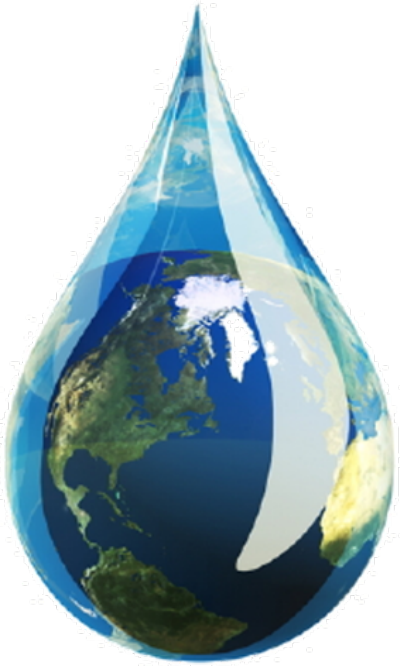
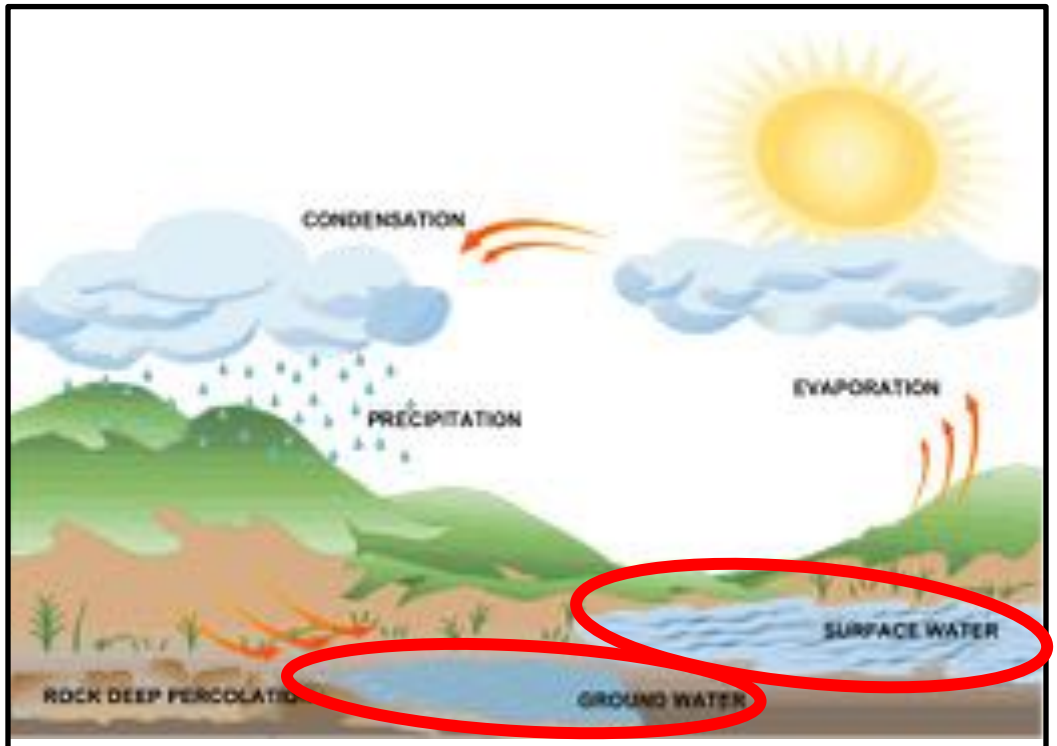
WORLD WATER



Situation
Challenges &
Opportunities

Before starting,
water resources at a glance:



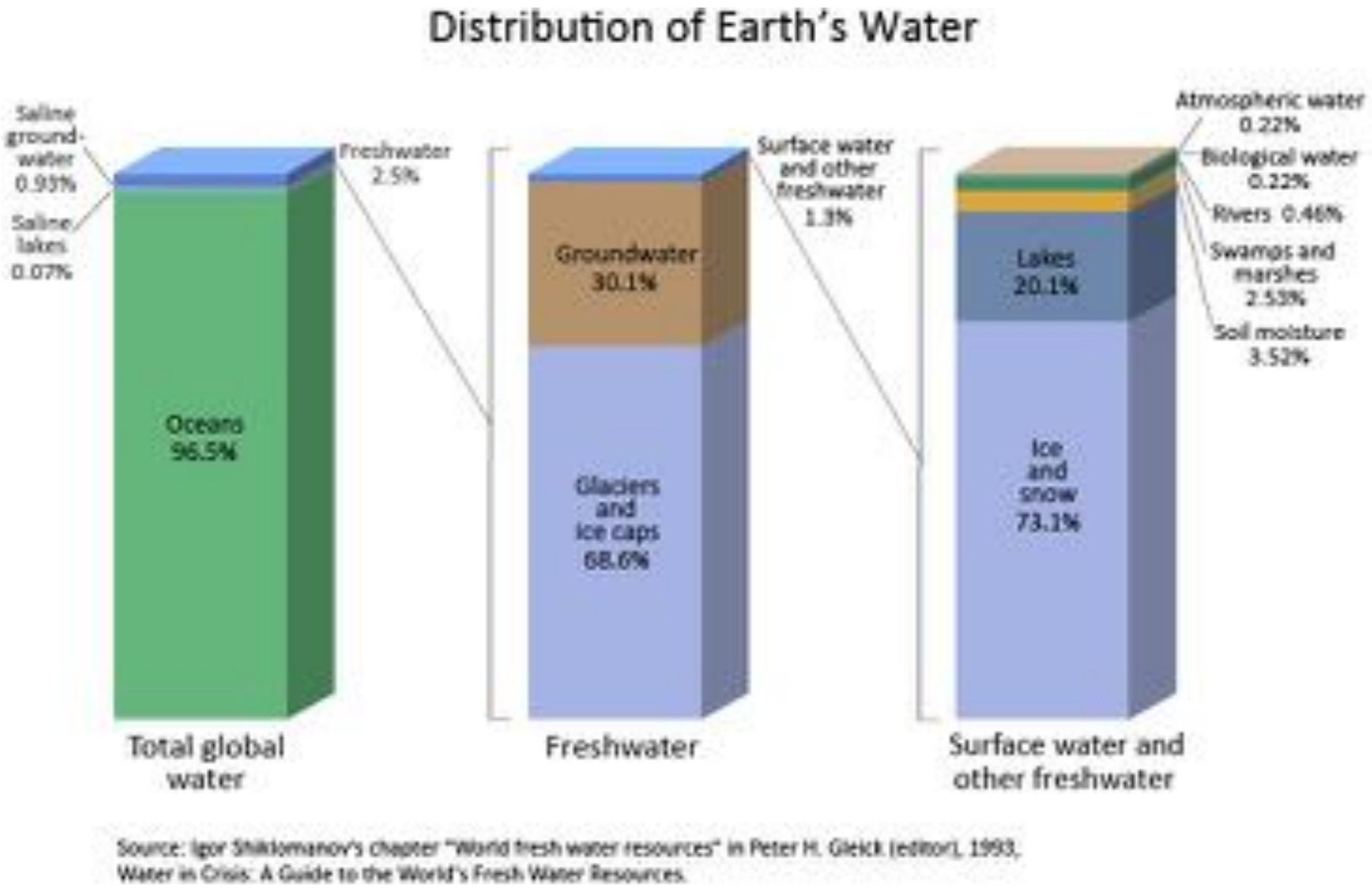
Simplified water cycle

Freshwater resources:

Surface water
- Easy to access
- High turnover
- Easy to pollute

Groundwater
- Harder to access
- Low turnover
- Harder to pollute

Recycling / Desalination
- High technology
- High cost
- High energy



Fresh water are 2.5% of the world water budget.

Accessible fresh water are 0.75% of the world water budget.

Some math:

World total renewable fresh water is 47,000 (km^3/y).

World population is ~7 billion.

Availability ~ 18,400 liters/person/day

Water consumption in North America (which is world highest) is 6800 (liters/person/day).

Hurray - Enough water for all.

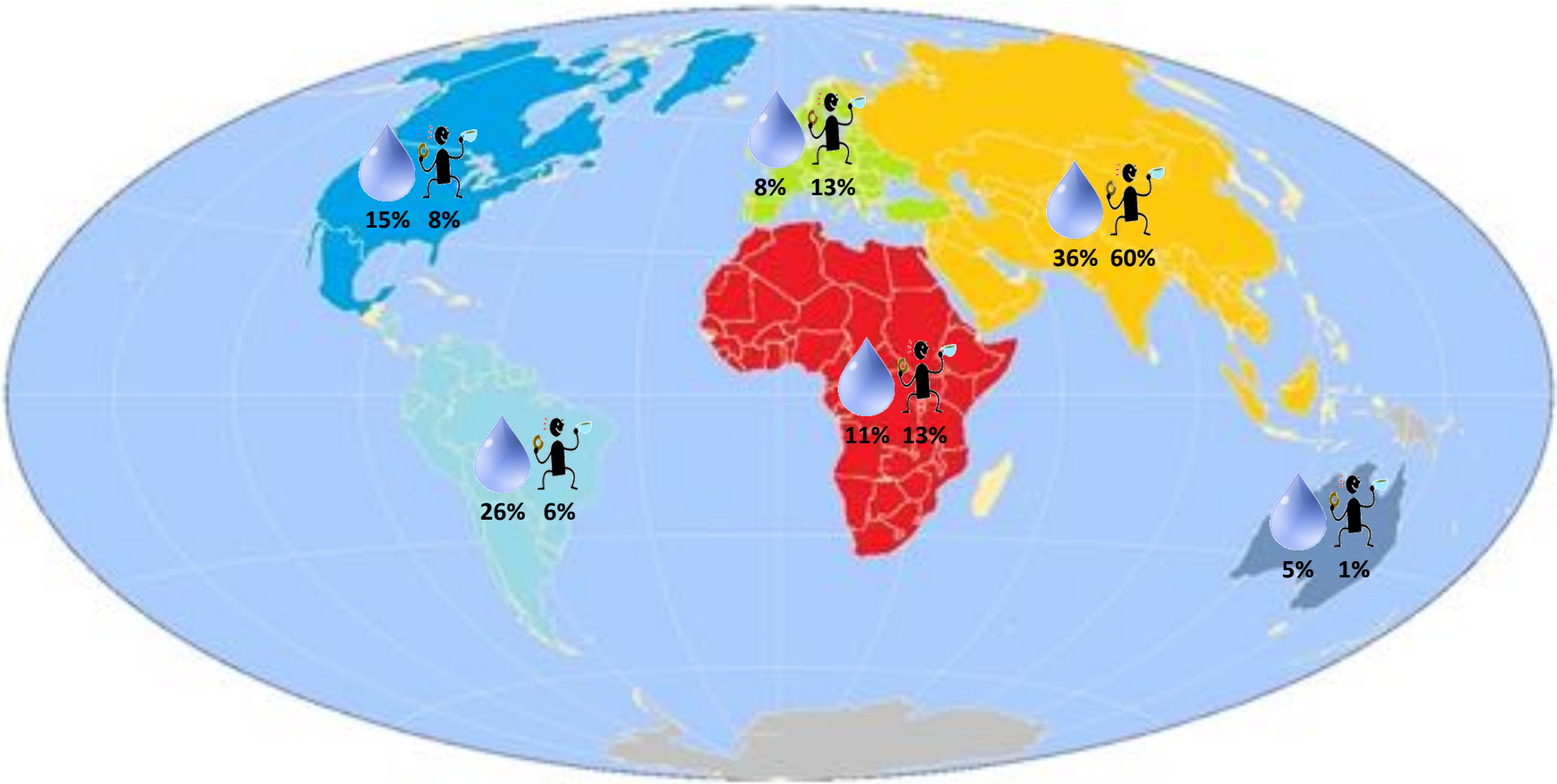
So how come that:

One of six people worldwide don't have access to safe freshwater

Every 20 seconds a child dies as result of poor sanitation
(150 kids during this talk)

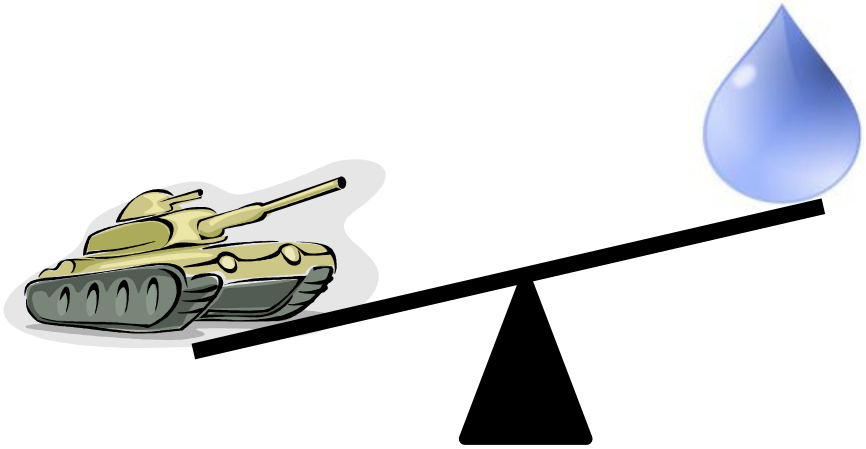
Between 1991-2000 over 665,000 people died in natural disasters, of which 90% were water related events.

World population and water resources are not evenly distributed



Add to that:

Politics



+

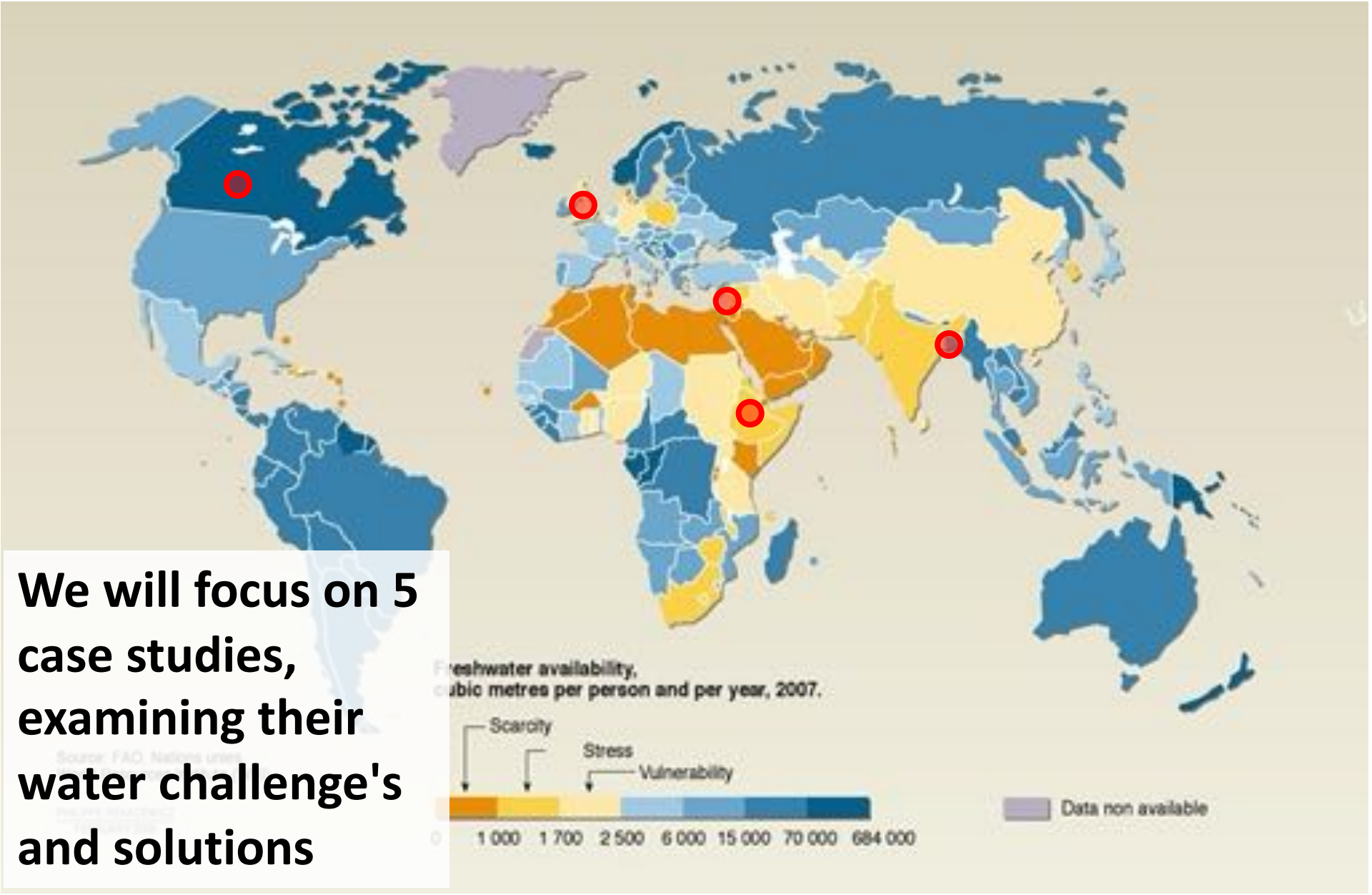
Technology
Education &
Economic
limitations

+

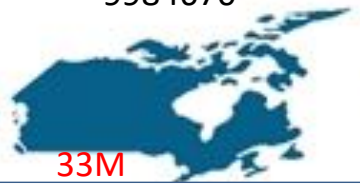
Water quality problems

=

World freshwater availability:



We will focus on 5 case studies, examining their water challenge's and solutions

	Canada	Israel	UK	Bangladesh	Ethiopia
Area (km^2) & population	9984670  33M	22070 7M	243610 62M	144000  147M	1104300  81M

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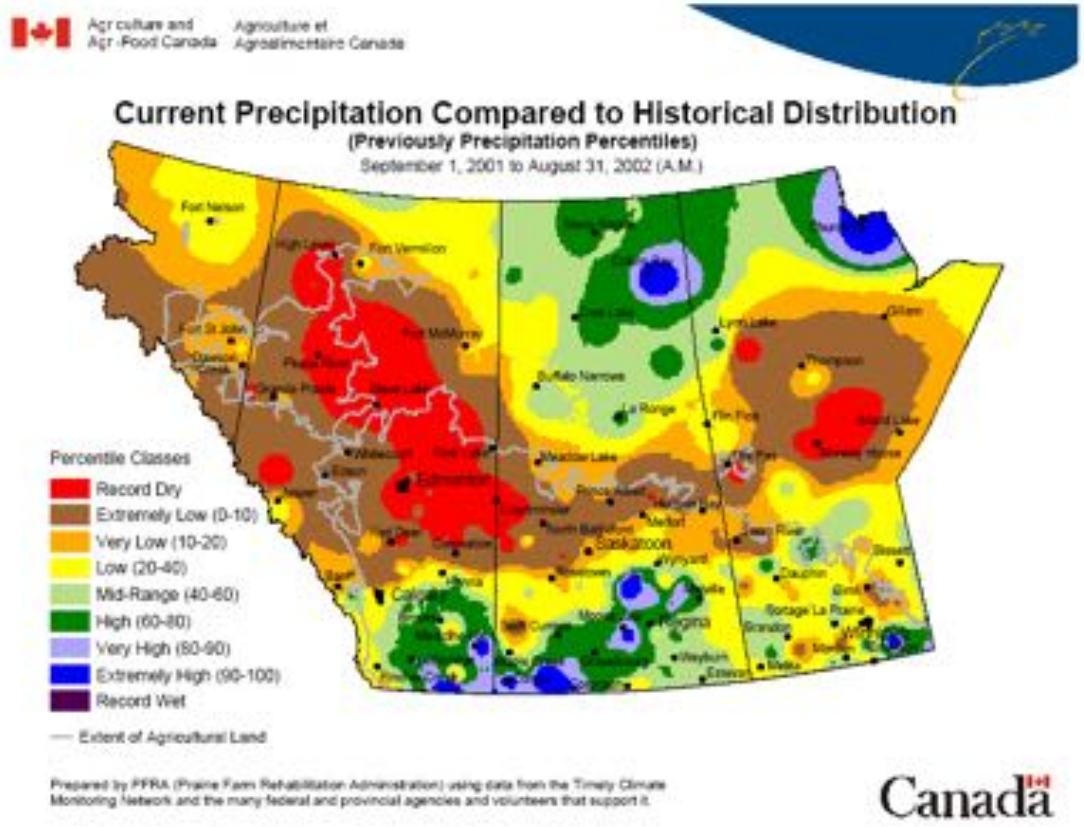
Water use per capita Per year (m^3)	1470	282	212	244	80.5
HDI	0.908	0.888	0.863	0.5	0.363

Canada:

Saskatchewan River Basin

Issues: Drought

Prairie Drought of 1999-2004
Most Expensive Natural Disaster in Canadian History



- $5.8 billion decline in GDP 2001-2002
- $3.6 billion drop in agricultural production, 2001-2002
- 41,000 jobs lost
- BC, Alberta forest fires
- Saskatchewan dust storms

Issues: Floods

Farmland in southern Manitoba, along the Red River valley, is covered with water.
Photo Credit: Josh Arason, Global News

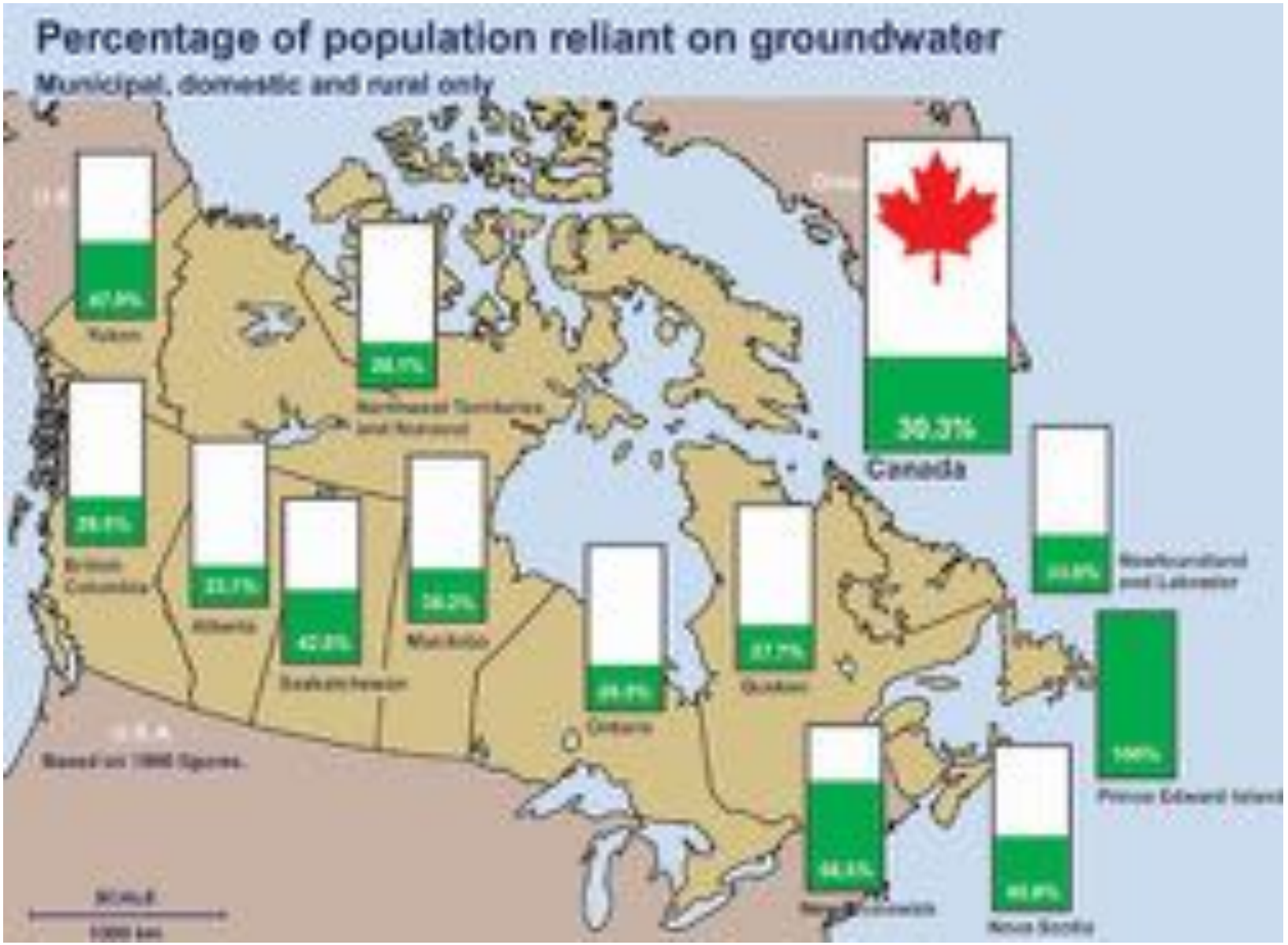
Issues: Water quality

Lake Winnipeg algal blooms covered 15,000 km^2 in 2007

Photo: Reuters
http://www.canada.com/news/Feds+lack+know+deal+with+dirty+rivers+lakes+report/3802002/story.html

Image: Greenpeace Canada
http://www.greenpeace.org/canada/en/Blog/beyond-factory-farming-hog-farms-and-friendly/blog/3761

Issues: Groundwater



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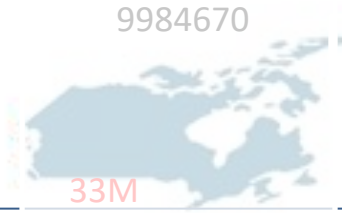
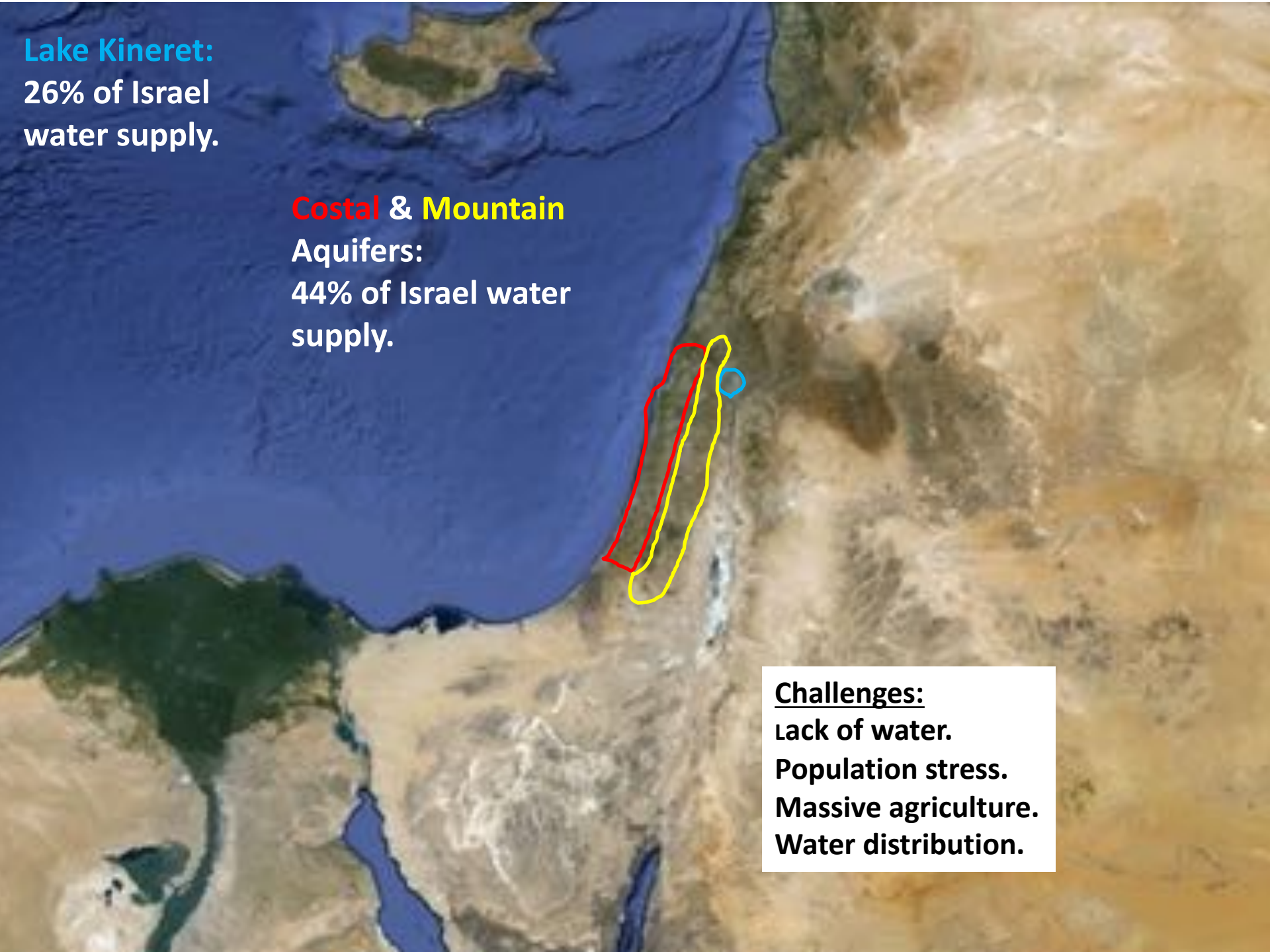
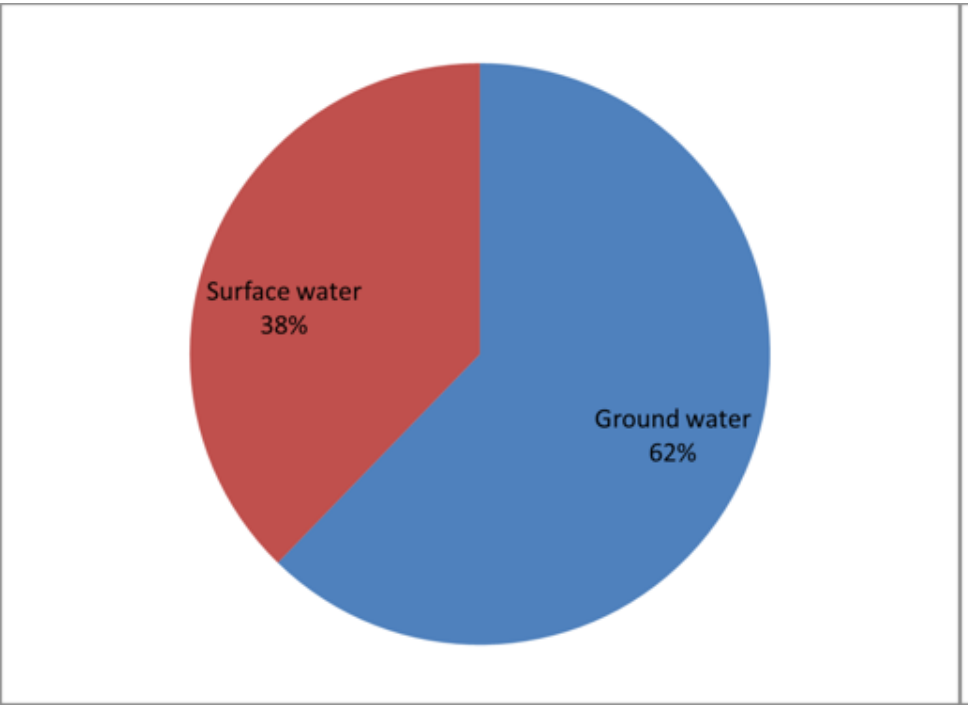
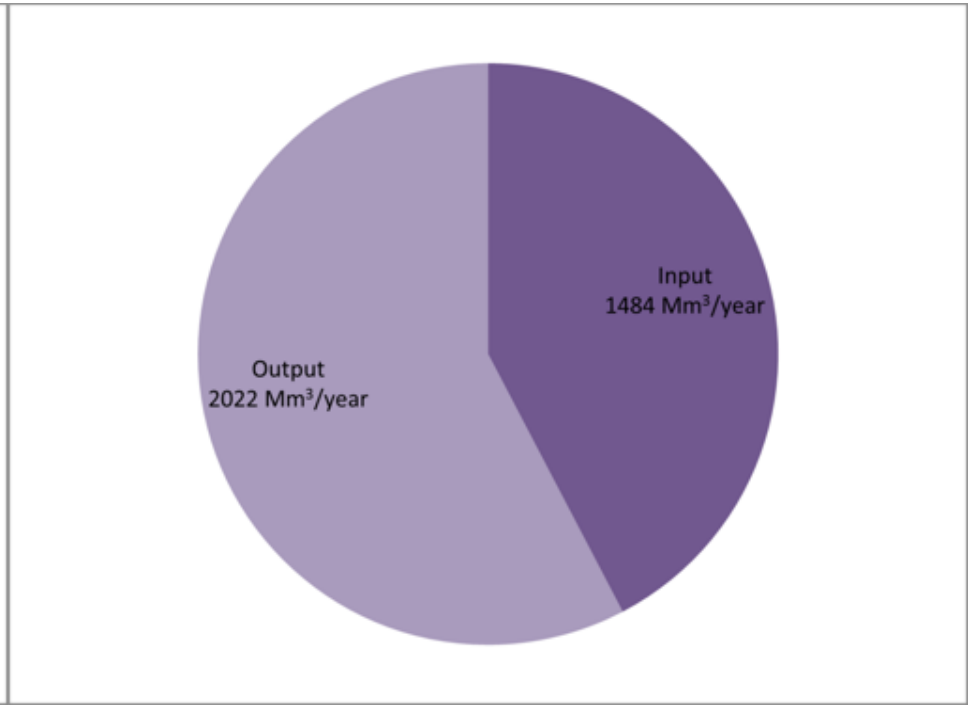



Lebanon
Jordan
<500km
~100km


Lake Kineret:
26% of Israel water supply.
Costal & Mountain Aquifers:
44% of Israel water supply.
Challenges:
Lack of water.
Population stress.
Massive agriculture.
Water distribution.

Israel natural water balance:



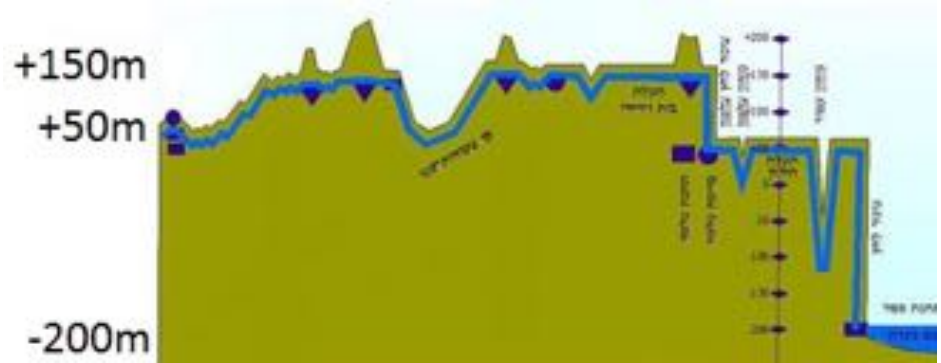


Problem!!!

Solutions:

Water transfer - National water carrier

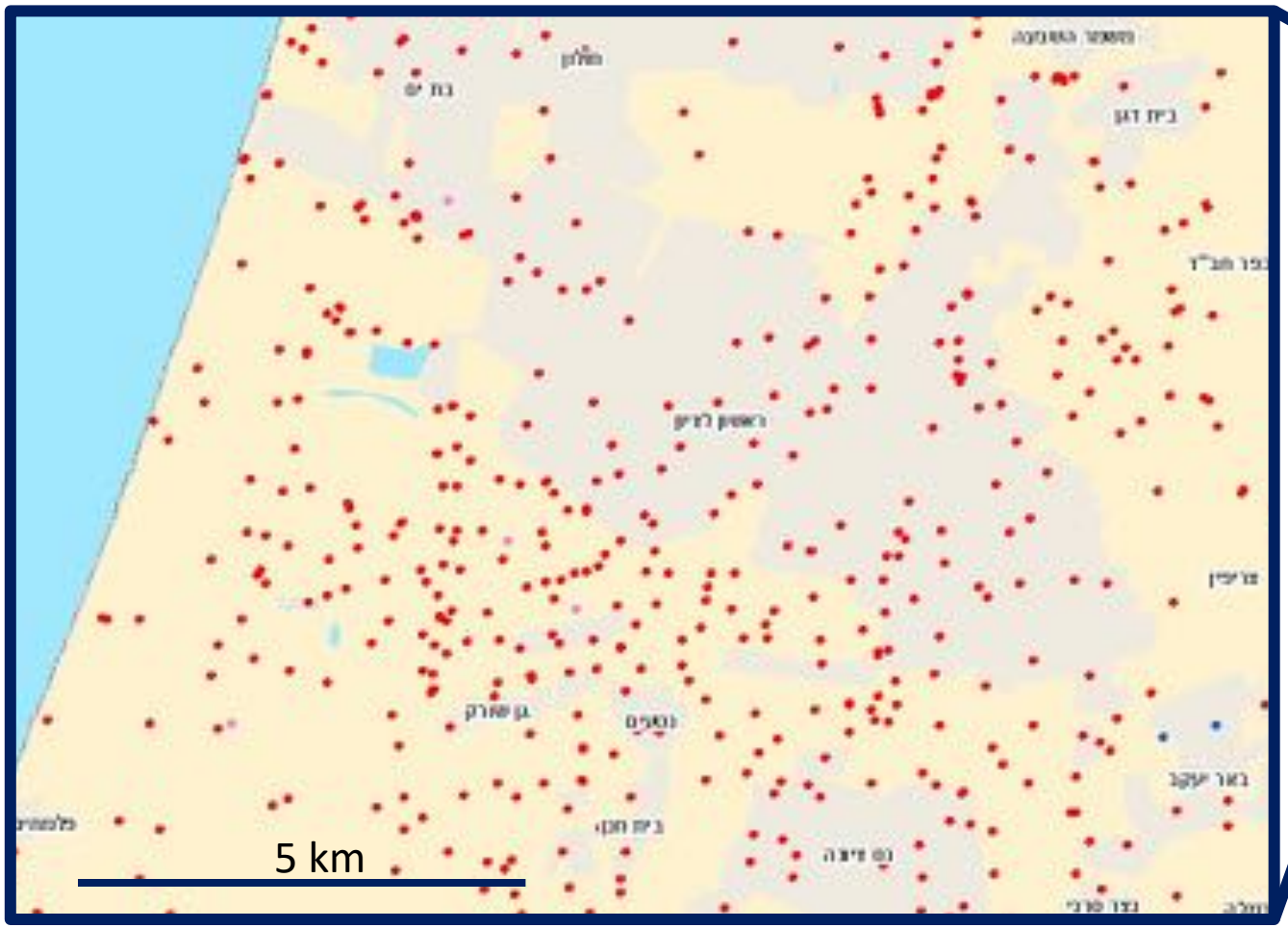
- **Max. flux: 450 Mm^3/year**
- **Energy : 4% of Israel consumption**



Solutions:

Ground water use

- **Hundreds of wells all over Israel supply 924 Mm^3/year.**



Solutions:

Desalination

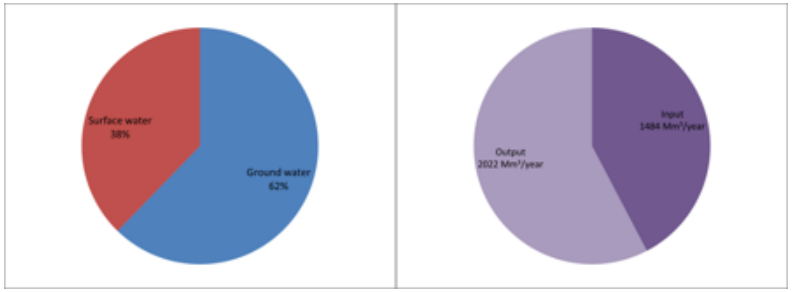
- By 2020 will supply 50% of domestic and industrial consumption.
- High energy consumer.
- cost of \$0.6 for $1m^3$, while cost of unsupplied $1m^3$ is \$2.
- Contributes 300 Mm^3/year.

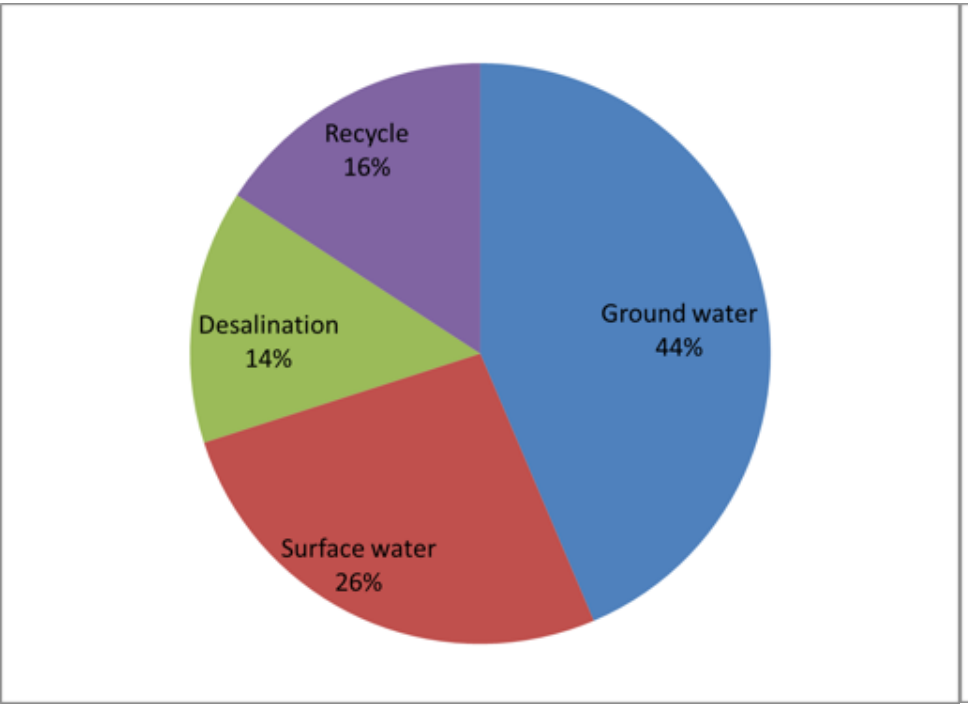
Solutions:

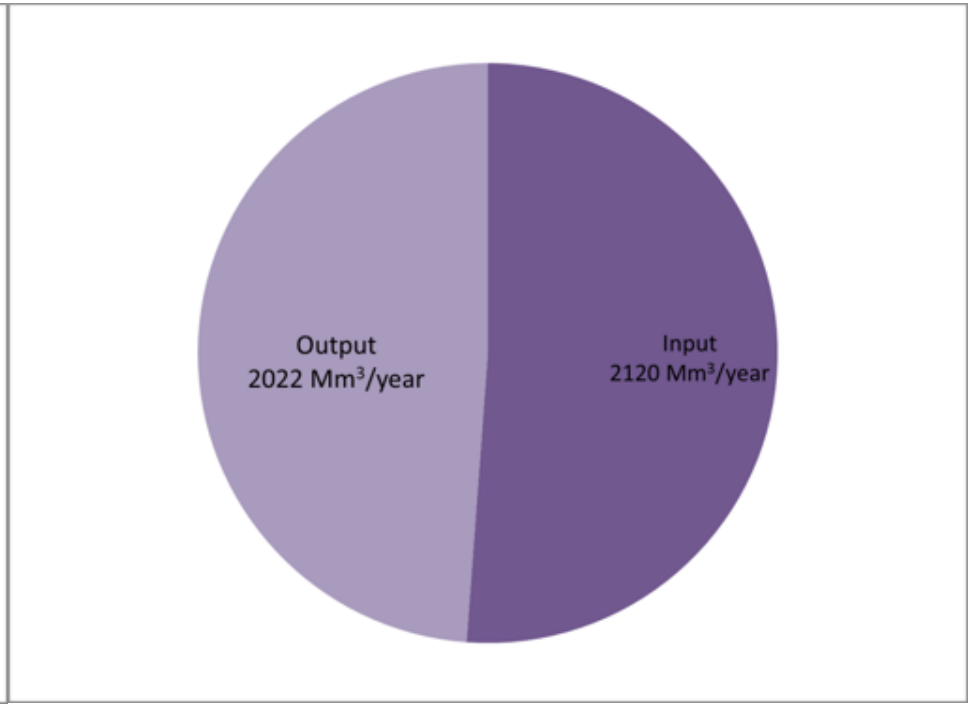
Sewage recycle

- More than 75% of the sewage in Israel is being treated.
- The treated sewage supply more than 30% of agricultural use.
- Contributes 335 Mm^3/year

Israel water balance:







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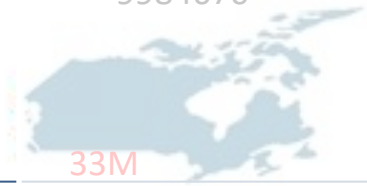
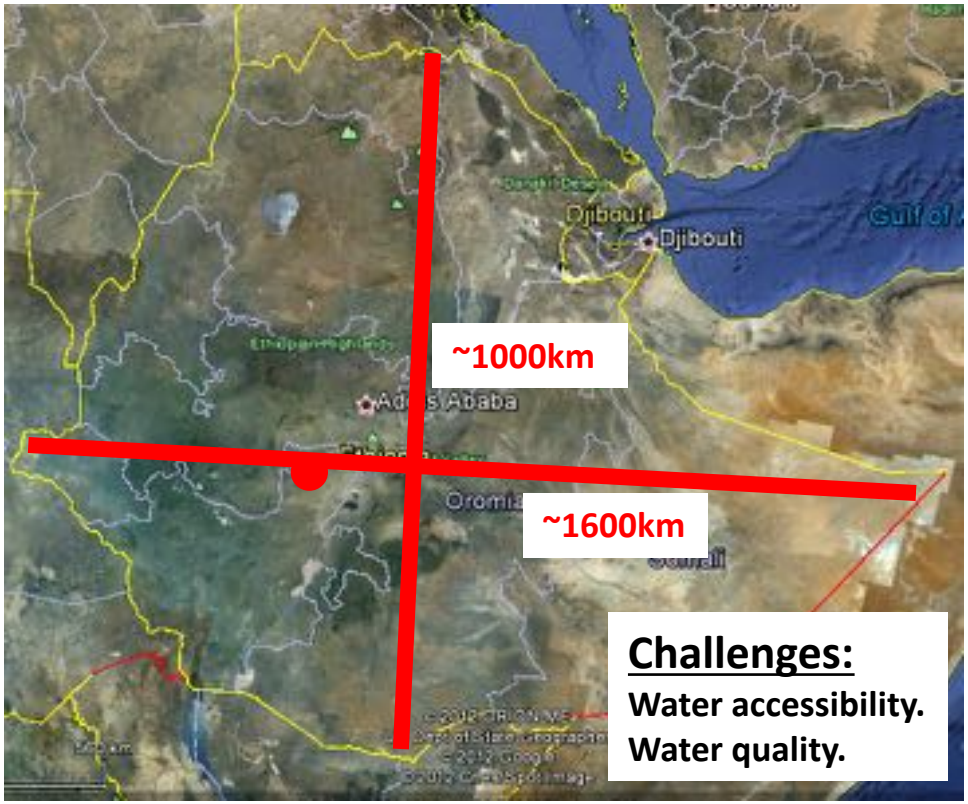


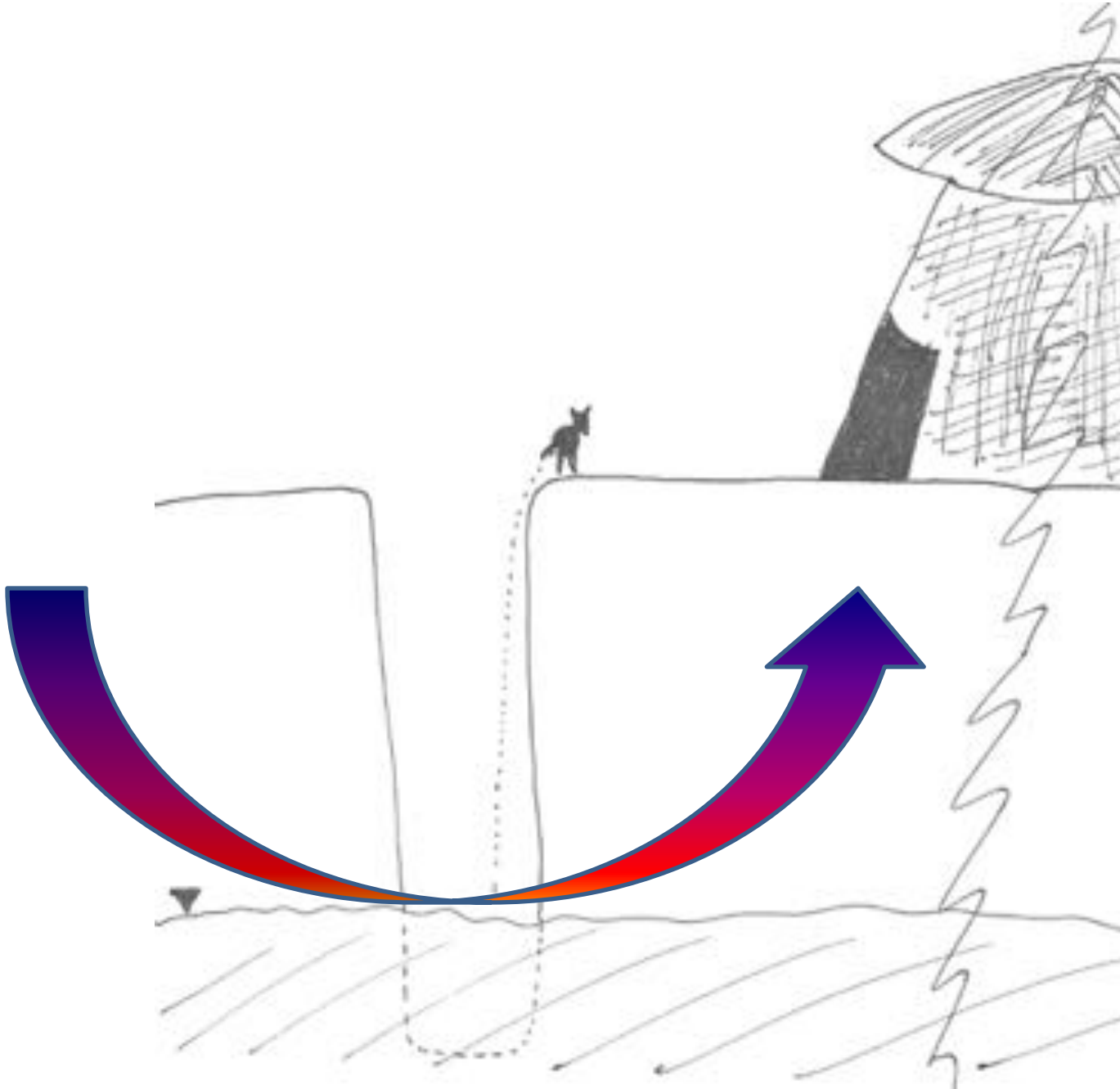
Ethiopia:

One example for local use of ground water



WaterForAll

Ben-Gurion University of the Negev
אוניברסיטת בן-גוריון בנגב



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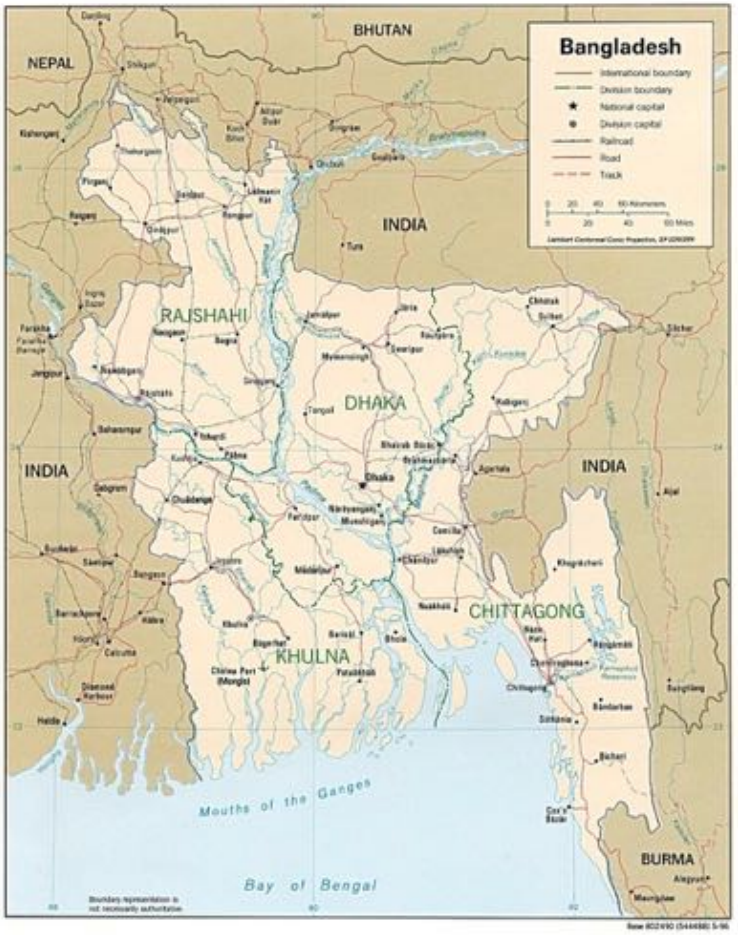
Bangladesh
~500km
~400km

Bangladesh



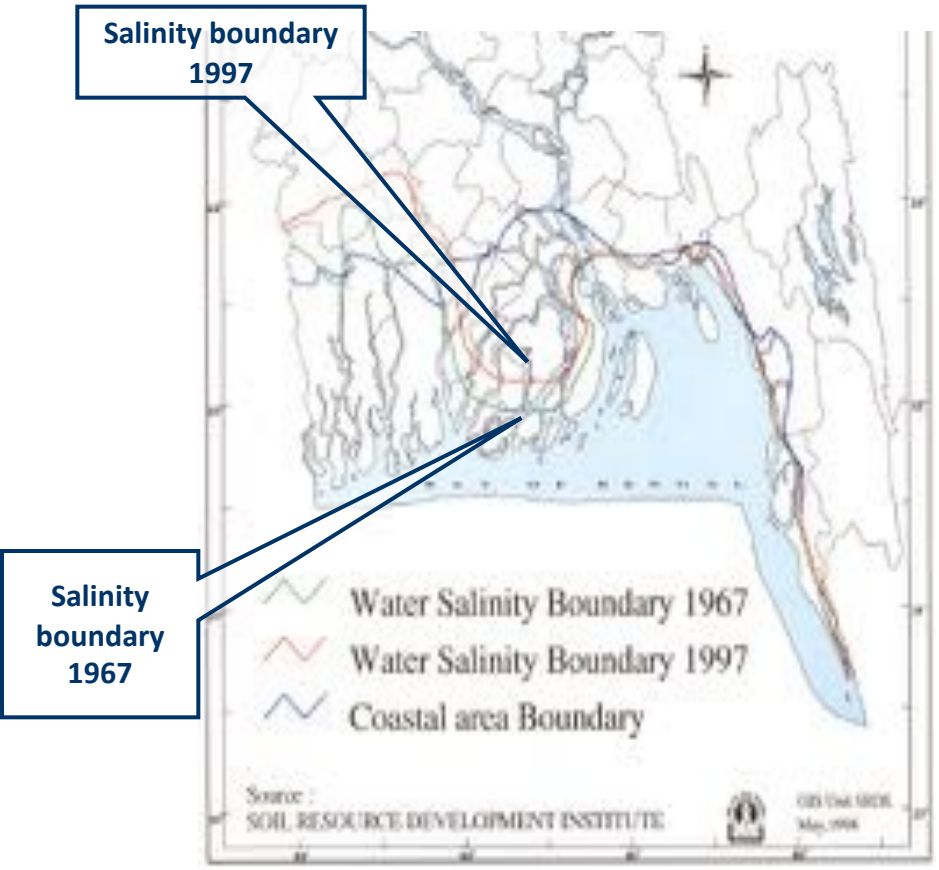
- Bangladesh is a **mega-delta**
- The **Ganges-Brahmaputra-Meghna** rivers drain the Himalayas through Bangladesh into the Bay of Bengal
- The country consists mainly of **low and flat land** formed by river sediments
- Humid, warm tropical climate and is Monsoonal
- Seasons:

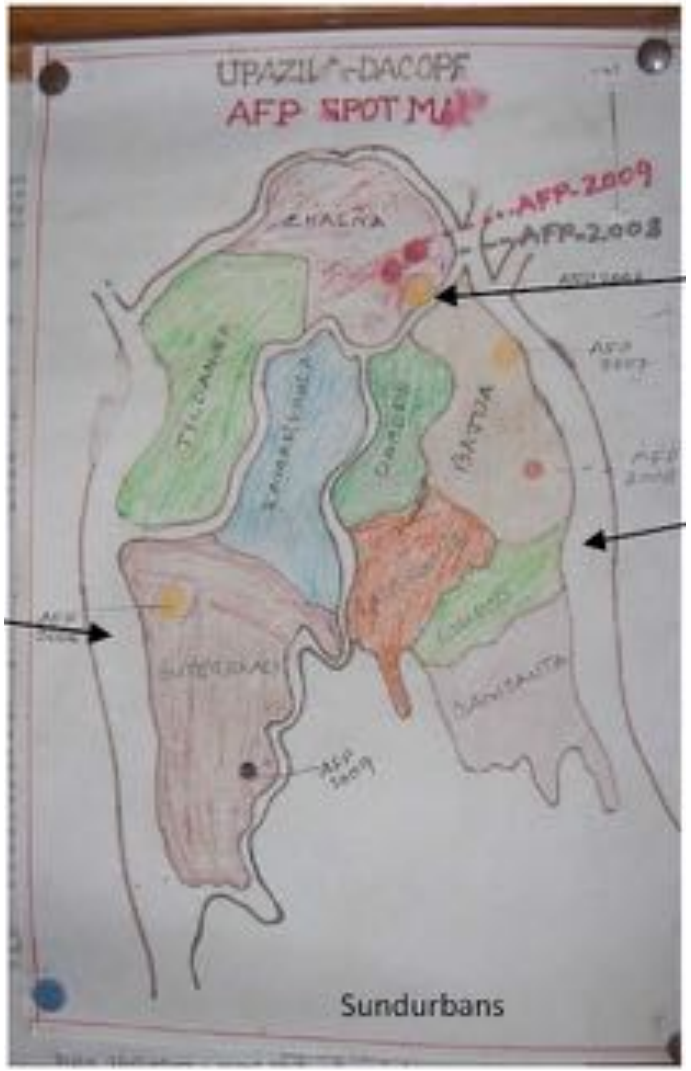
Winter (December to February) is relatively cooler and drier.

Pre-Monsoon (March-June): Hot, high evaporation, heavy rainfall.

Monsoon (June to October): Hot and humid, with heavy torrential rainfalls.
Post Monsoon (November) reduced rainfall, cooler nights.

Southwest Bangladesh






গর্ভজনিত ৫টি প্রধান
বিপদচিহ্ন
জেনে নিন
এর যে কোনো একটি বিপদচিহ্ন দেখা দিলে
তাড়াতাড়ি কাছের
চিহ্নিত হাসপাতালে যেতে হবে

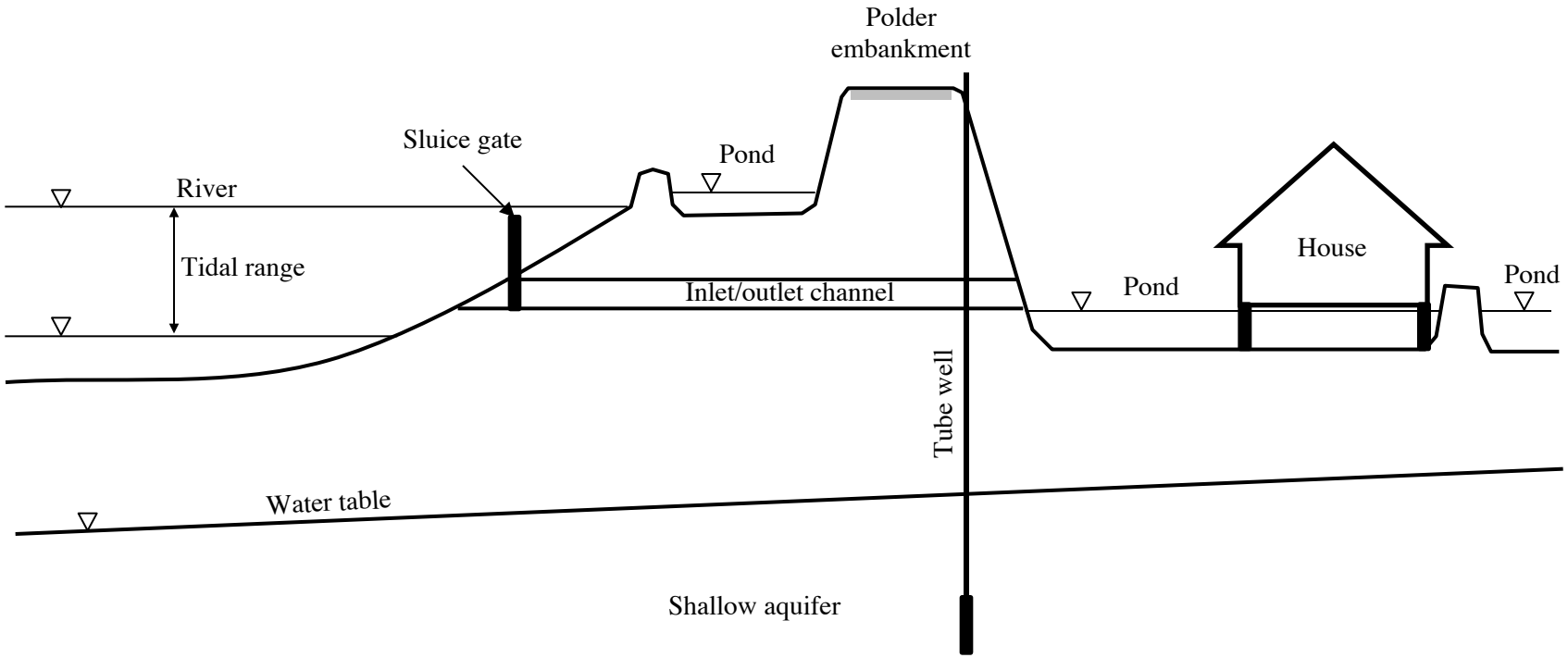
The problem

- Increased incidence of pre-eclampsia, eclampsia and hypertension in pregnant women; elevated maternal mortality. Linked to increased intake of salt.
- Salinity is penetrating further inland in rivers. At a point in the river salinity levels rise, and saline period lasts longer.
- Groundwater is saline in places, but poorly understood.
- Main source of drinking water is the rain fed ponds.

Scientific challenges:

1. What is driving the changes in salinity patterns in rivers (and groundwater)?
2. Are the ponds becoming salinized? If so, how? How can we prevent or mitigate pond salinization.

Pond salinization



SOURCE → **PATHWAY** → **RECEPTOR**

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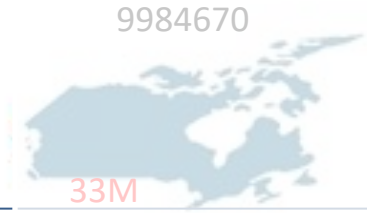
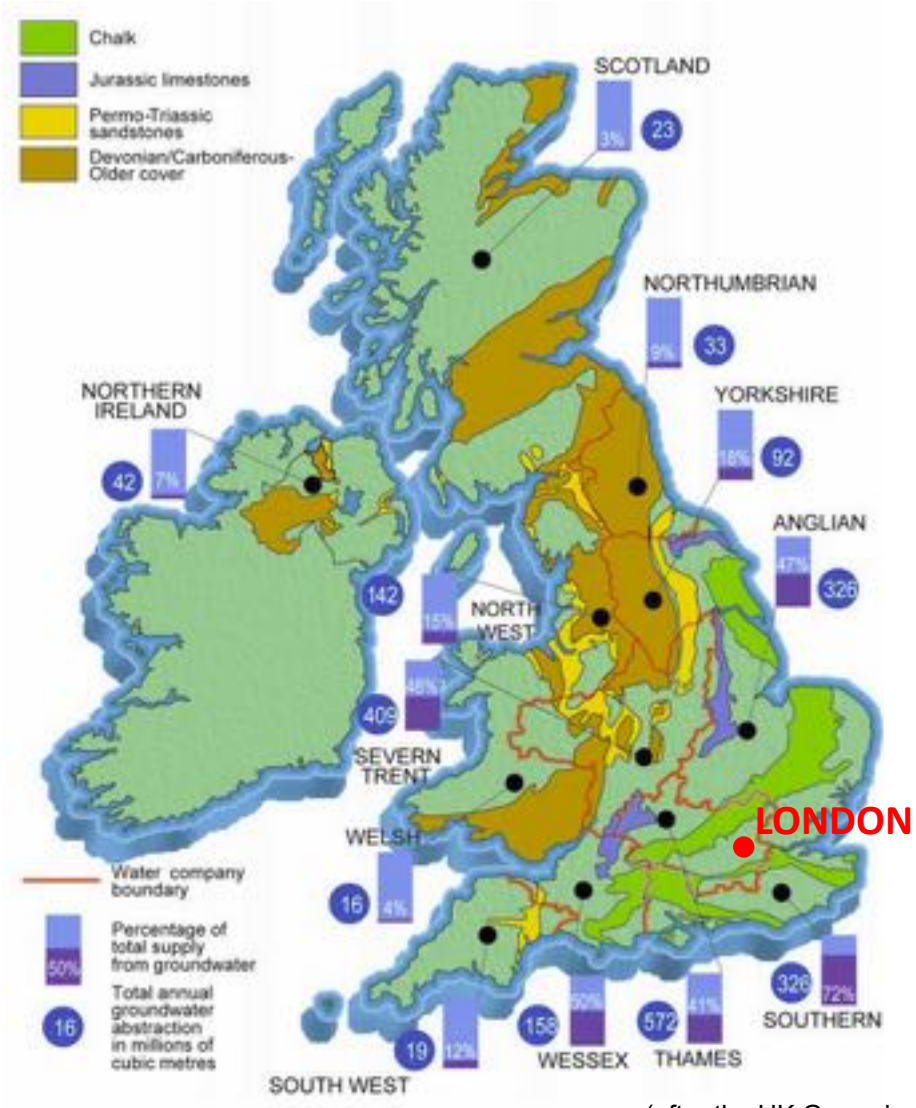


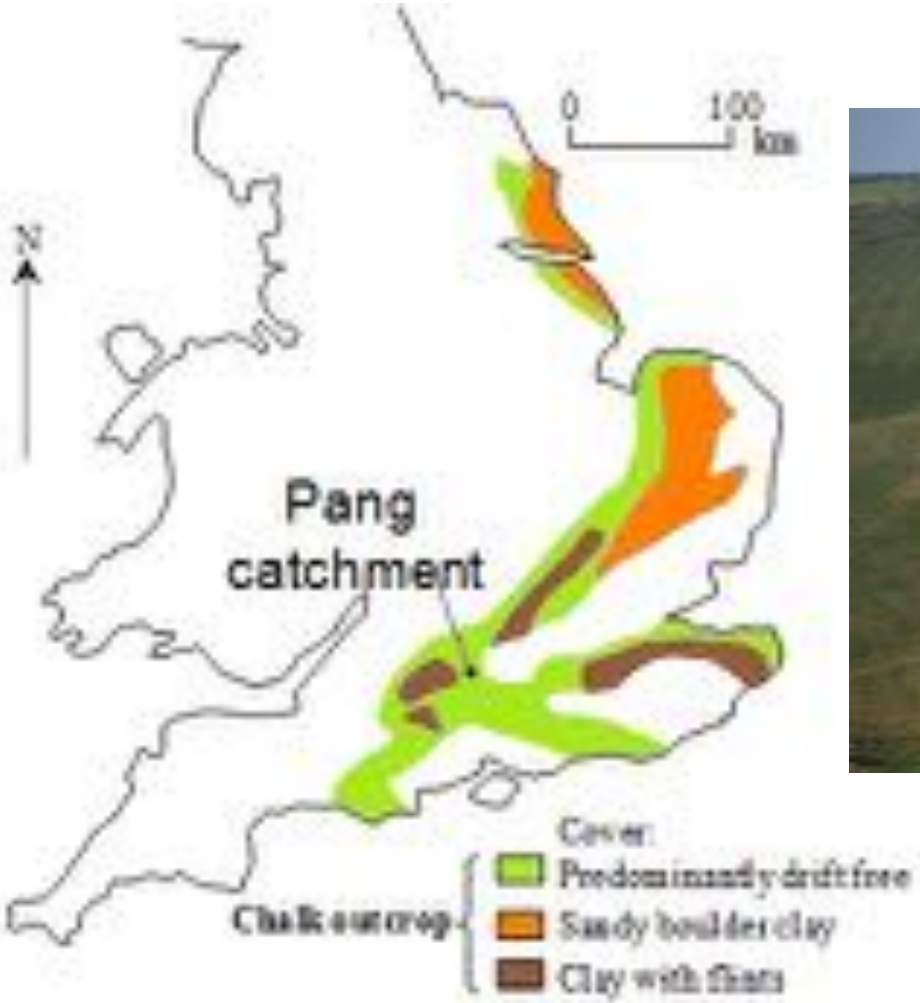
UK:

Groundwater resources in UK



(after the UK Groundwater Forum, 2004)

The English Chalk



Climate in SE England:

Ave. Precipitation ≈ 750 mm/y

Ave. Potential Evap. ≈ 480 mm/y

English Chalk: Landscape

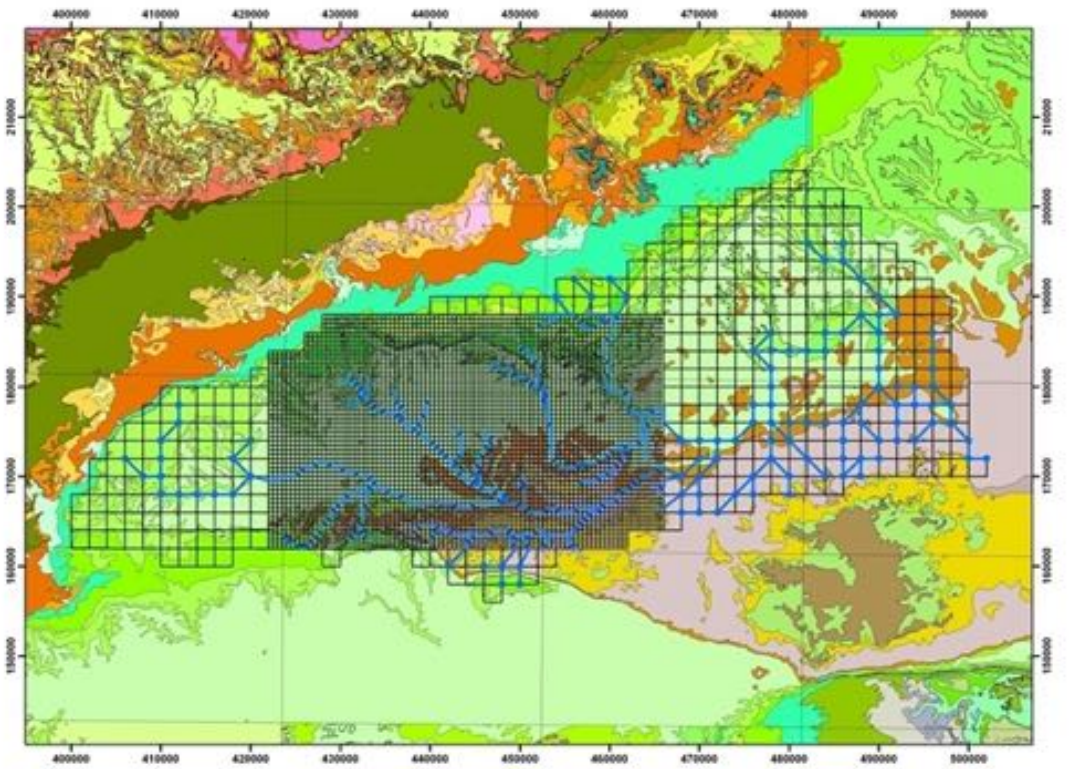
English Chalk: Streams

English Chalk: Streams

Groundwater models

- The UK Environment Agency has commissioned groundwater models of all the major UK aquifers;
- Such “physically based” models are extremely resource intensive to develop, but in principle serve multiple purposes:
- Flood risk and impact assessment
- Drought risk
- Groundwater pollution
- Sustainable groundwater management

Take home message: UK water resources are relatively well monitored and modelled.



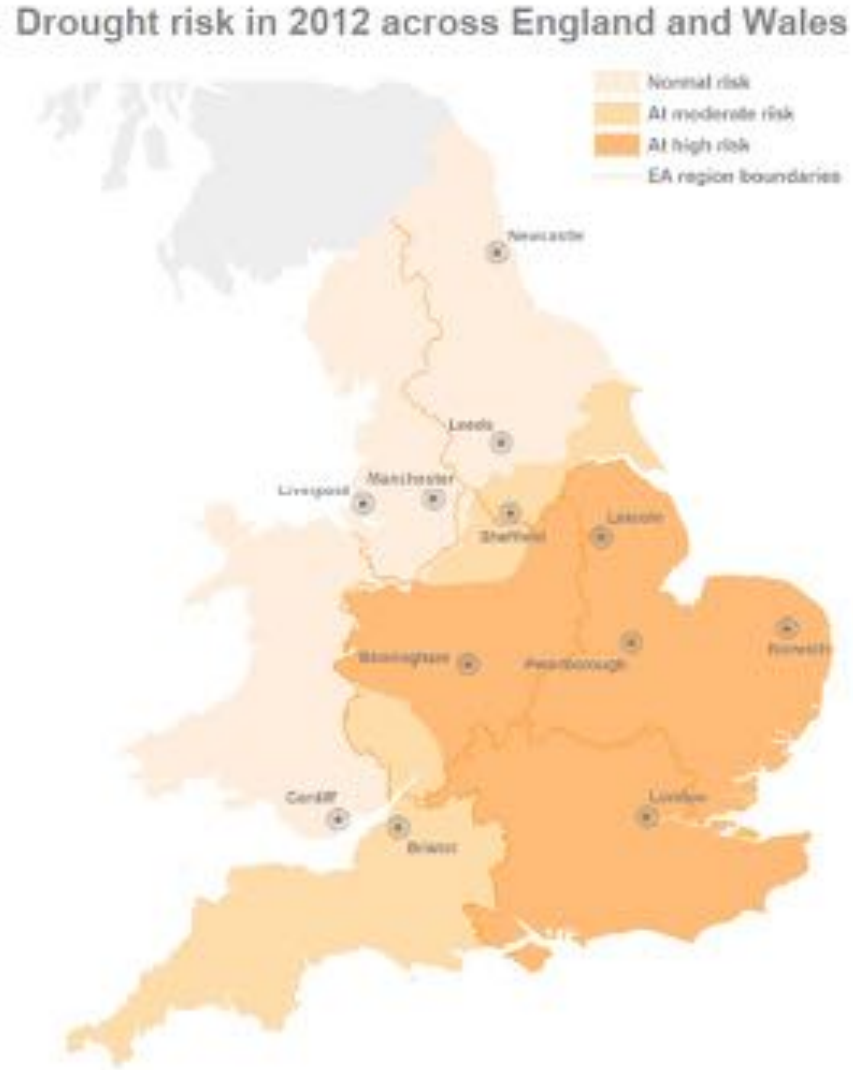
The BGS ZOOMQ3D groundwater model focusing on the Pang/Lambourn catchments

The 2012 Drought – March 2012 perspective

- Most of SE and E England was in drought due to 2 dry winters
- Past 6 months are driest since records began
- Low groundwater recharge has led to drying of streams – EA has pumped water into streams and wetland to rescue fish, and is trying to help farmers locally
- However, real impact of drought will hit in summer as plants transpire and dry soils out – severe drought is expected!
- Government, EA, Water companies, working together to manage the situation
- Important management decisions include:
  - Which farmers are allowed to fill irrigation reservoirs
  - Which rivers are priorities for environment and navigation.
  - Can water companies withdraw water below normally acceptable levels
  - What restrictions can water companies impose on consumers
- Contingency plans being prepared for 2013. A hot dry summer would lead to significantly worse impacts.

The 2012 Drought – March 2012 perspective

- Most of SE and E England is currently in drought due to 2 dry winters



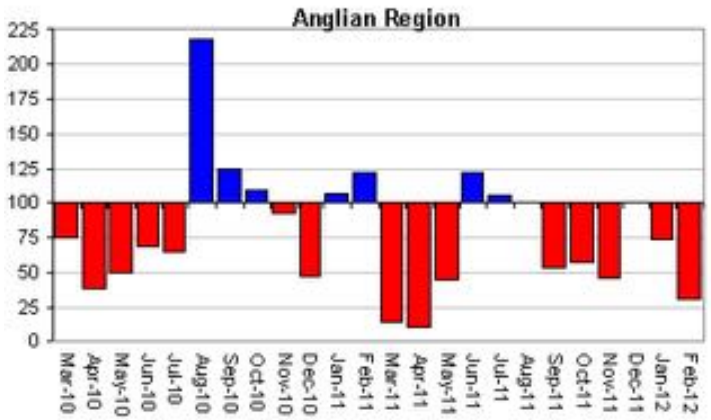
EA 2012: http://publications.environment-agency.gov.uk/pdf/GEHO0312BWDT-E-E.pdf

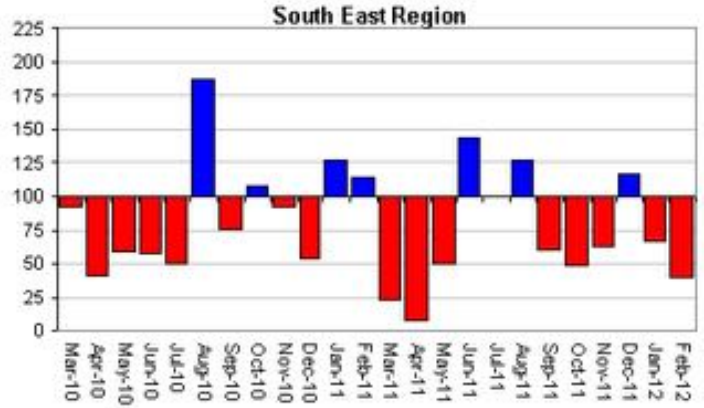
The 2012 Drought – March 2012 perspective

- 6 months up to Feb 2012 are driest since records began

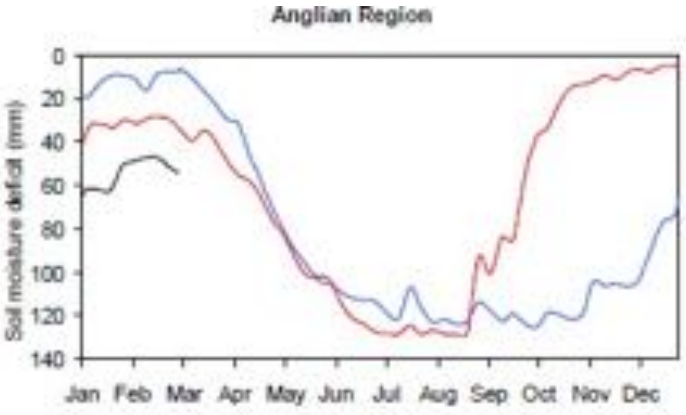
RAINFALL

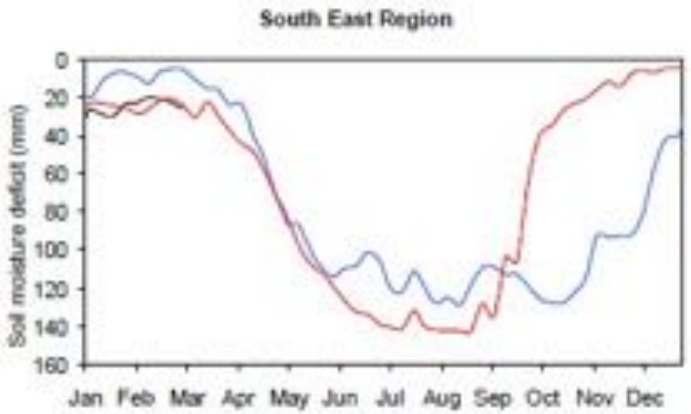
RAINFALL





SOIL MOISTURE



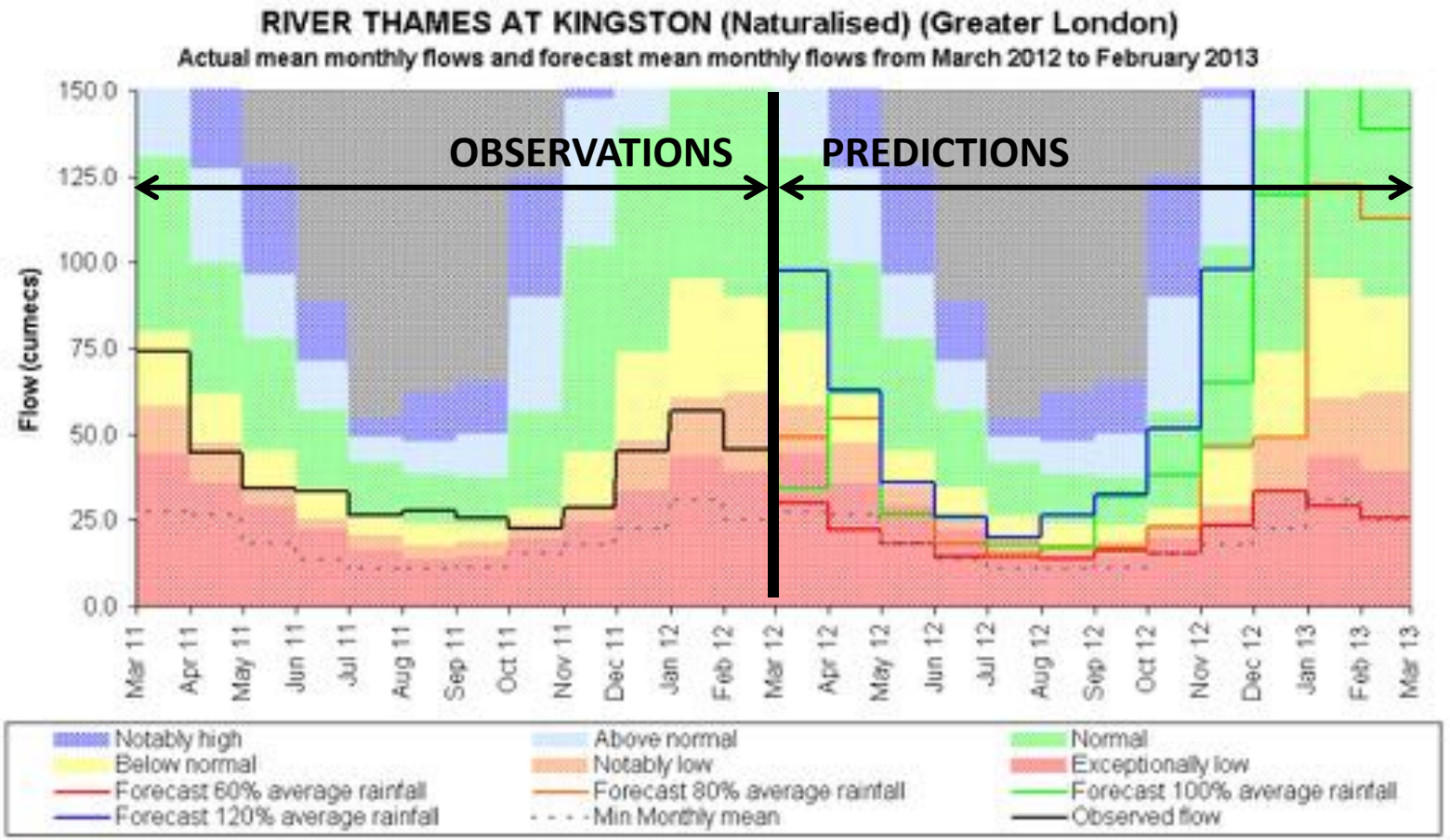


1976
2011
2012

EA 2012: http://publications.environment-agency.gov.uk/pdf/GEHO0312BWDT-E-E.pdf

The 2012 Drought – March 2012 perspective

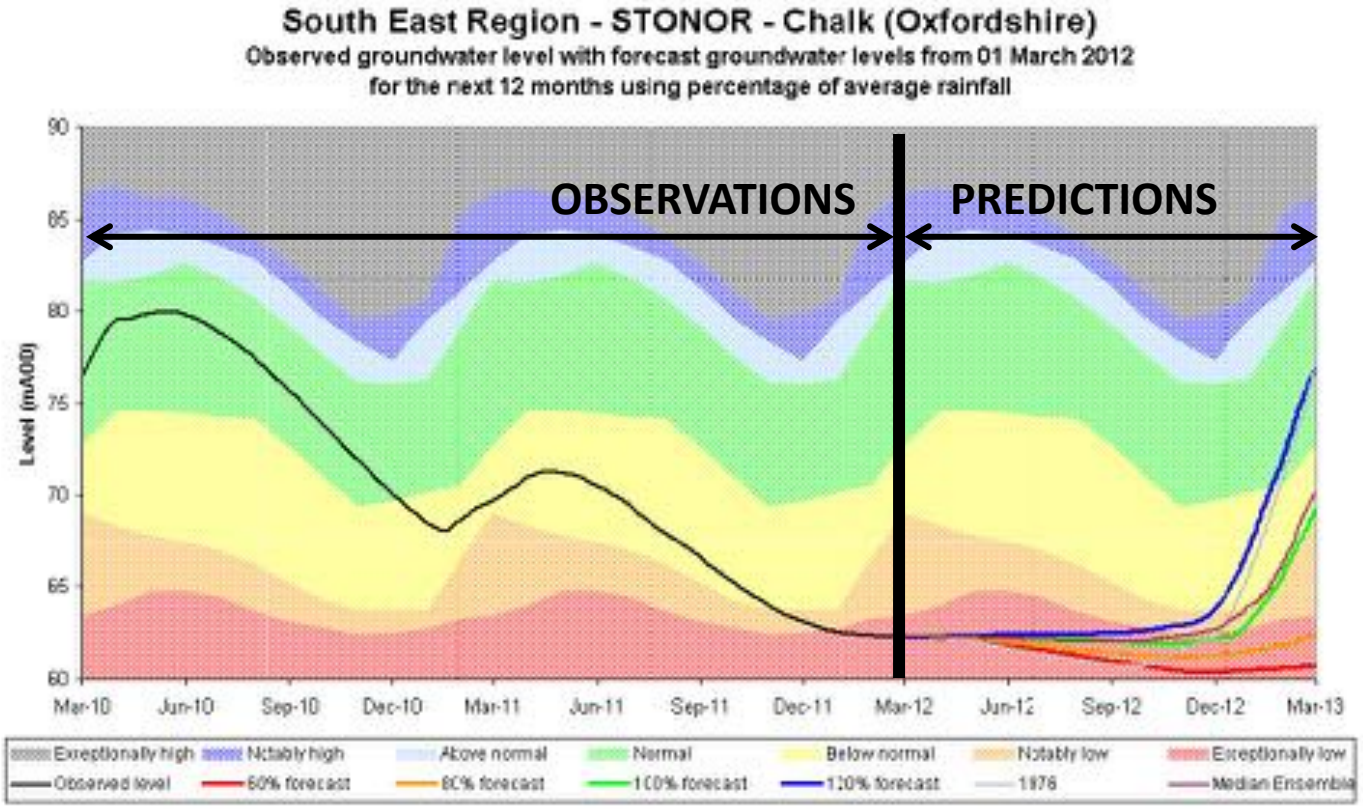
- Stream flow is low now, but forecasts are worse



EA 2012: http://publications.environment-agency.gov.uk/pdf/GEHO0312BWDT-E-E.pdf

The 2012 Drought – March 2012 perspective

- Delayed response in streams is because they are fed by groundwater
- Groundwater levels are declining:



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What about the Olympics!!!

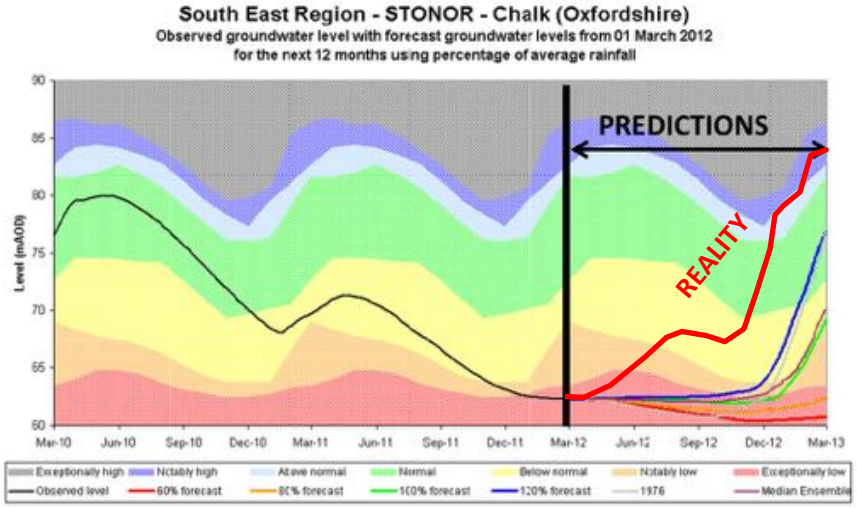
- New infrastructure was designed to reduce potable water usage significantly:
  - Rainwater harvesting from roofs, car parks and other hardstandings.
  - A non-potable supply network across the Olympic Park has been installed to supply water for events, irrigation and cleaning. This non potable supply network is planned to be supplied by a blackwater re-use plant, taking water from a Thames Water sewer main.
  - Water efficient fixtures and fittings (e.g. low flow taps, waterless urinals).
  - Swimming pool backwash recycling.

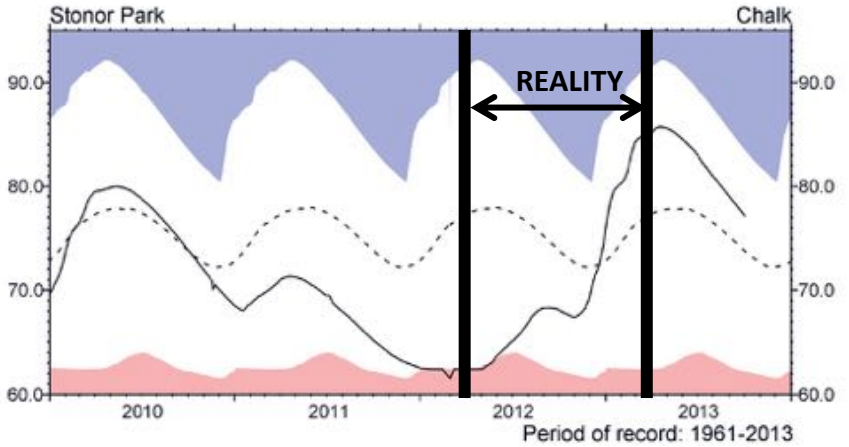
- However, the enhanced water demand is an additional consideration for planning
  - Rowing and canoe venues may be relocated.
  - Specific boreholes and streams have been identified as back up supplies

The 2012 Drought – what actually happened?

"The wettest drought in history"

- The driest spring for over a century gave way this year to the wettest April to June on record (230 yrs)[1]
- 20 million people had been issued with a hosepipe ban and 200 drought related environmental incidents and major roads cracking in the dry conditions
- Then "the heavens opened, river levels tripled and reservoirs went from their lowest ever levels to full or exceptionally high. Flooding hit almost every region of England and Wales from May to July"[1]





1. http://www.ceh.ac.uk/news/news_archive/drought-flood-transformation-uk_2012_54.html

Summary:

- Water is one of the most important resources.

- Many people are dying due to water related problems.
- Different challenges require different solutions.
- Sometimes similar challenges require different solutions due to cultural, economical and technological differences.
- There is a lot of water on Earth.
- The right management and priorities could save many lives.

- We are lucky!!
- As scientists we shouldn't forget the real problems of our world; which we have the privilege to contribute something for the solution.