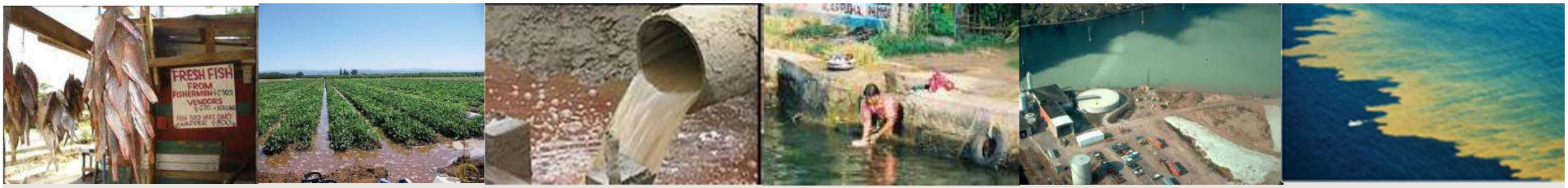

The Global Water Quality Challenge

… and realizing the SDGs

Joseph Alcamo
Inaugural Lecture ♦ University of Sussex, UK
February 2019

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Public water supply is rapidly expanding

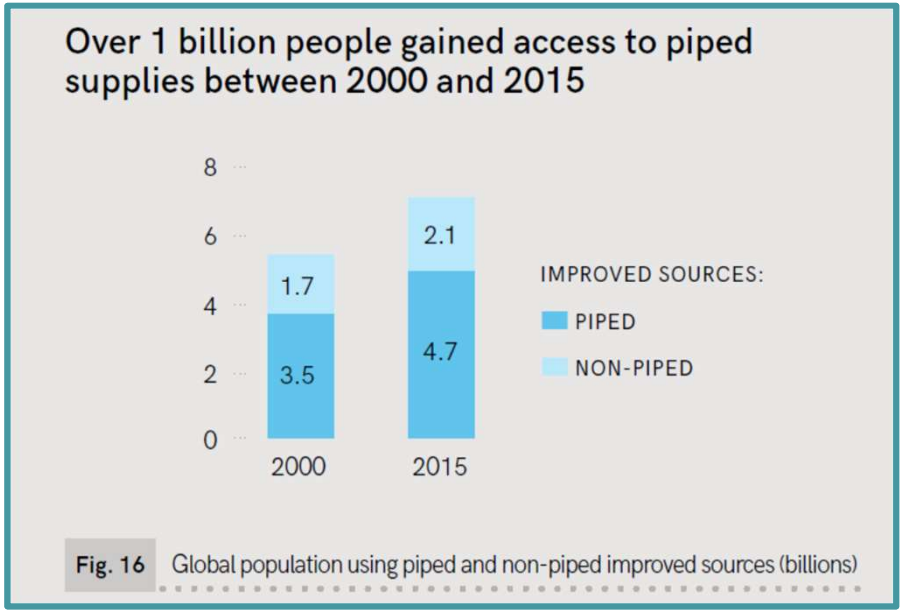


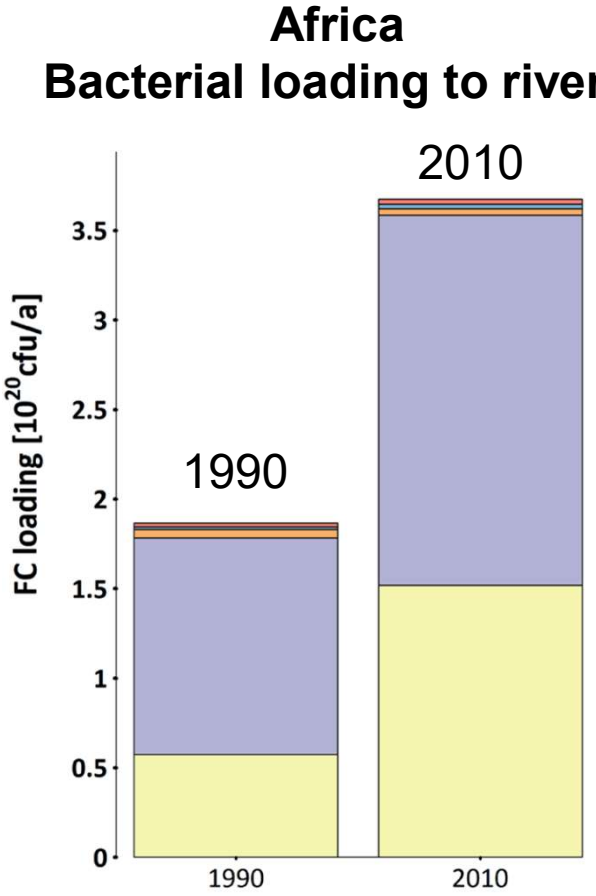
Fig. 16 Global population using piped and non-piped improved sources (billions)

Source: WHO/JMP, 2017

Water quality degradation in LMICs is speeding up

Population growth
+ Increased economic activity
+ Increasing sewerage connections without wastewater treatment

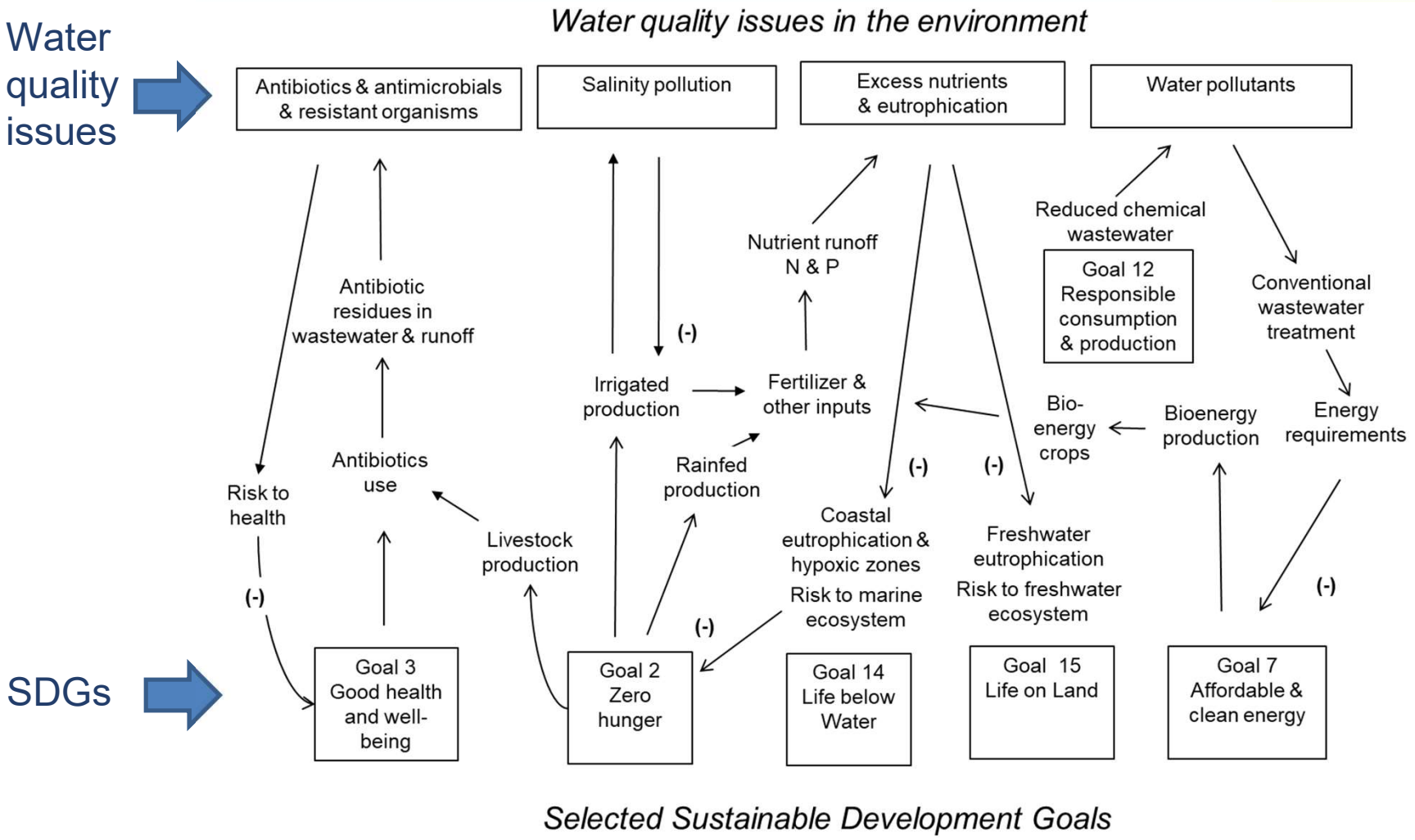
= More untreated wastewater to rivers and lakes.



Source: UNEP. 2016. *A snapshot of the world's water quality: Towards a global assessment*

Why are we concerned about water quality degradation?

Water quality in the context of SDGs



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Alcamo, 2019

Water quality closely linked to public health (SDG #4)

Health risk → people come into contact with contaminated rivers, lakes, other surface waters → washing, cleaning, bathing, collecting water

Literature: ~ 3-35% of rural population in LMICs use surface waters

Examples of diseases associated with contaminated water

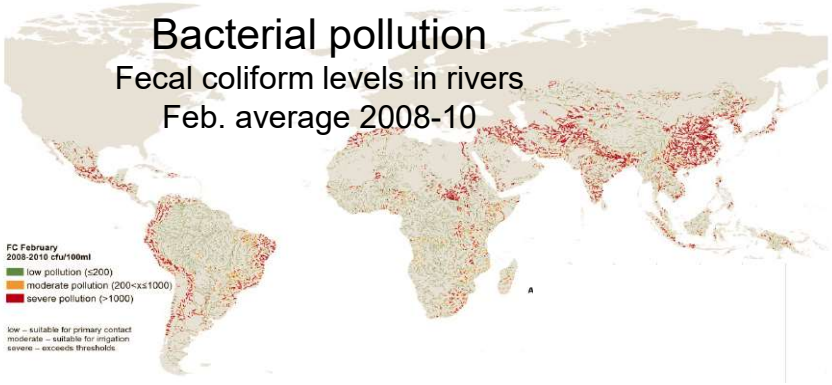
- Diarrhoeal disease: 2 M annual deaths attributable to unsafe water, sanitation and hygiene
- Cholera: > 50 countries still report cholera to WHO
- Schistosomiasis: ~ 260 M people infected

Source: WHO 2015 Facts and figures on water quality and health

Survey in East Africa: 1/3 of people relying on surface waters suffer from intestinal sicknesses.

Water quality closely linked to public health (SDG #4)

First continental estimates of extent of bacterial pollution in South



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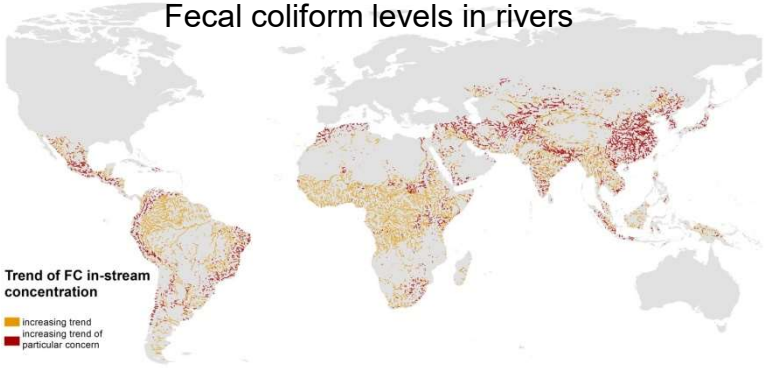

Source: UNEP. 2016. *A snapshot of the world's water quality: Towards a global assessment*

Latin America + Africa + Asia:
≈ 1/3rd total river kms with severe bacterial pollution

≈ 64% total river kms with increasing bacterial pollution (1990-2010)

Total # people in contact with polluted surface waters (2010)

- Latin America 8-25 M
- Africa 32-164 M
- Asia 31-134 M

Scarcity of water for household needs?

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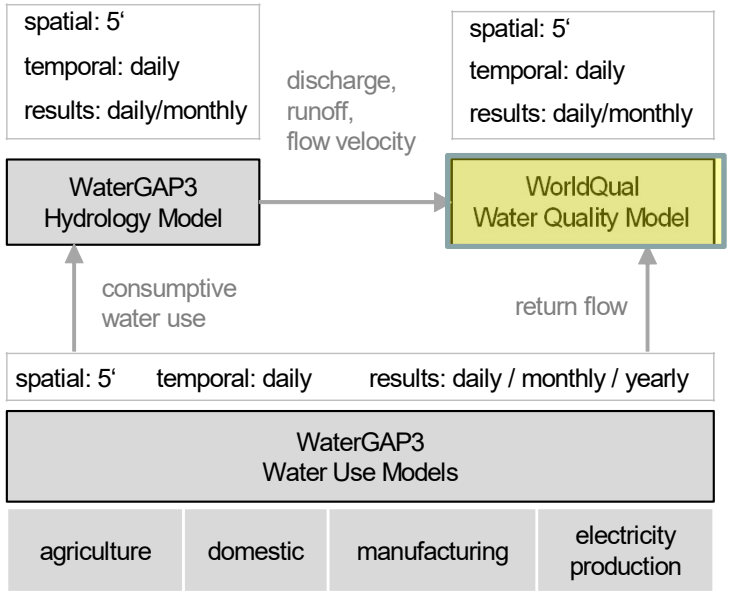
300k k

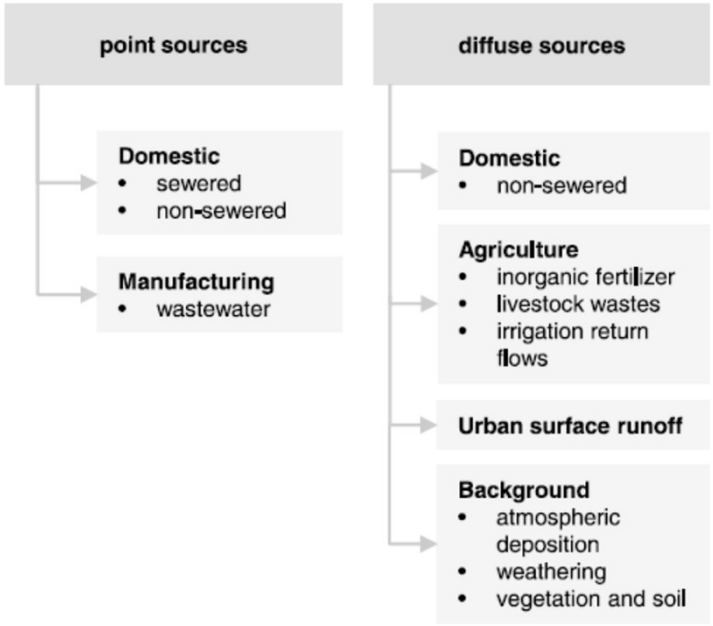
Source of continental estimates: New systems research

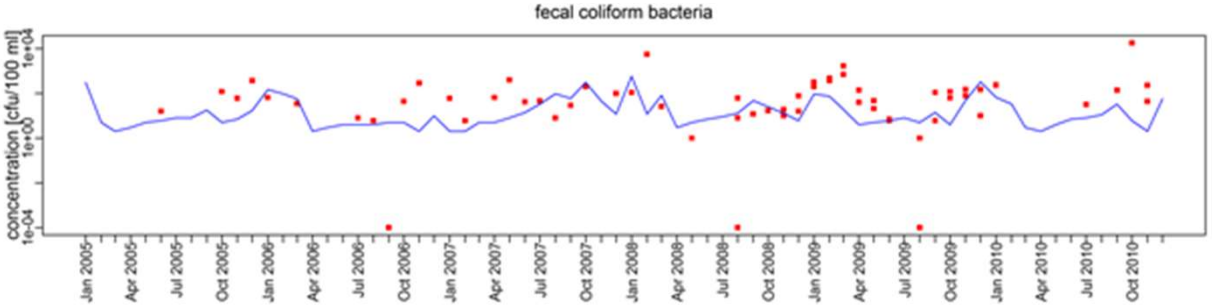
WaterGAP Modelling Framework



WorldQual Model

Water Pollution Categories





Example: Testing the WorldQual model

Station: Vaal River near Joburg 2005-2010

Reder et al. (2017)

Water quality closely linked to food security (SDG # 2) and biodiversity (SDG #15)

Crucial resource: The inland freshwater fishery

Link with food (SDG # 2):

95% inland fishery production from developing world

200 million Africans consume fish regularly

Inland fishery: Substantial contribution to diet
e.g. > 40% of animal protein in Malawi, Bangladesh, Cambodia

Link with livelihood (SDG # 8):

Gross Market Value*:* Inland fisheries in tropics = $US 6 billion/yr

Livelihood: 60 M people worldwide in freshwater fishing industry

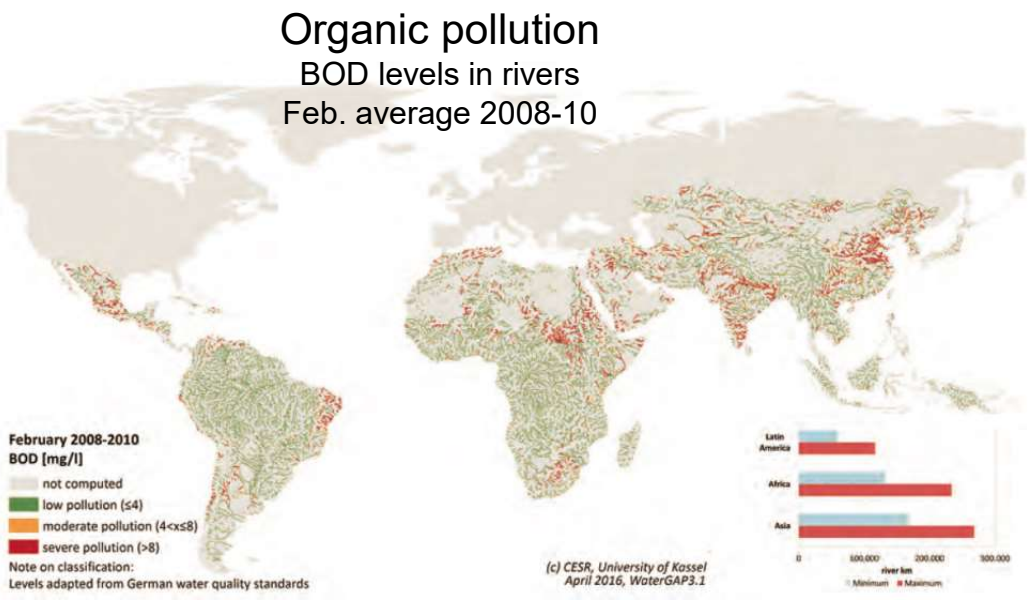
Link with freshwater biodiversity (SDGs # 6 ,15)

21% freshwater fish species in Africa threatened (IUCN, 2010)

Water pollution reduces fish habitat

Water quality closely linked to food security (SDG # 2) & biodiversity (SDG #15)

First continental estimates of extent of organic pollution in South



Source: UNEP. 2016. *A snapshot of the world's water quality: Towards a global assessment*

Organic pollution

Low dissolved oxygen, high levels ammonia, other pollutants

Threat to fish & aquatic ecosystems

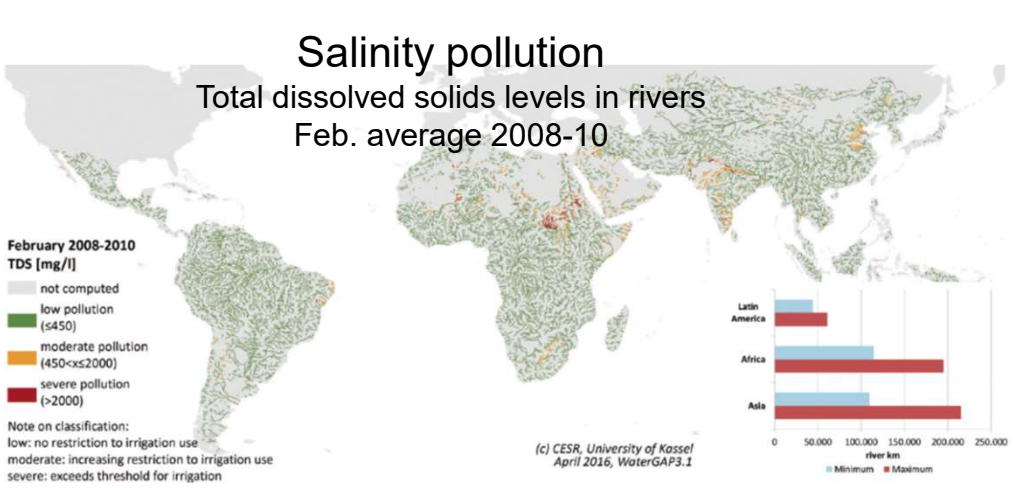
≈ 1/7th all river km's with severe organic pollution

≈ 63% of all river km's with increasing org pollution (1990-2010)

Scarcity of habitat for fish?

Water quality closely linked to food security (SDG # 2)

First continental estimates of extent of salinity pollution in South



Source: UNEP. 2016. *A snapshot of the world's water quality: Towards a global assessment*

Salinity pollution – Constrains water use for irrigation & other purposes

≈ 1/10th of all river km's mod./severe salinity pollution

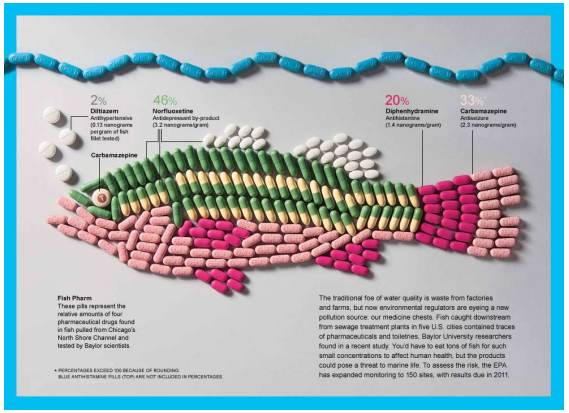
≈ 31% of all river km's with increasing salinity pollution (1990-2010)

≈ 1/3 of irrigated areas in Asia adjacent rivers with high salt content
Floerke, Alcamo. 2016 EGU Proceedings.

Scarcity of suitable water for irrigation?

'Emerging concerns' affecting North and South

Microplastics in freshwaters



Pharmaceuticals & other chemical compounds in freshwaters

<u>Endocrine-disrupting substances</u>

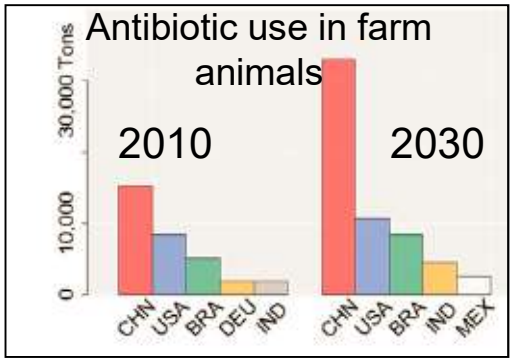
Impact on wildlife, humans?

<u>Antibiotic residuals</u>

Overuse of antibiotics → Antimicrobial resistance

Build-up antibiotic residuals and resistant bacteria in surface waters → Pathway of AMR??

Source of antibiotic residuals: Humans and livestock



Global
×1.67 ↑

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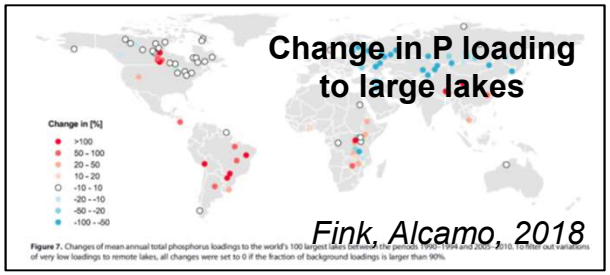
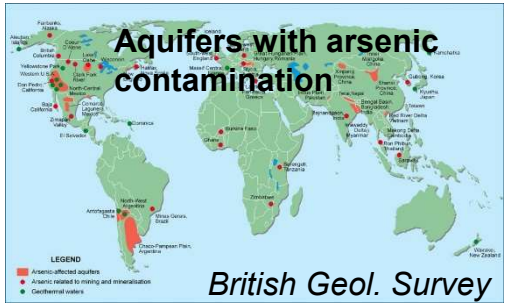
<5mm, who2018, 50k,↑65% 2000/15

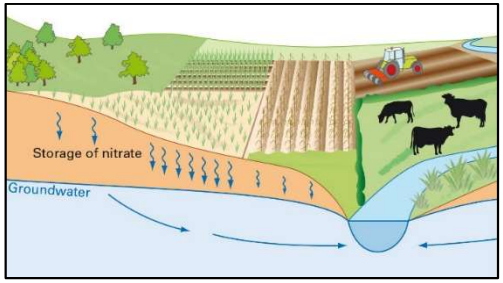
And let‘s not forget ...

Rivers: Other problems include sedimentation, pesticides, industrial chemicals, …

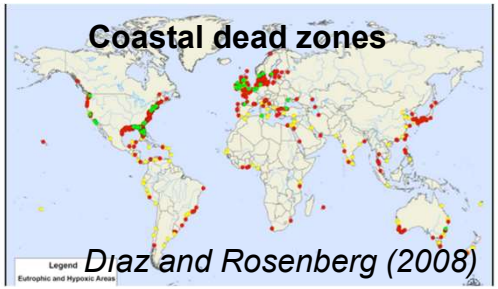


Lakes: Eutrophication (over-fertilization N & P); chemical pollution; …





Groundwater: Nitrate, arsenic, pathogen, organic chemical contamination; …

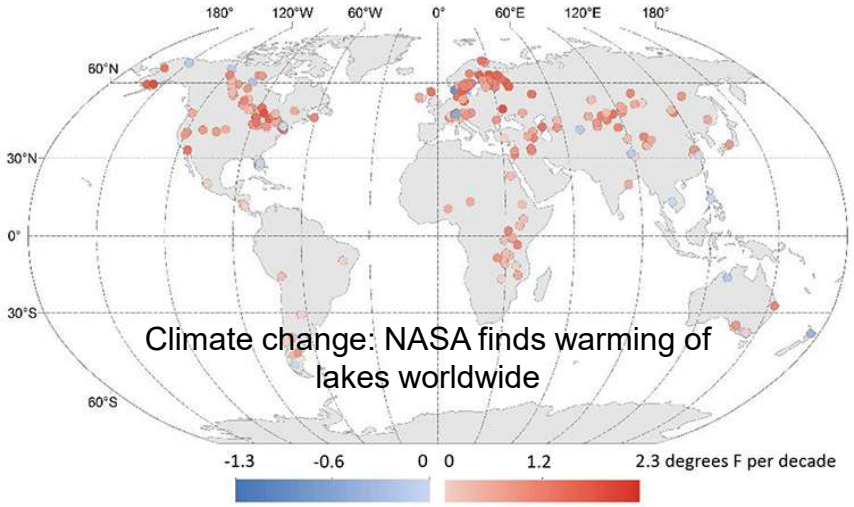


Coastal zone: Eutrophication, low oxygen - “dead zones”, from inland farming fertilizer, …

The water quality challenge has global drivers

Global drivers of water quality degradation

- *Climate change*
  - warmer water temperatures,
  - lower dissolved oxygen capacity,
  - more algal blooms,
  - flooding: sediment runoff and increases in contamination
  - droughts: less dilution capacity



Climate change: NASA finds warming of lakes worldwide

O'Reilly et al. 2015 *J Geophys Res*

- *International trade* → changing crop patterns → deforestation & agricultural runoff → water pollution
- *International consumer products* → new pollutants in freshwater systems
- *Global water programs of donors*
- *Investments - international water companies*

And so … ?

Finding solutions to a “wicked problem” …

The global water quality challenge is a *wicked problem*

Many different types of pollution – pathogen, salinity, organic, toxics, antibiotic residuals, eutrophication, temperature

Many varied sources

- Wastewater from households
- Wastewater from industry.
- Runoff from agricultural areas
- Runoff from urban land
- Climate change and other global driver

Many actors – Consumers, farmers, industries, governments

Many causes – Population growth, farming, economic activity, health care, climate **…**

Many scales – Local, upstream/downstream, transboundary, global


The usual response:
Conventional wastewater treatment
Need alternatives
1M 40k

1. Develop & use the right technology

Ecosystem & "community"-based approaches to reduce wastewater discharge

Rehabilitating wetlands as filters for pollutants

Constructed wetlands

Wastewater recyling centre

Locally-based ecological sanitation management

TepozEco pilot program; Tepoztlán, Morelos, Mexico

- Dual water supply for drinking water & service water
- Composting toilets
- Domestic rainwater use, grey water filters (reedbeds, mulch)
- Reuse of purified greywater for irrigation
- Recycling of nutrients

Hard questions:

- ✓ **Efficiency of pollution removal? Which pollutants remain?**
- ✓ **Long term maintenance, participation?**
- ✓ **Costs? Side effects?**

2. Reduce pollution at the source with the right governance

***Reducing the source* of pollution**
– sustainable consumption & production

Clean household consumption

Clean industrial production

Hard questions:

What price signals, what costs?

How much education/voluntary action vs regulatory or other incentives (taxes)?

Monitor not only household water use but exit water quality?

What impact on social equity? Compensation?

2. Reduce pollution at the source with the right governance

What's the appropriate governance for maintaining/restoring water quality ?

Water governance: political, social, economic and administrative systems in place that influence water's use and management (UNDP)

What is transferable from water governance experience? Best practice?

Should water governance be expanded to incorporate water quality management?

Governance all about power relations. What are power relations in managing water quality? How to maximise participation of civil society? What role has corruption played in failed water pollution control programs?

Wastewater treatment plants usually built in cities. What about rural poor upstream of cities? How can we ensure that *no one is left behind*?

A *rights-based approach* is being used by the UN and some donor countries to achieve a more just distribution of water services. Is this approach suitable for protecting water quality and ensuring no one is left behind?

Governance has to work on & across all scales: local, catchment, national, transboundary, global. SDGs provide framework that cuts across scales. Should the SDGs be at the core of dealing with the global water quality challenge?

2. Reduce pollution at the source with the right governance

The **Water Quality SDG Target 6.3**: "By 2030, improve water quality …"

New SDG partnerships to achieve synergies between water quality & other goals/targets

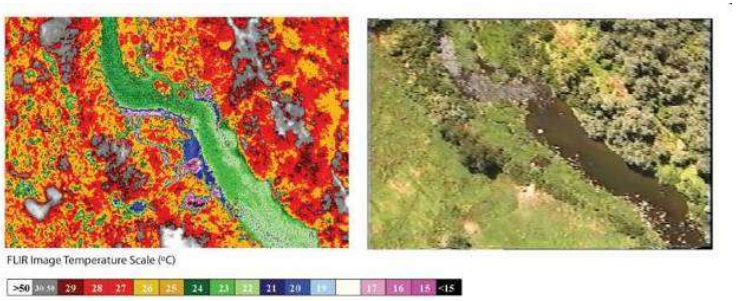
- ✓ SDGs 6 & 3 (Clean Water & Good Health) – Policies & measures to curtail antibiotic overuse
- ✓ SDGs 6 & 12 (Clean Water & Responsible Consumption) – Programmes to phase-out plastic bags, replace polluting household products
- ✓ SDGs 6 & 2 & 15 (Clean Water, Zero Hunger, Life on Land) Actions to protect priority freshwater fisheries
- ✓ SDGs 6 & 2 & 15 & 13 (above plus Climate Action) Expand sustainable agriculture to reduce runoff from farmland and protect quality of irrigation water supply

Local, regional, national authorities, civil society, researchers, UN, NGOs, health professional societies & other professional societies, private sector, others …

3. Scope out the challenge

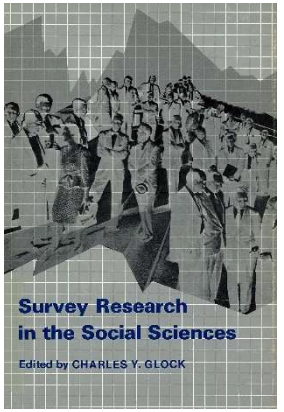
Closing the data gap

- To understand the state of water quality – geographic variability, bounding
- To understand recent and future trends



Remote sensing of river water quality

Field studies with citizen science

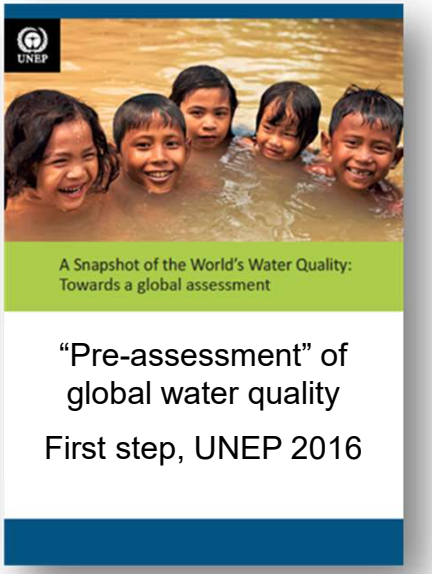


Social science surveys

A wide range of options for acquiring data

3. Scope out the challenge

Assessments

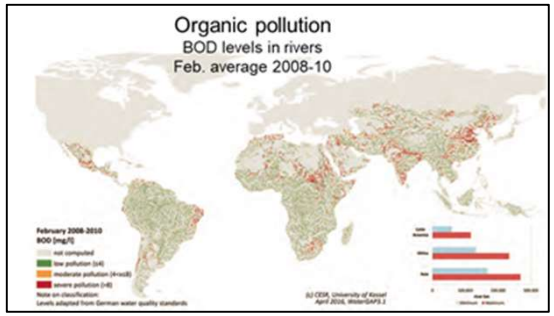


"Pre-assessment" of global water quality

First step, UNEP 2016

Data necessary but insufficient …

Need partnerships for assessment, analysis, and research …



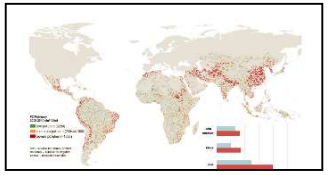
Questions:

Which water quality problems are most important, where? causes? hot spots?

Intensity of water quality problems at various locations?

What are options for management & governance in context of villages, catchments, regions, countries?

Summing up the global water quality challenge



Water pollution serious and increasing in LMICs.

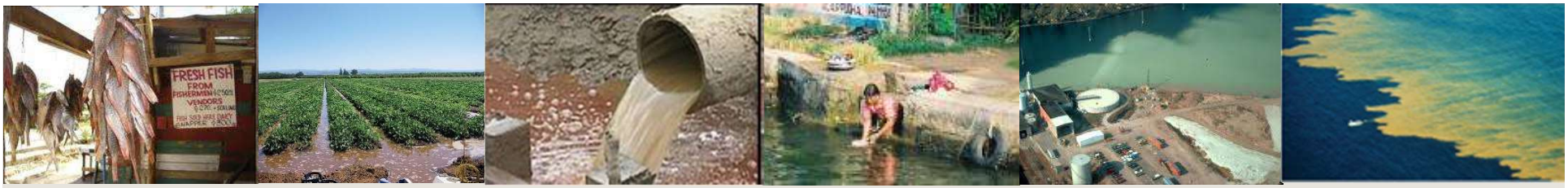
Millions people coming into contact with polluted water.

Pollution hindering use of hundreds of thousands of kms of rivers on 3 continents for water supply, household uses, and for irrigation; and constricting the habitat of fish.

Water pollution is the new water scarcity, poses threat to Sustainable Development Goals for water, health, food, and land.

Traditional and new water pollutant problems also widely plague the North.

- **Find the right technology** to reduce wastewater discharge
- **Reduce pollution at the source** with effective **governance**
- **Scope out the challenge**: close the data gap, do the research, set priorities, seek partnerships



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