# NEW ENDANGERED SPECIES:

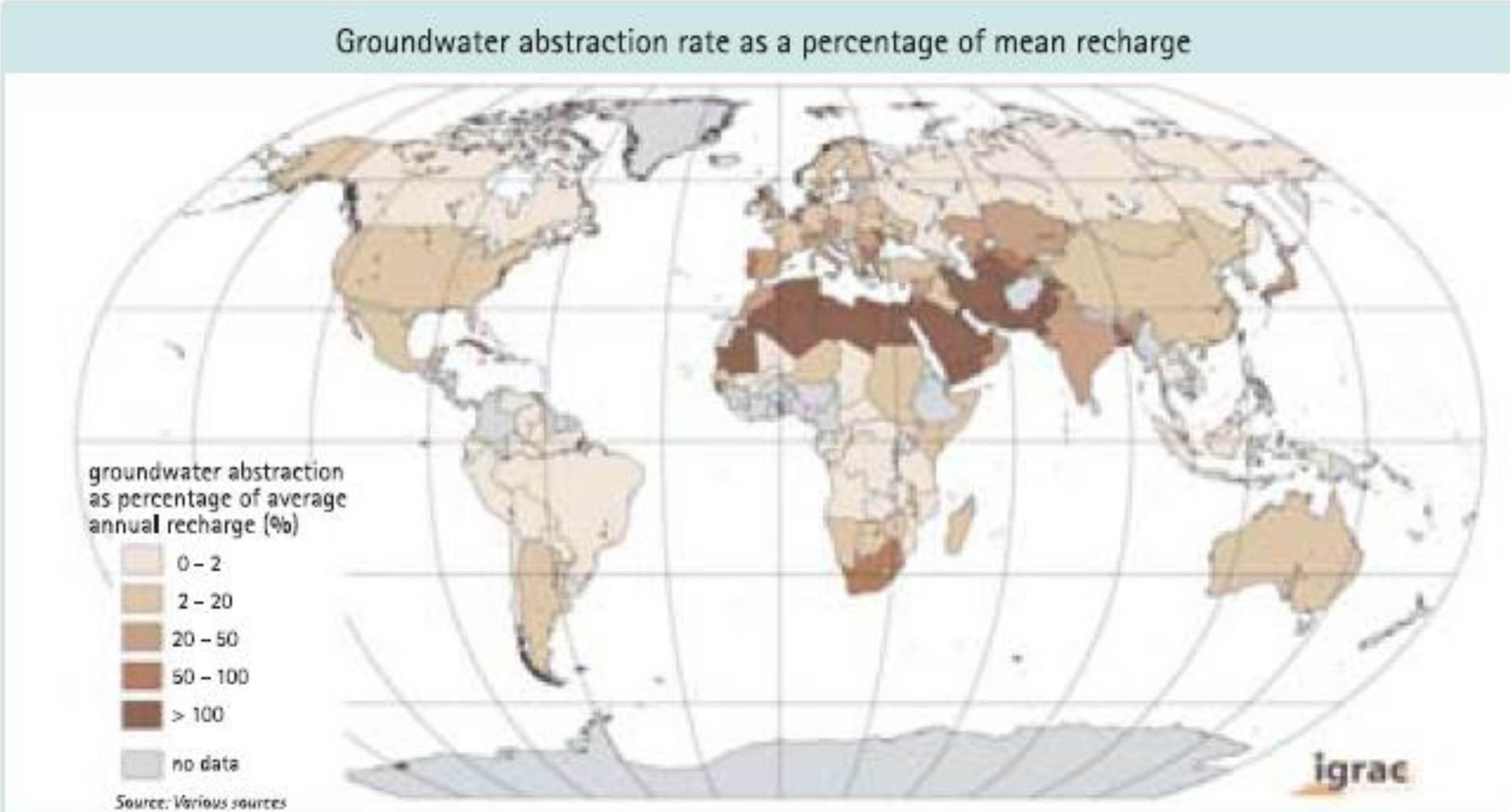
# MID-ATLANTIC STREAMS

# A New Tool

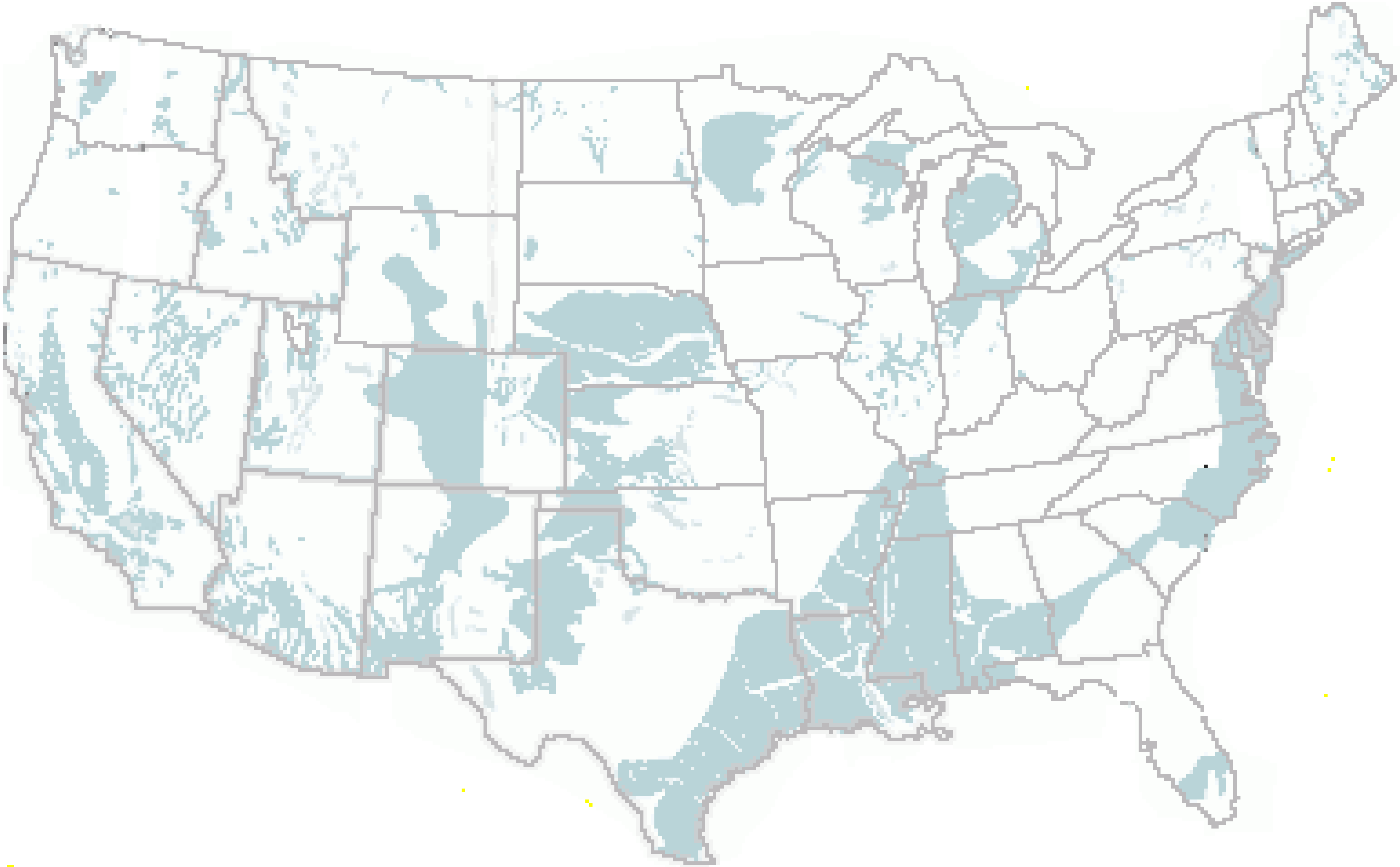
# WATERSHED-BASED PLANNING APPROACH

## TO SUSTAINABILITY
## OF OUR WATER RESOURCES

# WE ARE RUNNING OUT OF WATER!

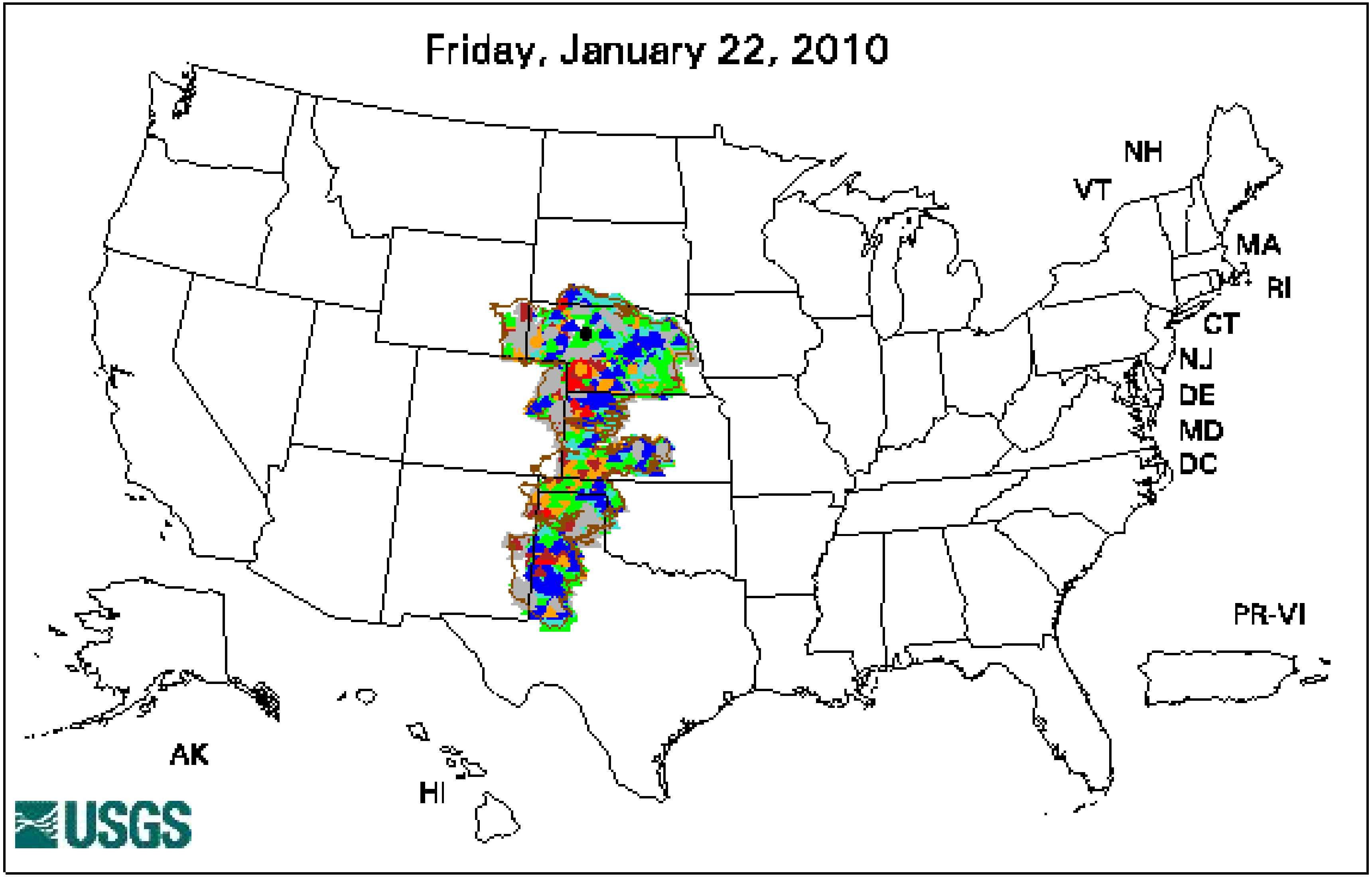


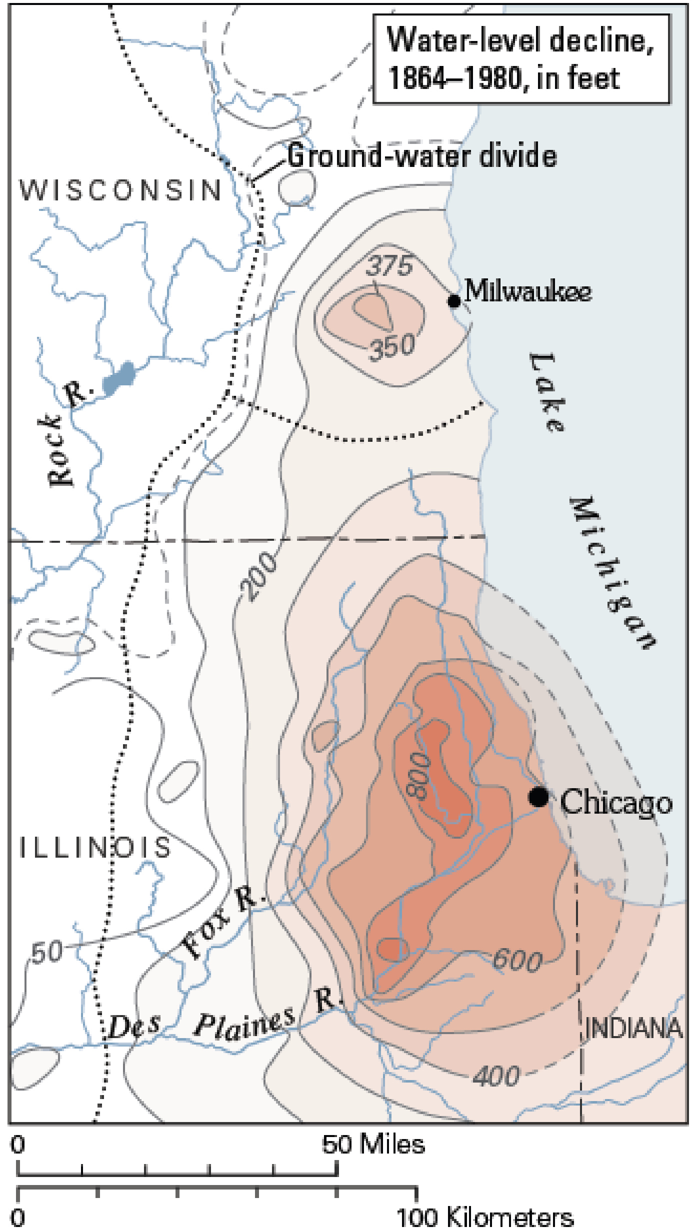

Groundwater depletion exceeds recharge in some parts of the globe. (UNITED NATIONS Report: http://www.unesco.org/water/wwap/wwdr/wwdr2/ and http://pubs.usgs.gov/circ/circ1223/pdf/C1223.pdf)



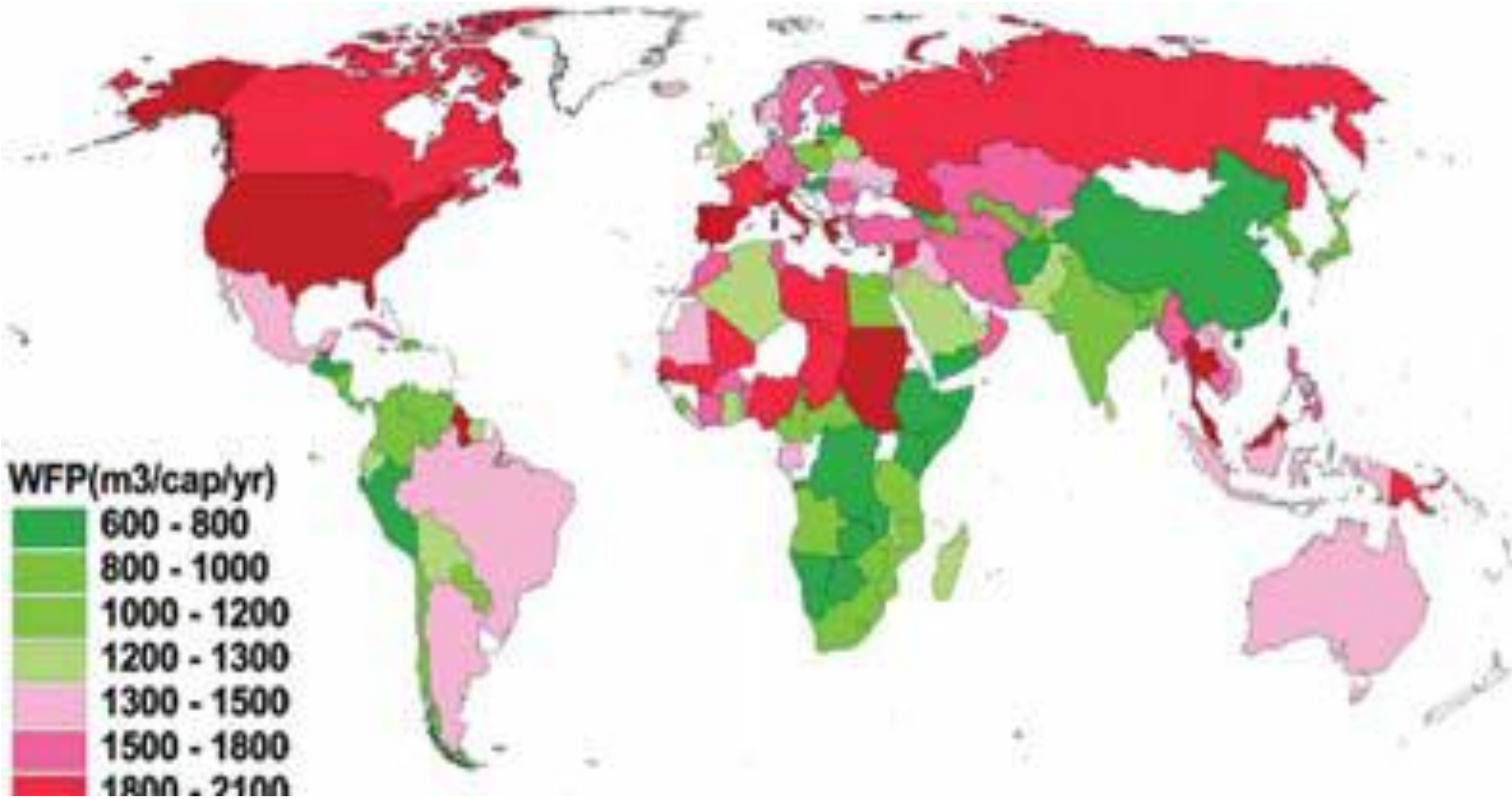
GROUNDWATER DEPLETION HAS CAUSED SUBSIDENCE (USGS)

# HIGH PLAINS AQUIFER
## Groundwater table has decreased 100 feet



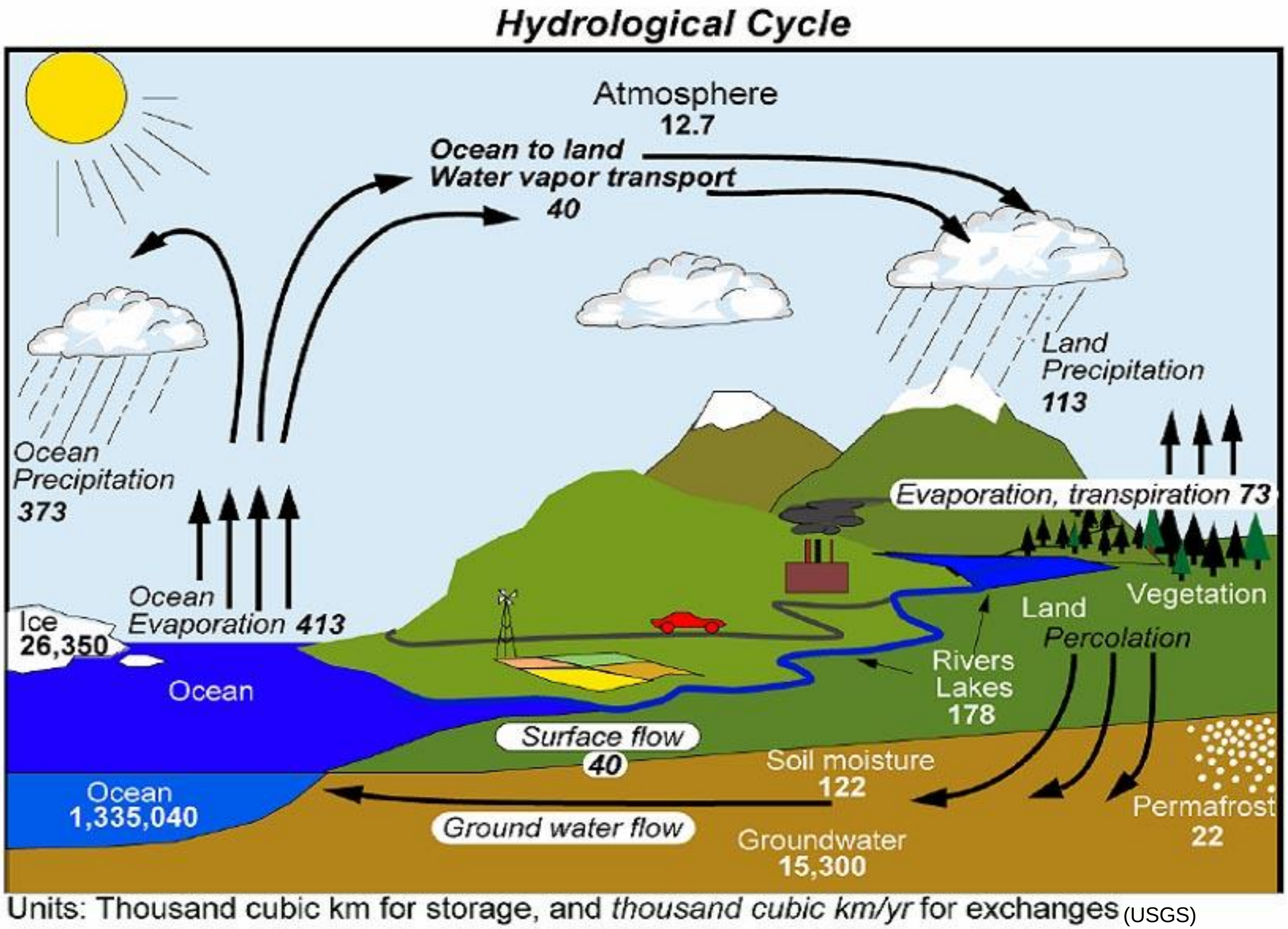



Decline in ground-water levels in the sandstone aquifer, Chicago and Milwaukee areas, 1864-1980 (Alley and others, 1999).




National Water Footprints Around the World, 2004

(http://www.unesco.org/water/wwap/wwdr/wwdr2/)



(USGS)

**NOTE THE BALANCE:**

**40 thousand cubic km/yr FROM THE OCEAN TO THE LAND**

***BALANCED WITH***

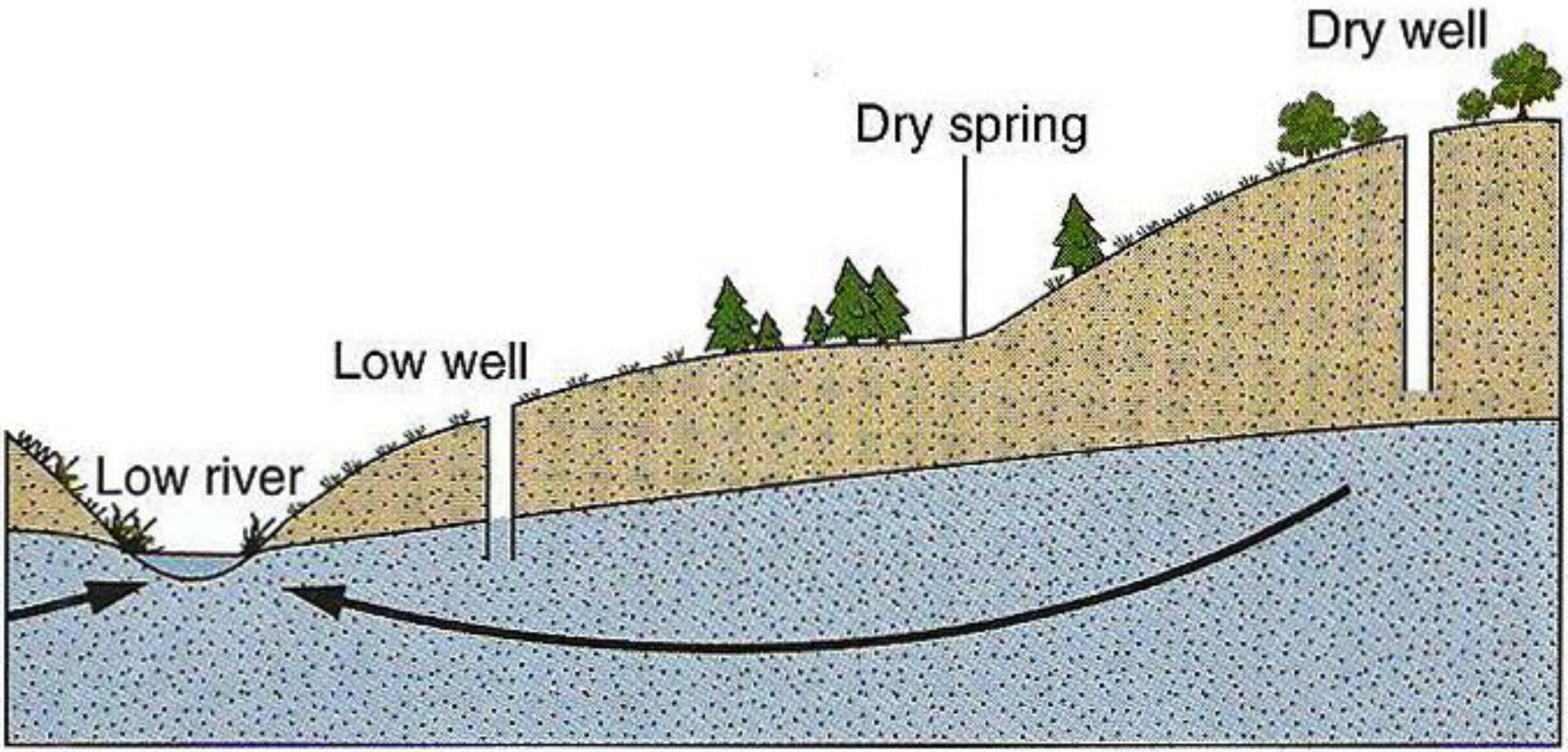
**40 thousand cubic km/yr OF SURFACE FLOW**

**FROM THE LAND TO THE OCEAN**

# DROUGHT

*Meteorological drought – low precipitation*

*Socioeconomic drought – inadequate resource management*



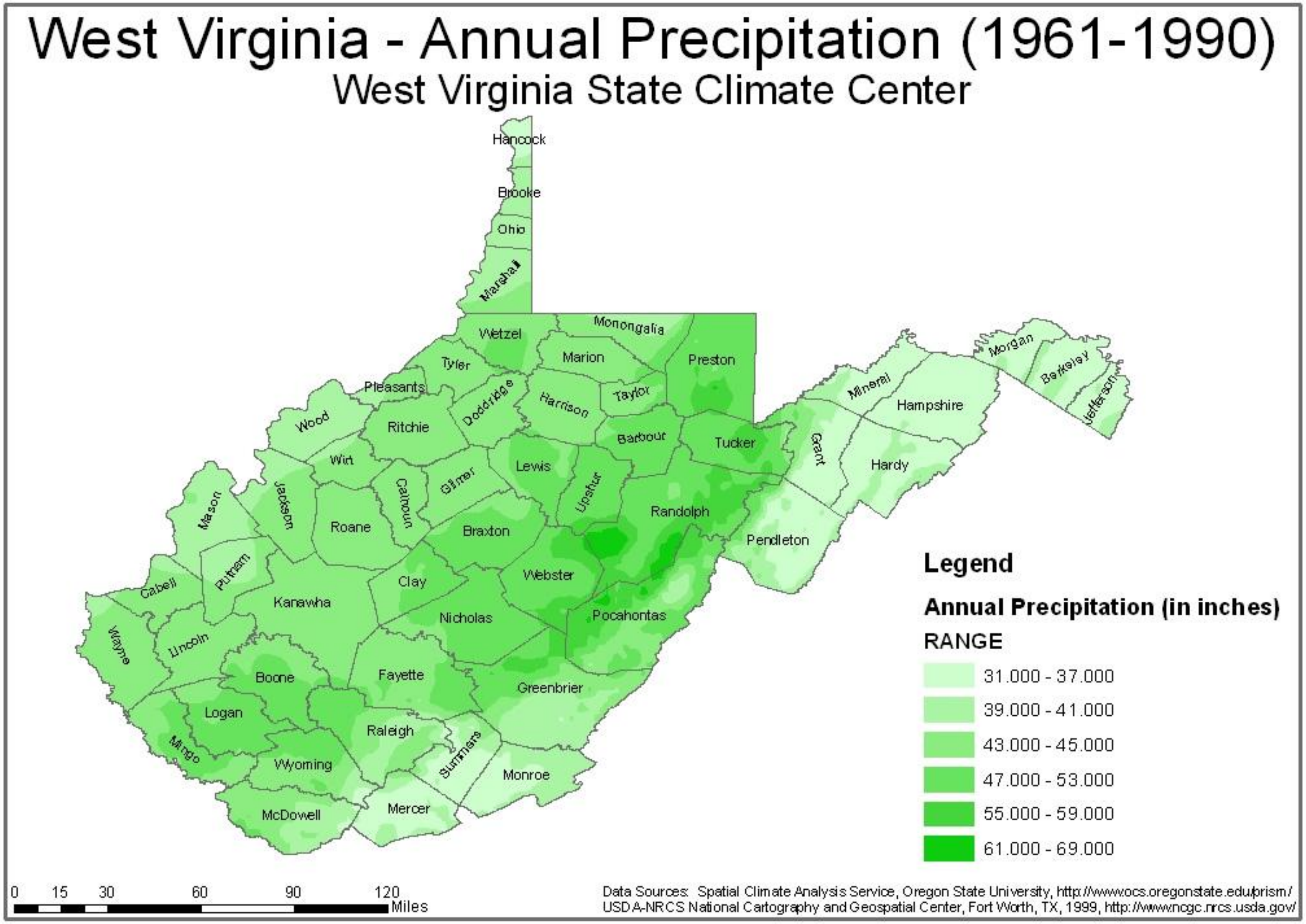

**STREAMS and GROUNDWATER are INTER-RELATED and INSEPARABLE**

***GROUNDWATER*** replenishes stream water during times of low water.

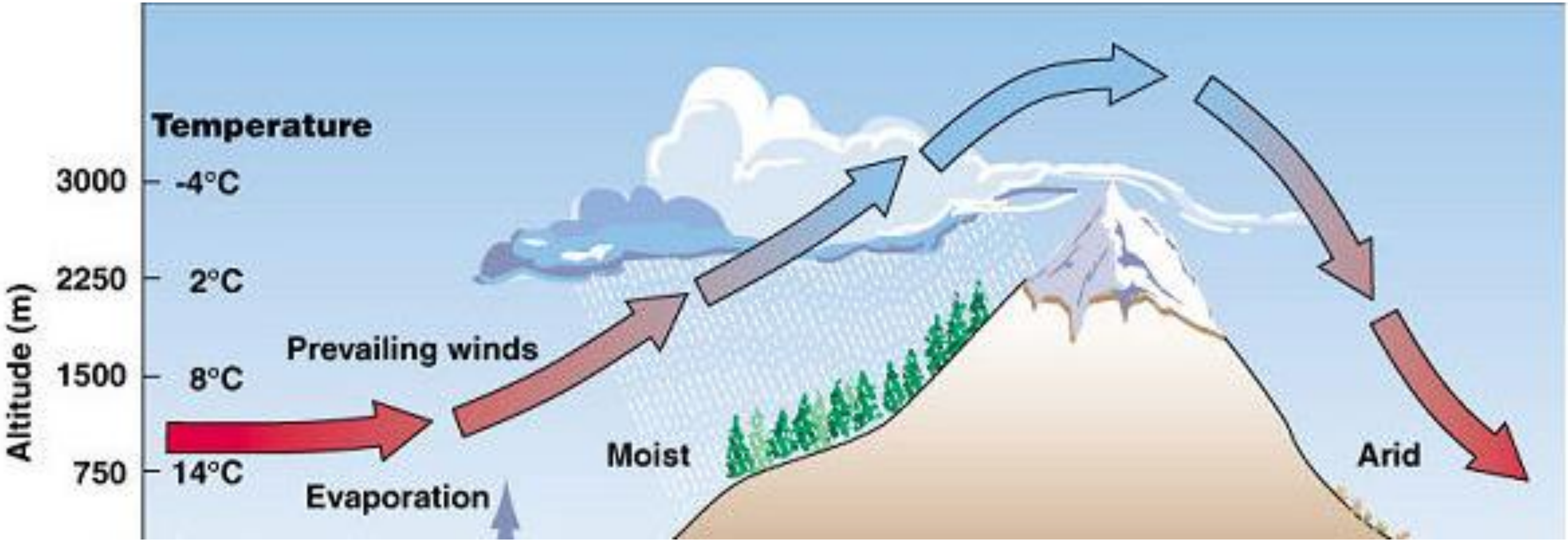
# *STREAMFLOW* HAS *INCREASED*
# Due to *OVER-DEVELOPMENT*

**Table 1.2 Average Annual Streamflow for Potomac River @ Hancock Maryland**

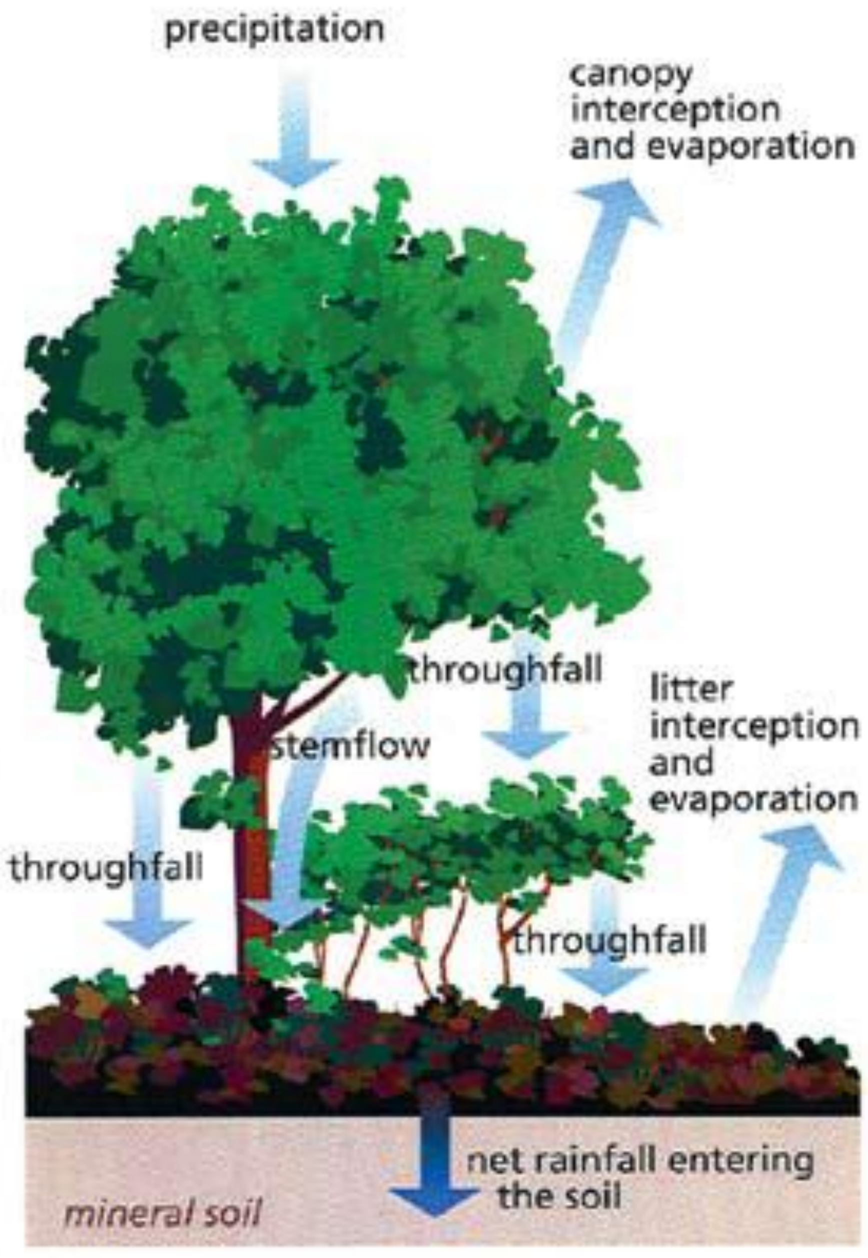
| 1933-2003 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Year** | **Annual mean Streamflow, in gal/s** | **Year** | **Annual mean Streamflow, in gal/s** | **Year** | **Annual mean Streamflow, in gal/s** | **Year** | **Annual mean Streamflow, in gal/s** |
| **1933** | 34,991 | **1951** | 35,754 | **1969** | 13,898 | **1987** | 30,219 |
| **1934** | 17,787 | **1952** | 35,769 | **1970** | 33,488 | **1988** | 24,781 |
| **1935** | 32,022 | **1953** | 29,643 | **1971** | 38,978 | **1989** | 34,991 |
| **1936** | 44,611 | **1954** | 24,953 | **1972** | 56,654 | **1990** | 27,661 |
| **1937** | 45,291 | **1955** | 32,703 | **1973** | 40,242 | **1991** | 24,856 |
| **1938** | 18,117 | **1956** | 30,339 | **1974** | 29,972 | **1992** | 23,899 |
| **1939** | 29,583 | **1957** | 25,604 | **1975** | 42,651 | **1993** | 40,414 |
| **1940** | 32,396 | **1958** | 28,865 | **1976** | 30,907 | **1994** | 43,160 |
| **1941** | 18,880 | **1959** | 19,426 | **1977** | 25,148 | **1995** | 24,243 |
| **1942** | 36,667 | **1960** | 29,853 | **1978** | 38,896 | **1996** | 68,075 |
| **1943** | 27,586 | **1961** | 33,204 | **1979** | 50,550 | **1997** | 27,295 |
| **1944** | 28,701 | **1962** | 29,434 | **1980** | 31,790 | **1998** | 41,783 |
| **1945** | 32,149 | **1963** | 24,467 | **1981** | 22,934 | **1999** | 17,024 |
| **1946** | 23,106 | **1964** | 26,614 | **1982** | 30,930 | **2000** | 20,480 |
| **1947** | 16,531 | **1965** | 24,706 | **1983** | 35,231 | **2001** | 21,221 |
| **1948** | 34,827 | **1966** | 21,550 | **1984** | 40,699 | **2002** | 24,101 |
| **1949** | 34,909 | **1967** | 32,875 | **1985** | 38,821 | **2003** | 61,560 |
| **1950** | 35,044 | **1968** | 25,649 | **1986** | 25,469 | | |




**PRECIPITATION is GREATEST on the MOUNTAINS**




WARM, MOIST AIR RISES,
THEN COOLS OVER THE MOUNTAINS,
CONDENSING TO PROVIDE PRECIPITATION




**Mountain FORESTS**
***INTERCEPT* RAINFALL**

**Allowing Rainfall to**
***GENTLY* REACH THE GROUND**

**Thus Allowing**
***LESS SURFACE RUNOFF***
***and***
***GREATER GROUNDWATER RECHARGE***

## MOUNTAIN RIDGE HEADWATER AREAS ARE UNIQUE

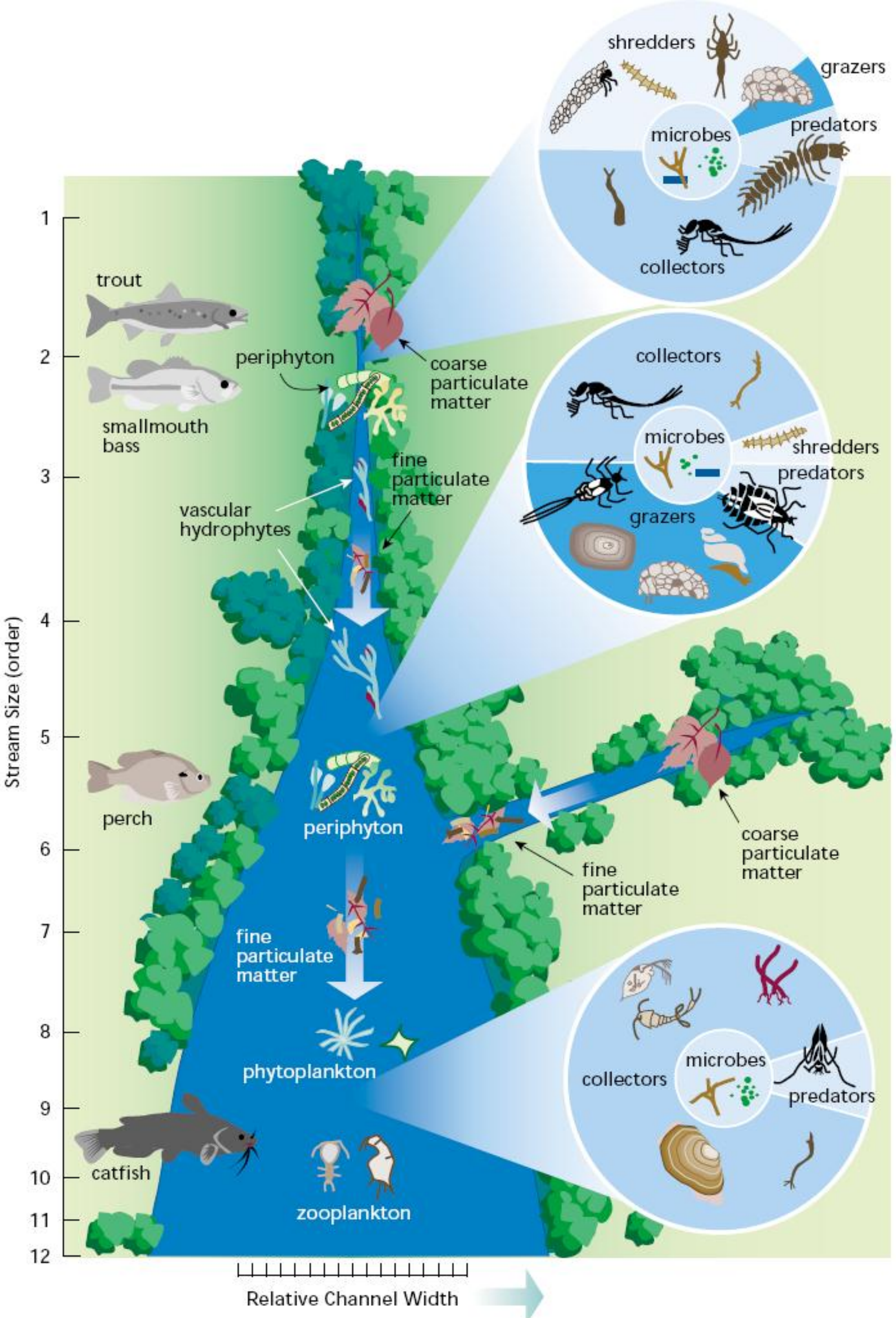
## *MOUNTAIN RIDGE DEFORESTATION:*

## 1) INCREASES LIGHT AND WATER TEMPERATURES

## 2) DESTROYS HEADWATER AREAS

## 3) INCREASES SURFACE RUNOFF

## 4) INCREASES EROSION AND SEDIMENTATION DOWNSTREAM



**MOUNTAINTOP REMOVAL DESTROYS FORESTED RIDGES**

Typical Transmission Line Deforestation and Excavation

Mountaineer Wind Facility, Tucker County, West Virginia

# CUMULATIVE IMPACT

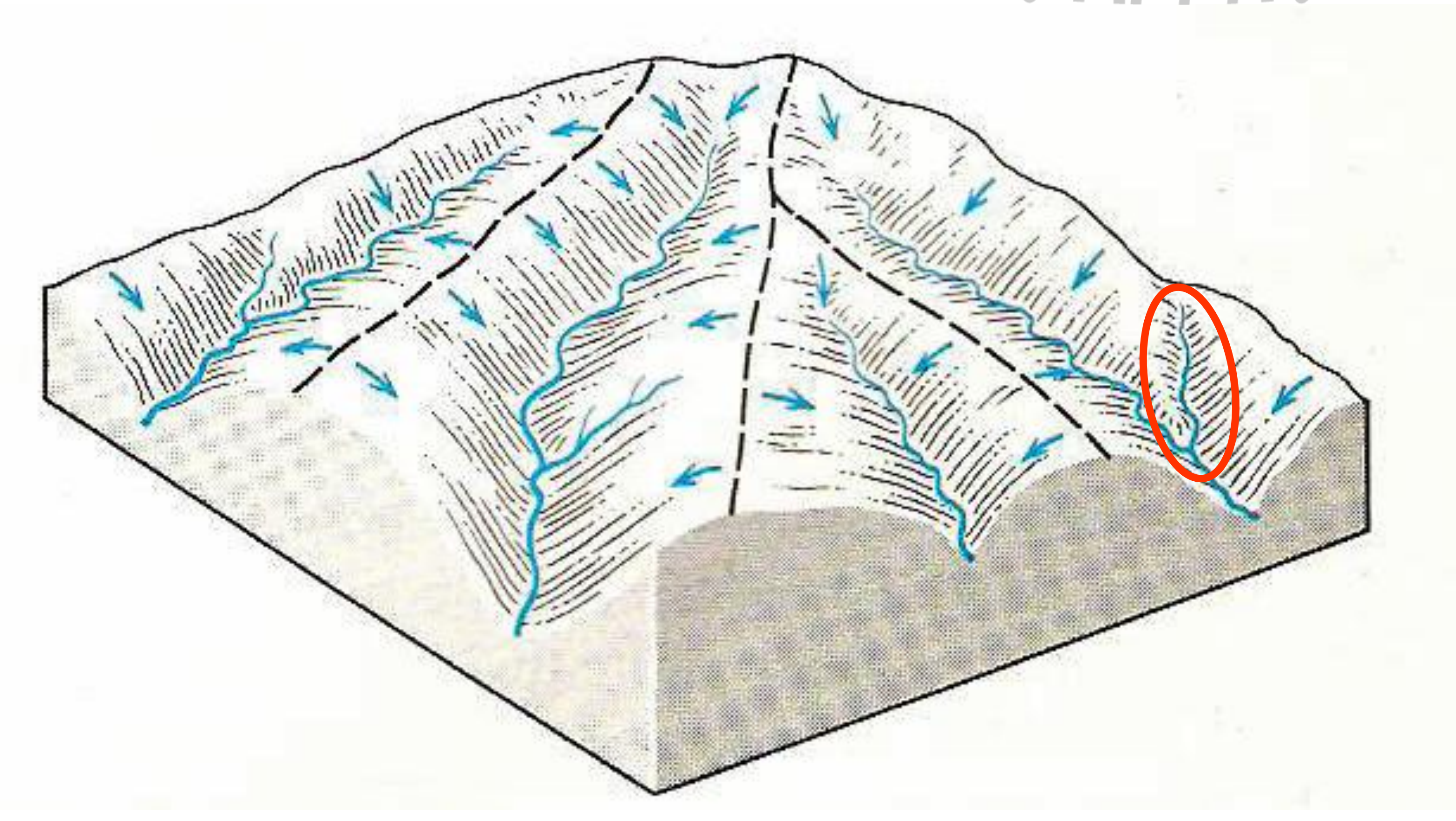
| | |
|---|---|
| AES Laurel Mountain Wind Project (Randolph & Barbour Co., WV): | 388 acres |
| AES New Creek Wind Project (Grant Co., WV): | 295 acres |
| Pinnacle Wind Project (Mineral Co., WV): | 102 acres |
| Mountaineer Wind Project (Tucker Co., WV): | 200 acres |
| **TOTAL ACRES** (just 4 projects): | **985 acres** |

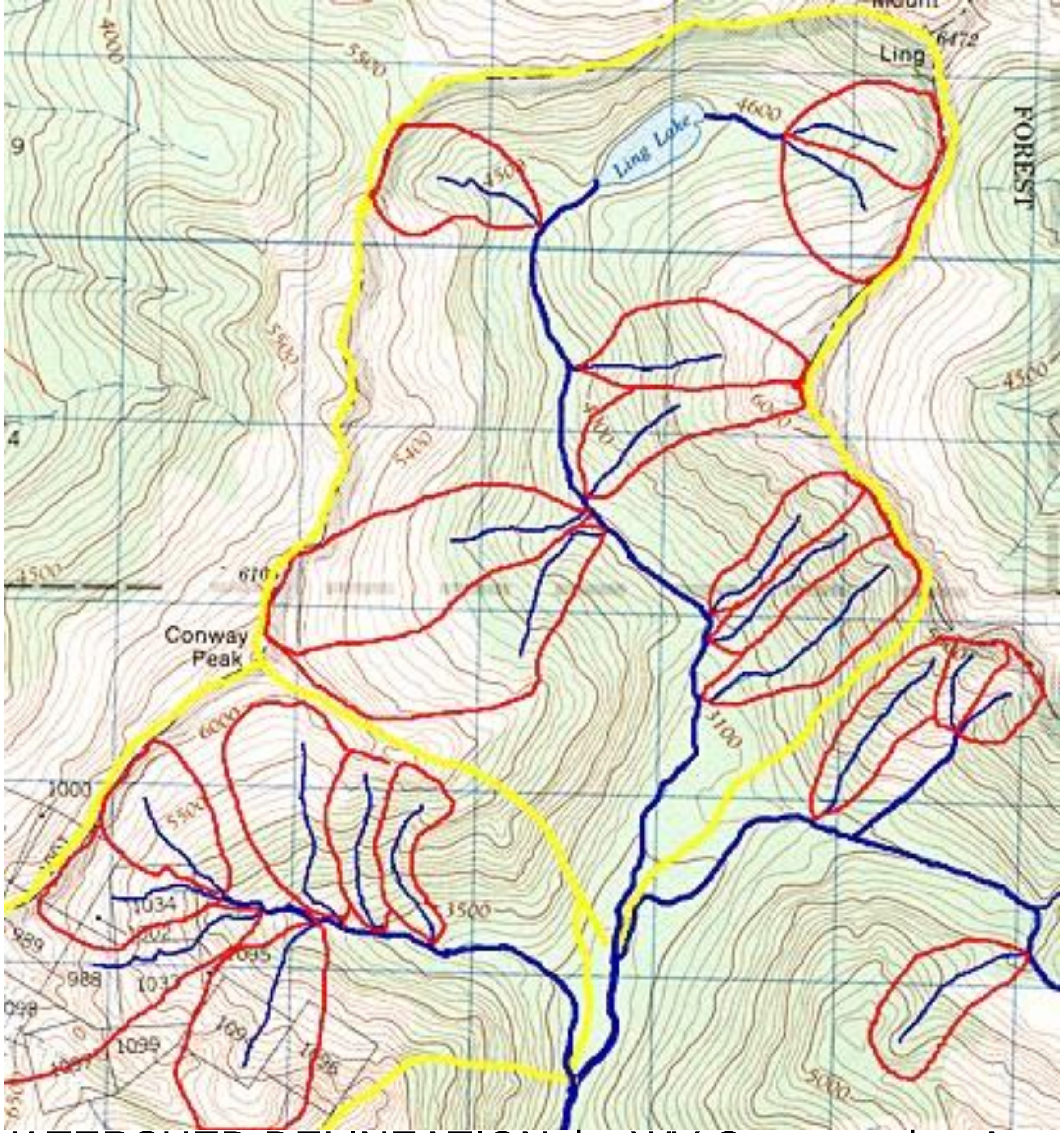
# Marcellus Shale Gas Extraction

Uses more than 1 million gallons of water per well

# Pipelines

# WATERSHED-BASED PLANNING APPROACH






WATERSHED DELINEATION, by WV Conservation Agency

http://www.wvca.us/envirothon/a5.html

# 10% Impervious Cover

# IMPACTS Watersheds

# RATIONAL METHOD:

**Oldest and most widely used method of calculating peak runoff rates for urban and rural watersheds that are less than 200 acres**

$$Q = CiA$$

**"Q" is Discharge**
**"C" is Runoff Coefficient (e.g. from tables in WVDOH Manual)**
**"i" is Rainfall Intensity (from NOAA charts)**
**"A" is Drainage Area (from GIS or Terrain Navigator)**

**Table 4-4**

**Recommended Runoff Coefficient (C) Values**

| Description of Area | Runoff Coefficient (C) | | |
|---|---|---|---|
| | **Flat areas** Slope 0% to 2% | **Moderate areas** Slope 2% to 10% | **Steep areas** Slope Over 10% |
| Pavement, Roof surfaces, etc. | 0.80 | 0.90 | 0.95 |
| Earth Shoulder | 0.55 | 0.60 | 0.70 |
| Gravel or Stone Shoulders | 0.45 | 0.50 | 0.60 |
| Grass Shoulders | 0.30 | 0.35 | 0.40 |
| Side Slopes–Earth | 0.50 | 0.60 | 0.70 |
| Side Slopes–Turf | 0.40 | 0.50 | 0.65 |
| Median Strips–Turf | 0.30 | 0.35 | 0.40 |
| Dense Residential Areas | 0.60 | 0.65 | 0.80 |
| Suburban Areas with Small Yards | 0.40 | 0.50 | 0.60 |
| Cultivated Land | | | |
| Clay and Loam | 0.35 | 0.50 | 0.60 |
| Sand and Gravel | 0.25 | 0.30 | 0.35 |
| Woods, Parks, Meadows, and Pasture Land | 0.20 | 0.25 | 0.35 |

*Source: WVDOH Drainage Manual, 1984*

CLAY & LOAM — C=0.60

WOODS — C=0.35

Runoff coefficient values represent an empirical, dimensionless ratio between rainfall and runoff.

# Q = CiA

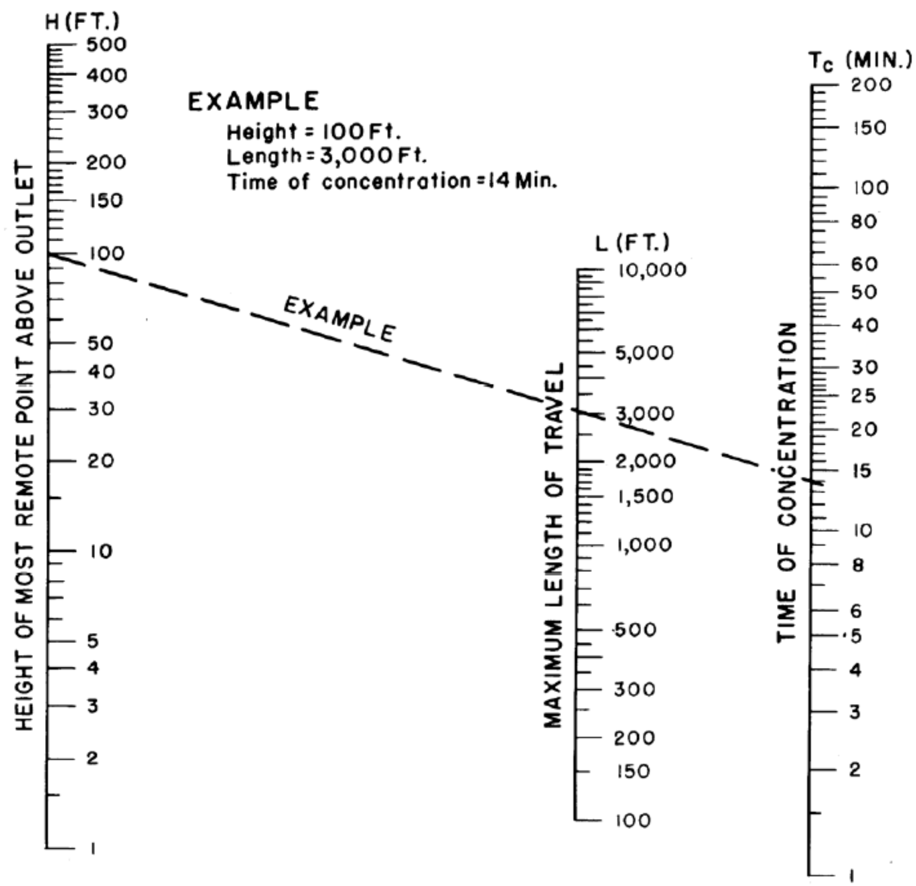
"i" is the rainfall intensity for a duration equal to the time of concentration for a selected return period, inches per hour (in/hr)

The time of concentration (Tc) is the time required for water to flow from the hydraulically most remote point of the drainage area to the point of interest. With the Rational Method, the duration of a rainfall event is set equal to the time of concentration and it is used to estimate the average rainfall intensity (i) from the intensity-duration-frequency curves (IDF) for a selected return period.

**Chart 4-1**

**Kirpich Method**

**$T_c$ for Overland and Channel Flow Segments for Rural Basins**

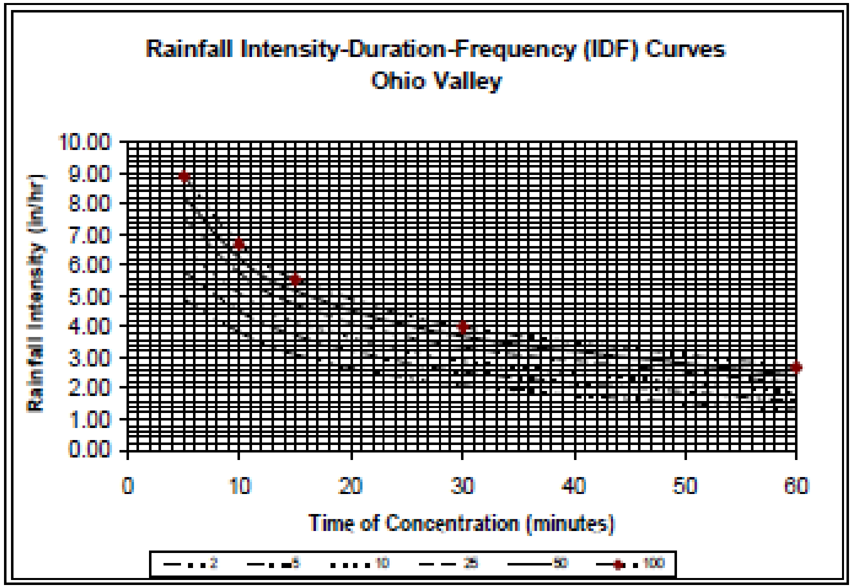


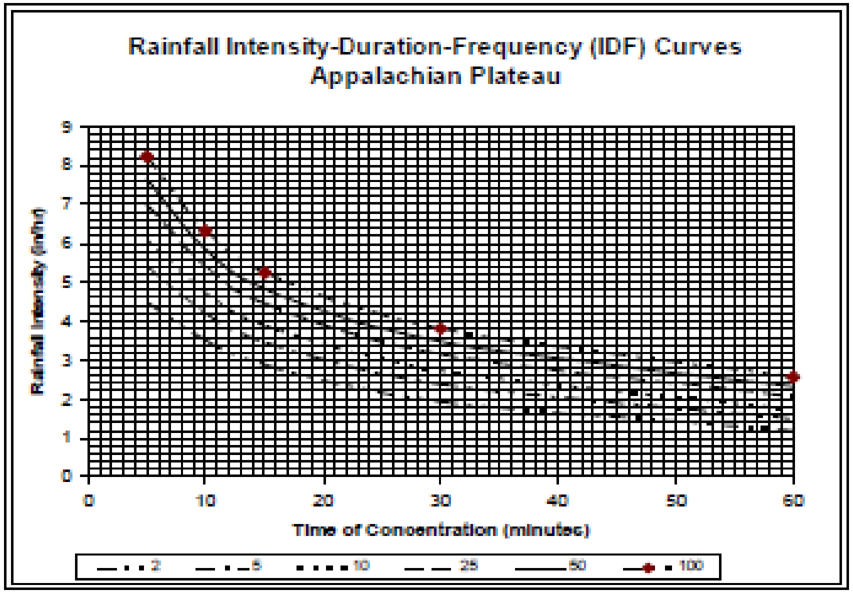

Based on study by P. Z. Kirpich,
Civil Engineering, Vol. 10, No. 6, June 1940, p. 362

$$T_C = \frac{0.0078\,L^{0.77}}{S^{0.385}}$$

S is in ft / ft

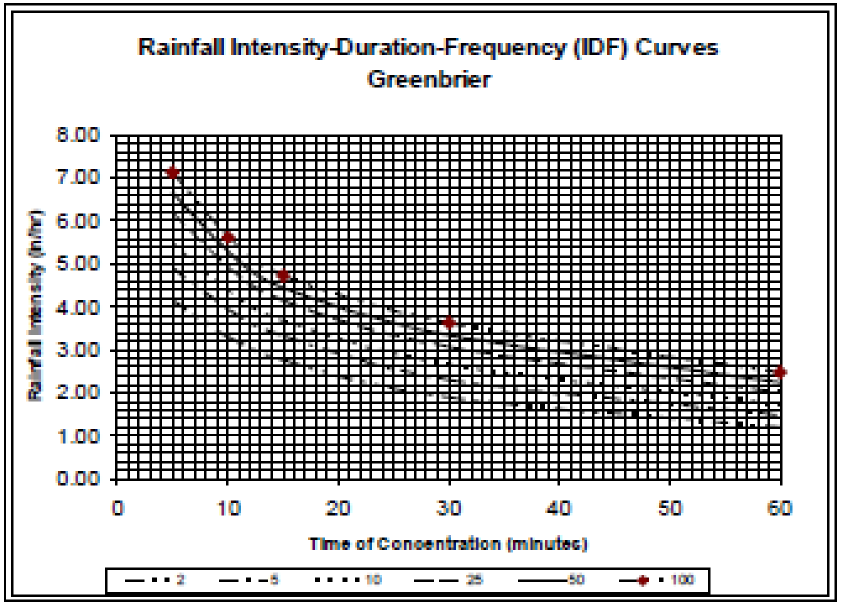
## Chart 4-2
## Intensity-Duration-Frequency Curves for West Virginia

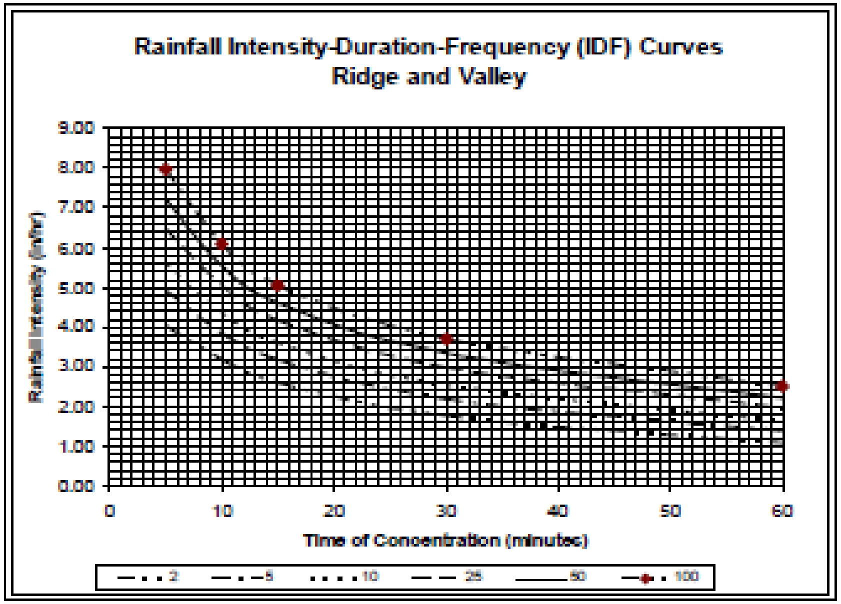


## Chart 4-3

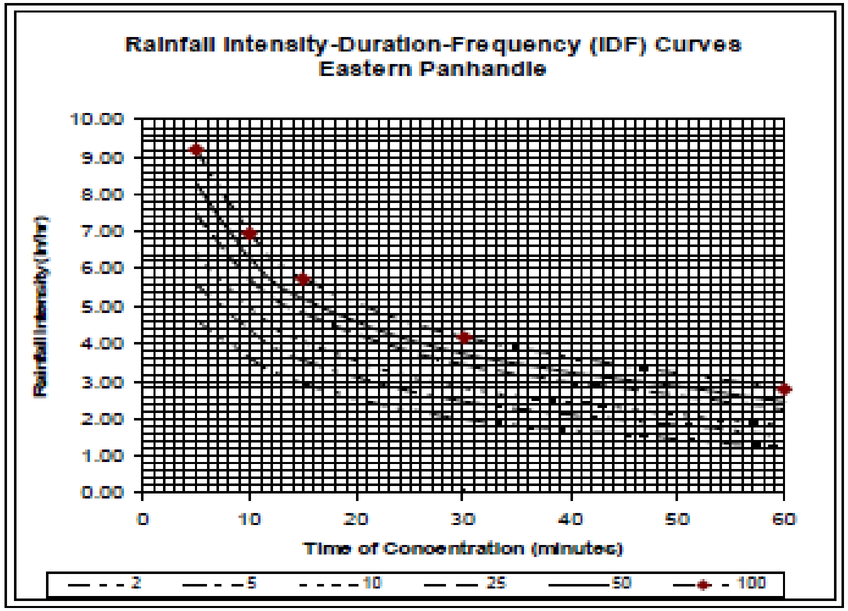
### Intensity-Duration-Frequency Curves for West Virginia



## Chart 4-4

## Intensity-Duration-Frequency Curves for West Virginia




*Source: NOAA Atlas 14, PFDS, National Weather Service, 2004*


JEEP
TRAIL
PIPELINE
C1 & G1
DP-35, 5.1cfs, 1.74ac
G2
C2
G3
C3 and G4
DP-34
DP-33, 9.1cfs, 3.98ac
DP-32, 7.1cfs, 3.20ac
2650
DP-31, 25.2cfs, 11.59ac
C5 &C6
DP-30, 98.3cfs, 48.27ac
BAKER
SCALE 1:10000
0 100 200 300 400 500 600 700 YARDS
0 1000 2000 FEET
0 100 200 300 400 500 600 METERS

# Q = CiA

Total Area = 154 acres
Undisturbed Area = 112 acres with C=0.35
Disturbed Area = 42 acres with C=0.6

## Pre-construction

Q = CiA = 0.35 x 4.6 x 154 = 247.94 cfs

## 10% Impervious Cover = 15 acres

Weighted C = [(139x0.35)+(15x1.0)]/154 = 0.413
Q = CiA = 0.413 x 4.6 x 154 = 292.56cfs

## Post Construction

Weighted C = [(112x0.35)+(42x0.60)]/154 = 0.418
Q = CiA = 0.418 x 4.6 x 154 = 296.11cfs

# Conclusion: NEGATIVE IMPACT


No protection of stream in headwaters of the Potomac River.  Truck tire tracks are evident.

**Plant riparian buffers**

# PROTECT OUR FORESTED MOUNTAIN RIDGES

# To SAVE Our WATER