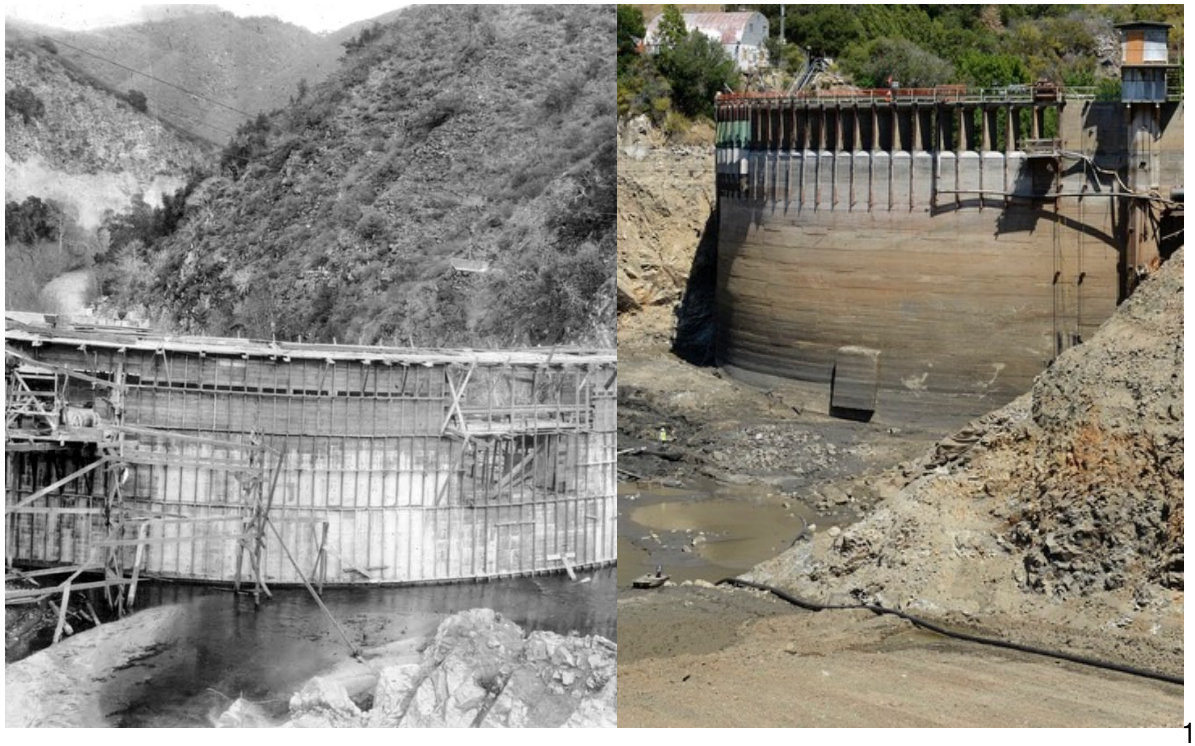
Benoit Delaveau, MS, BEAP, CEM (aka Prof. Ben)
benoit.delaveau@sjsu.edu
Office hours sign-up here: calendly.com/benoit-delaveau

ENVS 119 - Energy & the Environment
10 - Hydro Power. Is it renewable?



San Clemente dam, CA
(1921, 2015)

Hydro projects = Mixed use

1. Irrigation project
2. Water reservoir
3. Energy generation
4. Energy storage

DigitalGlobe / Getty Images

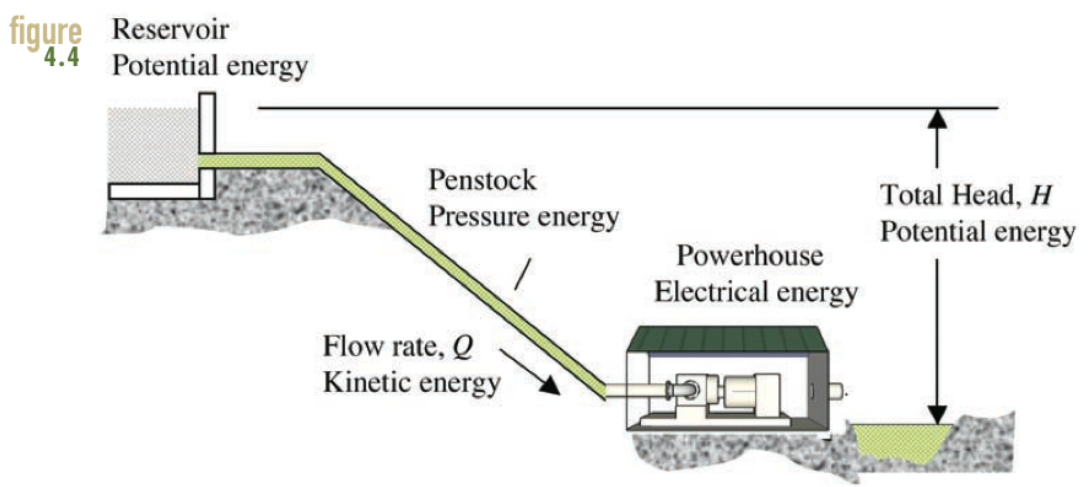
Cuanza River, Angola, April 28, 2013 – Cambambe Dam
http://science.time.com/2013/12/03/20-breathtaking-images-of-the-earth-as-seen-from-space/photo/bandlist-4-3-2/#ixzz2mWwwZWse

Hydro: How Electricity is Generated?

Eq. 4.8

$$P(\mathrm{W}) = 9810\,\eta\,Q(\mathrm{m}^3/\mathrm{s})\,H(\mathrm{m}) = \frac{\eta\,Q(\mathrm{gpm})\,H(\mathrm{ft})}{5.3}$$

where η = overall efficiency of conversion from potential energy to electrical energy

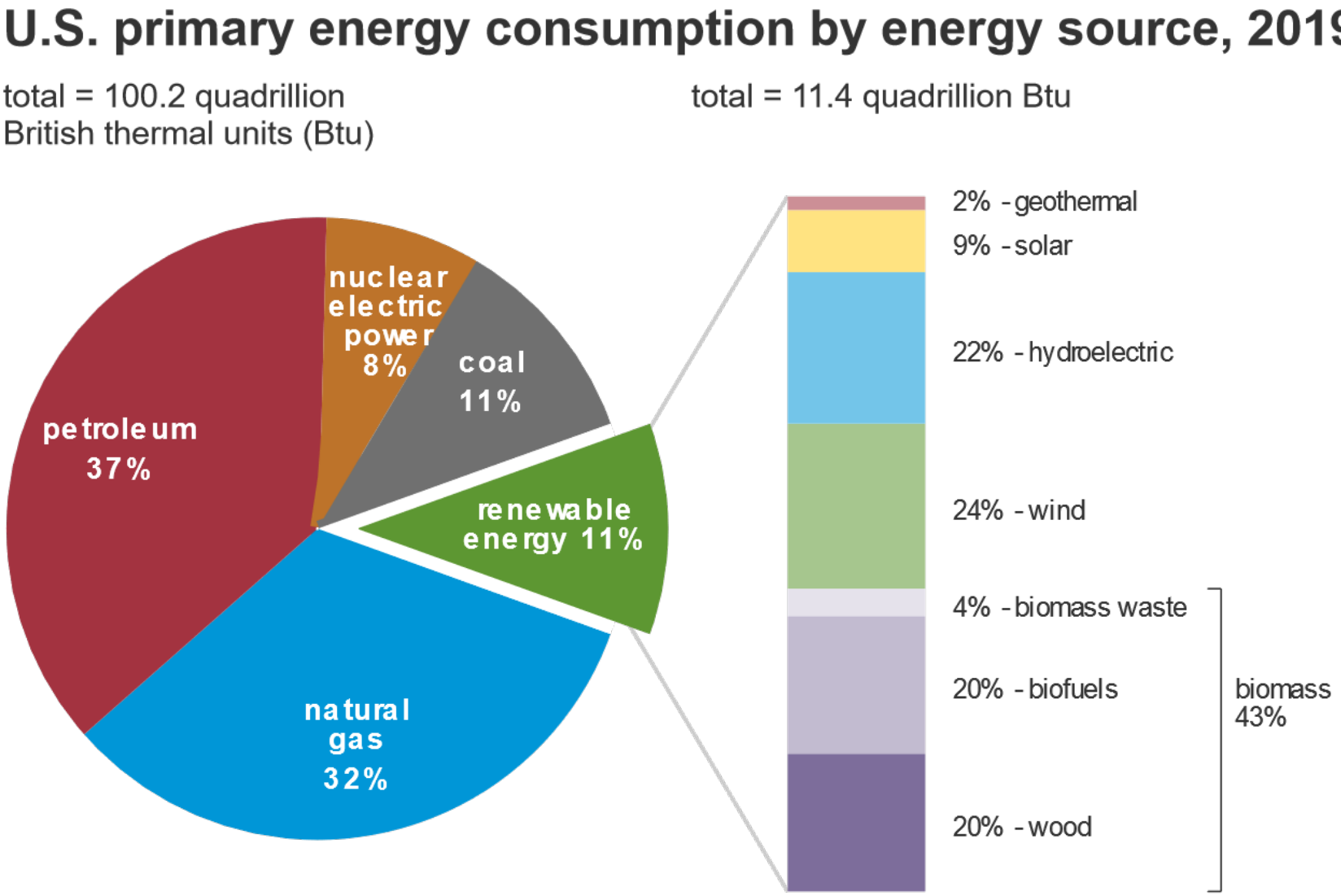


A hydropower system converts energy from potential, to pressure, to kinetic, and then electrical energy.

- Combine Efficiency
  (n = 30-60% or 0.3 to 0.6)
- Q = flow rate
  (m^3/s or gallon per min)
- H = Head
  (height of drop in meter or feet)
- Factor (x9810 or /5.3)
- = Power (W)

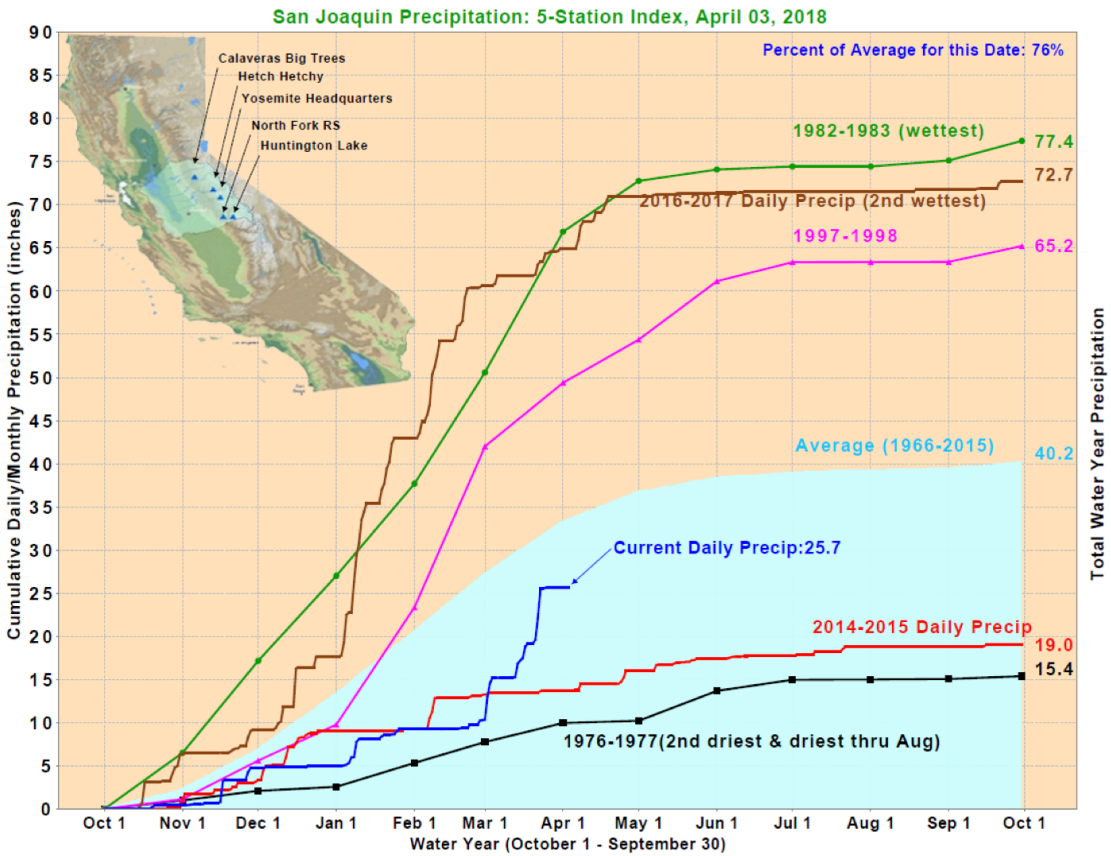
Randolph and Masters -Chap 4.7 p156

Hydro energy (US) = 22% of renewables

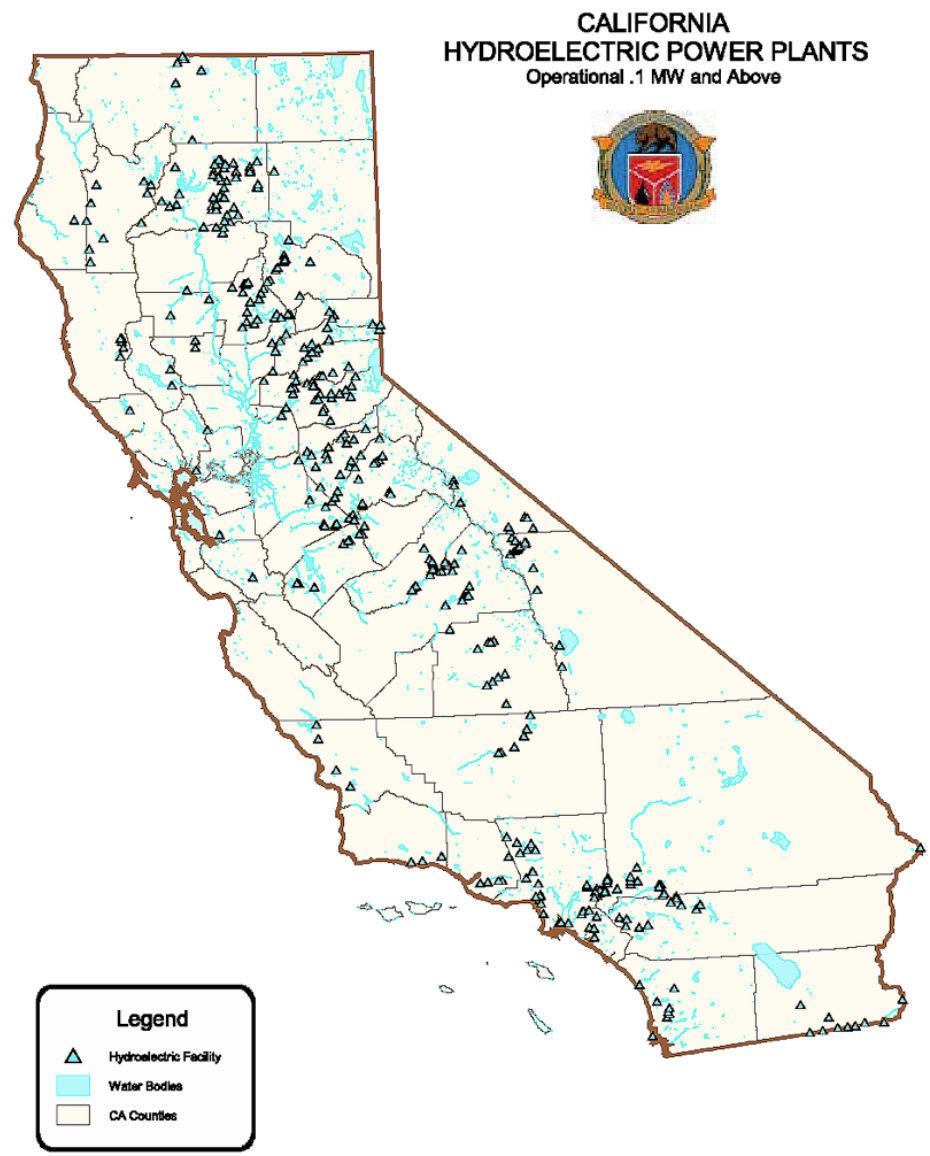


Note: Sum of components may not equal 100% because of independent rounding.
Source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 1.3 and 10.1, April 2020, preliminary data

Hydro in CA = Variability Year-to-Year



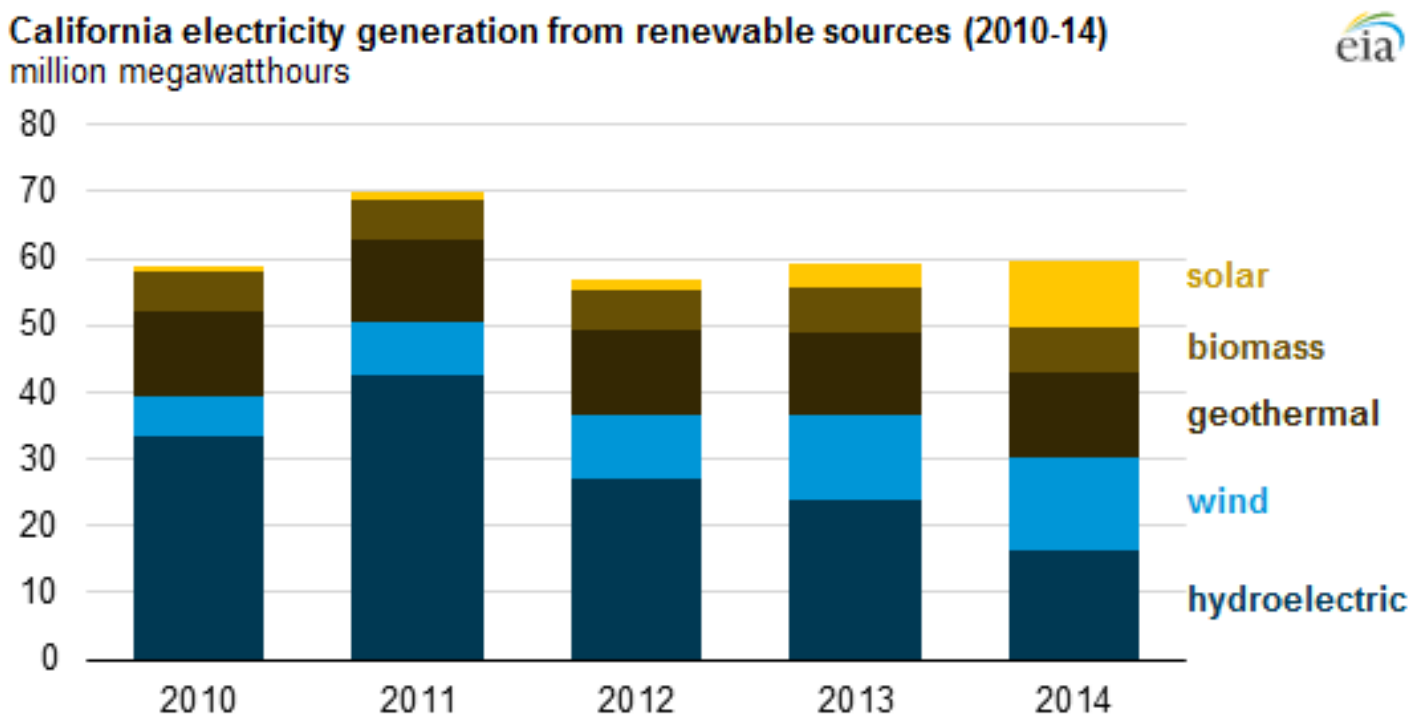
Source: California Department of Water Resources



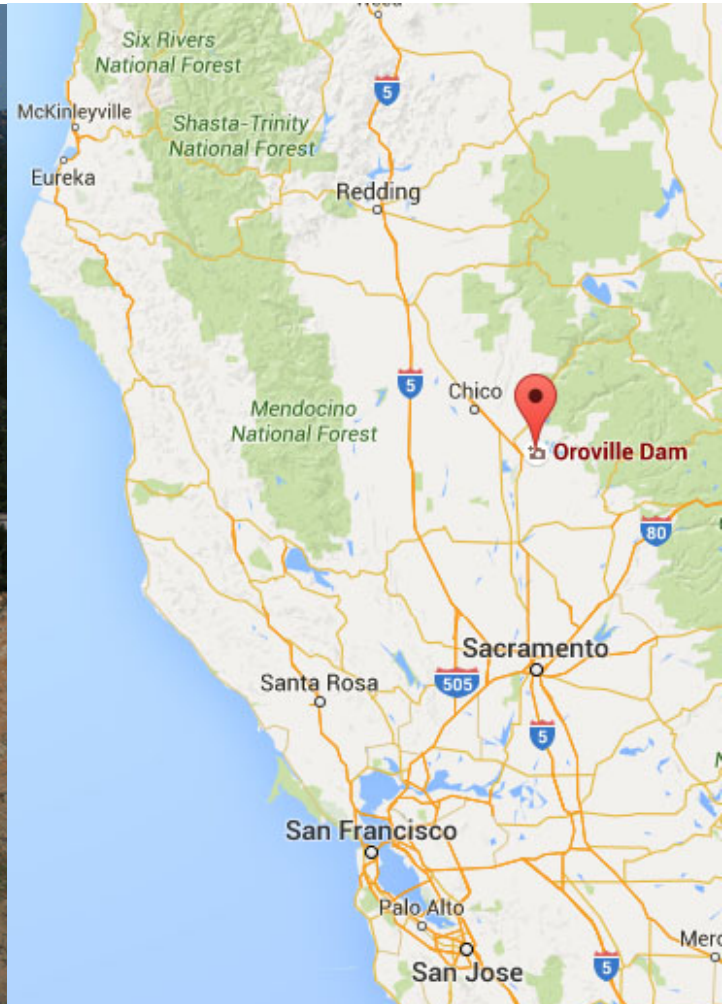
Source: U.S. Energy Information Administration, EIA Forms 923 and 826

YtoY Variability = How to predict Energy?

Only 1/3 to 1/4 of hydro power available during drought years.



YtoY Variability = Stress on Dams



Oroville Dam - 760 MW - 2/17/2017 https://youtu.be/Cg-isID0u4E

Hydro power - Other Cons.

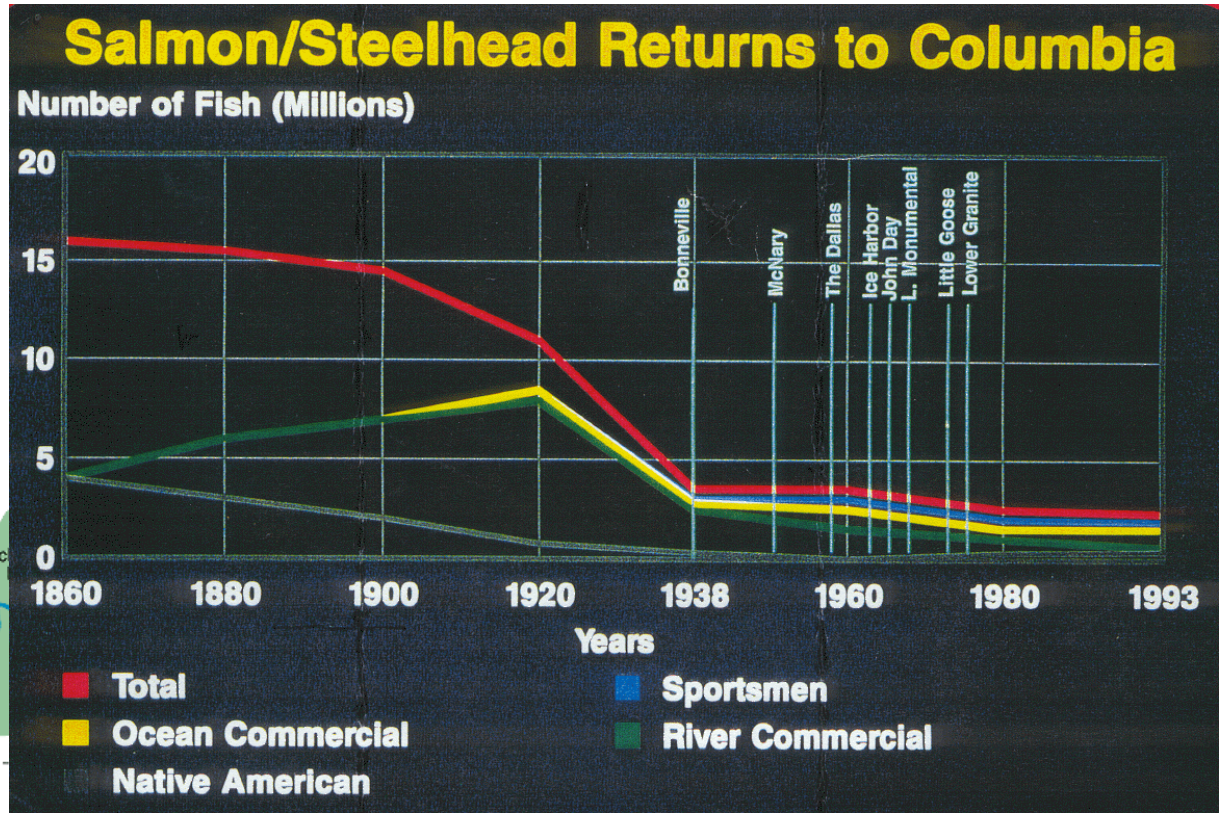
1. YtoY variability
2. Population displacement
3. Disruption on wildlife, local weather and plants
4. Fish population disruption

The Reschen Lake in southern Tyrol, Italy which covers the sunken village of Graun.

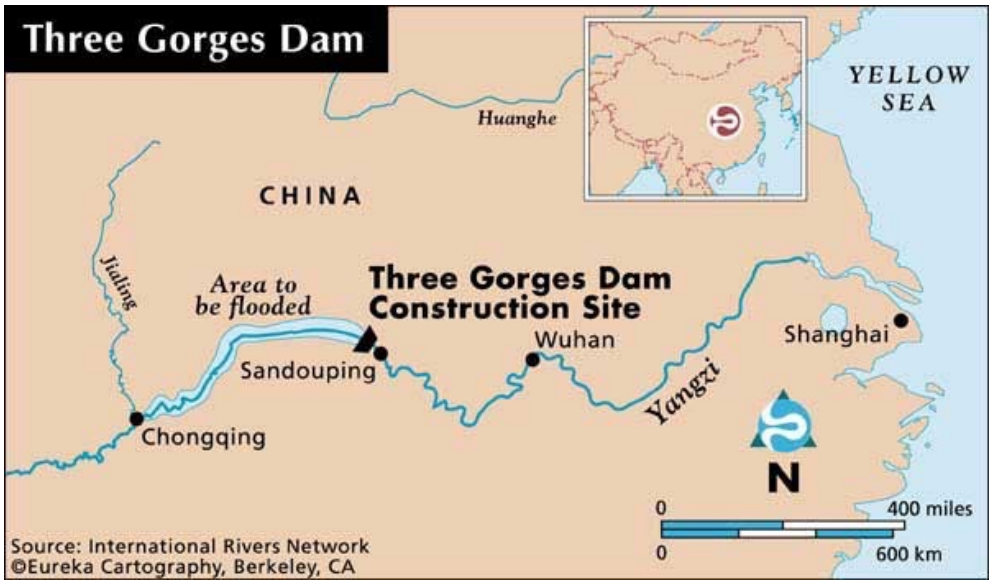
Columbia River System case (US, OR and WA)

Bonneville - 1,050MW

John Day - 2,160 MW



Three Gorges Dam, China



- 22GW
- 1.3 million people displaced
- 1994-2006

Hydro Energy Future - End

- Smaller (diversion) projects without Dams
- Energy storage (San Luis Obispo, CA)
- Q/A