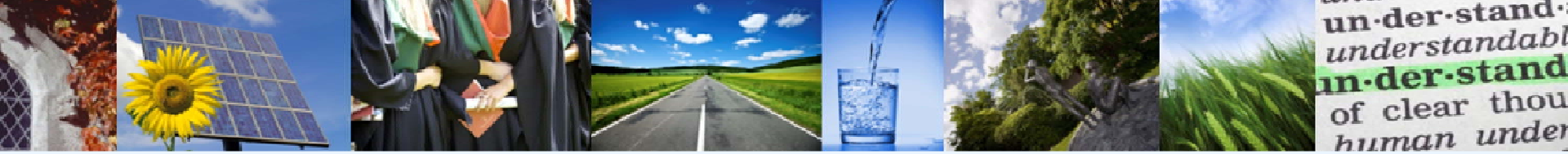
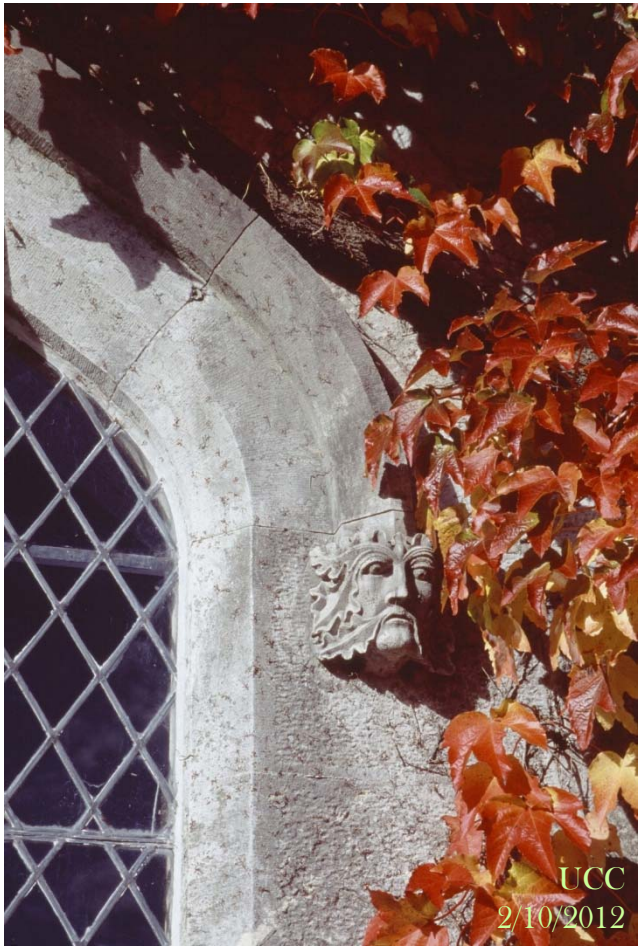


Sustainability and Modern Society



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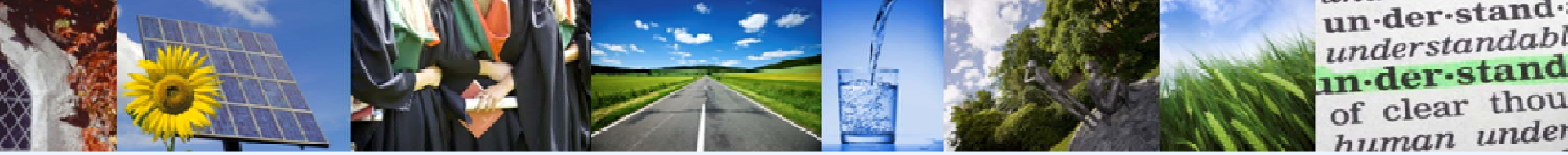
An unsustainable societal construct: Freshwater – an infinite resource?

- Dr Debbie Chapman

School of Biological, Earth and Environmental Sciences



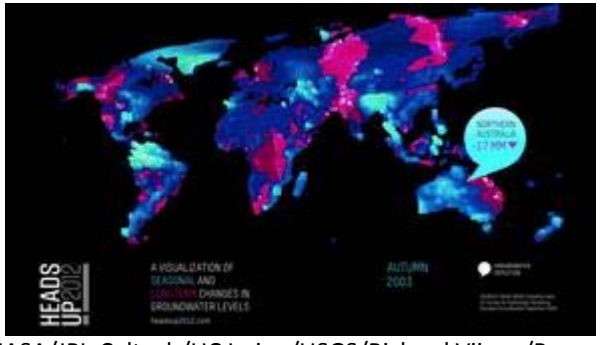
Freshwater is renewable – or is it?

Only 2.5% of all the water on the Earth is freshwater most of which is bound up in ice-caps and glaciers

Replenishment of groundwater can take years to decades

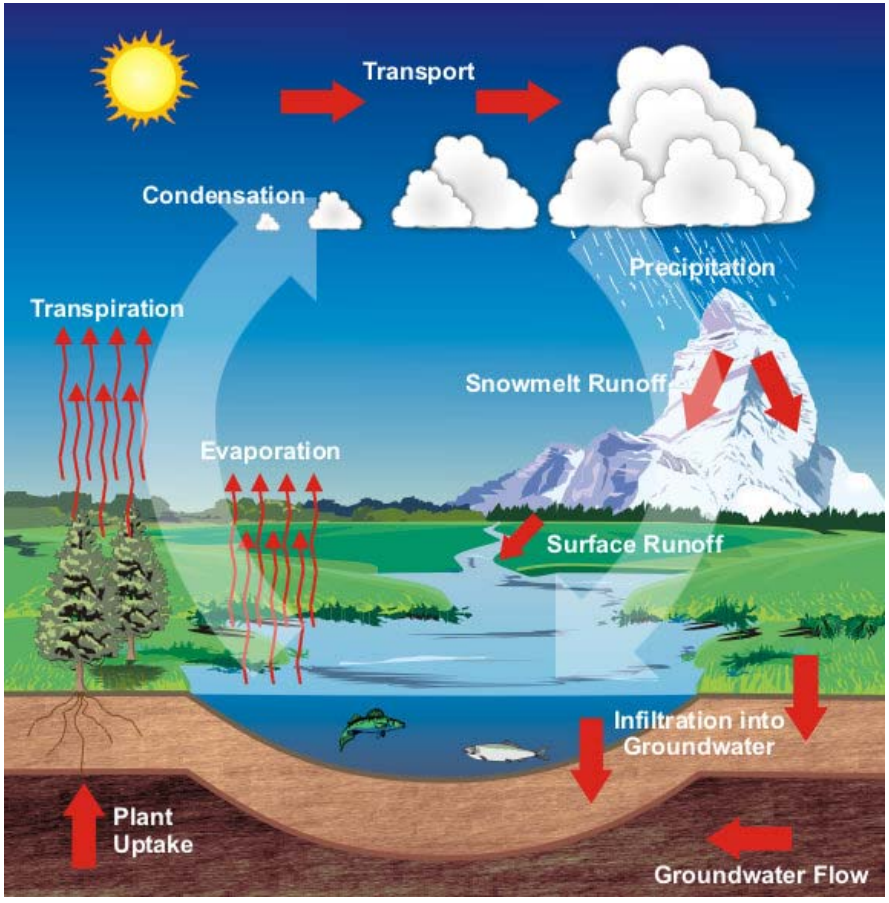
Refreshing of lakes can take days to decades

Abstraction for use can exceed replenishment

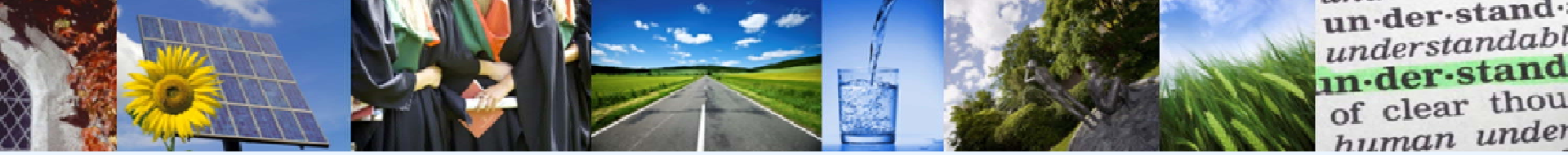


NASA/JPL-Caltech/UC Irvine/USGS/Richard Vijgen/Peggy Weil/

The hydrological cycle



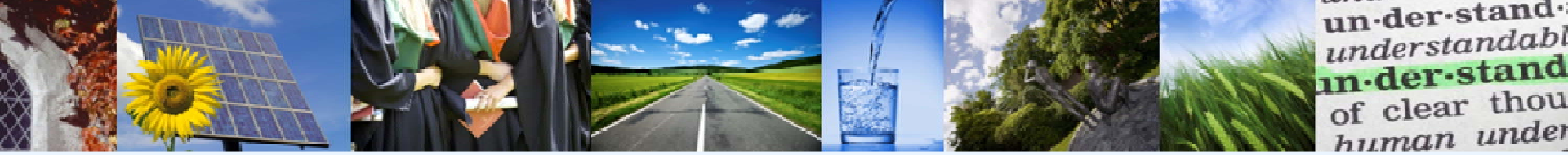
http://www.atmos.illinois.edu/earths_atmosphere/water_cycle.html



Freshwater is essential

- Drinking
- Food preparation
- Cooking
- Personal hygiene
- Other domestic activities

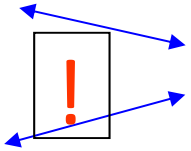
- *Water used generates wastewater*



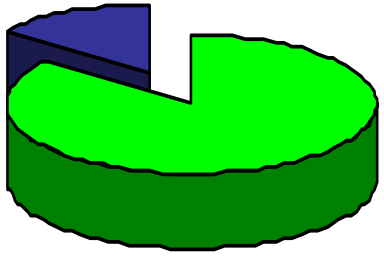
Average daily water consumption per person in Ireland

(www.taptips.ie)

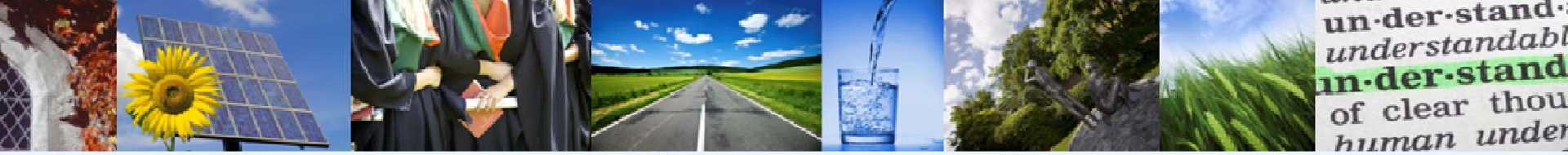
	Average litres/person/day
Shower	35
Toilet	27
Laundry Wash	40
Hand wash	12
Teeth Brushing	12
Dish wash	10
Cooking	10
Drinking	2
Total	**148**



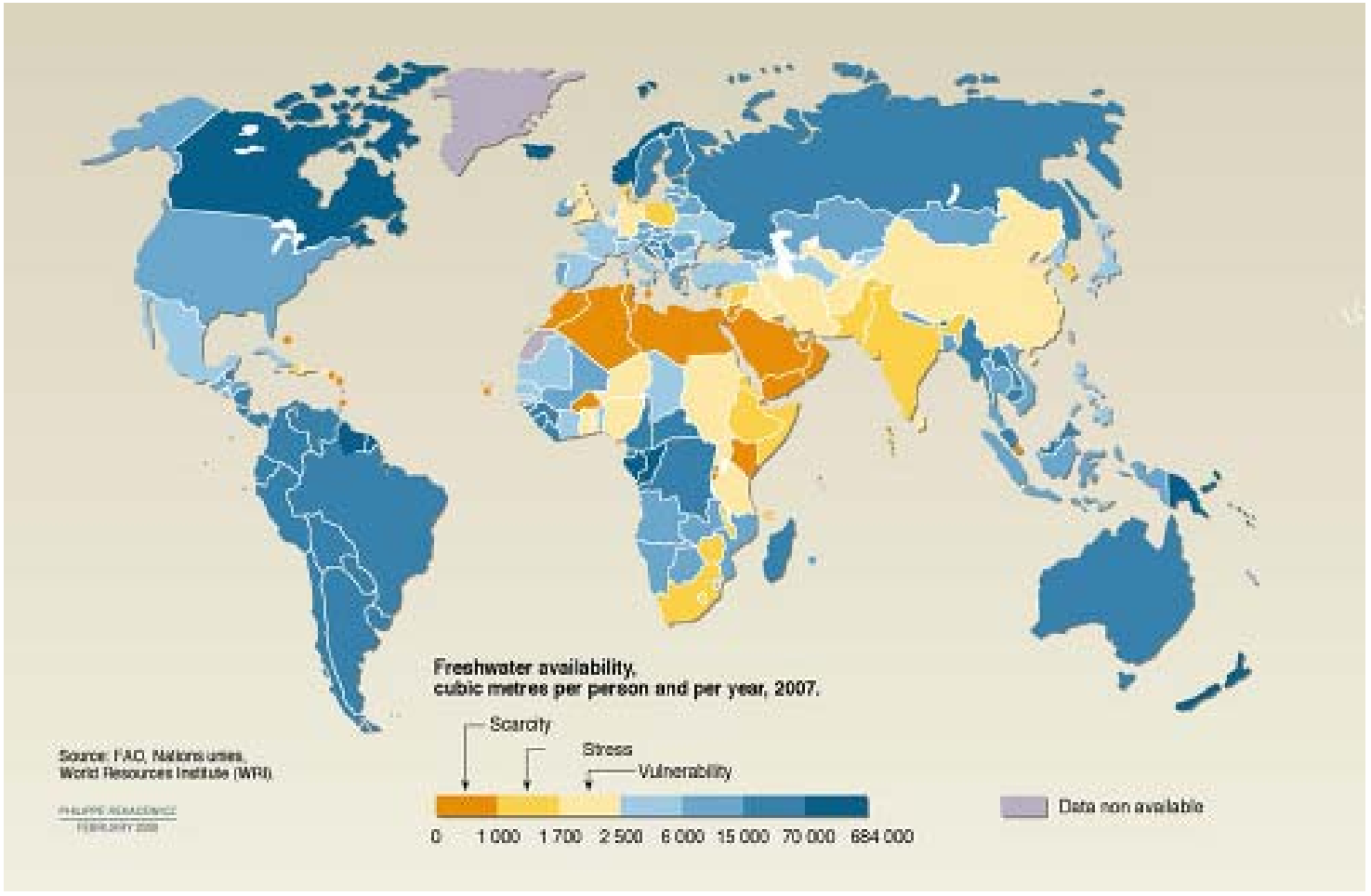
Developing world:
< 50 litres per person per day

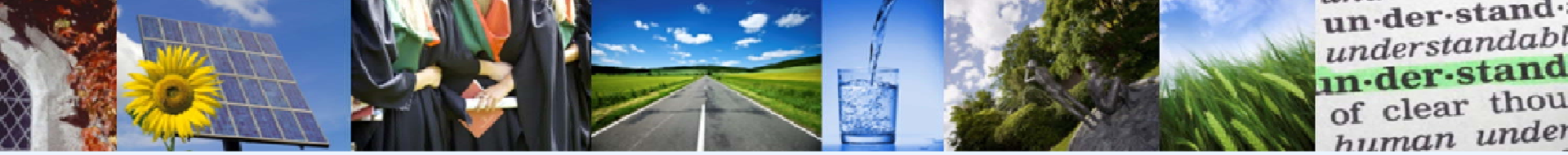


Developed world:
300 litres per person per day



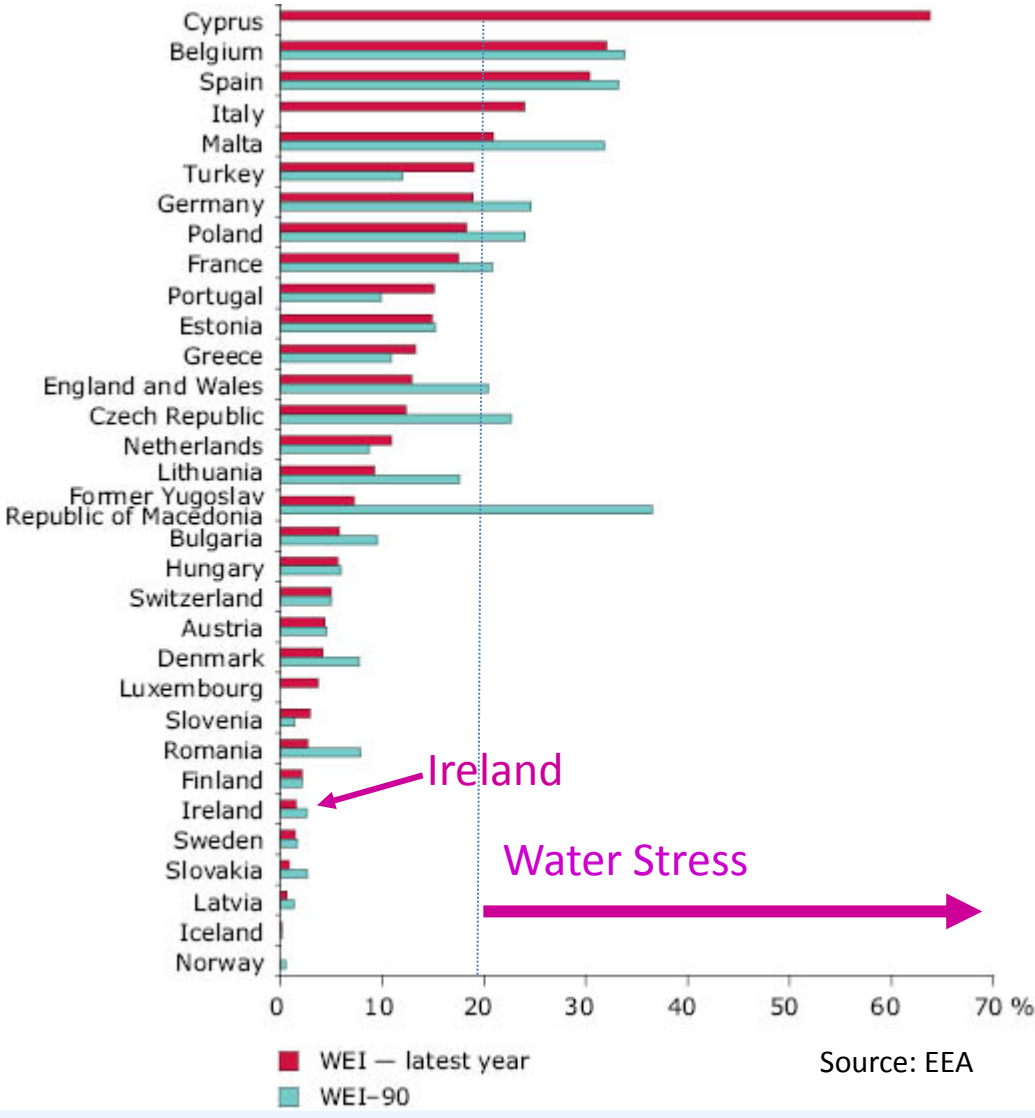
Water availability: not every country has enough water to meet its needs

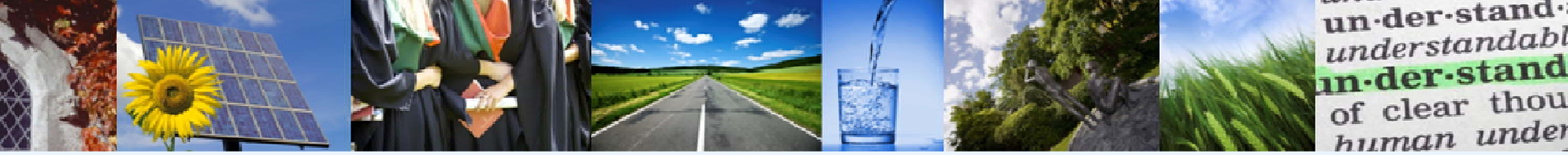




18% of Europe's population live in countries that are water stressed

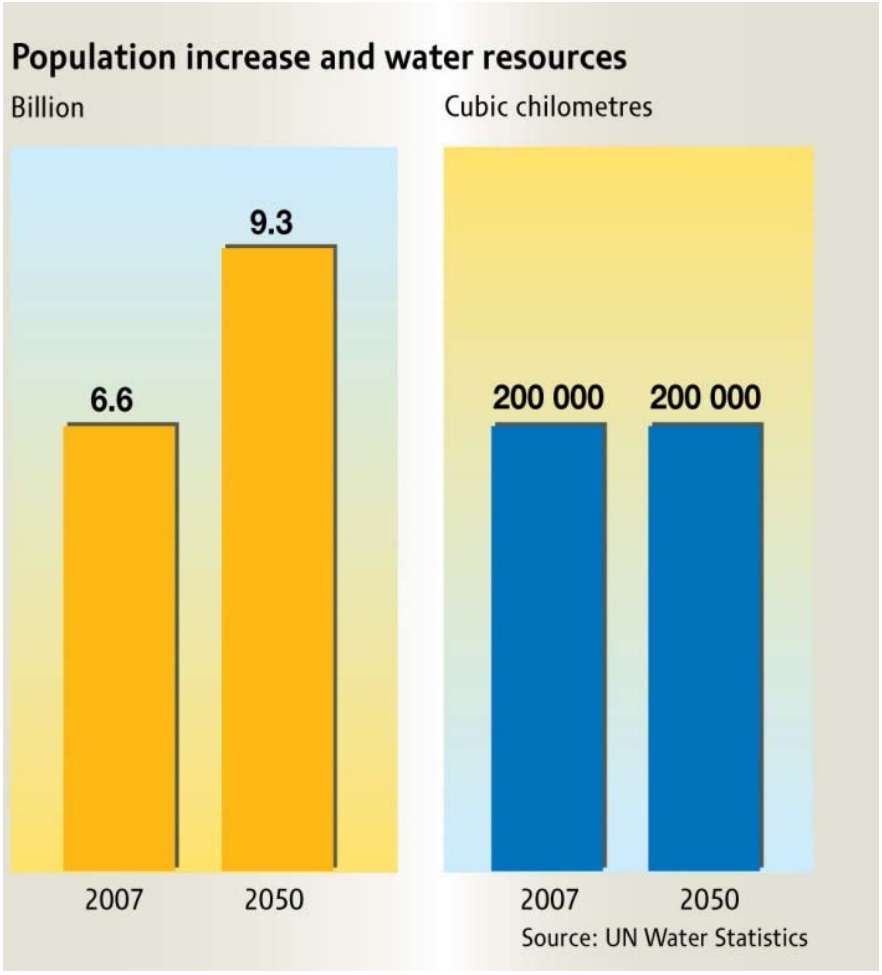
- Mean annual total abstraction divided by long-term average freshwater resources (including inflows from neighbouring countries)
- Water stress occurs at WEI > 20%
- Severe stress can occur for WEI > 40%



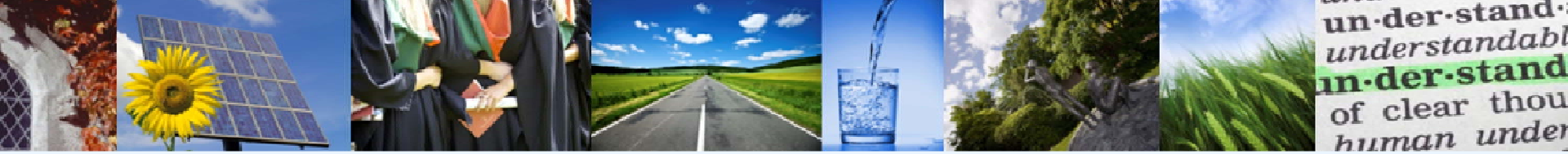


Water for the future

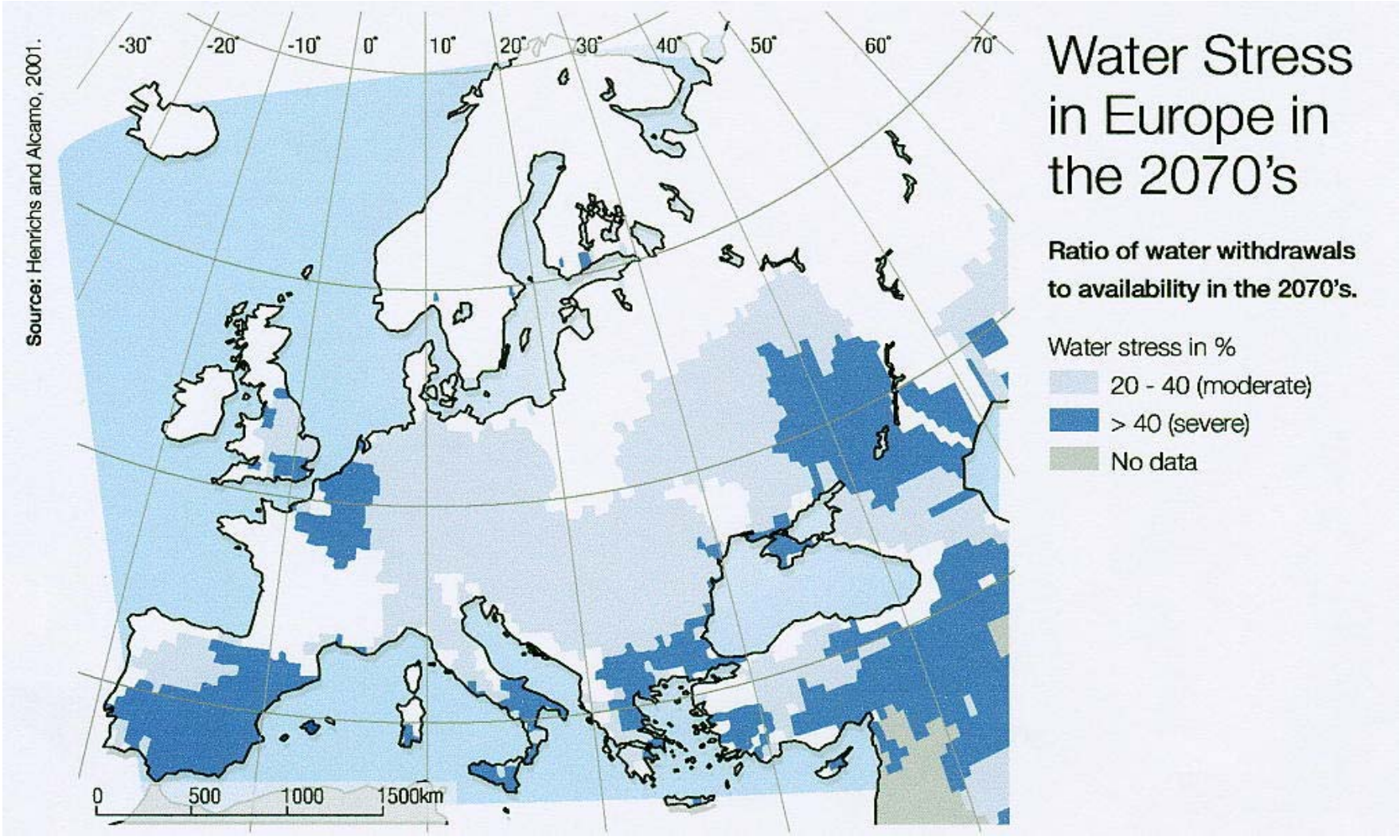
- Populations will increase but the total amount of water will remain the same
- There will be less water available per person in the future

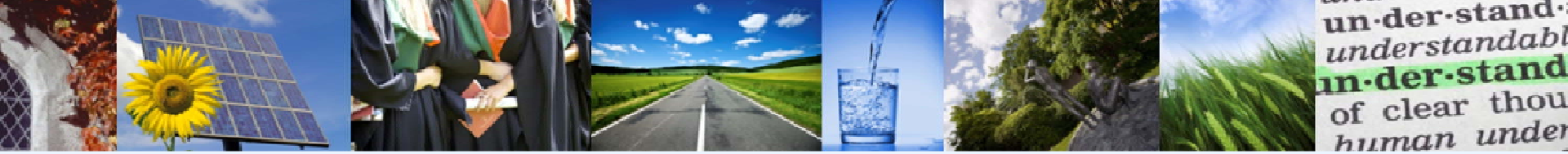


UNEP/GRID-Arendal, Population increase and water resources, *UNEP/GRID-Arendal Maps and Graphics Library*, http://maps.grida.no/go/graphic/population-increase-and-water-resources (Accessed 15 February 2012)

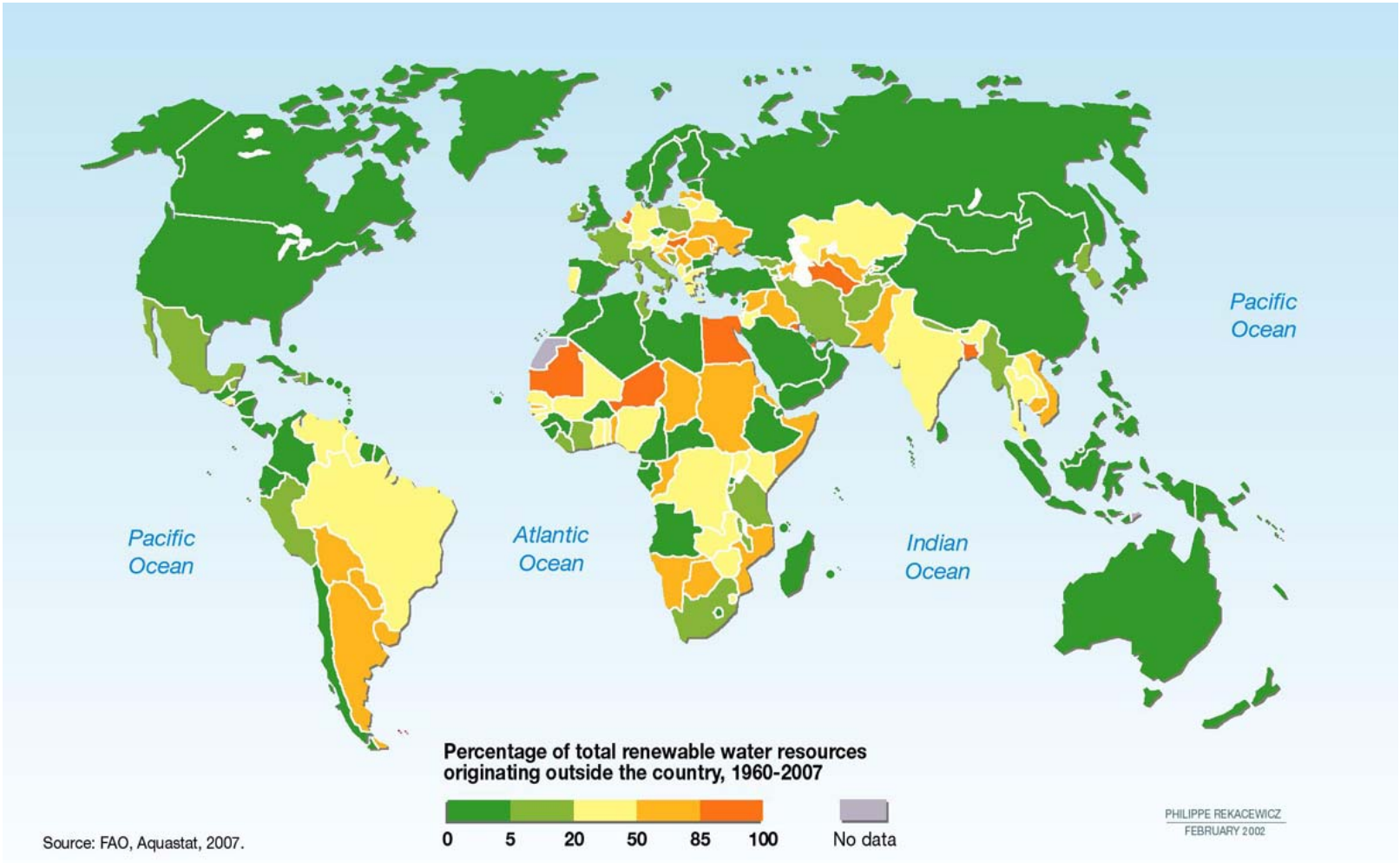


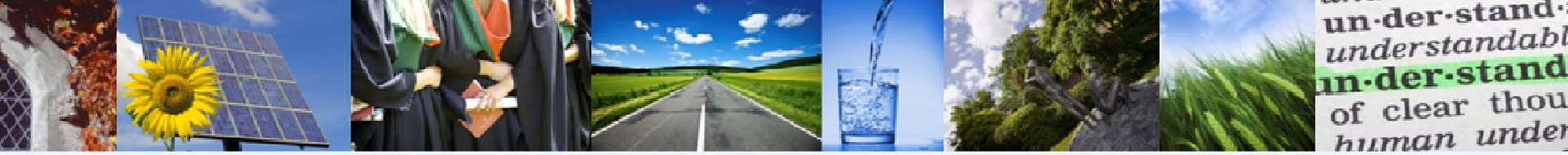
Water Stress in Europe in the 2070's



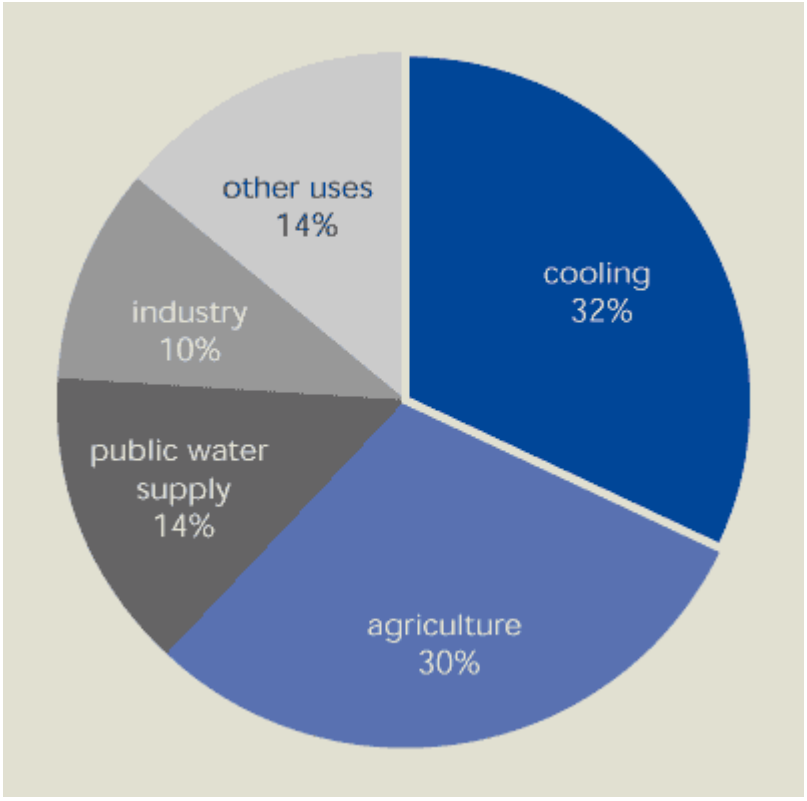


Some countries rely on water that comes from elsewhere



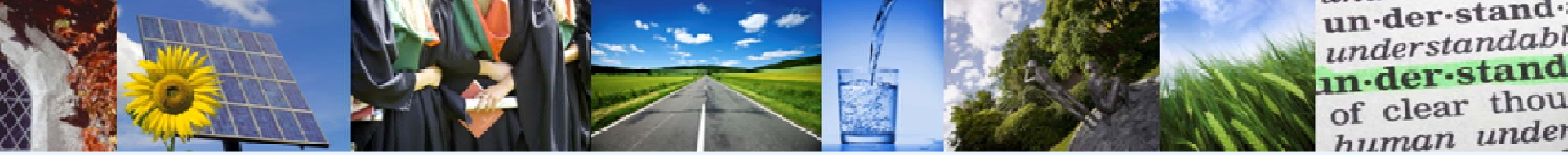


Water use in European Environment Agency countries

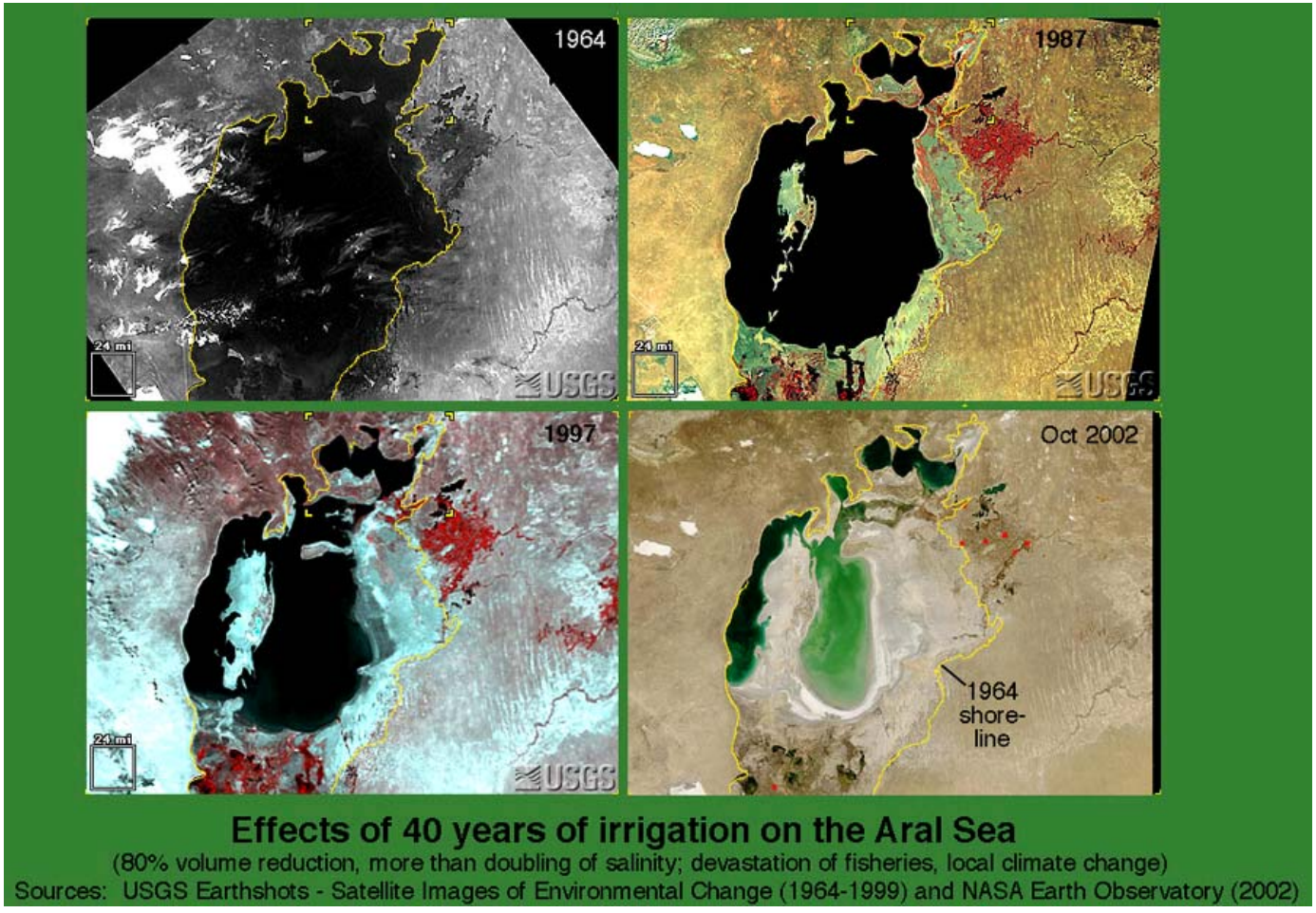


Source: EEA

Digital Vision



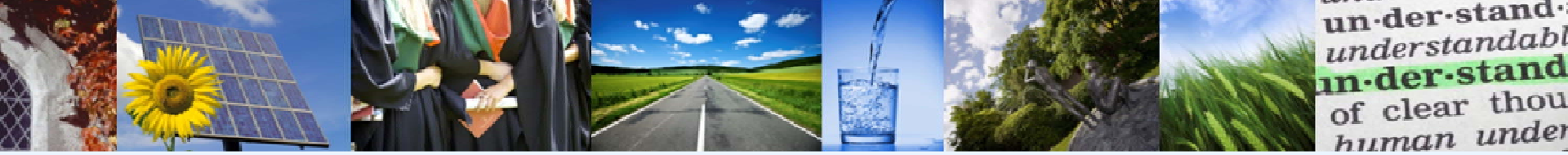
Unsustainable use: The Aral Sea



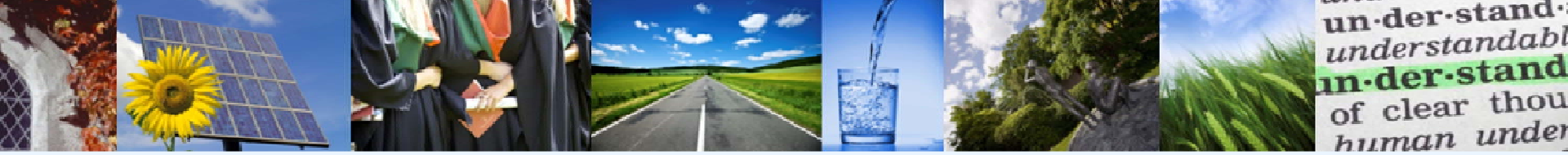
Effects of 40 years of irrigation on the Aral Sea

(80% volume reduction, more than doubling of salinity; devastation of fisheries, local climate change)

Sources: USGS Earthshots - Satellite Images of Environmental Change (1964-1999) and NASA Earth Observatory (2002)

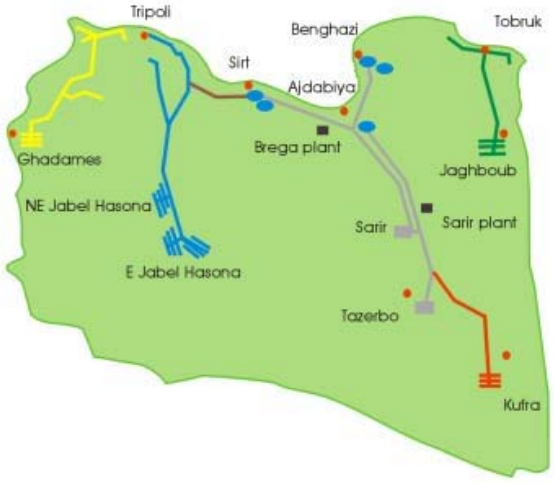


The result of excessive water abstraction for agriculture

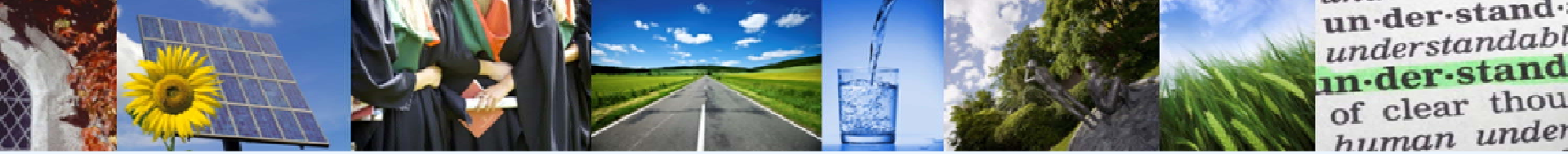


Unsustainable use: The Great Man Made River Project

- Conceived in 1984
- Now includes almost 4,000 km (2,485 miles) of mainly 4-meter diameter pre-stressed concrete cylinder pipe (PCCP)
- Objective: to convey over 6.0 10^6 m^3 of water every day from well fields deep in the Sahara desert to the population centres on the northern coastal strip

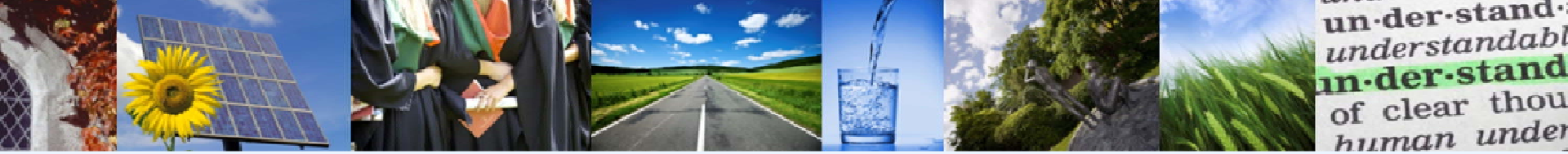


www.gmmra.org



Even if we have enough water – is it suitable for our use?

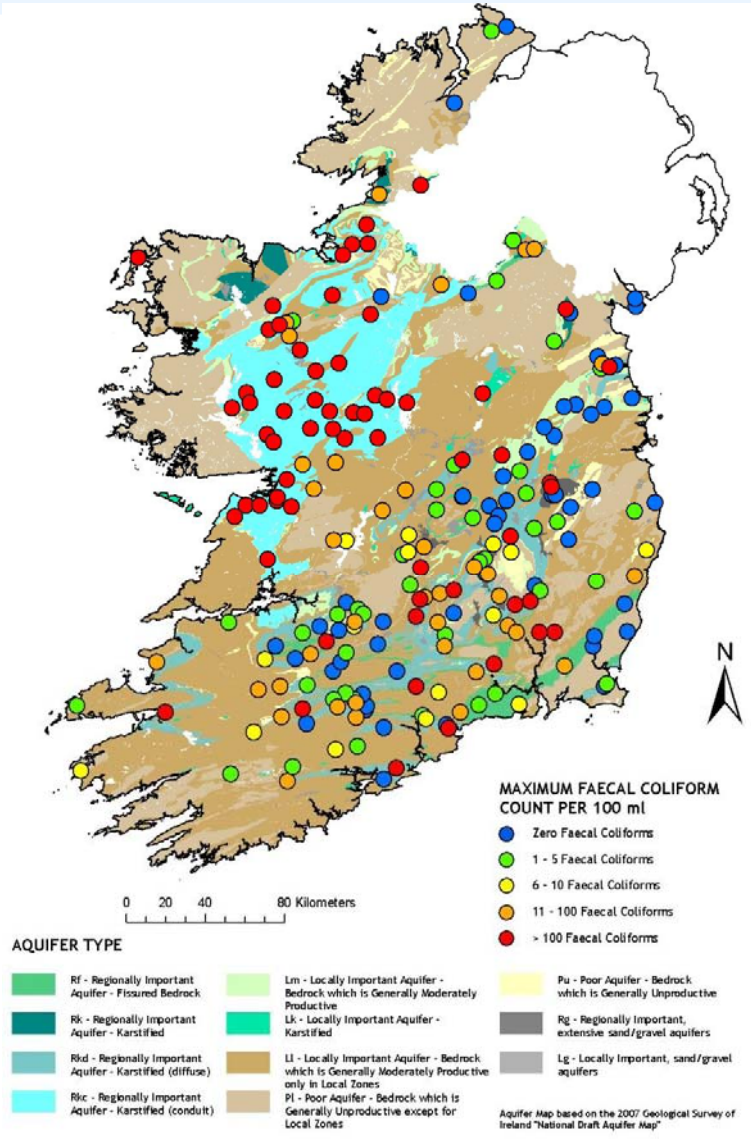
Industry, agriculture and human settlements generate wastewaters that affect the quality of water

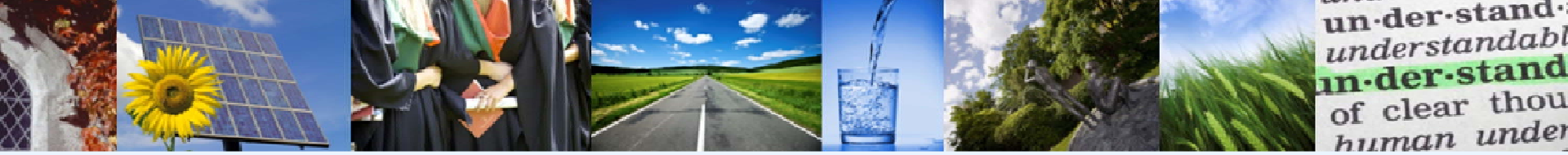


Status of Groundwater in Ireland (2007-09)

- 34.8% of samples positive for faecal coliforms
- 74.4% of sample locations were positive for faecal coliforms
- Situation getting worse
- Faecal contamination due to:
  - (i) human activities, and
  - (ii)vulnerability of groundwater in some locations
- Improvements may occur if there is better control over septic tanks and better treatment of domestic wastewaters

Source: EPA 2010





Looking deeper into unsustainable use

Real water

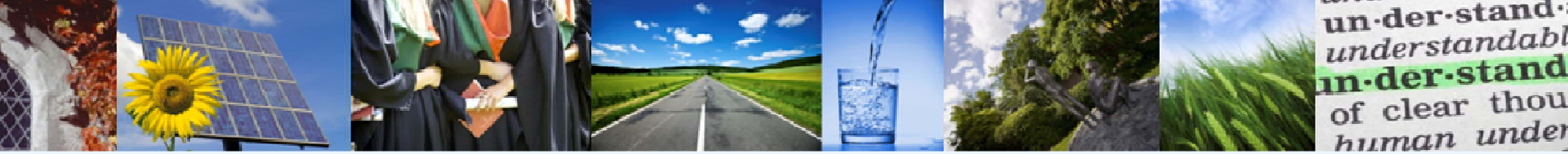
- Rainwater
- Surface waters (rivers, streams, lakes, reservoirs, ponds, ditches and canals)
- Groundwater
- Bottled water!

Virtual Water

- "Unseen" water
- Water used to produce a product
  - Growing crops and fodder
  - Animals to drink
  - Processing food and drinks
  - Manufacturing goods







Water footprints

Water Footprint

- The volume of fresh water used to produce a product, summed over the various steps of the production chain
- **National water footprint**: total amount of water used in the production of goods and services at the national scale
  - Internal (domestic)
  - External (international) trade footprints
- Commercial/business water footprints
- **Consumer/domestic water footprints**

Water Footprint NETWORK

Water footprint of one sheet of A4 paper

- Assume standard 80g paper (i.e. 80g/m^2)
- Assume the paper is produced from wood
- **Total: 10 litres of water**

Van Oel, P.R. and Hoekstra, A.Y. (2010) The green and blue water footprint of paper products: methodological considerations and quantification, Value of Water Research Report Series No.46, UNESCO-IHE, Delft, the Netherlands.

[Hoekstra & Chapagain, 2008]

The water footprint of a cow

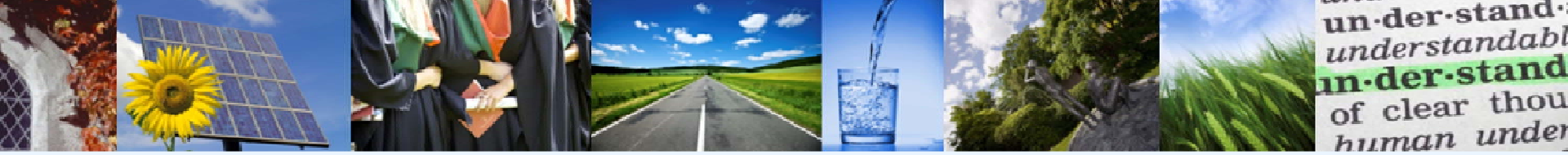
Food – 90% of water footprint

- 1 300 kg of grains (wheat, oats, barley, corn, dry peas, soybean, etc)
- 7 200 kg of roughages (pasture, dry hay, silage, etc)

Water – 1% of water footprint

- 24 000 litres for drinking
- 7 000 litres for servicing

[Hoekstra & Chapagain, 2008]

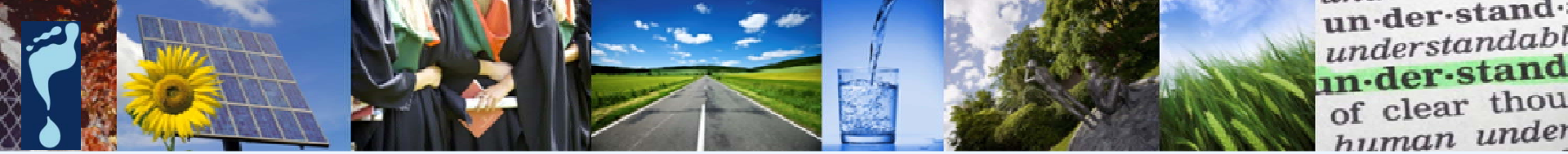


Water footprints of some common products

Global average virtual water content of some selected products. per unit of product

Product	Virtual water content (litres)
1 glass of beer (250ml)	75
1 glass of milk (200ml)	200
1 glass of wine (125ml)	120
1 glass of apple juice (125ml)	190
1 cup of coffee (125ml)	140
1 cup of tea (125ml)	35
1 slice of bread (30g)	40
1 slice of bread (30g) with cheese (10g)	90

Product	Virtual water content (litres)
1 potato (100g)	25
1 bag of potato crisps (200g)	185
1 egg (40g)	135
1 hamburger (150g)	2400
1 cotton T-shirt (medium, 500g)	4100
1 sheet A4 paper (80g/m²)	10
1 pair of shoes (bovine leather)	8000
1 microchip (2g)	32



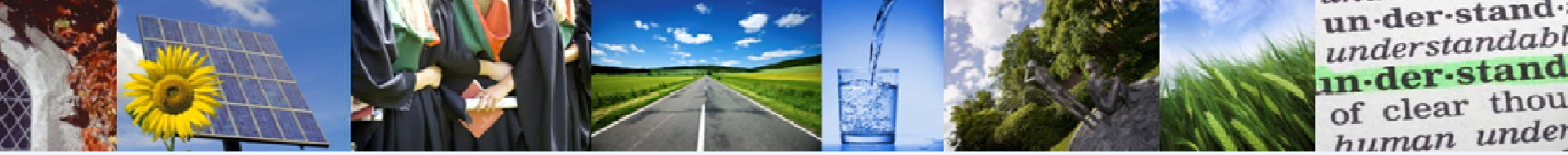
The total water footprint of a consumer in the UK

About 3% of water footprint is at home
150 litre/day

About 97% of water footprint is ‘invisible’, i.e. it is related to the products bought in the supermarket

- 3,400 litre/day for agricultural products
- 1,100 litre/day for industrial products

About 60 to 65% of water footprint lies abroad



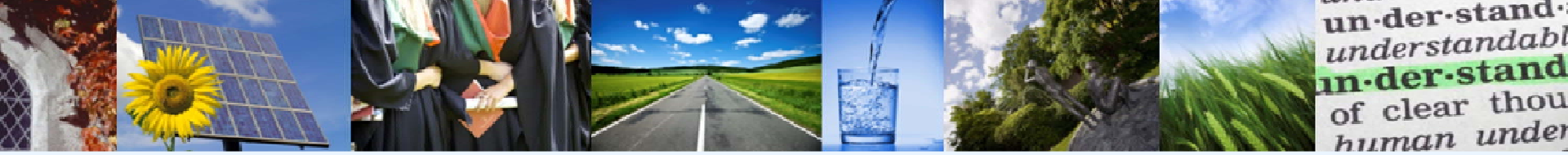
How do we value water?

Total and virtual water use

- World average water footprint per person – 1,240 m^3/year
- Irish domestic consumption per person – 37 m^3/year
- Irish water footprint per person – 1,301 m^3/year
- USA average daily per capita consumption of **virtual** water – 6,000 litres
- China average daily per capita consumption of **virtual** water – 2,000 litres

External water footprints

- Egypt imports 14 billion m^3/year in addition to the 65 billion m^3/year domestic withdrawals
- Jordan imports the equivalent of 5 billion m^3/year (5 times more than it withdraws from its own territory!)



Unsustainable exploitation of water for financial gain

Most of the external water footprint is associated with agricultural products

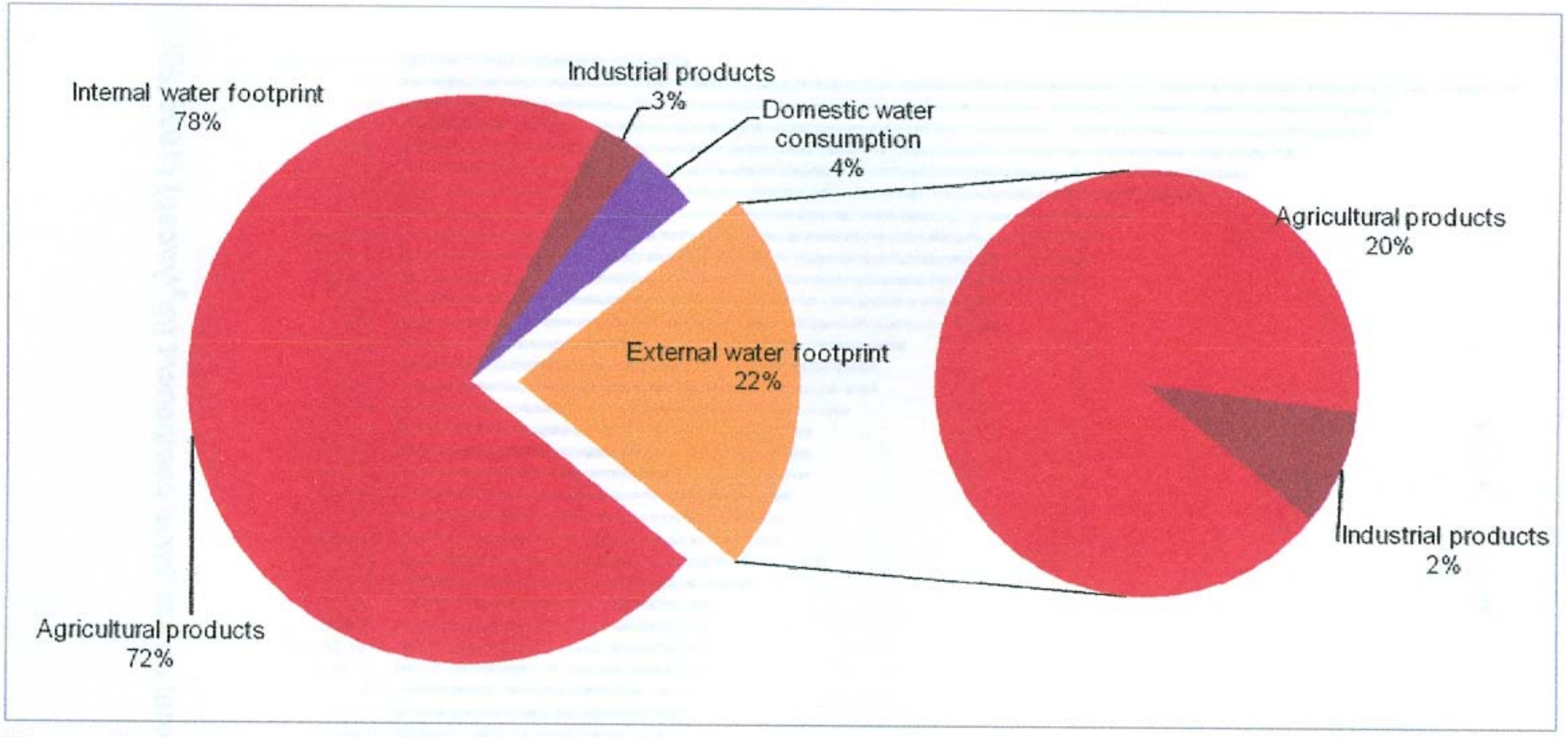
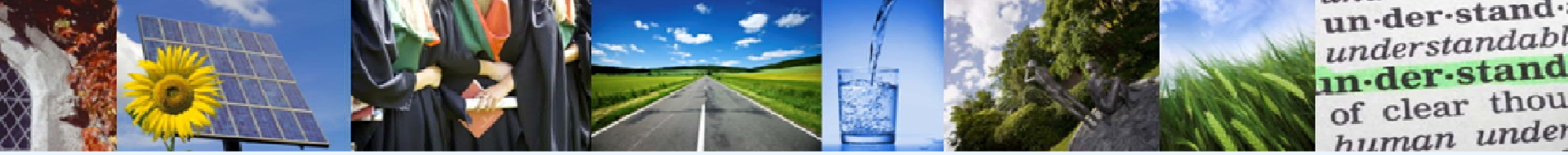


Figure 13. Contribution of different consumption categories to the global water footprint, split into internal and external water footprint.

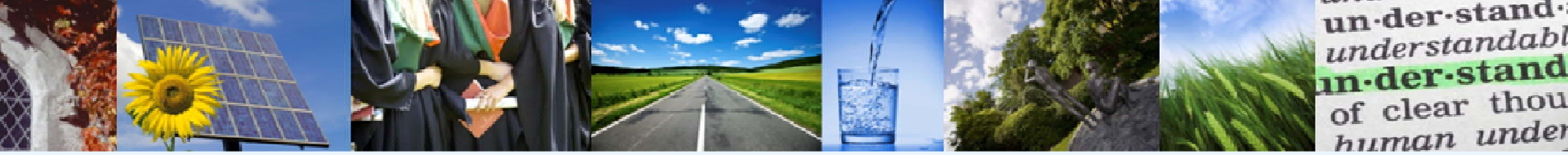


Unsustainable use: trade in real and virtual water

☹ Intensifies water shortages in nations where water resources are not managed appropriately

☹ Encourages countries to produce products for financial gain at the expense of their own water resources

☹ Contributes to ecosystem degradation in water scarce areas



Some key questions

- How do we place a value on a natural resource?
- How do we make access to water fair and equitable?
- How do we conserve the water resources we have?