Precipitation in Modeling

Rainfall as Model Input

- Form and detail largely determined by model output desired
  - runoff volume requires daily rain
  - peak rates require short duration amounts (min., hr.)
  - erosion, sediment and chemical transport require storm rainfall
- Amounts usually are from point records
  - must be averaged over watershed area

Rainfall as Model Input

- Types of rainfall data required
  - space
    - one gage averaged to represent watershed
    - multiple gages each assigned to a part of watershed
  - time
    - daily
    - hourly
    - equal time increment
    - breakpoint

Rainfall as Model Input

- Types of rainfall data required
  - erosivity
    - rainfall energy (E) x intensity (I)
    - E is summed using shortest reasonable durations and corresponding intensities

$$\text{total energy (E) x } \frac{I_{30}}{100} = \text{R factor}$$

  - for good results gage must be on or very near watershed

Rainfall Energy vs. Intensity

TABLE 3.1 KINETIC ENERGY OF NATURAL RAINFALL (METRIC TON-METERS PER HECTARE PER CM) (MODIFIED FROM WISCHMEIER AND SMITH, 1958)

Intensity cm/h	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0	121	148	163	175	184	191	197	202	206
1.	210	214	217	220	223	226	228	231	233	235
2.	237	239	241	242	244	246	247	249	250	251
3.	253	254	255	256	258	259	260	261	262	263
4.	264	265	266	267	268	268	269	270	271	272
5.	273	273	274	275	275	276	277	278	278	279
6.	280	280	281	281	282	283	283	284	284	285
7.	286	286	287	287	288	288	289	289	290	290
8.	291	291	292	292	293	293	294			

Rainfall as Model Input

- Types of rainfall data required
  - intensity for given duration (=T_c)
    - Rational formula
  - amount for certain duration and frequency of occurrence (design storm)
    - not actual data; be careful!! -- runoff frequency resulting may not be same as for rainfall

Snowfall Models

- Significant part of hydrology in many areas
- Important properties in modeling
  - water equivalent
  - density (increases with time)
  - depth
  - optical properties
  - areal extent

Snowfall Models

- Methods of division between rain and snow
  - base on temperature of 0°C (NRCS method uses 1.7°C at ground level since snow forms at heights)
  - combination of dry bulb and dewpoint temperature
  - if only daily mean temperature is available assume fraction of precipitation is rain and rest snow

Snowmelt Models

- Energy balance approach
  - heat sources
    - net radiation
    - convection of sensible heat from air
    - latent heat by condensation of moist air on pack
    - heat from rain (sensible and latent from rain freezing on pack)
    - conduction of heat from ground

Snowmelt Models

- Energy balance approach
  - any heat raising pack temperature above 32°F is used to melt pack
  - account for changing albedo of pack with new snow
    - affects net radiation
    - decreases over time

Snowmelt Models

- Simplified approach
  - degree-day accumulation because air temperature is easily measured

$$M = K(T_a - T_b)$$

- Spatial variability comments regarding rainfall also apply to snowmelt
  - varying cover depth as well as melt rates (topo and slope orientation effects)