Hydrological Models for Climate Change

Back to the Basics
Model Construction

\[ \text{Water Balance} \]

\[ E_p(i) \quad \text{Evaporation} \]

\[ R(i) \quad \text{Rainfall} \]

\[ \text{Effective Rainfall} \]

\[ X(i) \]

\[ \text{Other Losses} \]

\[ \hat{Y}(i) \quad \text{Runoff} \]

\[ \text{Diffusion or Routing} \]
Diffusion/Routing

- Sherman’s UH,
- Nash’s Gamma Function IUH
- Simple Linear Model – Convolution Summation
- Linear Transfer Function (Muskingum)
- Non Linear - CLS, LPM, SVRC, LVGFM, MLM etc.
Water Balance

\[ S(t) = S(t-1) + R(t) - Y(t) - E(t) - G_w(t) \]

Lumped Conceptual Models
NAM, SACREMENTO, SMAR, Etc.
Systems & Lumped Conceptual

Real Time Forecasting
Data Reconstruction / Data Synthesis

Parameters: Optimised
Evaluation: Nash Sutcliffe
Ungauged Catchments

• Data Reconstruction Vs. Data synthesis
• Least Squares Vs. Moments (Pitman’s Argument)
• Parameter Calibration Vs. Estimation from Catchment Characteristics
SWAT is The Next Best Thing

Distributed Conceptual Model
whose parameters are estimated (not measured) from Catchment Characteristics.

Designed for
impact assessment of C. Change &/or Deforestation not only on flow but also on Sediment generation, nutrients, water quality, pesticide movement, Sociology, Economics etc.
Climate Change Methodology

Step 1: GCM output
Step 2: Conversion of GCM output into time series of Rainfall, Pot. Evap

These Time Series are not Weather Forecasts but synthetic data of one possible climatic sequence.

Step 3: **HYDOROLOGY:**
Conversion of Synthetic Data of Climate into Synthetic Data of Flow.
Low Accuracy

Basic issue is to estimate % change in Annual Flow for a given % change in Rainfall

Trying to measure in grams with a weighing scale that has a relative error of kilos.
Optimisation

- Loss of physical significance
- Maintains the Run off Coefficient
- Results in linear proportionality of increase/decrease
SWAT
Climate Change Impact - 3

**Insensitivity**

- Renders Distributed character useless
- Causes Errors in Boundary Conditions
- Reduces reliability of results
Extreme Events

- $Q(T)$ would occur regardless of Climate Change
- Pdf will not change but its moments will
- $Q - T$ relationship will change