0.3%   Lakes and river storage
30.8% Groundwater, including soil moisture, swamp water and permafrost
68.9% Glaciers and permanent snow cover

Freshwater
2.5%
35 000 000 km³

97% of human available freshwater is groundwater

Saltwater
97.5%
1 365 000 000 km³

Source: Igor A. Shiklomanov, State Hydrological Institute (SHI, St. Petersburg) and United Nations Educational, Scientific and Cultural Organisation (UNESCO, Paris), 1999.

Water Budget

- **Input - Output = Change in Storage**
- Also called water balance
- Quantifies water cycle stores and fluxes *for a specific place and time*
  - Often for a year or season
  - Often for a watershed

What is a watershed?

- An area that drains into a stream, lake, or ocean
- Bounded by topographic divides
- Multiple scales
  – Breakneck Creek →
    Cuyahoga River→
    Lake Erie →
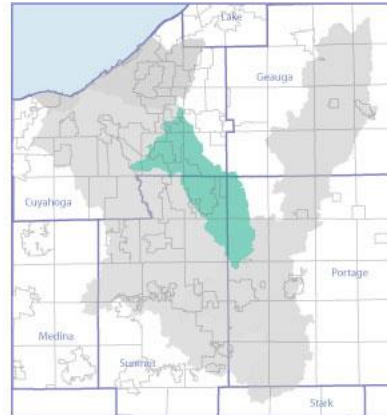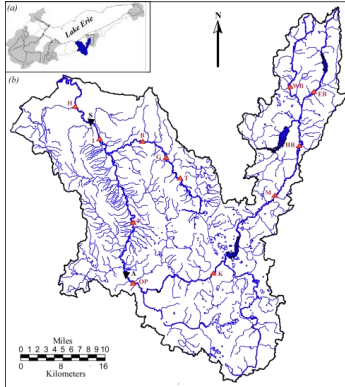   Great Lakes/St. Lawrence
- Same as a catchment and a drainage basin

Image source: http://techalive.mtu.edu/meec/module01/whatiswatershed.htm

Very simple water budget for a very simple watershed

- Inputs - Outputs   = Change in Storage
- P   –   E - T - R = ΔS
- What is ΔS?
  – Soil moisture
  – Groundwater
  – Surface water in streams lakes and ponds
  – Ice and snow at the surface
  – Temporary depression storage
  – Intercepted water on plant surfaces

Example Water Budget Question:

What is the long-term average evapotranspiration for the Tinker's Creek watershed?

Watershed area = 217.3 km² = 2.173 x 10⁸ m²

Image sources: http://fyuan.wordpress.com
http://www.cuyahogariverrap.org/tinkerscreek.html

$$P - ET - R = \Delta S$$
$$P - R - \Delta S = ET$$
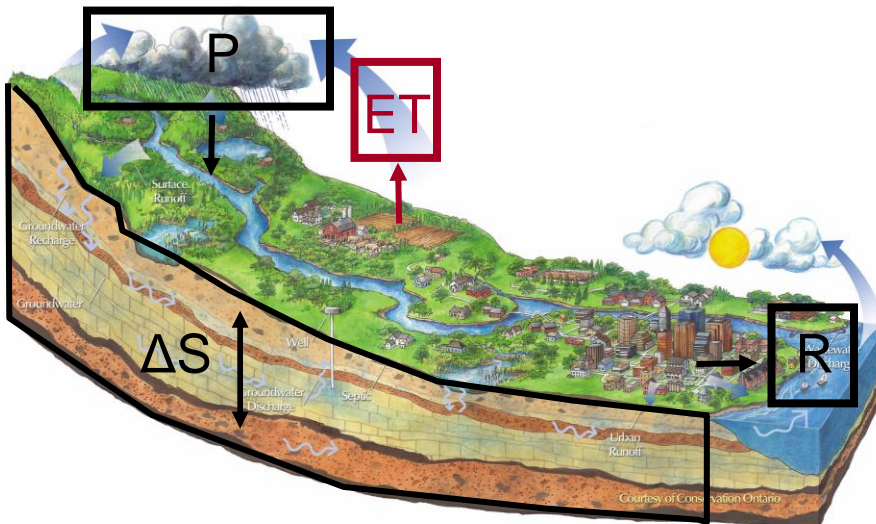
Image modified from
source:

Tinkers Creek Water Balance

Average Annual Precipitation
Ohio

Legend (in inches)

	Under 36		40 to 42
	36 to 38		42 to 44
	38 to 40		Above 44

Period: 1961-1990

This map is a plot of 1961-1990 annual average precipitation contours from NOAA Cooperative stations and (where appropriate) USDA-NRCS SNOTEL stations. Christopher Daly used the PRISM model to generate the gridded estimates from which this map was derived; the modeled grid was approximately 4x4 km latitude/longitude, and was resampled to 2x2 km using a Gaussian filter. Mapping was performed by Jenny Weisburg. Funding was provided by USDA-NRCS National Water and Climate Center.

Input: Precipitation

- ~40 in. =
  ~1.016 m/yr

Tinkers Creek Water Balance
Output = Runoff

USGS 04207200 Tinkers Creek at Bedford OH

---- Provisional Data Subject to Revision ----

4
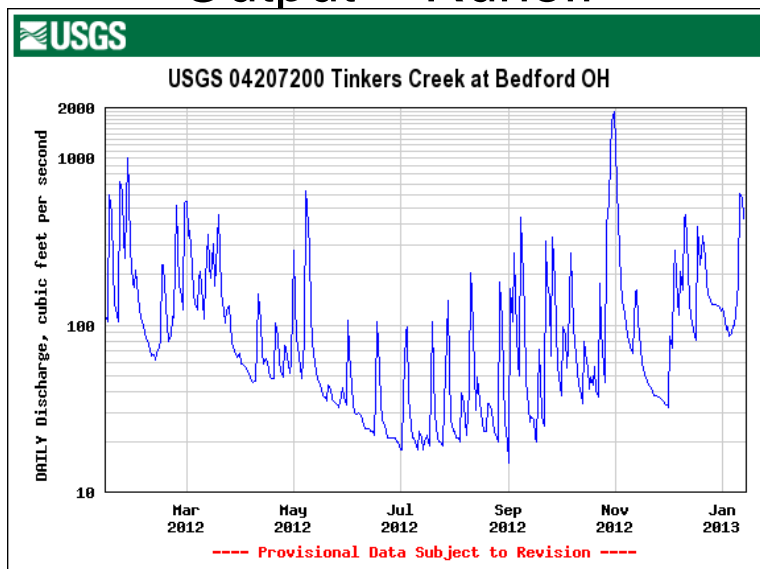
Tinkers Creek Water Balance

Observed mean discharge at Bedford for 1964-2011 is 139 ft³/s or 3.93 m³/s

Discharge (per second) x seconds (per year) =
3.93 m³/s x 3.16 x 10⁷ s/yr
= 1.24 x 10⁸ m³ /yr

Discharge (per year) / Watershed Area = Runoff
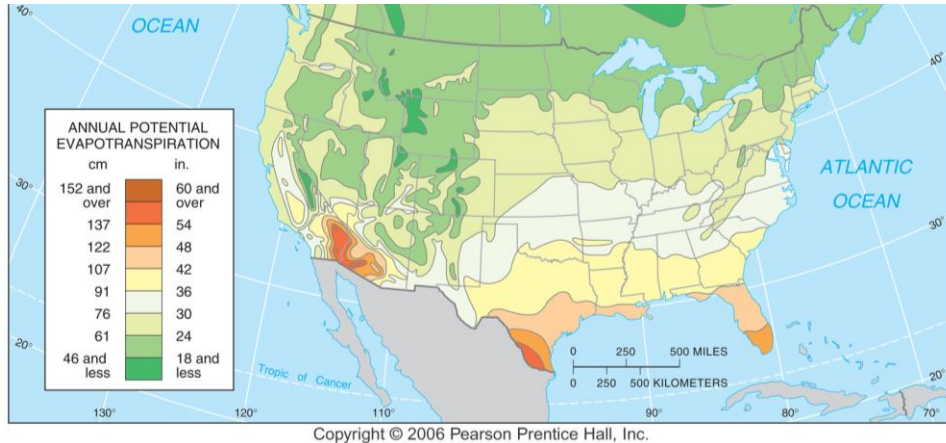1.24 x 10⁸ m³ /yr / 2.173 x 10⁸ m² = 0.571 m/yr

Tinkers Creek Water Balance

- Assume no change in storage?
- Input = Output
- Precipitation = Runoff + ET
- Precipitation - Runoff = ET

1.016 – 0.571 = 0.445 m/yr = ET

Tinkers Creek Water Balance

- We estimated ET = 44.5 cm/yr.
- *Is that reasonable?*

ANNUAL POTENTIAL EVAPOTRANSPIRATION

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If it's not reasonable, what might explain it?