Lecture 27: Intro to Hydrologic Modeling

Ok., Now let’s try the rest of the lecture from last time again...

A Brief Overview of Hydrologic Modeling

Hydrologic Modeling

- Goals:
  - Prediction of streamflow
  - Flood forecasting
  - Navigability of Rivers, etc
  - Understanding of broader hydrologic processes

Intro

- Hydrology and Atmospheric Sciences are conjoined twins
  - Hazards
  - Weather Associated
  - Strong Operational Element
  - No surprise that many NWS meteorologists become service hydrologists (often one at each office)
  - MetEd pages at COMET/UCAR have a number of excellent teaching presentations!

Hydrologic Modeling

- Problem:
  - Localized quasi 1-D Phenomena controlled by regional processes
  - Reasonably solid physical understanding
    - Straight Fluid Mechanics
  - Challenge of macroscale characterization of processes and behavior (e.g., representing large-scale surface/ground-water interactions)

Types of Operational Modeling

- Long Term
  - Management of resources (e.g., navigation and hydro-power generation)

- Short Term
  - Flood Forecasting
  - Storm Flow

Paper Specifics Due Wednesday at Closing Time (Class)

- Details Syllabus Page
- Distance Students PDF it and email it.
- DON’T FORGET TO PROPERLY CITE EVERYTHING!
The Basic Hydrologic System

- The Environment
  - The Basin
  - The Stream
- The Forcing
  - Precipitation
  - (Infiltration)
  - Evaporation
  - Upstream Flow

The Approaches

- Lumped Approaches
  - Forcings are applied to a basin and a given output is provided at the output
  - Easy to Calibrate
  - Don’t provide “fiddle” room with lots of specific characteristics (thus easy to calibrate – less stuff to fiddle with)
  - Cannot represent sub-system processes
  - Often vulnerable to scale – more so than ATM processes.

Unit Hydrograph Theory

- Based on the Pulse-Response Principal
  - Sherman - 1932
  - Horton - 1933
  - Wisler & Brater - 1949 - “the hydrograph of surface runoff resulting from a relatively short, intense rain, called a unit storm”
  - The runoff hydrograph may be “made up” of runoff that is generated as flow through the soil (black, 1990)

Linearity of Unit Hydrograph

- In addition, when unit hydrograph theory is applied, it is assumed that the watershed responds uniformly.
- Meaning that peak flow from 2 inches of excess P-E will be twice that of 1 inch of excess P-E.
Graphical Representation

Duration of excess precipitation
Lag time
Time of concentration
Base flow

The Approaches

- Distributed (and Quasi-Distributed) Approaches
  - Catchments (or a gridded surface and discretized stream) are individually characterized and forced.
  - Some cannot be fully calibrated (e.g., fully physically based) without great difficulty
  - Can represent heterogeneous systems
  - High-Maintenances – needs lots of descriptive data.
  - You can "mess" with it.

Which is best?

Depends on whatchawannado!

Types of Models

Operational Forecast Models

- NWS River Forecast System
  - Sacramento Soil Moisture accounting of surface moisture (needed for runoff)
  - Then get the runoff with a unit hydrograph
  - Channel Route it between forecast points
- Flash Flood Monitoring and Prediction (FFMP – also used by NOAA) L-QD forced by NWS Radar

Sediment Transport Models

- BASINS (Better Assessment Science Integrating Point and Nonpoint Sources)
  - Sediment Transport (TMDL)
  - Includes the Hydrological Simulation Program -- Fortran (HSPF) Model
- WEPP Water Erosion Prediction Project

Distributed Hydrologic Models

- CASC2D
- DSHVM (Distributed Hydrology Soil Vegetation Model)
  - Distributed Hydrologic Models (Gridded Land, 1D River System)
Decision Support Systems

- AHPS
  - http://www.crh.noaa.gov/cgi-bin/ahps.cgi?unr

- BASINS...

- And more...

WEPP Activity

Water Erosion Prediction Project

http://topsoil.nserl.purdue.edu/nserlweb/weppmain/