The role of water quality in the nexus of food, energy and water

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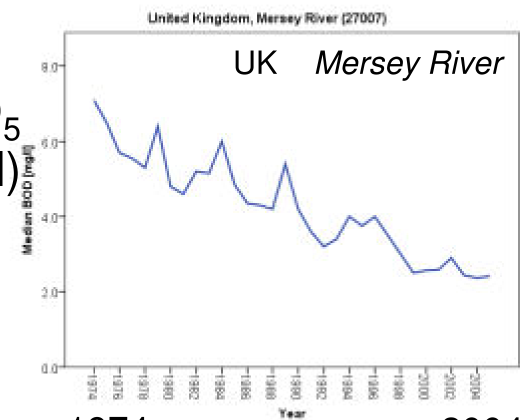
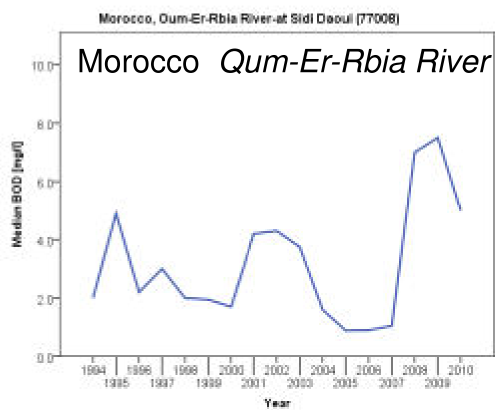
Different parts of the world, different trends

Different trends of organic pollution

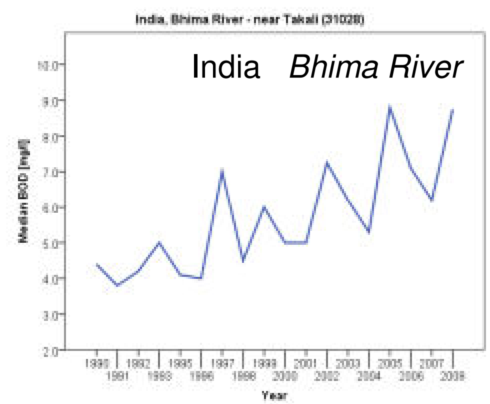
Decreasing organic pollution



No clear trend



Increasing organic pollution

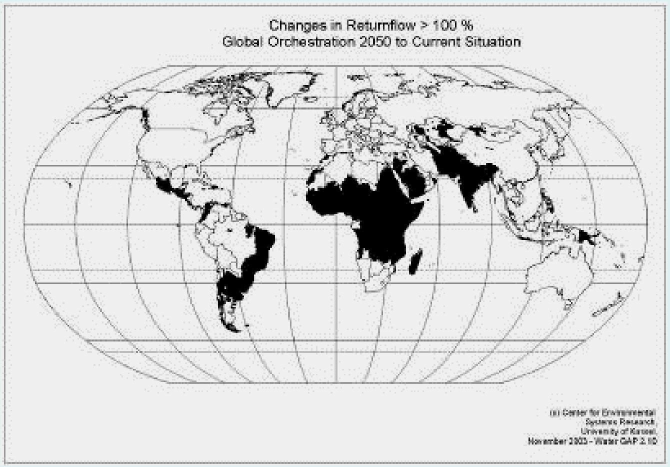


Source: UN World Water Quality Assessment (Pre-Study)

Why protect water quality?

Water quality degradation in developing countries is speeding up

Wastewater production at least doubling by 2050



Sub-Saharan Africa: 3.6-5.5 x

Source: Millennium Ecosystem Assessment Scenarios

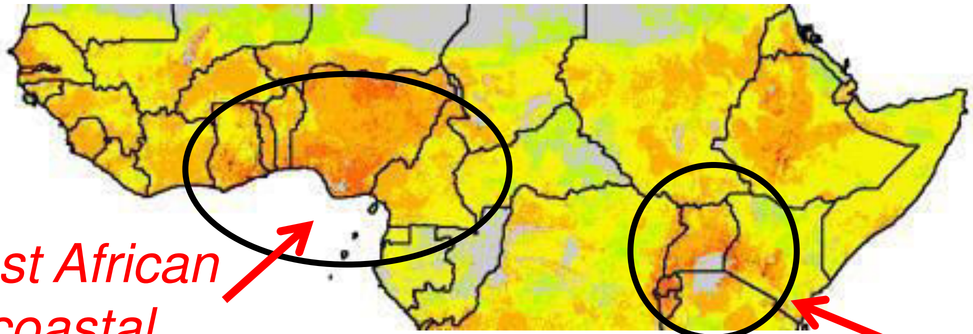
Sewerage connections increasing.
But not wastewater treatment.
More untreated wastewater to rivers and lakes.

Country	% population connected to sewerage		% wastewater treated	
	1990	2010	1990	2010
Kenya	6.7	7.4	4.9	4.9
Madagascar	0.1	2.9	0	0
Somalia	--	11.1	0	0

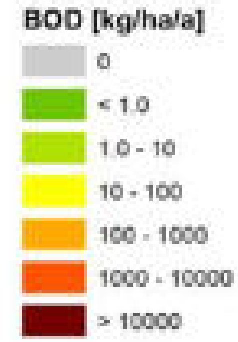
Sources: UNICEF & WHO Joint Monitoring Programme data base; Baum et al. 2013

Why protect water quality?

Hot spot areas of organic pollution (preliminary)

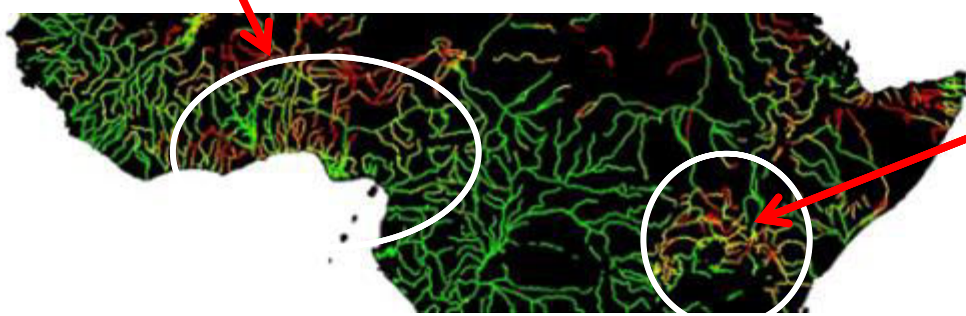


BOD loading from settlements
(kg/ha-year)
2005



West African coastal settlements

Nairobi & Victoria Lake region



BOD concentration in rivers
(mg/l)
Feb. 2005

Source: UN World Water Quality Assessment (Pre-Study)

Why protect water quality?

Risks of water pollution – Health,food security,economy

Health:

Health risk of contaminated rivers & lakes → contact with surface waters → washing, cleaning, drinking

Africa: 768 million people without improved water supply (2011); Zimbabwe rural survey: ~ 43% use river (2003)

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

Economy:

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

Livelihood: 58 M people worldwide in freshwater fishing industry

Food Security:

95% inland fishery production from developing world

200 million Africans consume fish regularly

Nexus example #1.

Energy & water quality: Energy costs of clean water

Energy costs are high

Water + wastewater in UK: 7703 GWh/yr → Enough to power 2.3 M UK homes

Annual electricity requirements for wastewater treatment of city of 1 M in Africa ≈ equivalent to annual electricity consumption of 40,000 people in Ghana

Options for reducing energy costs:

demand side: improve energy-efficiency in the treatment plant (biogas usage; pump & motor down-sizing); calibrate aeration, reduce wastewater production at source, …

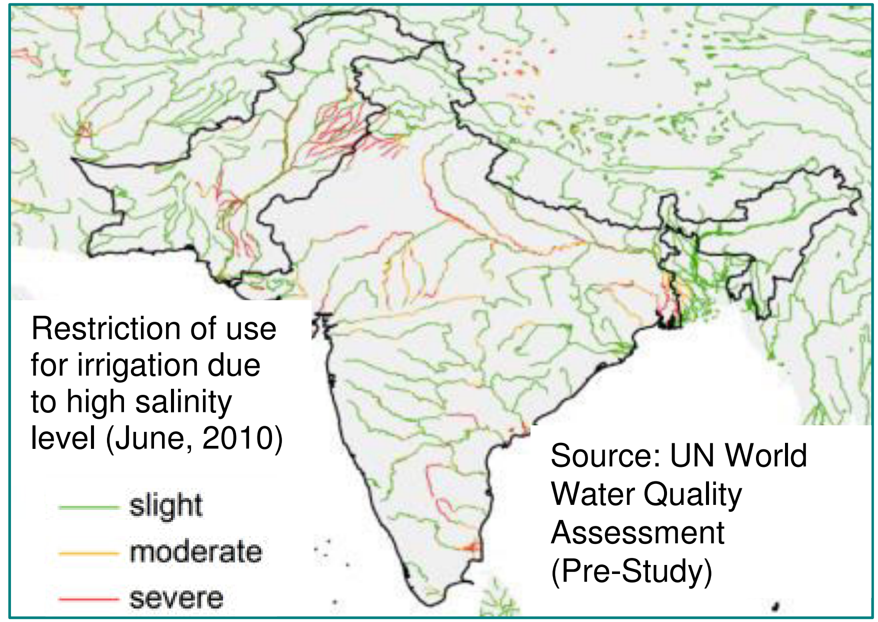
supply side: solar-powered treatment facilities; constructed wetlands; …

Wastewater as *source* of energy

e.g. Recover energy from wastewater flows → biogas, biomass production, heat recovery … e.g. potential to cover 7% of current South Africa total electricity supply (Stafford, 2013)

Nexus example #2

Food & water quality: The self-limiting cycle of producing food from irrigated farmland



food demand → irrigated agriculture → agricultural runoff → downstream high salinity levels in rivers → unsuitable for irrigation

Stretches of river with restricted use for irrigation due to high salinity levels

„Degree of restriction on use“	India [km]	India [%]	Pakistan [km]	Pakistan [%]
Slight to Moderate	7,863	16.6	1,679	8.7
Severe	6,208	13.1	4,401	22.8

Source: UN World Water Quality Assessment (Pre-Study)

Nexus example #3

Energy & food & water quality: The case of biofuels and nitrate pollution

Biofuels & food: e.g. US ethanol expansion (2005 - 2011) → increase food/feed corn prices → cost to developing countries: + US$6.6B (Tufts Univ.)

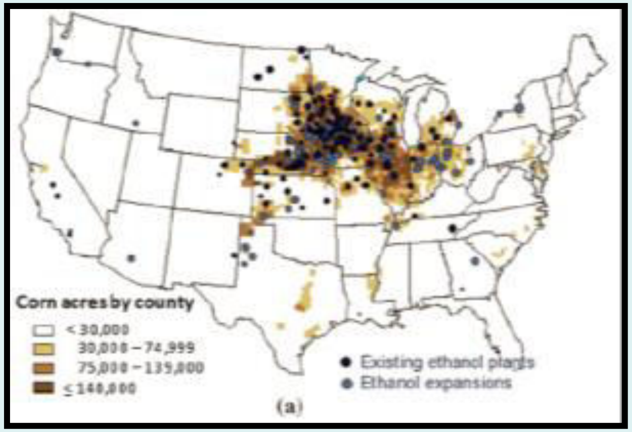
"The energy - water pollution - energy spiral"

Domestic energy demand/energy security → increased ethanol production → fertilizer use → nitrate contamination of groundwater → increased water treatment and ***energy demand***

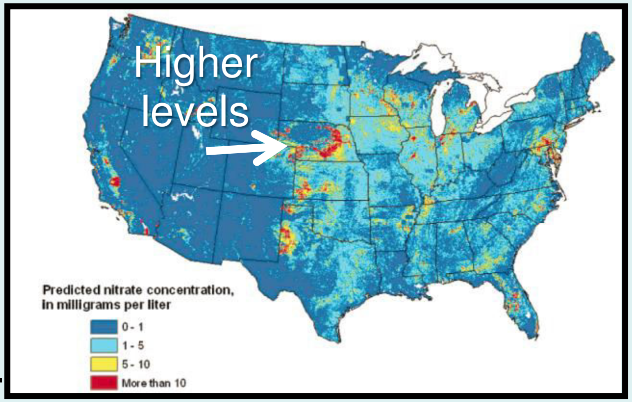
USA Case Study:

- Ethanol production (2007-2022) ≈ +2/3
- Nutrient loading: + 10-37%
- Additional water treatment to remove nitrates from groundwater → 2,360 M kWh /year (Twomey et al., 2010).

Solutions: 2nd generation energy crops; more electricity & fewer liquids from bioenergy; integrated nutrient management;



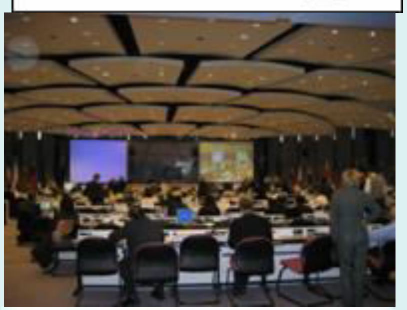
Corn acreage by county (Twomey , 2010)



Nitrate concentration in groundwater (Nolan, 2006)

So what to do?
Scientific approaches to implementing the nexus






Governance – Science-Policy Interface

- National & regional governments: Joint cross-departmental working groups on energy-agriculture-water
- Expand portfolio of watershed authorities already concerned with water quality protection to include water-food-energy nexus
- Governments require full life-cycle studies of pollution control alternatives (e.g. energy costs of wastewater treatment)

So what to do?
Scientific approaches to implementing the nexus

Research

Launch advanced studies of renewable energy pathways:

Which end-to-end renewable energy systems are most compatible with our goals for food, energy and water quantity & quality?

Launch advanced studies of sustainable agriculture:

Which scaled-up models of sustainable agriculture are most compatible with our goals for food, energy and water quantity & quality?

In connection with the Post-2015 Agenda & Sustainable Development Goals for Water:

What are the advantages/disadvantages of alternatives to conventional energy-intensive wastewater treatment?
(e.g. constructed wetlands, grey water recycling, recycling wastewater for irrigation ...)

Summing up

- Water pollution increasing in developing countries → health, food security, economy, …
- Water quality linked with food & energy, e.g.
  → energy costs of wastewater treatment
  → water quality constraints to irrigation,
  → water pollution impacts of biofuels, …
- Water quality at the heart of the food-energy-water nexus