Richard Damania, Sébastien Desbureaux, Aude-Sophie Rodella, Jason Russ, Esha Zaveri

GWSP
GLOBAL WATER
SECURITY & SANITATION
PARTNERSHIP

www.WorldBank.org/QualityUnknown

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Water

When a river is on fire, something is seriously wrong.


Lakes full of
algae set off
alarm bells, too.

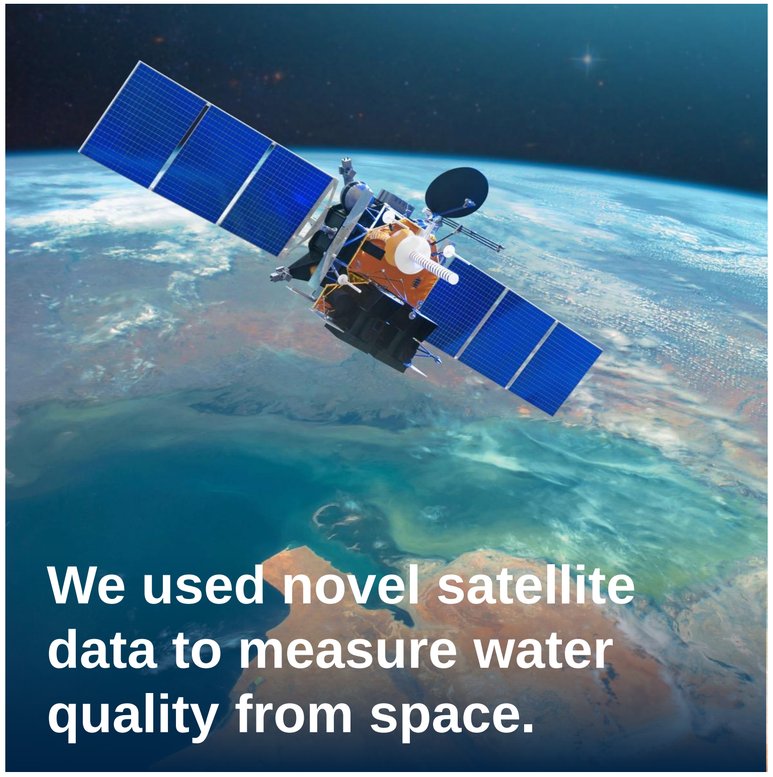
We need to dive beneath the surface to understand what is happening.

Built What May be the Largest Data Base on Water Quality

1

We measured water quality beneath the surface.

2



We used novel satellite data to measure water quality from space.

3

We used AI—the power of machine learning—to infer water quality parameters.

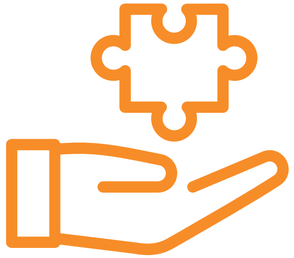
Our Data Attempts to Shed Light on Three Fundamental Questions

1

Where is the problem of water quality most severe?

2

What is the impact on human health and the economy?



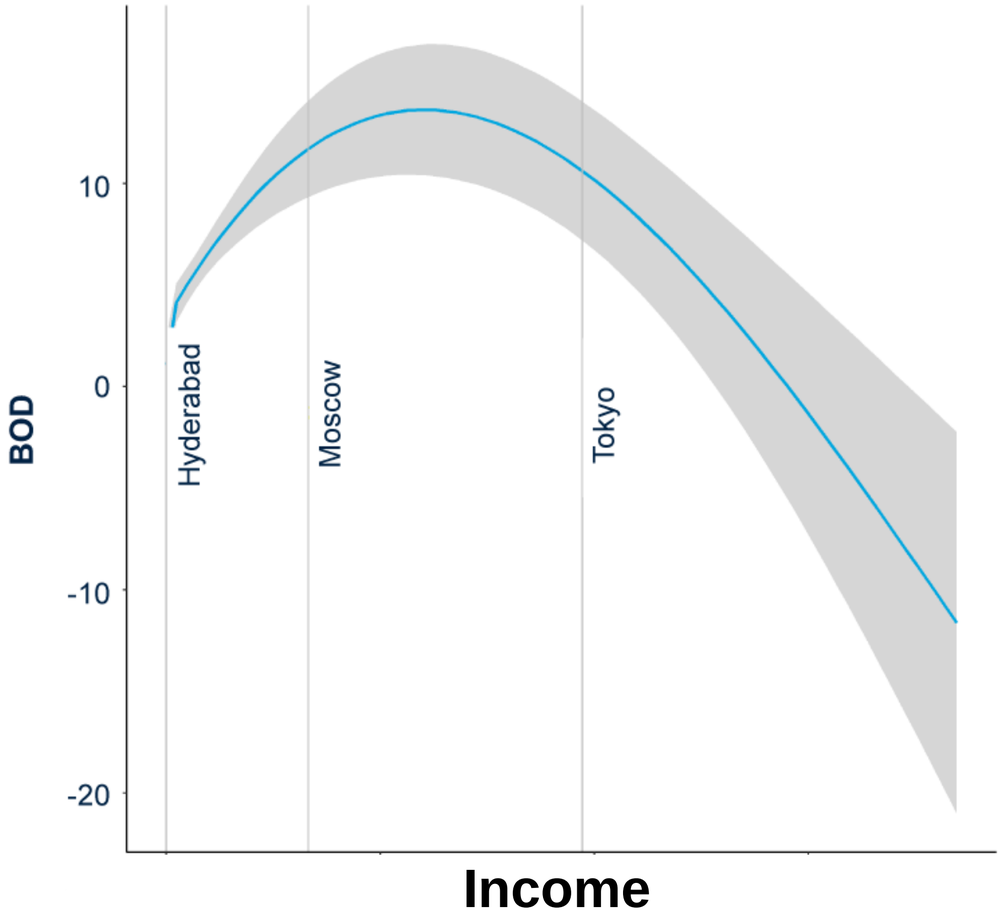
3

What are the solutions?

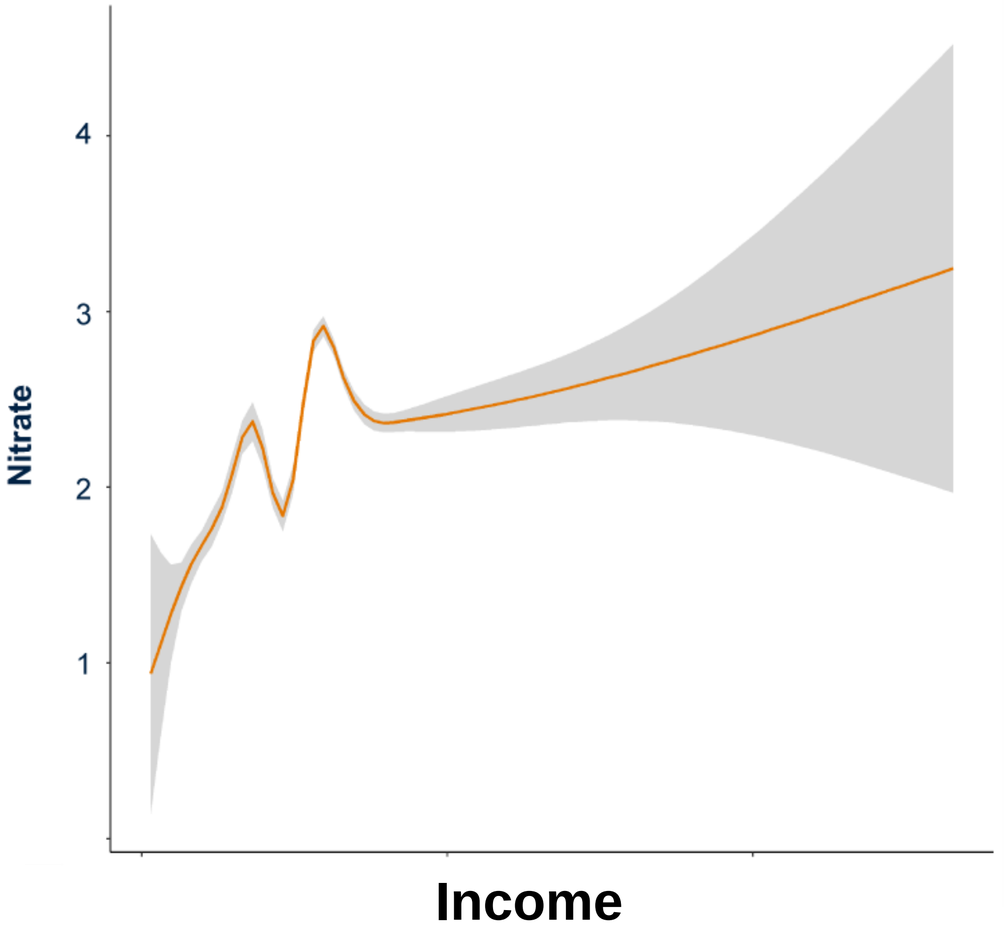
Grow first
Clean up later?

Nitrogen Use Reveals a Strange Paradox of Growth

Biological Oxygen Demand



Nitrogen



As Countries Develop, a Wide and Growing Range of Pollutants from Many Different Sources are Introduced

Each year, over 1,000 are introduced to the environment

New Chemicals

Focus on Pollutants Identified as Priorities by the Sustainable Development Goals

SDG 6.2

- Sanitation-related pollution, fecal coliform

SDG 6.3

- Nutrients (nitrogen/phosphorus)
- Salts (electrical conductivity, pH)
- Biochemical/umbrella proxies (BOD, DO)

SDG 6.2 Sanitation Related

- Diarrhea
- Stunting
- Education deficit
- Production deficit
- Continuation of the cycle of poverty

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SDG 6.2

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SDG 6.3

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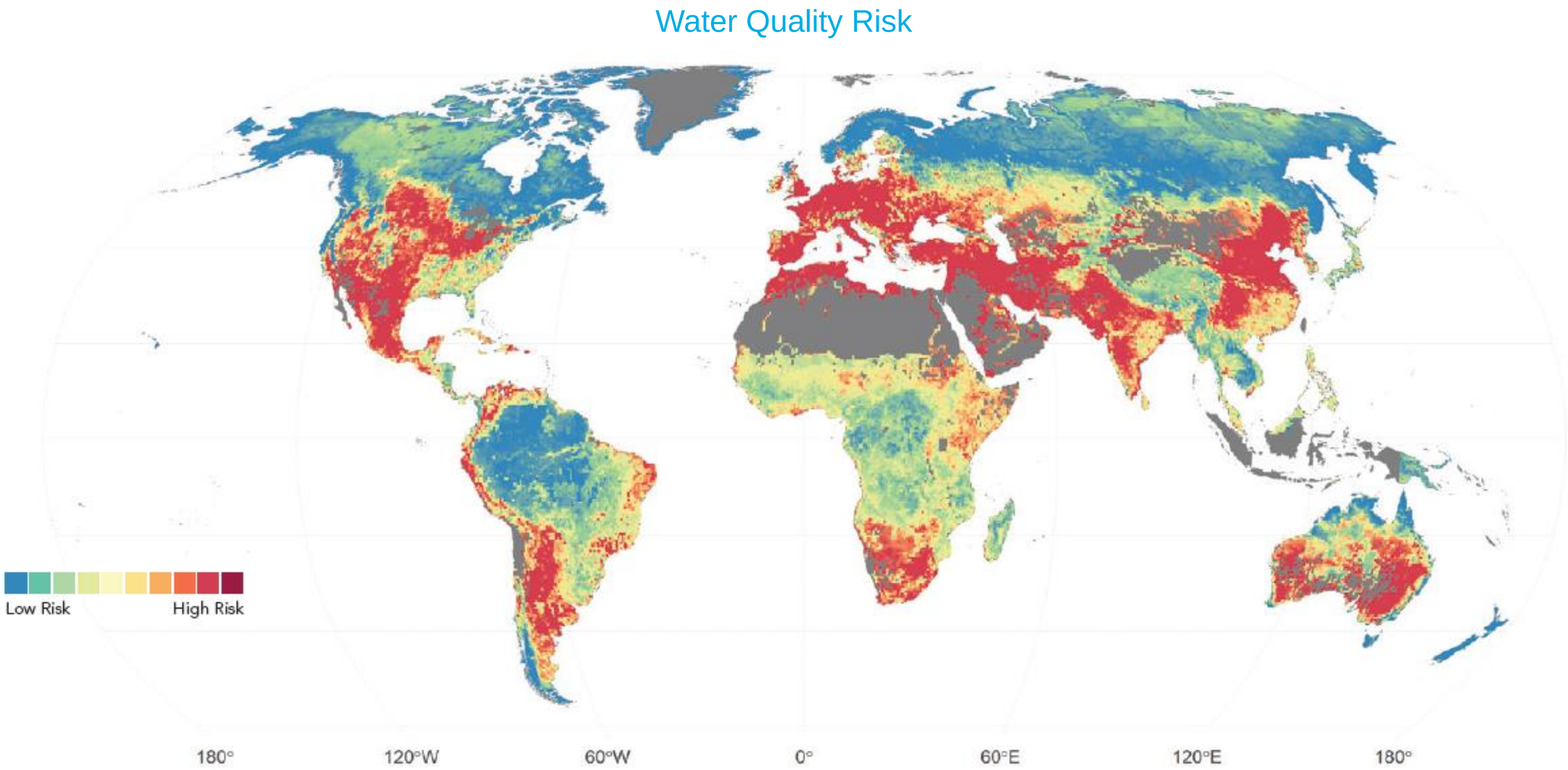
- Biochemical/umbrella proxies (BOD, DO)

New Data Tells us Where the Biggest Risks to Water Quality Exist



Nitrogen

'Brot aus Luft' or 'Bread from Air'

Carl Bosch and Fritz Haber - 1908

"Greatest geoengineering feat"

Discovered way to transform atmospheric nitrogen → to (solid) ammonia → apply to crops

Carl Bosch and Fritz Haber
Source: The Nobel Foundation

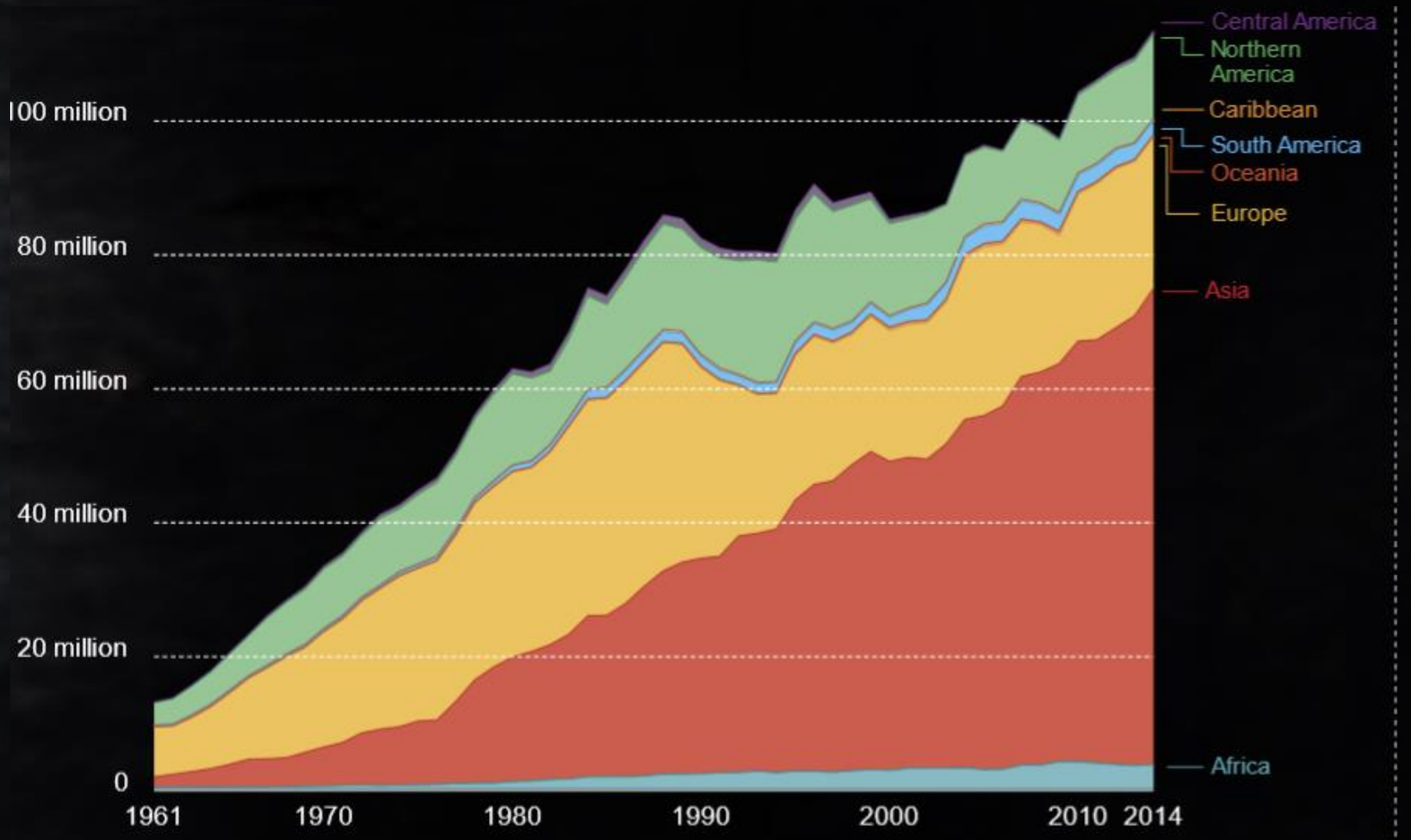
Bread from Air or Toxic Plumes?

1. Transformed the way we grow food
2. Led to 30% of yield increases
3. Saved and enabled several billion more lives

(Erisman et al. 2008; Stewart et al., 2005).

Fertilizer Usage Accelerates Globally

Nitrogen fertilizer production, tonnes

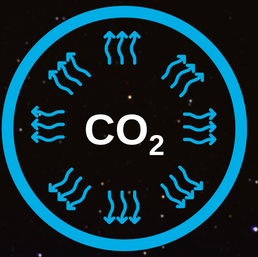


Source: UN Food and Agricultural Organization (FAO)

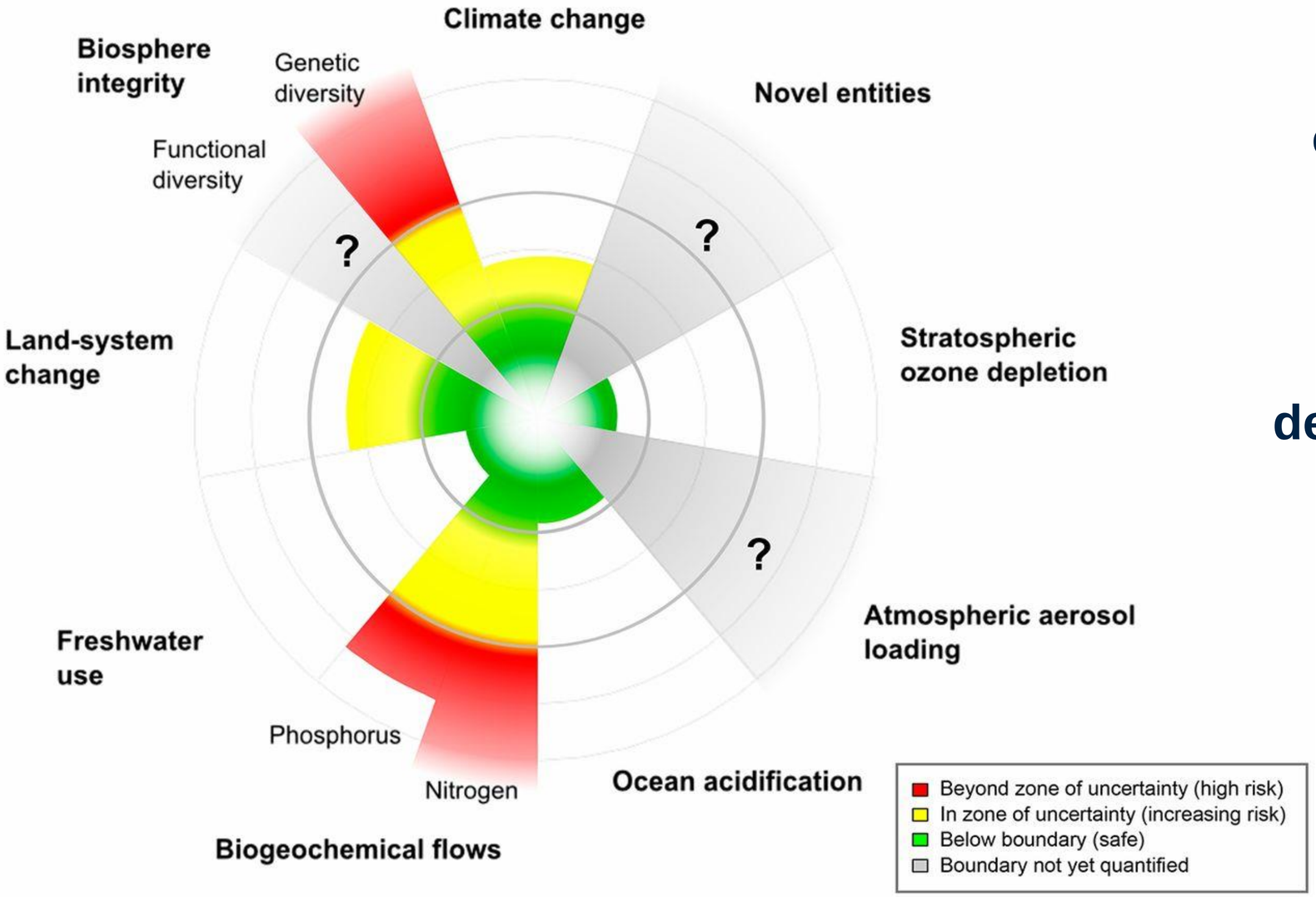
Leached into water

Volatized into the Air

Nitrous Oxide is **300x** more potent at **trapping heat** than CO_2



Nitrogen has Passed Safe Planetary Boundary



World's largest global externality, rivaling carbon
(Keeler et al. 2016)

Trending upwards nearly everywhere, including in developed countries like the United States
(Keiser and Shapiro 2018)

Nitrates are linked to fatal Blue Baby Syndrome.

Long-term Risks from Nitrogen

Nitrate Intake and the Risk of Thyroid Cancer and Thyroid Disease

Mary H. Ward,[a] Briseis A. Kilfoy,[a] Peter J. Weyer,[b] Kristin E. Anderson,[c] Aaron R. Folsom,[c] and James R. Cerhan[d]

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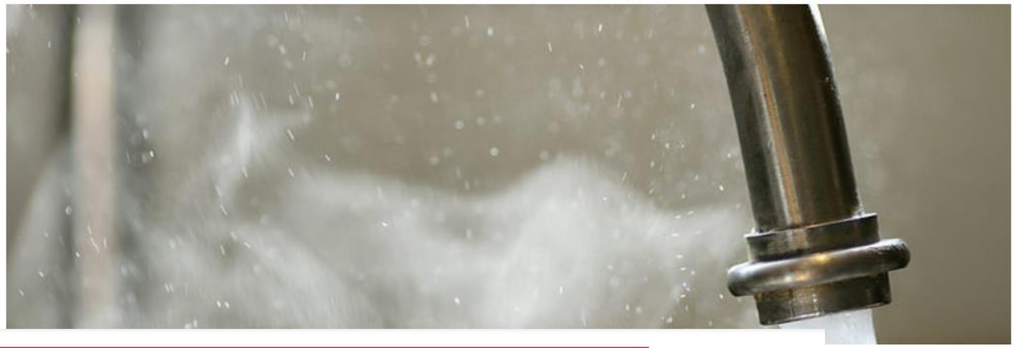
NEW ZEALAND / HEALTH

Health expert renews call for study on nitrates in drinking water

12:29 pm on 28 July 2019 Share this

A leading public health scholar warns 50 people could be dying from bowel cancer every year because of nitrate levels in their drinking water.



Talking with the experts: Scientists are working to reduce cancer risk of nitrates in drinking water

University of Minnesota Aug 8, 2019 Updated Aug 8, 2019 0

Studies show too many nitrates in drinking water can cause cancer. A good filter that's changed regularly will help reduce the risks.

IJC International Journal of Cancer

Cancer Epidemiology

Nitrate in drinking water and colorectal cancer risk: A nationwide population-based cohort study

Jörg Schullehner ✉, Birgitte Hansen, Malene Thygesen, Carsten B. Pedersen, Torben Sigsgaard

First published: 13 February 2018 | https://doi.org/10.1002/ijc.31306

Many studies observed impacts at levels that were below regulatory limits (Ward et al. 2018)

An Ancient Problem

An Ancient Problem

An Ancient Problem

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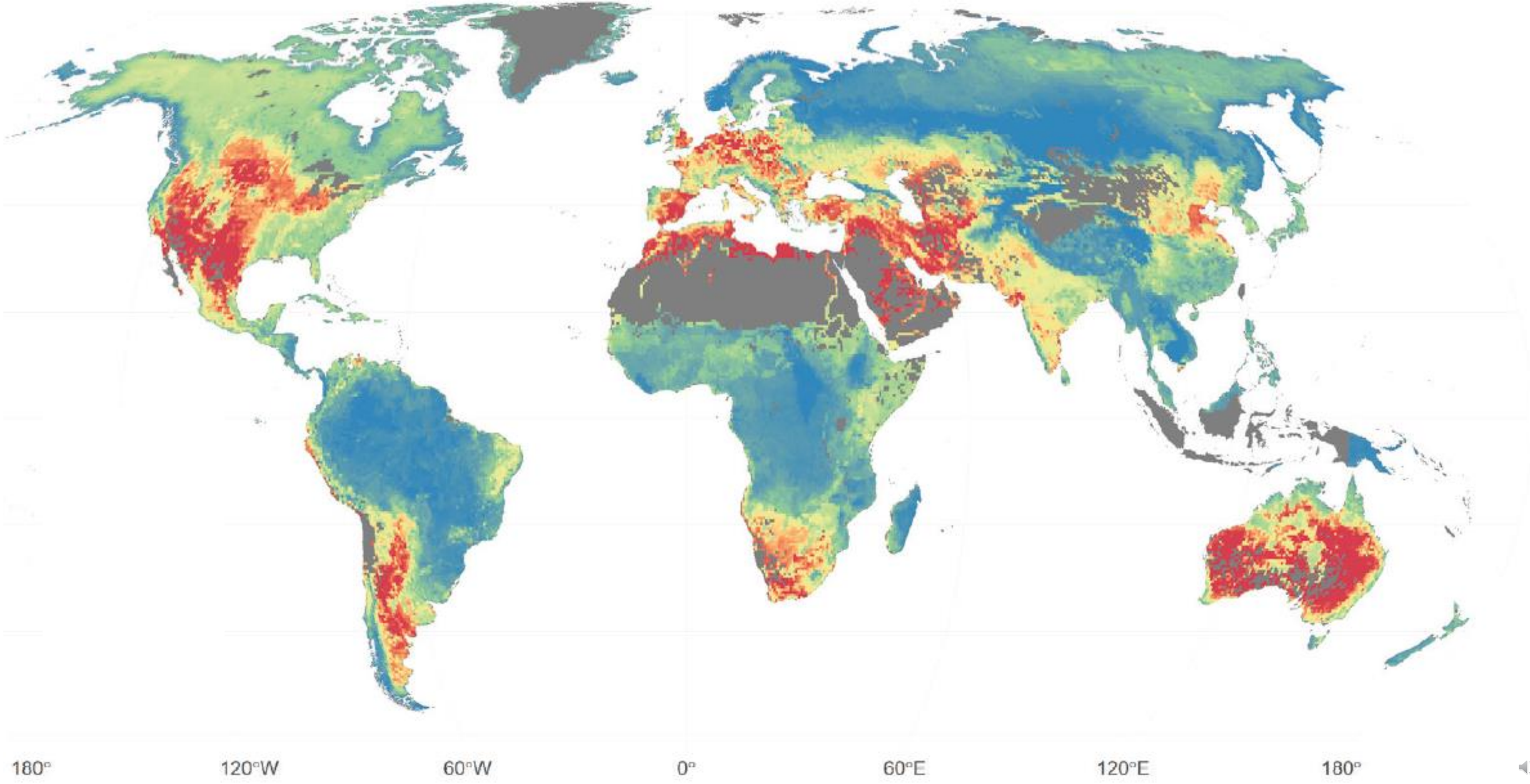
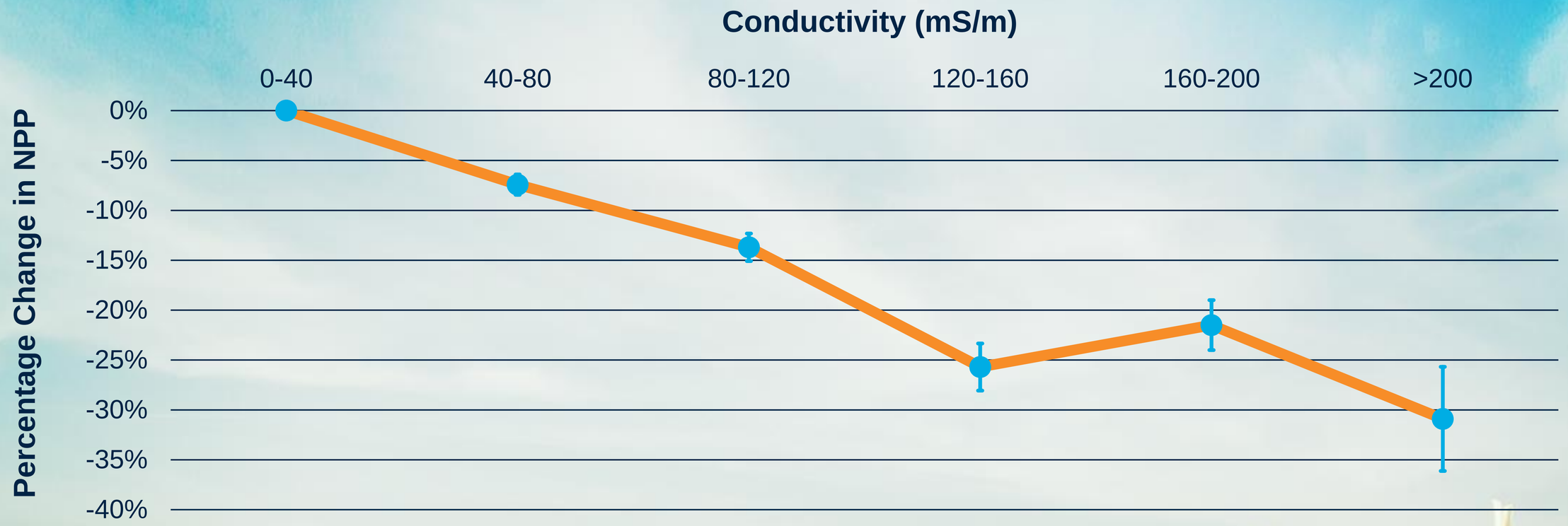
Salinity Risks

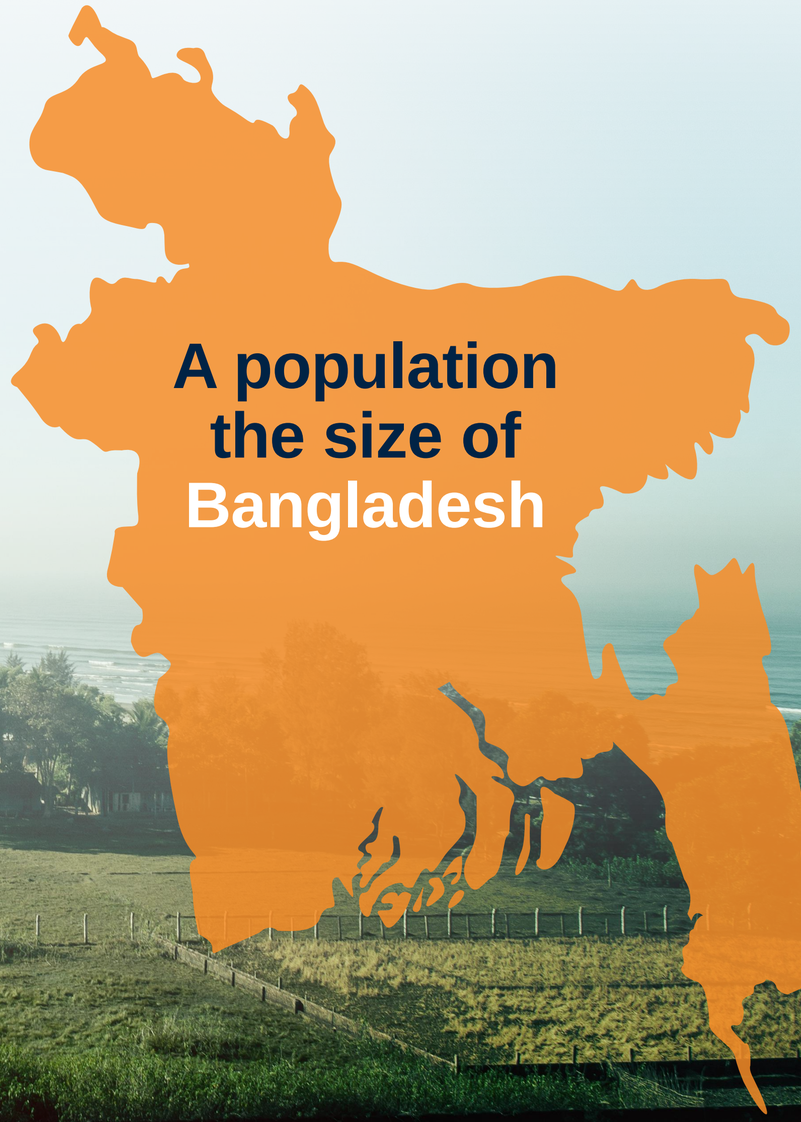


Agricultural Production is Sensitive to Varying Levels of Salinity



Saline Water Reduces Food Production

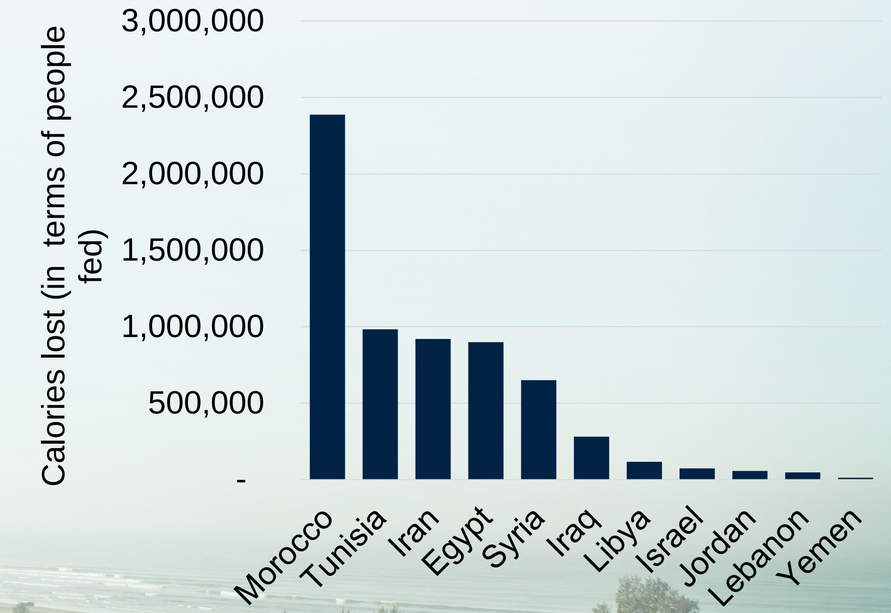
Enough to feed 170M people a year



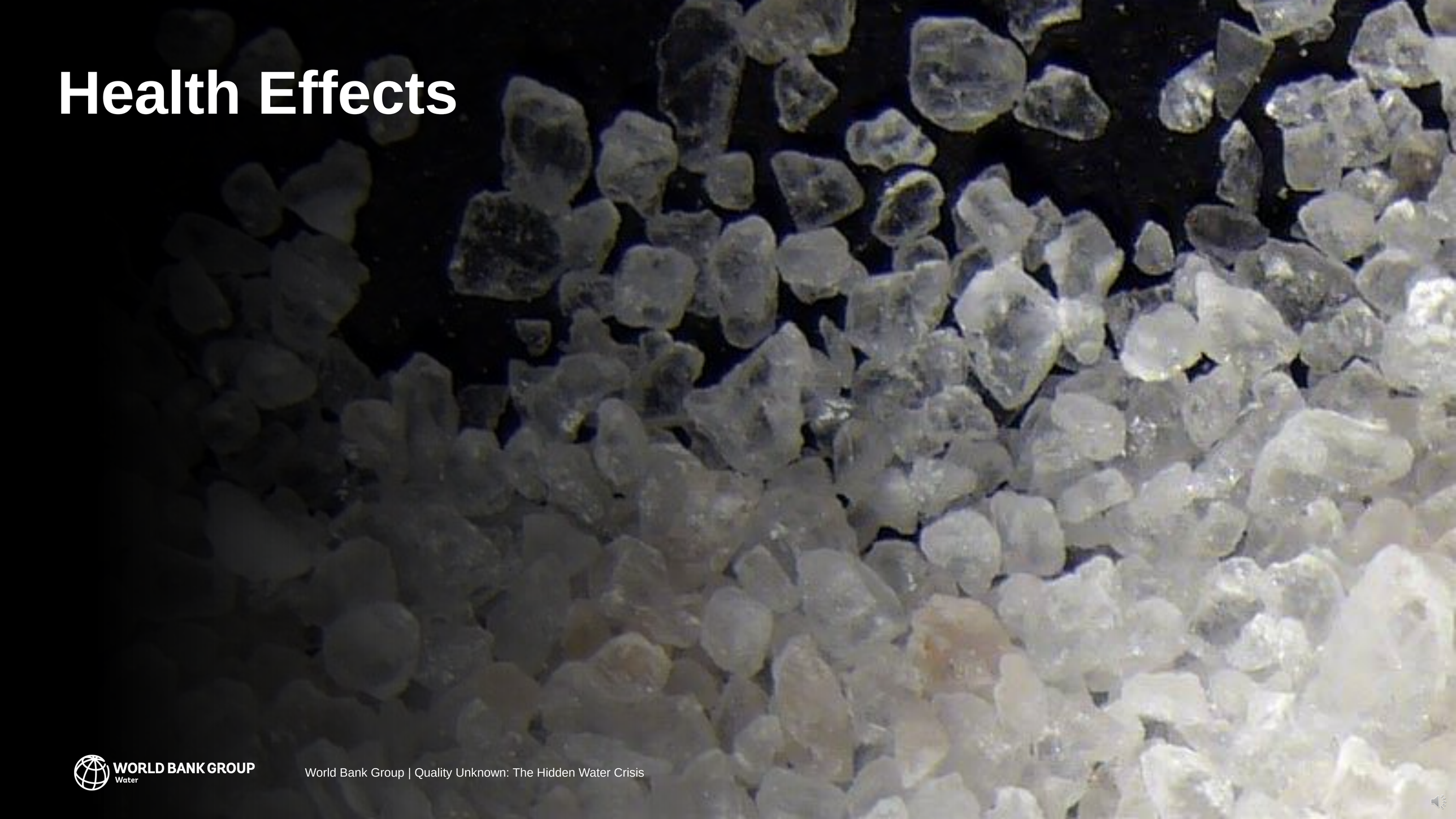
Saline Water Reduces Food Production

In MENA:

Enough to feed



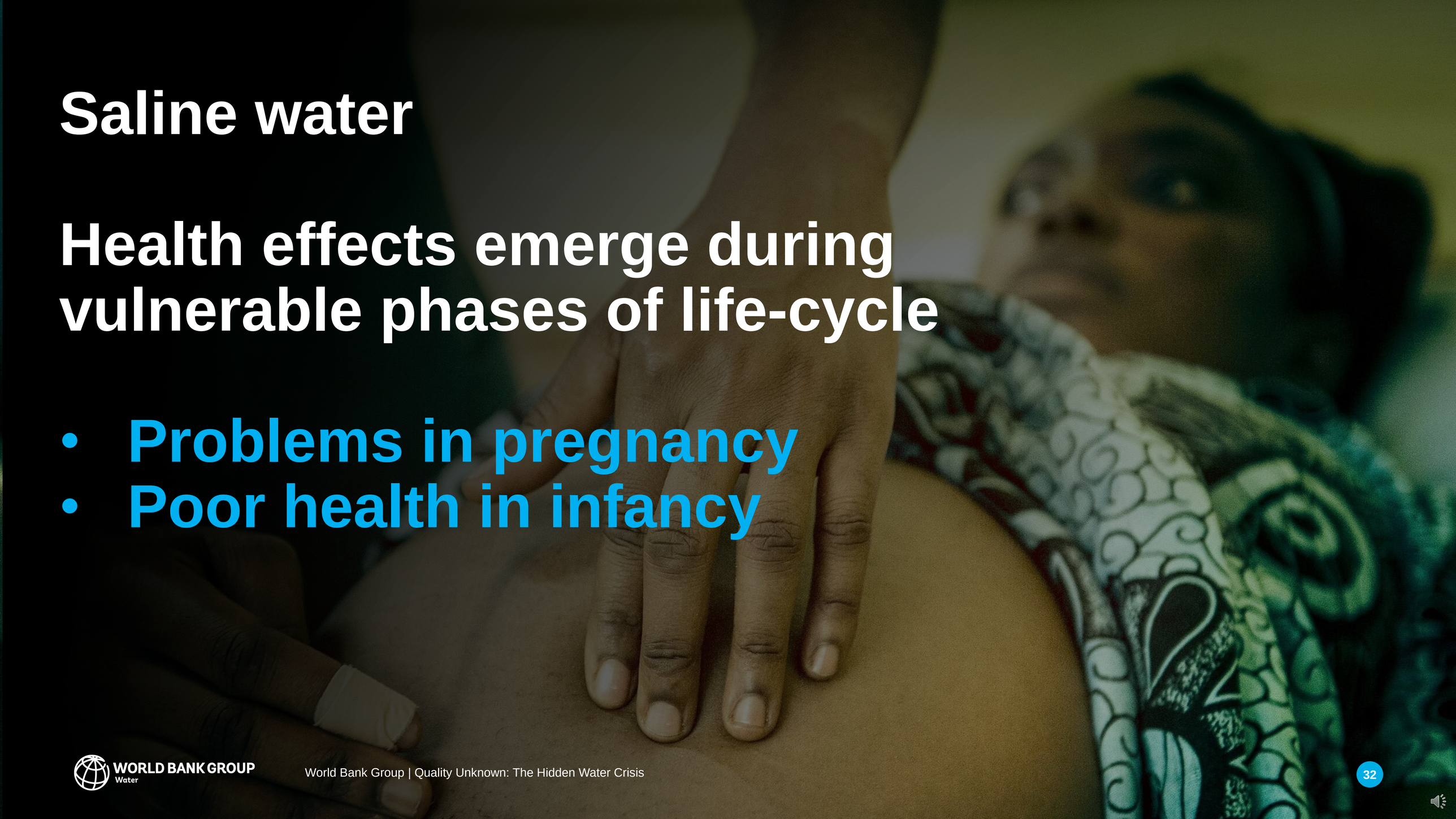
Health Effects



Saline water

Health effects emerge during vulnerable phases of life-cycle

- **Problems in pregnancy**
- **Poor health in infancy**



Salinity at Even Low Levels Impacts Infant Mortality and Infant Health

Colombia

Low Salinity Levels

Bangladesh

High Salinity Levels

But no health based salinity standards for drinking water!

Small Particles with Big Problems

New products- new risk

As countries develop, microplastics and nanoplastics are more prevalent in water.

Pharmaceuticals in our water supply are a new and emerging concern.

Can we quantify the total economic costs of water pollution?

Can we quantify the total economic costs of water pollution?

When BOD exceeds 8mg/L GDP growth declines by 1/3rd

Wicked Problem

Impacts- wider and deeper

Uncertain- scale and timing

Only 3 Options Available

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1. PROACTIVE

Prevent, abate or mitigate

Only 3 Options Available

1. PROACTIVE

Prevent, abate or mitigate

2. REACTIVE

Treat

Only 3 Options Available

1. PROACTIVE

Prevent, abate or mitigate

2. REACTIVE

Treat

3. Passive

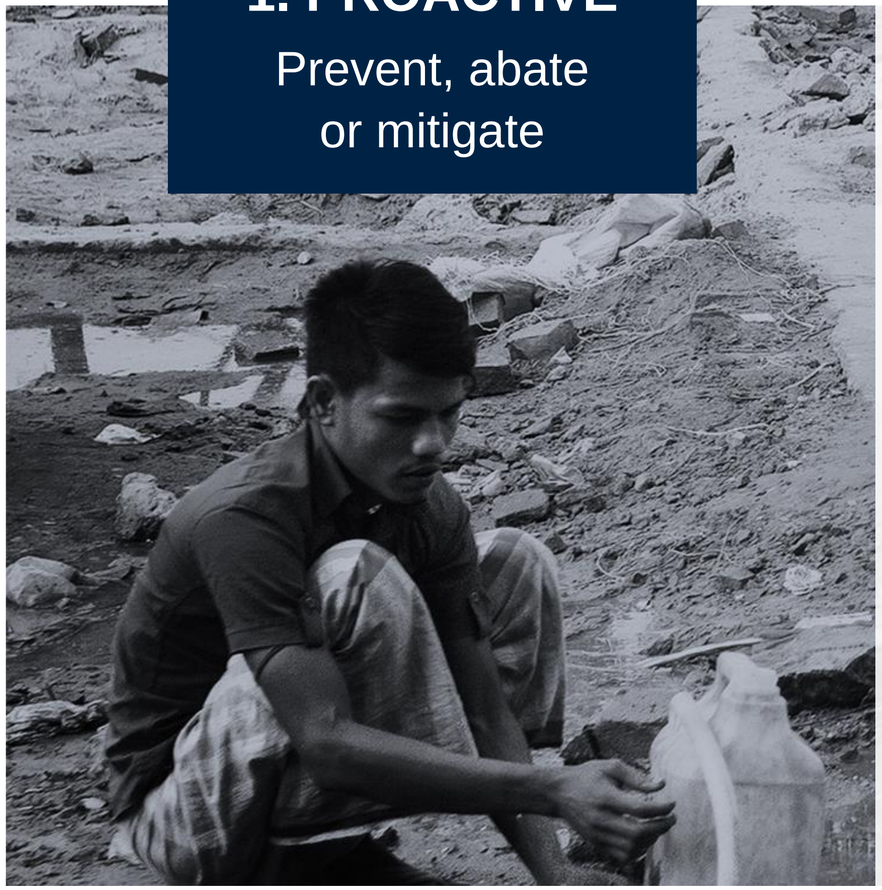
Leave it up to individuals

An Ounce of Prevention is Often Better than a Pound of Cure

Proactive Approaches- more cost effective

1. PROACTIVE

Prevent, abate or mitigate



Regulate emissions

Measure/monitor compliance

Incentivize (enforce compliance)

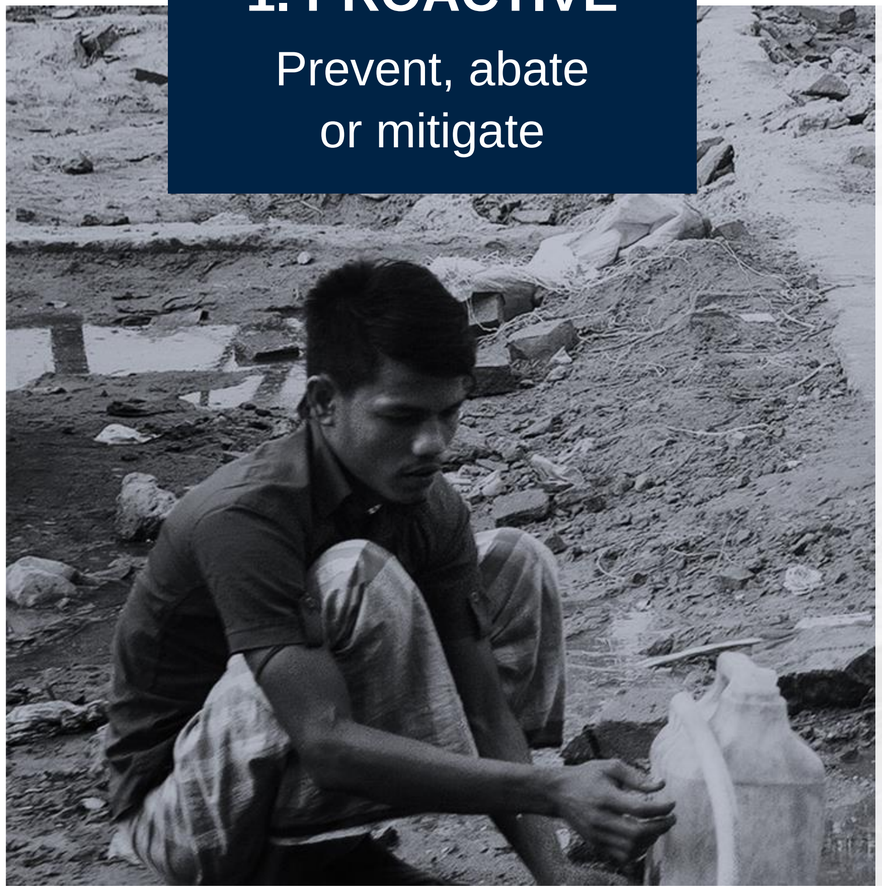
- **Economic instruments (taxes, permits, …)**
- **Command and Control**

An Ounce of Prevention is Often Better than a Pound of Cure

Proactive Approaches- more cost effective

1. PROACTIVE

Prevent, abate or mitigate



Conventional Approaches

- High Capacity needs
- Low Compliance levels

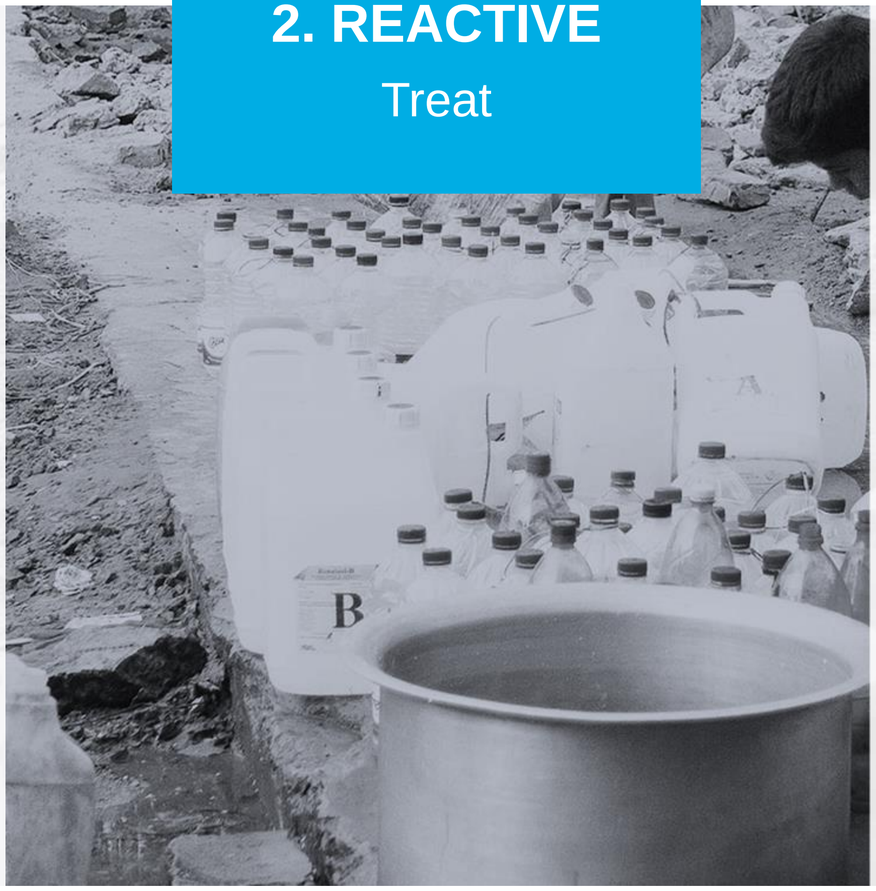
New Possibilities

- Monitoring → Tamper-proof (blockchain, satellite..)
- Enforcement → Smart Contracts

Reactive Approaches

2. REACTIVE

Treat

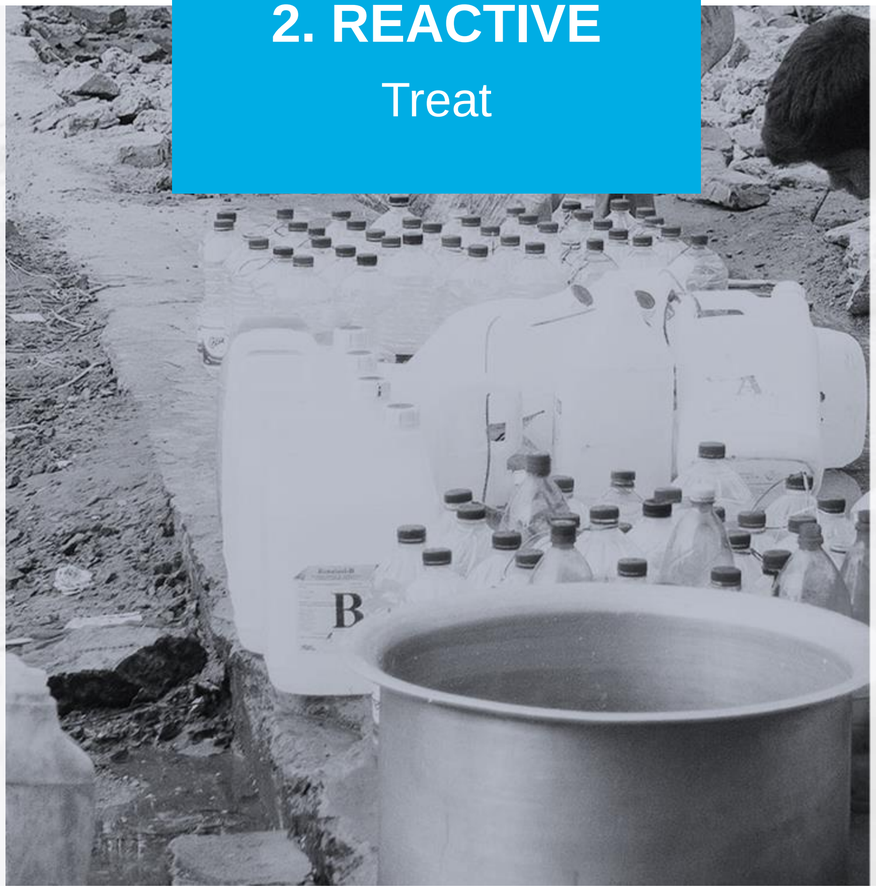


Require better incentives to attract private sector investments.

Reactive Approaches

2. REACTIVE

Treat



Finance- Treatment is costly and public funds limited

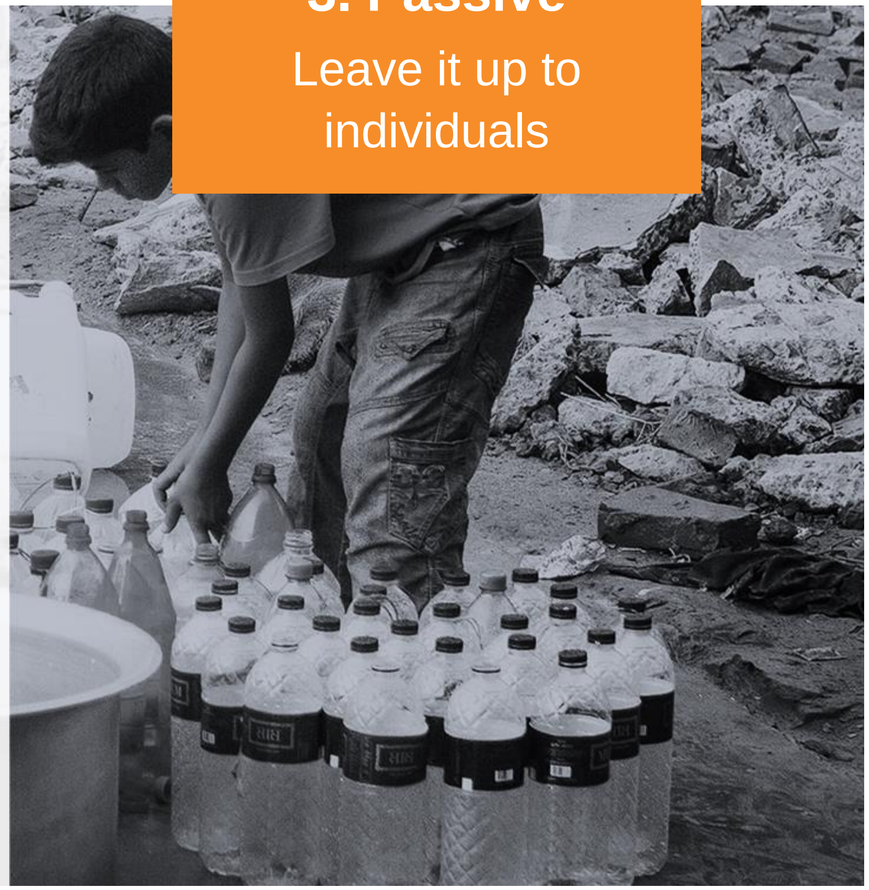
Functionality- evidence of no (low) impact on WQ despite large investments.

"Ignore" (Laissez-faire) Approaches

3. Passive

Leave it up to individuals

Information is a *safety net*, when there is high uncertainty




Threats may be invisible
But the impacts are not
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Water

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World Bank Water Data:
www.wbwaterdata.org

Thank You

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