Introduction to Soil Water Assessment Tool

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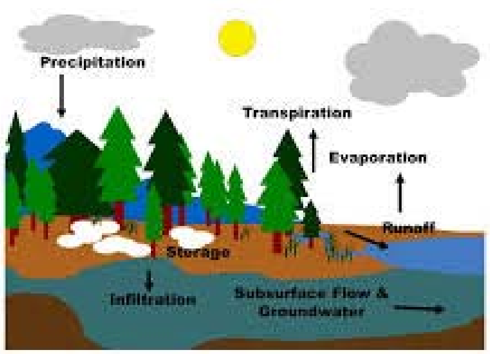
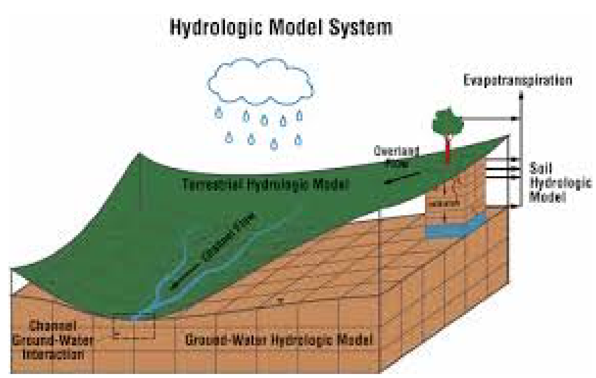
What is a Hydrologic Model?

- Mathematical representation of a hydrologic system to simulate the input output transformations in a hydrologic system





Why Hydrologic Model?

- Understand and predict behaviour of a hydrologic system
- Necessary to accomplish various tasks in planning and operation of Integrated Water Resources Management

Planning phase : Estimation of water levels, flow discharges, flood inundation etc.

Operation phase: Determine operation rule curves

- To handle the foreseen impact of global climate change
- Aids in making decisions, where data is scarce

Soil Water Assessment Tool (SWAT)

- Physical Conceptual
- Semi distributed
- Continous
- Deterministic

Purpose: To assist water resource managers in assessing the impact of management on water supplies and nonpoint source pollution in watersheds and large river basins

SWAT Hydrology

$$SW_t = SW + \sum_{t=1}^{t} (R_i - Q_i - ET_i - P_i - QR_i) \qquad (1)$$

where SW is the soil water content minus the 15-bar water content, t is time in days, and R, Q, ET, P, and QR are the daily amounts of precipitation, runoff, evapotranspiration, percolation, and return flow; all units are in mm.

SWAT Hydrology: Runoff

SCS Curve Number Method

$$SW_t = SW + \sum_{t=1}^{t} (R_i - \boxed{Q_i} - ET_i - P_i - QR_i) \qquad (1)$$

$$Q = \frac{(R - 0.2\,s)^2}{R + 0.8\,s}, \qquad R > 0.2\,s$$

$$Q = 0.0, \qquad R \le 0.2\,s \qquad (2)$$

where Q is the daily surface runoff (mm), R is the daily rainfall (mm), and s is a retention parameter. The retention parameter, s, varies (a) among watersheds because soils, land use, management, and slope all vary and (b) with time because of changes in soil water content. The parameter s is related to curve number (CN) by the SCS equation (USDA-SCS, 1972).

$$s = 254\left(\frac{100}{CN} - 1\right). \qquad (3)$$

SWAT Hydrology: Evapotranspiration

$$SW_t = SW + \sum_{t=1}^{t} (R_i - Q_i - \boxed{ET_i} - P_i - QR_i) \qquad (1)$$

- Hargreaves Method
- Priestly Taylor Method
- Penman Montieth Method

- Model computes evaporation from soils and plants separately
- **Potential soil water evaporation** is estimated as the function potential ET and Leaf Area Index
- **Actual soil water evaporation** is estimated by using exponential function of soil depth and water content
- **Plant water evaporation** is simulated as a linear function of potential ET and Leaf Area Index

SWAT Hydrology: Percolation

Storage Routing Technique combined with Crack Flow

$$SW_i = SW_{ei} \exp\left(\frac{-\Delta t}{TT_i}\right) \qquad (6)$$

where SW_O and SW and the soil water contents (mm) at the beginning and end of the day, respectively; Δt is the time interval (24 h); and TT is the travel time (h) through layer i. Thus, the percolation can be computed by subtracting SW from SW_O.

$$O_i = SW_{Oi}\left[1 - \exp\left(\frac{-\Delta t}{TT_i}\right)\right] \qquad (7)$$

where O is the percolation rate ($mm \cdot d^{-1}$).

$$SW_t = SW + \sum_{t=1}^{t} (R_i - Q_i - ET_i - \boxed{P_i} - QR_i) \qquad (1)$$

The travel time, TT_i, is computed for each soil layer with the linear storage equation

$$TT_i = \frac{(SW_i - FC_i)}{H_i} \qquad (8)$$

SWAT Hydrology: Lateral Flow

Kinematic Storage Model

$$SW_t = SW + \sum_{t=1}^{t} (R_i - Q_i - ET_i - P_i - QR_i) \qquad (1)$$

$$q_{lat} = 0.024 \frac{(2\ S\ SC\ \sin(\alpha))}{\Theta_d\ L} \qquad (11)$$

where q_{lat} is lateral flow (mm d^{-1}), S is drainable volume of soil water (mh^{-1}), α is slope (mm^{-1}), Θ_d is drainable porosity (mm^{-1}), and L is flow length (m). If the saturated zone rises above the soil layer, water is allowed to flow to the layer above (back to the surface for the upper soil layer). To account for multiple layers, the model is applied to each soil layer independently, starting at the upper layer.

SWAT Hydrology

- Routing : Variable Storage Coefficient Method
- Sediment Loss: Universal Soil Loss Equation
- Sediment Routing
- Nutrient and Pesticide Routing
- Crop Growth Model

SWAT Execution

- Delineate Watershes
- **HRU definition**
- Meteorological inputs
- Define model time period and time step
- Run the model
- Analyse the results

Thank You