

Water quality, quantity and climate change

The world-wide challenges of water quality and quantity related health problems as result of climate change

Setting the context: IPCC

Conclusions IPCC technical report:

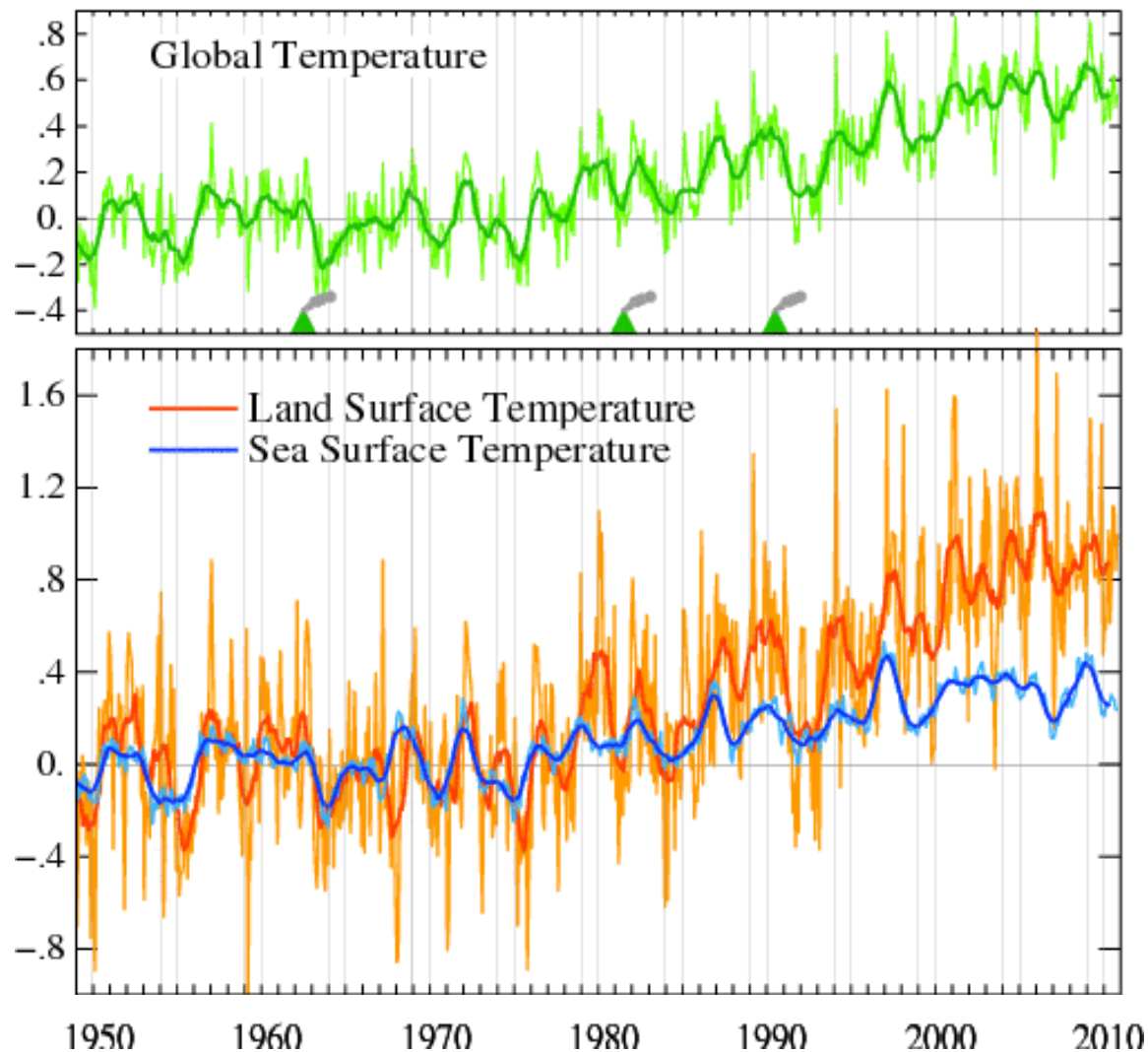
- Global warming during the last decades has been linked to changes and hazards such as:
 - *Increasing atmospheric vapour content*
 - *Changing precipitation patterns: more extremes*
 - *Melting of ice*
 - *Rising sea level*
- Climate models suggest that precipitations and river run-off will increase in high latitudes and decrease in lower-mid latitude regions

Setting the context

- Higher water temperatures and changes in extremes:
 - Floods and droughts
 - Affect food availability, stability & access
- Climate change affects the function and operation of:
 - hydropower
 - structural flood defences
 - drainage and irrigation systems
 - water management practices
- Several gaps in knowledge: research needs related to climate change and water

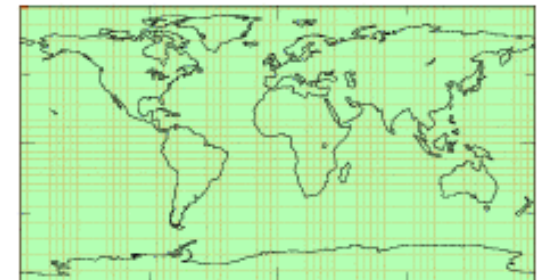
Setting the context

Temperature Anomalies in Different Regions (°C)

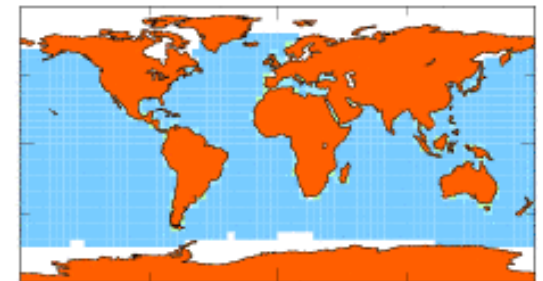


Regions of Integrations

Global



Land and Ocean



Source: NOAA National Weather Service Climate Prediction Centre.

Setting the context:

Climate change and Public Health

Public health impact of climate change induced events: warming, humidity, rainfall, drought and extreme events (floods):

- Injury/death from hunger
- Epidemics
- Mental health issues
- Water-related infections



How does climate change affect water

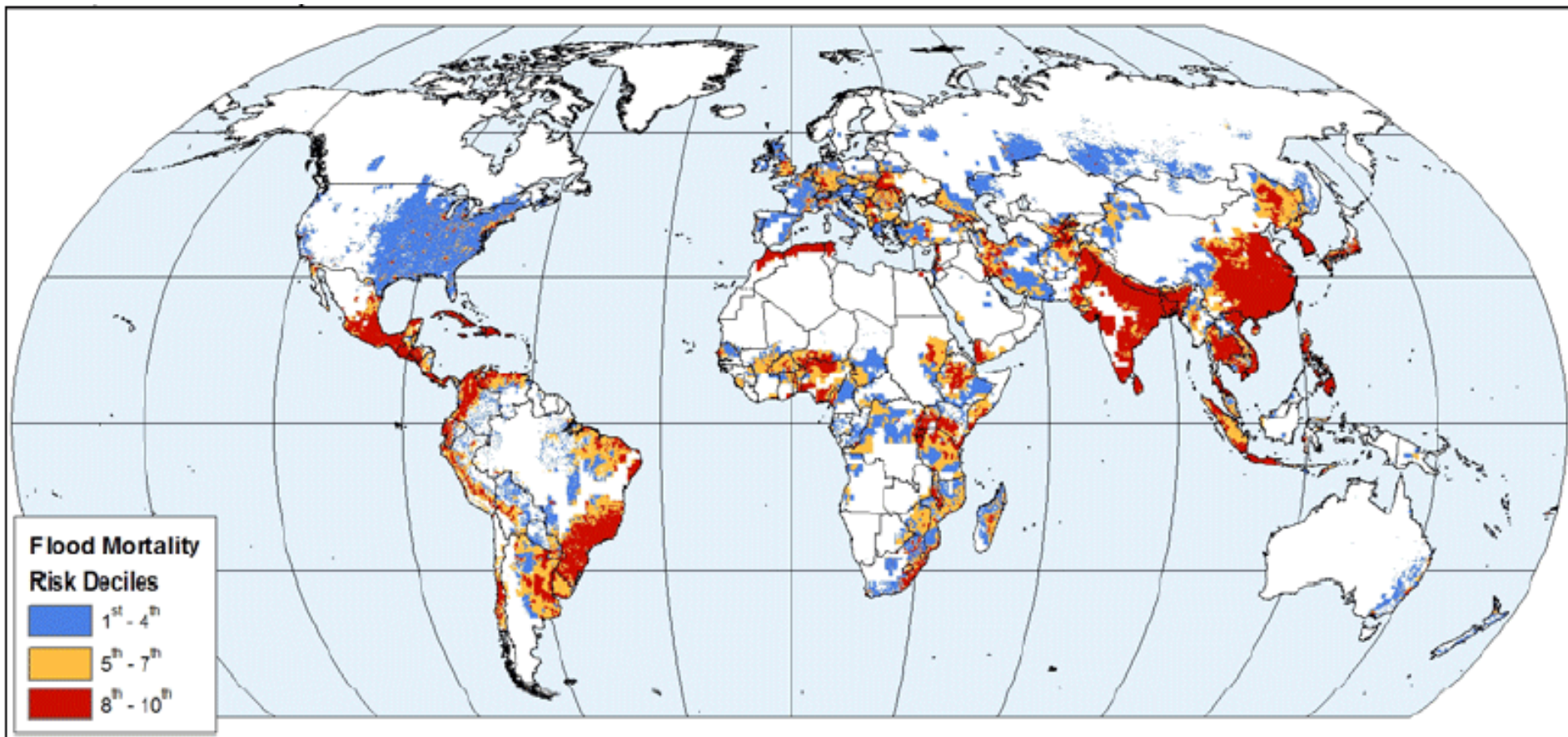
Higher water temperatures and changes in extremes (including floods and droughts) can affect water quality and water quantity by:

- Microbiological contamination
- Chemical contamination
- Salt intrusion

Possible negative impacts on ecosystems, human health, and water system

How does climate change affect water

Global Distribution of Flood-Related Mortality Risk

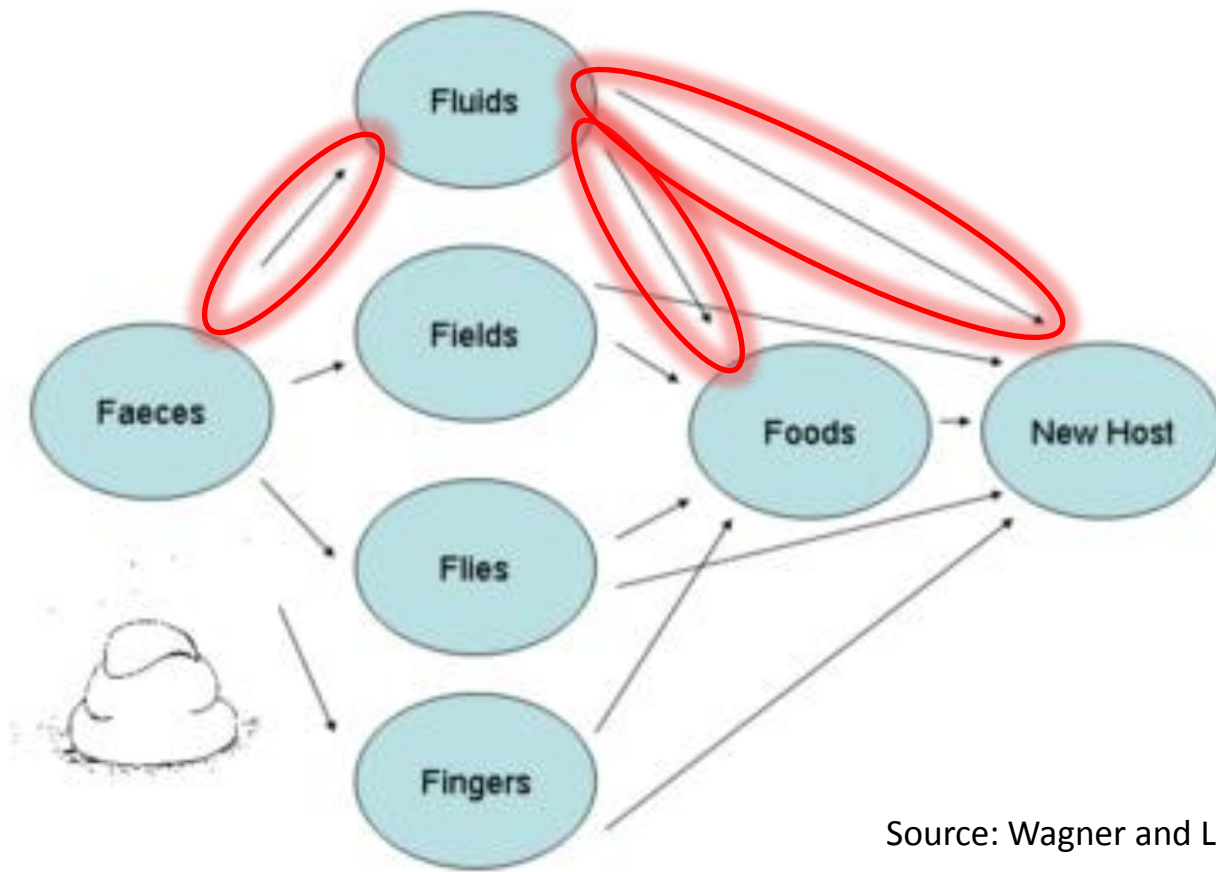


Microbiological Contamination

Microbiological contamination:

- Bacteria, viruses, parasites
- linked to human (or animal) excreta
- Often present in the environment (latrines, septic tanks, defecation areas, etc)
- Washed into the residential areas by flood water
- More favourable circumstances for bacteria growth

Microbiological Contamination



Source: Wagner and Lanois 1958

Microbiological Contamination

Flood-related bacteriological contamination may lead to infectious disease outbreaks caused by:

- Bacteria such as: *Vibrio cholerae*, *Leptospira*, *Escherichia coli*, *Salmonella enterica* (Typhi), *Shigella* sp
- Viruses such as: *Hepatitis A*, *Hepatitis E*
- Parasites such as: *Cryptosporidium parvum*



Microbiological Contamination

Cholera outbreak in flood-hit Pakistan

12:00 2 August 2010
Environment

Cholera outbreak feared in rural Haiti — 135 dead

☆☆☆☆☆ (0 Votes)

HAITI, OCT 22 -

At least 135 people have died in a suspected cholera outbreak, and aid groups are rushing in medicine and other supplies Friday to combat Haiti's deadliest health problem since its devastating earthquake.

The outbreak in the rural Artibonite region, which hosts thousands of quake refugees, appeared to confirm relief groups' fears about sanitation for homeless survivors living in tarp cities and other squalid settlements.



Wendy Zukerman, reporter

The worst floods in living memory in Pakistan have killed thousands stranded or homeless. "Massive devastation where link bridges and thousands of houses were washed away."

Pakistan.

caution. Thai embassy in Bangkok is urging travellers to reconsider their travel plans and to exercise caution. Thai economy may exceed \$A30 billion. Thai officials from the Irrigation Department on Thursday said half of the millions of cubic metres of floodwaters had flowed into the sea but another 11 days were still required before Bangkok was completely drained.

Microbiological Contamination

But why does it happen?

- Wells flooded
- Latrine pits full of water
- Bacteria no longer concentrated, but everywhere in domestic area



- Diseased person sheds billions of bacteria: water is transmission vehicle

Microbiological Contamination

How to control?

- Water treatment
- Alternative water sources
- Community awareness handling the diseased
- Community awareness seeking health care
- Isolation / quarantine
- Flood control / drainage
- (Re)construction of latrines

However...

Little evidence that flood itself leads to outbreaks. Often together with large people displacement and already poor sanitary infrastructure

Chemical Contamination

Magnitude/type of chemical contamination of drinking water (after floods) highly depends on:

- The presence of chemicals in coastal areas.
 - fuel products
 - Pesticides
 - etc
- Force of flood water / damage to chemical storage devices
- Slope, altitude and hydrology of the area

Difficult to predict the overall influence on public health

Chemical Contamination

- Chemical material may contaminate homes:
 - Mobilisation of dangerous chemicals from storage
 - Remobilisation of chemical already in the environment (e.g. pesticides)
- But...:

Less evidence exists to support hypothesis of flooding and clear causal effect on morbidity/mortality patterns due to chemical contamination

Chemical Contamination:

A few examples

Hurricane Mitch (1998) Honduras:

- Pesticides in drinking water: people reported headaches, tiredness, skin rash, abdominal pain, fever, etc

Tropical Storm and flood Alberto (1994) USA:

- Agricultural chemicals (fertilisers etc): Decreased appetite, fever, headache etc

Flood of mine (1950) Japan:

- Cadmium, lead and zinc: Leading to “*Itai Itai disease*” (osteomalacia)

Chemical Contamination

Ingestion of some contaminated water sources can lead to chronic and/or life threatening conditions:

- Nitrate (found in fertiliser): cause methaemoglobinaemia, or blue-baby syndrome, in bottle-fed infants under 3 months of age
- Wastewater: a potential source of exposure to mammary carcinogens: hypothesised to increase breast cancer risk



Chemical Contamination

- Industry and human dwellings: most common contaminants are heavy metals, and solvents, such as tri and tetrachloro-ethene
- Severe effects include
 - reduced growth and development
 - cancer
 - organ damage
 - nervous system damage
 - Death
- The foetus can be transplacentally exposed, and with its limited immune system the health effects might be more severe.

Salt intrusion

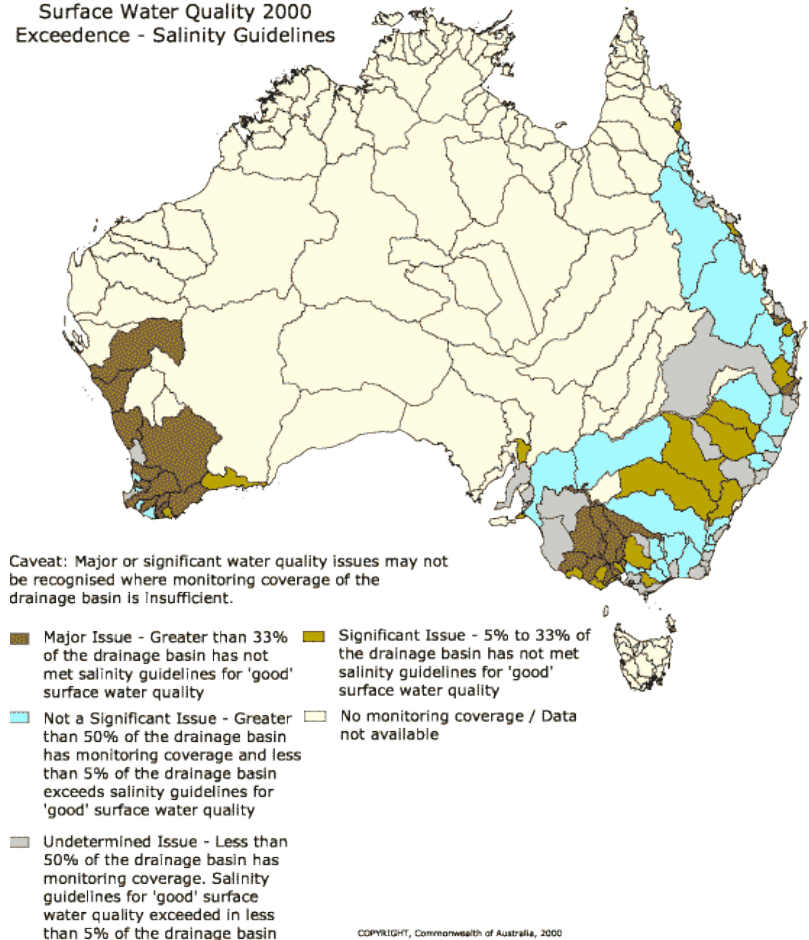
Another major problem concerning water quality after floods: **salinity of drinking water:**

- Affect millions of individuals in coastal regions around the world.
- Increase over time
- Intergovernmental Panel on Climate Change (IPCC):
“Groundwater, crop soils, and many rivers likely to become increasingly saline from floods, higher tidal waves and storm surges, as a result of climate change impacts”
- In addition: rapid population growth in (fertile)coastal areas → large pressure on available water resources.

Salt intrusion

- FAO guideline for sodium levels in drinking water: 0.5 ppt (grams per kilogram of water)
- Salinity of sea water (extremely harmful for humans): 35 ppt
- In Bangladesh: sodium levels up to 13 ppt were measured in sources used for human consumption (second lecture)

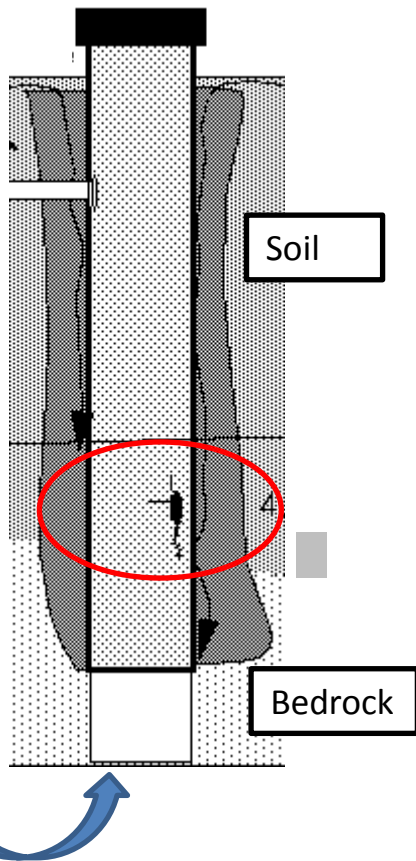
Surface Water Quality 2000
Exceedence - Salinity Guidelines



Salt intrusion

How does salt intrude the fresh water sources:

- Open: water just physically flows into the source (e.g. open well, river, pond)
- Protected sources (e.g. deep wells): sea water seeps in if not well constructed
- Ground water contaminated with saline water



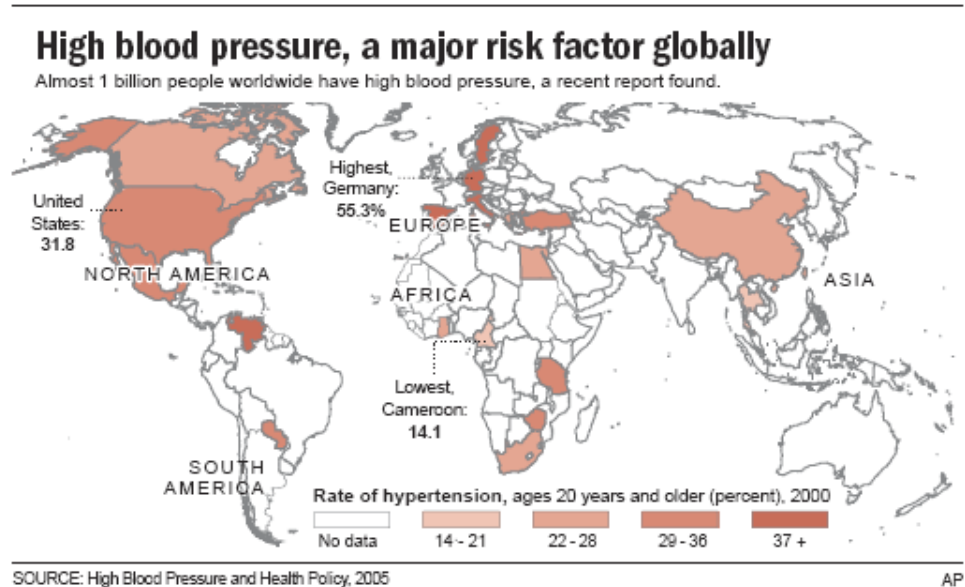
Salt intrusion: health effects

The health effects of increase salt studied by many: Most studies on dietary salt:

- Excessive dietary salt intake: high blood pressure
- High sodium intake: rise in systolic and diastolic BP
- Reducing salt: major effect on BP, preventing cardiovascular mortality
- High BP in developed countries is the major cause of cardiovascular disease, responsible for 62% of strokes and 49% of coronary heart disease
- In sub-Saharan countries: cardiovascular diseases responsible for 12% of all deaths. In Asian countries: 24%

Salt intrusion: health effects

- In pregnant women increased levels of sodium intake may lead to hypertension and (pre)eclampsia, which both affects the health of the mother and the unborn child.
- Results from studies to intake of saline water show conflicting results, after controlling for dietary sodium intake



Water quantity

In times of flood water SCARCITY major problem:

- Conventional drinking water sources contaminated
- Water systems damaged
- Areas inaccessible due to receding water

Priority: drinking water!



Water quantity

Public Health Impact of water scarcity:

- Dehydration
- Malnutrition / hunger
- Major economic losses due to reduced harvest & milk / meat production of cattle



Vector borne diseases

After the emergency:

- Receding water leaves puddles
- Expansion in range and number of vector habitats (breeding places) for mosquitoes
- Initially washes out breeding places, but increased risk when water is receding
- Lag time: 6 – 8 weeks after flood

Vector borne diseases

Major vector borne diseases after floods:

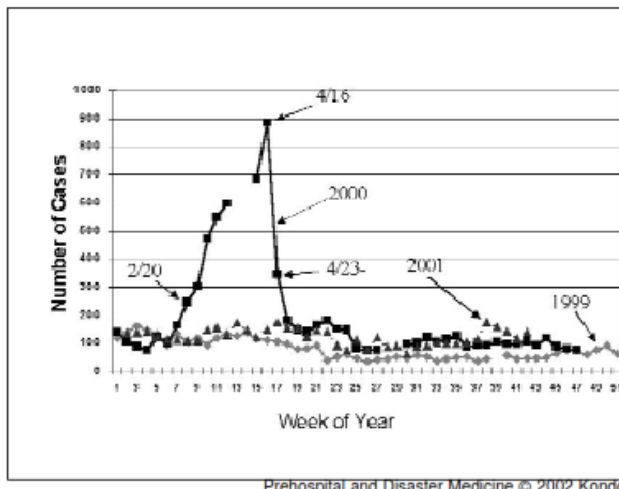
- Malaria
- Dengue
- West Nile virus
- Rift valley virus



Anopheles (albimanus)



Aedes aegypti



Examples:

- 2000 Mozambique
- 2004 Dominican Republic
- 2010 West Jawa

Other water related problems during / after floods

Multiple non-disease related public health risks associated with floods:

- Drowning
- Electrocution
- Hypothermia

When planning flood-relief activities, those issues should be taken into account as well.

Questions?

