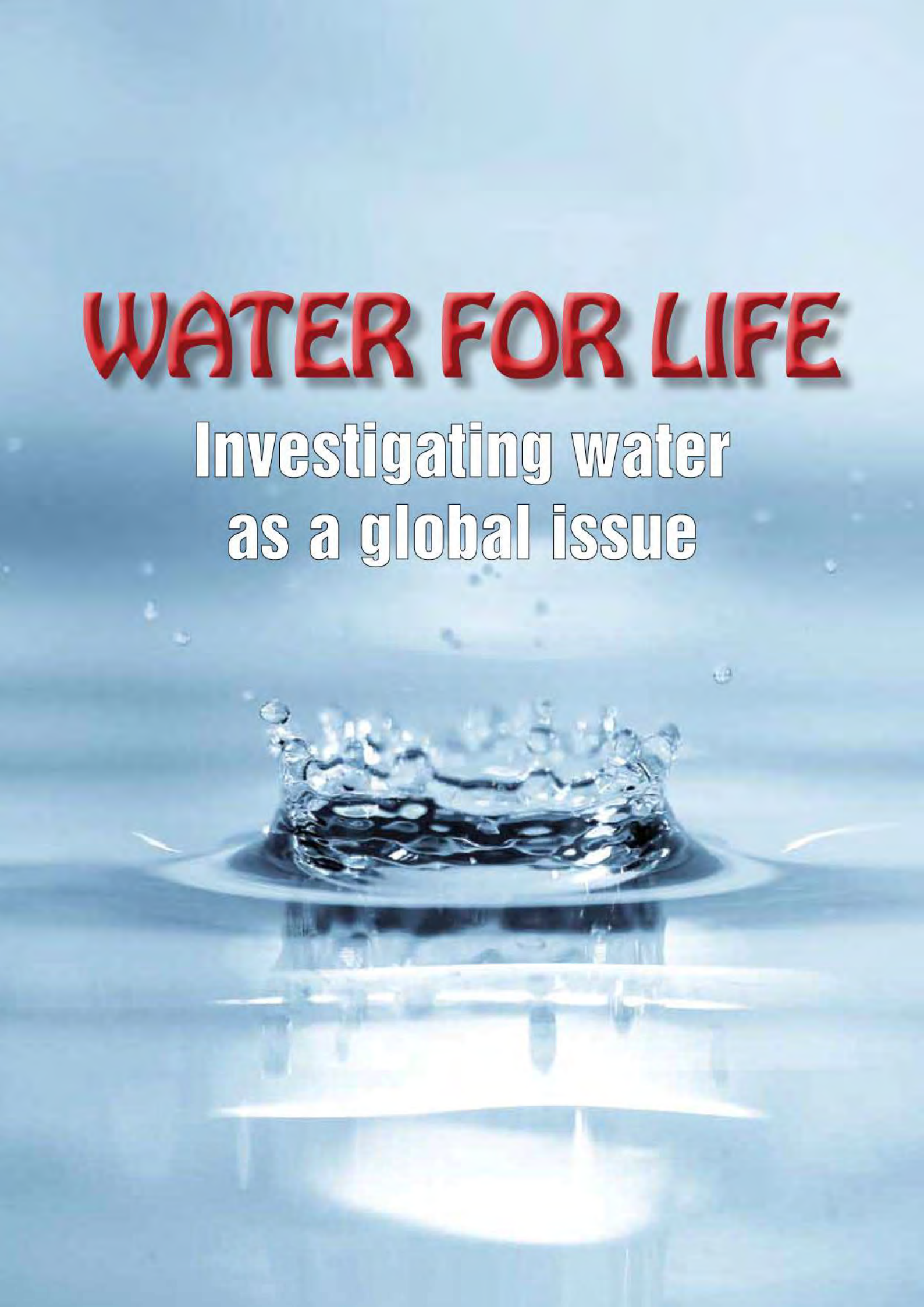
WATER FOR LIFE

Investigating water as a global issue



ISBN: 978-1-876703-23-3

Published by: Geography Teachers' Association of Victoria Inc (Global Education Project Victoria)

This project was funded by the Australian Government's Overseas Aid Program.

Written by: Kelli Ashton with contributions by Astrid Heckler and Claire Jones

Edited by: Judy Mraz, Director of Projects, Geography Teachers' Association of Victoria

Copyright and permissions: Kelli Ashton and Claire Jones

Design: Infographics

GLOBAL EDUCATION PROJECT
Professional Learning Initiative

Australian Government
AusAID

GEOGRAPHY TEACHERS' ASSOCIATION OF VICTORIA INC.

Contents

HOW IS WATER DISTRIBUTED ACROSS THE WORLD?

Interdependence and globalisation

Get the water facts!

- water is the world's most important natural resource
- water is a renewable resource – if used and managed properly, water can be reused or renewed
- water is a vital product for survival
- water covers 70 per cent of the Earth's surface – humans can survive for weeks without food but only days without water
- there is an estimated 1.4 billion cubic kilometres of water on Earth – 97 per cent of it is salt water and only three per cent is fresh water
- 70 per cent of fresh water resources are stored as ice, permanent snow cover in mountainous regions and at the North and South Poles.

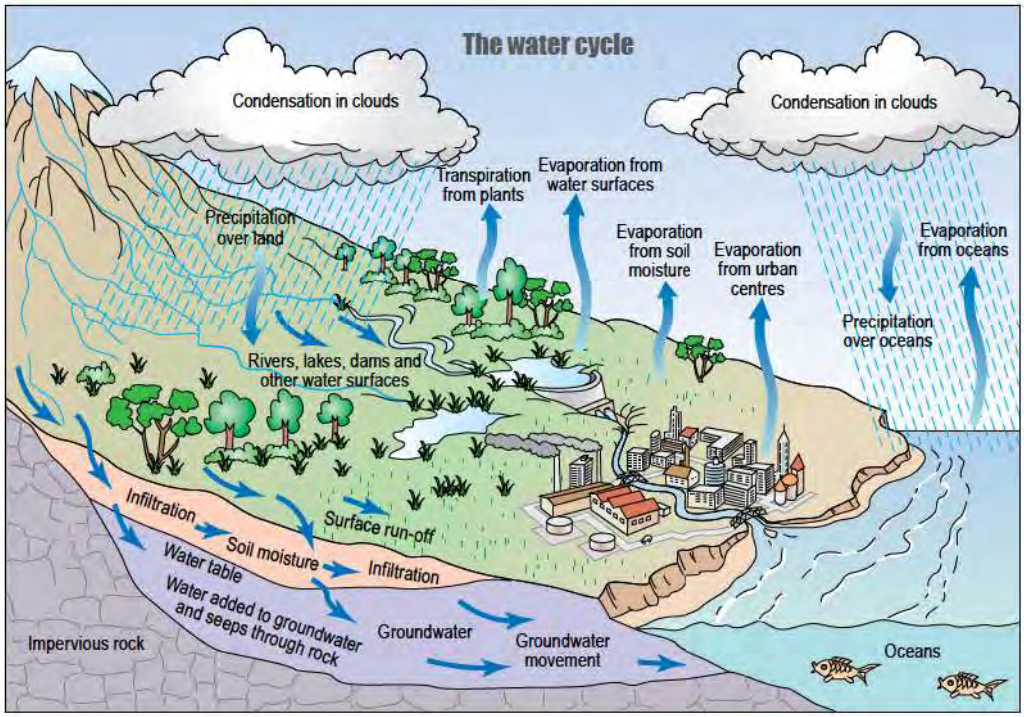


Figure 1.1 *Water is always on the move through the water cycle also known as the hydrological cycle*

The water cycle is a circulation system powered by the sun – no water leaves the system. The same amount of water exists on Earth today as did in the age of dinosaurs. Energy passes through, into and out of the system, transferring water through the atmosphere and back to the land and the sea. The basic stages of the water cycle include: evaporation, condensation, precipitation, infiltration and runoff.

Evaporation – the key to the water cycle

Evaporation changes water from liquid to a gas in the form of water vapour. Lakes, rivers, seas and oceans provide 90 per cent of the moisture in our atmosphere with the remaining 10 per cent coming from plant transpiration. Seventy per cent of the Earth is covered by oceans, allowing large amounts of evaporation to occur. The rate of evaporation from the oceans is so great that if they were not recharged by precipitation, runoff and discharge from aquifers, the Earth's oceans would empty.

Did you know?

- A large gum tree can transpire as much as 200 litres of water every day. This transpiration occurs when water, carried through plants from its roots to small pores on the underside of the leaves, is converted to water vapour and released.

Condensation

Condensation is the process responsible for the formation of clouds which in turn can produce precipitation. When water vapour droplets combine (coalescence) with one another they grow in size, forming clouds.

Precipitation

Precipitation is water falling from the atmosphere as rain, snow, sleet or hail. This occurs when water vapour droplets have increased to a size that they can no longer be supported in the atmosphere. Millions of water vapour droplets are required to produce a single raindrop.

Did you know?

- 250 mm of rain falling on one acre of land (which is equivalent to 15 tennis courts) is the equivalent of more than 100 000 litres of water.

Runoff and infiltration

Much of the Earth's water is stored in snow, ice, lakes and storages such as dams. However, some water continues moving through the water cycle through the processes of infiltration and runoff. Infiltration occurs when water seeps through the soil and rock becoming groundwater – much of this water eventually makes its way to rivers, streams and oceans. According to the United Nations Environment Programme (UNEP) more than 1.5 billion people rely on groundwater as their drinking supply.

Figure 1.2 *Infiltration of water into groundwater through the mouth of a cave*

Runoff occurs when rainwater falls on saturated or water-resistant surfaces causing the water to run over surfaces to streams and rivers. Surface water runoff carries sediment into waterways. When there are large amounts of runoff flooding can occur.

Where is the Earth's water?

The glaciers and ice caps of Greenland and the Antarctic hold up to two-thirds of the world's frozen fresh water supplies. Groundwater is the most abundant form of accessible fresh water followed by reservoirs, rivers and wetlands. Approximately 50 per cent of the world's lakes are located in Canada.

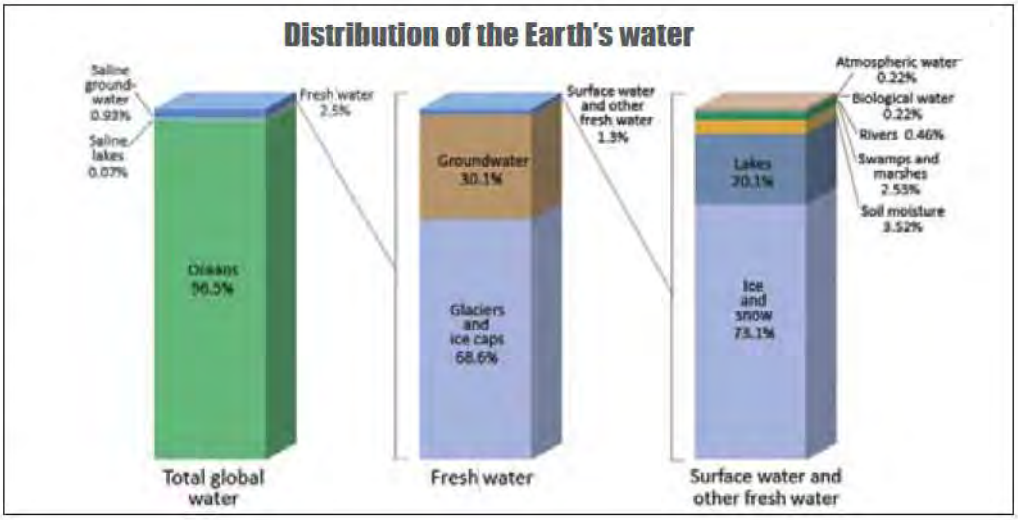


Figure 1.3 *Of the three per cent of the Earth's water that is fresh water, 66 per cent is locked in the ice caps and glaciers. Only 0.3 per cent of fresh water is readily available on the Earth's surface in lakes, swamps and rivers*

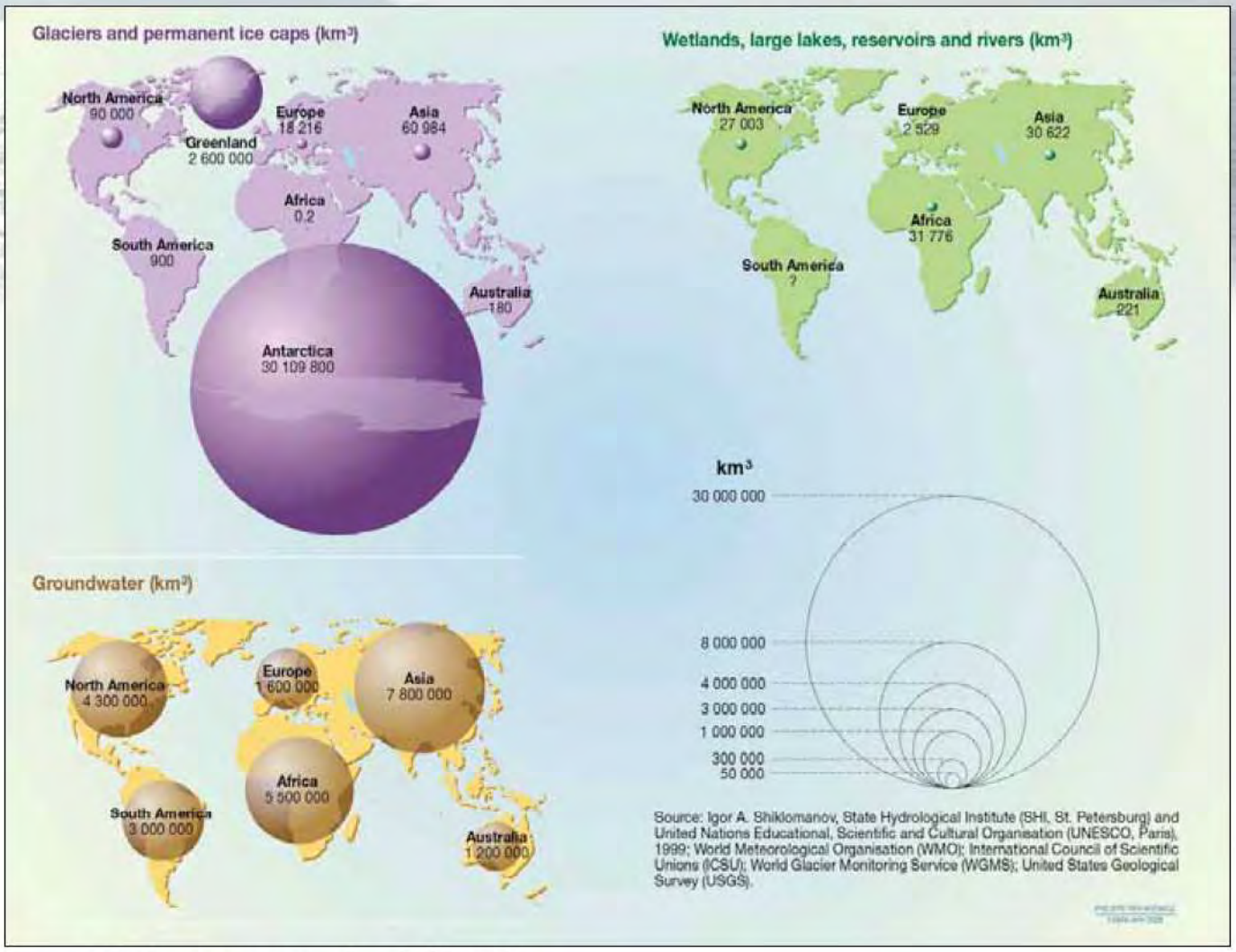


Figure 1.4 *Fresh water resources – volume (km³) by continent*

Figure 1.5 *It has been estimated by that every day across the world, women spend a total of over 200 million hours collecting water for domestic use. In developing countries, women and girls walk an average of six kilometres per day to collect fresh water.*

AusAID: Dirk Guinan

STUDENT ACTIVITIES

Explain

1. It is said that the water we are using today is the same water that the dinosaurs used. How does Figure 1.1 support this statement?
2. In your own words, explain why evaporation is the key to the water cycle.
3. What percentage of the Earth's water is available for drinking?
4. Refer to Figure 1.3 to fill in the blanks in the following paragraph: _____% of the Earths' water is saline (oceans) with only _____% fresh water. Nearly 70 per cent of the Earth's fresh water is locked in the ice caps and _____ and _____% in groundwater. Only _____% of fresh water is available as surface water with _____% stored in _____ and 11 per cent in swamps and two per cent in _____.

Elaborate

5. Draw your own version of the water cycle. Annotate your diagram with an explanation of the different key stages of the water cycle. Alternatively, you can use a program such as Movie Maker or iMovie to create an animation of the water cycle.
6. Refer to Figure 1.4
   a. Describe the distribution of the Earth's groundwater supply.
   b. Using your answer to part a., describe the relationship (or spatial association) between groundwater supplies and the cubic kilometres of wetlands, large lakes, reservoirs and rivers.
7. Write an account of a day in the life of a water droplet. Use your imagination in your presentation.

Engage

8. Create a "water cycle quiz" to test your class members. Using the stages of the water cycle and Figure 1.1, write up five quiz questions. Alternatively, use a computer program like ProProfs Quiz Maker. Test them out on your class members.

HOW HAS WATER AVAILABILITY CHANGED OVER TIME?

Interdependence and globalisation

"We never know the worth of water until the well is dry" Thomas Fuller 1608–1661. (English clergyman and author)

The availability of fresh water is one of the world's most basic human requirements. As the global population increases there is an ever-increasing demand on the Earth's water resources to meet demands of agriculture, industry and domestic uses. One of the most significant difficulties supplying fresh water is the disparity between where rain falls and the distribution of the world's population. In many densely populated regions, rainfall is insufficient and people turn to other water sources such as groundwater, which can become unsustainable if overused. Over 1.4 billion people live in river basins in which water use exceeds the recharge rate (the process by which water is replaced).

World water availability

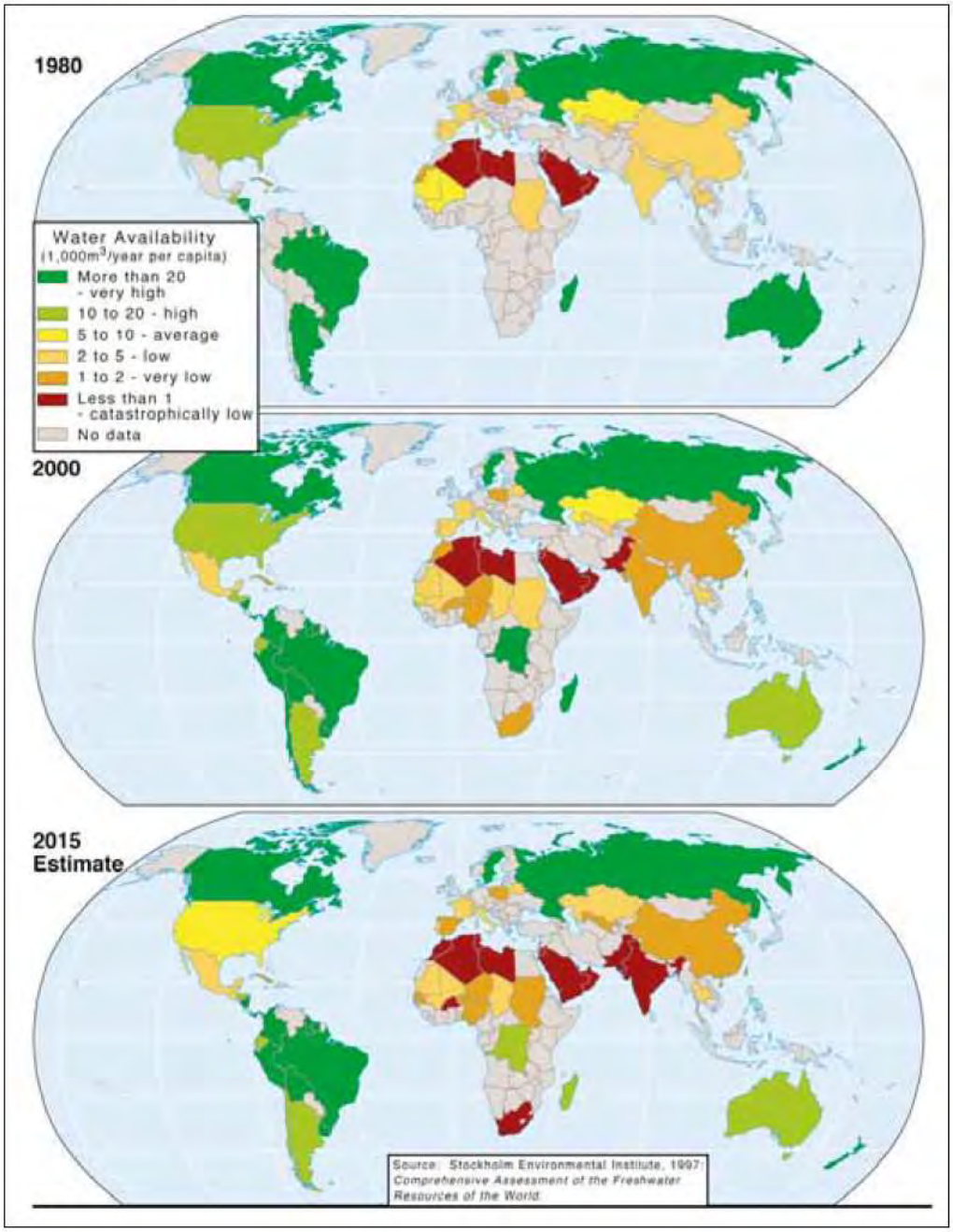


Figure 2.1 *Agriculture consumes up to 70 times more water for food production than domestic uses such as cooking, washing and bathing. Predicted population growth and climate change will also put pressure on fresh water supplies*

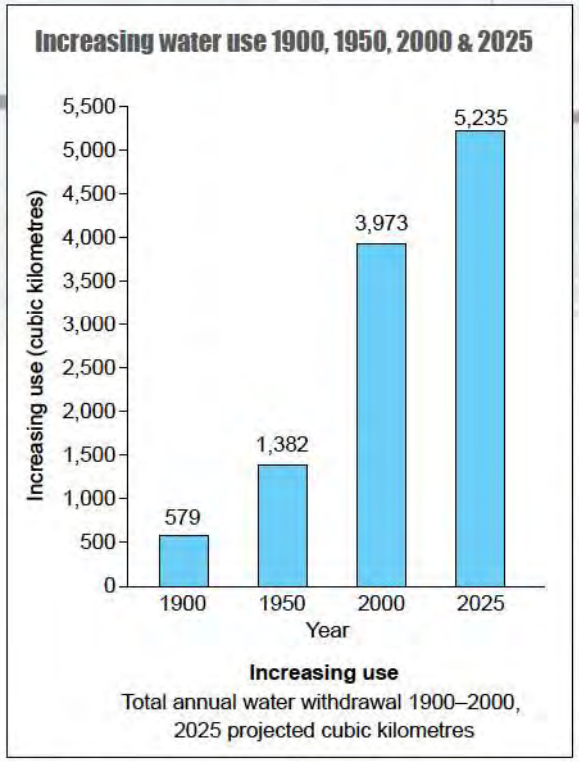


Figure 2.2 *Every year over 4000 cubic kilometres of water is withdrawn from the water cycle. This equates to approximately 1700 litres of water per person per day*

Population and rising water demands

Between 1990 and 2000, the annual, per-person water consumption almost doubled from 350 cubic metres to 642 cubic metres. This volume of water is more than what is needed for personal use. Large amounts of water are needed to supply high-consumption industrialised lifestyles. For example, industrial products such as cars, televisions and other household goods require water during the manufacturing process. Also, a meat-based diet requires high amounts of water. Globally, the level of water consumption is uneven, with more than one billion people lacking access to fresh water. Four out of every five of those one billion people live in rural areas that often lack modern water distribution systems such as dams. These people depend on natural sources and may need to travel great distances to collect safe drinking water. People denied adequate access to fresh water often use less than 20–25 litres per person.

Water scarcity and water stress

What is water scarcity?

Water scarcity is the imbalance between water availability and demand for fresh water, leading to water shortages. This often occurs in arid and semi-arid regions affected by droughts and changes in climate. Water scarcity is closely linked with poverty and with unclean water and lack of sanitation.

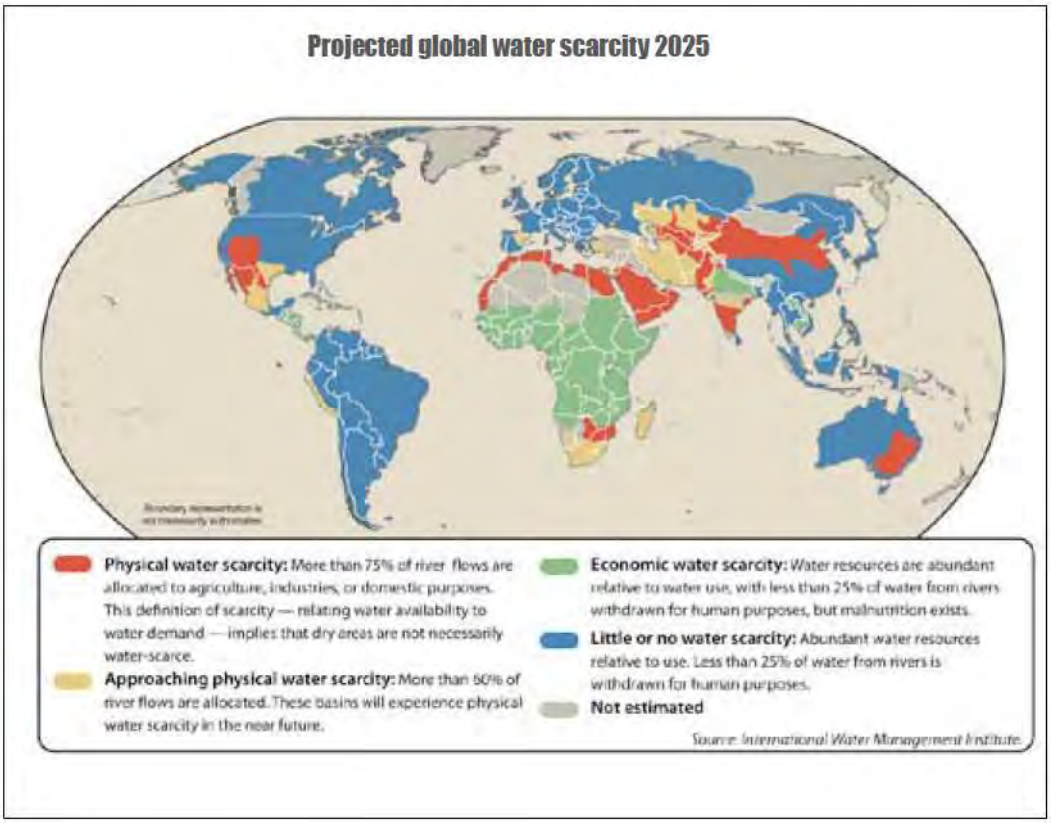


Figure 2.3 *Water can be physically or economically scarce. Physical water scarcity occurs when demand for water by the population exceeds supply. Evidence of physical scarcity also includes severe land degradation, river desiccation (the river dries up), pollution and declining groundwater levels. Economic scarcity occurs as a result of the lack of investment in infrastructure and unequal distribution of water resources. In regions where water was once abundant, an alarming trend of water scarcity has emerged due to overuse of water in agriculture*

Water scarcity facts

- water scarcity affects one in every three people in the world – the situation is getting worse
- almost one-fifth of the world's population lives in areas where water is physically scarce
- water scarcity forces people to rely on unsafe drinking water sources
- water scarcity encourages people to store water at home increasing the risk of diarrhoeal diseases such as cholera, typhoid and dysentery, and mosquito-borne diseases such as dengue fever and malaria
- water scarcity increases the use of waste water in agriculture – approximately 10 per cent of the world's population consumes food irrigated by waste water that contains chemicals or disease-causing organisms.

Water scarcity vs water stress

- By 2025, almost two million people will be living in countries or regions with absolute water scarcity and two-thirds of the world's population could be under water stress conditions. Water stress occurs when a country's annual water supply drops below 1700 cubic metres per person. Water shortages occur when supply is between 1000 and 1700 cubic metres per person. However, water scarcity results when annual water supplies drop below 1000 cubic metres per person. (One cubic metre is equivalent to 1000 litres).

What is water stress?

According to the World Water Council, water stress is the result of an imbalance between water use and water resources. Water stress causes the decrease in the quantity and quality of fresh water. A decrease in water quantity is caused by over use, while fresh water quality is affected by eutrophication (a process in which the oxygen levels are depleted), pollution and increasing levels of salt in the water.

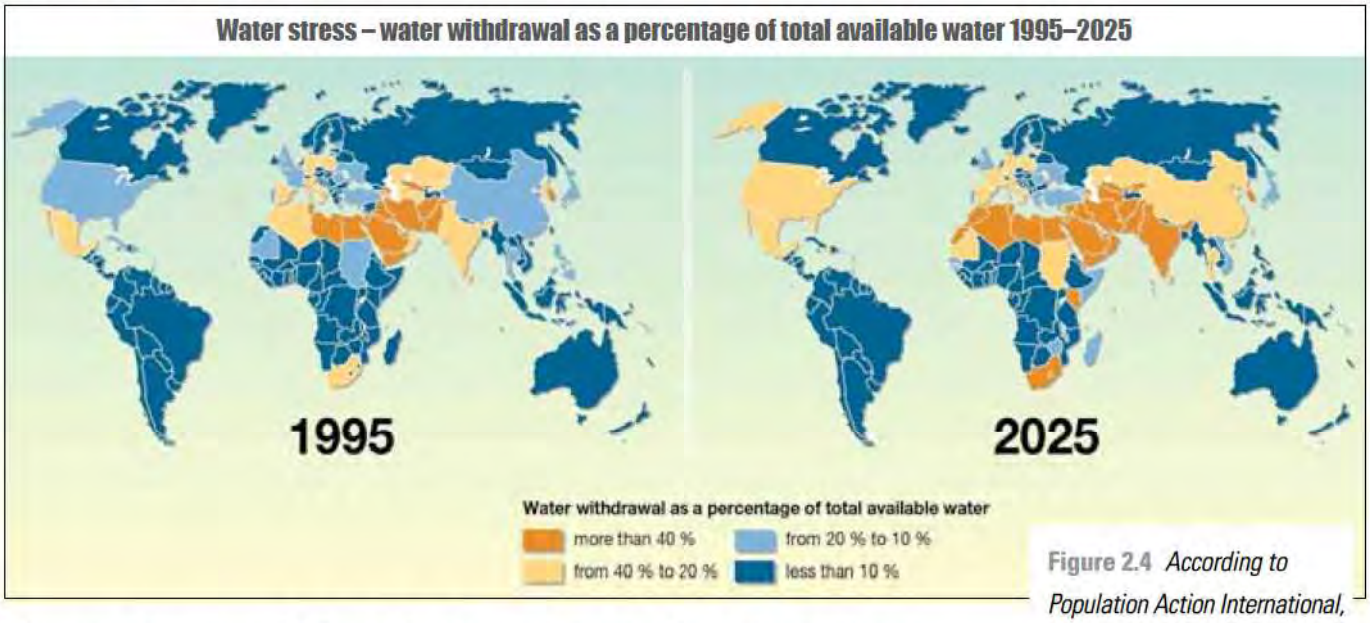


Figure 2.4 *According to Population Action International, by 2025, almost three million people in 48 countries will face water stress or scarcity. In the next 25 years, Ethiopia, India, Kenya, Nigeria and Peru are likely to run out of water if new sources are not found*

Towards a world with clean water for everyone

The United Nations considers universal access to clean water a basic human right and an essential element in improving living conditions. In 2000, the United Nations Millennial Declaration was agreed upon by the world's leaders. The eight Millennium Development Goals (MDGs) are a response to the world's main development issues and a commitment to reduce extreme poverty. Measurable targets relating to poverty and development, based on the way the world was in 1990,

were established. The goal is to achieve these targets by 2015. If MDG Goal 7C (halving the proportion of the population without sustainable access to safe drinking water and basic sanitation) is achieved by 2015 the result will be:

- some 203 000 fewer child deaths in 2015 and more than one million children's lives saved over the next decade
- an additional 272 million days gained in school attendance as a result of reduced episodes of diarrhoea
- a gain of 3.2 billion working days for people between the ages 15–59 by reduction in episodes of diarrhoea
- total economic benefits of approximately $38 billion annually. The benefits for Sub-Saharan Africa (about $15 billion) would represent 60 per cent of its 2003 aid flows. Gains for South Asia would represent almost $6 billion
- the total estimated cost of $10 billion represents less than half of the amount rich countries spend each year on mineral water.

Figure 2.5 *AusAID provides clean water to communities throughout the Asia-Pacific region, which is essential for improving health, economic development and reducing poverty*

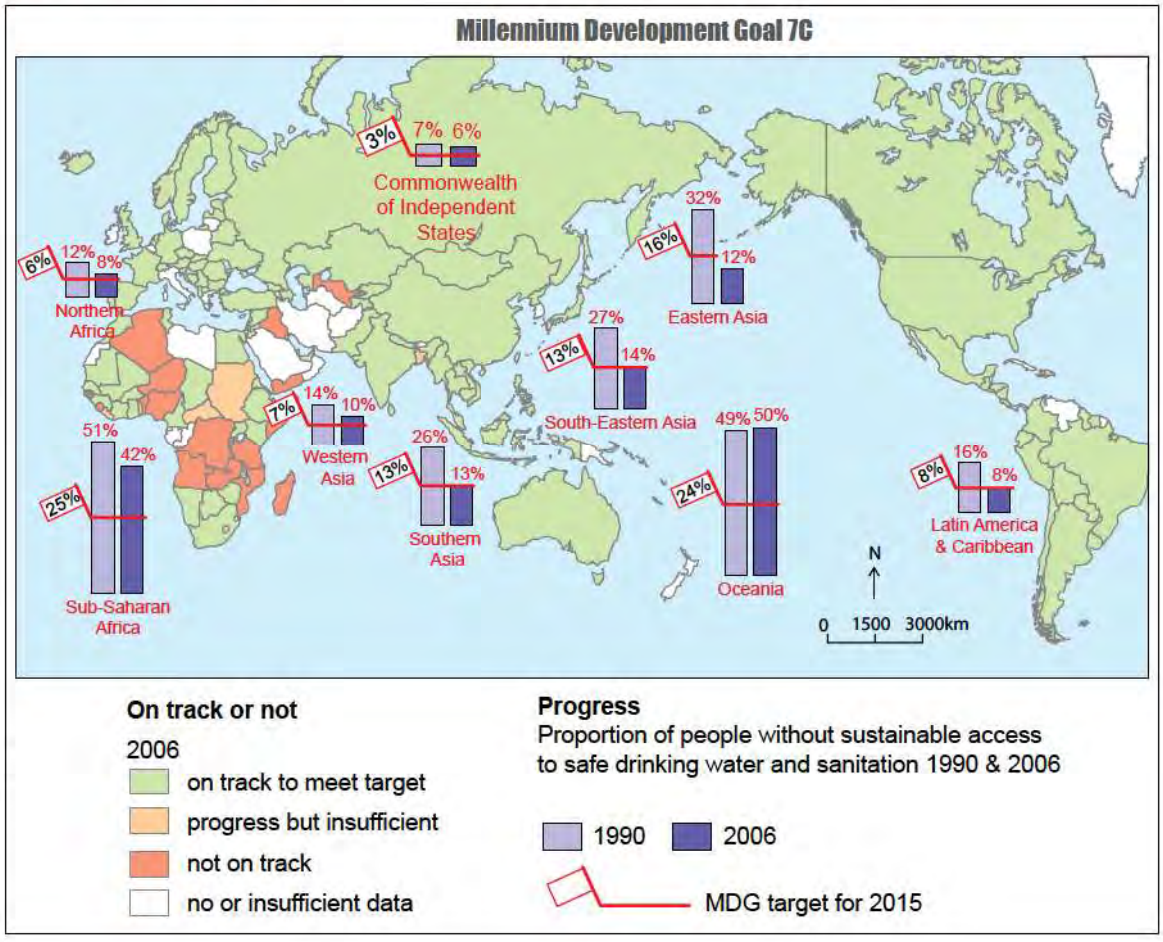


Figure 2.6 *Halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation*

On target for 2015

A progress report on how the world is working towards MDG Goal 7C states that in 2011:

- the world is on track to meet the drinking water target, though much remains to be done in some regions
- accelerated and targeted efforts are needed to bring drinking water to all rural households
- safe water supply remains a challenge in many parts of the world
- with half the population of developing regions still without sanitation, the 2015 target appears to be out of reach
- disparities in urban and rural sanitation coverage remain daunting
- improvements in sanitation are bypassing the poor.

SIGNIFICANCE OF IMPROVED WATER AND SANITATION IN MEETING MDGS

MDG	Role of water services and management
Goal 1: Eradicate extreme poverty and hunger	Improve access for subsistence farmers; raise agricultural productivity to meet demand for affordable food; make household supplies more accessible, reliable, and safer.
Goal 2: Achieve universal primary education	Provide separate in-school water and toilet blocks for staff, boys and girls, thereby reducing drop-out and disaffection by students and staff.
Goal 3: Promote gender equality and empower women	Improve women's access to water supplies, reduce time spent in water collection, and release energies for income-generating and other family support tasks.
Goal 4: Reduce child mortality	Hygiene in the home, nutritious food for infants and children, safe drinking water and correct faeces disposal have a vital influence on child illness and its outcomes.
Goal 5: Improve maternal health	Reduce risks to mother and infant by better access to safe water, especially where childbirth takes place at home; improve maternal health by better diet and hygiene.
Goal 6: Combat HIV/AIDS, malaria, and other diseases	Reduce water-related diseases by measures to control vectors, and by access to safe water, hygiene knowledge and sanitation.
Goal 7: Ensure environmental sustainability	Reverse the loss of environmental resources, and reduce by half the proportion of those without sustainable access to safe drinking water and basic sanitation.
Goal 8: Develop a global partnership for development	Practitioners, researchers and decision-makers should engage co-operatively in the integrated management of water resources.

Figure 2.7 *If the aim of halving the number of people without access to safe drinking water and basic sanitation is not achieved, then none of the remaining MDGs can be met. Water and sanitation are required to address the targets of hunger, poverty, public health, environmental protection and sound water management*

STUDENT ACTIVITIES

Explain

1. **a**. Describe the distribution of water availability in 2000, as shown in figure 2.1.

   b. Describe the spatial change over time in water availability between 1980 and 2015.

2. What is the difference between water scarcity and water stress? Explain in your own words.

3. Which four countries are likely to run out of water in the next 25 years?

4. Research either on the Internet or use a dictionary to write out a definition of the following terms:
   deterioration over-exploitation eutrophication saline intrusion.

5. Refer to Figure 2.4.
   a. Draw a table to list the countries experiencing water stress in 1995 and the countries projected to experience water stress in 2025.

Name of country	Water stress in 1995 (more than 40 per cent of available water withdrawn)	Projected water stress in 2025 (more than 40 per cent of available water withdrawn)

   b. Are there any countries that experienced water stress in 1995 that are projected to experience water stress in 2025? Highlight these countries.
   c. Which countries are new to the list of projected water stress in 2025?
   d. Refer to Figure 2.6, are these countries on target to meet the MDG Goal 7C?

Elaborate

6. Refer to Figure 2.3 and an atlas showing population distribution. Describe the relationship (or spatial association) between regions experiencing water scarcity (both physical and economic) and countries with high population distributions.
7. Construct a Venn diagram to compare the similarities and differences between water scarcity and water stress. Go to the Global Education website to download a Venn diagram template – go to **http://www.globaleducation.edu.au/resources-gallery/resource-gallery-templates.html** and click on Templates.
8. Imagine that you are one of the boys shown in figure 2.5, and that you have recently had the taps installed supplying fresh clean water to your village. Describe your daily routine as a diary entry from morning to night before you had access to clean water and then describe your daily routine after the taps are installed.
9. Refer to figure 2.7. In your own words discuss the following statement using facts and figures from the chapter:
   "If the aim of halving the number of people without access to safe drinking water and basic sanitation is not achieved, then none of the remaining MDGs can be met."

Engage

10. In small groups, discuss the topic of global water availability. Brainstorm ways to educate Australians about this issue. Select one of your ideas and develop it into a slogan, a poster, an advertisement, a Wordle (**www.wordle.net/**) or a Prezi presentation (**http://prezi.com/**).

Extension

11. The Kalahari Bushmen in Botswana have had their nomadic lifestyle halted as the government closes access to wells.
    Watch **www.youtube.com/watch?v=ztzDHDiOSUY** (19 minutes).
    Write a report outlining what has happened to the Kalahari Bushmen and explain why water plays a significant role to them.

Identity and cultural diversity

Everyone has access to water, however, not everyone has access to clean, safe drinking water. It is this uneven access that is an issue. Approximately one billion people across the world lack access to safe drinking water. Each year, 3.5 million people die as a result of water related diseases. And – for those who can least afford to pay – they are spending over 15 per cent of their annual household income on water alone.

Did you know?

- A bath holds approximately 151 litres of water; a person living in a city slum in a developing country may only get 30 litres of water for all his/her daily needs.

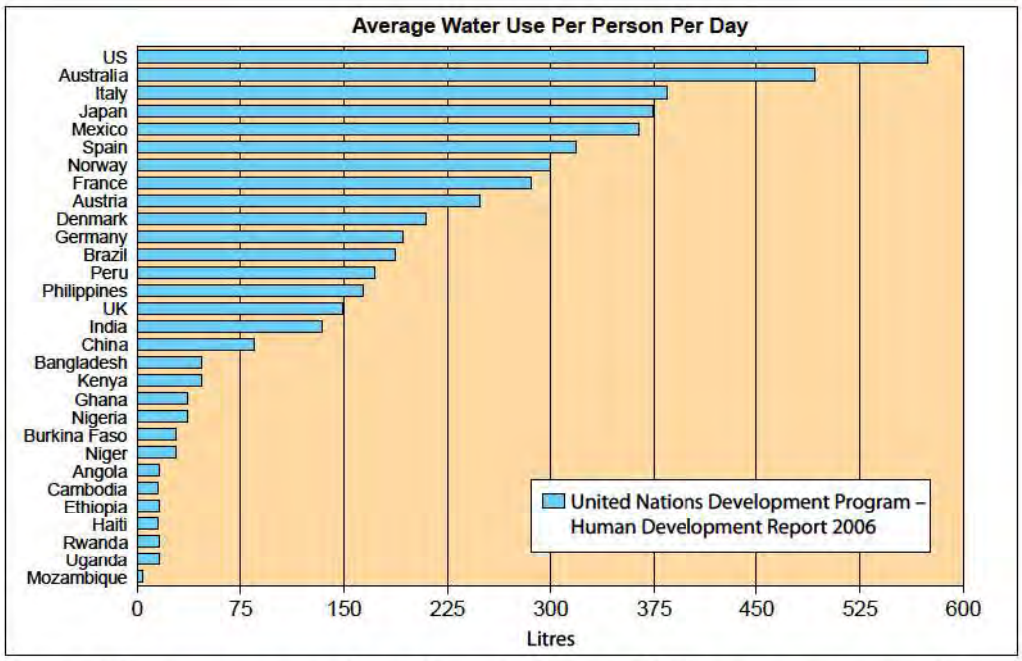


Figure 3.1 *The average water use for each Australian is almost 500 litres per day compared to the average water use for people in Angola, Cambodia, Ethiopia, Haiti, Rwanda, Uganda and Mozambique, which is less than the World Health Organisation's minimum of 20 litres per person per day*

Out of daily necessity

Everyone needs water to carry out basic daily functions such as drinking, cooking and personal hygiene. More time spent collecting water means less opportunity to go to school or work. In rural areas of many countries, it is mainly women and children who collect water each day. This adds to the poverty cycle as family members cannot make a living or further their education when so much time is spent getting water.

In developing countries, the poor living in slums can often pay five to ten times more per litre of water than wealthy people living in the same city.

Water costs nothing for those with everything and everything for those with nothing

The poor pay huge sums for small amounts of water. To get it, they walk great distances, wait hours, and compete with other equally desperate people for the precious resource. Overcoming inequality is more than making sure that all people receive 20 litres of water everyday – those 20 litres must be clean and affordable – and free for the poor.

Figure 3.2 *Water inequality*

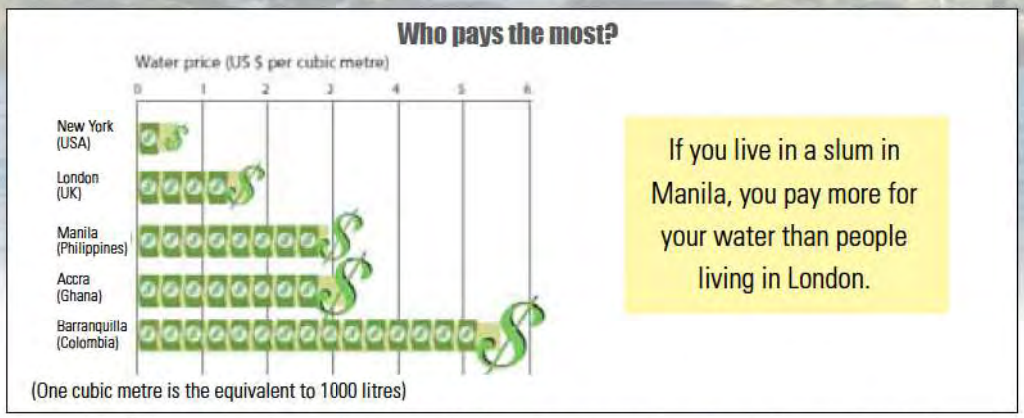


Figure 3.3 *The poor are often at the mercy of informal water vendors who truck water into their communities and then charge exorbitant prices for water. In developed countries access to adequate fresh water is often taken for granted.*

The spirituality of water

- In many communities water is essential in a spiritual sense, be it for baptism, initiation rites or religious offerings. The Ganges River is considered the spiritual centre of India. Hindus in India believe that the water of the river has healing properties and can even cure deadly disease. It is a popular practice for bodies to be cremated on the banks of the river, as the souls of the dead are believed to attain "moksh" or salvation.

Figure 3.4 *The Ganges River is considered the spiritual centre of India*

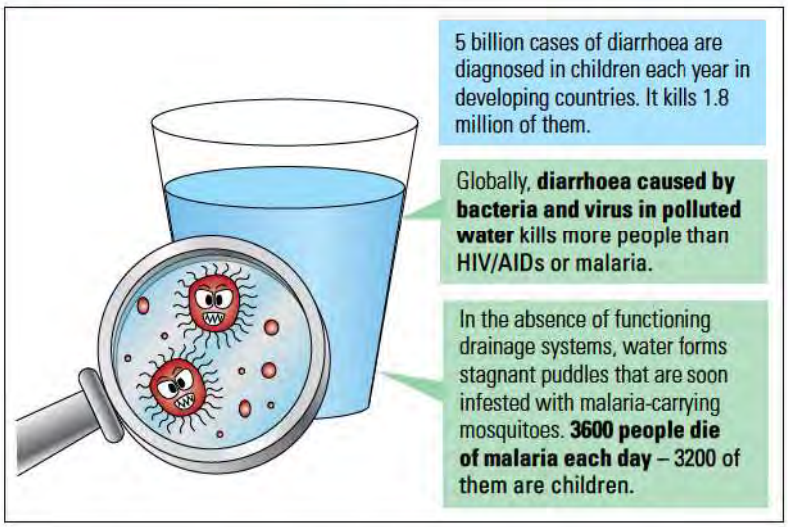


Figure 3.5 *What's in the water?*

Water and disease

Water, sanitation and health are closely interrelated. For example, in Orangi, Pakistan, before one sewer truck started operating in the early 1980s, the infant mortality rate was 130 deaths per 1000 live births – it is now 40 deaths per 1000 live births.

Drinking contaminated water leads to water-borne diseases such as diarrhoea, typhoid, hepatitis A, dysentery and cholera. The lack of water in the home for personal hygiene together with un-hygienic practices, can contaminate water and cause skin and eye infections as well as faecal-oral diseases. Poorly managed water resources also exposes people to the threat of parasitic infections such as malaria, Japanese encephalitis and schistosomiasis – which infects an estimated 260 million people worldwide.

Are you thirsty?

Figure 3.6 *In the United States UNICEF created a dirty water vending machine. They put it in the middle of Manhattan in New York City during World Water Week in 2010. They sold (took donations) of US$1 per bottle of dirty water flavoured with eight different diseases including malaria, cholera, hepatitis, dengue fever, dysentery, typhoid, salmonella and yellow fever. The campaign received worldwide attention and increased donations. It also educated over 7500 New Yorkers about the plight of thousands of children dying each year because of the lack of safe drinking water.*

STUDENT ACTIVITIES

Explain

1. Why do you think Australians use much more water than the World Health Organisation's recommended minimum amount of 20 litres per person per day?
2. **a**. Answer true or false to the following statements:
   - Everyone in the world has access to safe drinking water.
   - Each year, 3.5 billion people die as a result of water related disease.
   - Those who can least afford to purchase fresh drinking water are spending as much as 50 per cent of their households' annual income on water alone.
   - In developing countries, the poor living in slums can often pay five to ten times more per litre of water than wealthy people living in the same city.
   - The consumption of safe drinking water prevents water borne diseases such as diarrhoea, typhoid, hepatitis A, dysentery and cholera.

   b. Re-write the statements that are false to make them true.

Engage

3. Refer to Figure 3.3. Brainstorm with a partner the reasons why people in developing countries pay so much more for water than people in developed countries.

4. Go to the following website: **www.dirtywaterinfo.com/**

   a. View the video clip of the vending machine in Manhattan, New York.

   How effective do you think this campaign would have been at promoting the importance of safe drinking water? Justify your response.

   b. Work in small groups to design another campaign to promote the importance of safe drinking water.

Explore

5. Water bucket

   Look at your last water bill and find the average water use per person in your house. Instead of just turning on a tap in your home, imagine you now had to collect and carry that water from another location. What would that be like?

   Note to the teacher: This activity is best done outdoors. Have a number of buckets set up some distance such as 50 metres from a water tap, from which the bucket can be filled. Students are to carry the empty buckets to the tap and fill them and carry them back to the starting point, being careful not to spill any. They continue this until they have collected their personal water quota. Other students can record how long this takes.

   After you have experienced the effort involved in carrying full buckets of water think of three ways in which you could reduce your water consumption.

   If one litre of water weighs one kilogram, how much does your average water usage weigh?

   When you have finished this activity, complete the empathy task outlined in question 7.

Elaborate

6. The WHO and UNICEF identify three key hygiene practices as having the greatest potential health impact:

   - hand washing with soap (or ash or other aid)
   - safe disposal of children's faeces
   - safe water handling and storage.

   Use Movie Maker or iMovie to create a short video that demonstrates how each of these practices can be taught to local communities. List the factors that you would need to consider to make your video relevant and understandable. Limit your presentation to one minute and upload your movie to a class Wiki.

7. Empathy task

   Imagine you live in the slums of Manila. Keep a water diary by recording your daily role of collecting and paying for water, explain how you store your water and portray the risk you have of contracting disease. What are your thoughts and feelings about your access to safe drinking water?

HOW IS WATER USED IN AGRICULTURE?

Sustainable futures

The production of food relies on water. For every calorie of food eaten, one litre of water has been used in its production. Approximately 70 per cent of the world's available fresh water is used in agriculture, with the remaining 30 per cent used in industry (20 per cent) and for domestic use (10 per cent). Since 1960, food production and consumption has grown resulting in a 72 per cent increase in the amount of land used for agriculture. Many of the crops grown are high yielding and are planted intensively, requiring large amounts of water mostly supplied through irrigation. This water is either from rivers, dams or groundwater. It is estimated that the world's farmers pump groundwater at a rate that exceeds natural replenishment by at least 160 billion cubic metres per year. This is the same volume as the water in 285 Sydney Harbours.

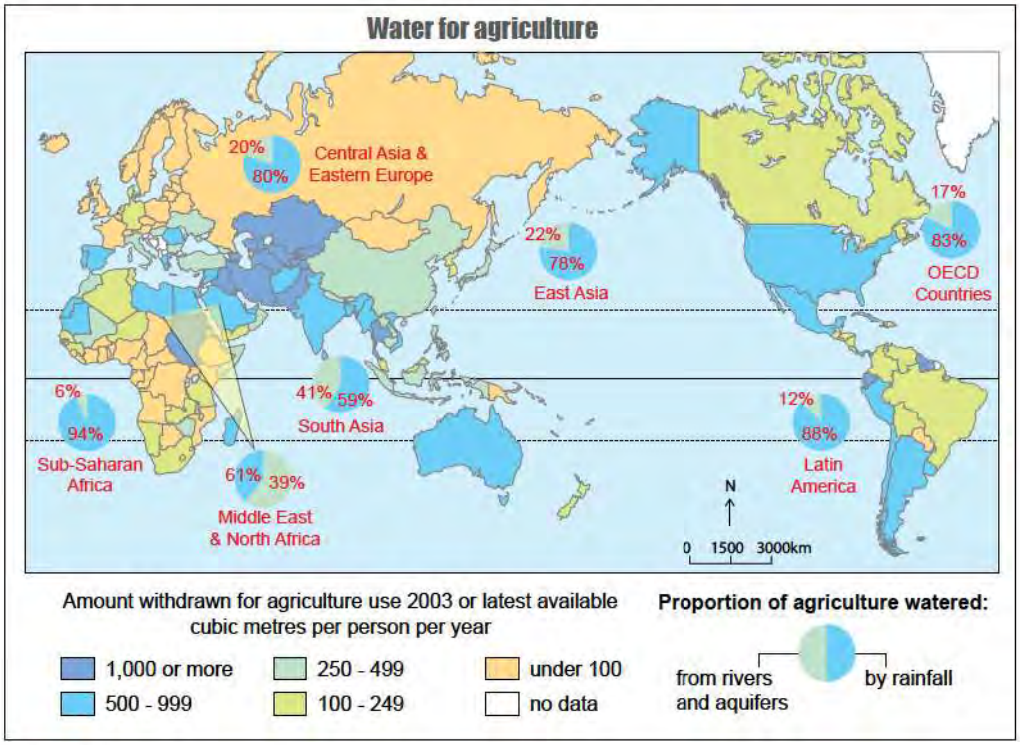


Figure 4.1

Green and blue water

- Water that falls as rain and is stored in the soil is known as "green" water, whereas water that is sourced from rivers, lakes and aquifers is "blue" water. Approximately 80 per cent of water used in agriculture is "green" water, however, in the last century "blue" water withdrawal has increased significantly.

Water for irrigation

Irrigation is water that is brought to the land by artificial means through ditches, streams or pipes. It is used on land that contains crops, grass for grazing or vegetables in areas that would not usually receive adequate rainfall or naturally sourced water.

Australia and irrigation in the Murray Darling Basin

In 2010, Australia had a total of 1.8 million hectares of irrigated land. In the Murray Darling Basin alone, the area of irrigated agricultural land is 976 000 hectares. Irrigation in Australia consumes over 70 per cent of the available water resources. Food production is an important benefit to the economy.

Cotton is a highly profitable crop – approximately 90 per cent of all of Australia's cotton is grown in the Murray Darling Basin. However, it is also the thirstiest, consuming up to 21 per cent of all water used for agriculture and accounting for 764 gigalitres of irrigation water within the Murray Darling Basin. This is the same volume as the water in 1.4 Sydney Harbours. Irrigation channels surround the plants to supply the large volumes of water required.

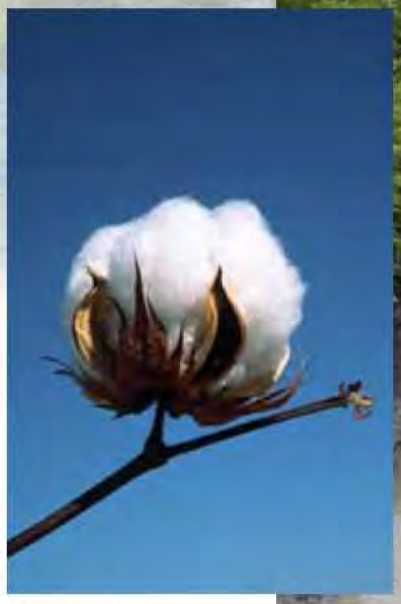


Figure 4.2

Figure 4.3 *Irrigation and cotton in the Murray Darling Basin*

Arabian Peninsula and irrigation

The Rub' al Khali or Empty Quarter is the world's largest sand desert and covers one-fifth of the Arabian Peninsula and parts of four Arab nations including Saudi Arabia, Oman, Yemen and the United Arab Emirates. Despite the average annual rainfall in this arid environment being less than 100 mm, this region supports heavily irrigated agricultural production including alfalfa and wheat. Water is sourced from groundwater wells from 100–200 metres deep.

Figure 4.4 *Centre pivot irrigation is a form of irrigation where the equipment or sprinklers rotate around a central pivot point forming circles. Each of these irrigation circles is approximately one kilometre in diameter and can support arable growth for four months, however, the ground needs to be irrigated all year to prevent salt leeching through to the surface. Every year 10 000 cubic metres of water is used for every 100 cubic metres of crops produced*

Water for a hungry world

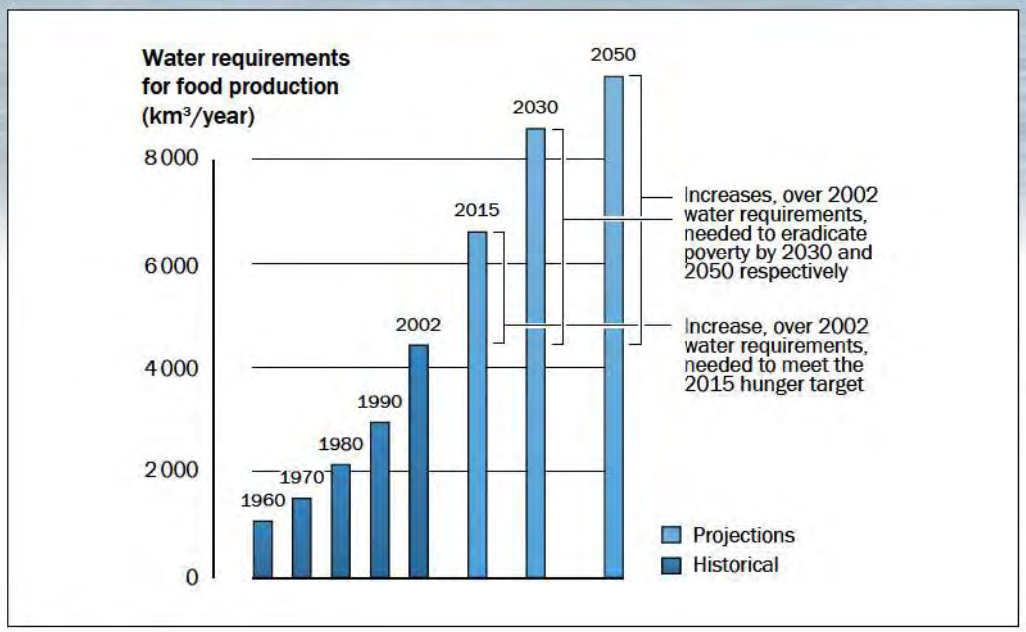


Figure 4.5 *The amount of water used in agriculture in developing countries will need to increase to meet MDG Goal 1 of halving the number of people who suffer from hunger*

Water footprint

The water footprint of a country is determined by the volume of water required to produce goods and services consumed by the population. Several factors contribute to the calculation of a country's water footprint including water consumption, patterns of consumption (e.g. diets high in meat), climatic conditions and water efficiency in agriculture. Virtual water is also a factor in determining water footprints as it incorporates the total volume of water used in various stages of production of food, goods and services. The concept of virtual water acknowledges that the majority of water is used in the production stages rather than in the final product.

Figure 4.6 *How big is your water footprint?*

Global water footprint

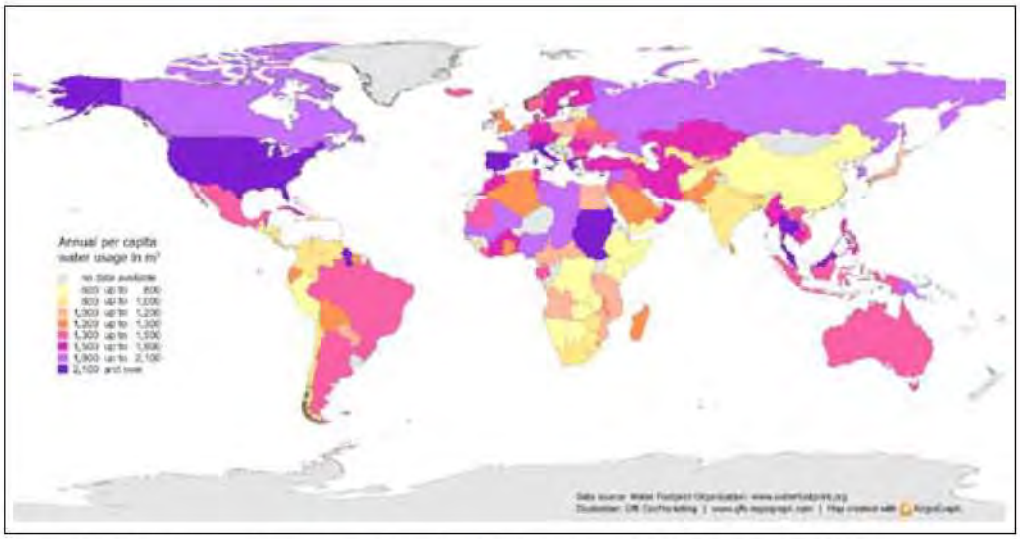


Figure 4.7 *Some countries use more than the global average whilst others use much less*

Did you know?

- It takes 1153 litres of virtual water to produce one 250 gram bag of peanut M&Ms. This huge of amount of water is used throughout the entire chain of production beginning with the agricultural process through to the packaging of the chocolates.

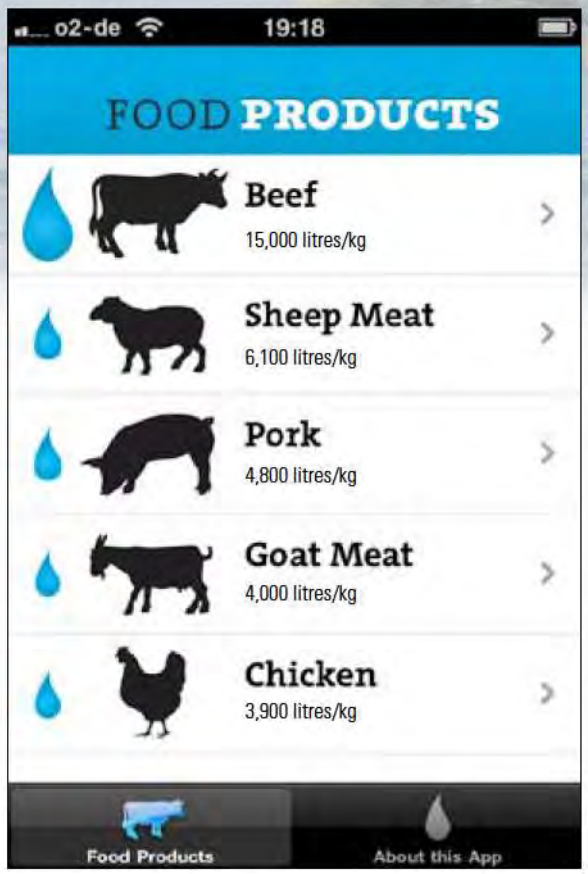


Figure 4.8 *Water footprint and the food we eat*

What you can do to reduce your footprint

Change of diet

- reduced meat consumption can save a household as much as 35 per cent of their total virtual water usage
- animal-based products in a diet require up to ten times more water than a vegetarian diet.

Waste less

- Australians consume 11.5 million tonnes of food each year and throw out 2.2 million tonnes. By reducing the amount of food wasted, the amount of virtual water wasted is also reduced.

Household water

- install water saving toilets and shower heads
- use less water in the garden
- recycle grey water
- recycle around the house – re-using 500 sheets of paper can save 5000 litres of water.

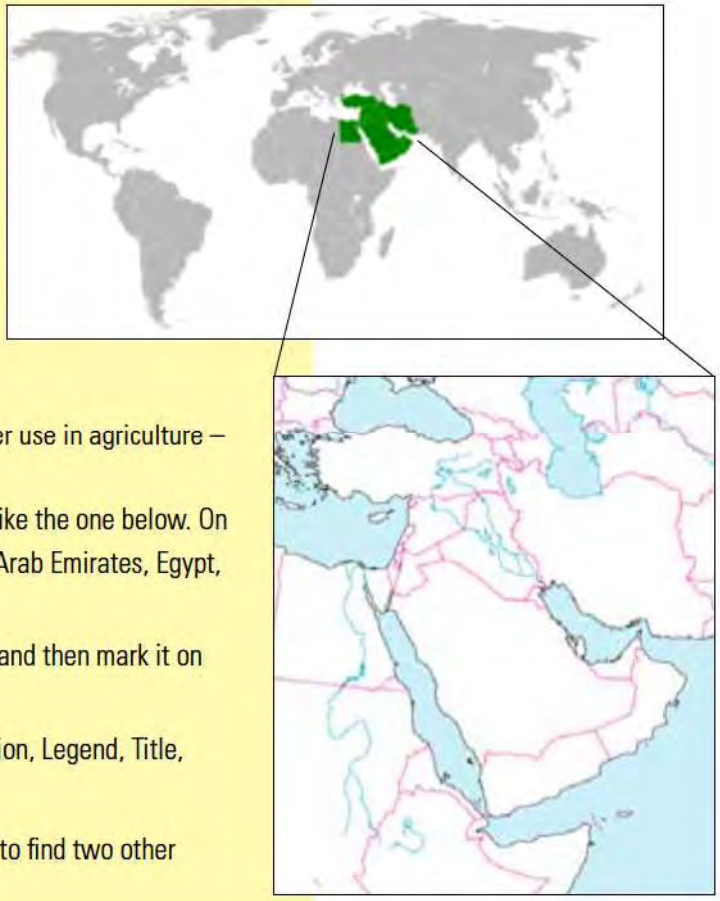
Water awareness

- making informed decisions about the food eaten by taking into account the amount of virtual water used in its production. iPhone Apps such as "Virtual Water" can be a portable companion to becoming more water aware.

STUDENT ACTIVITIES

Explain

1. Define the following terms in your own words:
   - blue water
   - green water
   - water footprint
   - virtual water.
2. Suggest some reasons why water use – including blue water use in agriculture – increased in the last century.
3. **a.** Use the Internet to find a blank map of the Middle East like the one below. On your map label Saudi Arabia, Oman, Yemen, the United Arab Emirates, Egypt, Iraq and Iran.
   b. Use the Internet to find the location of the Rub' al Khali and then mark it on your map.
   c. Finish your map by completing BOLTSS (Border, Orientation, Legend, Title, Source and Scale).
4. What is centre pivot irrigation? Research using the Internet to find two other regions where centre pivot irrigation is also used.



Elaborate

5. Refer to Figure 4.1

- **a**. Describe the distribution of the countries with the highest water use for agriculture.
- **b**. Locate a world rainfall map using an atlas or through research on the Internet.
- **c**. Describe the relationship (or spatial association) between high water use for agriculture and low rainfall and arid regions.

6. Explain why water plays such an important role in meeting Millennium Development Goal 1. Incorporate into your response the impact of population growth and climate change.

7. **a**. Describe the meal eaten by your family last night.

- **b**. Study Figure 4.6 and calculate how much virtual water your family consumed.
- **c**. Use the data to plan a meal that uses much less virtual water.
- **d**. Combine the meals to create a class recipe book. Share this on a school Wiki.

8. Visit **www.josephbergen.com/viz/water/** to examine water usage and water footprints.

- **a**. Select two countries.
- **b**. Construct a Venn diagram to compare the similarities and differences between their water usage and water footprint. Go to the Global Education website to download a Venn diagram template – **www.globaleducation.edu.au/resources-gallery/resource-gallery-templates.html globaled** and click on **Templates.**

Engage

9. With the help of your family, calculate your water footprint:

- **a**. Visit **www.waterfootprint.org/?page=cal/WaterFootprintCalculator**
- **b**. What is your family's water footprint?
- **c**. How could it be reduced?
- **d**. By researching on the Internet or using this text, suggest three other ways in which your family's water footprint could be reduced.

10. In small groups design a website or film an advertisement (using Movie Maker or iMovie) to educate people about their water footprint and how to reduce their water footprint.

DOES CLIMATE CHANGE AFFECT WATER AVAILABILITY?

Sustainable futures

The global impact of climate change will have an impact on water availability. The predicted temperature increases will influence the entire water cycle.

Predicted impacts of climate change on water availability

- global rainfall patterns will be altered with the high latitude and tropical regions predicted to experience increased precipitation while the sub tropical and lower-to-mid latitude regions will experience a decline
- increase in the average annual runoff and water availability in high latitude regions
- increase in rainfall intensity and variability resulting in more flooding and droughts
- reduction of the world's glaciers and snow cover affecting the water availability for more than one billion people that live in regions that rely on water supply from the snow melt of mountain ranges e.g. India and Bangladesh
- higher water temperatures will affect water quality – warmer water contains less dissolved oxygen and this would lead to a reduction in fish stocks
- sea level rise will increase the amount of salt in groundwater which therefore reduces the use of that water source for people and the ecosystems in coastal regions.

Figure 5.1

Melting glaciers change country borders

Figure 5.2 *As alpine glaciers have melted and receded, the border between Italy and Switzerland has altered. The 1941 convention established the border as the ridge (crest) of the glacier on Matterhorn. In 2009, the border was redefined to coincide with rock.*

Credit: Climate Change and Water IPCC Technical Paper VI; Author – WMO & UNEP

Tuvalu – a case study of climate change and water availability

Located in the Pacific Ocean, south of the equator between Hawaii and Australia, Tuvalu is one of the world's smallest and most isolated nations. Tuvalu has a population of approximately 10 000 living on eight extremely low-lying coral atolls – none rise more than four metres above sea level. The effects of climate change are already being felt in Tuvalu with king tides, cyclone winds, rain and high seas becoming more frequent. The Intergovernmental Panel for Climate Change (IPCC) predicts that by the end of this century sea level will rise between 0.09 and 0.88 metres. The consequences of this rise will be devastating for the people of Tuvalu. It will result in the loss of coastal lands, flooding, soil salinisation, and the destruction of homes, infrastructure and commercial activities. Salt-water intrusion from sea level rise affects fresh water supplies and, consequently, agriculture and food production. Already many Tuvaluans have moved to the main island of Fanafuti to escape the effects of climate change. 40 per cent of the population currently live on Fanafuti, making the population density 347 people per square kilometre – Australia's average population density is only 2.8 people per square kilometre. More than 3000 Tuvaluans have left their island nation to settle in other countries including New Zealand and Australia.

Figure 5.4 *Rising sea levels and floods in Tuvalu*

WWW.tv

- In 2000, the Tuvaluan government sold the country's domain ".tv." for US$50 million. The money has permitted Tuvalu to join the United Nations and the Pacific Island Climate Change Assistance Program to address climate change. The money has also helped improve the living conditions for all Tuvaluans.

Bangladesh's climate refugees

Bangladesh has 150 million inhabitants living in the deltas of three waterways. With the majority of Bangladesh located less than six metres above sea level, the IPCC's predicted sea level rise of 0.09 and 0.88 metres by the end of this century will flood more than one-quarter of the country and destroy more cultivated land than anywhere else in the world. This would also displace more than 15 million people, making Bangladesh the source of more climate refugees that any other country. By 2080, almost all of the 97 million people living in coastal zones will be forced to leave as a result of rising sea levels.

Figure 5.5 *Climate migration in Bangladesh has already begun because of a series of tidal floods. Internal migration to cities such as Dhaka is common, with some people crossing the border into India*

Figure 5.6 *The Indian government has constructed a 3000 kilometre fence along their border with Bangladesh. The fence is to stop illegal immigration, smuggling and anti-government militants. India claims that there are over five million illegal Bangladeshis living in the country. The Indian Government views climate change as a threat to national security; do they also view the climate refugees of Bangladesh as a threat?*

Predicted global impacts of climate change on water availability

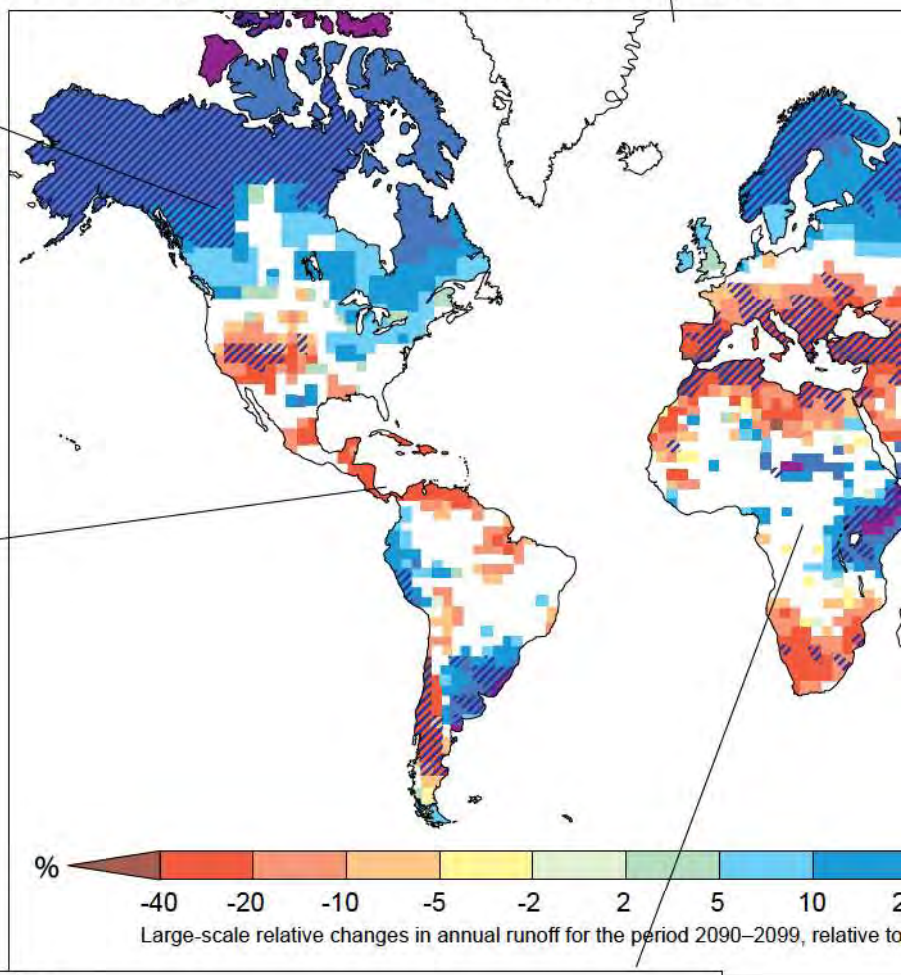
North America

Altered rainfall patterns and temperature increases will markedly affect this region. The south-west United States is predicted to experience a decrease in precipitation while rainfall in the remainder of North America is expected to increase. Along with increased melting snow, this raises flood potential in some regions. In contrast, some regions of lower rainfall that also rely on annual snow melts – such as the Colombia River – are predicted to decline by the middle of the century.

Polar regions

The earliest and most profound impacts of climate change are predicted to occur in the Polar regions. The abrupt change of water from a solid to liquid state from melting glaciers, ice caps and the Antarctic and Arctic ice sheets will increase run off and cause sea level rise.

Figure 5.3 *Changes in annual water runoff 2080–2099 compared to 1980–1999*



Large-scale relative changes in annual runoff for the period 2090–2099, relative to

Latin America

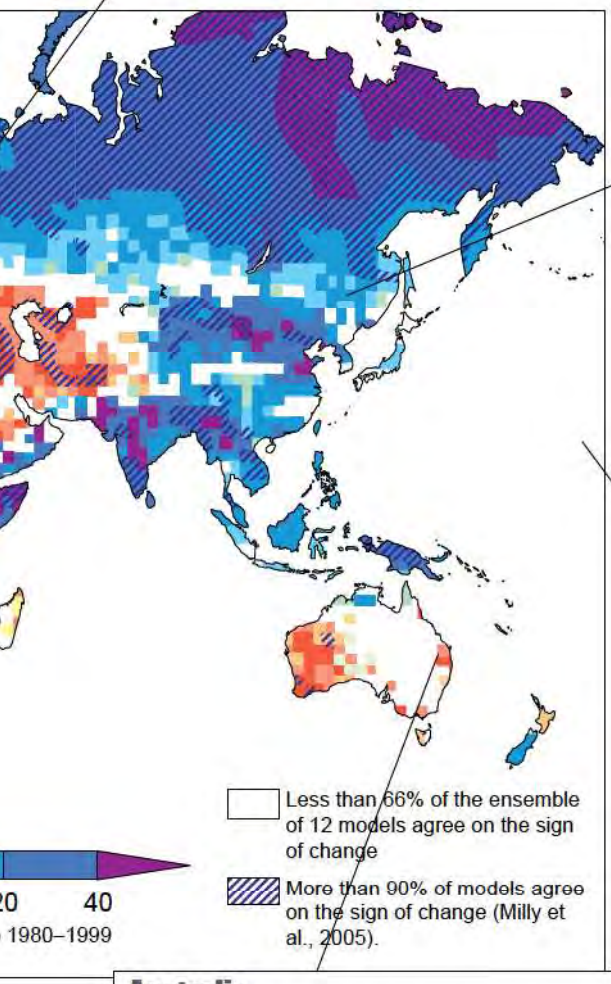
Climate extremes of floods, drought and landslides are predicted as a result of climate change in Latin America. The rapid recession of the glaciers and altered rainfall patterns will affect the runoff and volume of water available for consumption, power generation and agriculture. There may also be significant impacts on the environments – for example, savannas could replace the tropical forests in eastern Amazon and central and southern Mexico if rainfall decreases substantially and for long enough periods.

Africa

By 2025, approximately 65 per cent of people living in Africa will be at risk of water stress and water scarcity – by 2050 this figure could be as high as 600 million people. Altered patterns of precipitation will reduce soil moisture threatening some plants and animals with extinction. The predicted scenarios are not all negative for Africa for example, the reduction in frosts in highland zones could make it possible to grow more temperate crops and result in an increase in food production.

Europe

It is predicted that variable rainfall patterns will cause annual precipitation rates to decline in northern Europe and increase in southern and central Europe. Flash flooding across the entire continent will become more common due to a combination of melting snow cover, glacial retreat and increased rainfall in some regions.



Asia

Throughout most of the delta regions of Pakistan, Bangladesh, India and China, the predicted reduction in precipitation will result in the drying and severe degradation of wetlands. Several countries in Southern and Central Asia will experience an increase in water due to melting snow and glaciers and these might also contribute to episodes of flooding. The Gangotri glacier – one of the main sources of the Ganges River in India – is retreating at a rate of 23 metres per year. Without water from the glacier as it melts in spring, the Ganges will be reduced to one-third its current summer flow, affecting food and water supplies of 500 million people. The most significant environmental concern of climate change in this region is the increase in areas of South East Asia that will experience water stress – an estimated one billion people by 2020.

Small island nations

The availability of fresh water is a critical issue for small island nations. There is already some evidence of the effects of climate change in many Pacific island nations – in the Pacific Basin the average annual sea level rise has increased by 0.7 mm per year for the last 25 years.

Salt-water mixing with fresh water supplies (known as salt-water intrusion) because of rising sea levels, decreases water quality and quantity for many small island nations.

Australia

Climate change is predicted to decrease rainfall in some parts of Australia and may impact on water security by 2030. This would result in declines in annual stream flows of as much as 25 per cent by 2050. Water quality problems such as toxic algal blooms are likely to occur more frequently. Some parts of Australia will experience periods of heavy rainfall which could affect the rates of water-borne diseases such as Ross River and dengue fever and also increase the frequency of floods.

Credit: Climate Change and Water IPCC Technical Paper VI; Author – WMO & UNEP, Page 30, Figure 2.10

Bottled water – think again

The worldwide sales of bottled water is between $50–100 billion per year and yet to provide access to fresh drinking water for half of the one billion people currently without access to safe water would cost between $10 and $30 billion.

What is the real cost of a bottle of water?

- the average bottle of water costs AU$2.53 per litre but only one cent from the tap
- manufacturing bottled water is between 240 and 1000 times more expensive despite the fact that 25 per cent of all bottled water comes from the tap
- over 90 per cent of the cost of a bottle of water is the bottle, lid and label
- 70 per cent of bottles will end up in landfill and will take over 1000 years to break down
- Australians spend more than half a billion dollars on bottled water each year
- more than 200 millilitres of oil is used to produce a one litre bottle of water
- in Australia during 2009–2010, almost 46 000 tonnes of carbon dioxide was emitted in the production of bottled water
- an Australian newspaper recently analysed bottled water and found that it was no better than the tap water from Melbourne, Sydney and Adelaide.

Waste not, want not

Figure 5.7 *Plastic water bottles in India are cleaned and reused over and over again. Plastic mechanics will mend broken bottles by heating the plastic. If the bottle is beyond repair, scavengers known as rag pickers will collect the bottles to sell them at the waste markets – plastic is sold for 12 rupees (AU$0.25 cents) per kilogram*

The cost for Fiji of bottled water

For more than 20 years, a Los Angeles-based company has sourced water from the artesian aqueduct in Fiji to bottle water. The operation, *Fiji Water*, provides employment for over 700 locals and generates over $US150 million for the Fijian economy as well as additional community development programs. Despite the positive aspects of this industry, there are many negative. For example, *Fiji Water* bottles more than 3.5 million litres of water each month and sells each of these litres for US$3–4, while one-third of the Fijian population does not have access to a clean drinking water supply. Other negative aspects in the production of *Fiji Water* are the energy costs required to transport the bottled water thousands of kilometres around the world as well as the plastic waste created.

In late 2010, the Fijian government announced a tax increase on the extraction of water from one third of a Fijian cent per litre to 15 Fijian cents per litre. The company that owns *Fiji Water*

responded to this tax increase which increased their tax from $500 000 Fijian to $22 million Fijian, by shutting down operation and dismissing its staff. The next day the company re-employed the staff and continued production stating that they were committed to continuing their work in Fiji. The company has been criticised for their response to the tax hike when their annual marketing budget for *Fiji Water* is US$10 million or $17.4 million Fijian.

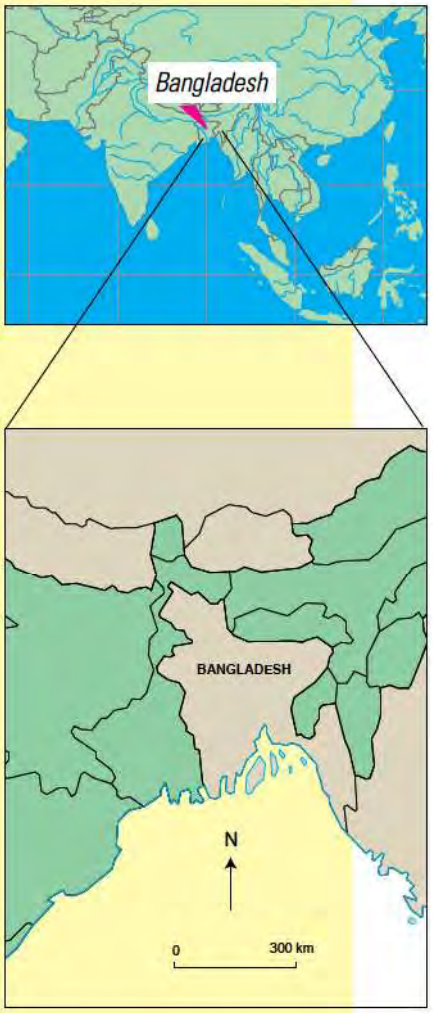
STUDENT ACTIVITIES

Explain

1. Using an atlas, name two high latitude areas that will experience an increase in the average annual runoff as a result of predicted climate change.
   Refer to Figure 6.2
2. Describe the distribution of regions of the world that will experience a decline in runoff by 2090.
3. List some of the impacts this decline will have in the regions identified.
4. Create a mind map of the impacts of climate change on water availability. To complete this electronically try using *Bubbl.us* on the Internet – **https://bubbl.us/**
5. Explain the connection between the production and consumption of bottled water and climate change.
6. **a.** The Australian Government has stated that assistance will be offered to the people of Tuvalu as they are forced from their homes as sea levels continue to rise – but only as a last resort. Do you think this is an appropriate response? Justify your answer.
   b. New Zealand also has a resettlement program for Tuvaluans. Conduct some research on the Internet and outline how the New Zealand government is responding. Compare this to Australia's response.

Elaborate

6. Select another small island nation in the Pacific (such as Tonga, Vanuatu, Fiji, Papua New Guinea, Samoa, Palau) and investigate the impacts of climate change on this nation. Create a "compare and contrast" table for the impacts of climate change between Tuvalu and your chosen nation.
7. Develop your own resettlement program responding to the sea level rise in Tuvalu. Provide some specific examples.
8. **a.** Use the Internet to find a blank map of Bangladesh like the one at right. On your map label Bangladesh, India (on the west of Bangladesh) and India (on the east), Nepal, Myanmar (Burma), the Ganges and Brahmaputra Rivers and the Bay of Bengal.
   b. Use the Internet to find an image of the fence built between India and Bangladesh and then paste it into your work.
   c. Finish your map by completing BOLTSS (Border, Orientation, Legend, Title, Source and Scale).



Engage

9. View the film *Climate Refugees* at **www.climaterefugees.com.**
   In small groups make your own video (using Movie Maker or iMovie) or create a Prezi about the plight of people being forced from their homes as a result of climate change.
10. View the video "The story of bottled water" at **http://storyofstuff.org/bottledwater/**
    Conduct a class discussion about the issue of bottled water.
    How can your class make a difference? Develop a campaign to educate people and reduce or stop the sale of bottled water in your school canteen.

CASE STUDY: WATER ISSUES IN THE ASIA-PACIFIC

Social justice and human rights

The Asia-Pacific region is home to 60 per cent of the world's population although it has only 36 per cent of the world's fresh water resources. Rapid population growth and urbanisation as well as economic development place heavy demands on the region's fresh water supplies. An improvement in water supply in the Asia-Pacific region would result in an improvement in livelihood, health and, most importantly, a reduction in poverty.

Kiribati

Land	811 sq km
Water	0 sq km
Population (2011)	100 743
Total renewable fresh water resources	n/a
% population living in urban areas	44
% population living in rural areas	56
GDP per capita	US$6200
% population using improved drinking water source (2005)	64
% urban population using improved drinking water source (2005)	77
% rural population using improved drinking water source (2005)	53

Figure 6.1 *Kiribati fact file*

Kiribati is one of the world's most isolated countries. Located in the central Pacific Ocean, it consists of 33 low-lying coral islands and atolls, most of which are no more than four to five metres above sea level. Kiribati is particularly vulnerable to severe weather and climate change and, as a result, fresh water supplies are under pressure. The main sources of fresh water in Kiribati are from fragile fresh water lenses with the remainder from rainwater collected in tanks.

Salt water intrusion into the fresh water from king or high tides, periods of high water use, droughts and the impacts of climate change contribute to make some of the islands of Kiribati uninhabitable. Pressures from population growth, water pollution from human and industrial waste also place pressure on the scarce fresh water resources.

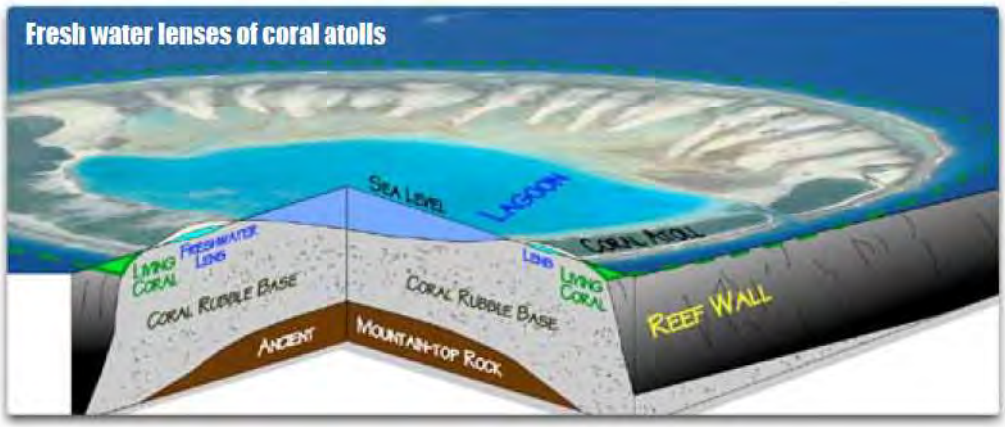


Figure 6.2 *Rainwater penetrates through the porous coral creating a lens-shaped pocket of fresh water that floats on sea water (because fresh water is lighter than sea water). The lens is only replenished by rainwater – therefore, it is a delicate balance between the rate of water withdrawal from the lens and the rate of replenishment*

Figure 6.3 *The impacts of climate change are already being felt in Kiribati. Sea walls have been constructed to protect the coastline from increasing sea levels, which threaten houses along the coastline*

AusAID and Kiribati

Australian funds of AU$2.9 million in 2008 were used in Kiribati to protect the fresh water supplies of the islands. AusAID's work involved improving water management and enhancing rainwater catchment and storage.

Figure 6.4 *Water tanks purchased with AusAID funds improve rainwater collection and provide safe drinking water and storage*

Papua New Guinea

Land	462 840 sq km
Water	9980 sq km
Population (2011)	6 187 591
Total renewable fresh water resources	801 cu km
% population living in urban areas	13
% population living in rural areas	87
GDP per capita	US$2500
% population using improved drinking water source (2008)	40
% urban population using improved drinking water source (2008)	87
% rural population using improved drinking water source (2008)	33

Figure 6.5 *Papua New Guinea fact file*

Papua New Guinea (PNG) is located on the eastern half of the island of New Guinea and also includes a further 1400 surrounding islands. 87 per cent of Papua New Guinea's population live in rural areas where only one-third have access to safe drinking water. Along with very poor sanitation and a lack of understanding of good hygiene practices, people are exposed to water-borne diseases as they access polluted water. In rural regions, there is a direct correlation between the lack of safe drinking water and high mortality and morbidity rates from water-borne diseases.

AusAID steps in to help with cholera outbreak

An outbreak of cholera (a bacterial infection spread through contaminated water) on Daru Island in the Western Province of Papua New Guinea in late 2010 was causing up to 70 people per day to become ill. The Australian Government responded through AusAID to ensure that the outbreak was contained and that future outbreaks were prevented. The Australian High Commissioner and the head of AusAID flew to Daru Island with over 400 kilograms of medical equipment, including:

- 4000 aqua tabs
- 300 water containers
- 500 doses of oral rehydration salts and
- 190 litres of intravenous fluid.

As well as providing clean drinking water, AusAID works together with the Australian and PNG Red Cross to educate people and promote awareness about safe water and hygiene practices.

Figure 6.6 *Education helps teach people in villages how to prevent the spread of cholera and how to use water purification tablets*

Figure 6.7 *Local community leader Kevin Sida educates people about the ways to prevent and control the spread of cholera*

Figure 6.8 *Lack of safe drinking water and unsanitary conditions increase the risk and spread of cholera and other water-borne diseases*

Vietnam

Land	310 070 sq km
Water	21 140 sq km
Population (2011)	90 549 390
Total renewable fresh water resources	891.2 cu km
% population living in urban areas	30
% population living in rural areas	70
GDP per capita	US$3100
% population using improved drinking water source (2008)	94
% urban population using improved drinking water source (2008)	99
% rural population using improved drinking water source (2008)	92

Figure 6.9 *Vietnam fact file*

Vietnam has an abundant supply of fresh water, however, a lack of finances and poor infrastructure has meant that access to safe drinking water has been limited. Despite steady progress in recent decades, in many regions of the country – especially amongst heavily-populated ethnic minority groups and in remote rural communities – people still do not have access to safe drinking water.

Access to safe drinking water in Vietnam is also threatened by contamination of groundwater with arsenic. In the densely populated Red River Delta province alone, 65 per cent of wells contain unsafe levels of arsenic that can cause cancer, skin rashes and neurological problems – approximately seven million people are at risk of chronic arsenic poisoning. Arsenic is naturally occurring. Contamination of water supplies is the result of over-exploitation of groundwater supplies causing fluctuation in water table levels.

Examples of improving water quality

When Dao Van Manh, a vegetable farmer from Ha Nam Province, was shown evidence of arsenic in his family's drinking water he immediately decided to install a filter. "We really had no idea about the hazards of well water." Manh is parting with the equivalent of nearly $100 – about one-tenth of his annual income – to buy a simple sand filter. He considers the price well worth the peace of mind. "I am more than satisfied," he says, "I have two daughters and I worry very much about their health. I am quite ready to do more work to upgrade the filter if necessary." A partnership between AusAID and the World Health Organisation (WHO) provided AU$2 million to improve water and sanitation across Vietnam and six surrounding countries. To deal with the

Figure 6.10 *Dao Van Manh is able to access clean water since he installed a sand filter into his water supply*

Figure 6.11 *Since her family stopped using well water for cooking and drinking Phan Thi Thu has noticed an improvement in her health*

issue of arsenic poisoning in Vietnam the AusAID-WHO partnership taught communities about safe water standards, how to manage supplies as well as installing sand filters.

STUDENT ACTIVITIES

Explain

1. What are the main factors placing demands on the fresh water in the Asia-Pacific region?
2. **a**. In your own words, explain what a fresh water lens is. Use a labelled diagram to support your explanation.

   b. Why are fresh water lenses so important to the people of Kiribati and other small island nations?

   c. What have the people of Kiribati done to overcome the effects of climate change?

   d. These structures are classified as hard engineering, shore-based structures. Using the Internet find two problems which may arise as a result of building these structures.
3. **a**. Create a compound bar graph for Kiribati, Papua New Guinea and Vietnam to show the percentages of urban and rural populations using improved drinking water sources.

   b. Which country has the best access to improved drinking water?

   c. Which country has the worst access to improved drinking water?

   d. Use some of the other facts about each of the countries to suggest some reasons to explain the difference in access to an improved water source.

Elaborate

4. Draw a tri-Venn diagram showing the similarities and differences in access to water and water issues in Vietnam, Papua New Guinea and Kiribati. Downland a Tri-Venn diagram template from the Internet.
5. Investigate a country in the Asia-Pacific region affected by arsenic contamination of the groundwater. Write a report including:
   - a map of the country
   - a fact file – using *The World Factbook* create a table for your country containing the same indicators as figure 7.1
   - the causes of the arsenic contamination
   - the impacts on people and the environment
   - responses from people and organisations.
6. Find out what the Civil Society WASH Learning Fund is doing in the Pacific Region by visiting **www.learningfund.org.au/case-studies**. Work with another student and write three reasons why you think these programs are successful.

Engage

7. In pairs create a presentation (using PowerPoint or Prezi – **http://prezi.com/**) on one of the following water-borne diseases: cholera, typhoid, dysentery, hepatitis A, guinea worm disease or botulism. You should include the following information:
   - how the disease is transmitted
   - an explanation of the symptoms
   - where the disease is found (include maps)
   - what is being done to reduce or eradicate the disease
   - what you can do to help.

   Present your findings to your class or upload to a class Wiki.
8. Visit the LearnZone on the WaterAid Australia website – **www.wateraid.org/australia/** – and play one of the online games; Pani the handpump, GlobalWise Hitosa or Soozhal investigation. Upon completion of the game write a short paragraph describing what you learnt.

CASE STUDY: WATER ISSUES IN AFRICA

Social justice and human rights

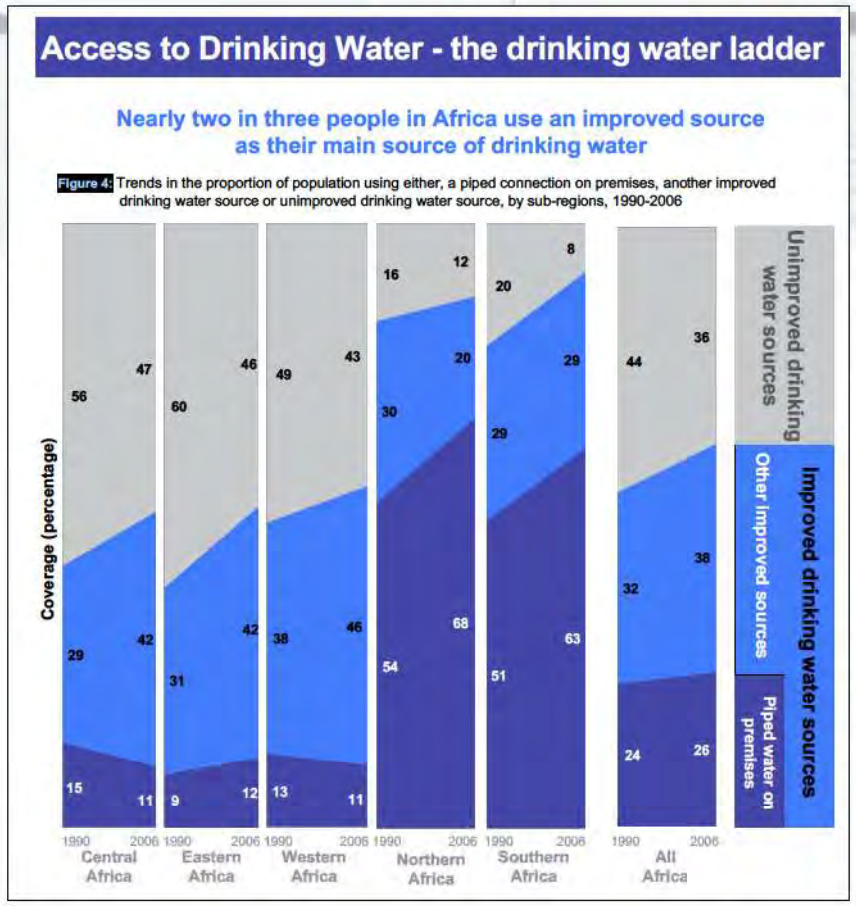


Figure 7.1 *There are huge disparities in access to water across Africa. Almost two-thirds of people in northern and southern Africa have access to a piped water connection to their premises, while only one-quarter have the same access in central, eastern and western Africa. In fact, in these regions, only 60 per cent of the population has access to improved drinking water.*

Of the one billion people worldwide who lack access to safe drinking water, over one-third live in Africa. Only 26 of Africa's 46 countries are on target to meet Millennium Development Goal 7c – to reduce by half the proportion of people without sustainable access to safe drinking water. Infrastructure development to provide access to safe drinking water cannot keep up with rapid population growth in many countries throughout Africa.

Land	197100 sq km
Water	43 938 sq km
Population (2011)	34 612 250
Total renewable fresh water resources	66 cu km
% population living in urban areas	13
% population living in rural areas	87
GDP per capita	US$1300
% population using improved drinking water source (2008)	67
% urban population using improved drinking water source (2008)	91
% rural population using improved drinking water source (2008)	64
% population using improved access to sanitation (2008)	48
% urban population using improved access to sanitation (2008)	38
% rural population using improved access to sanitation (2008)	49

Figure 7.2 *Uganda fact file*

Many communities in both urban and rural regions of Uganda still use unsafe water sourced from contaminated open streams and wells. Fresh water sources have been threatened by erratic rainfall causing flood conditions in 2010 and the El Niño weather phenomenon in 2011 which caused severe drought throughout the country. Access to adequate food as agricultural production has also been hindered by floods and drought. Rapid population growth and destruction of the natural environment such as wetland reclamation, deforestation and pollution have also played a role in altering access to water. Since 2006, access to fresh water has progressed at an average annual rate of 1.49 per cent. At this rate, the Ugandan Government's goal of 100 per cent safe water access in urban areas will not be met by 2015. In order to achieve this goal, a 2.1 per cent average annual increase is required to accommodate the rapid population growth occurring in Uganda – the third highest in the world.

Figure 7.3 *A typical day for young girls and women in Uganda*

Margret Aketch's feet are scorched, parched and seared for a girl her age. She lives with her frail HIV-positive mother at the foothills of Koya in Abim District. Every morning before cock-crow, the 10-year-old girl slowly but stealthily sneaks out of the aging hut she calls home to make her usual trek to Wilela, a three-kilometre journey in search for clean water for her family. The night is pitch black but she is joined by four other friends trapped in the same circle. The little girl dreams of becoming a nurse, but this dream is far-fetched as she will drop out of school next year if no water facility is constructed near her village to cater for the growing water needs of her expanding family.

Ugandan women and water

Gender inequalities persist in many developing countries, including Uganda. These inequalities are clearly apparent in labour involved in accessing safe drinking water. Women labour to provide water for their households – they collect and transport it, and cook, wash and clean with it. Water collection is often done at the expense of pursuing other income-generating activities. When women are actively involved and participate in the decision-making processes, the operation and maintenance of water facilities are better managed. Subsequently, the health of the community improves, as does the dignity of women, and more girls will attend school thereby increasing their future opportunities and income potential.

Figure 7.4 *Ugandan woman at her home in Kampala washing clothes*

Women making a difference

Katosi Women Development Trust (KWDT), a Ugandan Non-Governmental Organisation, works to empower rural women to improve their livelihood and manage their social, economic and political development. With support from other partners, KWDT started Domestic Rain Water Harvesting. This program involves 26 women trained in the construction, maintenance and operation of cement tanks for rainwater harvesting. In 2011, 187 households and 19 government-aided schools each have tanks that hold up to 8000 and 20 000 litres respectively. These rainwater tanks provide clean safe drinking water. The women involved in the project are committed to their role of carrying out annual checks on the tanks, repairing damage as well as being hired by other communities to construct tanks. This project provides access to clean safe drinking water for thousands of people.

Figure 7.5 *A young girl collects clean water from a supply at her home near Kawempe in Uganda. Australia (AusAID) recognises the importance of access to clean water to the health and livelihoods of people.*

STUDENT ACTIVITIES

Explain

1. Fill in the missing words.
   - **a**. Of the _____ people worldwide who lack access to safe drinking water, over _____ of them live in _____. Only 26 of Africa's _____ _____ countries are on target to meet Millennium Development Goal ____ of reducing by _____ the proportion of people without sustainable access to safe drinking water.
   - **b**. More than _____ out of _____ Africans _____access to improved drinking water are living in rural areas.
   - **c**. When water is not directly piped to premises, _____are _____ times more likely to be responsible for water collection than _____. Despite _____ per cent of the population in Sub-Saharan Africa having access to improved water source, it is still more than a _____-minute round trip to collect it.
2. Work with a partner. Refer to figure 8.2 and suggest some reasons why access to improved drinking water is higher in urban areas compared to rural.

Elaborate

3. Refer to figure 8.1.
   - **a**. Describe the disparities of access to drinking water across Africa.
   - **b**. Using a map of Africa, create a map by shading the regions of Africa according to their access to improved drinking water source using the legend below:
     - **i**. darkest shade – over 60 per cent
     - **ii**. lightest shade – below 60 per cent
     - **iii**. annotate your map with the percentage of the population with water piped to premises in each region
     - **iv**. don't forget to include Border, Orientation, Legend, Title, Source and Scale (BOLTSS).
   - **c**. Compare your map to the graph in figure 8.1. Which do you find easier to interpret? Explain.
4. Create a multimedia presentation about the women and water in Africa.
   Research on the Internet to find some other examples of organisations helping women improve their lives and reduce the burden of water collection.

Evaluate

5. In small groups, develop your own proposal for a non-profit, Non-Governmental Organisation (NGO) to work in Uganda. Your group needs to respond to the following issue:
   "Despite 87% of Ugandans living in rural areas, access to safe drinking water is not as good in the urban areas".
   Develop an action plan for rural Uganda to improve access to safe drinking water.
   Your organisation needs to provide specific and well-researched information about how it is going to provide safe drinking water for the rural communities. It must involve local people and be sustainable.
   Present your action plan to the class in a creative format – role-play, website, TV advertisement or pamphlet.

WHAT ACTION CAN BE TAKEN TO IMPROVE WATER AVAILABILITY?

Sustainable futures

Access to a reliable and safe water source is essential for survival yet it is not available to everyone. Many organisations work towards providing this basic requirement and, as technological advancements improve, alternative forms of fresh water are developed.

Making more water

Desalination of seawater or brackish groundwater has the potential to harvest seemingly endless quantities of water. The process separates saline water into two streams – one of fresh water for drinking and the other of brine water, concentrated with salts, which is discharged back into the ocean. Desalination is the fastest-growing form of water provision in the world. However, the high costs of desalination plants are prohibitive for developing countries where the vast majority of the one billion people live, who lack access to safe drinking water.

Wonthaggi – Australia's largest desalination plant

Australia's largest desalination plant will supply more than 150 billion litres of water each year to Melbourne, Geelong and surrounding regional centres. The plant will supply approximately one-third of Melbourne's household and industrial water supplies. A two-way water pipeline, 84 kilometres long, will secure Melbourne's water supply by transferring water to the supply network in Berwick and then feeding into Cardinia Reservoir. Water can then be transferred from the reservoir through the pipelines to regional towns in Gippsland and Western Port Bay as required.

Figure 8.1 *Planned to be completed in November 2012, the company states that the Wonthaggi desalination plant will be one of the greenest in the world. The plant will operate using renewable energy, and will have a unique design featuring a "living green" roof; a new coastal park will also be created*

Figure 8.2 *Not everyone is happy about a desalination plant*

Did you know?

- There are around 15 000 desalination plants across the world – the largest are found in the United Arab Emirates, Saudi Arabia and Israel. A further 120 desalination plants are planned or under construction.

Many people, particularly local community members, are opposed to the construction of the desalination plant at Wonthaggi because of the threat to aquatic life, pollution of the ocean, the large amounts of waste produced and the damage to a pristine, untouched stretch of Victoria's coastline

Drinking water from the Thames River, London

London's population is predicted to increase by 800 000 by 2016. In order to cope with the increased water demands, construction of the United Kingdom's largest desalination plant began in 2008. The £250 million (AU$400 million) *Thames Gateway Water Treatment Works* is situated on the banks of the Thames River in East London. It produced its first drinking water in March 2010. As much as 150 million litres of drinking water per day is being produced by the desalination plant – enough water for the one million people living in North East London. The desalination plant will use biodiesel sourced from the United Kingdom including recycled fat and oil from London's restaurants and households.

Drinking treated sewage water

- In 2006, the city of Toowoomba, Queensland, voted in a referendum on the use of treated sewage for drinking water. The result was a resounding "No", with 62 per cent of residents opposed to the scheme. However, Toowoomba residents may find that they will be drinking treated sewage water in the future. At the end of 2010, the Queensland State Government launched a pipeline linking Toowoomba to Brisbane's water supply. At the time, Toowoomba's dam supplies were extremely low at only 8 per cent capacity, prompting the government to act to ensure the long-term water security of the south eastern region of Queensland. As part of a AU$9 billion water grid project, Toowoomba will have purified recycled sewage water pumped into the dam systems when levels fall below 40 per cent capacity.

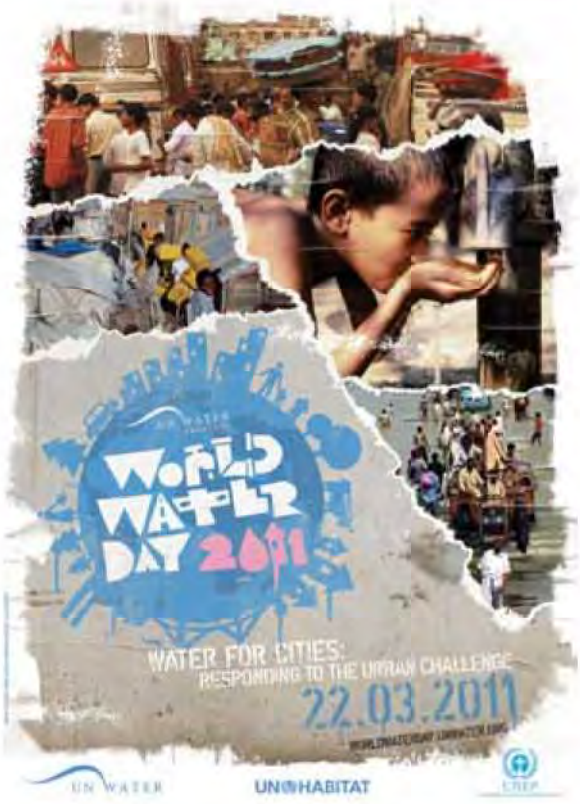


Figure 8.3 *United Nations World Water Day 2011 – Water for Cities: responding to the urban challenge*

Using recycled water

- The City of London is located downstream from a number of wastewater recycling plants which discharge into the Thames River. There is a common saying that a glass of London water has passed through several pairs of kidneys. London is not the only place where people drink treated sewage water. Supply of recycled and treated sewage water occurs in the United States, Africa and Singapore – in fact, approximately one per cent of Singapore's daily water consumption is sourced from recycled sewage water.

Global Responses
United Nations World Water Day

International World Water Day, held annually on 22 March, began in 1993 with the aim of drawing attention to the importance of fresh water and its sustainable management. Each year, World Water Day focusses on a different aspect of fresh water such as water quality, sharing water resources, water scarcity and sanitation. The focus of 2011 was *Water for Cities* – the rapid expansion of urban areas, continued industrialisation and the uncertainties of climate change and conflict. In 2011, over half of the world's population lived in urban areas. The United Nations predicts that urbanisation will continue to expand at a rapid rate, with 40 per cent of the world's urban growth occurring in slums. It is estimated that every year between 2005 and 2020, 27 million new slum dwellers will be added to cities in developing countries. Investment in water and sanitation infrastructure has not kept up with this growth and will struggle in the future. World Water Day 2011 highlighted the issue of fresh water access for cities.

Figure 8.4 *Does the tap water of a celebrity taste better?*

UNICEF – *Tap Project*

UNICEF's *Tap Project* promotes the life-saving importance of access to safe drinking water. In 2011, celebrities donated bottles of their tap water to be entered into a sweepstakes where people could donate money in the chance of winning a bottle of celebrity tap water. In 2007, UNICEF began the *Tap Project* by encouraging restaurant patrons in New York City to donate one dollar for a glass of tap water they would have usually enjoyed for free.

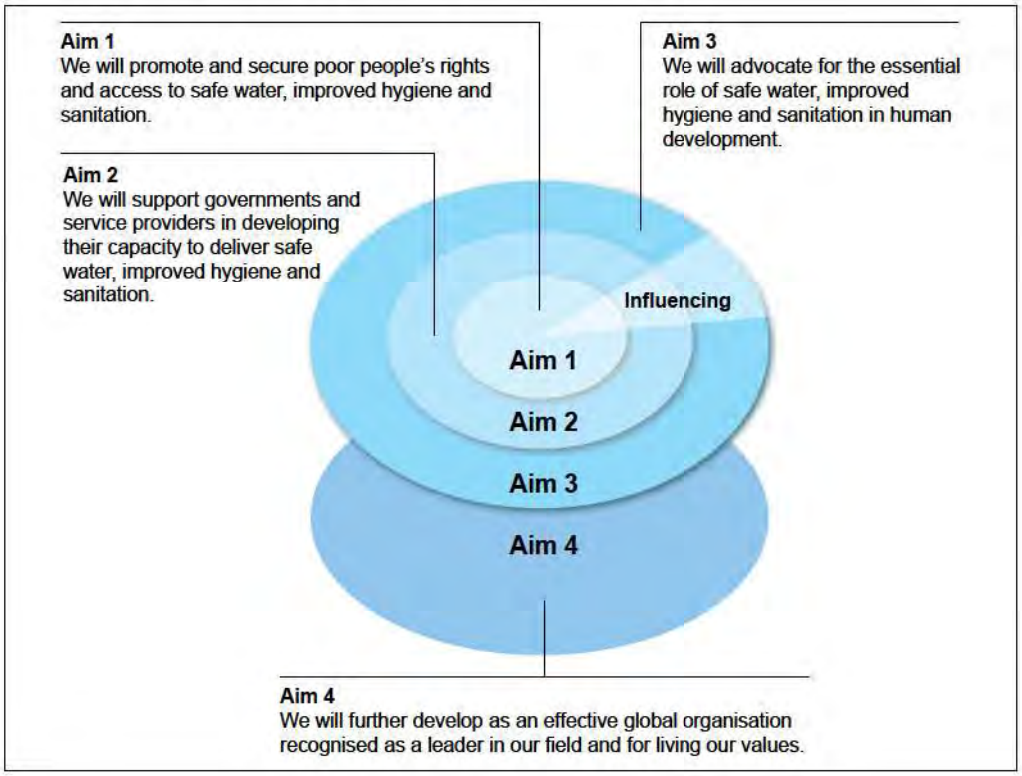


Figure 8.5 *Four aims of WaterAid's Global Strategy 2009–2015*

Science warms to iceberg-harvesting idea

An eco-entrepreneur, backed by a software company, claims to have proved that his plan to end droughts by towing giant icebergs to the Third World could become reality.

For 40 years, Georges Mougin has been struggling to convince the world that his idea to harvest icebergs could be used to solve water shortages. However, a cutting-edge computer simulation has shown that the ambitious scheme is possible and the French engineer is seeking backing to test his theory.

The breakthrough comes as droughts devastate the Horn of Africa, leaving more than 12 million people without water.

The 86-year-old's plan involves encircling the iceberg with a harness that contains a skirt made from strips of an insulating textile. This unfolds below the surface and covers the iceberg to prevent it melting. Then one tugboat uses ocean currents to help pull the massive load to warmer climes.

The team showed that a tugboat travelling at one knot could tow the iceberg along the entire route in 141 days, with only 38 per cent of it melting.

The high costs involved in the project have previously scared off investors. Travelling the route with a real 7 million-tonne iceberg would have cost at least 6 million pounds, but Mr Mougin believes the success of the simulation will help raise 2 million pounds for a trial next year towing a small iceberg from the Antarctic to Australia.

Figure 8.6 *Icebergs for fresh water*

Figure 8.7 *This stand pipe for water collection in Mozambique was installed as part of the World Bank Water and Sanitation Program supported by Australia*

WaterAid

WaterAid is an International Non-Government Organisation whose focus is improving access to safe drinking water, hygiene and sanitation of the people of developing countries. WaterAid works with partners in the Asia-Pacific region and Sub-Saharan Africa. They are planning to expand their efforts to Latin America and the Caribbean. The Global Strategy 2009–2015 addresses the need for innovative solutions to water and sanitation issues.

What is Australia doing?

Australian Government and AusAID

The Australian Government is committed to improving access to safe drinking water, hygiene and sanitation for people across the Asia-Pacific and Africa. An estimated AU$900 million will be spent over four years beginning in 2011–2012. Significant programs already underway in these regions include:

- Timor-Leste – the Australian Government has provided long-term support for water, sanitation and hygiene. Since 2002, approximately 100 000 people have gained access to improved water systems and sanitation through the Australian Government-funded Community Water Supply and Sanitation Program (2002–2006) and the Rural Water Supply and Sanitation Program (2007–2012)

- Australia's support for Vietnam's National Target Program on Rural Water Supply and Sanitation Phase 2 (NTP2: 2006–2010) has contributed to significant results over the program's five-year implementation period. In 2010 alone, 2.5 million people gained access to clean water and 756 000 households gained access to latrines
- in Indonesia the Australian Government has funded The Water Hibah Program – the first output-based grant implemented in Indonesia. This program is providing connections for 76 000 low income households to safe piped water and 7000 household connections to sewers.

Taking personal action

Water saving tips

- checking for leaks in taps, pipes and dishwasher hoses is an easy way to reduce water wastage. Remember, one leaking tap can waste more than 2000 litres per month
- the most water-efficient methods for cooking vegetables are microwaving, steaming or using a pressure cooker
- installing water-efficient taps or tap aerators is a great, inexpensive way to cut water usage without noticing
- prevent taps from leaking by turning taps off lightly and replace washers as soon as they begin to leak
- automatic dishwashers can use up to 40 litres of water per load. By using a dishwasher with at least a three star/AAA rating, this figure can be reduced to 18 litres per load
- it is best to wait until you have a full load in your dishwasher before using it. This saves water and energy, and reduces the amount of detergent entering the wastewater system
- keep a container of water in the fridge so that you will not need to run water down the sink until it is cool enough to drink
- washing fruit and vegies in a half-filled sink instead of under running water is a great way to cut back on water use
- rinsing your dishes in a plugged sink rather than under a running tap saves water
- use phosphate-free, eco-friendly detergents and cleaning products – there is a great range to choose from and they are much better for the environment
- most washing machines have a load adjustment button or dial, so try to set this to match the amount of washing being done. If your machine does not have a load adjustment function, try to wait until you have enough washing for a full load
- installing one of the latest three star/AAA rating showerheads can save around 10 litres of water per minute. They also save energy costs, as less hot water is used
- there is no need to leave the tap running while brushing your teeth.

STUDENT ACTIVITIES

Explain

1. **a**. What happens in the process of desalination?
   b. How many desalination plants are there around the world?
   c. Why are desalination plants important in responding to the global water issue?
   d. Why are desalination plants not an option for many developing countries?
2. The focus of the United Nations World Water Day for 2011 was *Water for Cities*. What has the United Nations predicted that makes it important to address water issues in urban areas?

Elaborate

3. Visit WaterAid's interactive Global Strategy 2009–2015 at **www.wateraid.org/australia/about_us/7934.asp** Read through the document and view the interactive videos. Draw a table (as shown below) to show how WaterAid will achieve each of the four aims as shown in figure 9.5.

WaterAid aims	Objectives	Challenges and opportunities
1		
2		
3		
4		

   Use this completed table to write an evaluation about the effectiveness of this global strategy.

   a. Using the Internet, research the possibility of harvesting icebergs as a water source for areas experiencing water crisis or drought. What could be gained and what problems would have to be overcome?

   b. Do you think harvesting icebergs is a solution for areas experiencing water crisis or drought? Explain your answer.

4. There are many projects completed by the Civil Society WASH Learning Fund. Read about these by visiting **www.learningfund.org.au/case-studies** (you looked at the Pacific Island communities in Chapter 7). Choose one of the other areas that interests you and summarise the message by creating a short 5-frame cartoon. Share this with other students by displaying it on your classroom wall.

Engage

5. Conduct a class debate using the following statement:
   "The desalination plant at Wonthaggi has many benefits for both people and the environment at a local and regional scale."
   Divide the class into two groups. One group will support and statement and the other will argue against it. Thinking about all the different groups of people who would be affected (whether positively or negatively), investigate and research on the Internet to respond to the statement.
6. Conduct a water audit of your school as outlined at the following website – **www.environment.gov.au/education/publications/enviroaudit.html**
   In small groups develop an action plan. Put together a proposal that can be presented to the school council or Principal.

Acknowledgements

The Global Education Project Victoria at the Geography Teachers' Association of Victoria gratefully acknowledge the permission given the following individuals and organisations for the use of their images in the production of this resource.

1.1: Pearson Australia
1.2: U.S. Geological Survey
1.3: U.S. Geological Survey
1.4: UNEP/GRID - Arendal
1.5: AusAID: Dirk Guinan
2.1: Office of the Director of National Intelligence
2.2: Earthscan
2.3: Office of the Director of National Intelligence
2.4: Philippe Rekacewicz (Le Monde Diplomatique), February 2006; UNEP/GRID-Arendal
2.5: AusAID
2.6: Earthscan
2.7: Earthscan
3.1: UNDP
3.2: UNDP
3.3: UNDP
3.4: Photolibrary
3.5: UNDP
3.6: ©Casanova Pendrill
4.1: Earthscan
4.2: Photolibrary
4.3: Murray Darling Basin Authority
4.4: Photolibrary
4.5: Hugo Ahlenius, UNEP/GRID-Arendal
4.6: Simon Kwok
4.7: Water Footprint Organization; **www.waterfootprint.org**
4.8: ©2007 Raureif GmbH, Berlin, Germany; **www.virtualwater.eu**
5.1: Climate Change and Water IPCC Technical Paper VI; Author – WMO & UNEP
5.2: Photolibrary
5.3: Climate Change and Water IPCC Technical Paper VI; Author – WMO & UNEP; Page 30; Figure 2.10
5.4: Jocelyn Carlin/Panos
5.5: Photolibrary
5.6: Getty Images
5.7: ©Kinsengele courtesy School Gallery, Paris
6.1: The World Factbook
6.2: Willis Eschenbach
6.3: Fairfax
6.4: AusAID: Lorrie Graham
6.5: The World Factbook
6.6: AusAID: Dave Vosen
6.7: AusAID: Dave Vosen
6.8: AusAID: Dave Vosen
6.9: The World Factbook
6.10: AusAID
6.11: AusAID
7.1: ©UNICEF and World Health Organization, 2008
7.2: The World Factbook
7.3: UWASNET
7.4: Kate Holt/Africa Practice
7.5: Kate Holt/Africa Practice
8.1: Newspix
8.2: gregnoakes.com
8.3: UN-Water - World Water Day 2011 Campaign
8.5: WaterAid
8.6: News Limited
8.7: Kate Holt/Africa Practice
8.8: Sydney Water

While every care has been taken to trace and acknowledge copyright, the publishers tender their apologies for any accidental infringement where copyright has proved untraceable. They would be pleased to come to a suitable arrangement with the rightful owner in each case.

WATER FOR LIFE

Investigating water as a global issue

GLOBAL EDUCATION PROJECT
Professional Learning Initiative

Australian Government
AusAID

GEOGRAPHY TEACHERS' ASSOCIATION OF VICTORIA INC.

ISBN 978-1876703233