The Automated Geospatial Watershed Assessment for Rangelands (AGWA-R): A GIS-based Hydrologic Modeling Tool for Watershed Assessment & Analysis

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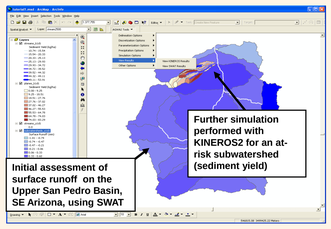
AGWA Background



Focusing time, energy, and money where it can be best utilized is in the best interest of land and water resource managers everywhere. Managers, scientists and stakeholders who have access to tools that facilitate the identification of potential problem areas can more effectively focus additional monitoring and/or mitigation activities. Hydrologic models are commonly utilized in this planning and assessment process. The Automated Geospatial Watershed Assessment tool (AGWA) is a GIS interface for data organization and parameterization, integration, and visualization of two watershed runoff and erosion models, the Soil & Water Assessment Tool (SWAT) and the Kinematic Runoff and Erosion (KINEROS2) model.

AGWA was developed under the following guidelines:

- Provide simple, direct, and repeatable method for hydrologic model parameterization
- Use only basic, obtainable GIS data
- Be compatible with other geospatial watershed-based environmental analysis software
- Be useful for scenario and alternative futures simulation work at multiple scales

AGWA is designed for relative change analysis and includes several powerful tools and features to facilitate this such as tools for land cover and weather/climate change, post-fire watershed assessment, and the ability to difference results from alternative input scenarios. These tools facilitate planning, predicting, and managing responses to climate, vegetation, and urban (development) change.

Current and Forthcoming Capabilities for Rangelands

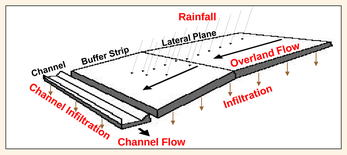
- Incorporation of DRHEM (Dynamic Rangeland Hydrology and Erosion Model);
- Ability to model complex slopes (DRHEM only), including: uniform, convex, concave, and s-shaped slopes;
- Improve parameterization based on vegetation characteristics and disturbance (DRHEM).
- Discretization along the contour of cascading planes on a hillslope (KINEROS2, DRHEM, KINEROS-OPUS)
- Buffer strip parameterization (KINEROS2, DRHEM, KINEROS-OPUS)
- Support for multiple HRUs per subbasin (SWAT)
- Inclusion of a Range Management Toolkit for placing management practices on a watershed, supporting: prescribed grazing, fencing, water, range improvement, riparian buffers, and stock tanks.
- Inclusion of an Ecosystem Service Toolkit to evaluate the effect of treatment on ecosystem services such as runoff, erosion and forage, and evaluate the economic impacts on the rancher.

AGWA is designed so assessments can be made at the pasture level, the individual ranch level or at the watershed level looking at multiple ranches. The tool will also allow managers to evaluate a suite of different alternatives.

1983 – Pre-cattle removal

1996 – Post cattle removal

Riparian Buffers

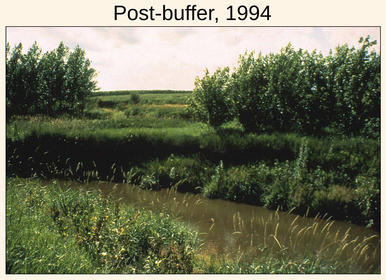


The most common best management practice, riparian buffer strips, can now be discretized and simulated using AGWA and KINEROS. Buffers can be added to any channel segment; the basic steps for creating riparian buffers include defining buffer strip endpoints along the channel and buffer strip width.

AGWA can simulate pre- and post-installation watersheds. Land cover characteristics can be set for each buffer element using pre-defined land covers or custom land covers. Slope and roughness can also be set for each buffer.

Pre-buffer, 1990

Post-buffer, 1994

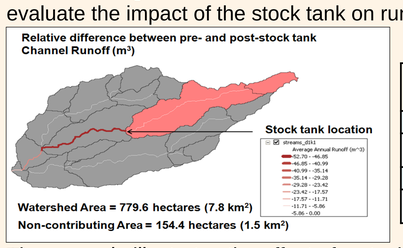


Photos by Dick Schultz, courtesy of Iowa State University, Department of Natural Resources Ecology and Management

Stock Tank Example

A common rangeland management is the installation of stock ponds to provide water to livestock. Stock ponds can also be viewed as storm water retention structures and sediment basins, common best management practices for flood and water quality mitigation.

In this example a stock tank is placed in a 7.8 km^2 watershed where 1.5 km^2 of the watershed (19%) is drained into the stock tank. It is assumed that 100% of the runoff from the subwatershed is retained in the stock tank with no release. This is a common design for stock tanks in the western United States. AGWA was used to evaluate the impact of the stock tank on runoff and sediment yield.



	Pre-stock Tank	Post-stock tank	Percent Difference
Runoff (m3)	82885	69685	-15.9
Sediment Yield (kg/ha)	5039	4982	-1.1
Peak Flow (m3/s)	50.5	45.6	-9.7
Peak Sediment Flow (kg/s)	2566	2111	-17.7

The example illustrates the affect of a stock tank on a small watershed where the largest net change is directly down stream of the stock tank location. AGWA for Rangelands can be used to examine the accumulative effect of multiple stock tanks across a larger watershed, or the accumulative effect of a suite of different best management practices.

Simulation Models

KINEROS2

The KINematic Runoff and EROSion model, KINEROS2, is an event-oriented, physically-based model developed by the USDA-ARS to describe the processes of interception, infiltration, surface runoff and erosion from small watersheds (< 100 km2). Watersheds are represented by a network of planes and channels, allowing rainfall, infiltration, runoff, and erosion parameters to vary spatially.

KINEROS2 can be used to determine the effects of various artificial features such as urban developments, detention reservoirs, or lined channels on flood hydrographs and sediment yield.

SWAT

The Soil Water Assessment Tool is a quasi-distributed model developed at the USDA-ARS to predict the impact of land management practices on water, sediment, and agricultural chemical yields in large (basin scale), complex watersheds with varying soils, land use and management conditions over long periods of time (> 1 year).

SWAT is a continuous, i.e. a long-term yield model, using daily average input values; it is not designed to simulate detailed, single-event flood routing. Major components include hydrology, sedimentation, crop growth, nutrients, pesticides, and agricultural management.

DRHEM

DRHEM is a process-based model that predicts hillslope-scale runoff and erosion rates under different rangeland management practices. It models splash and sheet erosion as the dominant erosion processes on rangeland sites in good condition with adequate cover, and also represents the process of concentrated flow erosion that may be important as a site is disturbed or if the cover consists of shrubs with large interplant distances of bare ground.

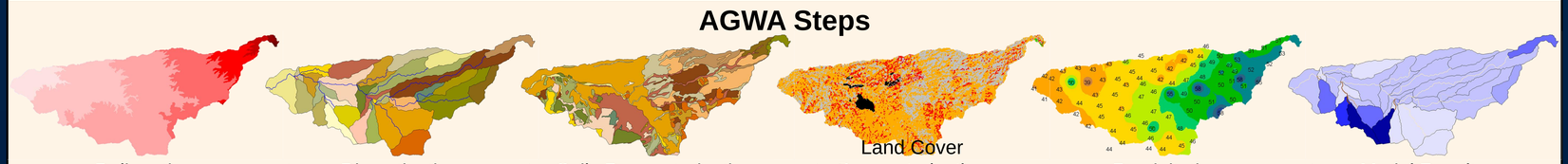
DRHEM was developed by the USDA-ARS. Featuring kinematic runoff and erosion simulation modeling and rangeland erosion and parameterization equations developed specifically from rangeland experimental data, it combines the Rangeland Hydrology and Erosion Model (RHEM) with KINEROS2.

KINEROS-OPUS

KINEROS-OPUS is a comprehensive, spatially distributed watershed model designed to simulate hydrologic and biogeochemical processes of small to medium sized watersheds. It combines KINEROS2 and Opus2, a continuous soil moisture, plant growth, and nutrient cycling model.

KINEROS-OPUS can simulate runoff, sediment transport, management, plant growth, nutrient cycling (nitrogen, phosphorus and carbon), water quality and chemical runoff.

AGWA Steps



Delineation → Discretization → Soils Parameterization → Land Cover Parameterization → Precipitation → Model Results

Availability

AGWA is publicly available for download in two different versions: AGWA 2.0 for ArcGIS 9.x and AGWA 1.5 for ArcView 3.x. Additionally, DotAGWA, an internet version sharing the AGWA 2.0 codebase, was developed as a proof-of concept. AGWA will be updated to support ArcGIS 10.x.

AGWA 2.0 requires ArcGIS 9.x, Spatial Analyst 9.x, and the .Net Framework. AGWA 1.5 requires ArcView 3.1 or later and version 1.1 of the Spatial Analyst extension.

http://www.tucson.ars.ag.gov/agwa