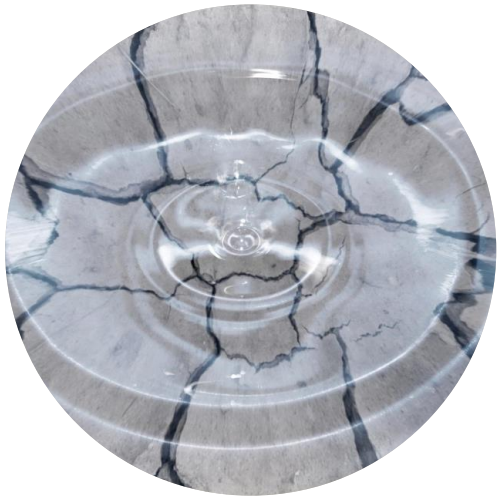
Future Water: Hotspots, Brightspots and Blind spots

Proclias/ISIMIP webinar

Prof Carolien Kroeze, Wageningen University, The Netherlands



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Take home messages

- Worldwide, clean water availability is at stake
- In the future, this may be worse
- Hotspots – most pollution from a few sources – targeted policies
- Brightspots – optimistic scenarios show that clean water availability can be secured worldwide, but may be a challenge in Africa
- Blindspots – we need to avoid tradeoffs and pollution swapping
- Need for multi-pollutant, multi-impact approach

SUSTAINABLE DEVELOPMENT GOALS


SUSTAINABLE DEVELOPMENT GOALS
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

Future Water Challenges

Too much

Too little

Too dirty

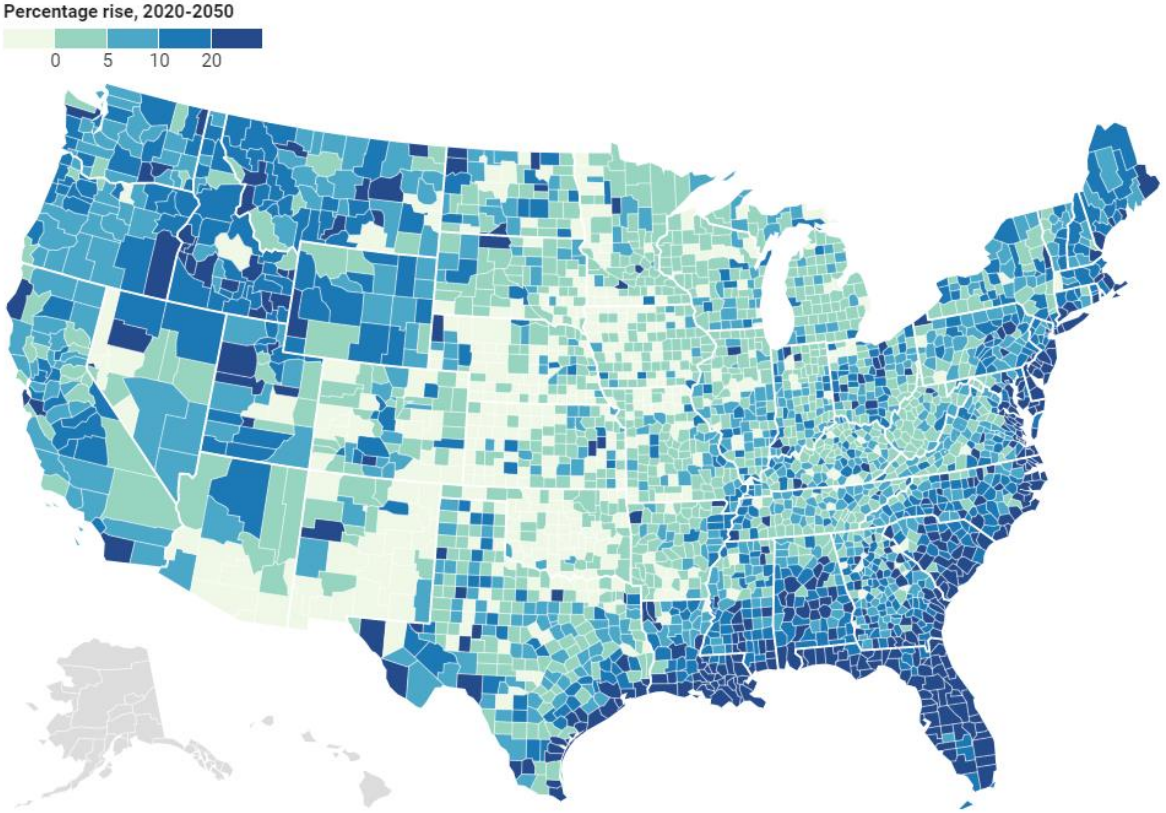
Too much (flooding) – Germany

Germany, July 2021. Photo: Stadt Erftstadt

Too much (flooding) – Pakistan

Where flood risk is projected to rise fastest in the US

A new analysis projects changes in flood risk between 2020 and 2050 by zooming in on every neighborhood across the U.S. The map shows county-level data on the average annual loss due to flood damage.



Flood damage measured in 2020 U.S. dollars.

Map: The Conversation/CC-BY-ND • Source: Wing, et al. 2022 • Get the data • Download image

Too little (droughts) – Europe

Europe faces a future of extreme droughts

Mitigation and adaptation measures are going to be crucial for future farming on the continent

A parched section of the Wayoh Reservoir in August 2018. Photograph: Paul Ellis/AFP/Getty Images

- Summer 2018
- 80% less rainfall across central Europe

Search The Guardian International edition

News website of the year

Too little (droughts) – Europe 2022 may be worse

https://nos.nl/artikel/2440817-europa-s-droogvallende-rivieren-in-beeld

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Future Water Challenges

Too much

Too little

Too dirty

Too dirty:
Nitrogen and Phosphorus (Nutrients)

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Too dirty – Dutch Texel Reserve

GENERAL

Water in the Dutch Texel nature reserve suddenly turns pink again after five years

By taketonews

JUN 24, 2022 Dutch, nature, pink, reserve, suddenly, Texel, turns, water, years

- June 2022
- "***Severe drought*** *on the Wadden Island. As a result, the* ***salt*** *content in the water is* ***high*** *and the* ***oxygen*** *content is* ***low****."* (https://taketonews.com/)

Too dirty: Pharmaceuticals

This lake was once a thriving waterbody, it now receives pharmaceutical waste flowing in through open nallahs. Photo: Shailendra Yashwant

Too dirty: Pathogens

Children fetch water as the cows also take from the same point in Amudat district (PHOTO/File).

Too dirty: Plastic

Future Water – The need for clean water

- Drinking water
- Irrigation water
- Industrial water
- Water for nature




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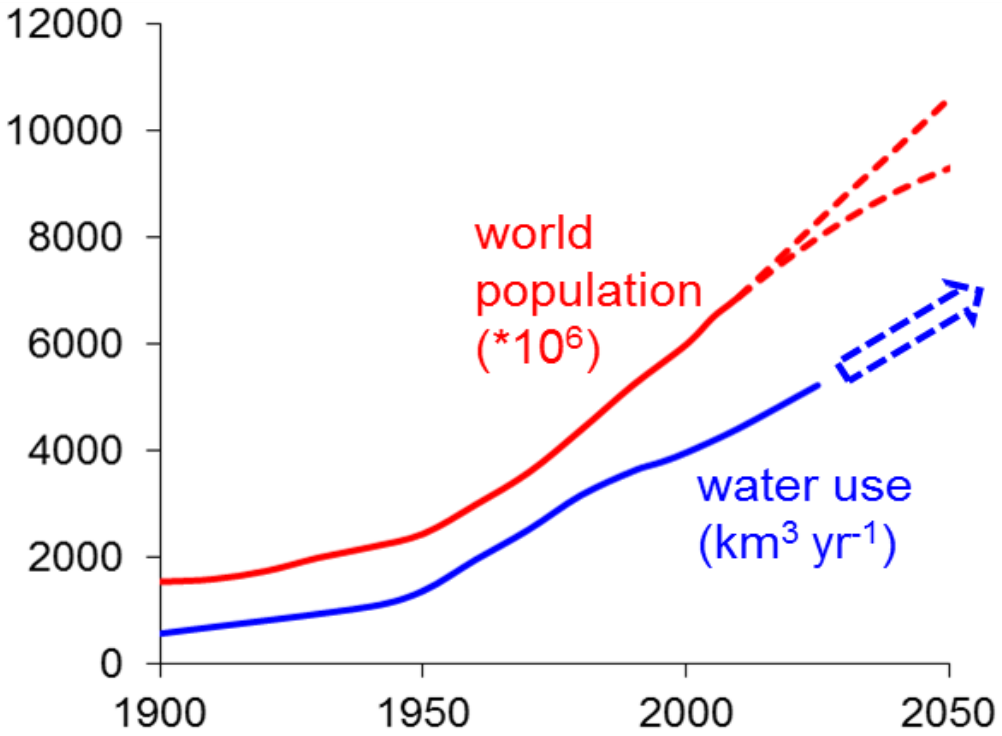
Future Water –
Demand for water is increasing



Based on data of Gleick et al. (2003) Science

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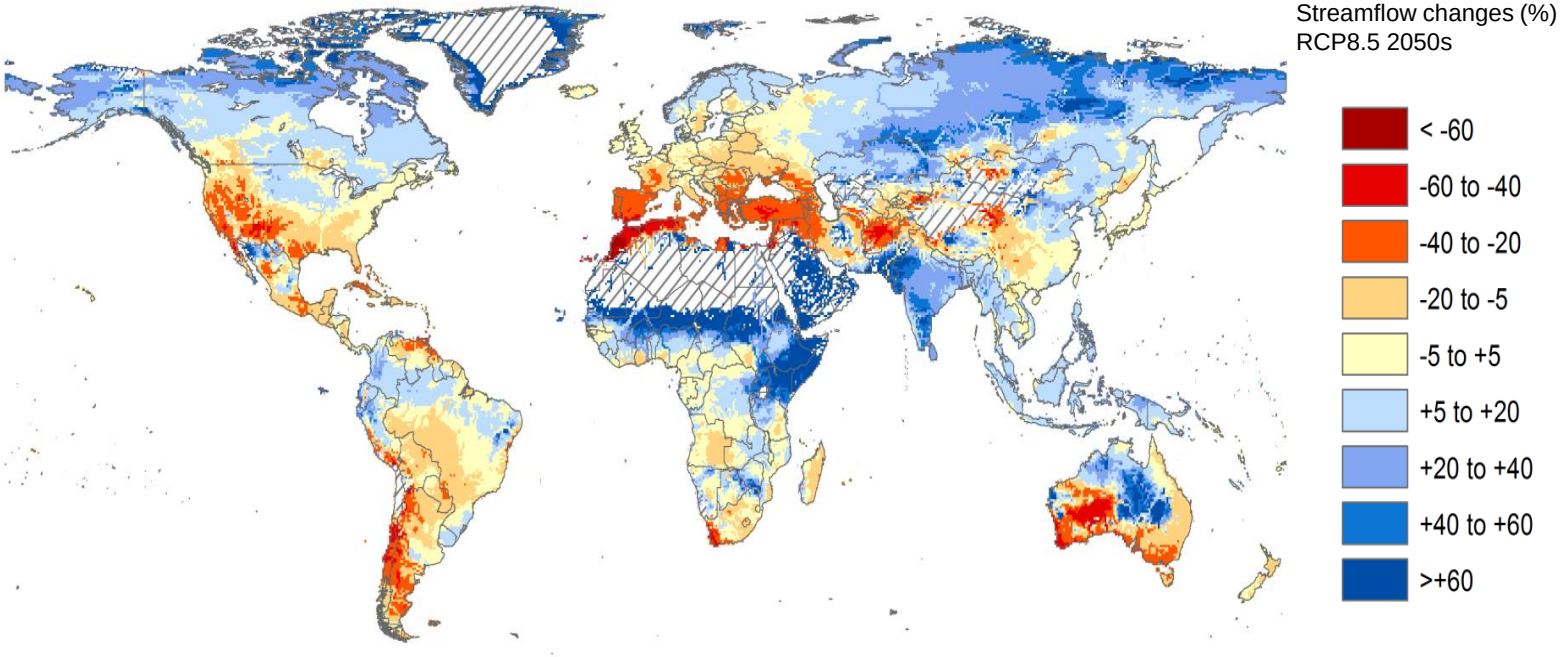
Future Water –
Climate change impacts on streamflow



van Vliet et al (2016), nature cc

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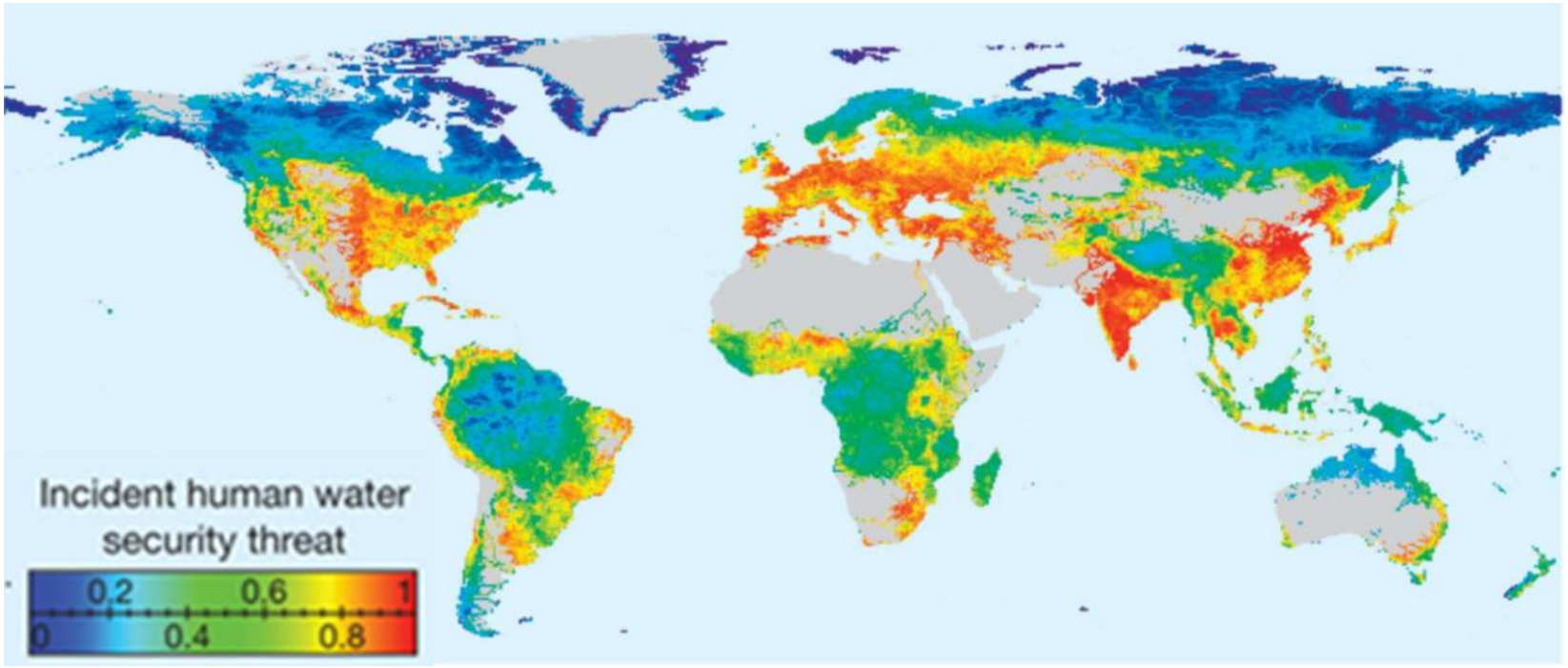
Future: More water stress worldwide

Increasing water demand

Changing water availability

Increasing water pollution

Water security at risk for 80% of the world population



CJ Vörösmarty *et al. Nature* **467**, 555-561 (2010) doi:10.1038/nature09440

Future Water - Pollution

- **Hotspots** of pollution
- **Bright spots** of transitions in society
- **Blind spots** in environmental policy

Future Water

- **Hotspots of pollution**
- Bright spots of transitions in society
- Blind spots in environmental policy

Hotspots of pollution

- 80% of water pollution from 20% of the sources
    - Hotspots: urbanization and food production
- Water pollution hotspots overlap for many pollutants
- Opportunity for focused pollution control
- In the future: more and more an urban problem
    - over two-thirds of the world population is urban in 2050

Water Research 209 (2022) 117906

Contents lists available at ScienceDirect

Water Research

journal homepage: www.elsevier.com/locate/watres

Multi-pollutant assessment of river pollution from livestock production worldwide

Yanan Li [a,b,*], Mengru Wang [b], Xuanjing Chen [c], Shilei Cui [a], Nynke Hofstra [b], Carolien Kroeze [b], Lin Ma [d], Wen Xu [a,*], Qi Zhang [a,b], Fusuo Zhang [a], Maryna Strokal [b]

npj | urban sustainability

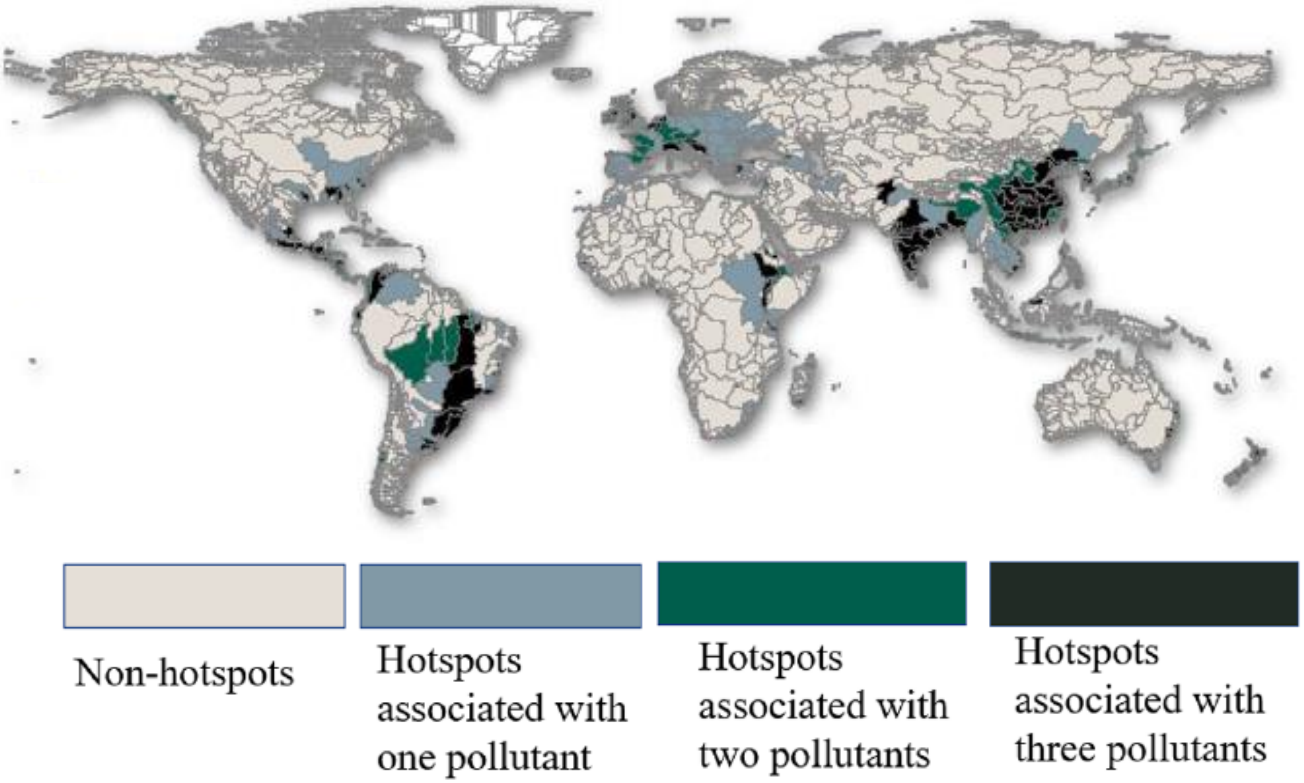
www.nature.com/npjUrbanSustain

ARTICLE OPEN

Urbanization: an increasing source of multiple pollutants to rivers in the 21st century

Maryna Strokal[1], Zhaohai Bai[2], Wietse Franssen[1], Nynke Hofstra[1], Albert A. Koelmans[3], Fulco Ludwig[1], Lin Ma[2], Peter van Puijenbroek[4], J. Emiel Spanier[1], Lucie C. Vermeulen[5], Michelle T. H. van Vliet[6], Jikke van Wijnen[7] and Carolien Kroeze[1]

Hotspots of river pollution by N, P and a pathogen from livestock in 2010 (MARINA model)



Li et al., (2022)

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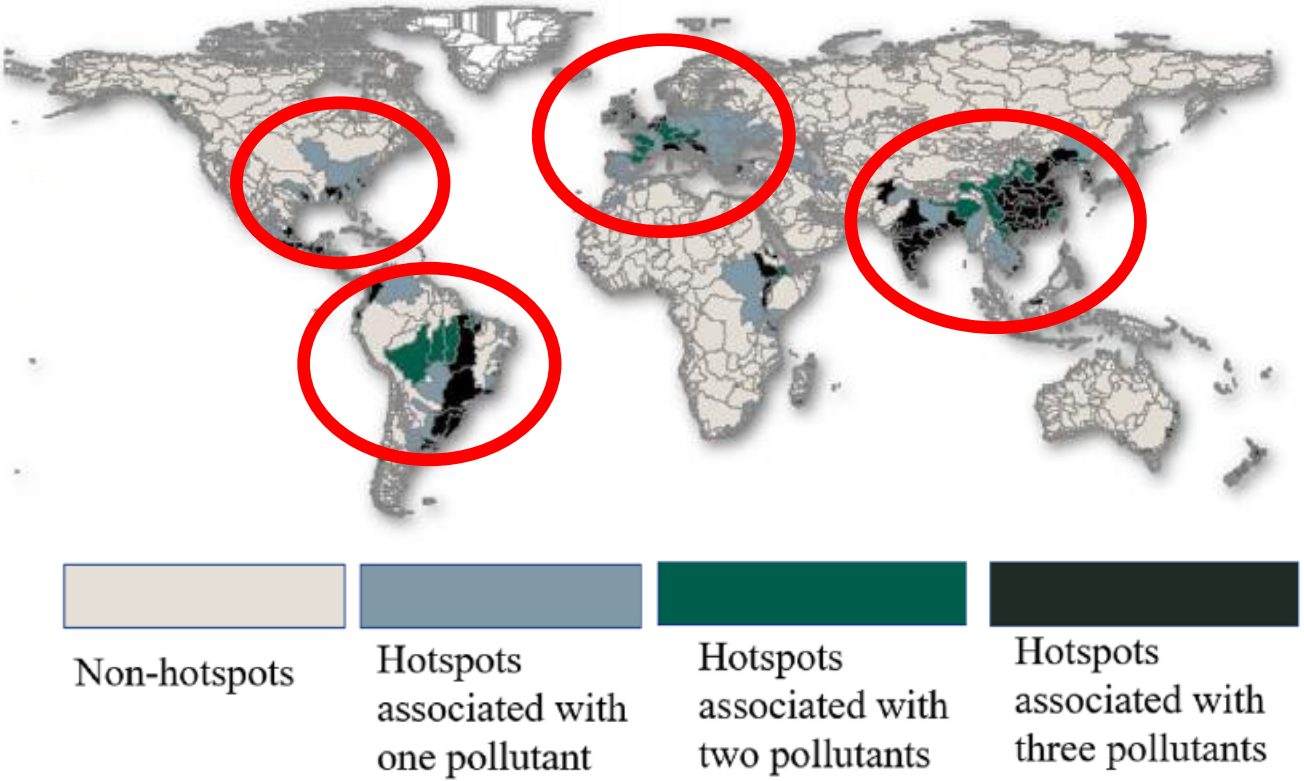


Li et al., (2022)

Hotspots of river pollution by N, P and a pathogen from livestock in 2010 (MARINA model)

Non-hotspots

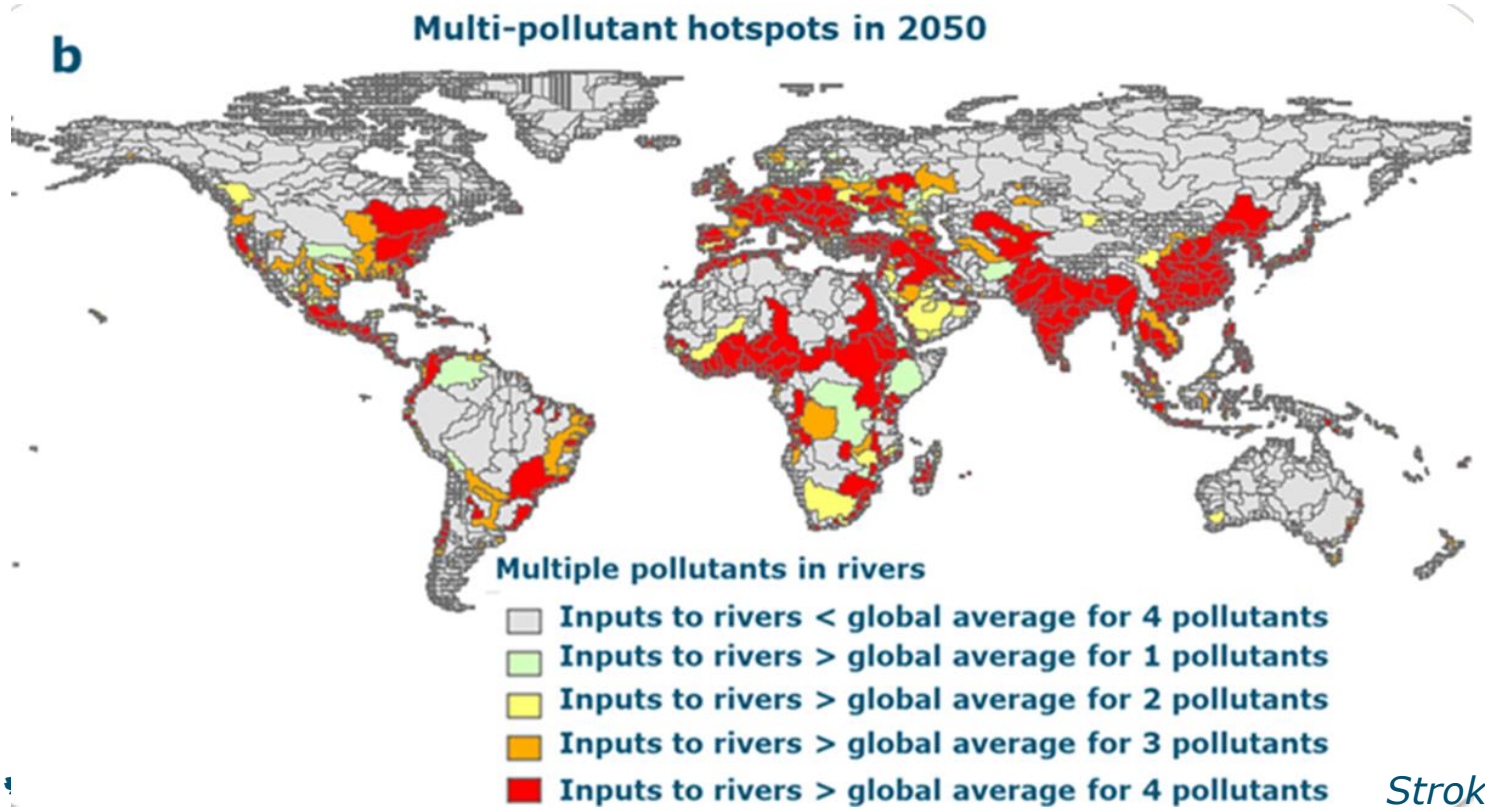
Hotspots associated with one pollutant

Hotspots associated with two pollutants

Hotspots associated with three pollutants

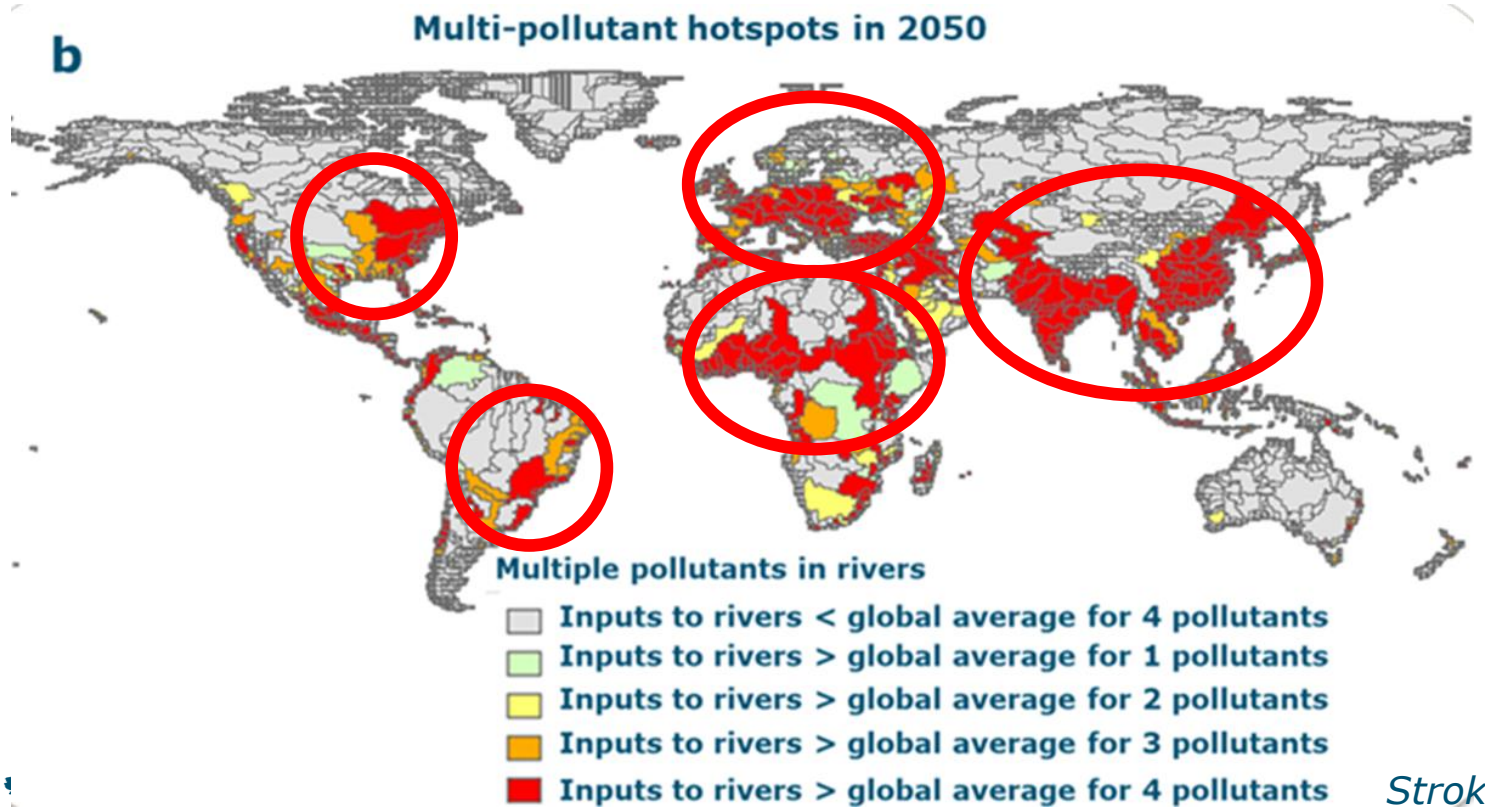
Li et al., (2022)

Hotspots of water pollution from cities in 2050 (MARINA model)



Strokal et al. (2021)

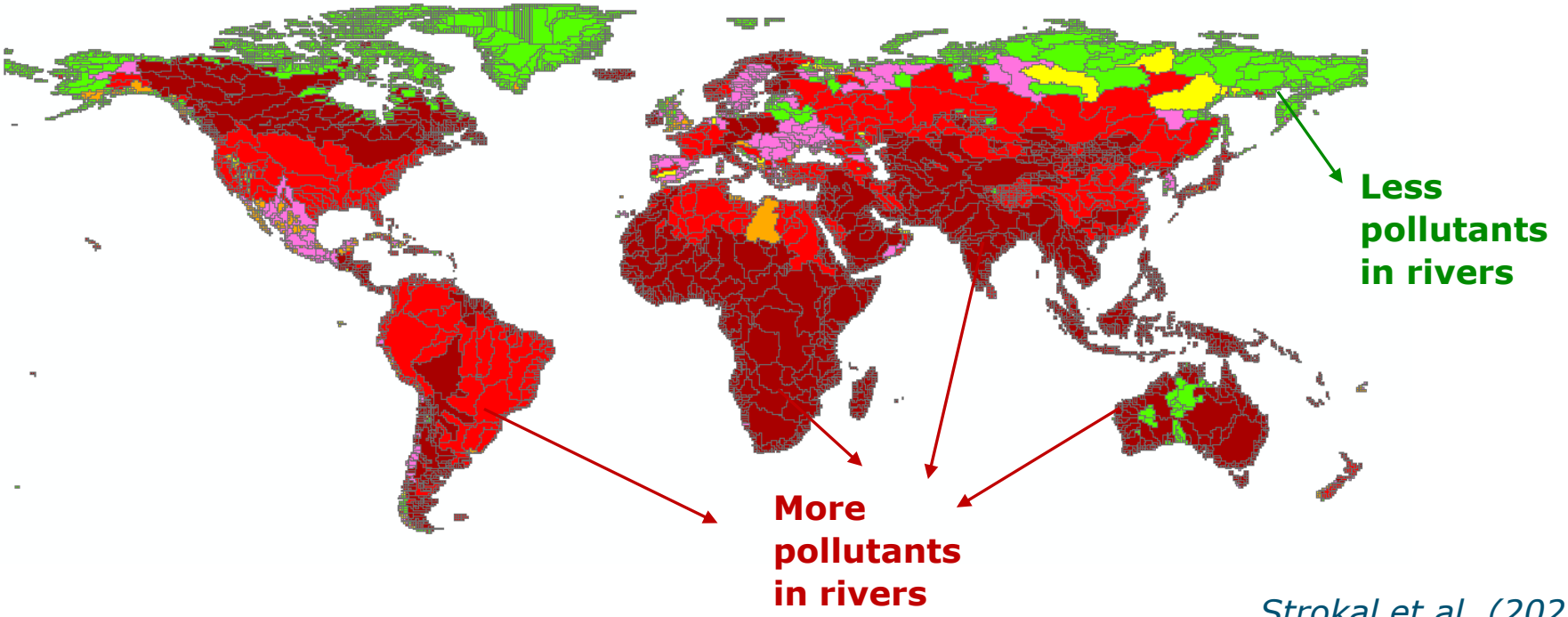
Hotspots of water pollution from cities in 2050 (MARINA model)



Strokal et al. (2021)

Future water pollution (N, P, pathogen) from cities

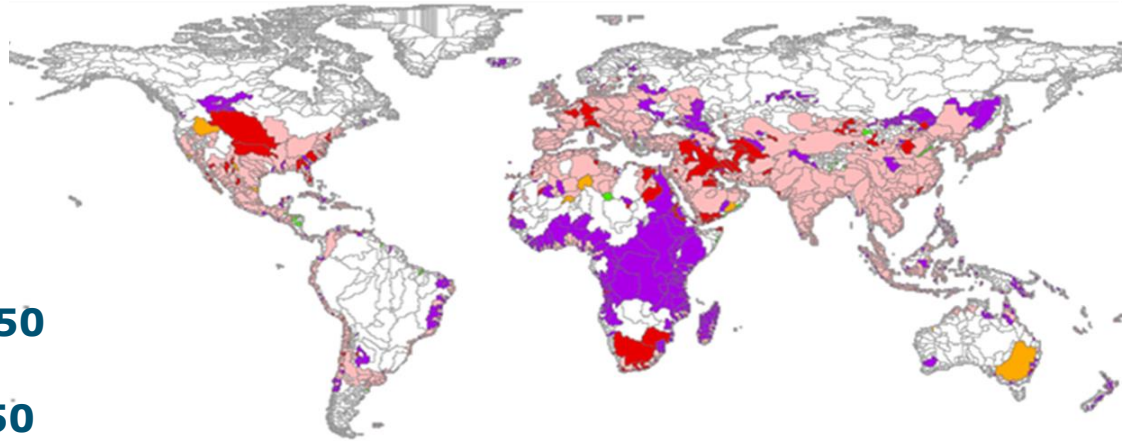
2010-2050 Business-as-Usual scenario



Strokal et al. (2021)

Future hotspots of nitrogen- related water scarcity 2010-2050 (Wang et al. unpublished)

Business-as-Usual Scenario



- **No hotspot**
- **Scarcity hotspot since 2010**
- **Recovered**
- **New pollution hotspot in 2050**
- **New quantity hotspot in 2050**
- **New scarcity hotspot in 2050**

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Future Water

- Hotspots of pollution
- **Bright spots of transitions in society**
- Blind spots in environmental policy

What challenges are for optimistic futures with clean water?

- www.menti.com
- 7513 1476

Future Water

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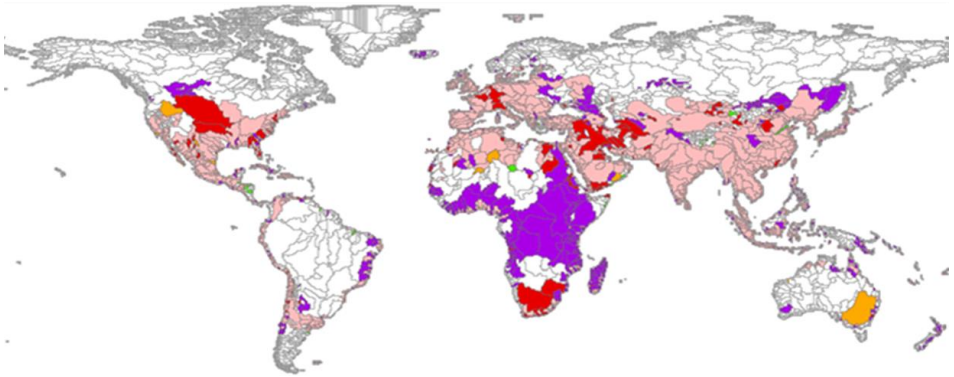

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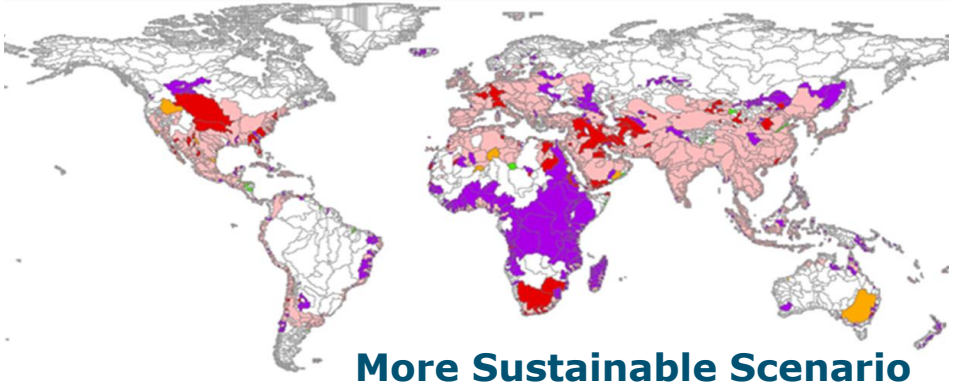
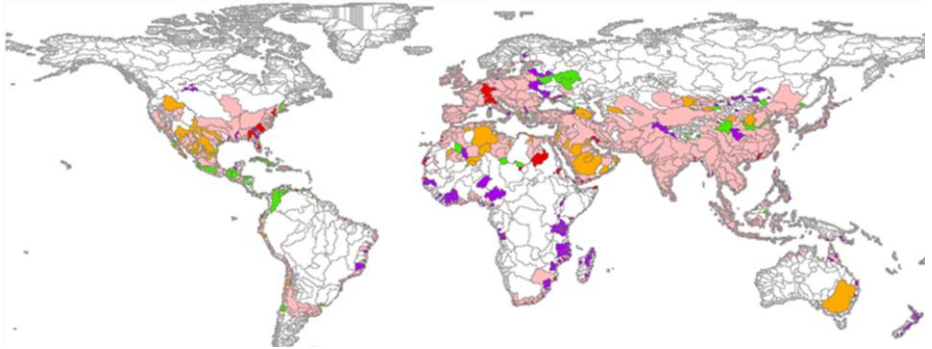
Business-as-Usual Scenario



More Sustainable Scenario



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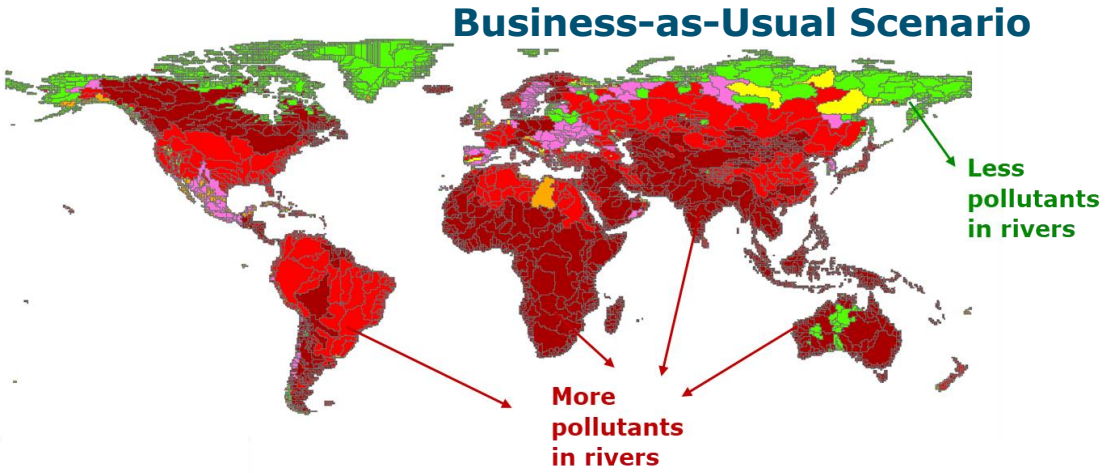
Future water pollution (N, P, pathogen) from cities

2010-2050



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Strokal et al. (2021)

Future water pollution (N, P, pathogen) from cities
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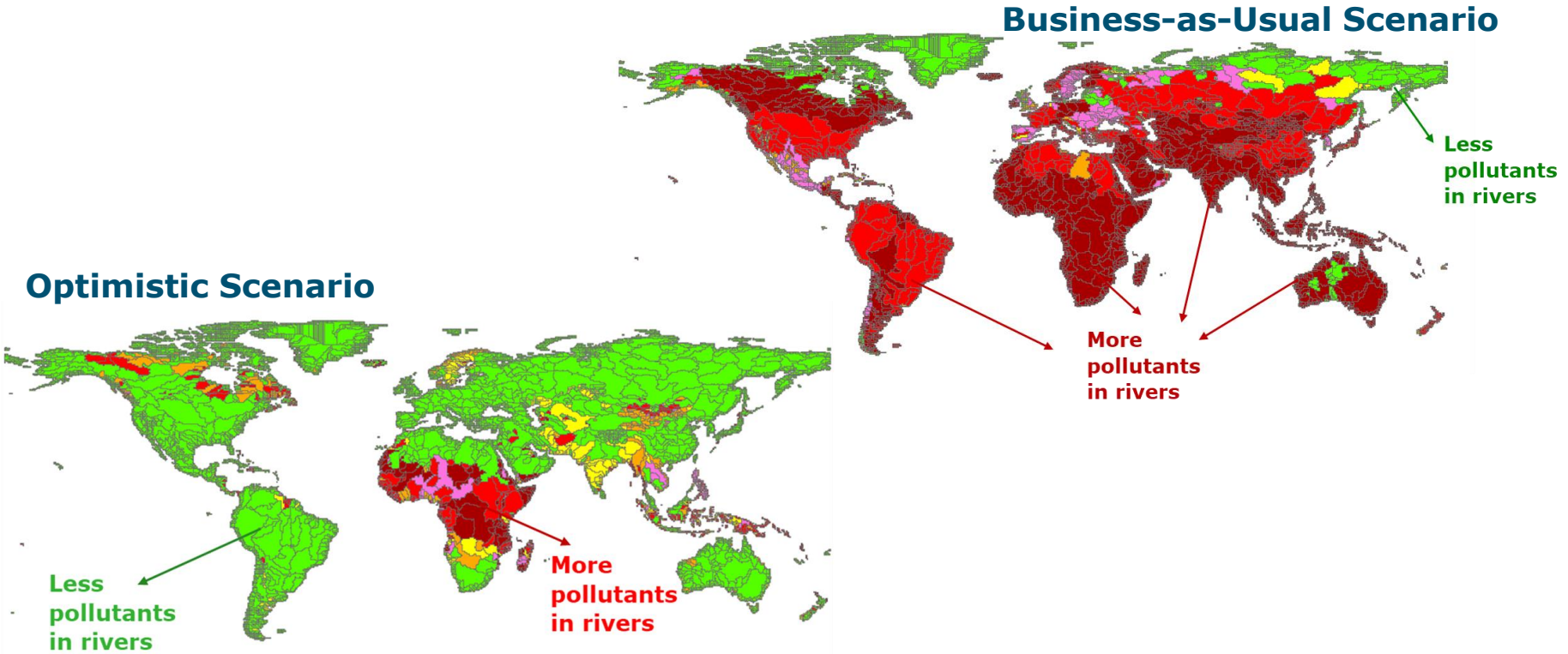

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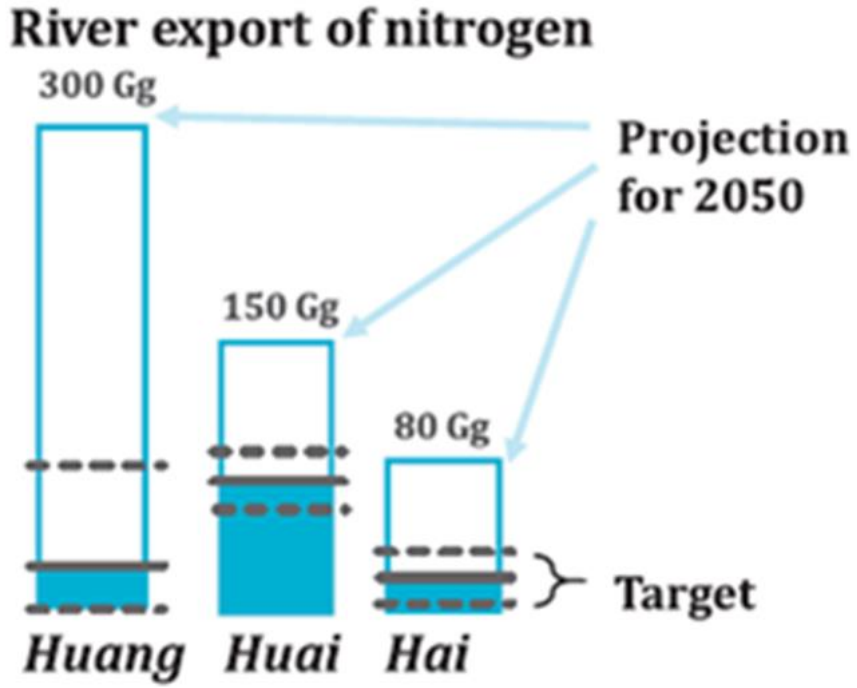
Strokal et al. (2021)

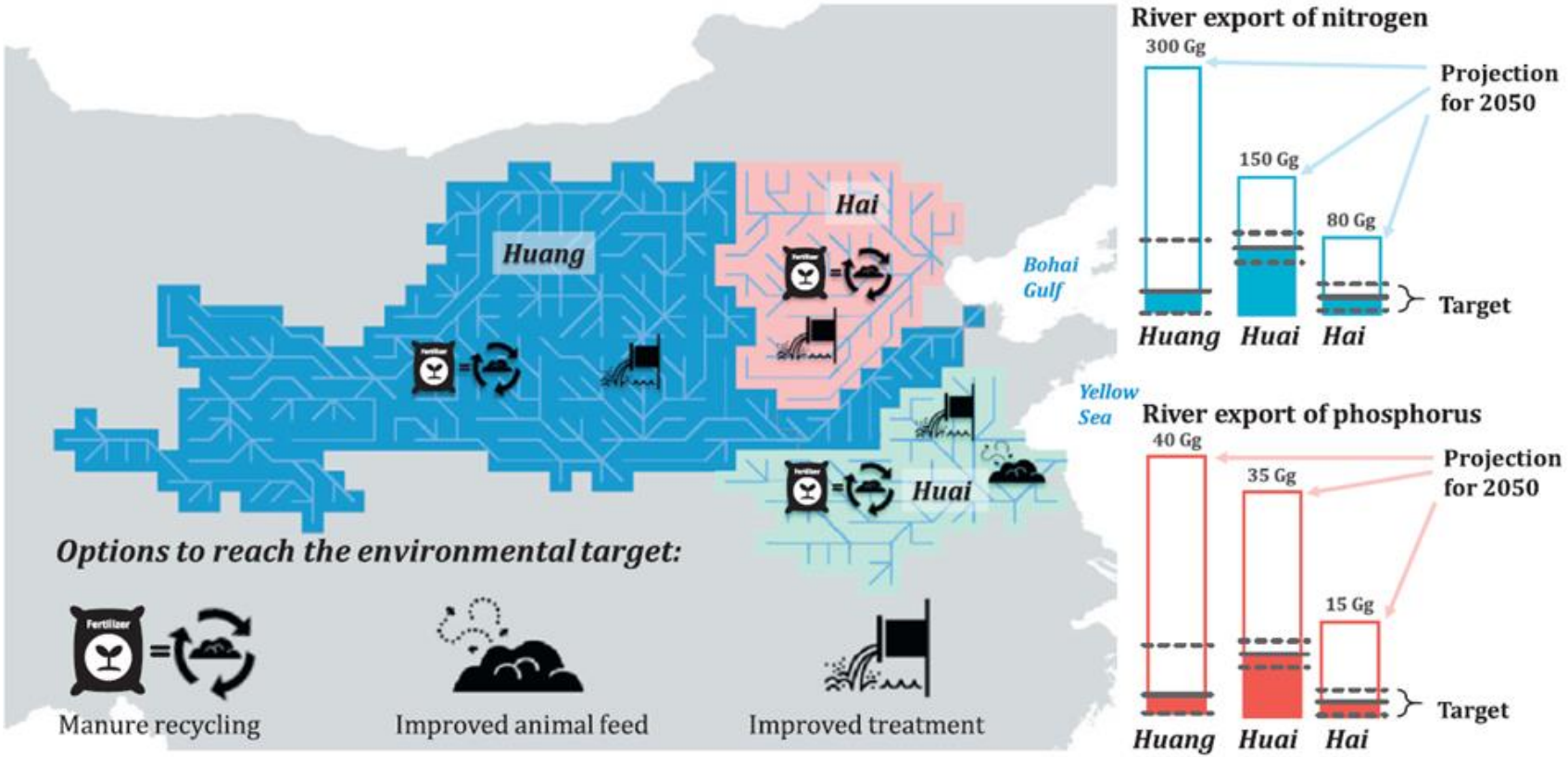
Bright spots

- Promising examples of transition in society
- However, not enough to reach SDG6 (clean water for all) worldwide
- Optimistic futures
- Backcasting
    - what future do we want, and how do we get there?

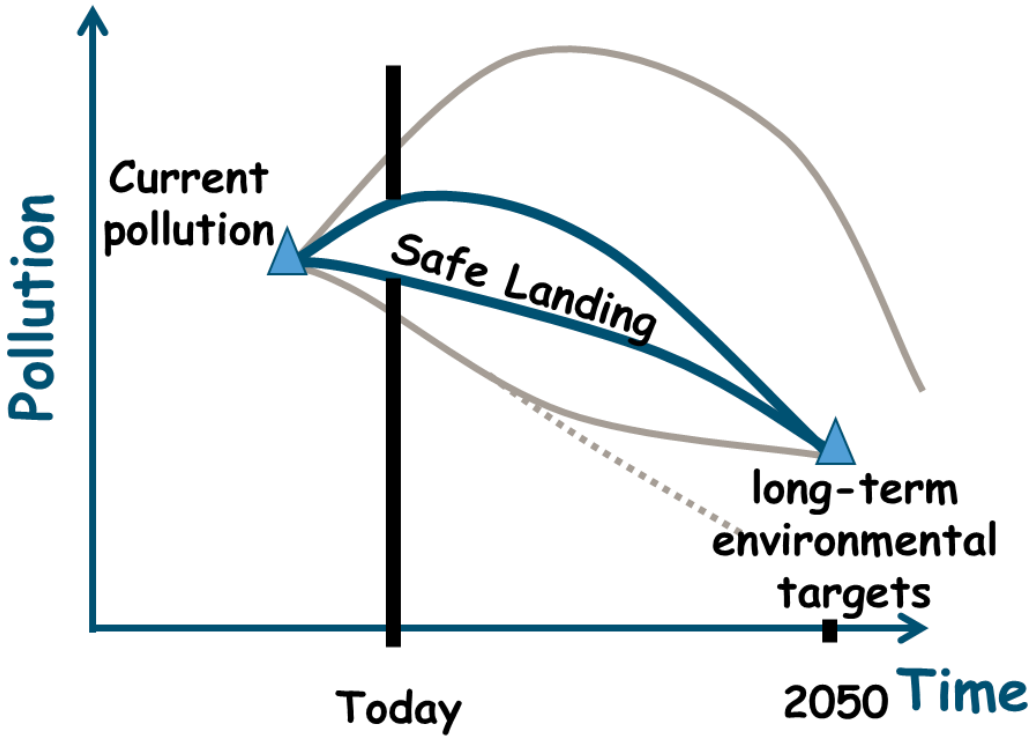
Backcasting: how to reach environmental targets? (Li et al. 2019)



Backcasting: how to reach environmental targets



Long term targets call for short term actions



Optimistic versus Optimal Solutions

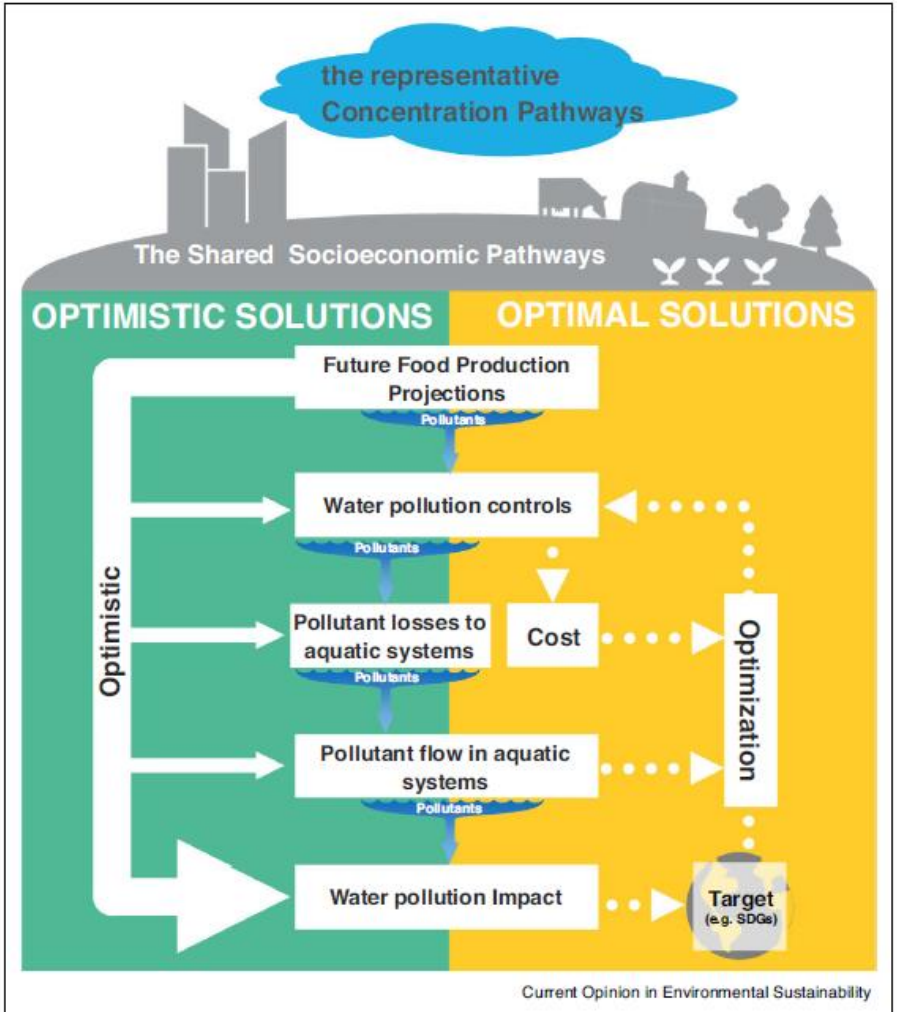
Optimistic

- Maximum feasible pollution control

Optimal

- Minimizing tradeoffs, costs
- Fair allocation of the burden

Li et al. (2019)



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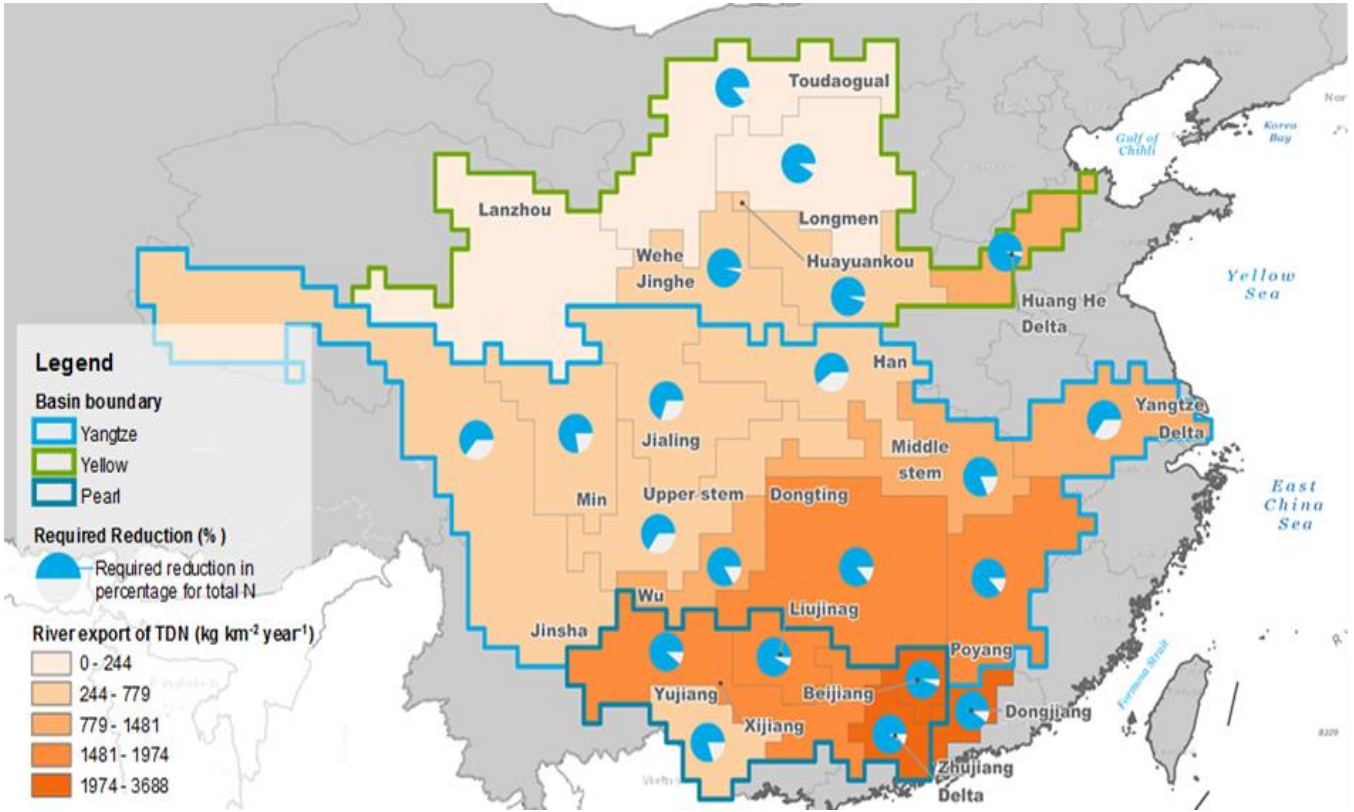
Optimal allocation of pollution rights

(Li et al. 2019)



Future Water

- Hotspots of pollution
- Bright spots of transitions in society
- **Blind spots in environmental policy**
    - **Trade-offs and pollution swapping**

Blind spot – Effects of climate change on water pollution

*"**Climate change** alone may **increase river export of nutrients considerably**: we calculate 24% higher river export of nitrogen and 16% higher phosphorus for a scenario assuming severe climate change compared to the same scenario with low climate change."*

Earth's Future

RESEARCH ARTICLE
10.1029/2019EF001280

Key Points:
- In 2050, rivers in China may be more polluted or cleaner, depending on socio-economic and climatic changes
- Climate change may increase nutrient pollution in rivers and coastal eutrophication in China
- Coastal eutrophication can be reduced by nutrient management and climate mitigation

Global Change Can Make Coastal Eutrophication Control in China More Difficult

Mengru Wang[1,2], Carolien Kroeze[2], Maryna Strokal[2], Michelle T. H. van Vliet[2,3], and Lin Ma[1]

[1]Key Laboratory of Agricultural Water Resources, Center for Agricultural Resources Research, Institute of Genetics and Developmental Biology, Chinese Academy of Sciences, Shijiazhuang, China, [2]Water Systems and Global Change Group, Wageningen University and Research, Wageningen, Netherlands, [3]Department of Physical Geography, Utrecht University, Utrecht, Netherlands

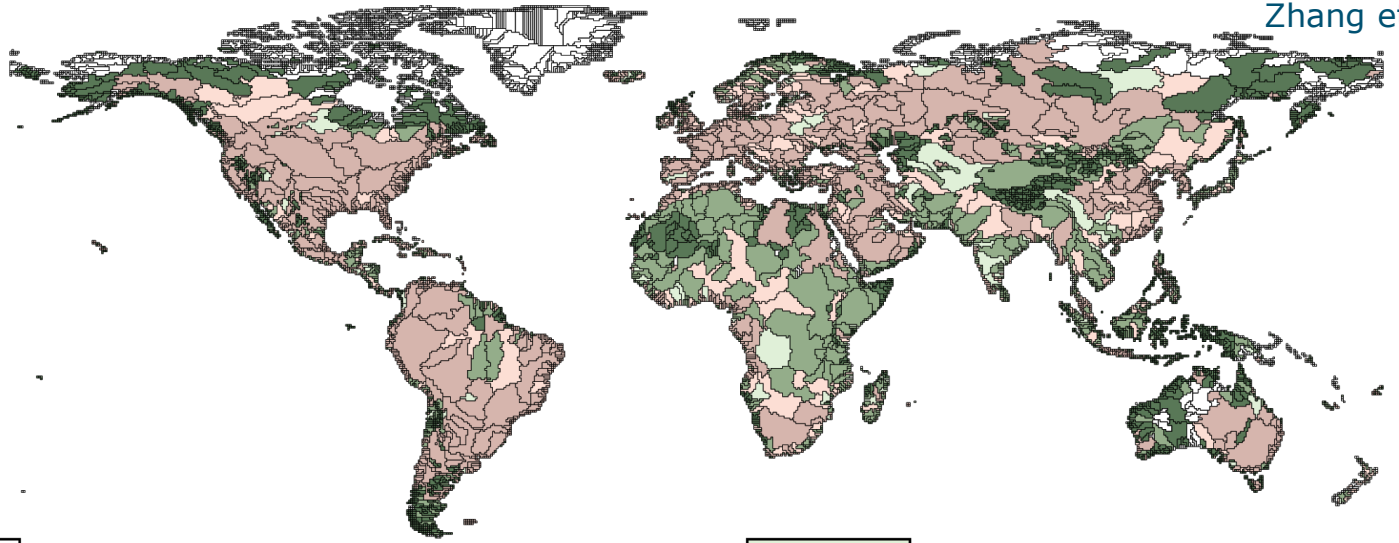
Blind spot – Effects of COVID-19 control on the environment?

- Worldwide
  - More use of plastic (masks, protection materials)
  - More use of soap (hand washing)
  - More use of pain killers

- Implications for water quality?

Blind spot – COVID-19 control resulted in more water pollution (plastic, soap, pain killers)

Zhang et al., (under review)



No data

Less pollution

No increase in pollution

Increase in one pollutant

Increase in two pollutants

Increase in more than two pollutants

SUSTAINABLE DEVELOPMENT GOALS

nature COMMUNICATIONS

ARTICLE

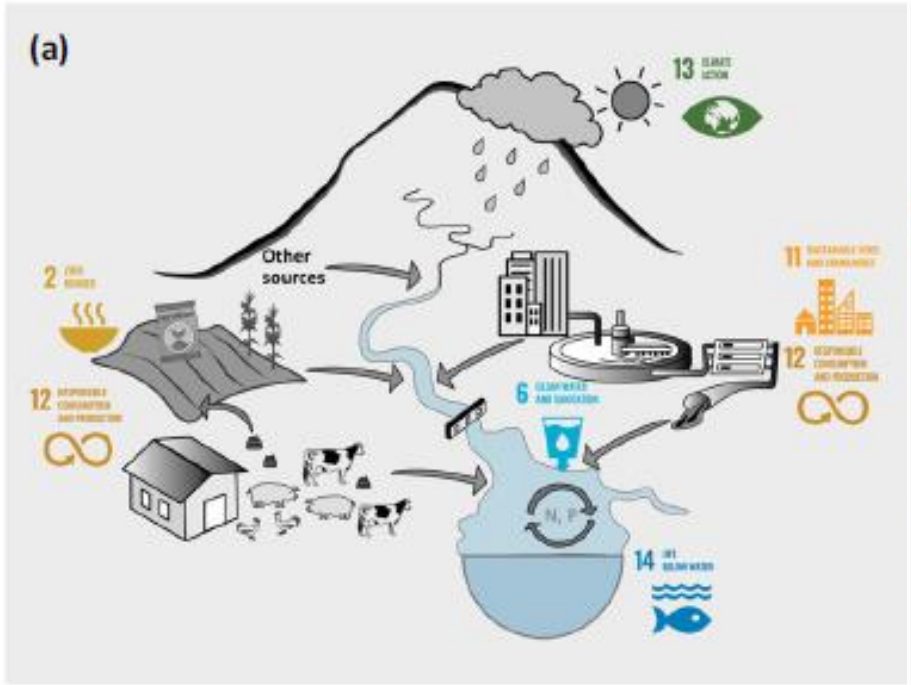
https://doi.org/10.1038/s41467-022-28351-3 OPEN

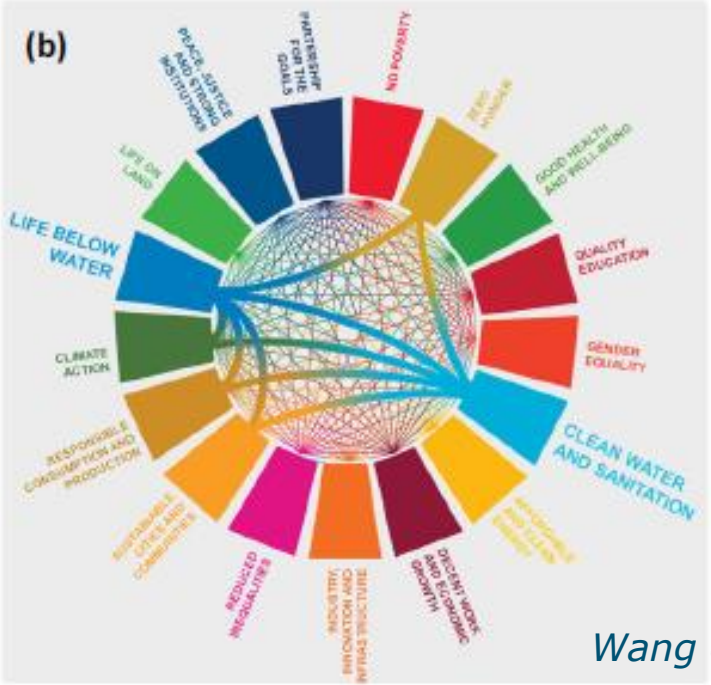
Accounting for interactions between Sustainable Development Goals is essential for water pollution control in China

Mengru Wang[1,2✉], Annette B. G. Janssen[2], Jeanne Bazin[2], Maryna Strokal[2], Lin Ma[1✉] & Carolien Kroeze[2]

319 interactions between Sustainable Development Goals for water sustainability

- **286 synergies** (e.g., water - climate – food)
- **33 trade-offs** (e.g., water – urbanization)





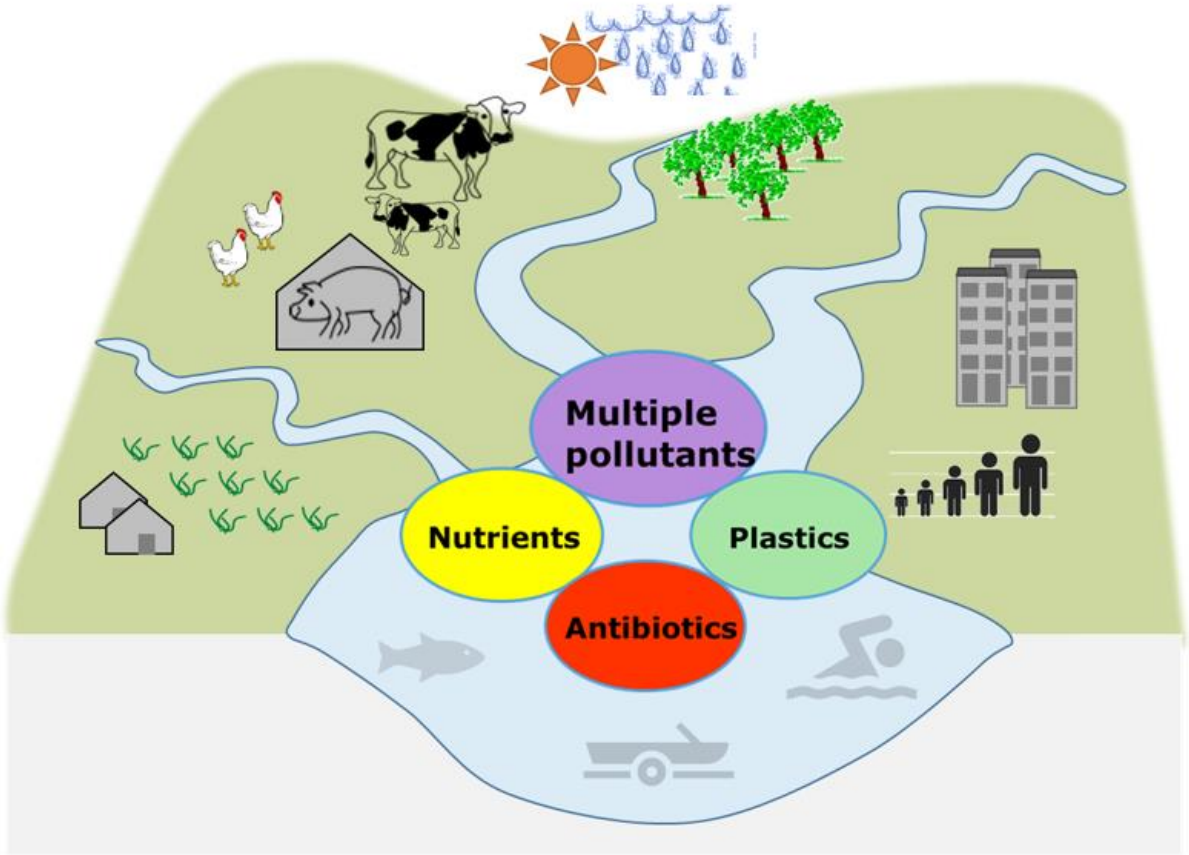
Wang et al., (2022)

A new science agenda

- Multiple sources
- Multiple pollutants
- Multiple impacts

- Need for creative, inclusive and bright solutions

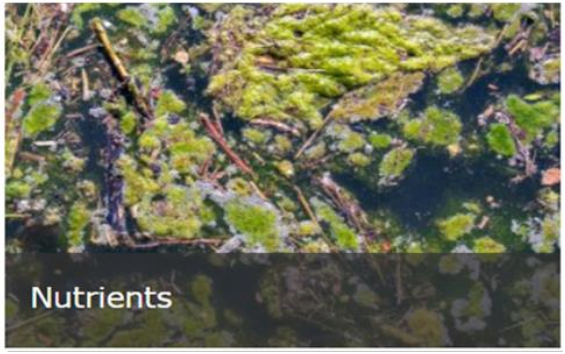
We need a multi-pollutant approach



- Common sources
- Diverse interactions
- Diverse impacts

Strokal et al., (2021)

MARINA: Model to Assess River Inputs of pollutaNts to seAs (Strokal et al. 2021)



- Multiple pollutants
- Climate-water-land-society interactions
- Pollution sources
- Effective solutions

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https://www.wur.nl/en/Research-Results/Chair-groups/Environmental-Sciences/Water-Systems-and-Global-Change-Group/Research-1/Water-Quality/The-MARINA-models.htm

The MARINA models

MARINA Family

In short, MARINA is a **M**odel to **A**ssess **R**iver **I**nputs of pollutaNts to se**A**s.

Contact
dr. M (Maryna) Strokal MSc
Contact form
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Contact
prof.dr. C (Carolien) Kroeze
Contact form

MARINA videos

Curious to learn more about water pollution in general and on how to use the MARINA models? We invite you to take a look at our MARINA video channel.

MARINA video channel

Take home messages

- Worldwide, clean water availability is at stake
- In the future, this may be worse
- Hotspots – most pollution from a few sources – targeted policies
- Brightspots – optimistic scenarios show that clean water availability can be secured worldwide, but may be a challenge in Africa
- Blindspots – we need to avoid tradeoffs and pollution swapping
- Need for multi-pollutant, multi-impact approach

Challenges for optimistic futures

- Grand challenges (climate, biodiversity, water, food)
- Need for transitions in society
- Natural and social sciences
- Involvement of society
- From mono- to multi- to inter- to transdisciplinarity
- Beyond Earth & Environmental Science

Thank you for your attention

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