Lesson 2
Population increase and Climate Change

or obstacles to maintaining future high water usage

What does population increase mean for the future of our water consumption?

How does climate change impact water cycle?

How will the climate change locally, what will happen in the UK?

What tools are available to engineers to plan our water's future?

Homework review

- What is your water footprint?

- Let's compare the results and see what the class average is?
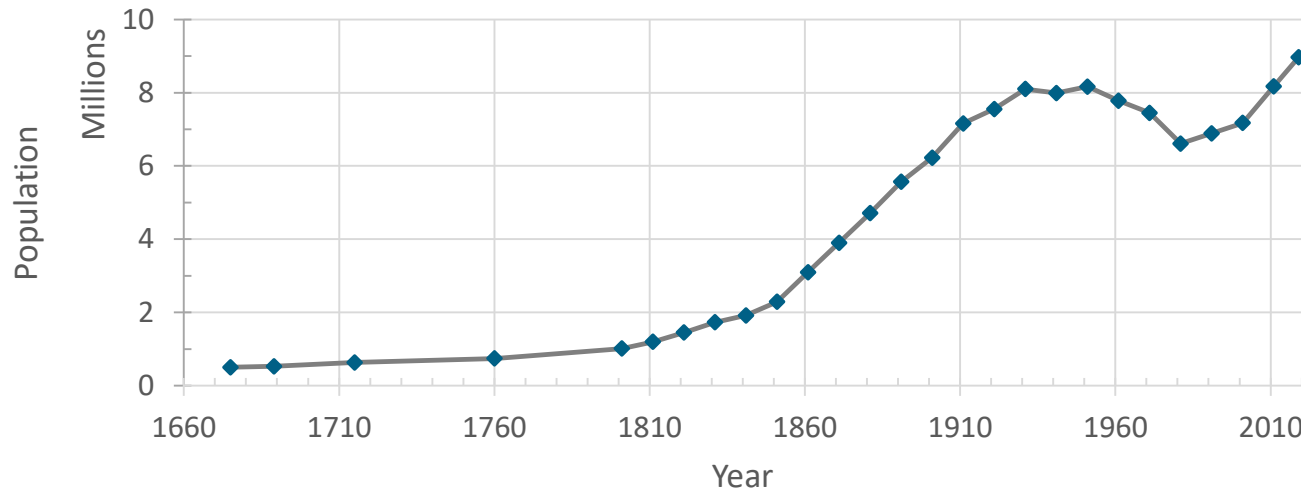
Population increase

How do we know that UK population is increasing?

What are population projections?

What does it mean for water resources?
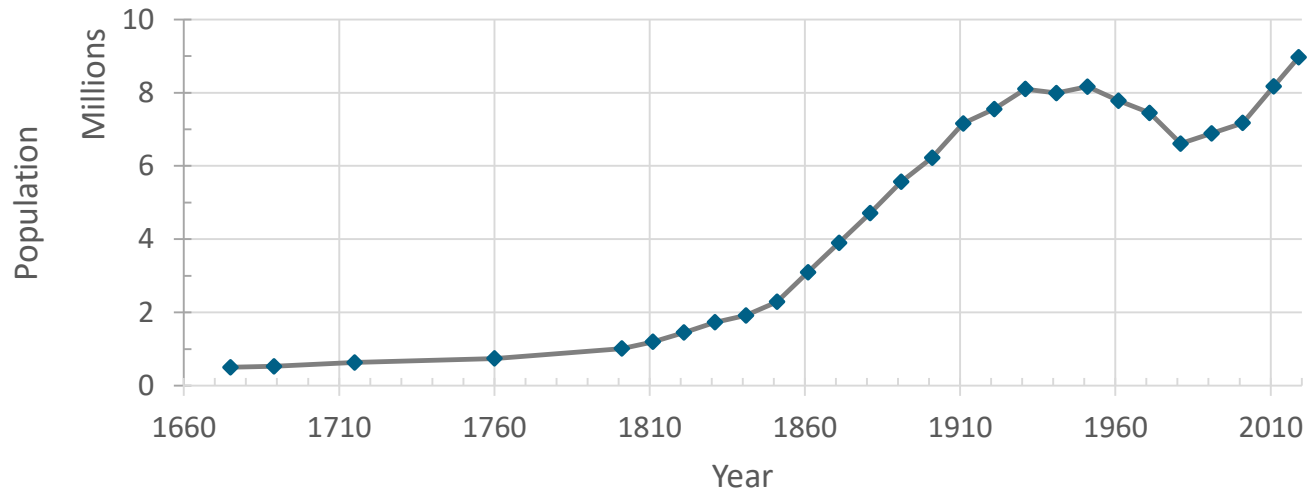
How many people live in London now?
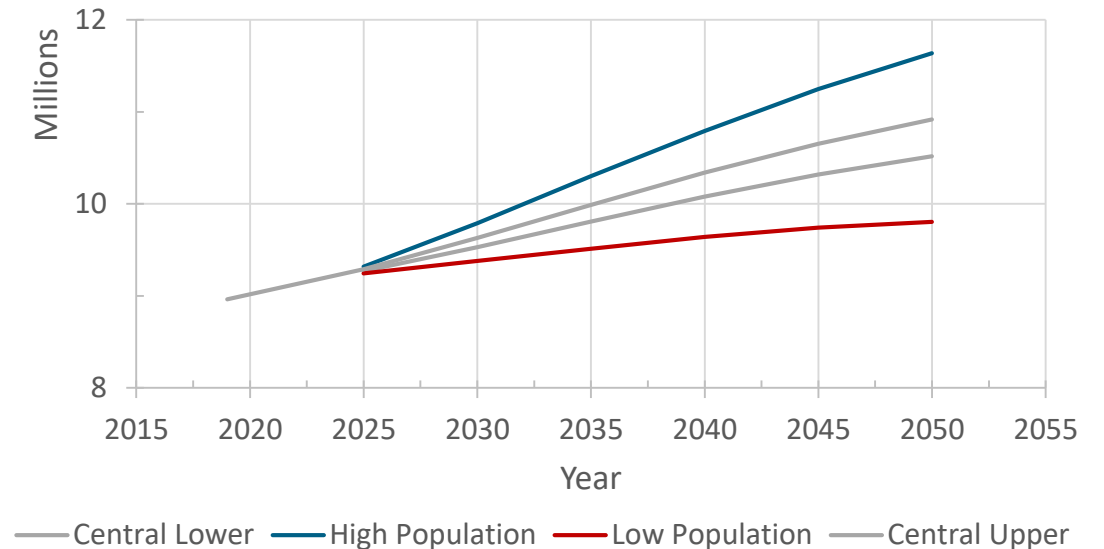
Historical population

- How about 50 years ago?
- How about 100 years ago?

How many will live in London in the future?

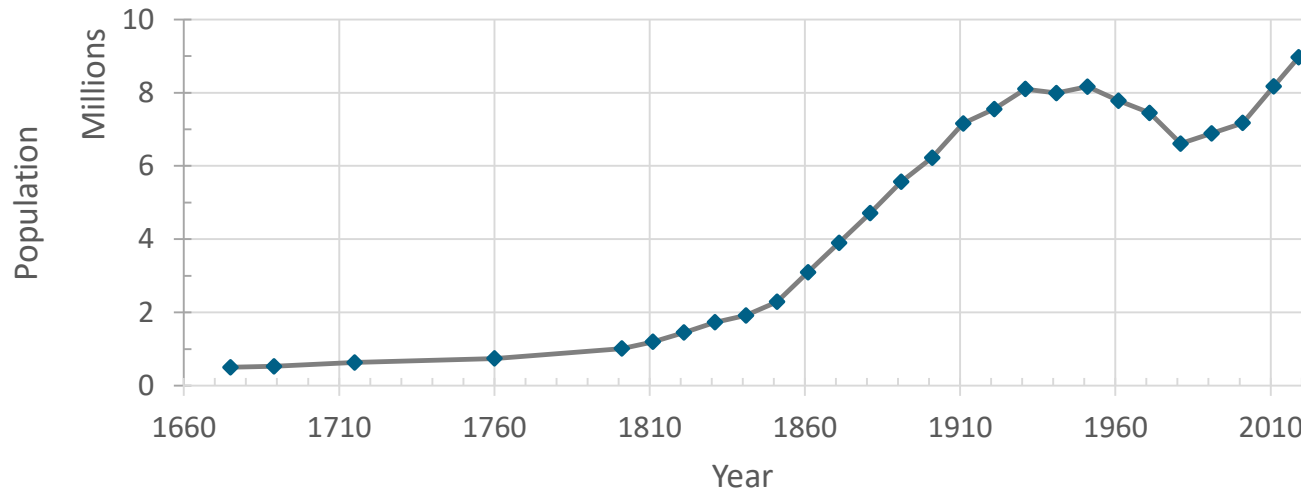Historical population

Future population estimates

Central Lower — High Population — Low Population — Central Upper

• How about 50 years ago?

• How about 100 years ago?

• How about in 30 years?

BGS British Geological Survey

Data sources:
https://www.oldbaileyonline.org/static/Population-history-of-london.jsp
https://en.wikipedia.org/wiki/Demography_of_London#cite_note-5
https://data.london.gov.uk/dataset/trend-based-population-projections

When was the first attempt to bring Londoners safe drinking water?

Historical population

** Goodman, David C. and Chant, Colin (1999)
   European Cities and Technology (London: Routledge)

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British Geological Survey
BGS

Remember this simplified image and all the pipes that exist to distribute water?
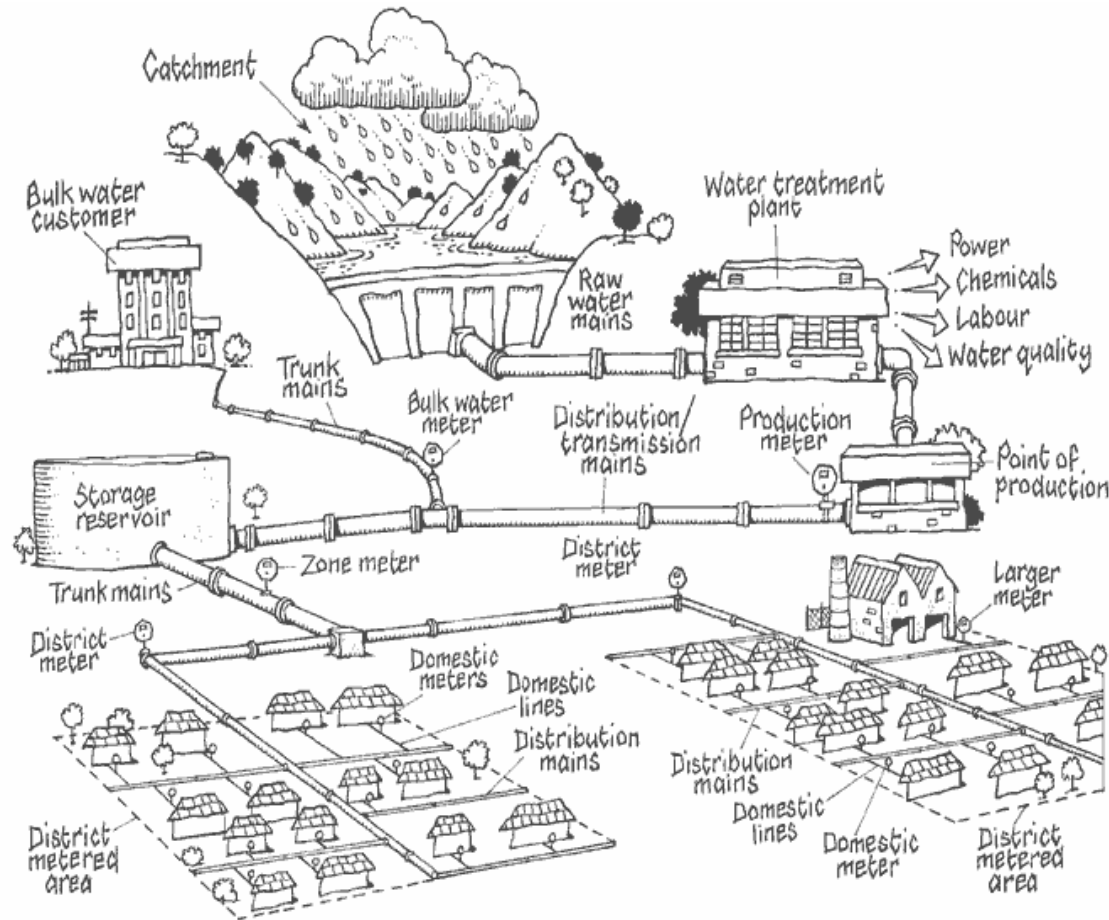

- To compare the 13,000 miles of pipes under London: from London to Wellington, the capital of New Zealand is 11,685 miles

- The amount of water they transfer each day (only for household consumption) is more than 1,704,000 m^3 *

* based on 142 l/day an average person in the UK uses times 9 million people plus 25% losses

Pipes leak over time... What do you think, what was the percentage of leakage from London's water distribution network in 2019?

- 4%
- 10%
- 25%
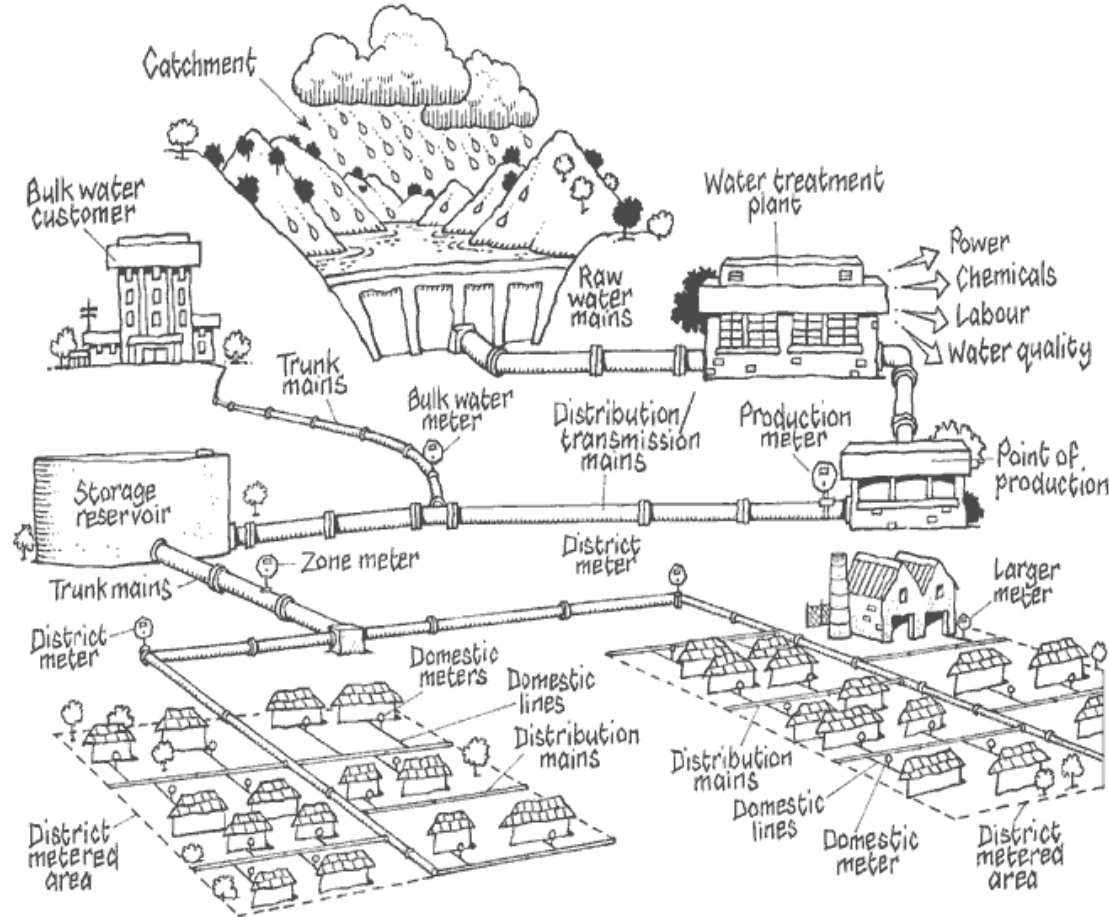
How does population increase affect drinking water? The answer is many fold
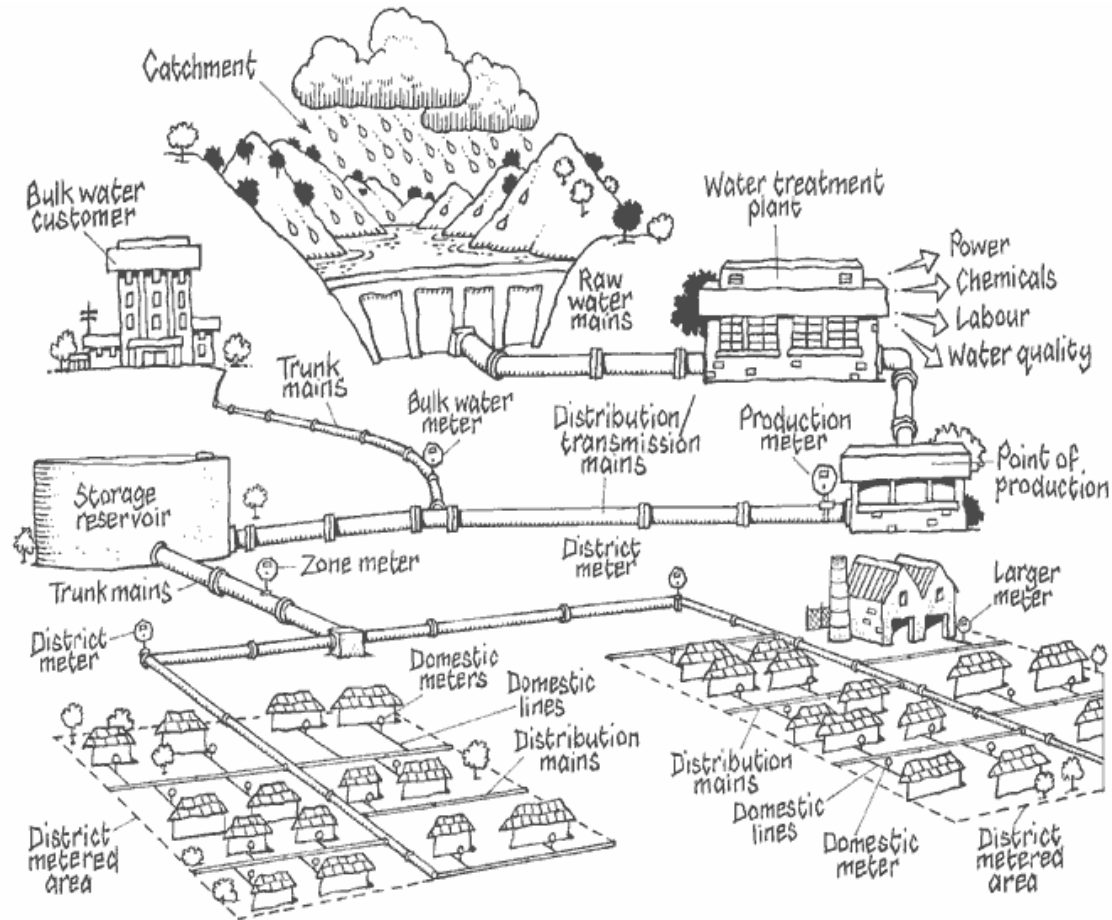
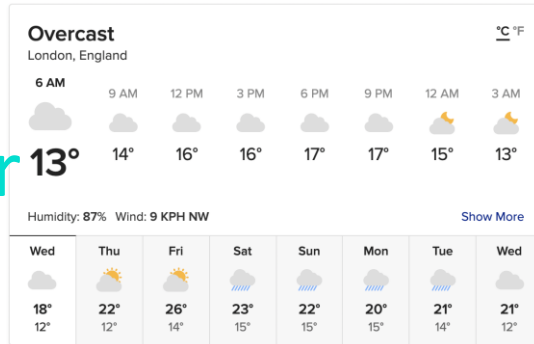# How does **climate change** affect water?

What is the difference between weather and climate?
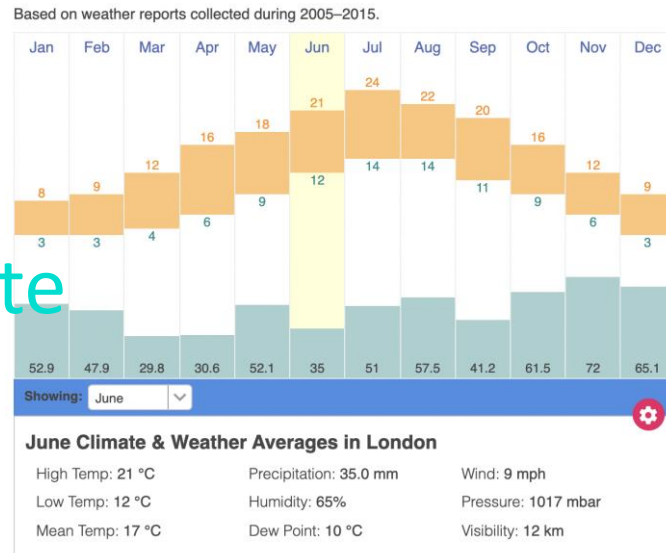
How do we know climate is changing?

What does it mean for the UK and its water resources?

# What is the difference between weather and climate?

Weather

Climate

If climate defines usual weather conditions. What is London's climate?

- **warm and temperate**, with a significant amount of rainfall during the year. This is true even for the driest month.

- The annual rainfall is 690 mm | 27.2 inch.

- The **driest** month is March, with 47 mm | 1.9 inch of rainfall.

- The **wetest** month is November with an average of 67 mm | 2.6 inch of precipitation.

- The **warmest** month is July, with an average temperature of 17.8 °C.

- The **coldest** month is January with an average temperature of 4.8 °C.

How do we know that the climate is changing?
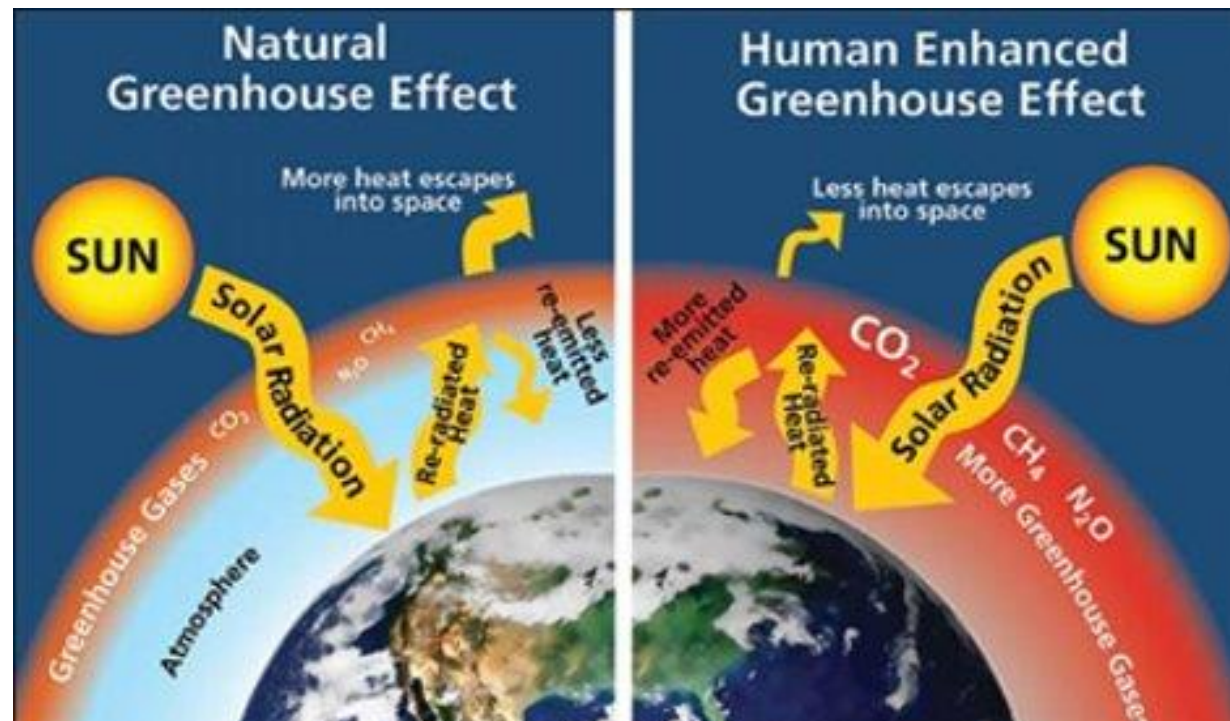
How do we know that the climate is changing?

- There are many parameters that scientists are recording and monitoring. The <u>sea level rise</u>, <u>acidity of the ocean</u>, <u>temperature of the ocean</u>, <u>carbon dioxide</u> (CO_2) levels in the atmosphere, <u>air temperature</u> above ocean and land, <u>Arctic sea ice</u> extent, <u>glacier mass</u> balance…

- Some of these parameters have been recorded for a long time (since 40s and 50s, the longest being temperatures, where we have records from the 1850s)

- Met Office climate dashboard: https://www.metoffice.gov.uk/hadobs/monitoring/dashboard.html

# Climate change, what does it mean for these London climate parameters?

What will happen in the UK as a consequence of climate change?
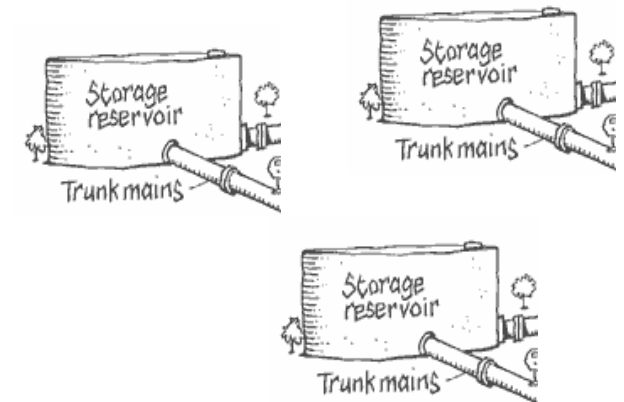
As the Mett office explains:

- the UK is likely to have hotter, drier summers and warmer, wetter winters

- Extreme weather events such as heatwaves and heavy downpours could become more frequent and more intense

What do these changes (population increase and climate change) mean for the local drinking water?

- **If summers become drier**
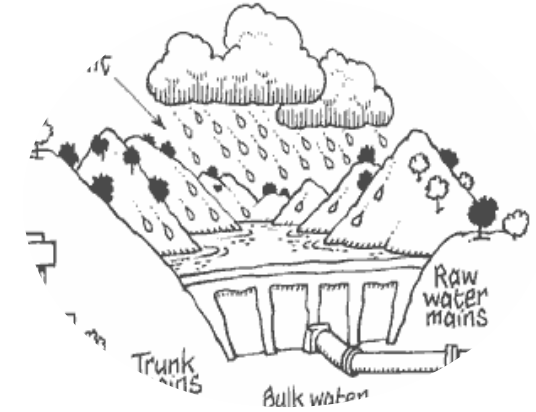
- **If winters become wetter**

Now we know our problems What next?

Can these problems be solved?

What tools do we have to find possible future outcomes?

What tools do engineers have to study the water cycle?

Tub (or Bucket or Tank) model

- Called this way because a tub is used to describe the storage

- The model helps engineers understand how quickly a water storage can fill for different inputs and outputs

- Equation:

$$\text{Change in storage (tub) over time} = \text{Amount of water coming } \mathbf{in} \text{ the tub} - \text{Amount of water coming } \mathbf{out} \text{ of the tub}$$

What tools do engineers have to study the water cycle?

You have a tub with a volume of 300 l. If the tub is empty at the time you turn on the shower head, and the rate of water coming in is 10 l/min and the rate of water leaving the tub is 5 l/min. How long will it take for the tub to fill?

storage = 300 l

in = 10 l/s

out = 5 l/s

Equation:

$$\frac{storage}{time} = in - out$$

in

out

Homework

- Consider the bucket model and everything we learned about our water system. Also go back to the entrance homework for lesson 1. Which stores can be considered as water storage and which flows would be classified as water coming in versus water going out of that storage?

- Look at your home water bill, what do you pay as part of your bill?

Additional reading and video resources:

- Stories and data
  - How a scientist reported global ocean cooling and realized it was a mistake that he then corrected:
  https://earthobservatory.nasa.gov/features/OceanCooling
  - NASA's climate time machine
  https://climate.nasa.gov/interactives/climate-time-machine
- Videos
  - How acurate are world population estimates:
  https://www.gapminder.org/answers/how-reliable-is-the-world-population-forecast/
  - Climate change:
  https://www.youtube.com/watch?v=_WUNMzC98jI
  - Impact of CO2 emmisions on oceans:
  https://www.youtube.com/watch?v=mQ10xBl8XMQ

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