Precipitation Measurement

CE 3620: Water Resources Engineering
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**Figure 7.1.4:** Schematic diagram of a drainage basin. The high terrain on the perimeter is the drainage divide.
Precipitation Measurement: Rain

← Standard Rain Gauge

NEXRAD

http://www.nws.noaa.gov/om/marine/nexrad.htm
Precipitation Measurement: Snow

Snow Water Equivalent (SWE)

• Obtained by melting snow collected in gauge
• Equivalent depth of precipitation if fell as rain
• Example:
  If snow covering a specified area has an SWE of 0.5 m, then it will melt into a pool of water 0.5 m deep covering the same area.
Ski patrol raises board to snow surface and sweeps it clean at 8am and 4pm during storms.

http://www.id.nrcs.usda.gov/snow/siteinfo/typical_snotel.html
Temporal Representation

**Point rainfall** – station (gauge) measurements

**Rainfall hyetograph** – plot of rainfall depth or intensity as a function of time

**Mass curve of rainfall** – plot of accumulated precipitation over time
Figure 7.2.6: Average monthly precipitation in the U.S. in inches.
Figure 8.3  The watershed is modeled as a system of subbasins, stream reaches, and reservoirs.

The Mississippi River Basin in the United States
Areal Precipitation Estimation Methods

1. Arithmetic Mean
   • Easy
   • Applies equal weight to all rain gauges within watershed
   • Does not account for spatial variation

Average precipitation depth over watershed:

\[ P = \frac{1}{n} \sum_{i=1}^{n} P_i \]
2. Thiessen Polygons

- Most commonly employed method
- Uses rain gauges within watershed and nearby gauges
- Accounts for spatial variation by estimating area \( (A_i) \) covered by each rain gauge; area is subdivided into polygonal subareas using rain gauges as centers
- Not suitable for mountainous areas due to orographic influences

Average precipitation depth over watershed:

\[
P = \frac{\sum_{i=1}^{n} A_i P_i}{\sum_{i=1}^{n} A_i}
\]
3. Isohyetal Method

- Most accurate, accounts for topographic effects
- Most involved; requires skilled analyst
- Create isohyets (lines/countours of equal rainfall depth) -- similar to surveying and creation of topographic map (elevation contours)
Thiessen Polygon Construction

1. Form triangles: Draw dashed lines to connect rain gauges considering the shortest distances, and in a way that lines do not cross.

2. Form polygons: Draw perpendicular bisectors of dashed lines. Extend bisectors until they meet one another (lines do not cross) or the watershed boundary.

3. Compute $A_i$: Determine portion of watershed covered by each gauge (area of polygon within watershed boundary). Express as percentage of total watershed area.

4. Compute average precipitation depth over watershed:

$$P = \frac{\sum_{i=1}^{n} A_i p_i}{\sum_{i=1}^{n} A_i}$$