

WARMF: Watershed Analysis Risk Management Framework

Contact Information

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Download Information

Availability: Proprietary
 Cost: Depending on projects (Systech conducts an initial model setup)

Model Overview/Abstract

WARMF was developed by Systech Engineering under sponsorship from Electric Power Research Institute (EPRI) as a decision support system to support the watershed approach. It was designed to take stakeholders through a series of steps to develop and evaluate water quality management alternatives for a river basin. WARMF also provides a procedure to calculate the total maximum daily load (TMDL) of pollutants. All necessary databases, simulation models, and graphical software are integrated into a Windows Graphical User Interface (GUI).

Model Features

- Calculates TMDLs using a bottom-up approach. TMDLs are determined for multiple control points and different allocations of point and nonpoint loads.
- Links catchments, river segments, and lakes to form a watershed model.
- Uses data commonly available from National Climatic Data Center, EPA, USGS, Natural Resources Conservation Services, state and other local agencies, and private data purveyors.
- Uses meteorological data to dynamically simulate runoff and nonpoint source loads from land.
- Predicts daily hydrology and water quality of rivers and lakes.
- Simulates flow, pH, temperature, dissolved oxygen, ammonia, nitrate, phosphate, suspended sediment, coliform bacteria, major cations and anions, three algal species, and periphyton.
- Simulate metals such as iron, zinc, manganese, and copper.
- Displays spatial distributions of point and nonpoint loading using GIS map format.
- Displays water quality status in terms of suitability for fish habitat, swimming, water supply, and other uses.
- Accounts for the source controls of atmospheric deposition, nonpoint and point source loads.
- Evaluates cost sharing schemes for pollution trading between point and nonpoint dischargers.

Model Areas Supported

Watershed	High
Receiving Water	Medium
Ecological	None
Air	Low
Groundwater	Medium

Model Capabilities

Conceptual Basis

WARMF is organized into five linked modules—Engineering, Data, Knowledge, Consensus, and TMDL. The Engineering module is the dynamic, simulation model that drives WARMF. The Data module provides time series input data (meteorological, point source) and calibration data. The Knowledge module is a utility to store documents for the watershed. The Consensus and TMDL modules provide road maps to engage stakeholders in building consensus on a watershed management or TMDL plan.

Scientific Detail

The computing engine is taken from the Integrated Lake-Watershed Acidification Study (ILWAS) model. The ILWAS model divides a watershed into catchments, stream segments, and lake layers. The hydrologic module simulates the processes of canopy interception, snow pack accumulation and snow melt, infiltration through soil layers, evapotranspiration from soil, ex-filtration of groundwater to stream segments, kinematic wave routing of stream flows, and flow routing of the terminal reservoir. The chemistry module performs mass balance and chemical equilibrium calculations to account for the processes of dry deposition to the canopy, nitrification of ammonia on the canopy, ion leaching from sap to the canopy surface, washoff by throughfall, ion leaching by snowmelt, and the soil processes (e.g. litter fall, litter breakdown, litter decay, nitrification, denitrification, cation exchange, anion adsorption, weathering, and nutrient uptake). Algorithms for sediment erosion and pollutant transport from farm lands and other land uses were adapted from ANSWERS and the Universal Soil Loss Equation (USLE). The pollutant accumulation and washoff from urban areas was adapted from the Storm Water Management Model (SWMM).

Model Framework

- Watershed (up to five soil layers)
- One-dimensional stream segments
- Lake layers (option to select CE-QUAL-W2)

Scale

Spatial Scale

- Watershed
- One-dimensional stream
- Lake layers

Temporal Scale

- Daily

Assumptions

- The catchment is idealized by a series of compartments (canopy, snow pack, and soil layers).
- Each compartment is considered as a continuously stirred tank reactor (CSTR) for flow routing and mass balance calculation.
- Stream hydrology is based on conservation of mass.
- The model represents the stream segment as a CSTR.

Model Strengths

- For lakes and reservoirs, it has an option of one-dimensional horizontally mixed and vertically stratified or two-dimensional vertically stratified.

Model Limitations

- The user needs to contract Systech to setup and calibrate the model.
- In the TMDL module, percent reductions can be specified for either point or nonpoint source and WARMF will calculate the other. However, as the TMDL module runs through its iterations, it will reduce all upstream sources equally. For example, if multiple point sources exist within a subwatershed or upstream, all nonpoint sources are reduced equally; the model can not account for individual source contributions.

Application History

WARMF has been applied to various watersheds in the United States and the Techí Watershed of Taiwan.

Model Evaluation

WARMF is being tested on the Catawba River (Duke Energy), Cheat River (AEP and Allegheny Power), Chartiers Creek (Pennsylvania power companies), and Oostanaula Creek (TVA) basins. In addition, WARMF is being tested in cooperation with government agencies and other stakeholders in the Truckee River (California/Nevada) and Blue River (Colorado) watersheds.

Model Inputs

- Meteorological data
- Point source loading information
- Atmospheric deposition loads
- Fertilizer application
- Subbasin shape file
- Land use shape file
- Reach Network shape file

Users' Guide

Documentation reports (e.g., User's Guide to WARMF, Documentation of Graphical User Interface) are available to WARMF users and all reports are available for purchase from Electric Power Research Institute (EPRI).

Technical Hardware/Software Requirements

Computer hardware:

- PC

Operating system:

- Graphical User Interface

Programming language:

- Computational code: FORTRAN

Runtime estimates:

- Minutes to hours

Linkages Supported

None

Related Systems

None

Sensitivity/Uncertainty/Calibration

An uncertainty analysis can be performed to evaluate the chance of failure for a management plan.

Model Interface Capabilities

- Pre- and post-processors
- Data display tools

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