# Texas A & M University and U.S. Bureau of Reclamation
# Hydrologic Modeling Inventory
# Model Description Form
**JULY 28, 2000**

**Name of Model:**
Bochum Water Balance Model

**Model Type:**
Spatially distributed continuous soil moisture accounting and precipitation/snowmelt-runoff simulation model

**Model Objective(s) :**
Streamflow simulation and spatial estimation of hydrologic variables for forecasting, water management, land management, water quality modeling, climate change studies

**Agency and Office:**

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**Model Structure or Mathematical Basis:**
Model is intended for mesoscale (approx. 100-10000 km$^2$) watersheds. Model continuously simulates streamflow and all components of the water balance on a spatially distributed basis at a daily time step. Individual components include:

- Precipitation, temperature: inputs are given as spatial fields. A method based on detrended kriging is used to compute the fields from station data.
- Snowmelt: a degree-day method is available, or spatial snow depth and melt fields (e.g., from another model) can be read in.
- Evaporation: three methods are available (FAO, Turc-Wendling, Penman-Monteith).
- Interception: based on leaf area index of vegetation type on each modeling unit.
- Soil moisture: based on a variable capacity bucket concept; capacities are determined from soil porosity and vegetation rooting depth. Due to the daily time step, there is no explicit modeling of infiltration, so all water enters the soil moisture storage.
- Percolation and lateral subsurface flow: based on a nonlinear reservoir concept.
- Groundwater storage: two linear reservoir storages.
- Runoff components: four components (surface, subsurface, and fast and slow

groundwater).

- Channel routing: all runoff is assumed to reach a channel within the modeling unit, hence no overland flow routing is done. Channel routing is by either a simple time delay based on the flow distance to the watershed outlet, or a geomorphologic instantaneous unit hydrograph (GIUH) method can be used.

**Model Parameters:**

There are approximately 10 parameters that apply to the entire watershed and that must be given values either manually or by calibration. All other model parameters are listed in the input data section, as they are derived from GIS information and are not modified by calibration. The 10 parameters have to do with the rate of release of water from the soil moisture storages and the channel routing.

**Spatial Scale Employed in the Model:**

Can be grid cells or defined hydrologic units. Grid cell size is generally 500 m - 2 km.

**Temporal Scale Employed in the Model:**

Daily computational time step.

**Input Data Requirements:**

Model requires as input both map data and tabular data. Map data, with the same grid resolution as used in the model computations, include:

- Digital elevation model and derived fields (flow direction, TOPMODEL topographic index, slope)
- Vegetation type
- Soil texture
- Climate data: daily time series images of precipitation and temperature; optionally, relative humidity, wind speed, and solar radiation, depending on evaporation method used

Tabular data include:

- Observed streamflow
- Monthly leaf area index and root depth for each vegetation type
- Soil hydraulic properties (porosity, wilting point, saturated hydraulic conductivity) for each texture type.

**Computer Requirements:**

Program runs on a standard Pentium-based PC under Windows 95, 98, or NT with 32 MB RAM. Program files require about 5 MB of disk space. Watershed data file requirement varies depending on size of watershed and number of years of data; should count on 5-10 MB. Also need Microsoft Access and Excel installed on the computer, which are used for data storage and graphical display.

**Model Output:**

Tabular output of all internal state variables, water storages, and runoff components are written to Access and Excel files. User interface allows graphical display of these time series as well as map output.

**Parameter Estimation / Model Calibration:**

For the approximately 10 watershed-wide parameters that must be set, a graphical sliding bar display allows easy manual assignment of values, or an automatic search algorithm, based on the shuffled complex evolution method, can be used. Three objective functions for the optimization are available.

**Model Testing and Verification:**

The model is quite new, with parts still under development, therefore it has not yet been extensively tested. It was developed on the Nims and Prüm catchments in Germany. Other watersheds it is being applied to are the Boise River in the USA and the Danube in Germany.

**Model Sensitivity:**

A systematic sensitivity analysis has not yet been performed.

**Model Reliability:**

Good accuracy in simulation of streamflow has been obtained in the test watershed. Further tests are underway to examine the applicability of the model to other types of environments.

**Model Application / Case Studies:**

Model targets mesoscale basins. Foreseen applications include: snowmelt runoff forecasting, water management, water quality modeling, climate change studies.

**Documentation:**

There are several conference papers available that describe the model. Comprehensive user guides etc. have not yet been written.

**Other Comments:**

This model is still under development and hence is not yet available for wide distribution. It is available to collaborators interested in exploring the application of a GIS-based model that has been conceptualized from the outset to take advantage of this new data source. As such, it has several advantages over many current models, even those that have been "retrofitted" to accept data derived from GIS sources, as these were conceptualized prior to the advent of GIS. The Bochum Water Balance Model has been designed to take maximum advantage of GIS-based information so that there is a greater physical basis than previous models, and the number of calibration parameters has been kept to a level that can be feasibly identified with an automatic search algorithm.