USDA-ARS
Southwest Watershed Research Center

Sound Science for Watershed Decisions

Mission

• To develop knowledge and technology to conserve water and soil in semi-arid lands
Selected Accomplishments from Walnut Gulch

- Precipitation Analyses
- Flood Frequency
- Transmission Losses
- Hydrologic Instrumentation
- Erosion and Sediment Transport
- Developing Natural Resource Simulation Models
- Data and Data Access
Scope of the research unit

Facilities

- Main office - Tucson
  - 8 scientists, 3 support scientists, 20 Staff
- Field office - Tombstone
  - 3 Field Technicians
- Experimental Watersheds
  - Walnut Gulch
  - Santa Rita Experimental Range
Walnut Gulch
Experimental Watershed

Hydrology

• Watershed models & decision support systems
  – AGWA for watershed management and assessments
  – Remote sensing to better parameterize models

• Semiarid water, carbon and energy balance
  – Land-atmosphere exchange of CO2 and water flux
  – Remote Sensing for Soil Moisture and Roughness
  – Remote sensing and micrometeorological techniques combined for ET and CO2 fluxes.
  – Satellite-based rainfall totals

• Urban-rural interface
  – Ephemeral stream channel recharge
  – Variability in infiltration due to urbanization
Erosion and Sediment

• Rates and Processes
  – Understanding Erosion Processes in Rangelands
  – Channel Geomorphology and Processes
  – Tracers to identify Source Areas and Processes

• Conservation Practices
  – Small Rock and other Structures
  – Conservation Effects Assessment Project – Rangelands

• Models and Tools
  – Rangeland Hydrology and Erosion Model
  – Linking Satellite data to model input
  – Economic returns of conservation
  – Using remote sensing to estimate rangeland productivity - RANGES

Runoff - Large Watersheds

• 10 watersheds
• 2 - 150 km²
• Evaluate the effects of channel network, spatial distribution of rainfall
• Event Hydrographs

Flume 6
Runoff - Unit Source Area

- 10 watersheds
- 0.2 - 4.4 ha
- Evaluate the effects of soil, vegetation, rainfall intensity
- Event hydrographs

Developing Natural Resource Simulation Models

- WEPP - Water Erosion Prediction Project
- KINEROS - Kinematic Erosion and Runoff Model
- EPIC - Erosion Productivity Impact Calculator
- CREAMS - Chemicals, Runoff, and Erosion from Agricultural Management Systems
- RUSLE – Revised Universal Soil Loss Equation
- AGWA – Geospatial Interface for SWAT & KINEROS
- RHEM – Rangeland Hydrology and Erosion Model
The purpose of CEAP is to quantify the environmental benefits of conservation practices implemented under the 2002 Farm Bill (retrospective analysis). Tracking these benefits over time will allow policy-makers and program managers to implement and modify existing programs to more effectively and efficiently meet goals (prospective analysis).

The CEAP Project has Two Major Components and Reporting Scales

National assessment - provides estimates of conservation benefits at the national scale

Ecosystem assessment - provides detailed assessments of ecosystem goods and services in regional watersheds
Micrometeorological and eco-physiological techniques are used better understand and quantify ecosystem energy, water and carbon dioxide exchanges in order to:

- quantify riparian water use and improve basin surface and ground water budgets
- understand the interactions between CO₂ and water cycles in semiarid regions
- determine the ecohydrologic consequences of woody plant encroachment
Improved Quantification of Semiarid Water Budget Components

To quantify the impacts of conservation practices on:

- sediment retention
- soil moisture
- vegetation

With respect to:

- design
- landscape position
- rainfall/runoff

Rangeland Soil Conservation Research
Runoff and Erosion Processes

- Variable intensity (25-180 mm/hr)
- Small (0.75 m²) and Large (2x6 m) plots
- Semi-arid grassland, shrub, and oak woodland sites
- State and Transition models
- Grazing and Fire
- Runoff and Erosion

Partial Area Response
Spatial Heterogeneity

**Infiltration and Runoff**
Steady state infiltration increases with rainfall intensity

**Erosion**
Partial area response – raindrop detachment, deposition
Entire area response – potential flow detachment and continuous transport
Improved Watershed Modeling Capabilities

- Surface Water Hydrologic Modeling
- Incorporation of Remotely Sensed and GIS Data into Hydro Models
- Improved modeling of water quality and Best Management Practices (BMP’s)
- Integration of Research with Elected Officials and Decision Makers

Urban-rural interface element – combinations of various runoff – run-on combinations

The AGWA (Automated Geospatial Watershed Assessment) Tool

AGWA delineation of buffer strip BMP model elements in KINEROS2

AGWA – Automated Geospatial Watershed Assessment Tool

AGWA requires commonly available spatial data that describe an area’s topography, soils, and land cover to perform watershed analyses...

- Automatically prepares complex input files for two hydrologic models, SWAT & KINEROS.
- Provides visualization of landscapes & model results (interactive)
- Useful for management scenarios, identifying sensitive regions, & decision support

AGWA is a cooperative effort with the US-EPA
Remote Sensing

- Vegetation
- Temperature
- Soil Surface Roughness
- Soil Moisture & Water Deficit Index
- CO$_2$ Fluxes

Rahman et al. 2005

Surface Soil Moisture (m$^3$/m$^3$ in top 5 cm)

Rahman et al. 2005
Net Daytime CO$_2$ Flux
(g m$^{-2}$ (12 h)$^{-1}$)

• From WDI (vegetation & temperature), calculations of instantaneous fluxes, and daily flux measurements

Methods: Cesium 137 and Rare Earth Element Tracers

Lucky Hills, WG Shrub Area

Holifield et al. 2004
Other Projects

- Upper San Pedro Partnership
- Conservation Effects Assessment Project (CEAP) Western Rangelands
- China – Urbanization, and Vegetation

**Upper San Pedro Partnership (USPP)**

*USPP Goal:* “Assuring an adequate long-term groundwater supply is available to meet the reasonable needs of both, the areas residents and property owners (current and future) and the San Pedro National Riparian Conservation Area”
“This effort is a step beyond the traditional science-stakeholder form of interaction to that of a true partnership where research is planned and conducted specifically to meet the needs of decision makers and resource managers”