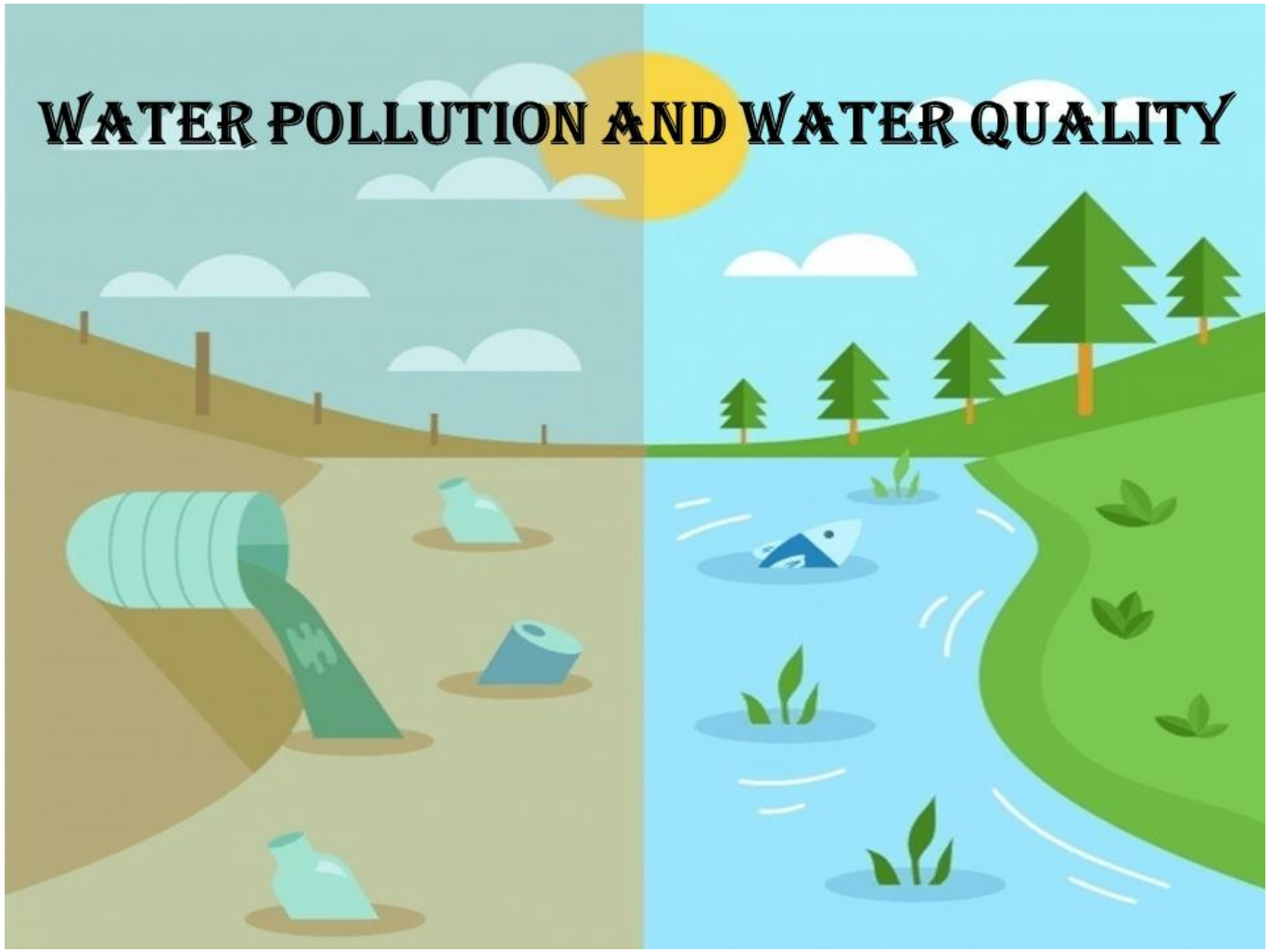

The 35th Annual Conference
EMERGING ENVIRONMENTAL ISSUES
Jacksonville, FL
August 5 - 10, 2019

Environmental Science and Policy – a road ahead

Water quality monitoring, modelling and management



Water quality monitoring, modelling and management: Current needs, challenges and opportunities.

Pete Loucks
Cornell University

Water quality monitoring, modelling and management:

Needs, Challenges, and Opportunities:

- **Improving the utility of water quality models - for management.**

Monitoring, Modeling and Managing Water Quality

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  - **applies in particular for emerging pollutants.**

Monitoring, Modeling and Managing Water Quality

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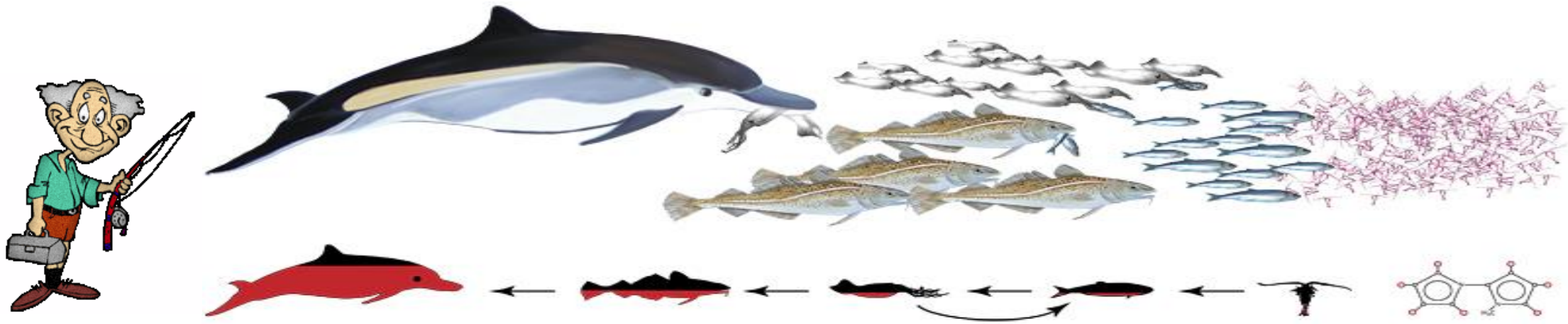
- Improving the utility of water quality models - for management.
- Obtaining sufficient data for modeling.
- Maintaining long term monitoring.
- Knowing what to monitor.
  - applies in particular for emerging pollutants.
- Modelling water quality at regional scales
  - to better understand future (regional, global) changes.
  - to quantify indicators and linkages among SDGs.

Challenges:

Major water pollutants.

1) Pesticides and fertilizers used to produce food.
2) Chemicals used to extinguish fire and make other products.
3) Antibiotics and other medicines used to treat humans and animals.
4) Plastics used in clothing, packaging, products, … just about everything.
5) Radioactive material used for energy, medicine and weapons.
6) Heavy metals used in industry, agriculture, medicines, and domestic apps.



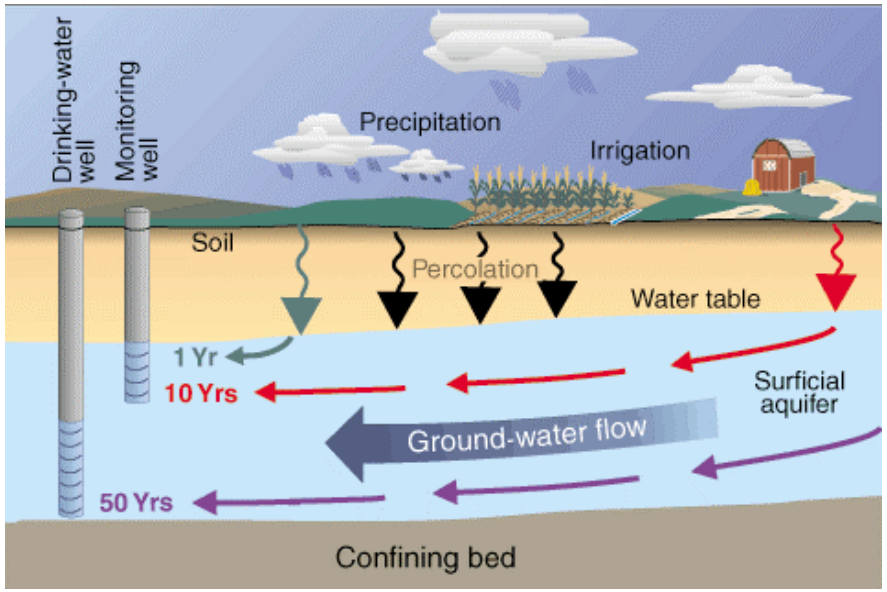
Challenges:

Major water pollution issues.

1) Pesticides and fertilizers used to produce food.

Examples:

- More than 1,000 pesticides used around the world.
- Each pesticide has different properties and toxicological effects.
- Toxicological effects of multiple pesticides can be greater than the sum of their parts.



Source: https://water.usgs.gov/edu/pesticidesgw.html

Examples:

- **More than half of the total crop production in the world is based on inorganic fertilizers and pesticides .**
- Excess fertilizers in the soil can alter soil fertility (acidity).
- Nitrogen and other chemicals present in fertilizers can degrade quality of the ground waters including those used for drinking.
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"More than 50% of the lakes in the United States are eutrophic!" USGS

Examples:

- The world's population, and its agriculture with its nitrogen-rich waste, is increasing.
- As a result, more and more nitrogen being dumped into the environment.
- Algal blooms and dead zones — as in the Gulf of Mexico or Chesapeake Bay — are on the rise.

A satellite image of algal blooms around Lake Erie of the Great Lakes, visible as swirls of green

Examples: UK

Ammonia pollution damaging more than 60% of UK land – causing >3000* deaths/yr.

Plant and wildlife habitats are the most affected.

UK Government has no clear plans to monitor impact .

18 Jun 2019

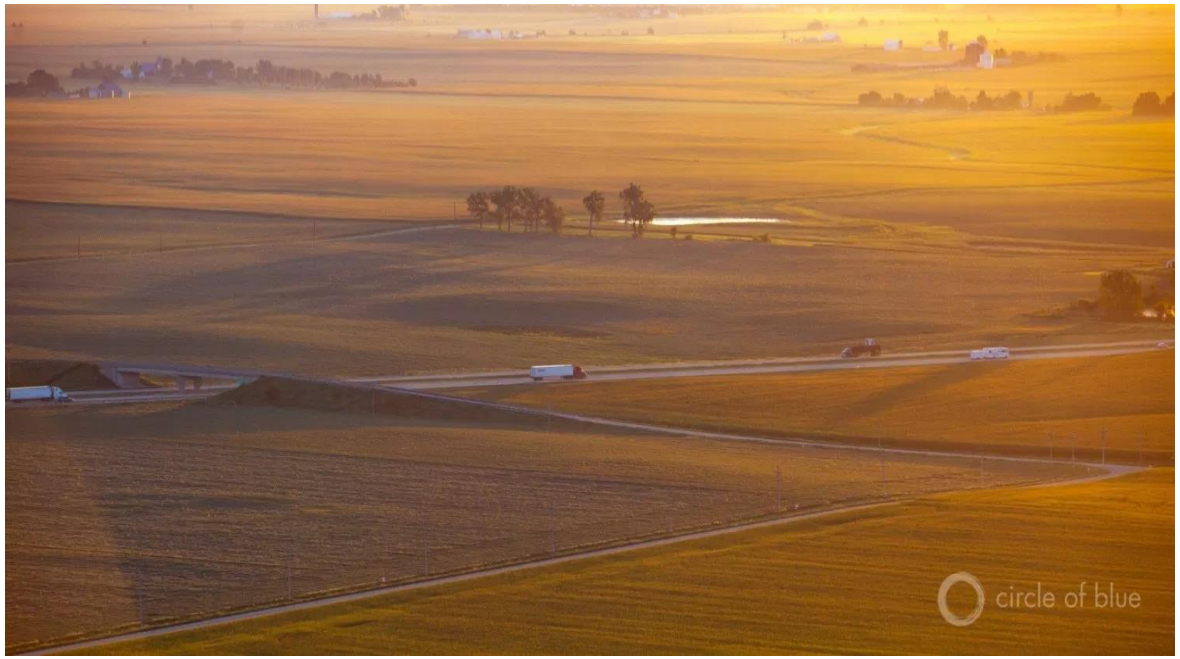
Prevented by halving NH_3 loadings

Examples:

States in the Midwest have some of the highest nitrate concentrations in groundwater because of farm fertilizers and manure.
J. Carl Ganter / Circle of Blue

Ten percent of household wells tested in Minnesota in areas vulnerable to nitrate contamination had levels above the EPA standard. USGS

Increased risk for cancers of the bladder, ovaries, kidneys, and thyroid.



Sunrise over Illinois farmland.

Examples:

“Red Tide Menaces Florida Coast” NY TIMES

Example:

- 2018 - Florida experienced one of the worst algal blooms in its history.
- “Red tide” affected 100 miles of coastline along southwest Florida.
- Red tide killed more than 300 sea turtles, 115 manatees, 48 dolphins, many species of birds, sea turtles and manatees and a variety of fish including a whale shark, goliath groupers, and tarpon.
- blue-green algae covered most of Lake Okeechobee and the estuaries of the St. Lucie and Caloosahatchee rivers.

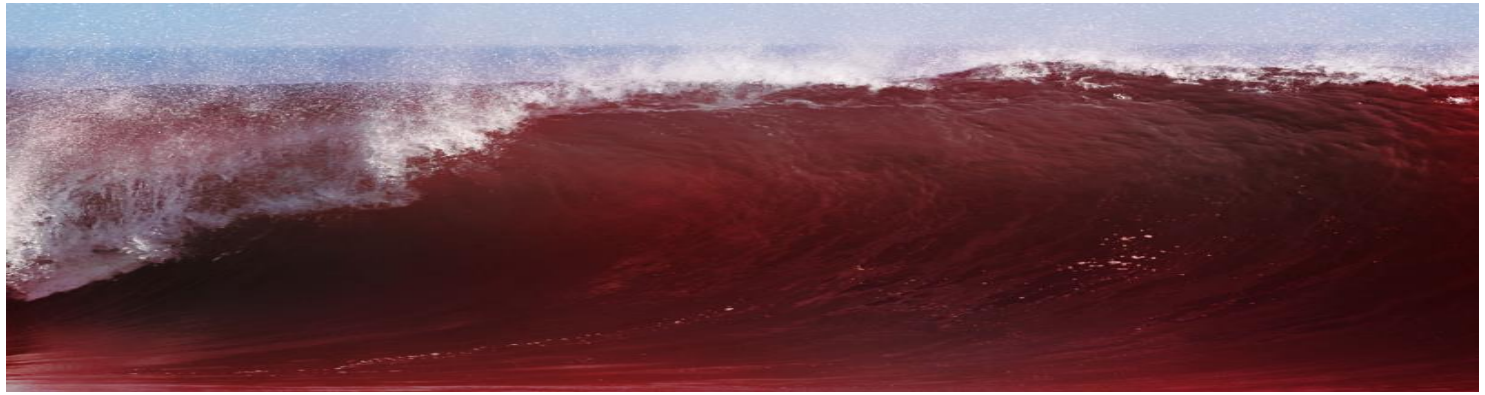
Example:

Reaction: "Florida gutted water quality monitoring – as killer algae increased."

"Over the last decade, Florida State Government:

- **fought federal efforts to protect water,**
- **shrunk its environmental and water-management agencies,**
- **cut funding to an algae task force,**
- **Decreased funding for monitoring of water quality."**

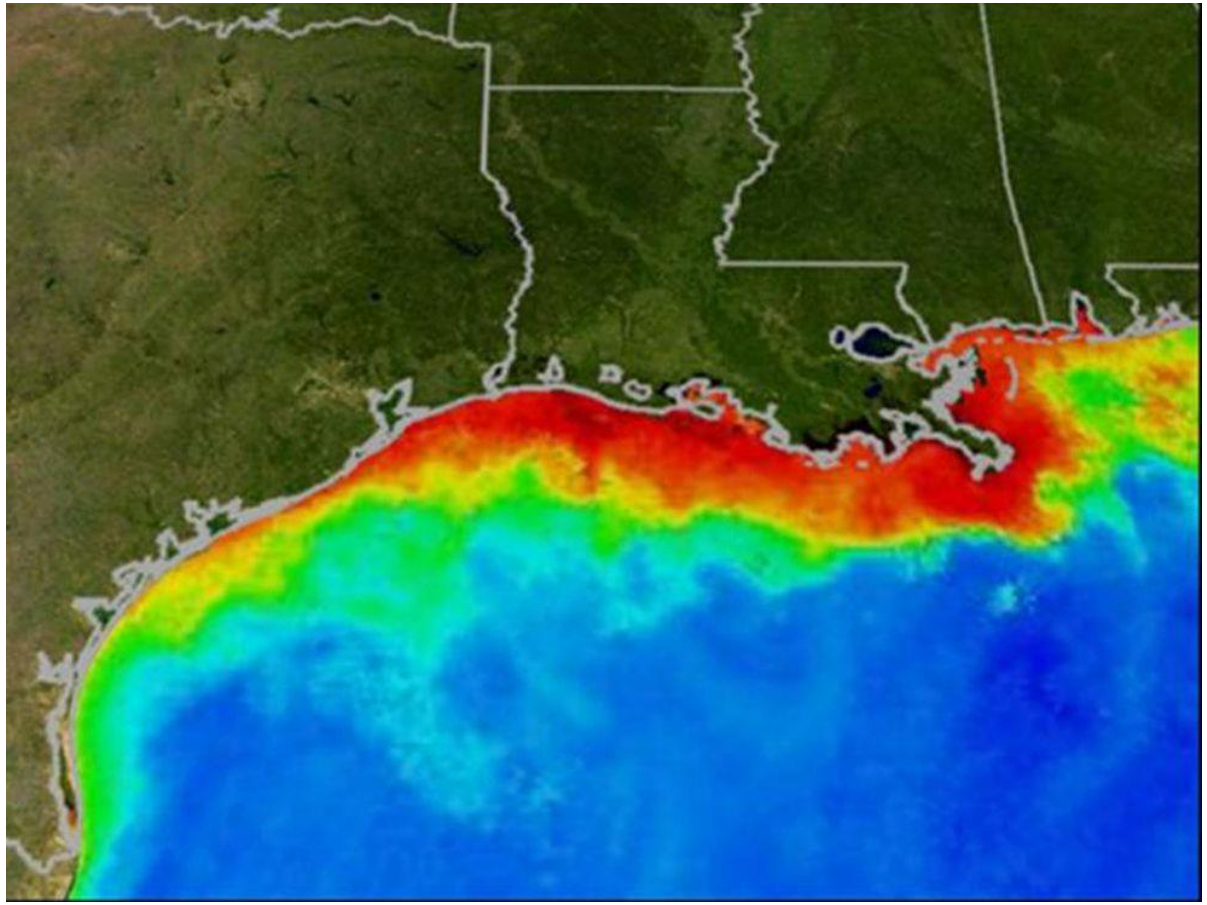
The BUZZ, Staletovich Aug. 7, 2018



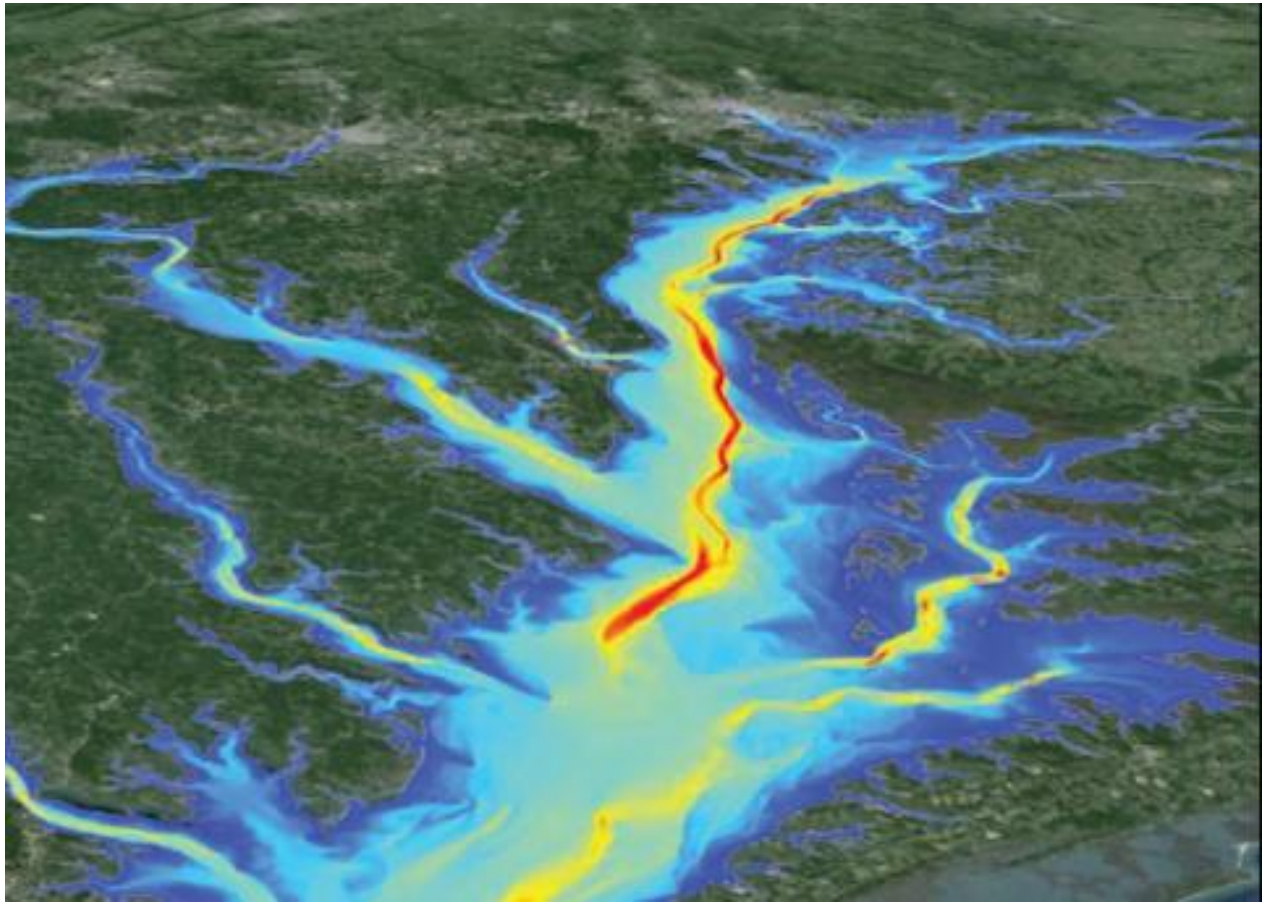
Examples:

Dead Zones: A Banner Year "a process now on steroids."

mnn.com *June, 11, 2019.*



~ 8000 sq. miles of dead fish.



Chesapeake Bay

Examples:

Climate crisis drives a record 'dead zone' in the Gulf, as hundreds of dolphins die

“In 2018, red tide killed millions of fish in the waters off Florida. This year, toxic blooms are killing dolphins, sea turtles, all the state’s oyster beds, and everything else around the mouth of the Mississippi. All Mississippi beaches are currently closed to swimming.”

The New York Times July 8, 2019

Examples:

“In 2019….?

Challenges:

Major water pollution issues.

2) PFAS Chemicals used to extinguish fire, and to produce products.

Examples:

Per- and polyfluoroalkyl substances (PFAS)—a family of nearly 5,000 chemicals.

- **PFAS are used in a wide variety of industrial and commercial products.**
- **Persistent in the environment; resistant to environmental degradation processes.**
- **Widely distributed; found in soil, sediments, groundwater, air, and tissue.**
- **Some can bioaccumulate in animals including humans,**
- **Exposure to PFAS can lead to adverse health outcomes.**
- **Sources of PFAS in waterproof clothing, shoes, tubing, gloves, insect repellent, sunblock, and even field notebooks.**

Examples:

“The toxic PFAS compounds are ‘most insidious pollutant since PCBs.’"

“US Water Quality Wake-Up Call:

Approximately half of Americans worry about lead, PFAS, microplastics and other contaminants in water supply,” Bluewater Feb 07, 2019, 17:00 ET

2.4 million People in California’s Los Angeles, Riverside, and Orange Counties exposed to toxic PFAS chemicals: U.S. EPA July 30, 2019, Desert Sun

Examples:

“Michigan’s next water crisis is PFAS - and you may already be affected.”

Examples:

As PFAS Lawsuits Proliferate, Legal Tactics Emerge

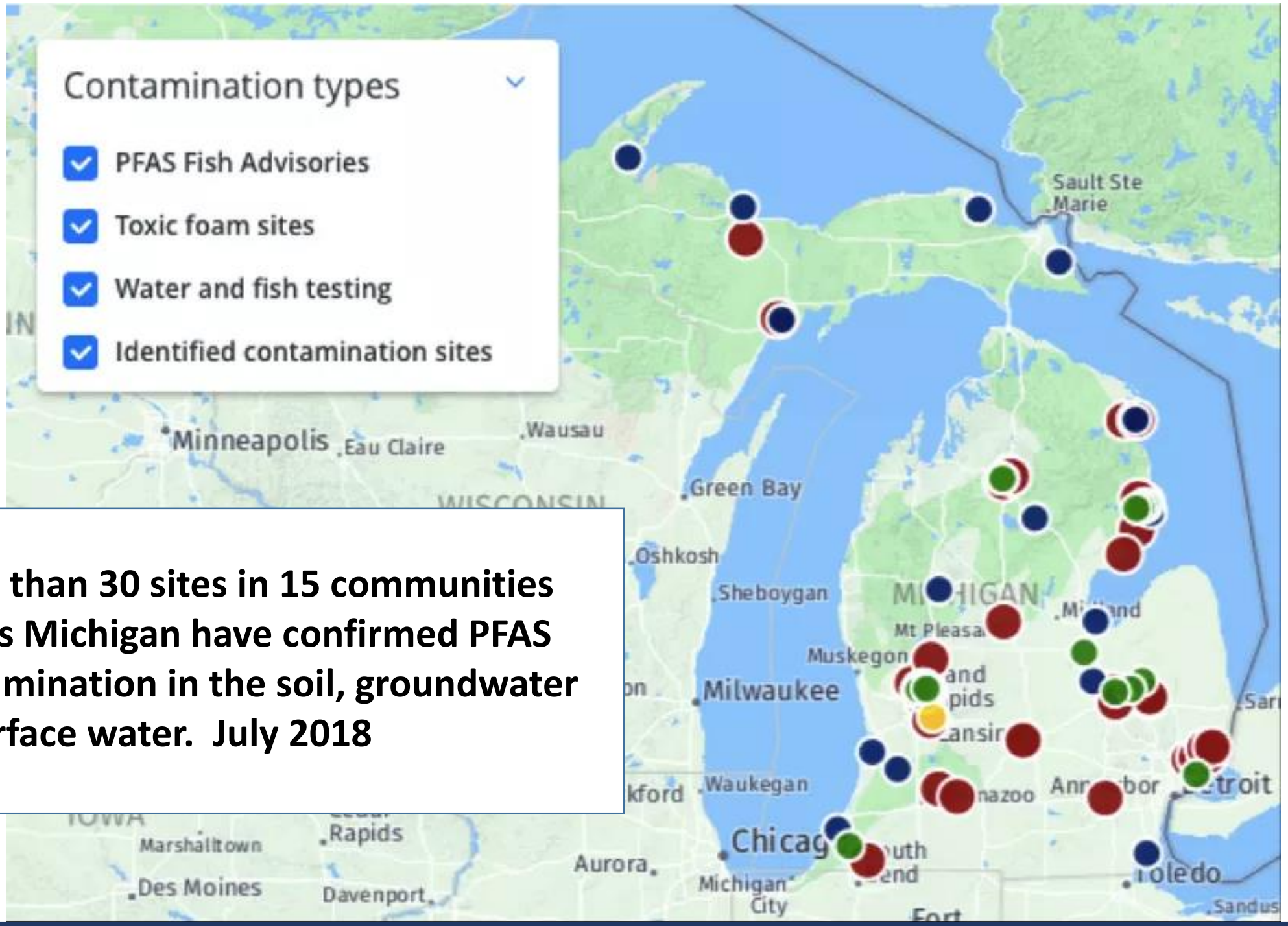
December 14, 2018/ in Water News, WEF /by Brett Walton

Individuals are suing upstream tannery for contaminating groundwater as well.

Photo © J. Carl Ganter/

Circle of Blue

Individuals, utilities, and states seek monetary compensation for chemical pollution of water supplies.



More than 30 sites in 15 communities across Michigan have confirmed PFAS contamination in the soil, groundwater or surface water. July 2018

Challenges:

Major water pollution issues.

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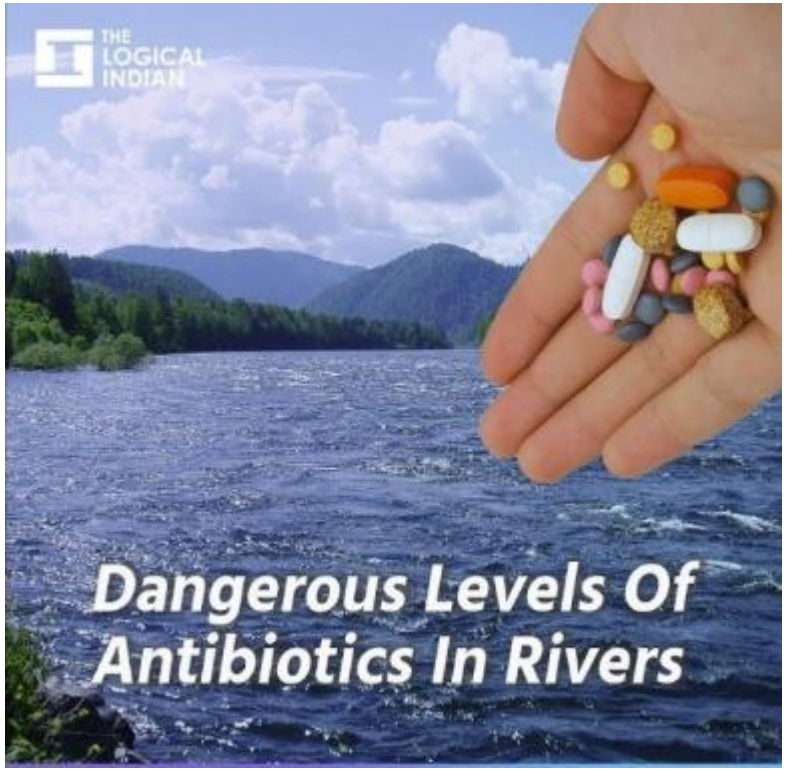

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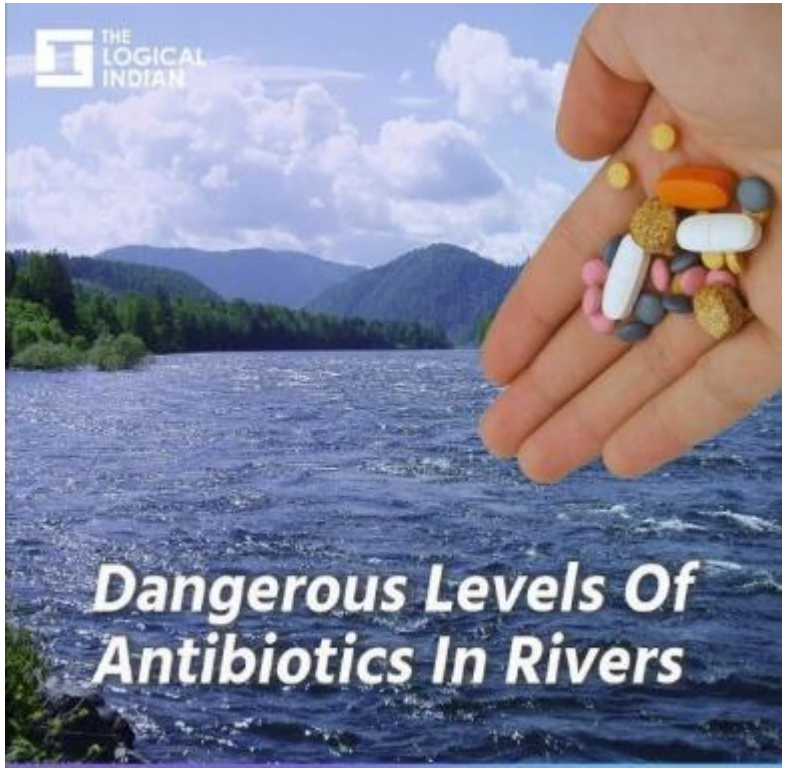
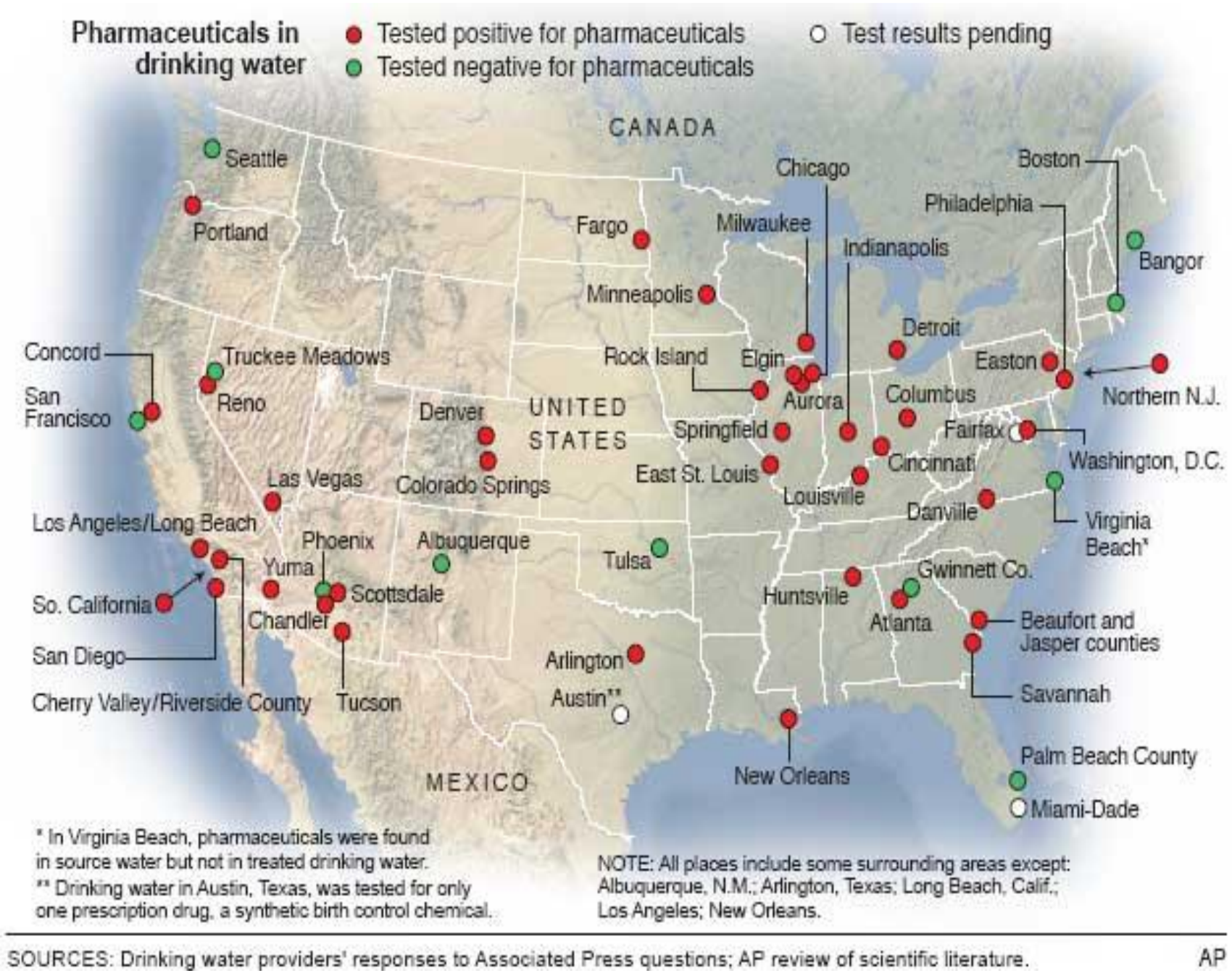
https://youtu.be/84-g3kuJ2cE



Examples:

“46 million in US have drugs in drinking water.”

2008 AP Associated Press



Examples:

World's rivers 'awash with dangerous levels of antibiotics,'

"Researchers tested 711 sites in 72 countries and found antibiotics in 65 % of them.

In 111 of the sites, the concentrations of antibiotics exceeded safe levels,

Worst cases more than 300 times over the safe limit." The Guardian, May, 27, 2019

Examples:

Seattle-Area Salmon Are Loaded With Anti-Depressants and Other Drugs.

By Elaisha Stokes Feb 24, 2016

Pharmaceuticals,
now ubiquitous in society,
and in the water,
aren't monitored.

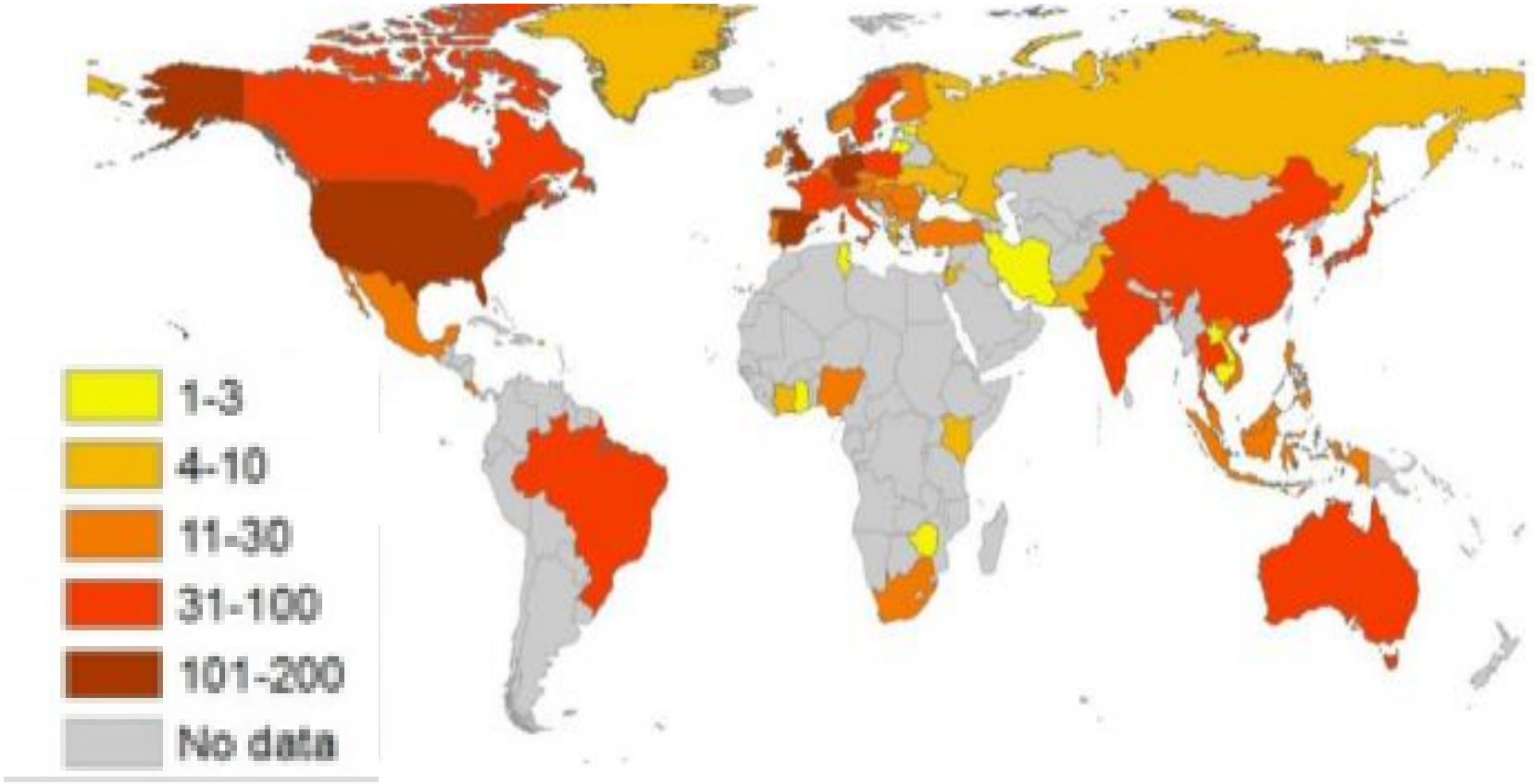
“Over 4,000 pharmaceuticals are currently in use or in development in the United States.
Many getting into rivers, streams, and lakes,
impacting wildlife, or even humans who consume fish.”

Examples:

“Increased drug use threatens aquatic environment.”

and pose health threats.

pharmaceutical substances detected in surface waters, groundwater, or tap/drinking water
(Weber et al., 2015)



The European Commission is proposing for the first time to regulate pharmaceutical pollutants in surface water, citing their potential health hazards to humans and aquatic life.

Challenges:

Major water pollution issues.

4) Plastics used in clothing, packaging, products, … everything.

Examples:

Mismanaged plastic waste 'kills up to a million people a year globally‘ WHO

Report says plastics adding to death tolls in the developing world from easily prevented diseases

Examples:

“The Amount of Plastic in the Ocean Could Outweigh Fish by 2050.”

John Dyer Jan 20, 2016

Examples:

“Beer, Drinking Water And Fish: Tiny Plastic Is Everywhere.”

August 20, 201811:57 AM ET
Heard on All Things Considered

Microplastics are in drinking water. In beer. In sea salt. In fish and shellfish.

There are microplastics on the moon!

There are microplastics in the stomachs of nearly 75 percent of mesopelagic fish caught in the Northwest Atlantic.

Examples:

It's Raining Plastic': Researchers Find Microscopic Fibers in Colorado Rain Samples

May 22, 2019/in Water News, Water Quality /by Brett Walton

"We're seeing plastics virtually everywhere we look," U.S. Geological Survey researcher says.

Plastic pollution in lakes in Rocky Mountain National Park..

Challenges:

Major water pollution issues.

5) Radioactive material used for energy, medicine and weapons.

Examples:

Radioactive water cover-up in Florida: Officials didn't warn the public for a month - NaturalNews.com *September 21, 2016*

Officials knew Floridians and guests to the state were drinking, bathing in and cooking with radioactive water.

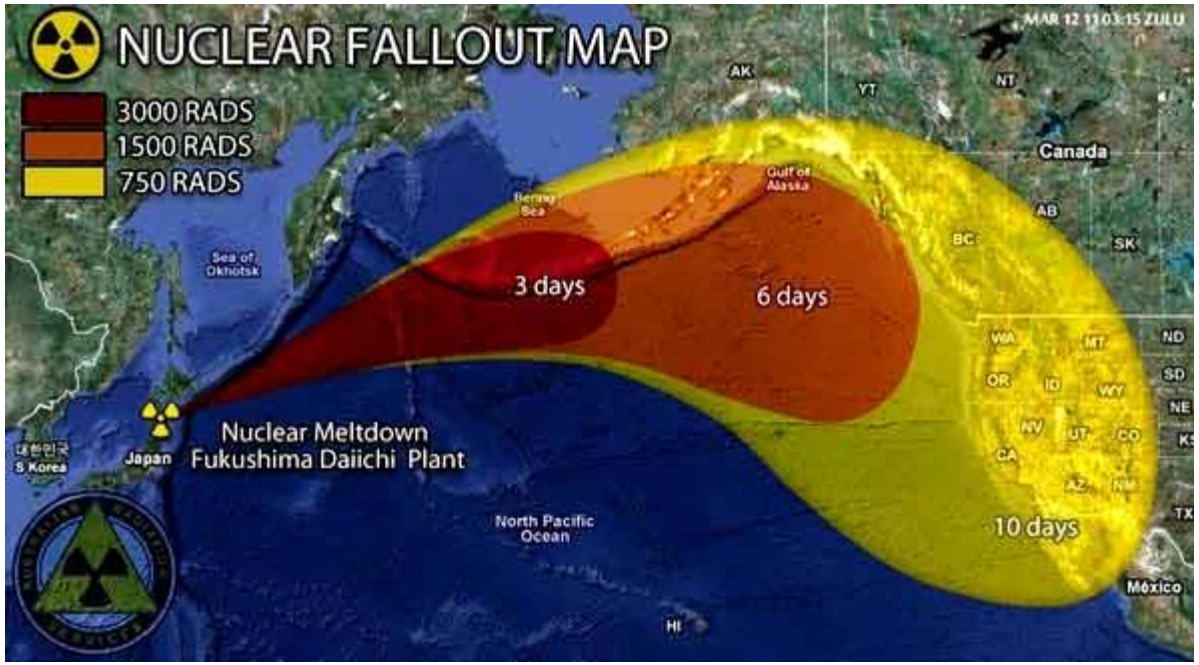
Wednesday, September 21, 2016 by: J. D. Heyes
Tags: radioactive water, EPA cover-up,
Florida sinkhole 13K
VIEWS

Examples:

New Radiation Level at Fukushima Dwarfs the Highest Peak at Chernobyl

Global Research, February 07, 2017.

Radiation will pollute the area around Chernobyl for 5 to 10 times longer than models predicted – between 180 and 320 years.



28 Signs That The West Coast Is Being Absolutely Fried With Nuclear Radiation From Fukushima

Michael Snyder Global Research, December 30, 2018

The Truth 21 October 2013

Examples:

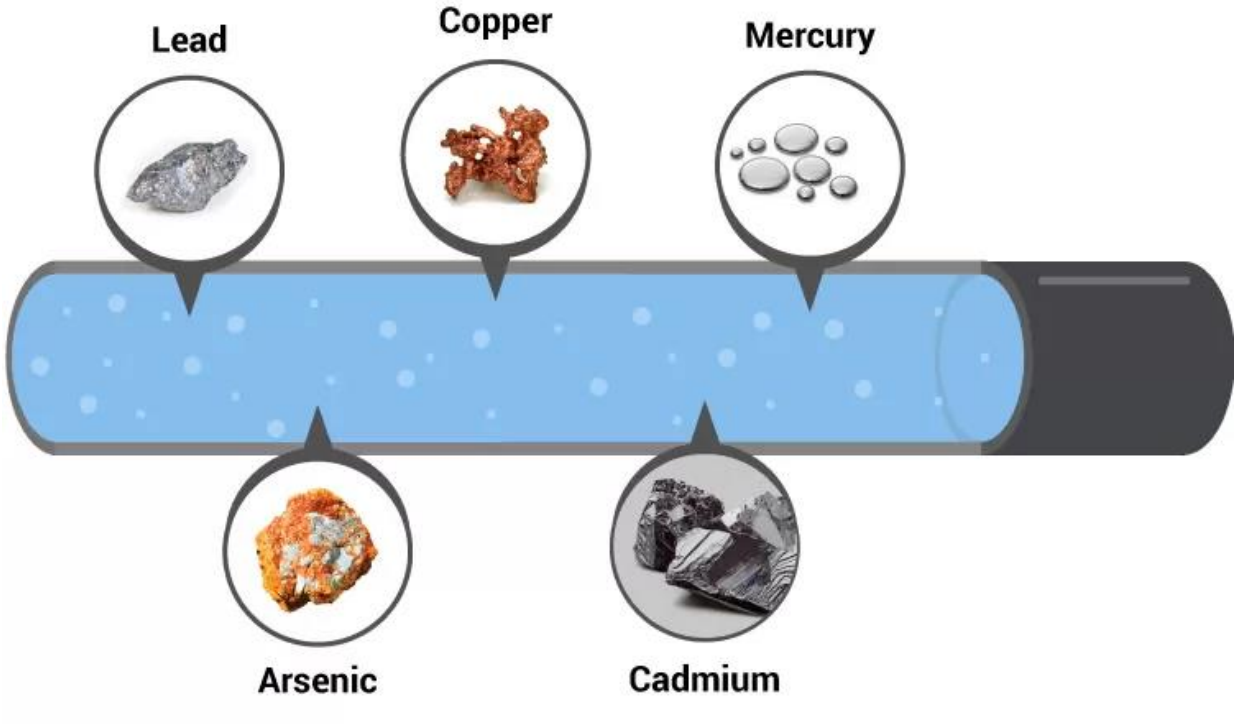
Nuclear waste: the 270,000-tonne legacy that won't go away

24.10.2012 World Nuclear Association (WNA)

Challenges:

Major water pollution issues.

6) Heavy metals used in industry, agriculture, medicines, etc.



Examples:

In Echo of Flint, Michigan, Water Crisis Now Hits Newark

Filters distributed free because of elevated lead levels in the city's water.

Sarah Blesener for The New York Times,
By Liz Leyden, Oct. 30, 2018

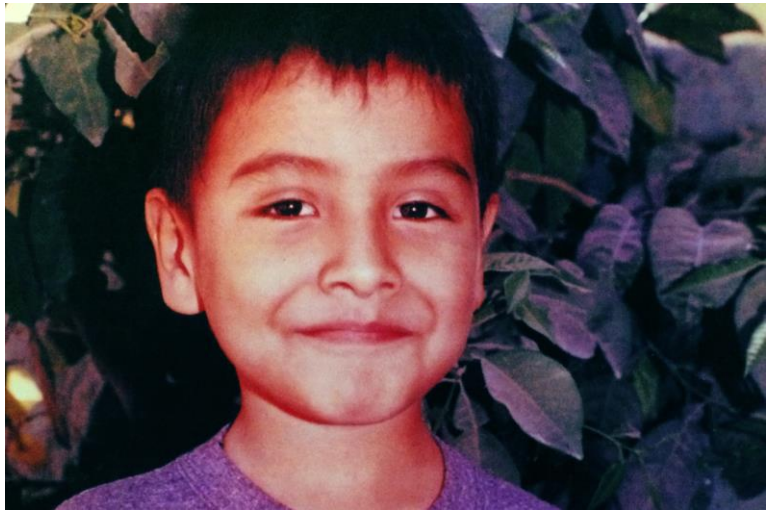
Examples:

Santiago River: “A River of Death

Most polluted river in Mexico.”

September 6, 2018

“An 8-year-old boy falls into one of Mexico’s most contaminated rivers. Eighteen days later, he’s dead.”



Examples:

“Ash decisions: North Carolina helped river-ruining Duke Energy duck pollution complaints.”

By Molly Redden on Feb 10, 2014

,

Dan River: “A River of Coal.”

toxic coal ash pits

Examples:

“According to industry's own data, more than 95% of the coal ash ponds in the United States are unlined. Almost all of them are contaminating groundwater with toxins above levels that the U.S. Environmental Protection Agency deems safe for drinking water. Earthjustice, JUL. 23, 2019

The Trump administration eased rules for handling toxic coal ash from more than 400 U.S. coal-fired power plants after utilities lobbied against regulations adopted under President Barack Obama.

Andrew Wheeler: “changes will save utilities roughly $30 million annually.”

Examples:

Rare Earth Mining

The Toxic Aftermath of Rare Earth Mining

MICHAEL STANDAERT • JULY 2, 2019

“The end impact,” Huang said, “could be on the central nervous system, cancers like bone cancer, skin cancer, and cardiovascular and respiratory issues.”

Challenges:

Major water pollution issues that continue to persist and have not yet been successfully managed.

1) **Pesticides and fertilizers.**
2) **PFAS Chemicals.**
3) **Antibiotics and other medicines.**
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Why Care: **Our own health and that of our environment and ecosystems depend on it!**

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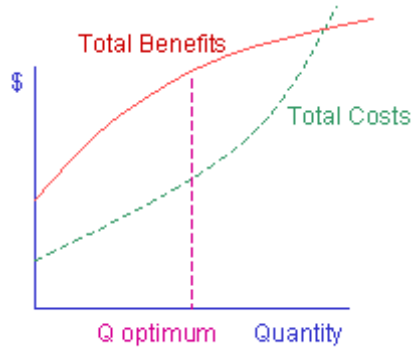
- B/C estimates would help guide policy recommendations for pollution control.



Total Benefits and Total Costs

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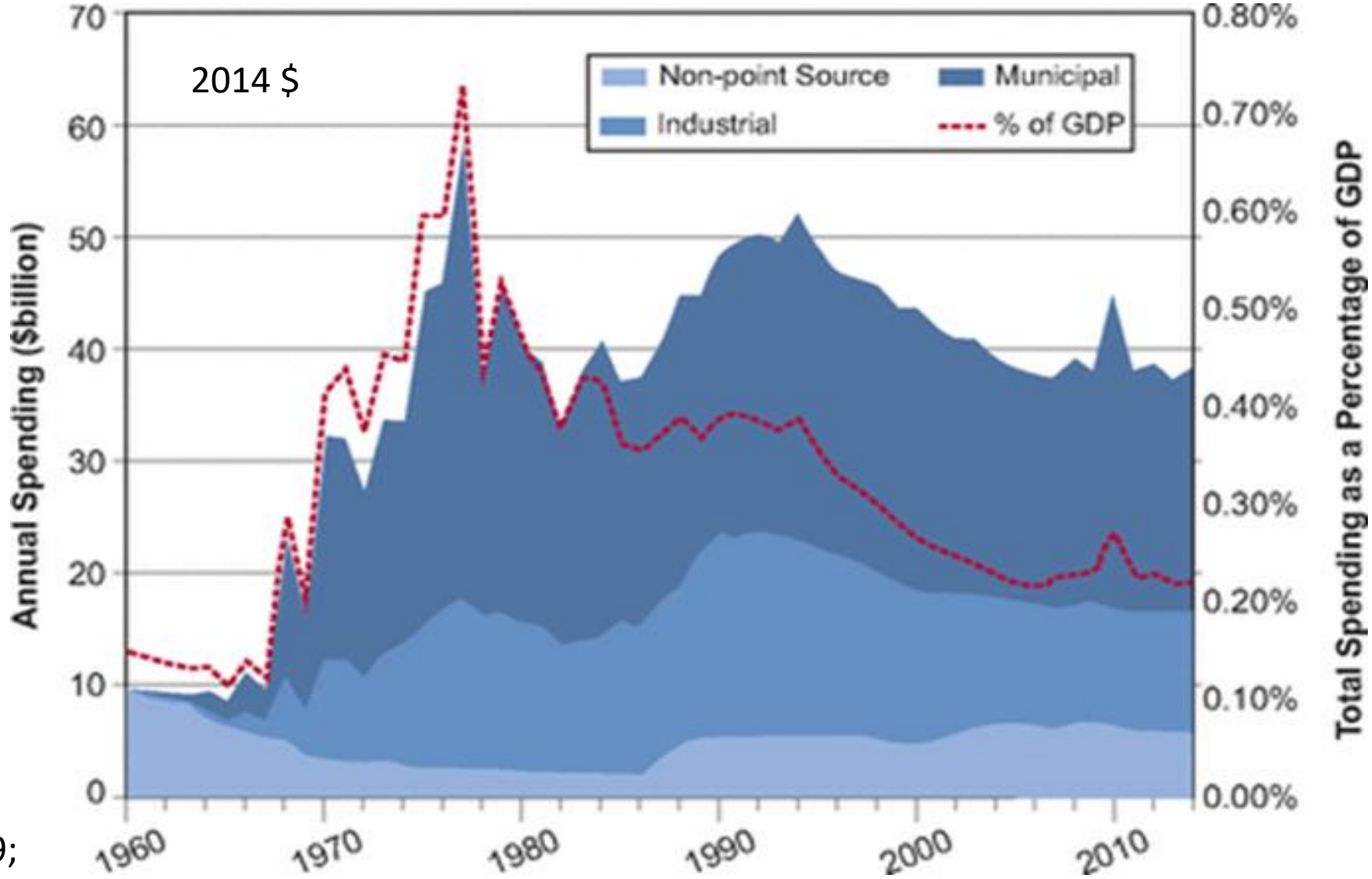
As we spend tens of billions of dollars each year on pollution issues, understanding the benefits, including human health, is as important as ever.

Do the costs of current US water quality regulations actually exceed their benefits?

Annual spending on water pollution control efforts from 1960 to 2014.

In the US, costs of energy consumption for wastewater and water utilities are already 30–60% of the total energy bill of municipalities



David A. Keiser, Catherine L. Kling, and Joseph S. Shapiro
PNAS March 19, 2019 116 (12) 5262-5269;

Example:

? Economic cost of Algal blooms in Florida?

“Water quality issues affecting the Sunshine State” include “red tide, harmful algal blooms, offshore drilling spills and fertilizers in the Everglades and Florida Bay.”

Question: What is the harm these deliver to Florida’s economy and public health, expressed in $?

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"Water quality issues affecting the Sunshine State" include "red tide, harmful algal blooms, offshore drilling spills and fertilizers in the Everglades and Florida Bay."

Question: the harm these deliver to Florida's economy and public health."

- **In 2016, harmful algal blooms drove away half of would-be Florida tourists, according to a University of Florida's Tourism Crisis Management Initiative study.**

- **That 2016 summer and 2018 summer, the governor declared a state of emergency for several counties.**

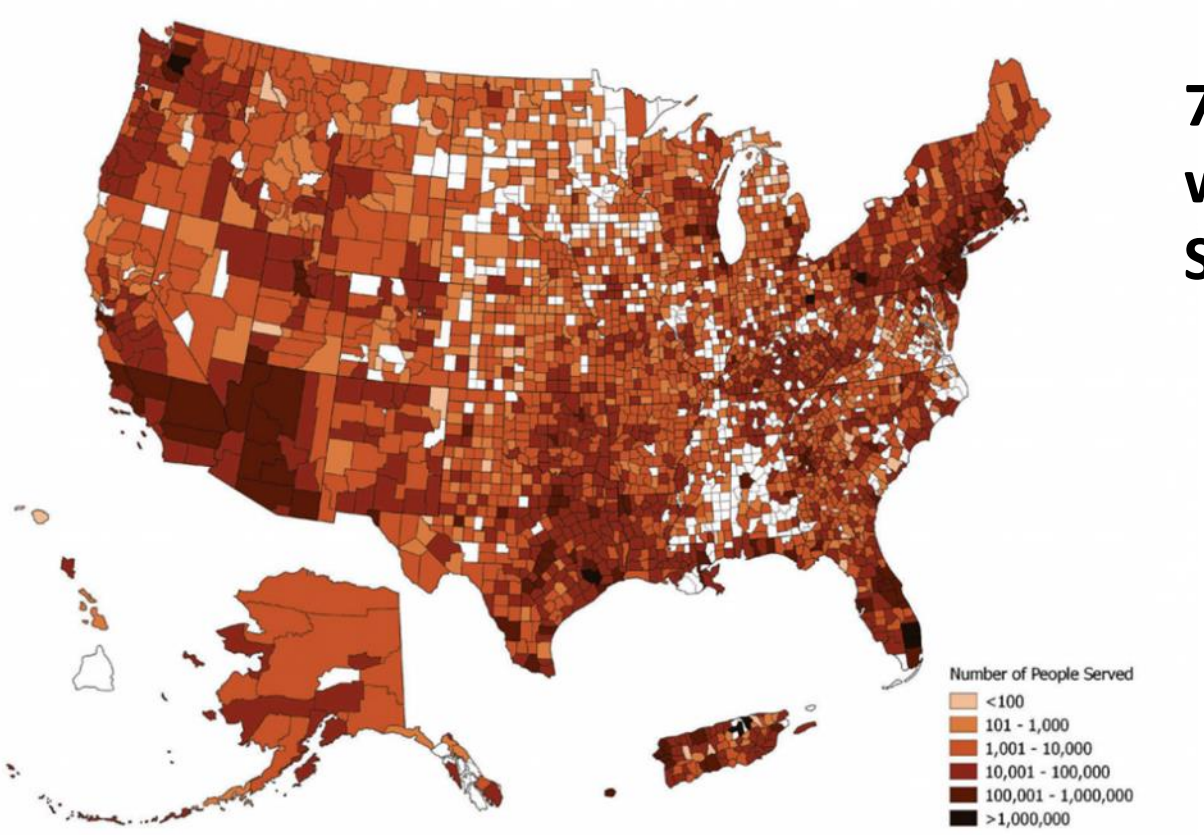
- **A 2015 Florida Realtors report concluded pollution in the Caloosahatchee and St. Lucie river systems negatively impacted home values.**

Political Reaction:

- Over the past decade, many protections eliminated or weakened,
- Many regulations replaced with voluntary and unenforceable “best management practices”.
- Budgets and personnel of environmental regulatory and monitoring agencies cut.
- Opportunities to acquire conservation lands ignored.
- Oversight of local growth management vanished.
- Required inspection of septic tanks stopped.

Since 1987, local Emerald Coast citizens organized more than 30,000 volunteers to remove 100 tons of debris from its beaches.

Unsafe Drinking Water?

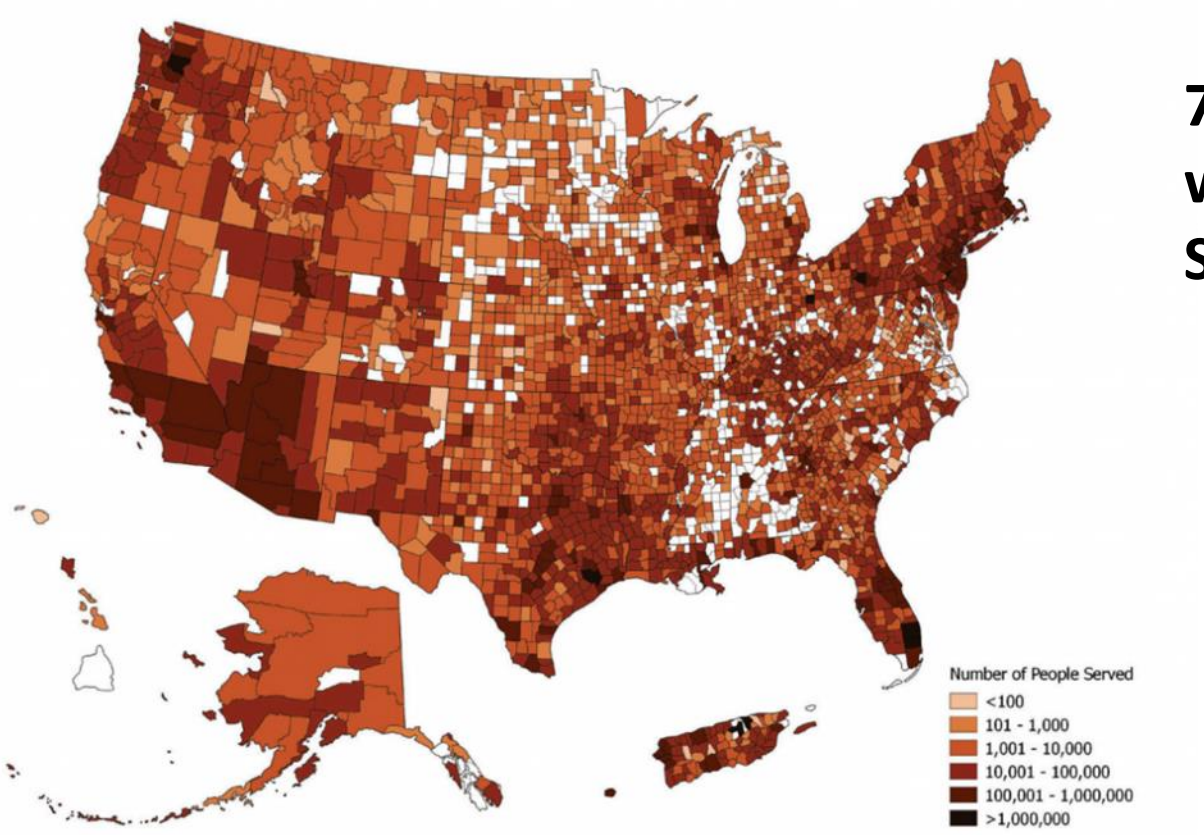


76.9 million people served by community water systems with reported violation of the Safe Drinking Water Act (2015).

“Approximately half of Americans concerned about lead, PFAS, microplastics, drugs and other contaminants in water supply”

NEWS PROVIDED BY
Bluewater
Feb 07, 2019, 17:00 ET

Unsafe Drinking Water?



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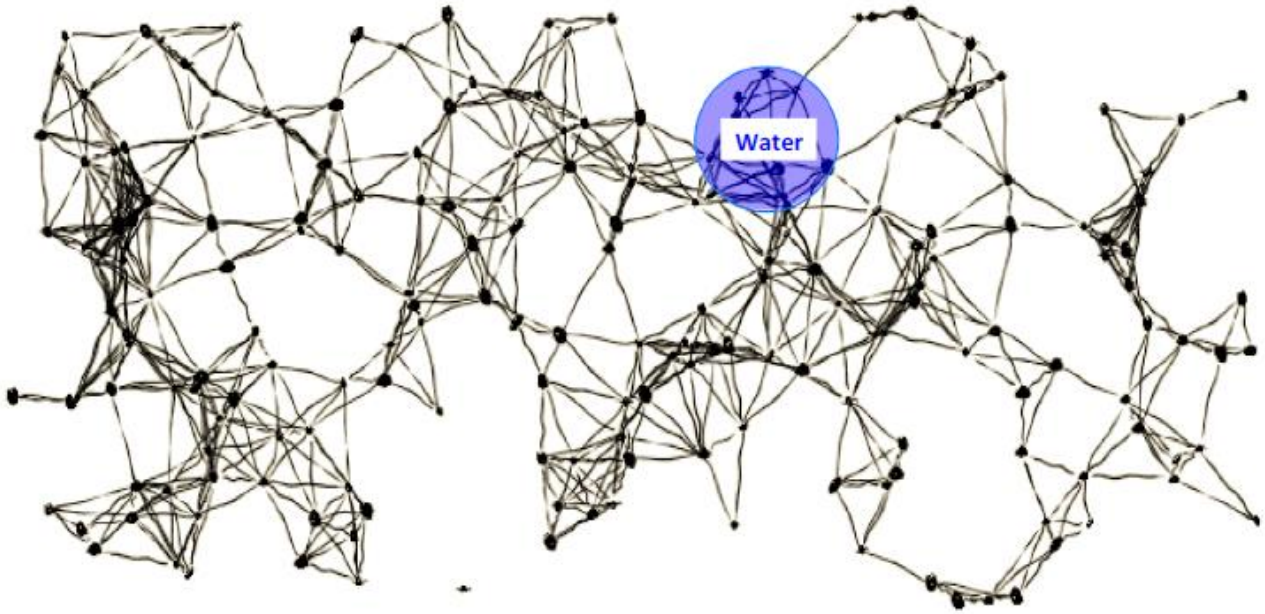
Feb 07, 2019, 17:00 ET

11 December 2018: EPA rolls back decades of Clean Water Act protections.

Water sector (system) within a complex human-natural system-of-systems.



Water: **Critical for life and everything we do or make.**

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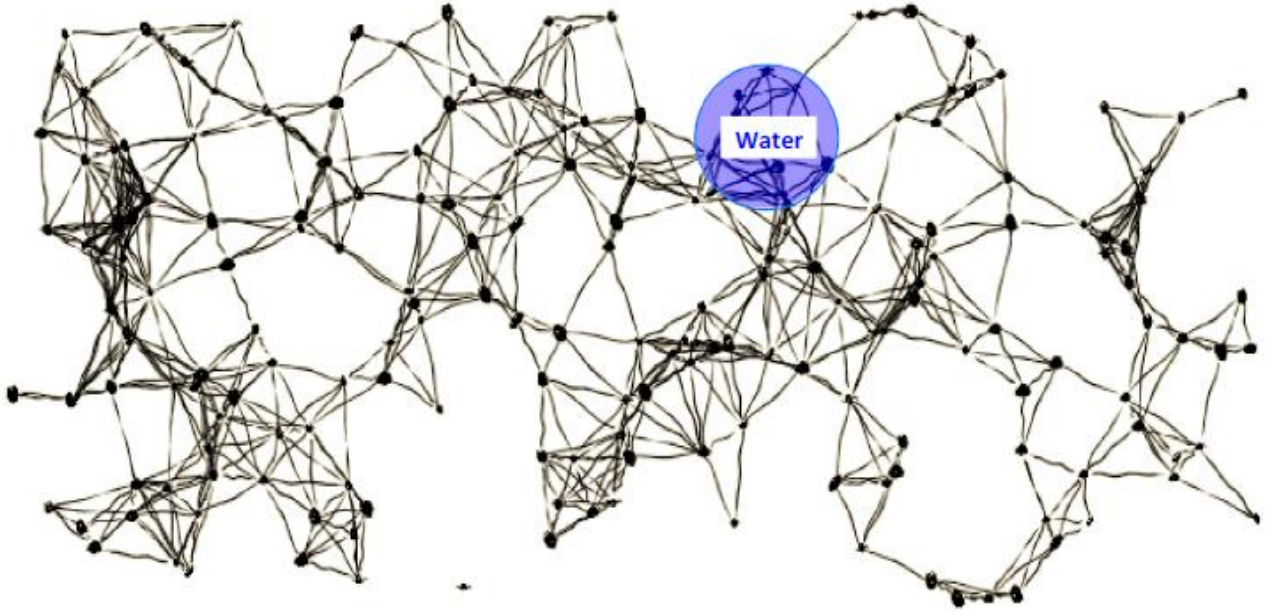

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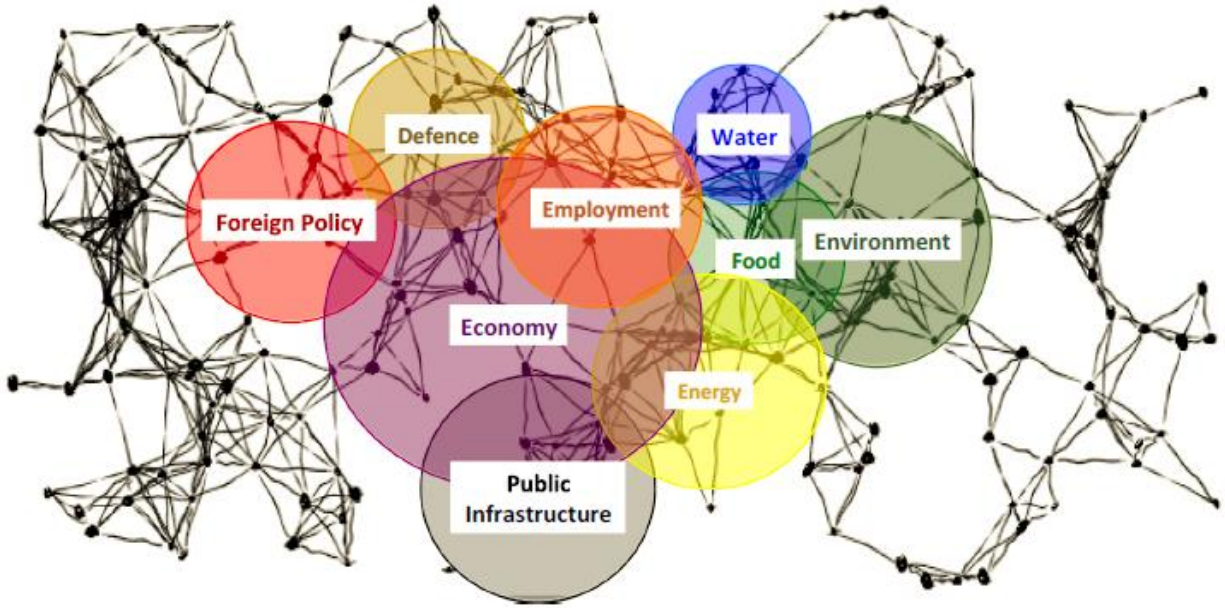

But: Water is a relatively small component of a large system-of-systems

and not normally a top public policy issue.

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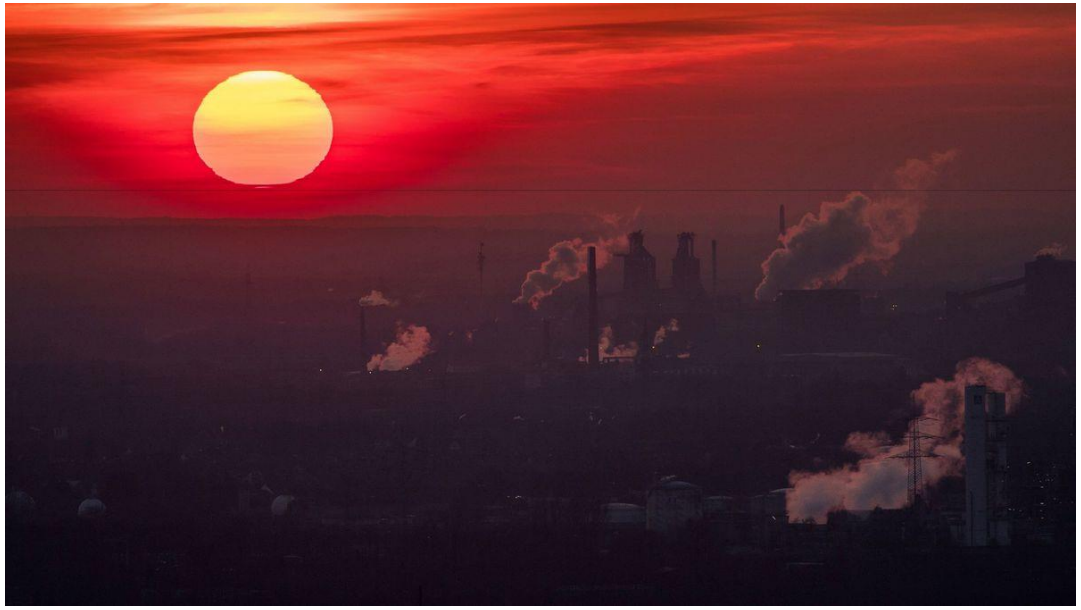
- **Do we need an extreme event or disaster to give us the opportunity to improve our nation's or the world's water quality?**
- **Extreme water related events can create a sense of urgency about water management and generate the political will to do something about it.**
- **Is the risk of complete collapse (e.g., Aral Sea or Lake Urmia desiccation or the drought-relevant security crisis and mass migration in Syria) make this type of reactive interventions worth waiting for, or planning on?**



Good news?

- U.S. Senator and presidential candidate Kamala Harris introduced the **"Water Justice Act,"** a bill aimed at **improving countrywide access to safe drinking water.** *PBS Newshour*
- California Gov. Gavin Newsom signed a measure to have the state allocate **more than $1 billion** over the next decade **to assist** poor communities with **water system maintenance**. Across the state, approximately 1 million residents cannot reliably access clean drinking water, according to the governor's office.
- Dr. Mark T. Esper, the new U.S. Secretary of Defense, has **launched a PFAS task force to investigate the presence of toxic chemicals** at hundreds of military bases across the country. Esper said that the Department of Defense plans to aggressively address the contamination and its effects. *MLive*
- NOAA seeks to define a **harmful algal bloom** of **"national significance."**
- The U.S. EPA has established health advisories for PFOA and PFOS in drinking water at 70 parts per trillion. They are part of larger group of compounds known as perfluoroalkyl substances (PFAS).
- **California** is considering a bill that would make it the **first state to** require that water agencies **notify their customers if PFAS chemicals** are detected **in their water supply**. *Desert Sun*

But:

- On July 12, the EPA submitted to the White House for final legal review its definition of which waterways are protected under the Clean Water Act. **reducing protections for rivers, wetlands, and intermittent streams.**
- The EPA submitted its revision of the federal Lead and Copper Rule on June 6.

Thanks!

Gracious!