WAM (Waterhsed Assessment Model) is a Geographic Information System (GIS) based model that allows users to interactively simulate and assess the environmental effects of various land use changes and associated land use practices within complex watersheds. WAM is useful in the assessment of watershed-related properties. WAM GIS-based coverages include:

- Land use
- Soils
- Topography
- Hydrography
- Basin and subbasin boundaries
- Point sources and service area coverages
- Climate data
- Land use and soil description files

WAM is capable of simulating the relative effect of alternative land use and management practices on surface and subsurface hydrology and pollutant loads, on a watershed scale. It has the flexibility necessary to consider upland landscapes with deep water tables, landscapes with shallow water tables, with and without artificial drainage, and special cases, such as wetlands, urban areas and mining sites.

**History and Background**

WAM was developed and is maintained by SWET (Soil and Water Engineering Technology), an engineering firm based out of Gainsville, FL. WAM was developed to allow users to assess the water quantity and quality of both surface water and groundwater based on the detailed physical properties of the watershed and the underlying hydrogeological system. The model simulates the primary hydrologic and chemical processes at the individual field level to determine the amount of water and nutrients originating at this scale. These flows and nutrient loadings are dynamically routed throughout the stream network to its discharge location. WAM was developed to allow engineers and planners to assess the water quality within a watershed by quantifying these flows and loads and evaluating the effectiveness of alternative management practices.

WAM was developed based on a grid cell representation of the watershed. The grid cell representation allows for the identification of surface and groundwater flow and phosphorus concentrations for each cell. The model then "routes" the surface water and groundwater flows from the cells to assess the flow and phosphorus levels throughout the watershed and at the discharge. It shows the conceptual routing schemes and flow distances that are calculated for each cell. Thus, the model simulates the following elements:

- Surface water and ground water flow allowing for the assessment of flow and pollutant loading for a tributary reach at both the daily and hourly time increment as necessary.
- Water quality including particulate and soluble phosphorus, particulate and soluble nitrogen (NO3, NH4, and organic N), total suspended solids, and biological oxygen demand. WAM was linked to WASP (SWET, 2003), which enables the simulation of dissolved oxygen and chlorophyl-a.
- Time e-series outputs at the source cells, subbasins, and individual tributary reaches including: source load maps (surface water and groundwater), attenuated subbasin and basin loads, ranking of land uses by load source, daily time series of flows and pollutants, and comparative displays of different BMP/Management Scenarios.

**Model Operation**
The model simulates the hydrology of the watershed using other imbedded models including "Groundwater Loading Effects of Agricultural Management Systems" (GLEAMS; Knisel, 1993), "Everglades Agricultural Area Model" (EAAMod; Botcher et al., 1998; SWET, 1999), and two submodels written specifically for WAM to handle wetland and urban landscapes. Dynamic routing of flows is accomplished through the use of an algorithm that uses a Manning's flow equation based technique (Jacobson et al., 1998). Attenuation is based on the flow rate, characteristics of the flow path, and the distance of travel. The model provides many features that improve its ability to simulate the physical features in the generation of flows and loadings including:

- Flow structures simulation
- Generation of typical farms
- BMPs
- Rain zones built into unique cells definitions, which also allows use with NEXRAD Data
- Full erosion/deposition and in-stream routing - is used with pond/reservoirs
- Closed basins and depressions are simulated
- Separate simulation of vegetative areas in residential/urban
- Simulation of point sources with service areas
- Urban retention ponds
- Impervious sediment buildup/washoff
- Shoreline reaches for more precise delivery to rivers/lakes/estuaries
- Wildlife diversity within wetlands
- Spatial map of areas having wetland assimilation protection
- Indexing submodels for BOD, bacteria, and toxins

The following image is an example of the change in land use for a watershed.
Model Output

The outputs of each of the subcomponents of WAM can be reviewed and compared to each other, providing a complete and holistic picture of the sources and cycling of each constituent throughout the entire watershed. For example, maps can be created that show both the spatial distribution of each constituent leaving the source cell, as well as the amount that is delivered to the reaches after overland attenuation has been accounted for. The simulated reach output can be plotted on temporal scales that show the cycling of constituents in the reaches, which can also be visually compared to monitoring data. Tables can also be created to compare different landscape features or geographic regions to each other. The model interface provides output tools that assist in streamlining the analysis through several standardized formats of tables, graphs, and maps.

Strengths

After calibration, WAM is able to represent both the spatial detail of the land source areas and the hydraulic complexity of a canalized drainage system, i.e., WAM is specifically designed to take advantage of the ever-improving GIS databases that are being developed. The primary strengths of WAM are its GIS foundation, spatial detail, process-based land field-scale modules, model database for Florida conditions, flexibility to accommodate varied hydrologic, water quality, land and water management processes, and
its facility for performing alternative scenario simulations. It provides an efficient mechanism to aggregate assumptions about system behavior and implementation of management rules to the watershed scale. It can be used to test assumptions and understanding about the watershed system and to evaluate outcomes of alternative land use and land management scenarios based on this understanding.

Limitations

Potential drawbacks and limitations is the ability to represent such complex systems and demands a high level of physical characterization data, which might be quite difficult to obtain for some locations, and modeling expertise for WAM setup and calibration. However, if data are available and in the hands of experienced WAM users, then complex watershed behaviors can be assessed to facilitate more effective water resource planning. Weaknesses that may limit WAM's utility include its simplified approach for cell-to-stream water and solute delivery, simplified in-stream water quality processes, inability to adequately represent small-scale short-term storm even impacts, and simplified representation of impervious urban land conditions. The most significant weakness associated with the WAM model however is the pervasive lack of attention to detail in rigorously documenting assumptions, methodologies, sensitivity analyses, calibration and verification efforts, and uncertainty analyses in the WAM Technical Documentation and WAM Application Reports.

References


SWET site Soil and Water Engineering Technology

EPA Assessment EPA Ecosystems Research, Watershed Assessment Model Review

External Links

SWET site

WAM model download site

EPA Assessment

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