of hydrologic data collection and long-term continuous record.

Continuous measurements of rainfall, temperature, soil moisture, evaporation, CO_2 exchange and plant water use contribute to studies of long-term rangeland sustainability.

Research Focus: The critical research issues in WGEW and semiarid rangelands include livestock grazing, water management, erosion control, urbanization, rangeland carbon budget, rangeland rehabilitation, fire, desertification and non-native plant invasion. Current research at SWRC is focused on 1) hydrologic processes, climate variability and water resources for semiarid watershed management and 2) soil erosion, sediment yield, conservation structures and decision support systems for sustainable land management. The anticipated products include better technologies and strategies to manage water, soil and carbon resources, a hydrology and erosion model specifically developed for rangeland applications, and decision support tools for public land managers on rangelands.

The long-term record at WGEW has been combined with short-term experiments and spatial databases, including satellite imagery, to study spatial patterns as well as temporal trends. Many projects are related to other initiatives, at the regional, national or global scale, to extend the watershed knowledge gained at WGEW to a broader audience of scientists, decision-makers, and the public. New long-term data collection efforts have been designed to coordinate with the existing network, and existing long-term measurements have been adapted to address new science issues. This flexibility and foresight has made, and continues to make, WGEW attractive for interdisciplinary research.

Mobile rainfall simulators developed by SWRC have resulted in the world's largest database on rangeland hydrology and erosion.