

Water Quality in the Central Plains: Challenges, Risks, and Opportunities for the Future

Jesse E. Bell, PhD

Claire M. Hubbard Professor of Water, Climate and Health
Director, Water, Climate and Health Program at UNMC
Director, Water, Climate and Health at Daugherty Water for Food Global Institute
UNMC College of Public Health
UNL School of Natural Resources





Water Quality & Health

Water Quality & Health in Nebraska



WATER QUALITY

Nebraska's nitrate problem is growing worse and it's likely harming our kids

Yanqi Xu Flatwater Free Press Oct 28, 2022 Updated Dec 5, 2022 8

Nebraska's nitrate problem is serious, experts say. Can we solve it?

Matthew Hansen and Yanqi Xu Flatwater Free Press Dec 31, 2022 Updated Jun 5, 2023 1

EDITOR'S PICK TOPICAL TOP STORY

FIGHTING NITRATES

Clean water doesn't come cheap: Nebraska towns are shelling out millions to treat nitrate-laced drinking water

YANQI XU Flatwater Free Press Dec 15, 2022 Updated Jan 20, 2023 3

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Researchers detect insecticides in water, home near troubled Nebraska ethanol plant

Nancy Gaarder Jun 16, 2022 Updated Aug 24, 2022 3

Nitrates A Costly, Persistent Problem For Small Towns

by Grant Gerlock, NET News/Harvest Public Media



Cover crops like this rye grass growing in a harvested field of corn can allow farmers to use less fertilizer. (Photo by Grant Gerlock, NET News/Harvest Public Media)

Listen to this story: 03:25 / 04:36

October 23, 2015 - 6:45am

Nitrogen fertilizer on farm fields helps crops grow. But if there's too much left over in the soil, it can pollute water supplies as nitrates. A big city lawsuit in Iowa over nitrates has grabbed headlines, but many small towns have the same problem.

Earlier this year, Des Moines, Iowa, [made news](#) when the city announced it would sue farmers in a legal battle over fertilizer. The city's water supply from the Des Moines and Raccoon Rivers often surpasses the [legal limit for nitrates](#) (10 mg/L), which commonly appear in water contaminated by runoff from farm fields.

Too many nitrates are a health hazard, particularly for infants whose blood can lose its ability to absorb oxygen. So nitrates must be reduced or removed, but cleaning nitrates from the city's water is a huge expense. When nitrate levels rise above the safe drinking water limit, Des Moines fires up [a filtering system that costs thousands of dollars to operate](#) each day.

Des Moines is unusual, though. In most cases, nitrate pollution is not a big city problem. It's most often a small town problem, says [Bruce Dvorak](#), professor of environmental engineering at the University of Nebraska-Lincoln.



Creighton, Nebraska water operator, Kevin Sornhisen, stands before the \$1.3 million water filtering system.

"Nitrates in drinking water is the most common source water problem in the region," Dvorak said. "And for many small towns this is a very major cost issue. It may mean water rates, if they're lucky, only *double*. And some cases it may go up by eight to ten times."

That's the case in Creighton, a small town in northeast Nebraska. Creighton installed a \$1.3 million water filtering system in 1993 to reduce nitrate levels in town's drinking water. It has been running ever since, pulling nitrates out of about 300,000 gallons of water per day.

Omaha World-Herald
MIDLANDS
SUNDAY MAY 3, 2020
SECTION B



Water from this spring-fed spigot runs constantly in downtown Steele City, according to Margo D'Angelo, who owns a bar across the street. She says residents fill up water jugs from the spigot every day. Steele City, with a population of 58, has been under a state order to find a clean water source since 2007.

Nebraska towns pay more for water

Communities are collectively paying millions of dollars to fight nitrate contamination as they watch their bills increase

By JESSICA FARREN WALSH
SPECIAL TO THE WORLD-HERALD

Residents in Nebraska towns as big as Hastings and as small as Ghent have one thing in common these days: higher water bills.

That's because a growing number of communities, most of them small, are spending collectively millions of dollars to build water pipelines to other towns or drill test wells or permanent wells because nitrate contamination has made their water unsafe to drink under federal standards.

In one of many examples, Edgar, with a population of about 400, is building a water line to Fairfield, about 12 miles

away, at a cost of \$2.98 million. While federal grant and loan money is covering the costs, residents face higher water bills.

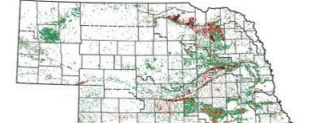
Nearly 33,000 Nebraskans are affected by nitrates in their drinking water. Nitrates are seen as a public health danger because excessive amounts can cause blue baby syndrome, which reduces the amount of oxygen in the blood. Some researchers believe nitrates in the groundwater also have a link to some types of cancer. Nebraska's age-adjusted pediatric cancer rate is the highest in the Midwest and seventh-highest in the country.

See Nitrates: Page 2

NITRATE-N CONCENTRATIONS IN NEBRASKA
Most recent recorded concentrations of 18,299 wells from 1999-2018

Nitrate Levels

0.01 to 7.49 mg/L 7.5-9.99 mg/L 10-20 mg/L More than 20 mg/L



NOTE: Empty areas indicate no data reported, not the absence of nitrate in groundwater.
SOURCE: Quality-Assessed Agricultural Database for Nebraska Groundwater, 2019 THE WORLD-HERALD

Nitrate & Drinking Water



Percentage get their home water from groundwater

- 85% of Nebraska
- >75% of Iowa
- ~70% of Kansas
- 33% of Missouri

Residents get their water from private wells

- >360,000 Nebraska residents
- >230,000 Iowa residents
- >150,000 Kansas residents
- >800,000 Missouri residents

Sources: Nitrogen fertilizers, animal and human waste

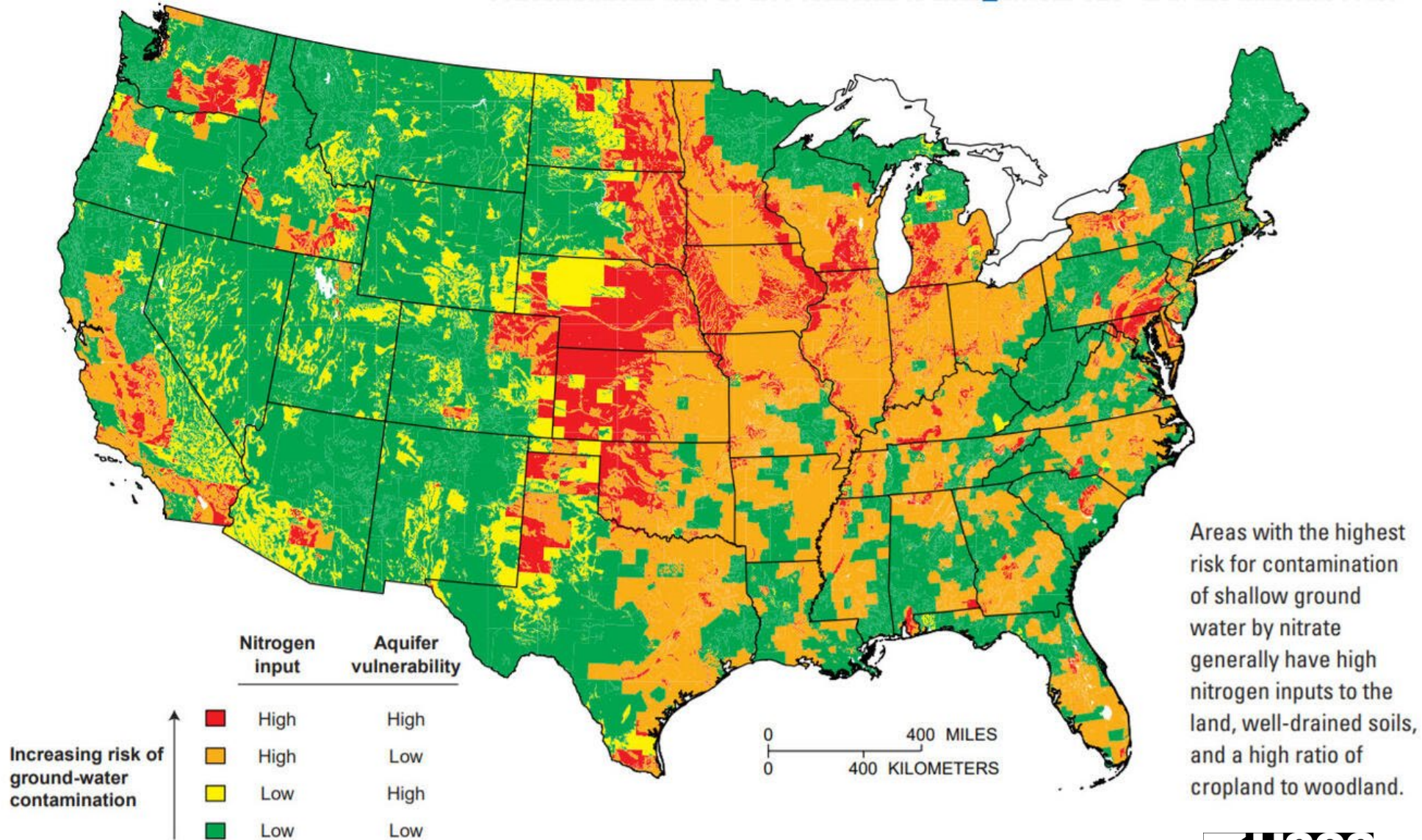
Regulatory limit: 10 mg/L as NO₂-N (USA)

Greatest exposure

- Agricultural areas
- Private wells
 - Not regulated
 - Sparse measurements

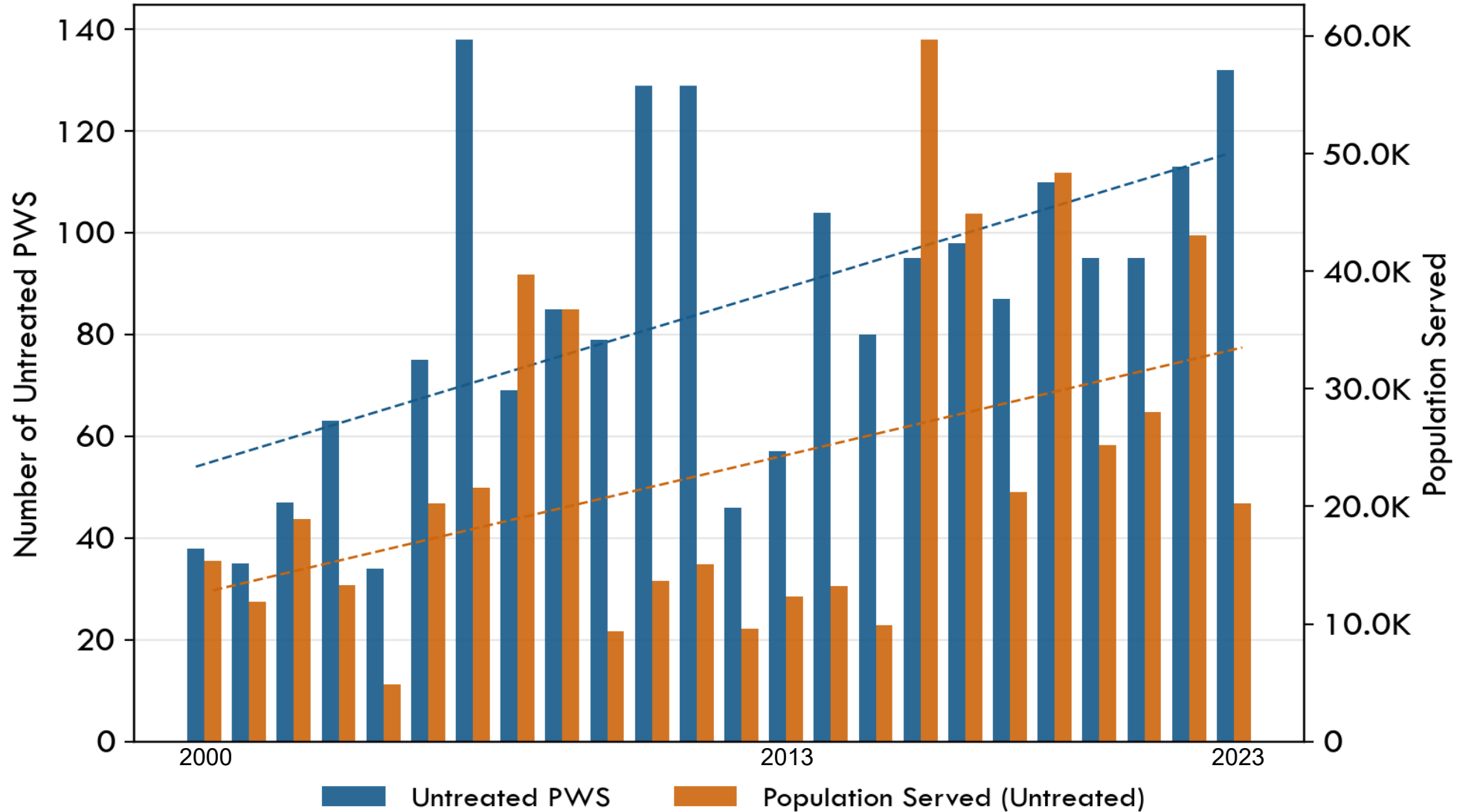


Areas of Highest Risk of Nitrate Contamination

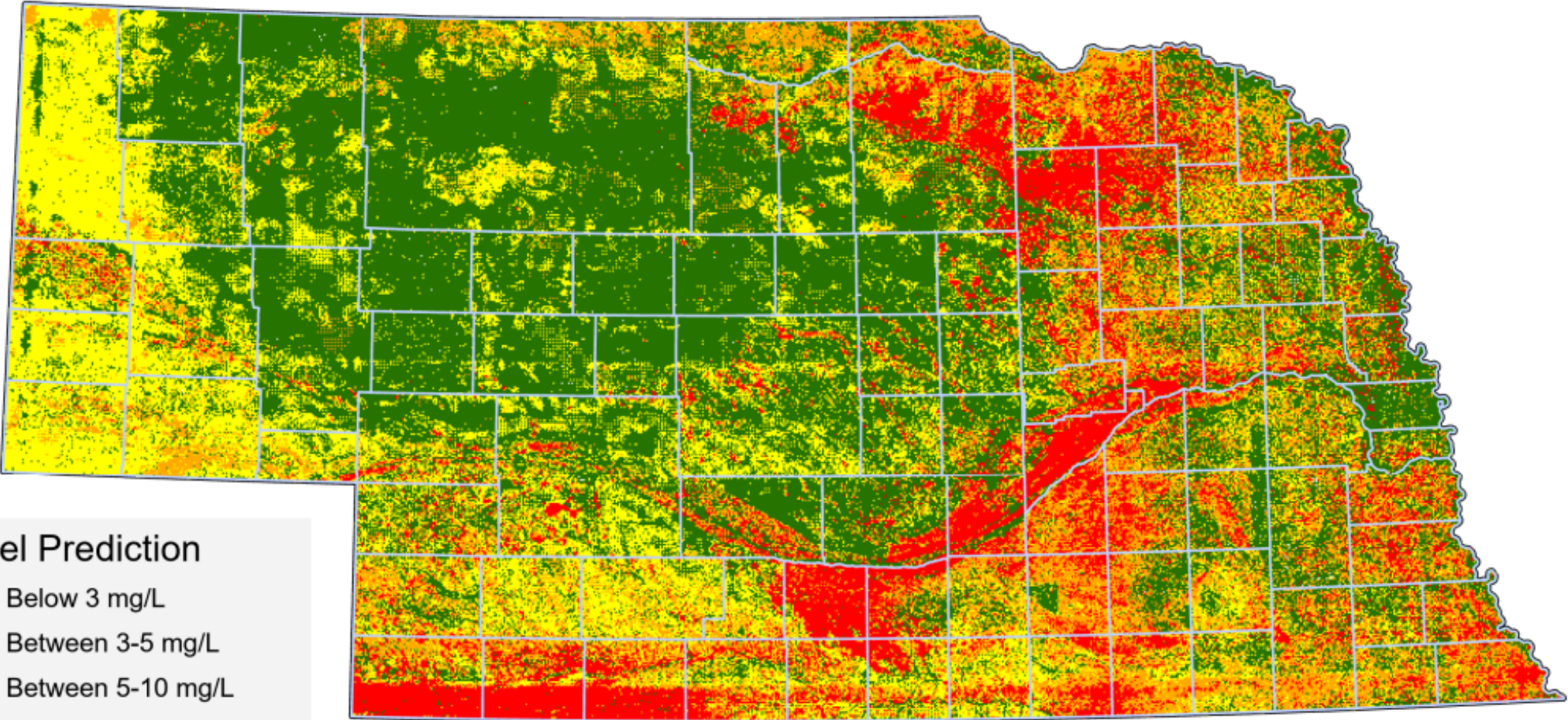


Areas with the highest risk for contamination of shallow ground water by nitrate generally have high nitrogen inputs to the land, well-drained soils, and a high ratio of cropland to woodland.

Number of Untreated Nitrate-violating Water Systems with Nitrate Violations



Nitrate impacts most of Nebraska



Model Prediction

- Below 3 mg/L
- Between 3-5 mg/L
- Between 5-10 mg/L
- Above 10 mg/L

Credits: NDEE Drinking Water and Groundwater Division
Spatial Reference: NAD 1983 State Plane
Nebraska FIPS 2,600 Feet
Projection: Lambert Conformal Conic



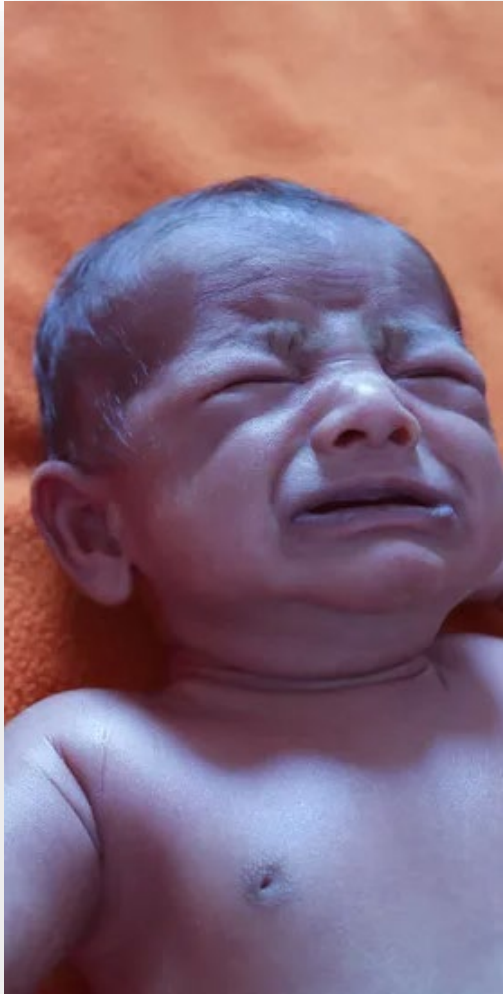
Regulatory limits of nitrate in drinking water are set for infant development of methemoglobinemia, not for other health outcomes

Numerous scientific studies have looked at the relationship of nitrate in drinking water on human health

High concentration of nitrate in drinking water has been linked to adverse health outcomes

Strongest links:

- Minor health ailments
- Methemoglobinemia
- Preterm birth issues
- Birth defects
- Pediatric cancers
- Adult cancers



N-nitroso compound (NOC) formation from ingested nitrate (drinking water & diet)

Oral bacteria: Nitrate → nitrite

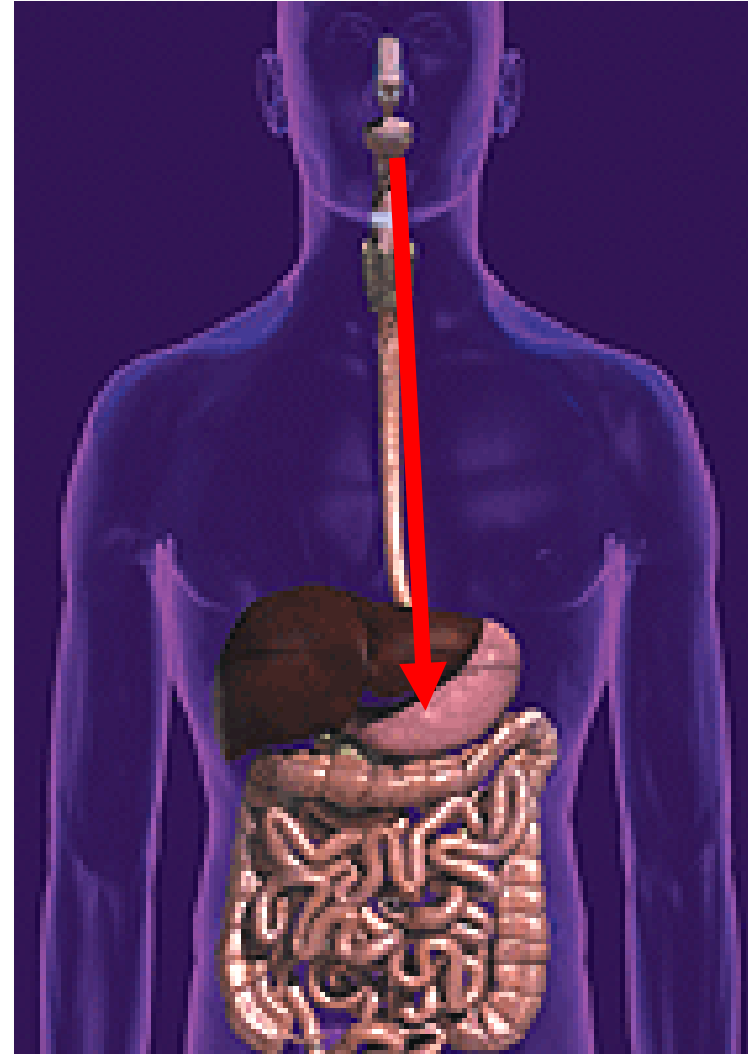
Nitrite + stomach acid

N_2O_3 +
amines/amides

NOC

↑
Heme iron
(red meat)
Thiocyanate
(smoking)

↓
Antioxidants
(vitamin C)



Increased heart rate, nausea, headaches, and abdominal cramps

Cancers

Colorectal cancer (5 studies; 4 positive)

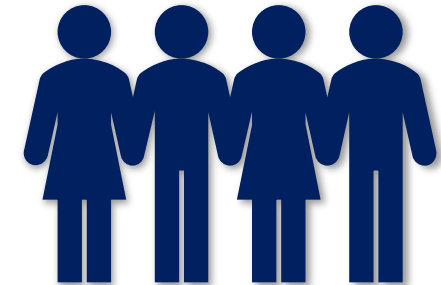
Thyroid disease (3 positive studies)

- Increase risk of thyroid cancer (5 mg/L)

Kidney cancer (2 studies; 2 positive)

Bladder cancer (4 studies; 2 positive)

Non-Hodgkin lymphoma (3 studies; 1 positive)



Alzheimer's, Diabetes And Parkinson's Disease

- Long-term ingestion of elevated nitrate in drinking water was associated with an **increased risk of bladder cancer** among postmenopausal women. *Jones et al. 2016*
- High nitrate levels in public drinking water and private well use may **increase ovarian cancer risk** among postmenopausal women. *Inoue-Choi et al. 2015*
 - Risk was elevated with increasing levels of **drinking water nitrate-nitrogen at 5mg/L**. *Ammons et al. 2025*
- Exposure to total trihalomethanes in drinking water is associated with the risk of rectal cancer. Nitrate in drinking water was **not associated with risk of colon or rectal cancers**. *Jones et al. 2019*
- Positive association between a relatively low dietary intake of nitrite from processed meats and stomach cancer risk in postmenopausal women. **No association between long-term exposure to nitrate** or TTHM levels in public water supplies and the risk of these **digestive system cancers**. *Buller et al. 2021*
- Drinking water nitrate-N exposure, at average levels > **10 mg L-1**, is a risk factor for **prostate cancer**. *Spaur et al. 2026*

Multiple health issues have been identified in children

- Methemoglobinemia (Infants less than 6 months)
- Pediatric brain cancers (2 studies; 2 positive)
- Non-Hodgkin Lymphoma (3 studies; 1 positive)
- Non-Hodgkin Lymphoma had a three-fold increase in risk with nitrates and atrazine in Nebraska study (Rhoades et al 2013)



CDC report 1996 showed a cluster of **spontaneous abortions (miscarriages)** in rural Indiana
Private wells 19-26 mg/L

California study found an increase in **spontaneous preterm births** with drinking water nitrate of 5 to 10 mg/L (Sherris et al. 2021)

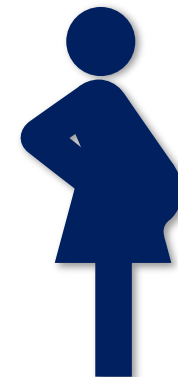
Fetal growth restriction with exposure of high nitrate in drinking water (Coffman et al. 2021)

Fetal hemoglobin is particularly susceptible to oxidation

Study shows **elevated methemoglobin cord blood** with exposure to nitrate during pregnancy (Tabacova et al. 1998)

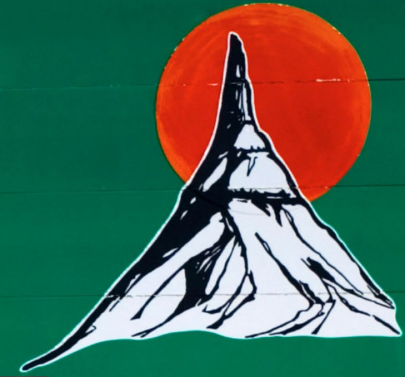
Central Nervous System (CNS) Malformations

5 of 6 studies found a positive association with nitrate
4 of the studies had **concentrations less than 10mg/L**



NEBRASKA

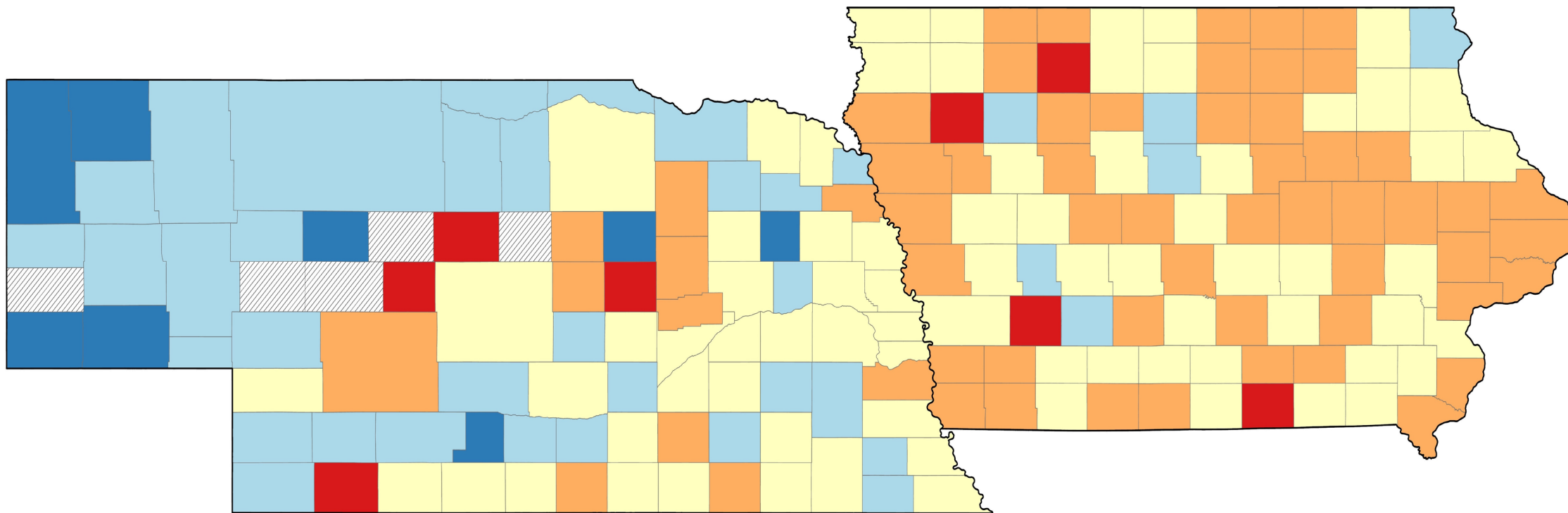
... the
good life



Day

Health Concerns in
Nebraska and other parts
of the Central Plains

Iowa & Nebraska have 5 of the Top 25

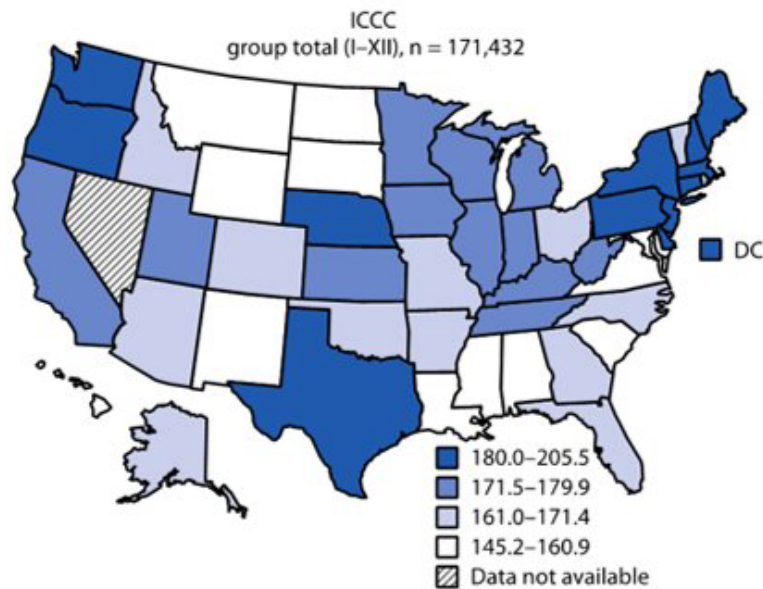


Incidence Rates



3 in the Top 10

Data from 2003 – 2014 and reported as age-adjusted incidence rates of childhood cancer per 1 million:



United States 173.7

New Hampshire	205.5
New Jersey	192.3
Maine	190.5
New York	190
Pennsylvania	186.6
Connecticut	185.8
Nebraska	183.2
Texas	183.2
Oregon	182.6
Massachusetts	181.5

ICCC: International Classification of Childhood Cancer

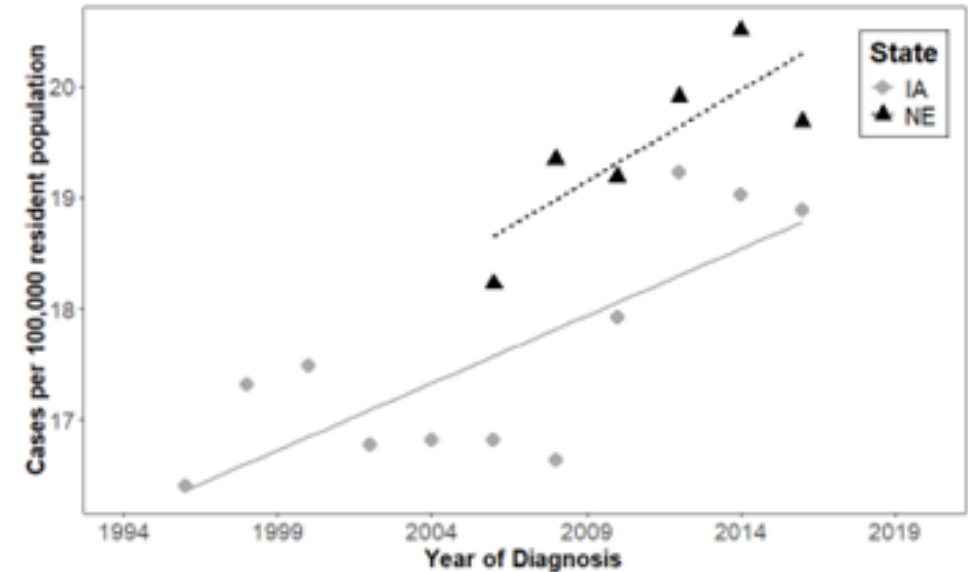
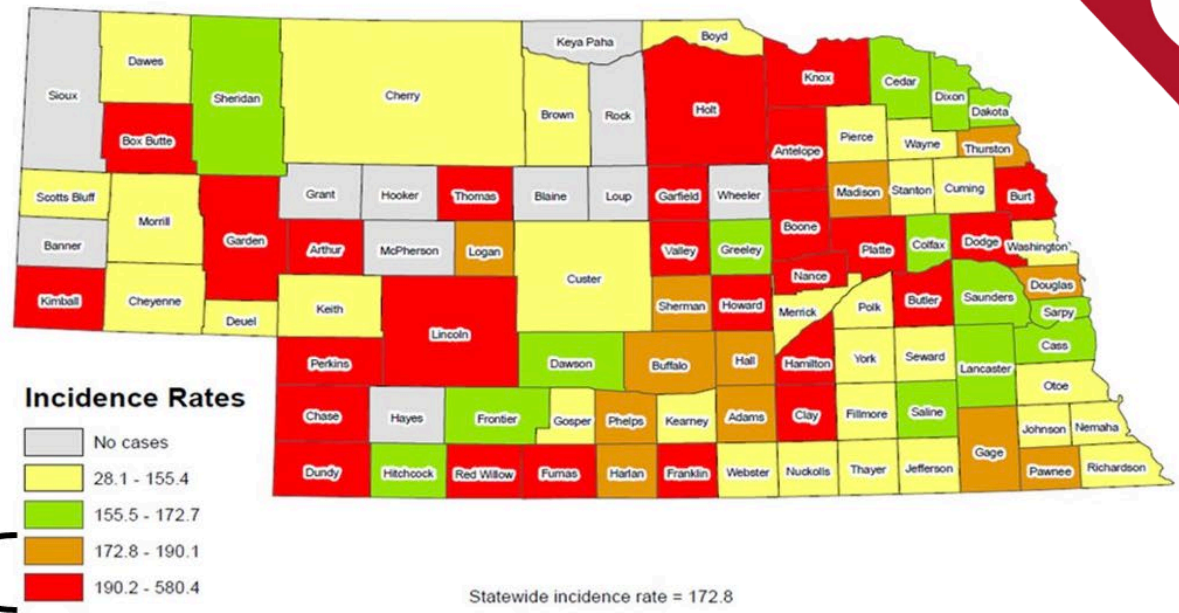


Figure 2. Change in PC Rates in Iowa and Nebraska (1994-2019)

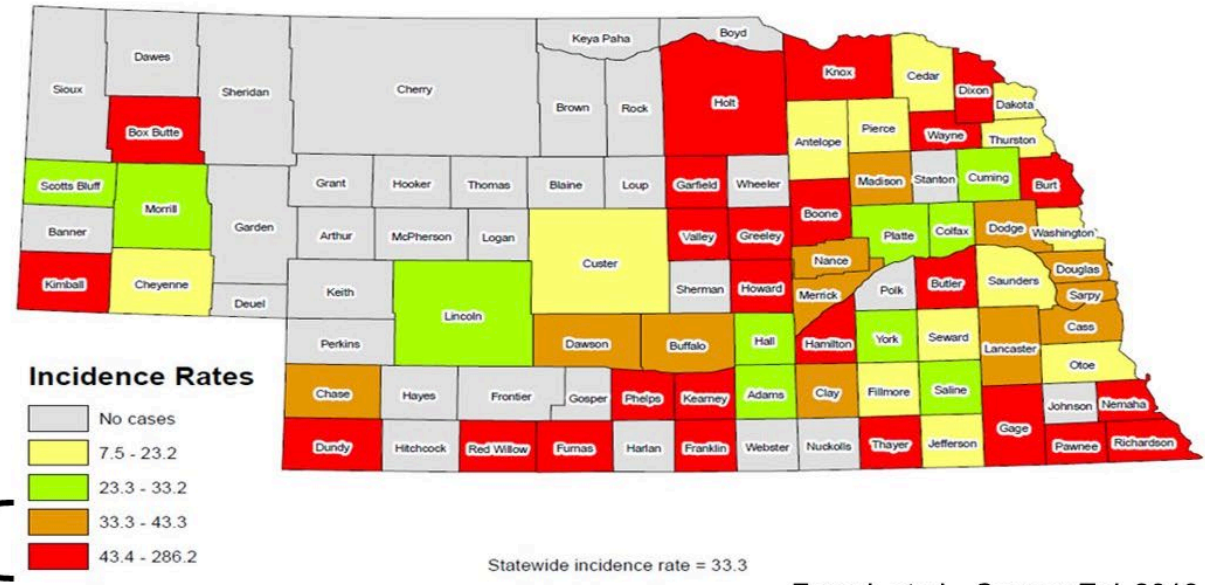
Siegel et al. Geographic Variation in Pediatric Cancer Incidence - US, 2003-2014. *MMWR*, 2018



All Pediatric Cancer



Pediatric Brain Tumors

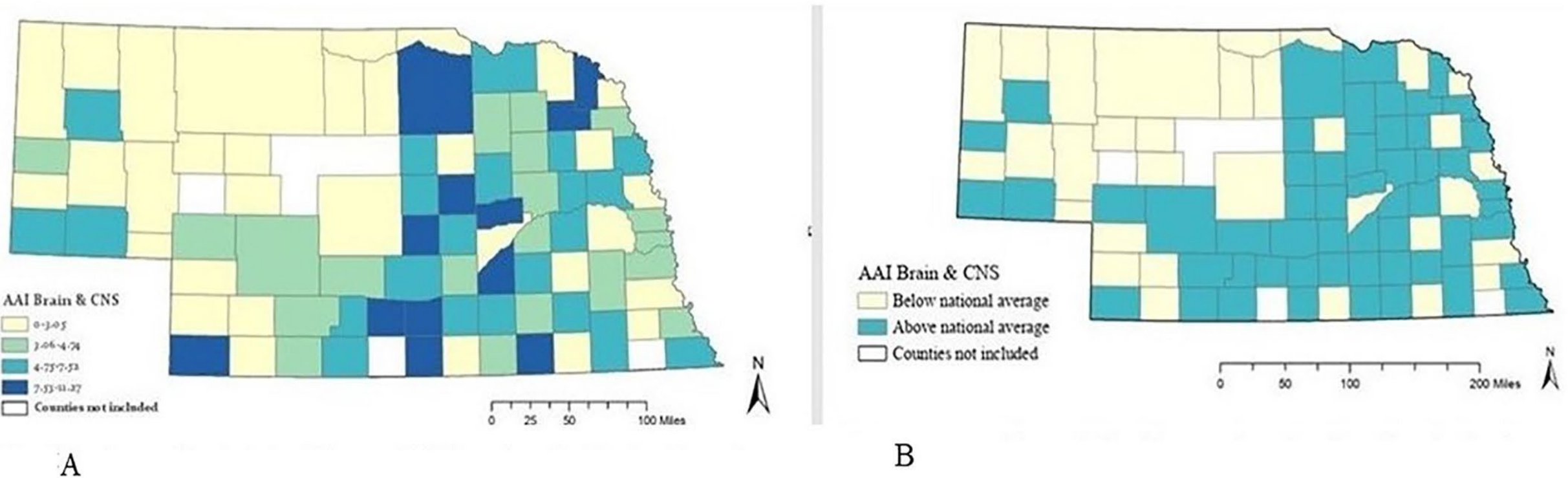


Incidence of pediatric cancers in Nebraska is among the five highest in the United States (Farazi et al., 2018).

Pediatric Brain & other CNS Cancers 1987- 2016



Nebraska counties with elevated atrazine or nitrate levels reported more childhood cancers than counties with lower levels of these chemicals.



Relative to the national average, the age-adjusted incidence of pediatric brain and other CNS cancers is higher in 63% (54/86) of the Nebraska counties.



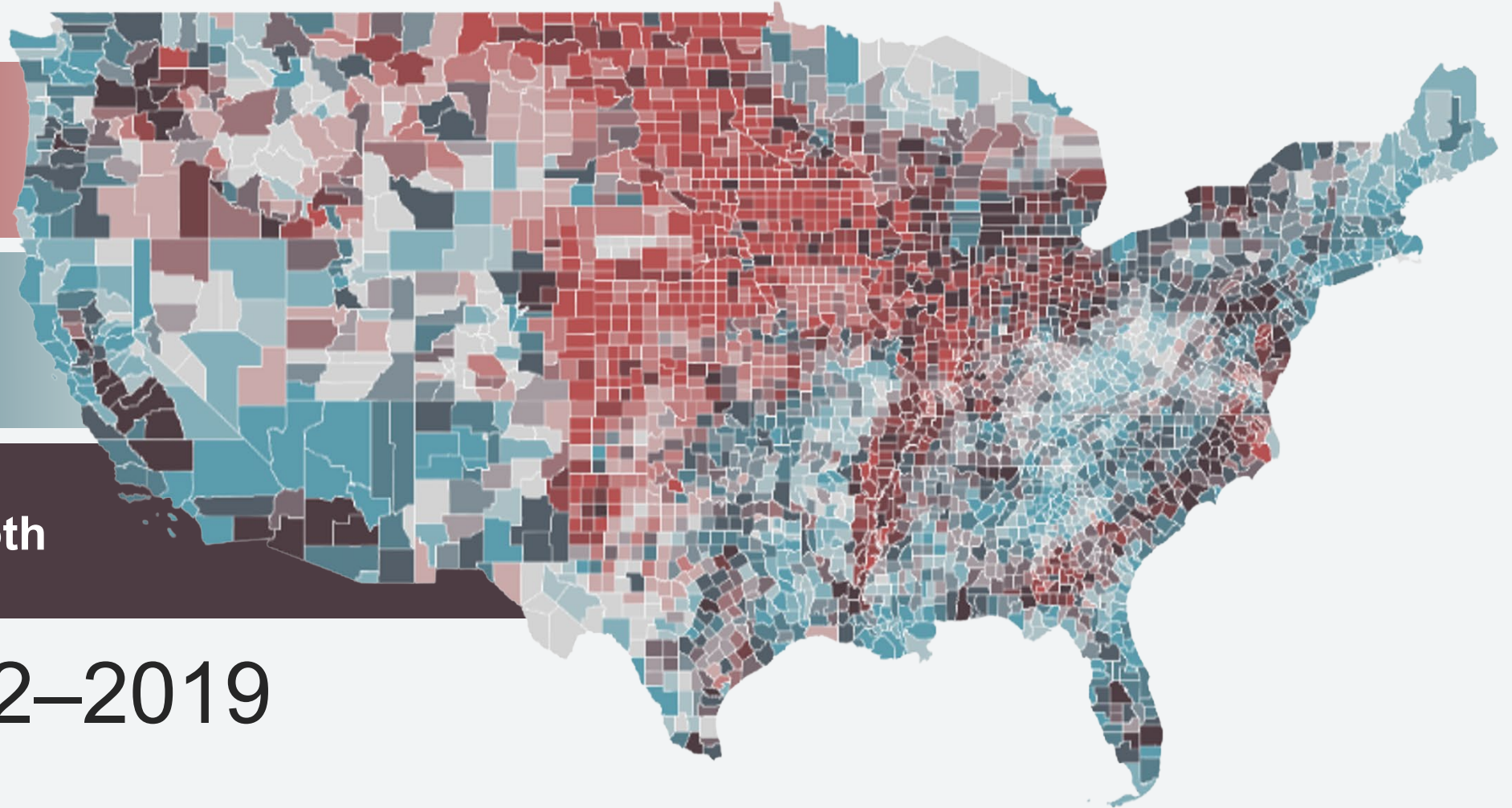
Results: Vulnerability Mapping

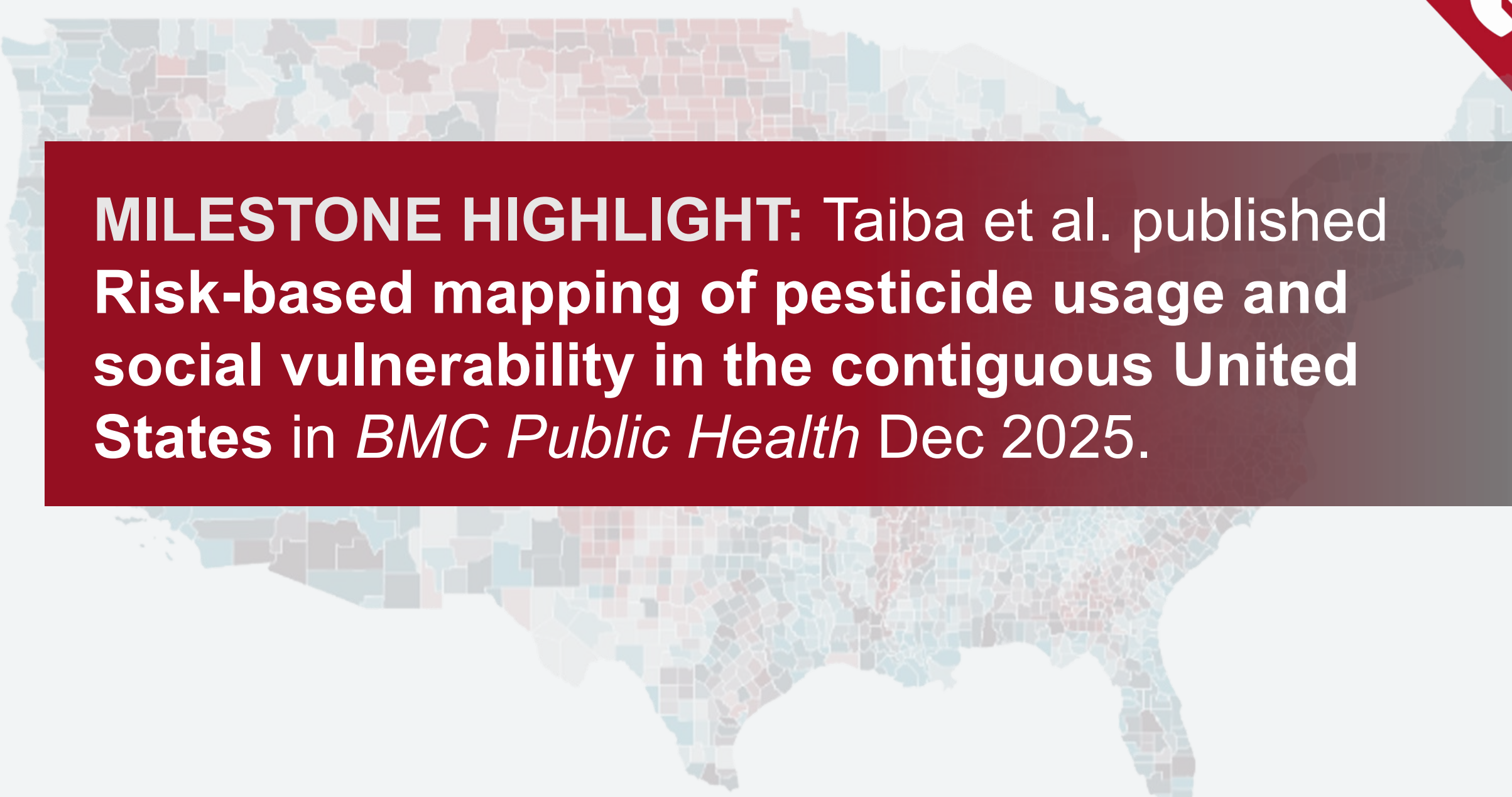
Average pesticide application

Susceptibility index

High values for both

1992–2019



A map of the contiguous United States is shown in the background, with each county shaded in a color representing a risk level. The colors range from light blue (low risk) to dark red (high risk). The map is partially obscured by a dark red banner containing text.

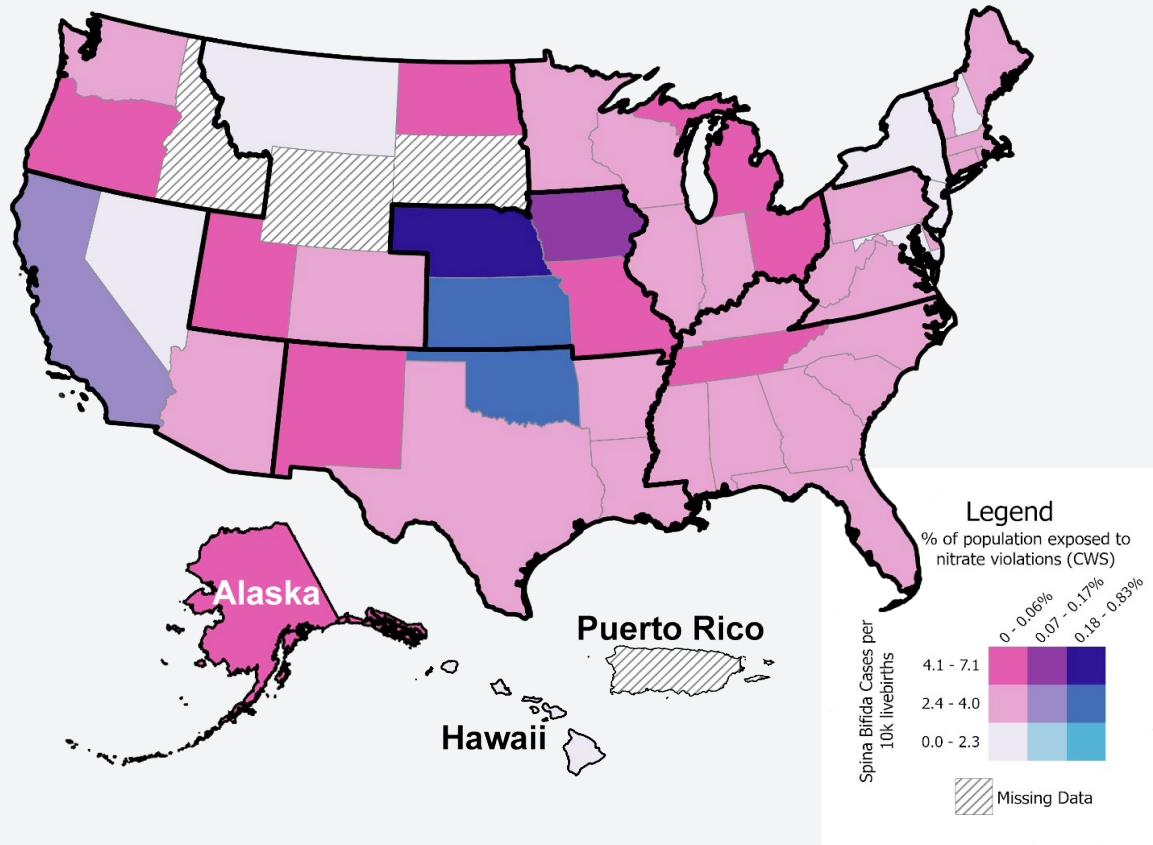
MILESTONE HIGHLIGHT: Taiba et al. published **Risk-based mapping of pesticide usage and social vulnerability in the contiguous United States** in *BMC Public Health* Dec 2025.



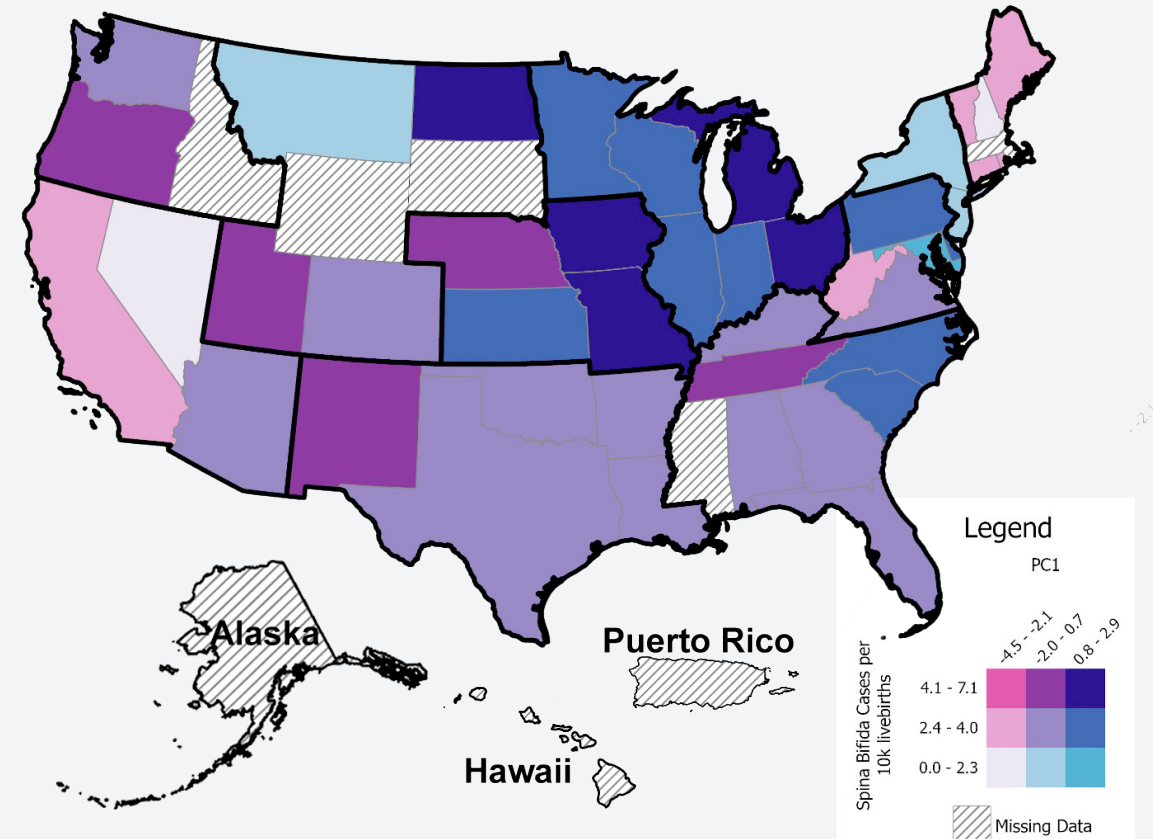
BIRTH DEFECTS

Bivariate mapping: Spina bifida prevalence and (A) % state population affected by known nitrate violations in community water sources and (B) aggregate pesticide application by state. **Purple represents correlations.**

A. Spina bifida and Nitrate



B) Spina bifida and Pesticides



Unexpected Costs



Moving

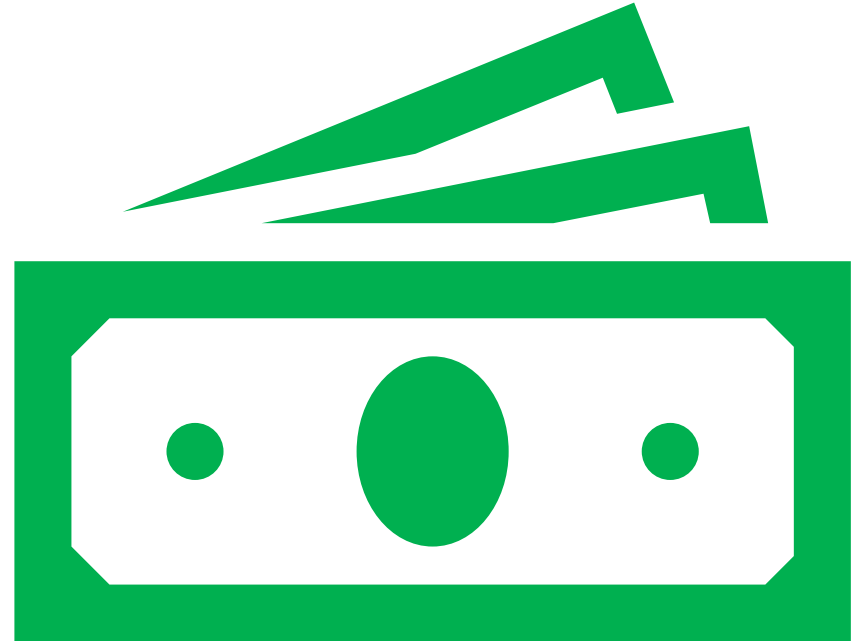
Financial burden

Higher rates of bankruptcy

Wisconsin study:

\$250,000-\$1.5 billion in medical expenditures

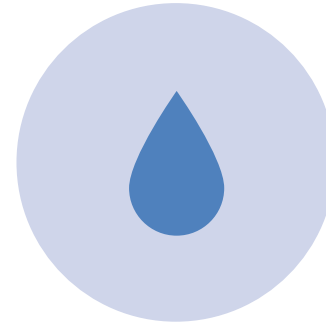
\$1.3-\$6.5 billion lost in productivity



Goals for Addressing Water Quality



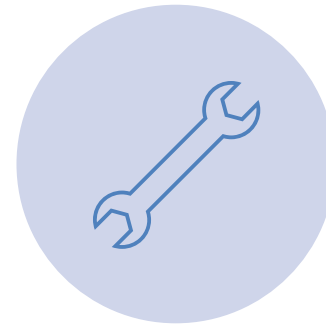
Identify at-risk areas and people



Encourage water testing



Find low-cost to no-cost solutions



Maintain these water systems

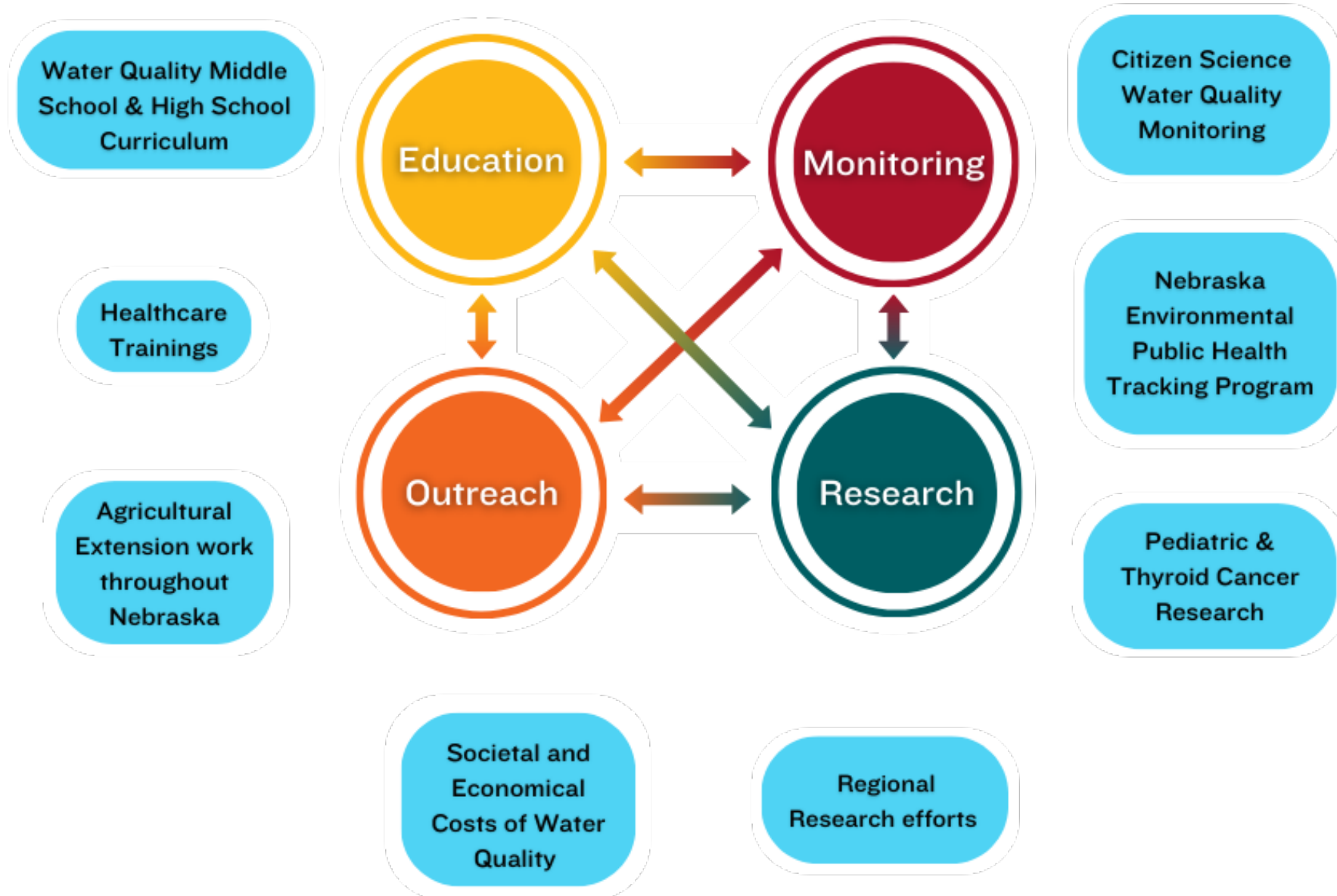


EXIT

Engagement and Outreach



Water Quality at the WCHP



Communication: Diverse Opportunities



***689**

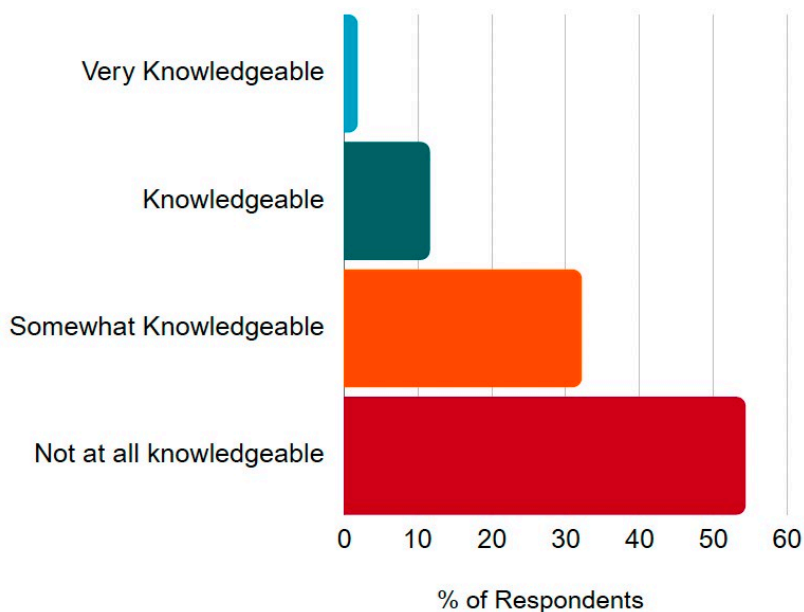
Healthcare providers
(HCPs) surveyed



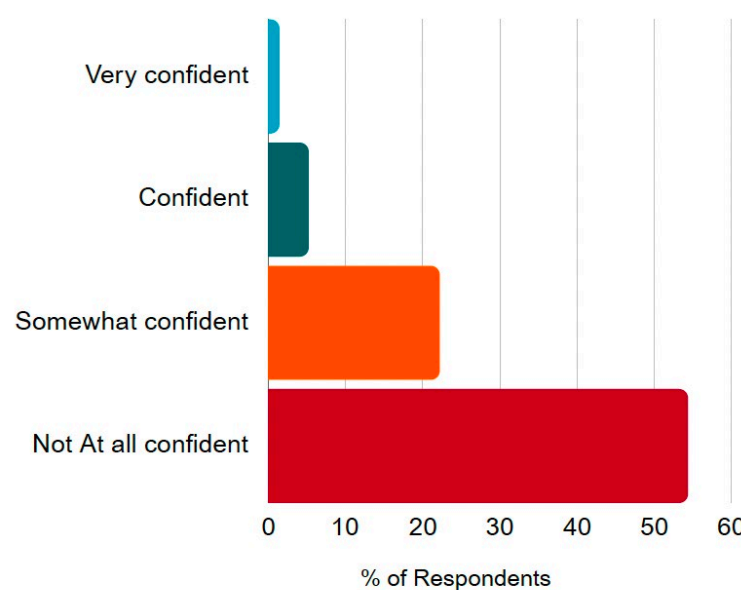
22

Natural Resource District
employees (NRDs)
surveyed

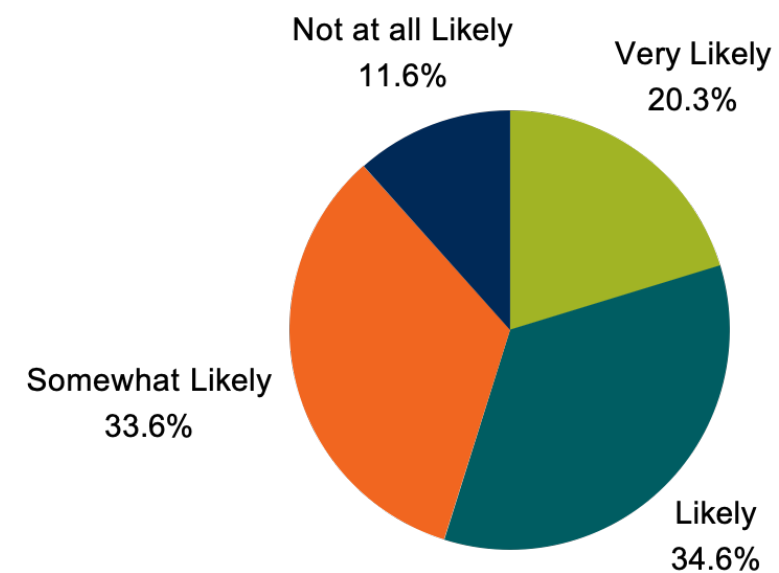
HCPs Self-Rated **Knowledge** of the Health Impacts of Nitrate Contaminated Drinking Water (n=655)



HCPs Self-Rated **Confidence** that They Can Advise Patients About the Health Impacts of Nitrate Contaminated Drinking Water (n=655)



HCPs Self-Rated **Likelihood** to Distribute Educational Products to Patients if they were Available (n=596)



Water Quality Education & Engagement



NEBRASKANS CAN TREAT THEIR DRINKING WATER FOR FREE!

If your drinking water has high concentrations of nitrate, the Nebraska Department of Environment and Energy (NDEE) is offering an opportunity for you to treat it for free with the Reverse Osmosis System rebate program.

Application opens: January 1st, 2023
Application closes: June 23, 2024

Eligibility Requirements:

- This program is open to anyone with a private well.
- The private well must be registered.
- Applicants will need to submit water quality data from the State laboratory, with testing results dated no earlier than January 1, 2022.
- Only wells with samples above 10 ppm nitrate will be eligible for this program.

Why Apply?

Treating your drinking water helps protect the health of you and your loved ones.

There are known health impacts for drinking nitrate contaminated water. The strongest linked are:

- blue baby syndrome
- preterm birth issues
- birth defects
- pediatric cancers
- adult cancers

Application for R.O. rebate program
<https://go.unl.edu/roapp>

Order state lab kit
<https://go.unl.edu/orderstatekit>

Check if your well is registered
<https://go.unl.edu/checkwell>

How to register your well
<https://go.unl.edu/registerwell>

More program details
<https://go.unl.edu/programdetails>

Get up to \$4,000 reimbursed!



NITRATE AND HEALTH

PROTECT THE HEALTH OF YOU AND YOUR LOVED ONES BY KNOWING WHAT IS IN YOUR DRINKING WATER!

WHERE AND WHAT IS NITRATE?

Nitrate is a form of nitrogen that can sometimes be found in our drinking water. Nitrogen fertilizers used for growing crops are the largest contributor to nitrate in our drinking water. Therefore, if you live in an area where there is a lot of agricultural production, you are at risk of drinking nitrate-contaminated water.

WHAT CAN I DO TO PROTECT MYSELF AND MY FAMILY?

If you drink water from a private well, it is up to you to ensure you are drinking safe water. There are no requirements for private well owners to test or treat their water. Nitrate is colorless, odorless and tasteless. The only way to know if you have nitrate in your drinking water is to test for it.

Private well users should test their drinking water annually. You can order a test kit from a certified laboratory or do-it-yourself test kits are available as well. The do-it-yourself kits should be used as a screening tool only. An analysis by an approved lab is recommended for the most accurate, reliable and precise measurement.

If you find nitrate above the safe drinking water level (10 ppm) in your water, the quickest and easiest solution is to install a reverse osmosis water filtration system in your house. For more information, go to <https://water.unl.edu/>

HOW CAN CONSUMING NITRATE IMPACT HUMAN HEALTH?

Children and Infants

- A result in infants consuming nitrate-contaminated water is methemoglobinemia (blue-baby syndrome). Bottle-fed babies under six months old are at the highest risk. This illness can cause the skin to turn a bluish color and result in serious illness or death.
- There are studies suggesting potential linkages between nitrate consumption and pediatric cancer. Nebraska has the highest rate of pediatric cancer in the Midwest and 7th highest in the entire United States. More research needs to be conducted before we can draw sure conclusions.

Pregnant Women

- During pregnancy, it is common for a woman's methemoglobin levels to increase from normal. Therefore, pregnant women are particularly susceptible to methemoglobinemia as well.
- Pregnant women exposed to too much nitrate are at greater risk of giving birth prematurely.
- Maternal exposure to nitrate through drinking water has been linked to birth defects. Nebraska has double the national average rate of birth defects.

Other Adults

- The University of Nebraska Medical Center, along with researchers across the globe, continue to study linkages between consuming nitrate and human health impacts.
- A growing body of studies indicate potential associations between nitrate and:
 - increased heart rate, nausea, headaches, thyroid disease, and other cancers such as colon, bladder, ovarian and kidney

**Please consult your doctor if you are experiencing any of these symptoms.*

Keep Your Baby Safe: Nitrates in Drinking Water from Wells Can Be Harmful

What are Nitrates?

Nitrates are chemicals that can get into private drinking water wells from:

- Farm fertilizers
- Animal manure
- Septic systems

The only way to know if your well water is safe to drink is to test it.

How Can Drinking Nitrates be Harmful?

During Pregnancy

High nitrates can increase the risk of:

- Early birth
- Low birth weight
- Pregnancy problems

Breastfeeding is safe- nitrates do not pass into breast milk.

Babies*

High nitrates can increase the risk of "Blue Baby Syndrome" (Methemoglobinemia) which can cause:

- Blue or Purple skin
- Trouble Breathing
- Low oxygen in the blood and even death

*Babies under 6 months are especially vulnerable to nitrate. Drinking formula mixed with nitrate-contaminated well water can cause serious health problems and, in severe cases, may be life-threatening. Do not make formula with water that tests above 10 mg/L of nitrate.

Citizen Science and Environmental Education Showcase: Empowering Youth, Inspiring Civic Action



Water Quality & Health Toolkit

Water Quality & Health Communications Resource
 For Public Health & Health Professionals In Nebraska

Why might we develop middle school and high school curriculum and train teachers to focus on water quality and citizenship skills?

Drinking Water and Health

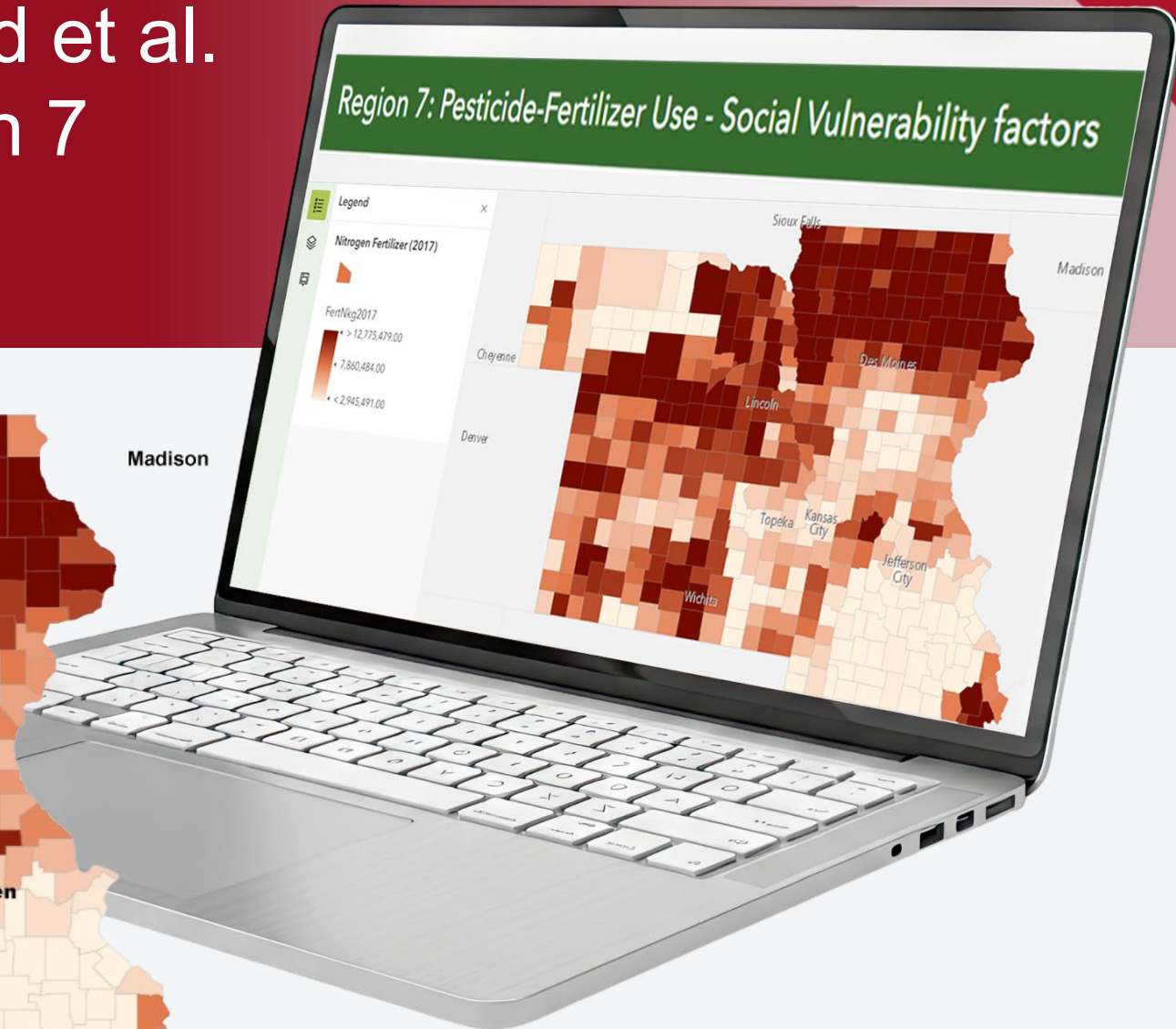
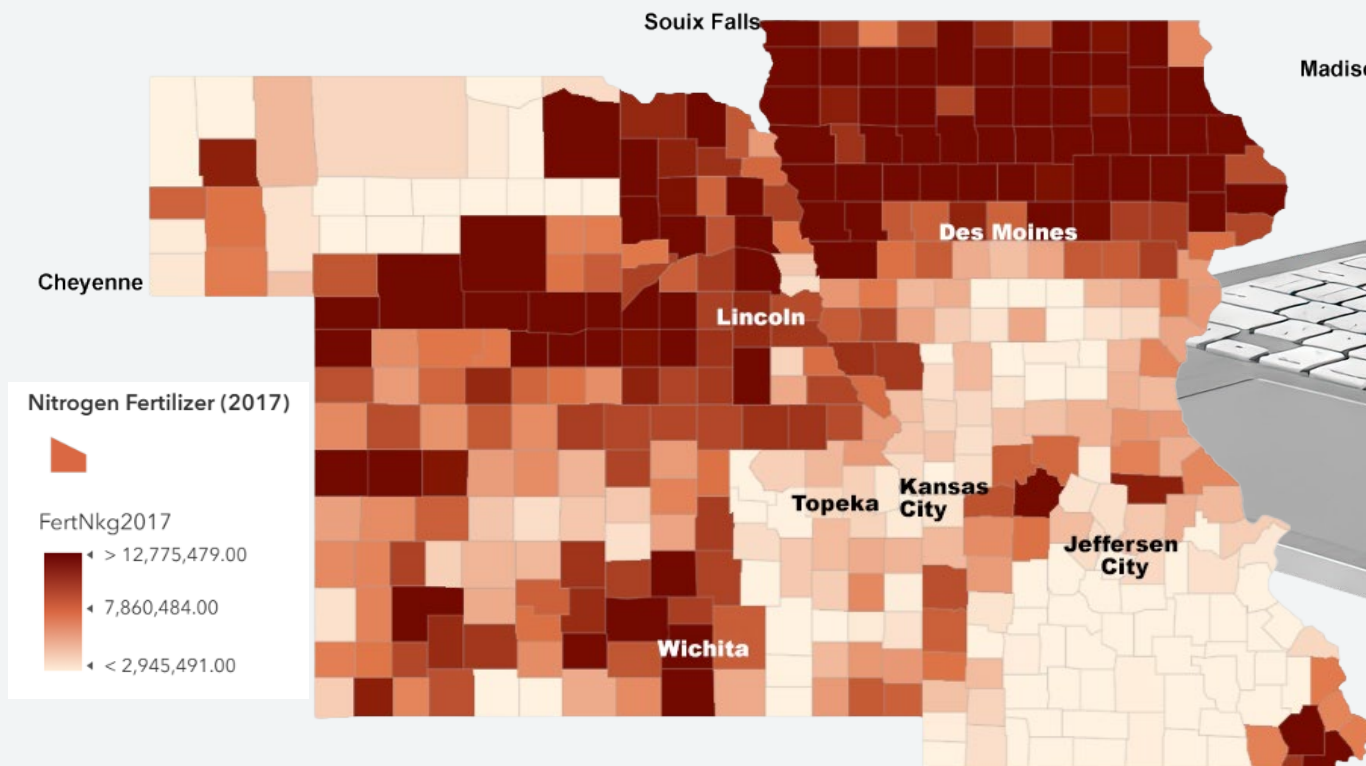
- 1. Drinking Water in Nebraska**
Did you know, water from private wells is not required to be tested or treated? Therefore, the only way to know if your water is safe to drink is to test to find out for yourself.
- 2. Common Water Contaminants**
Throughout much of Nebraska, water monitoring shows several harmful contaminants. The most common contaminant is nitrate- related to nitrogen fertilizer use.
- 3. Lifetime Health Impacts**
There are known health impacts for drinking nitrate contaminated water. The strongest linked are: blue baby syndrome, preterm birth issues, birth defects, pediatric cancers and adult cancers.
- 4. Who is the Most at Risk?**
The most vulnerable populations are pregnant women and their fetuses, young infants, children, and people with oxygen transport/delivery conditions.
- 5. Test Your Well Water!**
The only way to be sure of what is in your drinking water is to test it! The recommended way to test is to order a testing kit from an official Nebraska lab. After knowing what's in your water, you can begin building a treatment plan if necessary.

For more information: Laura Nagengast lnagengast3@unl.edu OR scan here

NEBRASKA
DEPT. OF ENVIRONMENT AND ENERGY



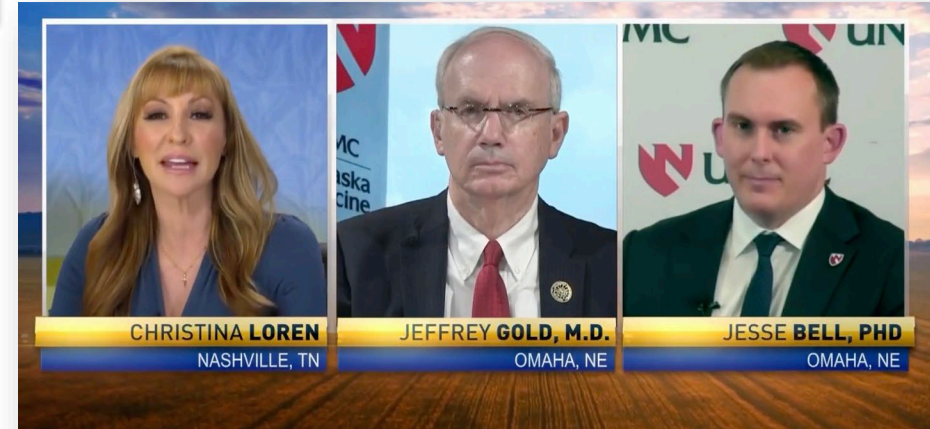
WORK IN PROGRESS: Fard et al. creating a web-based Region 7 Vulnerability Dashboard



WCHP In the Community & Beyond



Drs. Gold and Bell discussing private well testing on UNMC's *Rural Health Matters*, 2023



“Flatwater Free Press Forum on Nitrates in Nebraska’s Water” in Norfolk, NE in March 2023.



Check out the Healthy Living Webpage for more information!
<https://ncdhd.ne.gov/healthy-living-expo>

Discover your path to wellness at the **Healthy Living Expo in Niobrara! Partner Spotlight!**

UNMC Water, Climate, and Health Program- Laura Nagengast & Jessenia Hincapie

Dive into Water Quality Fun with Laura and Jessenia from UNMC! Test your knowledge of water quality, health, and environmental health with our spinning wheel game. Win cool prizes and learn how to keep your water clean and your health in top shape! Don't miss out – visit Laura and Jessenia at the Expo!

Come see us on **June 11, 2024**
 from **1 pm-7 pm**
 at the **Niobrara Public School**



Opportunities for Moving Forward



Partnerships to educate and do outreach



Improve testing of private wells



Continue to research these issues



Create education materials for stakeholders





The Water, Climate and Health Program is made possible through generous support provided by:



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