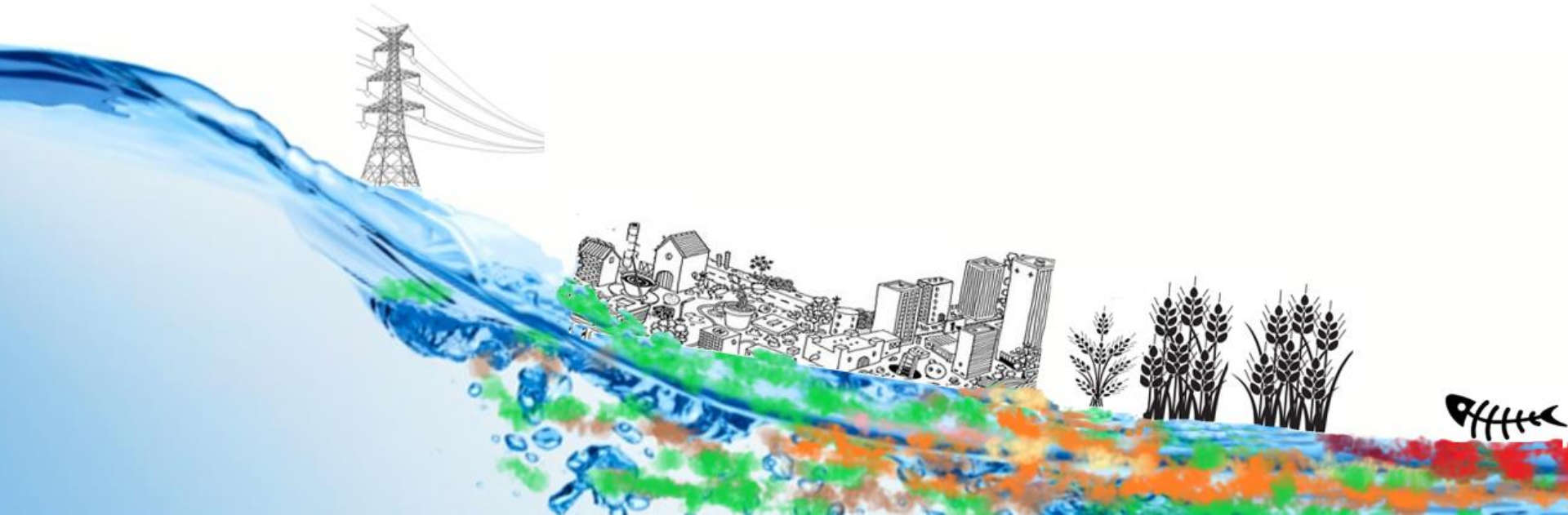
Challenges in Water Culture

Dr Derek Clarke
University of Southampton
United Kingdom

Overview of presentation

“…. aim to get the right amount of water of the right quality to the right place at the right time”



Overview of presentation

“…. aim to get the right amount of water of the right quality to the right place at the right time”

- Water availability
- Water control
- Sharing water
- Water quality

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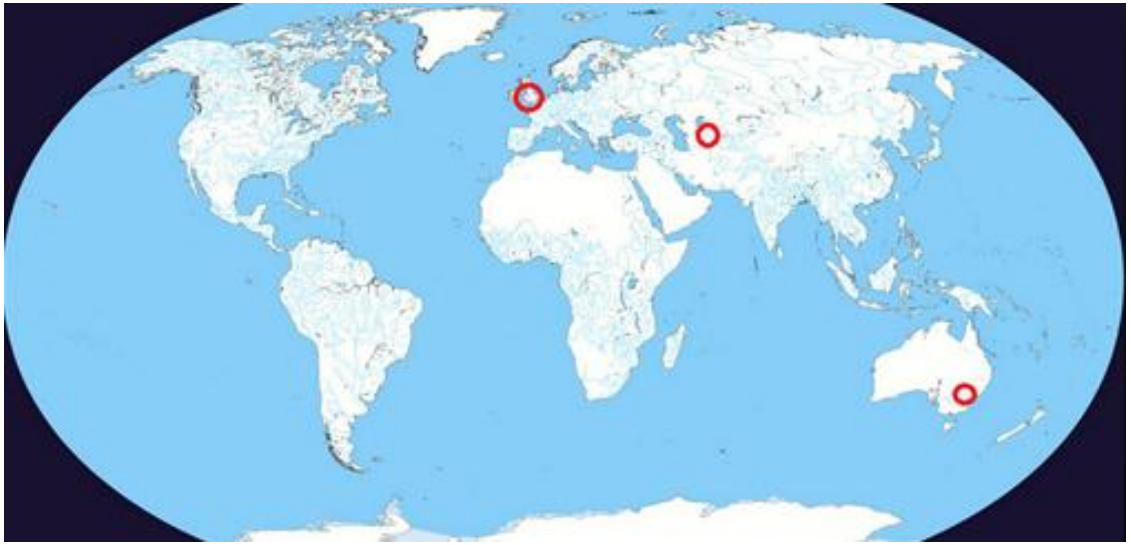
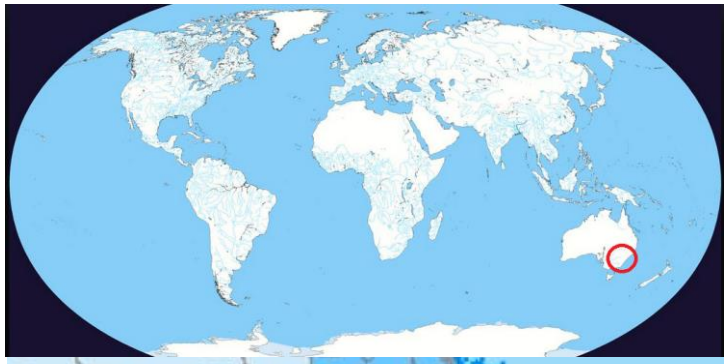


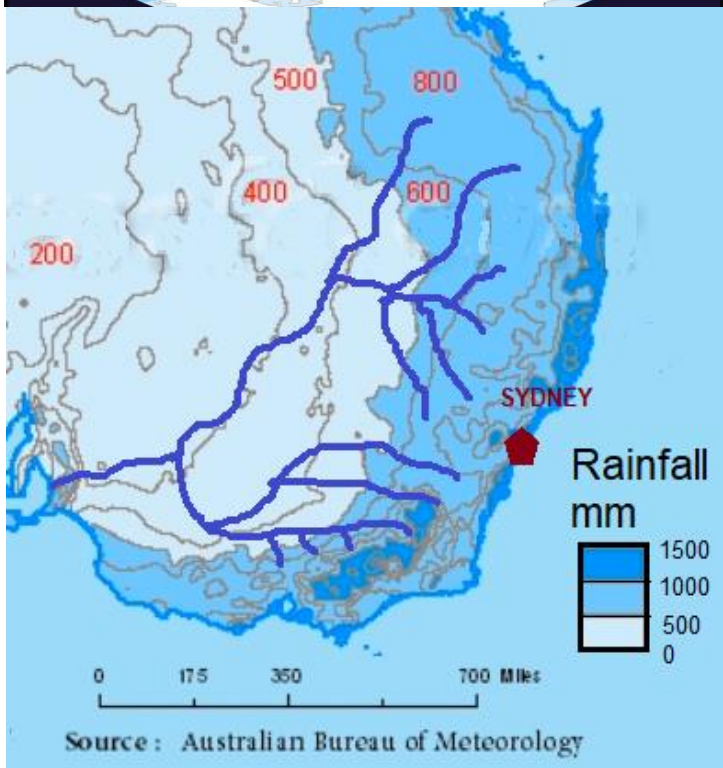
Murray – Darling Basin, Australia

A river basin suffering from drought and a conflict between demands for irrigation in the west and cities in the east

- Water availability

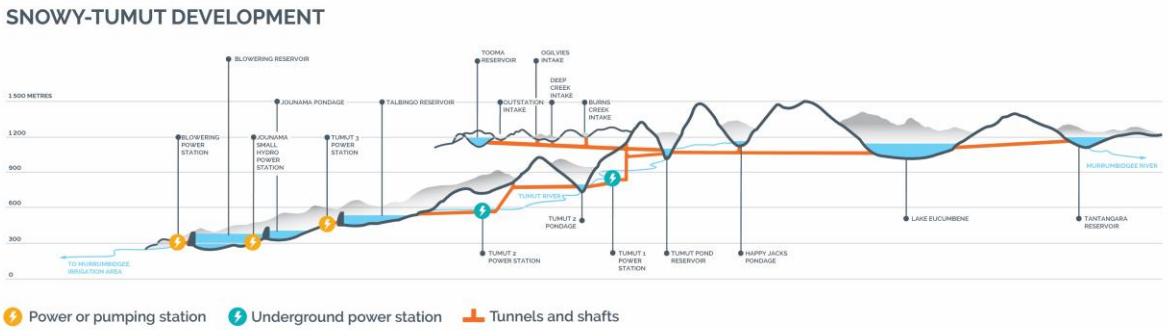
- Area 1,061,469 km^2
- Rainfall – very variable. Most rain falls in the Snowy Mountains west of Sydney
- Large irrigated areas in the west
- River flows decrease to almost zero by the time the river gets to the sea





Murray – Darling Basin, Australia

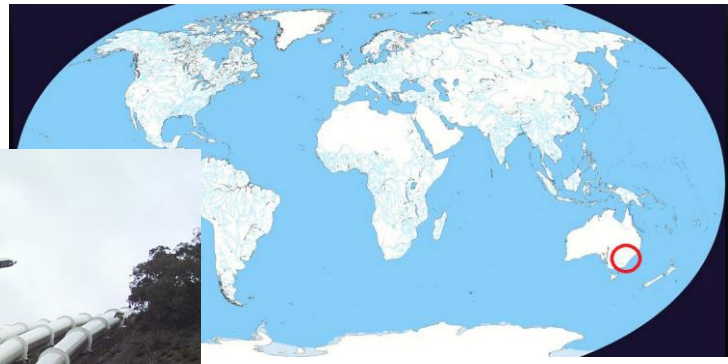
- Water control

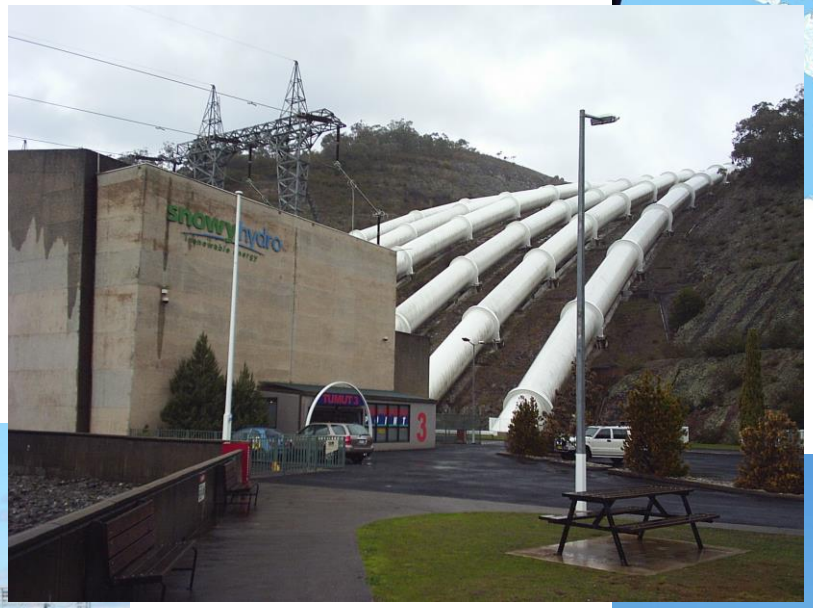


- Dams in the Snowy Mountains control river flow to the irrigated areas in the west
- Tunnels move water through the mountains to supply cities in the east
- Severe drought in last 20 years
- Conflict between farms and cities for water

Murray – Darling Basin, Australia

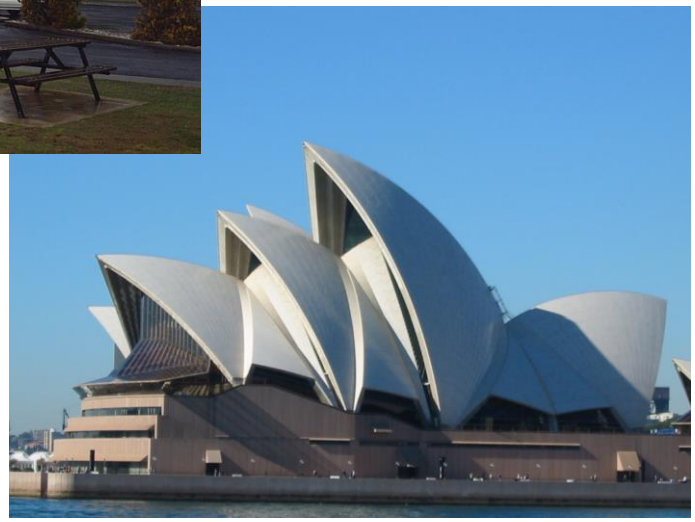
- Sharing water





Wine production

Urban water



Murray – Darling Basin, Australia

- Water quality
- Water abstraction for irrigation causes
  - Lower river flows
  - Higher concentration of salinity
  - Environmental degradation

Murray – Darling Basin, Australia

- Water quality
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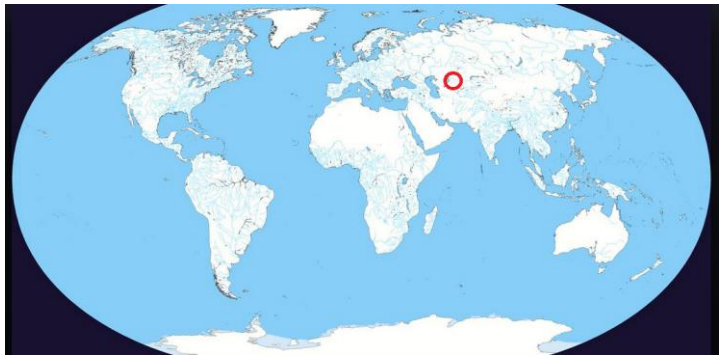
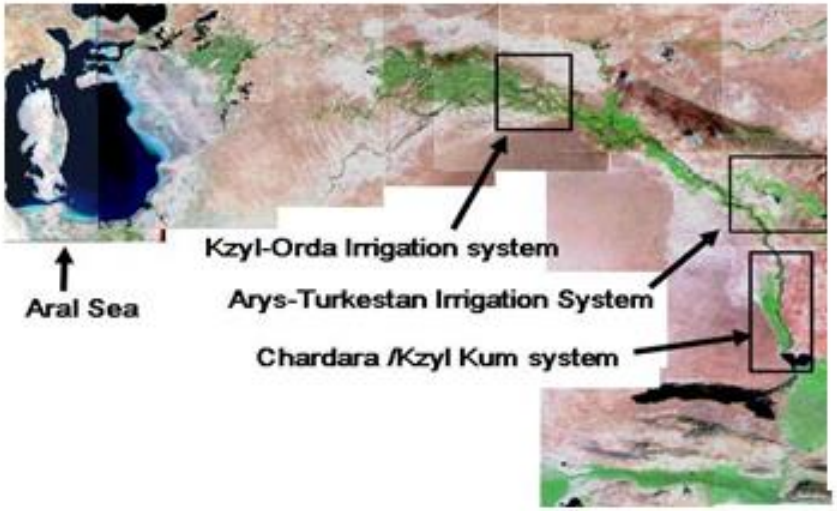
  - Lower river flows
  - Higher concentration of salinity
  - Environmental degradation
- **Plans being made to reduce irrigated areas by up to 30%**

Aral Sea Rivers, Asia

The rivers Amu Darya and Syr Darya were dammed in the 1960's to create large areas of irrigated cotton in Kazakhstan and Uzbekistan



- Water availability
- Precipitation – mainly as winter snow in the Tien Shan mountains.
- Large flat desert areas to the west
- Rivers drain into the inland "Aral Sea"
- Over use of water had caused the Aral Sea to almost dry up



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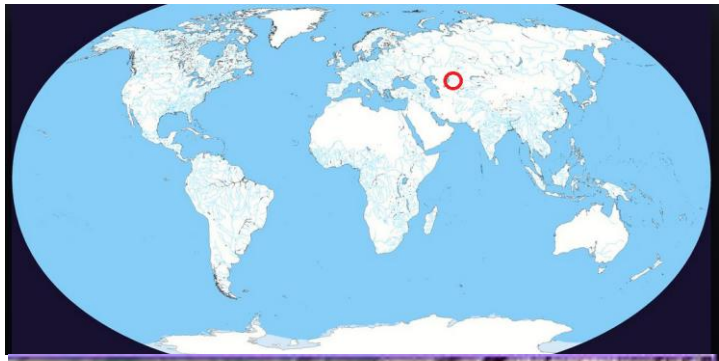

- Water control
- Dams have been constructed in the mountains to store winter snow melt.
- This is used both for
  - water supply for irrigation in the downstream countries (summer)
  - generation of electricity (winter)

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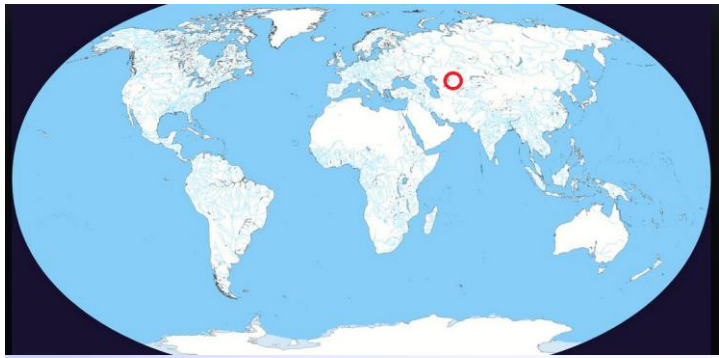

- Water control ?
  IRRIGATION

- Irrigation efficiency is very low
- Large canal leakage
- Poor water management
- Less than 30% of water taken from the dams for irrigation gets used by the crop

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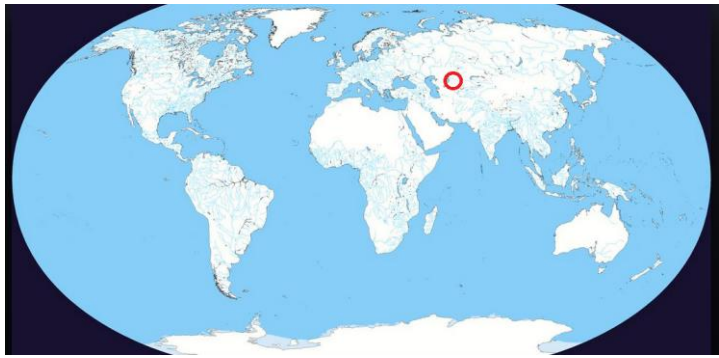
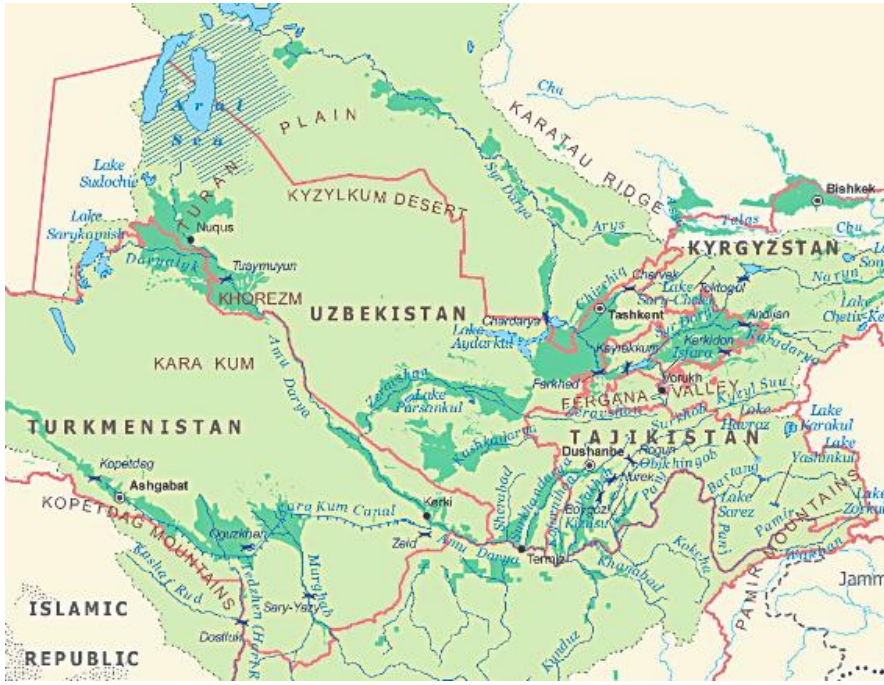


- Water sharing
- Transboundary water management has become a bigger problem since the break up of the former USSR.
- Upstream countries (Kyrgyzstan and Tajikistan) "control" the water in large dams and need to generate electricity.
- Downstream countries Kazakhstan, Uzbekistan need the water to irrigate crops in the summer



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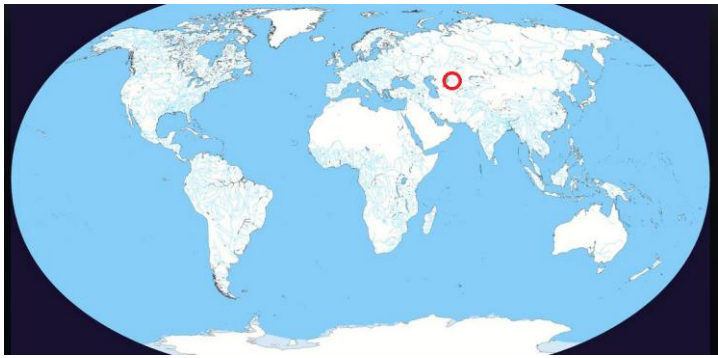
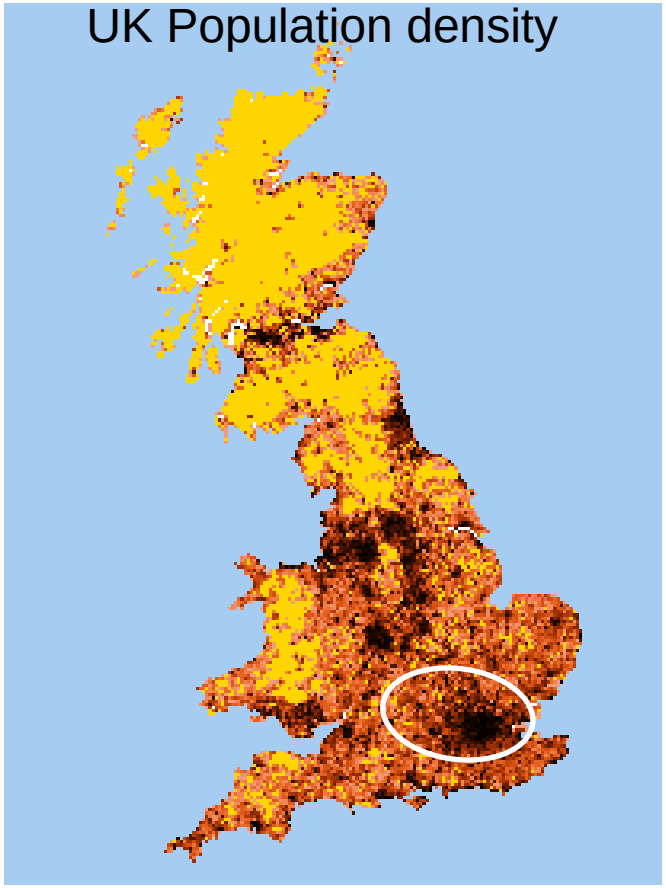


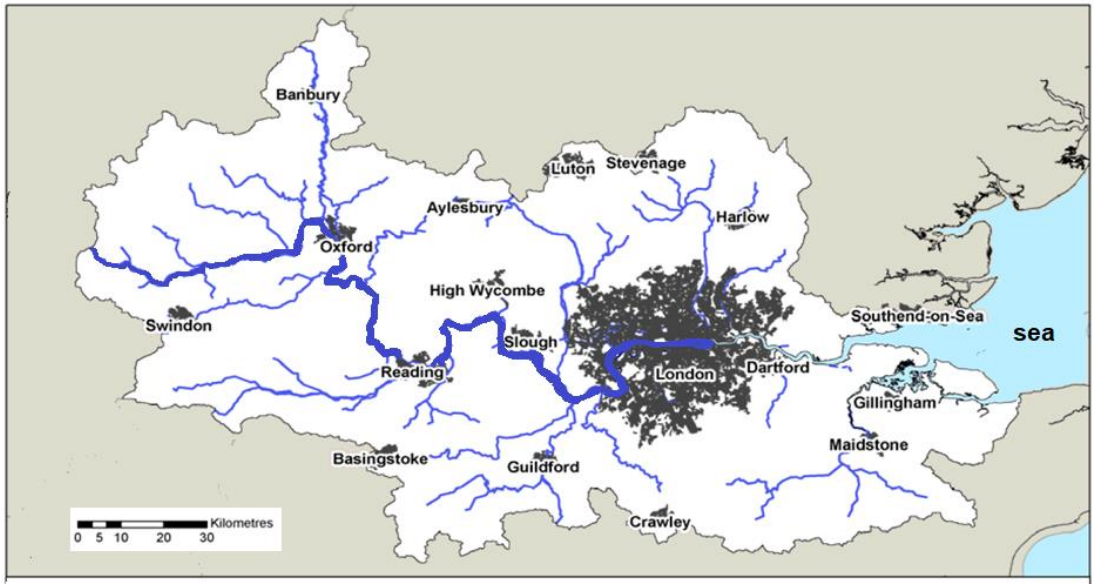
- Water quality
- Over extraction of water for agriculture from the 2 rivers reduced inflow into the Aral Sea
- The sea has almost totally dried up between 1977 and 2013
- The sea bed is made up of evaporated salts and chemical pesticides from the irrigation

1977 1986 1999 2006 2009 2013

River Thames in England

A highly developed river basin with 15 million people sharing one main river





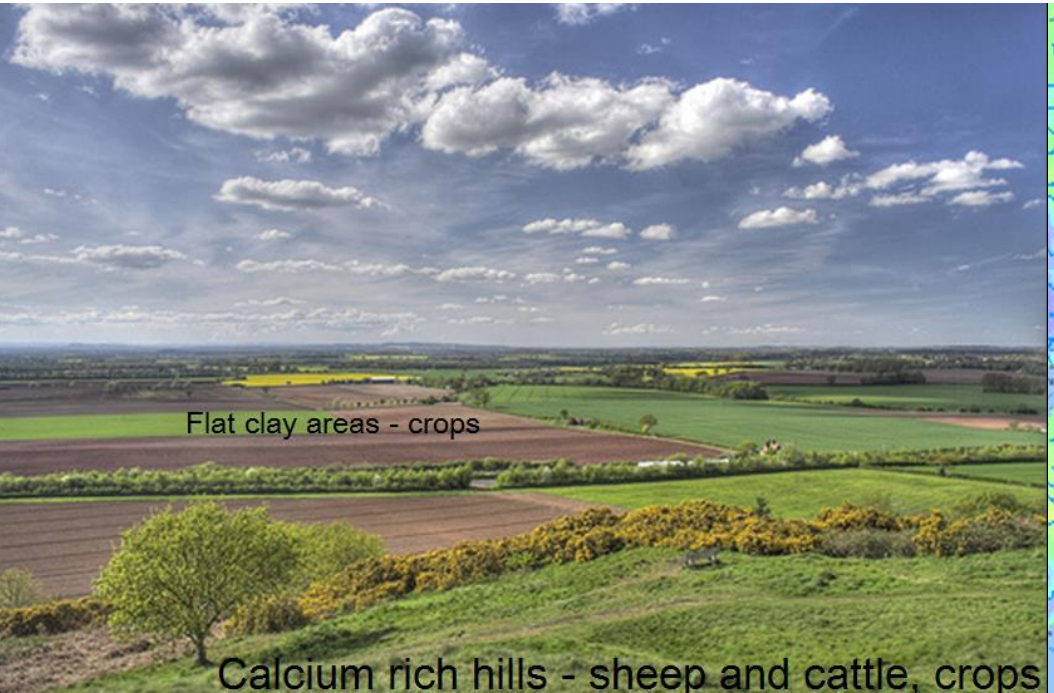
River Thames in England

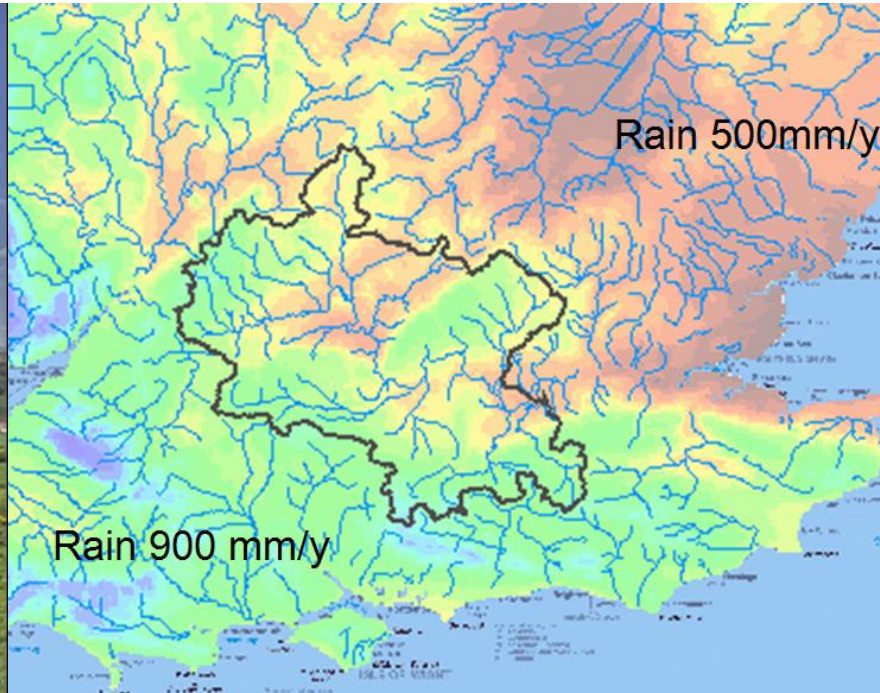
A highly developed river basin with 15 million people sharing one main river

UPPER THAMES RIVER
CONSERVATION AUTHORITY

River Thames - facts and figures

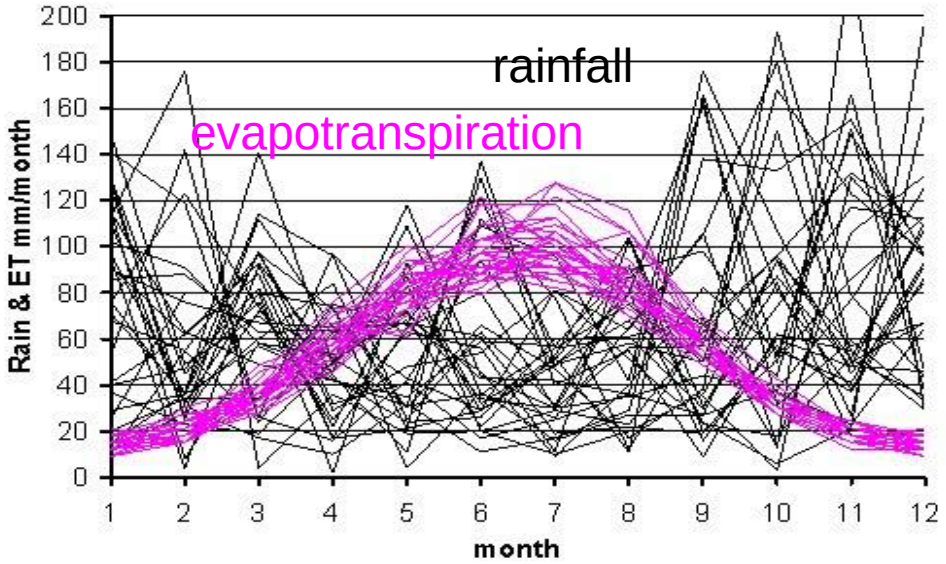
River Length	350 km	Catchment area 9948 km^2
Average River flow	66 m^3/s	Rainfall 720 mm/year
Max flow	800 m^3/s	
Min flow	10 m^3/s	
Population	15 million people	
Geology	Calcium Carbonate “Chalk” aquifer 4288km^2	
Highest elevation	330m	Lowest elevation 4m





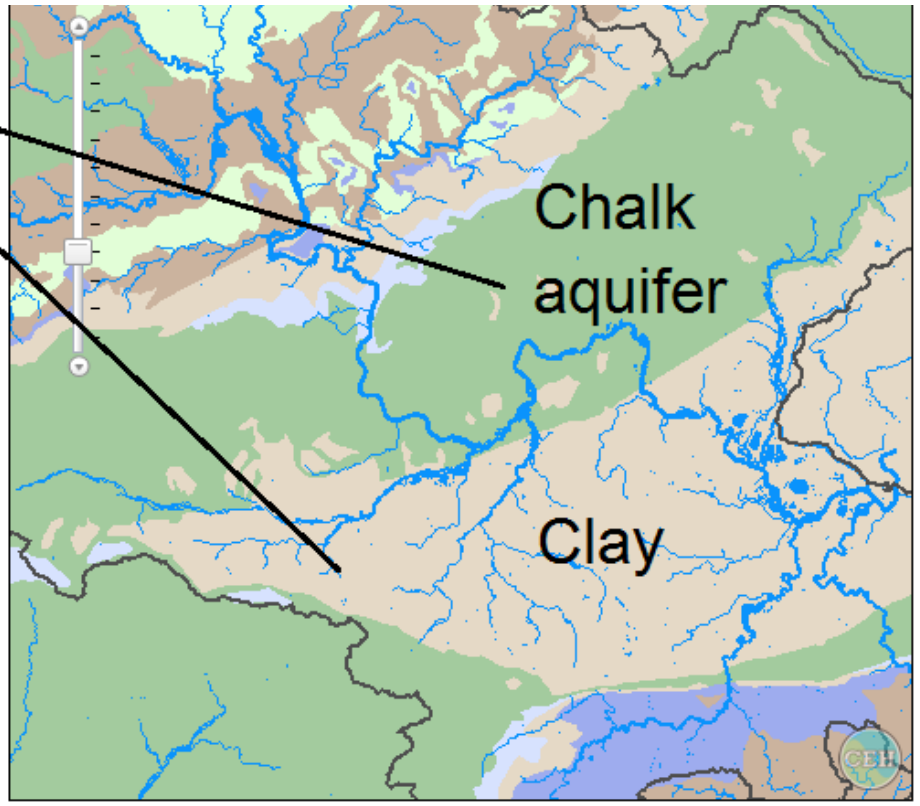
The Chalk aquifer acts as a large natural reservoir.

The aquifer fills in winter (high rain, low temperatures) and drains throughout the year giving the river a reliable minimum flow of 10 m^3/sec



High Permeability Bedrock: 43.2 %

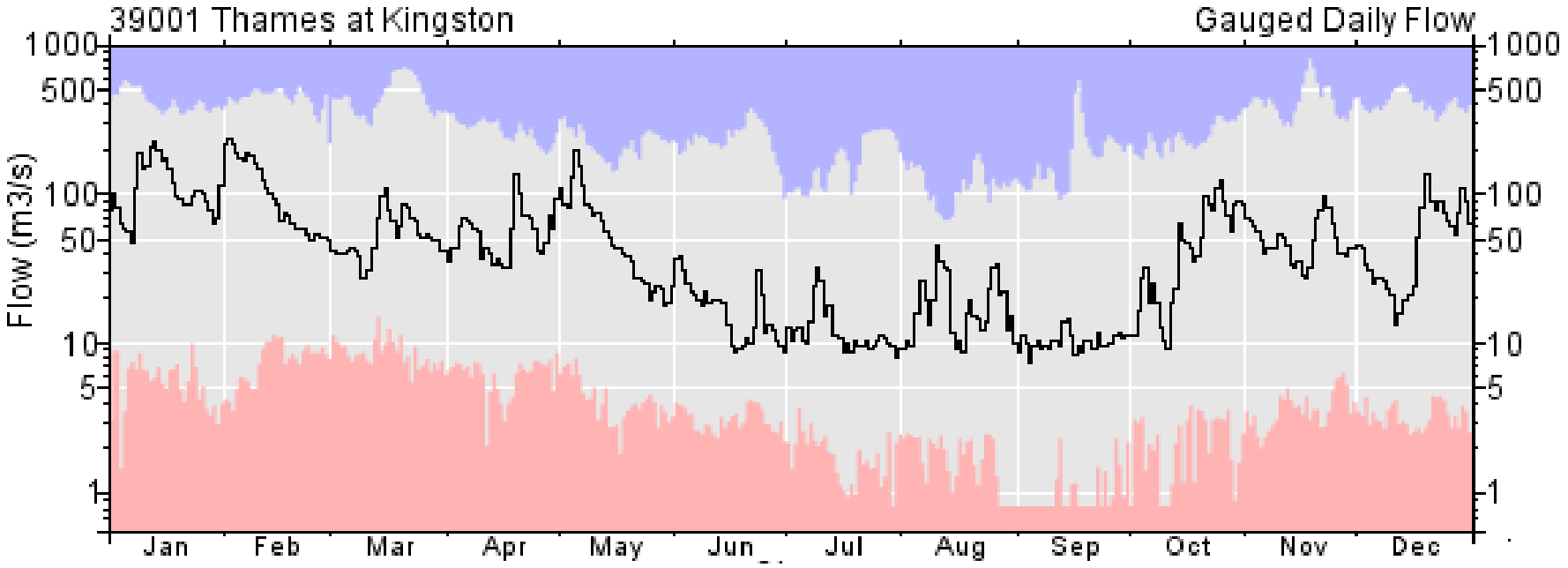
Low Permeability Bedrock: 37.1 %



River Thames average flow = 66 m^3/s

Rainfall = 720 mm/year
Evapotranspiration = 510mm/year
Excess = 210 mm/year

The excess water becomes river flow and aquifer recharge.
210 mm/year * catchment area = 0.12 * 9948*1000*1000 m^3/year
= 209 664 0000 m^3/year
= 66 m^3/s river flow



Measurements started in year 1884 !

Main issues and problems in the River Thames

The river basin is in the most developed part of the UK with a population of around 15 million people, which is a 20% of the United Kingdom.

Water demands :
HOUSES 142 liters/person/day * 15 million people with 25% water leakage-> 32 m^3/s. The demand for public water supplies has increasing by 1.7% each year. AGRICULTURE : no water available for irrigation, but this is not needed in most years.

Water Supply: In summer demands are 2 x river flow. Water is recycled river ->house -> sewer -> treatment works -> river 5 times before it gets of the sea!

Water quality : there are many water treatment systems along the river. Water quality is monitored and kept to a very high standard, but this is expensive

Flood Defences: The Thames barrier provides a high standard of protection to the 420,000 London properties at risk. Beyond 2030 upgrading of the barrier and associated defences will be necessary at an estimated cost of 4 billion pounds. The Thames barrier became operational in October 1982.

Other issues (less important)

Energy development: Water is used for cooling in power stations. The Thames is not used for hydroelectric power as the ground is not steep enough and there is not a sufficient head of water to drive turbines.

Industrial development: Some car factories**.** The Thames Basin contains much chalk, limestone, sand and gravel all of which create opportunities for mineral extraction.

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Recreation and leisure: Rivers offer many opportunities for leisure and recreation. It is used for fishing, swimming, canoeing, rowing, sailing, cruising, guided tours, walking and hiking.

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The Regulatory Framework for water management in the UK

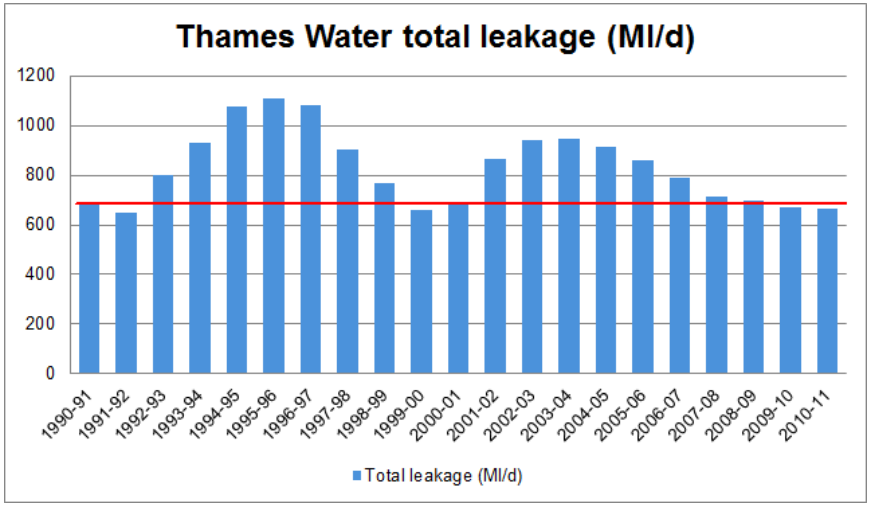
Main organisations involved in managing and using water

Water supply to houses, towns and industry is done by **private companies**. The private companies are also responsible for treating waste water in sewage treatment works and returning the water at a high quality back into the river

The main company in London is Thames Water

- Thames Water is the UK's largest water and wastewater services company, and supplies 2.6 gigalitres of drinking water per day, and treats 4.4 gigalitres of wastewater per day.

- Thames Water is responsible for a range of water management infrastructure projects including: the Thames Water Ring Main around London; Europe's largest wastewater treatment works and the UK's first large-scale desalination plant. Infrastructure proposals by the company include the proposed £4.2 billion London Tideway Tunnels, and the proposed reservoir at Abingdon, Oxfordshire, which would be the largest enclosed reservoir in the UK.



The private water companies are regulated by two government organisations:

The Environment Agency : responsible for water resources planning and regulation, flood control, water quality and pollution.

The Environment Agency is a Government Organisation and it was created in 1996. The Environment Agency's stated purpose is, "to protect or enhance the environment, to promote the objective of achieving sustainable development“. Protection of the environment relates to threats such as flood and pollution.

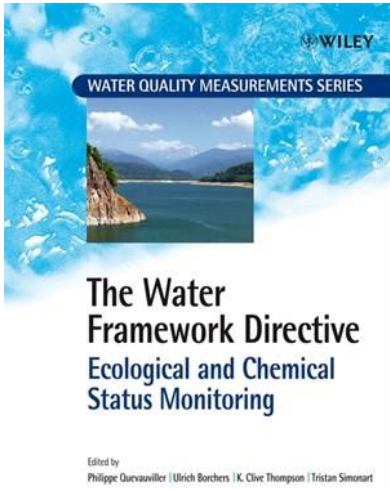
OFWAT is the Government’s Water Services Regulation Authority

The role of OFWAT is to control the prices that the private companies charge people for water supply and sewage treatment. The prices are controlled, taking into account proposed capital investment schemes (such as building new wastewater treatment works) and expected operational efficiency gains. OFWAT reviews the prices charged every 5 years

The Environment Agency and OFWAT have to work under European Union Laws including **the Water Framework Directive**, which sets high standards on water quality in rivers and the environment.

(source : Wikipedia)

The Water Framework Directive



The Water Framework Directive is a law passed by the European Union which came in to force in 2003.

The Directive aims for 'good status' for all ground and surface waters (rivers, lakes and coastal waters) in the EU. The status of surface waters are assessed according to the following criteria:

- Biological quality (fish, benthic invertebrates, aquatic flora)
- Hydromorphological quality such as river bank structure, river continuity of the river bed
- Physical-chemical quality such as temperature, oxygenation and nutrient conditions
- Chemical quality that refers to environmental quality standards for river basin specific pollutants.

- The chemical standards specify maximum concentrations for specific water pollutants. If even one such concentration is exceeded, the water body will not be classed as having a “good ecological status”.

- The Water Framework Directive stipulates that groundwater must achieve “good quantitative status” and “good chemical status” (i.e. not polluted) by 2015. Groundwater bodies are classified as either "good" or "poor".

- In the UK, the Environment Agency monitors the river water quality but the Private companies must develop water treatment systems to maintain or improve the water quality. OFWAT regulates the Private Companies to ensure that they spend money well to achieve the aims on the Water Framework Directive.

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Environment Agency

Thames Water

OFWAT

(source : Wikipedia)

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