

# Between wind and water: a history of humans and hydrology in the West

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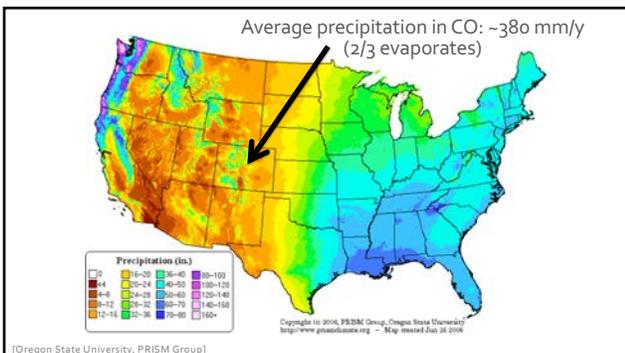
### Distribution of water by volume

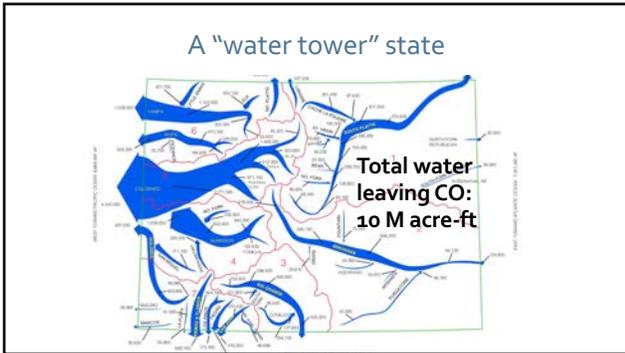
All of the water on earth as a 500-gal water truck

97% oceans

Three 1-gallon containers: 0.7% streams, lakes, groundwater, atmosphere

Two 5-gallon buckets: 2% ice caps and glaciers



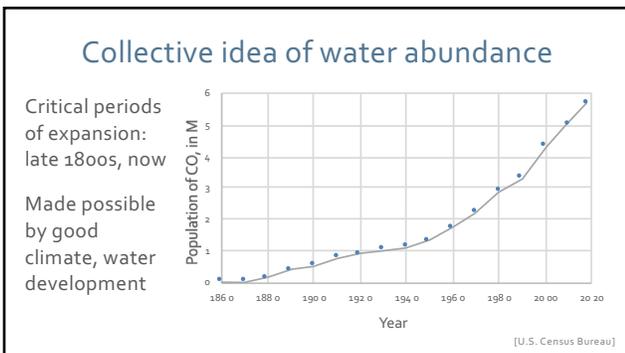
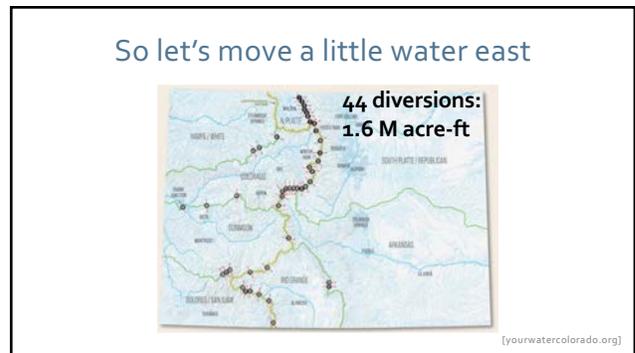
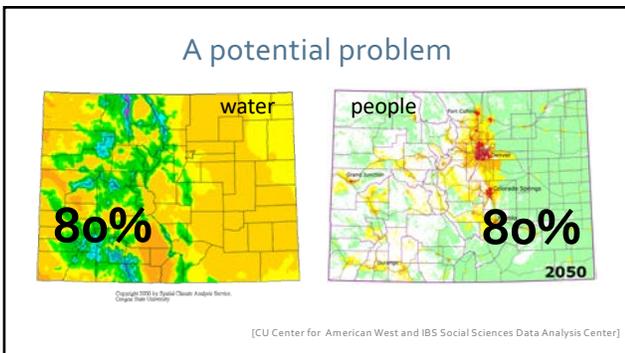


### An odd unit: the acre-foot

½ the volume of a Olympic size pool

~amount of water used by a family of 4 in a year

The diagram shows a 1-acre-foot volume as a blue rectangular prism measuring 1 foot in height, 272 feet in length, and 160 feet in width. It is compared to an Olympic pool (300 feet by 100 feet) and states that 1 acre-foot volume equals 325,851 gallons of water.



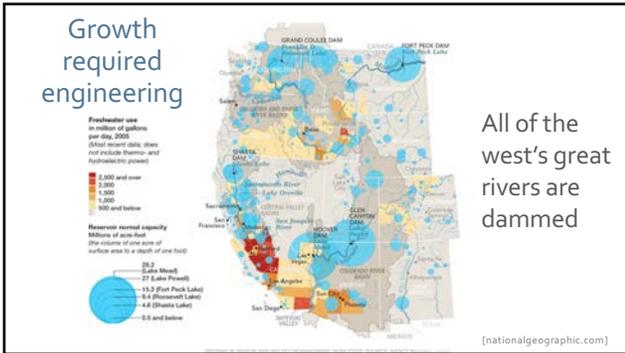
### Masking aridity

**Ataturk Dam, Turkey** [PressTV-Iran]

**Huacachina, Peru** [huacachina.com]

**Los Angeles Aqueduct** [waterandpower.org]

This block contains three images: the Ataturk Dam in Turkey, the Huacachina oasis in Peru (a desert island with palm trees), and the Los Angeles Aqueduct, which transports water from the mountains to the arid Los Angeles basin.

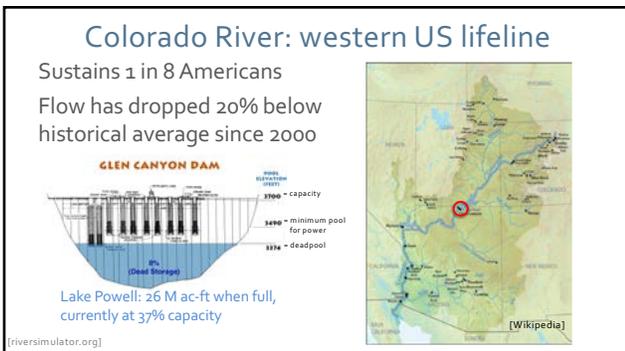


All of the west's great rivers are dammed

### There have historically been some good engineers, too

[arizonaexperience.org]

[Wikipedia]



### It hasn't been so great in the SE, either

One of the worst droughts on record:  
2005-2007

Humans try to affect the environment in whatever way we can

### Charles Hatfield

[latimes.com]

### Great Flood of 1861-1862

- Submerged entire Central Valley of CA for months
- 1/3 of state property destroyed, 1 in 8 homes washed away
- Killed 1000s of people, 200,000 cattle
- Governor, state employees weren't paid for 1.5 years

1860s: Zebulon Pike & John Wesley Powell



"Gentlemen, you are piling up a heritage of conflict and litigation over water rights, for there is not sufficient water to supply the land."

-JWP, 1893



Who needs science when you have good public relations campaigns

- Great American Desert? Great Plains!
- "Rain follows the plow"
- 1870s and 80s, 2M people moved in, was really wet
- WWI → good ag prices, 90M ac became farm land

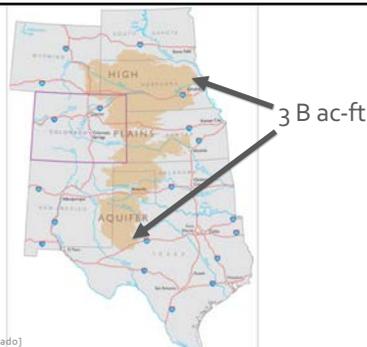


...and then, the unthinkable

Black Sunday, 14 April 1935: a wall of earth 2000' high, 200 miles wide, blowing through at 80 mph



An 8-yr drought, starting in 1930, made catastrophic by lands plowed and grazed

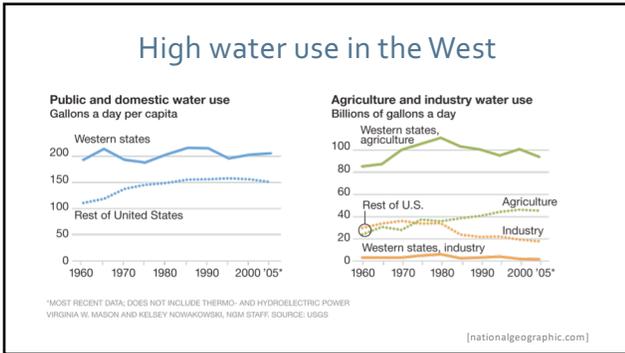


Could pump 1000+ gpm!

Extracted 20 M ac-ft/yr

Water levels have dropped 100 m in places

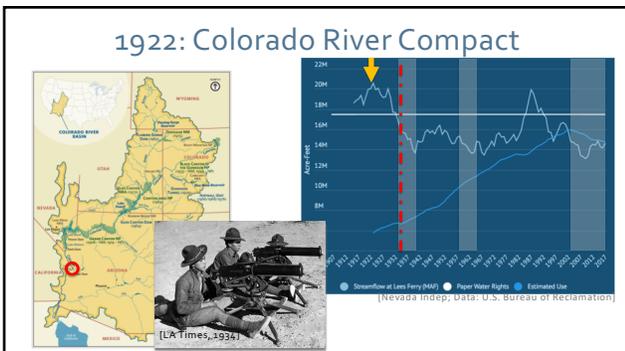




### 1882: Coffin v. Left Hand Ditch

- Prior appropriation: "first in time, first in right"
- Priority date is set when "beneficial" use started
- Rights can be lost by non-use
- What happens as climate changes and we urbanize?

[Boulder Community Network]



### Have we lost our memory?

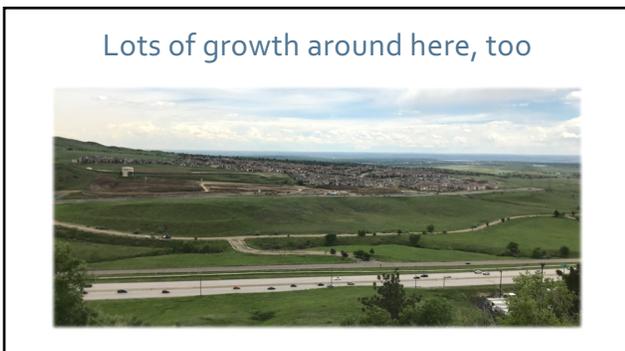
- Phoenix: the hottest, driest major city in the U.S.
- 180 mm/yr rain, 200+ golf courses, water parks

[golfadvisor.com]

[ArizonaGrand.com]

[plantbody]

[602.gov]



### DoD: At least 126 1 to cancer, birth de

By: Tara Coopp April 26

**Oglala Sioux of Engineer**  
Citiz  
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Flint water crisis  
Flint crisis, is left conti

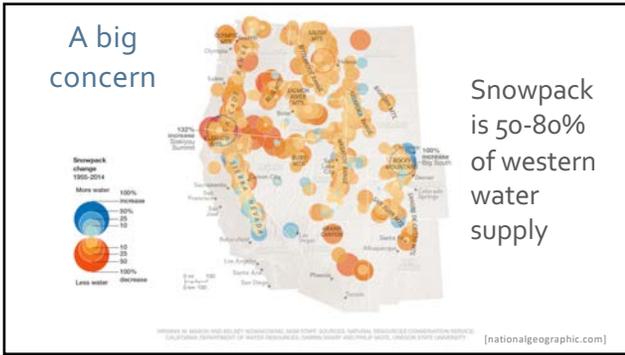
By: Liz

**Arnold** @Schwarzenegger  
I'm a simple guy so I have a simple remedy when people like Pruitt ignore or hide pollution: if you don't have a problem with Americans drinking contaminated drinking water, drink it yourself until you tap out or resign. politico.com/story/2018/05/...  
11:52 AM - May 16, 2018

metals  
pathogens  
nitrate  
fracking fluids  
pharmaceuticals  
antibacterial soap  
cosmetics  
fragrances  
cocaine  
ng to defend

**es Claim for**

EPA move on chemical study may trip up Pruitt  
Pruitt has blamed partisan witch hunts for the controversies around his spending and lobbyist ties. He'll struggle to make the same case this politico.com



### The (literal) bottom line?

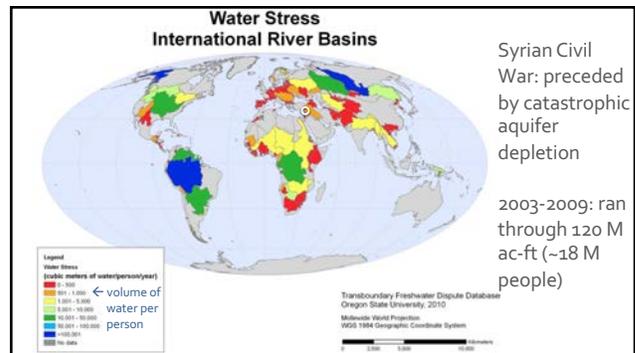
"I don't care what your water right is. If the lake goes that low, your water physically can't get to you. You know? Frame that water right. Hang it up on your wall. Admire it. It's useless."

—Patricia Molroy (former general manager for the Southern Nevada Water Authority), 2017

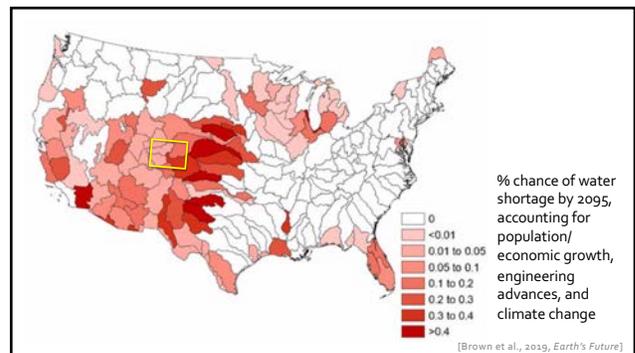
Lake Mead: 26 M ac-ft when full, currently at 42% capacity

### Tragedy of the commons?

Are the potentially renewable resources of agriculture being managed on a sustained yield basis, or are they too being "mined" of their perpetual productivity? Can this civilization of ours, situated as it is in a semi-arid land, look with complacency to a permanently productive future when history speaks so repeatedly and so eloquently of the failures of Old World civilizations nurtured in a similar desert environment? Must history repeat itself? Are we destined to follow the short road to glory and the long, painful road to poverty and decay that Mesopotamia, the Holy Land, Alexandria and Greece followed? These are questions desperately important to all of us, and to people best informed they are questions terrifying in their implications.



### Cape Town, South Africa



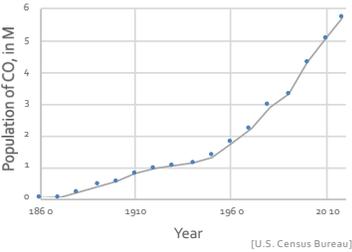
# Do we have enough water?

**between wind and water**  
 (nautical) In that part of a ship's hull which is frequently below the water surface and above water by the rolling of the ship or fluctuation of the water's surface.  
 (colloquial, by extension) At a vulnerable part or point of a ship's hull.



### How do we address a growing population and a changing climate?

“There is no lack of water here, unless you try to establish a city where no city should be.”  
 –Edward Abbey, Desert Solitaire



Population of CO<sub>2</sub> in M

Year

[U.S. Census Bureau]

### Complexity of solutions

Absurdities: prior appropriation, allocation by volume, basing laws on discredited science...but politically, not easy problems to solve

We've become dependent on the slop in the system

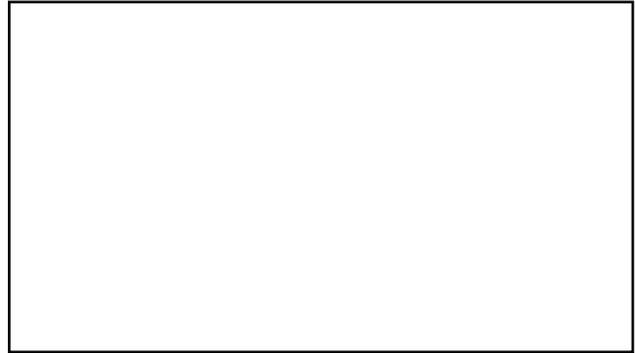
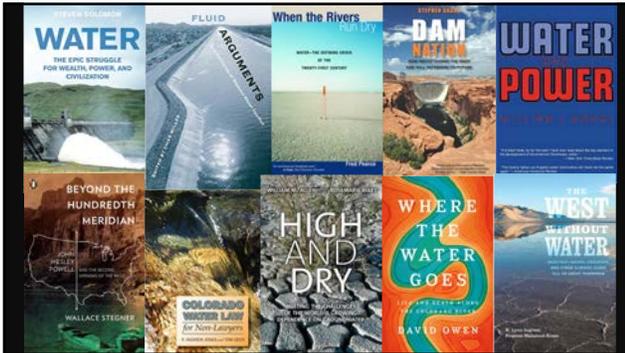


Discussing Water Rights, A Western Pastime  
 [Duckboy Postcards]

### The role of teachers, scientists, engineers

- Help with public education on complexities of water use and importance of management
- Conduct effective and independent exploration of earth systems, including long-term observations
- Quantify interactions between climate, surface water, and groundwater
- *We can't manage what we don't measure and monitor*

1 tomato 13 litres	1 potato 25 litres	1 cup of tea 35 litres	1 slice of bread 40 litres
1 glass of wine 120 litres	1 glass of beer 75 litres	1 glass of apple juice 190 litres	1 glass of orange juice 170 litres
1 cup of coffee 140 litres	1 glass of milk 200 litres	1 orange 50 litres	1 apple 70 litres
1 egg 135 litres	1 slice of bread with cheese 90 litres	1 cup of grapes 185 litres	1 hamburger 2400 litres



### Some "solutions"

- Update antiquated laws and policies—overallocation is a huge, unavoidable problem
- Develop more effective policies of water conservation
- Managing growth and development, ag efficiency
- Engineering solutions? Remove dams (thoughtfully), increase groundwater storage, develop new diversions, desalination methods, cloud seeding?
- Local solutions may be a big deal
- In all cases: need to consider timescales of consequences, engage stakeholders in decision-making