Water in the World

Stage 4 Geography - Revision Deck

What we are revising

We are revising how water resources are distributed, valued and managed, and how a real flood event affects a community.

Success criteria - I can:

- **I can explain the water cycle and what affects water availability.**
- **I can explain the causes, impacts and management of water scarcity.**
- **I can explain the economic, cultural, spiritual, aesthetic and social value of water.**
- **I can use the 2022 Lismore floods as a real case study of a water hazard.**

1. Water Resources and the Water Cycle

How water moves, and what affects how much of it we have

What counts as a water resource?

- **A natural resource is something that occurs naturally in the environment and is useful to humans, like water, soil, minerals or fossil fuels.**

- **Resources are either non-renewable (take millions of years to replace, e.g. fossil fuels) or renewable (replace themselves in a short period, e.g. water).**

- **Water is renewable, but the total amount of water on Earth is finite. It is constantly recycled between gas, liquid and solid states.**

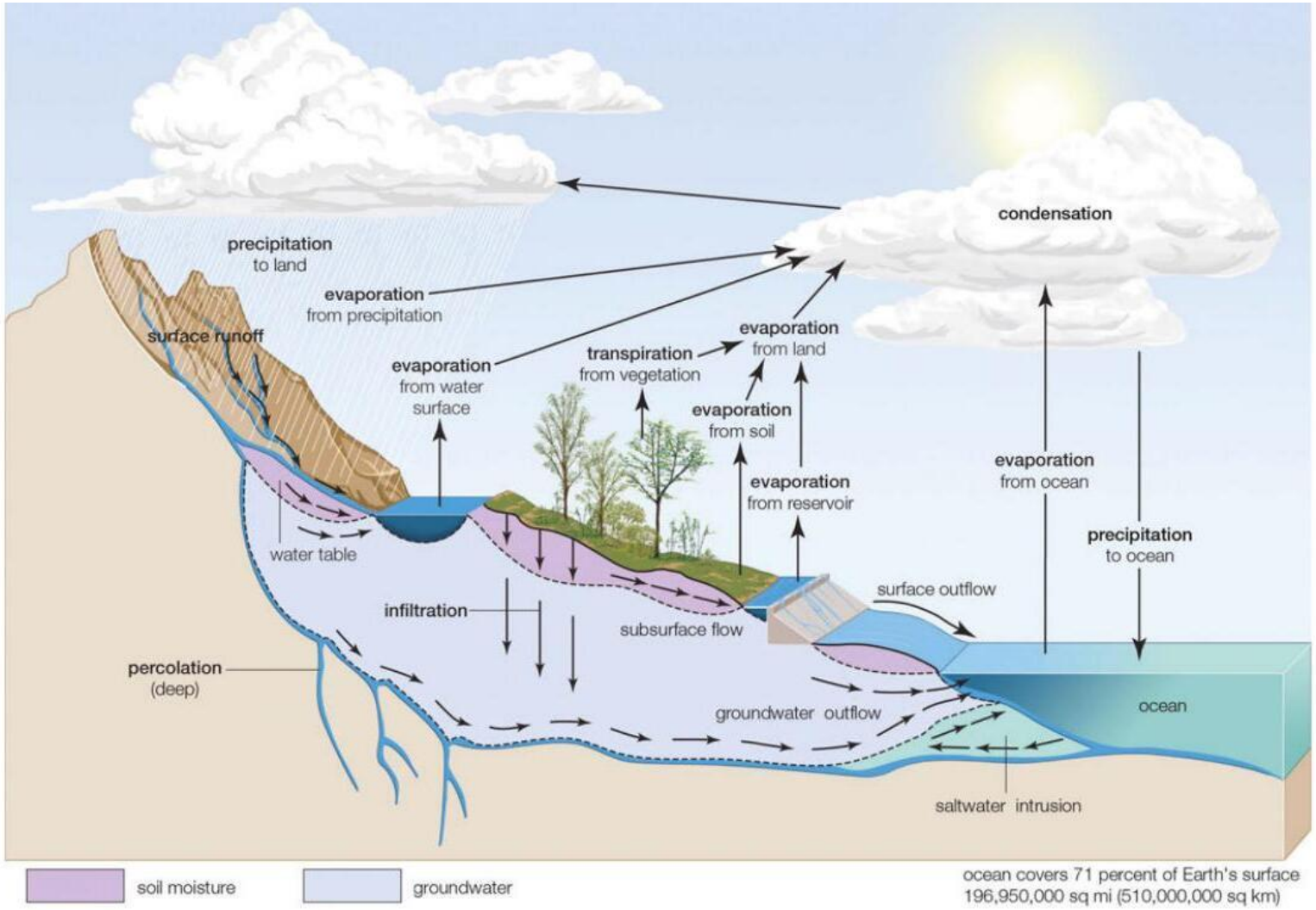
Key idea: the same water molecules have been falling as rain for millions of years. Nothing is created or destroyed, only moved and changed in state.

The hydrological (water) cycle

- **Evaporation - the Sun heats water on the surface, turning it into water vapour.**
- **Condensation - water vapour cools as it rises and forms clouds and fog.**
- **Precipitation - water droplets become heavy and fall as rain, hail, sleet or snow.**
- **Transpiration - plants release water vapour taken up through their roots.**
- **Run-off and infiltration - water flows over the surface, or soaks into the ground.**
- **Groundwater flow - infiltrated water accumulates and moves underground.**

Remember: the whole cycle is powered by the Sun, and every stage connects back to the next.

The hydrological (water) cycle



Source 12.2 The water cycle

Source 12.2 The water cycle. Cambridge Geography NSW Stage 4 7 & 8 (Thompson et al., 2016).

Catchments and drainage basins

- *Case study: the Murrumbidgee catchment (Blowering, Burrinjuck and Talbingo Dams)*

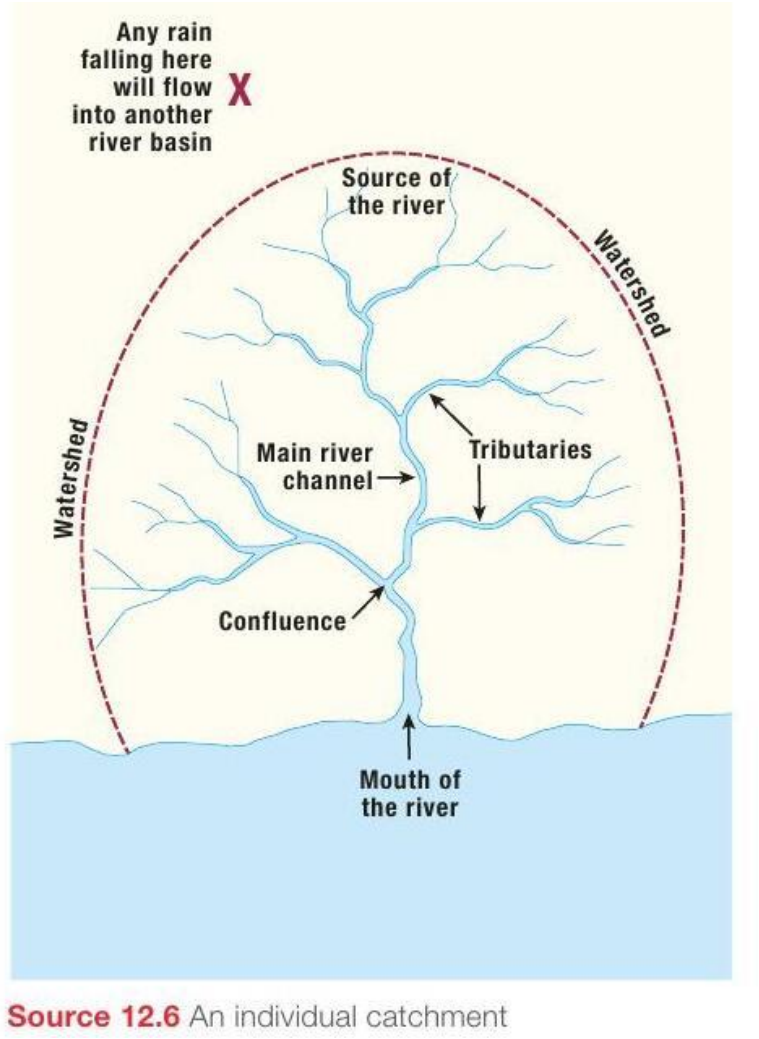
- **A catchment (or drainage basin, or watershed) is an area of land surrounded by hills or mountains where water collects and drains to one point.**

- **Headwaters are the steep, fast-flowing channels at the highest, most elevated part of a catchment.**

- **In the mid reaches, the river slows and deposits sediment, forming meanders, oxbows and levees on the floodplain.**

- **In the lower catchment, the river meets the sea and deposits sediment to form a delta.**

Catchments and drainage basins



Source 12.6 An individual catchment

Source 12.6 An individual catchment. Cambridge Geography NSW Stage 4 7 & 8 (Thompson et al., 2016).

Weather and climate are not the same thing

- **Weather is the day-to-day, short-term change in the atmosphere at a particular location.**

- **Climate is the average weather pattern in a place over a long period of time.**

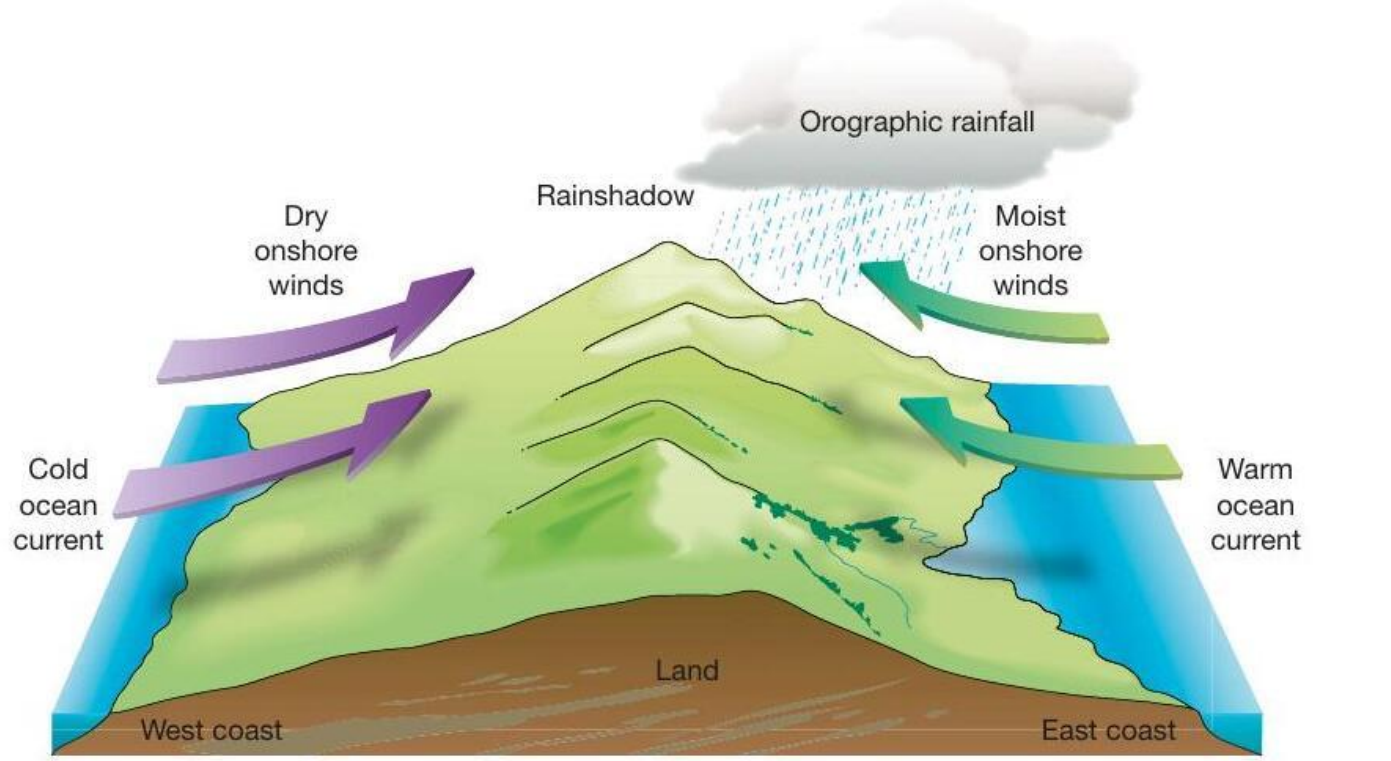
- **A synoptic chart (weather map) shows rainfall, wind and air pressure for a single point in time.**

- **Understanding the difference matters for water: a place's climate decides its long-term water availability, while weather decides whether a flood or a drought is happening right now.**

What affects how much water a place gets?

- **Latitude and altitude - the Sun's rays hit the poles at a more oblique angle, so less evaporation and rainfall happens there than near the equator; rainfall generally increases with altitude.**
- **Ocean currents - warm currents increase evaporation and rainfall; cold currents reduce it.**
- **Distance from the sea - places closer to the coast usually receive more rainfall.**
- **Geology - permeable rock like sandstone absorbs water; impermeable rock like granite causes more run-off.**
- **Topography - the windward side of a mountain gets the rain; the leeward side misses out. This is the rain-shadow effect.**

What affects how much water a place gets?



Source 12.11 Simplified cross-section from east to west across the continent, showing orographic rainfall on the eastern side of the Great Dividing Range

Source 12.11 Simplified cross-section from east to west across the continent, showing orographic rainfall on the eastern side of the Great Dividing Range. Cambridge Geography NSW Stage 4 7 & 8 (Thompson et al., 2016).

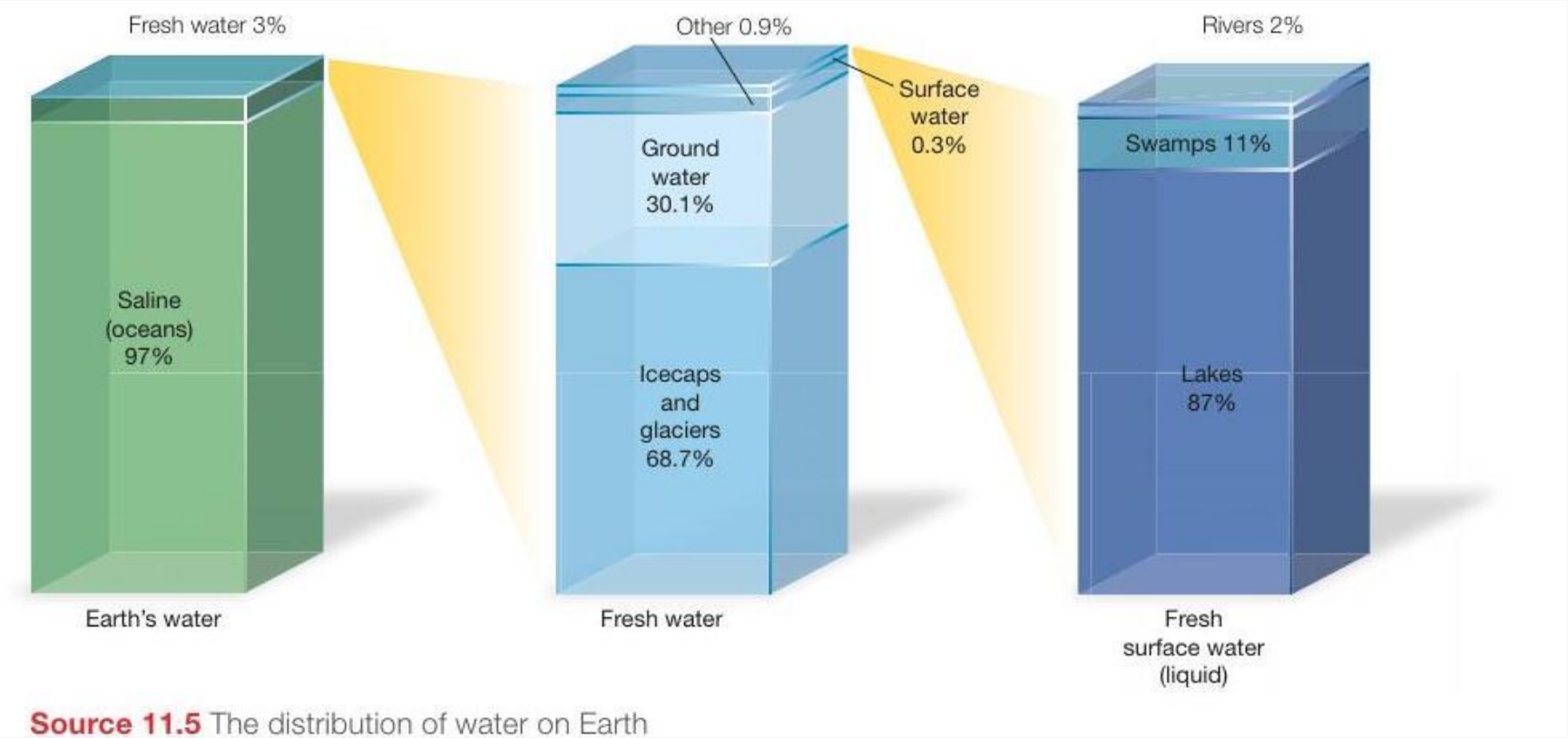
How much of Earth's water can we actually use?

< 1%

of all the water on Earth is useable fresh water

- **Water covers about 71% of Earth's surface, but 97.5% of it is salty ocean water.**
- **Of the 2.5% that is fresh water: about 69.5% is locked up in glaciers, snow, ice and permafrost.**
- **About 30.1% is groundwater, and only around 0.4% is in lakes, rivers, soil, wetlands and the atmosphere combined.**

How much of Earth's water can we actually use?



Source 11.5 The distribution of water on Earth. Cambridge Geography NSW Stage 4 7 & 8 (Thompson et al., 2016).

Blue water and green water

- **Blue water is the water you can see, in rivers, lakes and dams.**

- **Green water is water stored in soil and vegetation, which evaporates or transpires through plants.**

- **Globally, green water makes up around 60% of all the fresh water used in agriculture, and blue water the remaining 40%.**

Why it matters: most water-use statistics only count blue water, so they can understate how much water farming actually relies on.

Australia: the driest inhabited continent

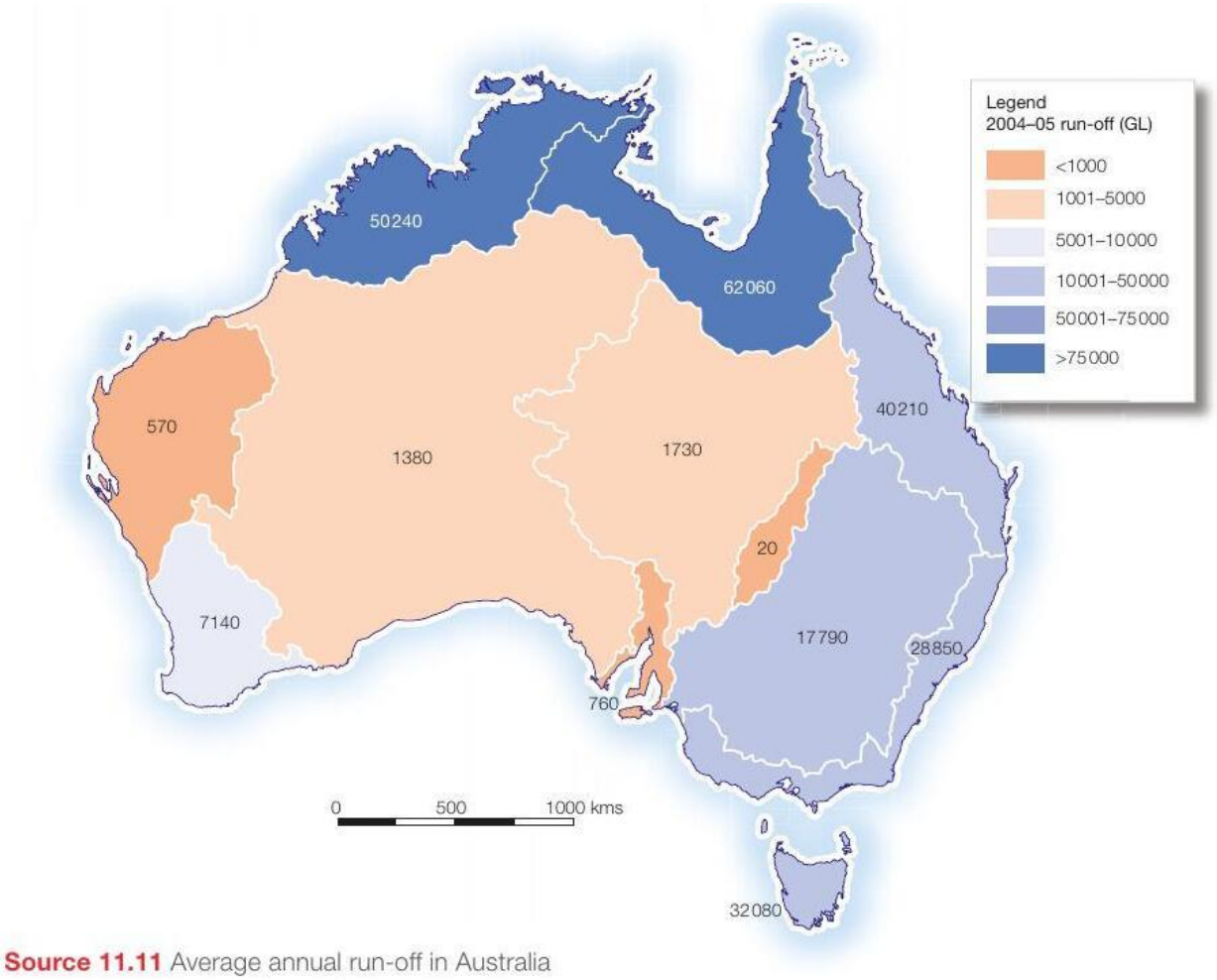
- About 70% of mainland Australia is classified as semi-arid, arid or desert.

- Australia is the second driest continent on Earth, and the driest one that is permanently inhabited.

- Settlement patterns follow water closely: most of the population lives near the coast, where rainfall and river systems are more reliable.

- Regional and inland towns rely heavily on groundwater, especially from the Great Artesian Basin, accessed through bores.

Australia: the driest inhabited continent



Source 11.11 Average annual run-off in Australia

TOPIC 3: WATER IN THE WORLD

Source 11.11 Average annual run-off in Australia. Cambridge Geography NSW Stage 4 7 & 8 (Thompson et al., 2016).

Case study: Sydney's water supply

- **Sydney's main water source is Lake Burragorang, created by Warragamba Dam on the Warragamba River.**

- **Warragamba Dam supplies around 80% of Sydney's drinking water.**

- **This makes Sydney's entire water security dependent on one large catchment and dam system, which is one reason water restrictions matter so much during drought.**

The Great Artesian Basin

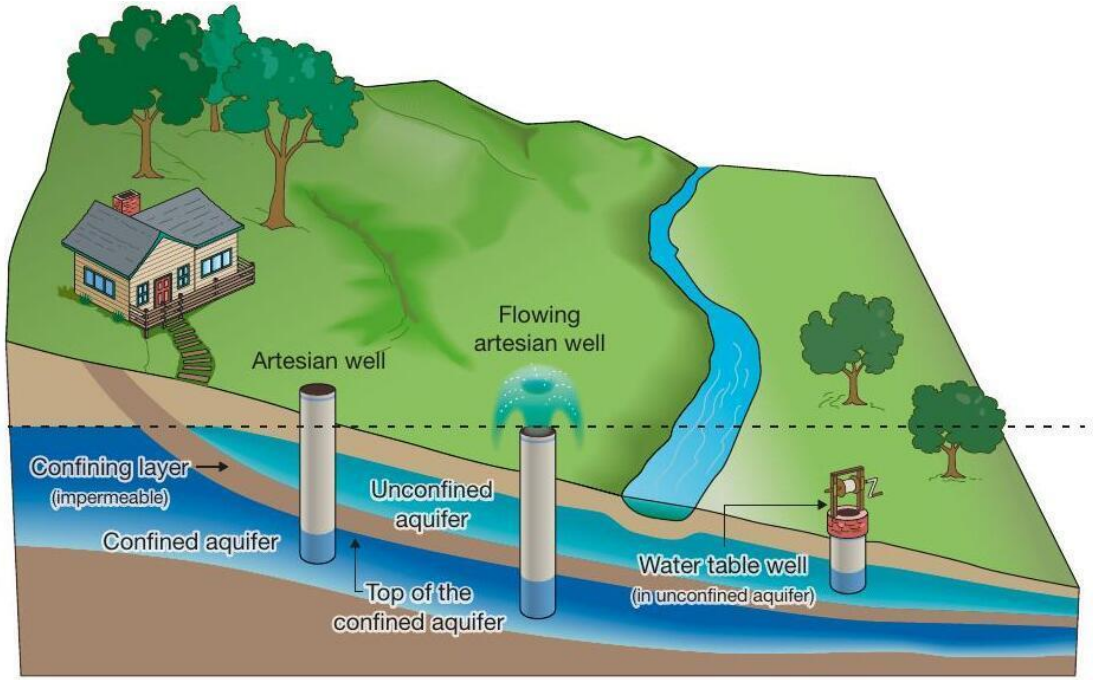
- **The Great Artesian Basin is one of the largest groundwater basins in the world, underlying much of inland Australia.**

- **It shares groundwater between Queensland, New South Wales, South Australia and the Northern Territory.**

- **An artesian aquifer is trapped between impermeable rocks, so pressure builds up; when a bore is drilled into it, water gushes to the surface on its own.**

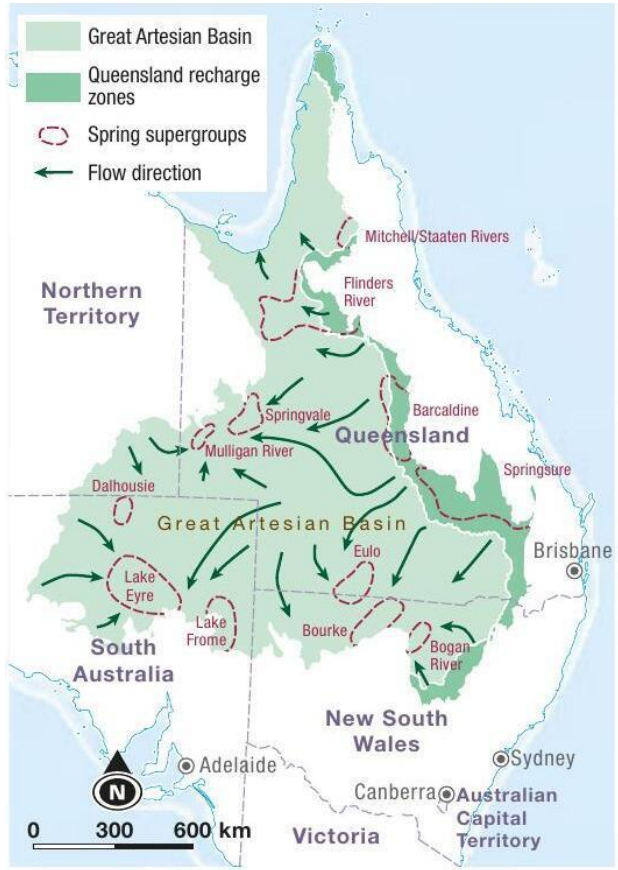
- **Regional towns rely on bores into the Basin, but over-extraction risks reducing pressure and depleting the resource long-term.**

The Great Artesian Basin



Source 12.5 Diagram showing how an aquifer works. Tapping into underground water systems, where water is confined between rock layers, is important in many regions worldwide.

Source 12.5 How an aquifer works. Cambridge Geography NSW Stage 4 7 & 8 (Thompson et al., 2016).



Source 13.2 The Great Artesian Basin. The arrows show the direction of water flow through the groundwater system, with water at some points entering important rivers and lakes, some of these located in the Murray–Darling Basin. The dark green regions represent areas where water enters and recharges the groundwater basin.

Source 13.2 The Great Artesian Basin: flow direction and recharge zones. Cambridge Geography NSW Stage 4 7 & 8 (Thompson et al., 2016).

Climate change and water availability

- **In NSW, climate change is expected to mean less water overall, because rising temperatures increase evaporation.**

- **At the same time, when it does rain, it is predicted to rain harder and faster, increasing run-off and flood risk.**

- **Globally, rainfall has increased significantly in North America, South America, northern Europe and northern/central Asia over the past 100 years.**

- **Rainfall has decreased in the Sahel, the Mediterranean, southern Africa and parts of Asia, increasing the risk of water and food insecurity in those regions.**

Check-in: water resources and the cycle

1. Which stage of the water cycle involves water vapour cooling to form clouds?

A. Evaporation
B. Condensation
C. Infiltration
D. Transpiration

2. What percentage of Earth's water is fresh water?

A. 25%
B. 10%
C. 2.5%
D. 50%

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2. Water Scarcity and Management

Why water runs short, who it affects, and what can be done

What is water scarcity?

- **Water scarcity means there is not enough safe fresh water to go around for a population.**

- **Physical water scarcity is when water is simply not abundant enough to meet demand.**

- **Economic water scarcity is when water exists, but there has not been enough investment in the infrastructure needed to access it.**

- **A region is considered water-stressed when annual water availability falls below 1700 cubic metres per person per year.**

What is water scarcity?

Source 14.3 Economic water scarcity: people filling drinking water from a tanker, Chennai, Tamil Nadu, India



Source 14.3 Economic water scarcity: people filling drinking water from a tanker, Chennai, Tamil Nadu, India. Cambridge Geography NSW Stage 4 7 & 8 (Thompson et al., 2016).

Water scarcity is a global problem

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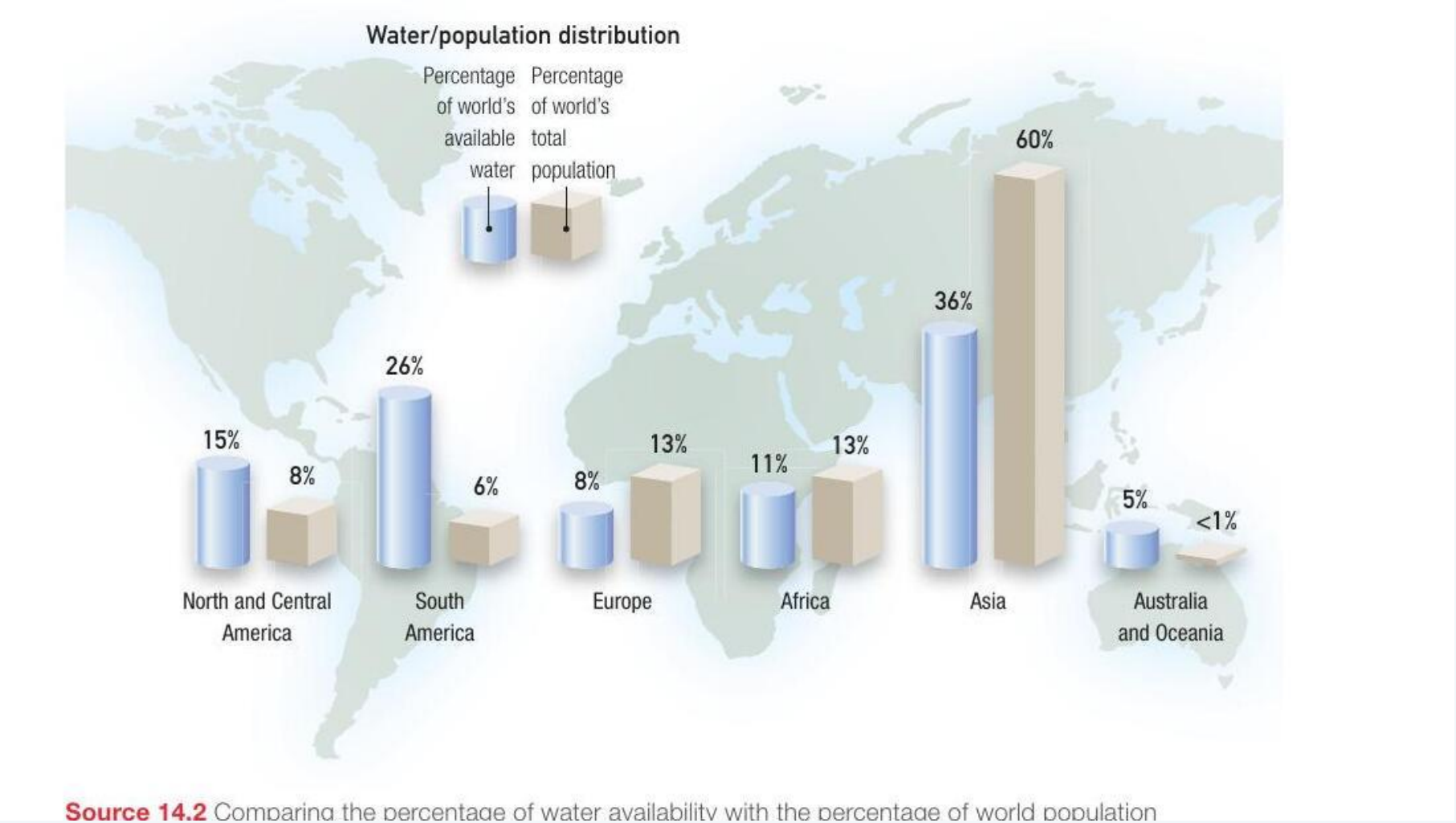
people still lack access to safely managed drinking water (WHO/UNICEF, August 2025)

- **Of those, 106 million people drink directly from untreated surface water sources.**

- **Globally, around 3 to 4 billion people experience severe water scarcity for at least one month each year.**

- **Agriculture uses around 70% of the world's accessible fresh water, and water use overall is increasing at more than twice the rate of population growth.**

Water scarcity is a global problem



Source 14.2 Comparing the percentage of water availability with the percentage of world population

Source 14.2 Comparing the percentage of water availability with the percentage of world population. Cambridge Geography NSW Stage 4 7 & 8 (Thompson et al., 2016).

What causes water scarcity?

- **Population growth increases demand faster than supply can keep up.**
- **Agriculture is the biggest user of fresh water worldwide, consuming around 70% of accessible supplies.**
- **Energy production uses huge volumes of water too: the global energy system uses around 370 billion cubic metres of fresh water a year.**
- **Climate change is shifting rainfall patterns, making some regions drier and reducing reliable supply.**
- **Ownership and water rights matter too: selling long-term water rights to investors, as has happened in countries like Mali and Sudan, can cut off access for local farmers and downstream users.**

Social impacts of water scarcity

- **Poor sanitation and hygiene from a lack of clean water spreads water-borne diseases and contributes to malnutrition.**

- **Collecting water is unevenly shared: women and girls in parts of Africa and Asia spend between 3 and 6 hours a day walking to collect it.**

- **The World Health Organization estimates more than 40 billion work hours are lost each year in Africa alone, just collecting drinking water.**

- **Water scarcity can force people to migrate from rural areas to towns and cities in search of a reliable supply.**

Environmental and economic impacts of water scarcity

- **Environmental: drying rivers, lakes and wetlands, loss of aquatic biodiversity, soil degradation and desertification, and more severe wildfires.**

- **Economic: water prices rise as supply becomes harder to find; property values can fall in unreliable areas.**

- **Farmers can lose crops and livestock to drought, pushing up food prices for everyone else.**

- **Governments end up spending more money finding and managing water supplies, and competition for water can lead to conflict between communities or even countries.**

Two very different responses to scarcity

Cape Town, South Africa - crisis response

- **Drought, water wastage and population growth combined to bring the city close to 'Day Zero' in 2017-18.**
- **The city introduced Stage 7 water restrictions as the crisis deepened.**
- **This was a reactive response: restrictions were tightened once the crisis was already underway.**

Singapore - planned strategy

- **Singapore's 'Four National Taps' strategy: imported water, recycled NEWater, local catchment collection, and desalination.**
- **This spreads risk across four different sources rather than relying on just one.**
- **This is a proactive response: the strategy was built in advance of a crisis, not in reaction to one.**

Water contamination and disease

- **Contamination comes from sewage and industrial waste, agricultural run-off, illegal dumping, and poor sanitation infrastructure.**

- **Around 2 billion people drink water contaminated by human or animal faeces.**

- **Named diseases spread this way include cholera, dysentery and typhoid.**

- **These diseases spread fastest where sanitation infrastructure is weakest, which is why water contamination and water scarcity are closely linked problems.**

Shared rivers can cause conflict

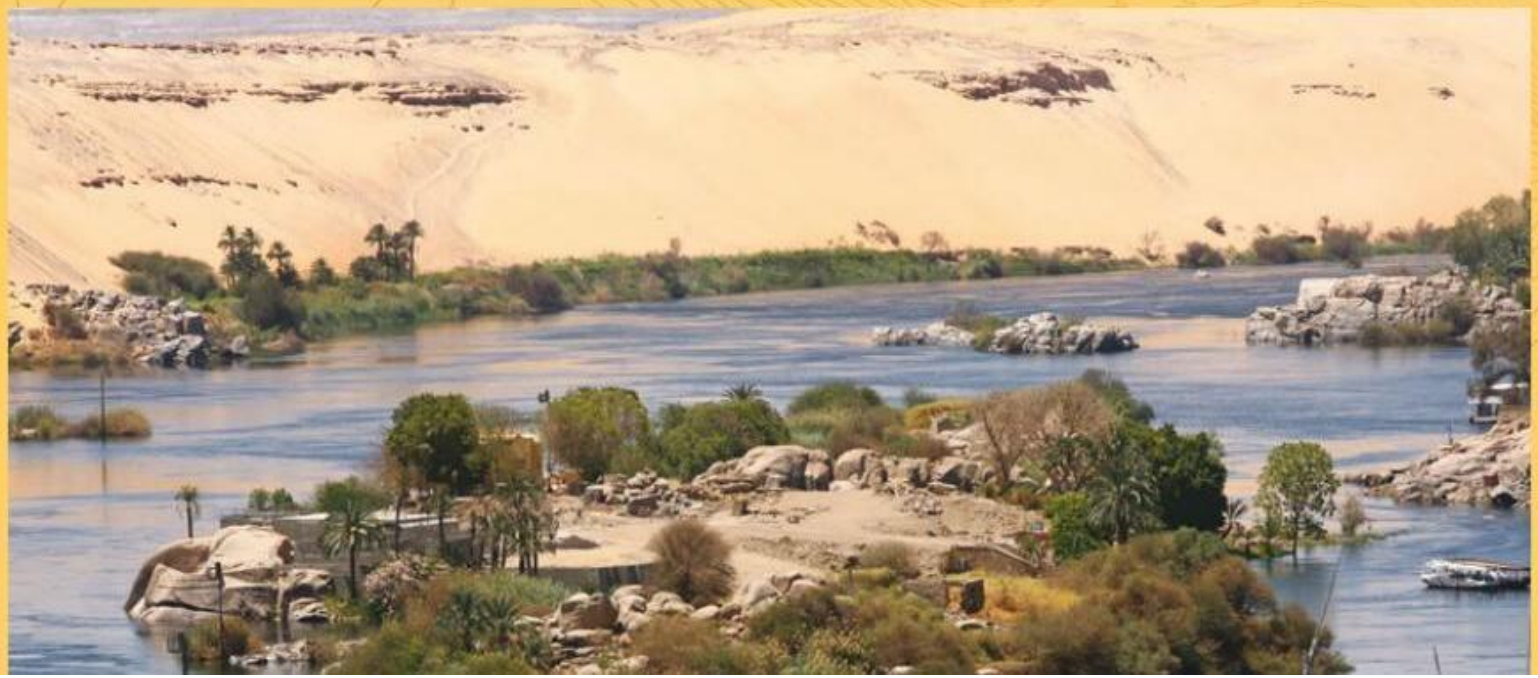
- **About 260 drainage basins across the world are shared by two or more countries, and 13 river basins are shared by five or more.**
- **The Jordan River flows through Syria, Jordan, Israel, Lebanon and the Palestinian territories, where political conflict, poor infrastructure and population growth have made water politics ('hydro-politics') extremely difficult.**
- **Australia has its own version of this problem: the Murray-Darling Basin spans four states and the ACT, and water taken out anywhere along its length affects everyone downstream.**

Key idea: water scarcity is not only a physical problem. Who owns and controls water, and how fairly it is shared, shapes who actually gets access to it.

Shared rivers can cause conflict

flows into the Nile, receives no water from the river.

Source 14.8 The Nile River is shared by 11 countries and through history has been the source of political disputes and conflict.



Source 14.8 The Nile River is shared by 11 countries and through history has been the source of political disputes and conflict. Cambridge Geography NSW Stage 4 7 & 8 (Thompson et al., 2016).

Case study: managing the Murray-Darling Basin

- **The Murray-Darling Basin is Australia's largest catchment, covering 14% of the country's landmass across four states and the ACT.**

- **In 2008, the Commonwealth Government took control of the Basin, after the previous system of separate state management caused ongoing conflict.**

- **The Murray-Darling Basin Authority now runs programs including a Native Fish Recovery Program, a Basin Condition Monitoring Program, and the 2026 Basin Plan Review.**

- **In 2018-19, very low rainfall and inequitable water use caused major fish kills in the Menindee Lakes, NSW, showing how badly shared management can go wrong.**

Case study: managing the Murray-Darling Basin



Source 12.7 The Murray–Darling Basin is Australia's largest catchment.

Source 12.7 The Murray-Darling Basin is Australia's largest catchment. Cambridge Geography NSW Stage 4 7 & 8 (Thompson et al., 2016).



Source 13.12 Diverting water from rivers in the Murray–Darling Basin for irrigated agriculture is crucial for Australia's food supply and economy. However, water use will need to become more efficient as the need for water resources, and therefore competition, grows.

Source 13.12 Diverting water from the Murray-Darling Basin for irrigated agriculture. Cambridge Geography NSW Stage 4 7 & 8 (Thompson et al., 2016).

Responses to water scarcity

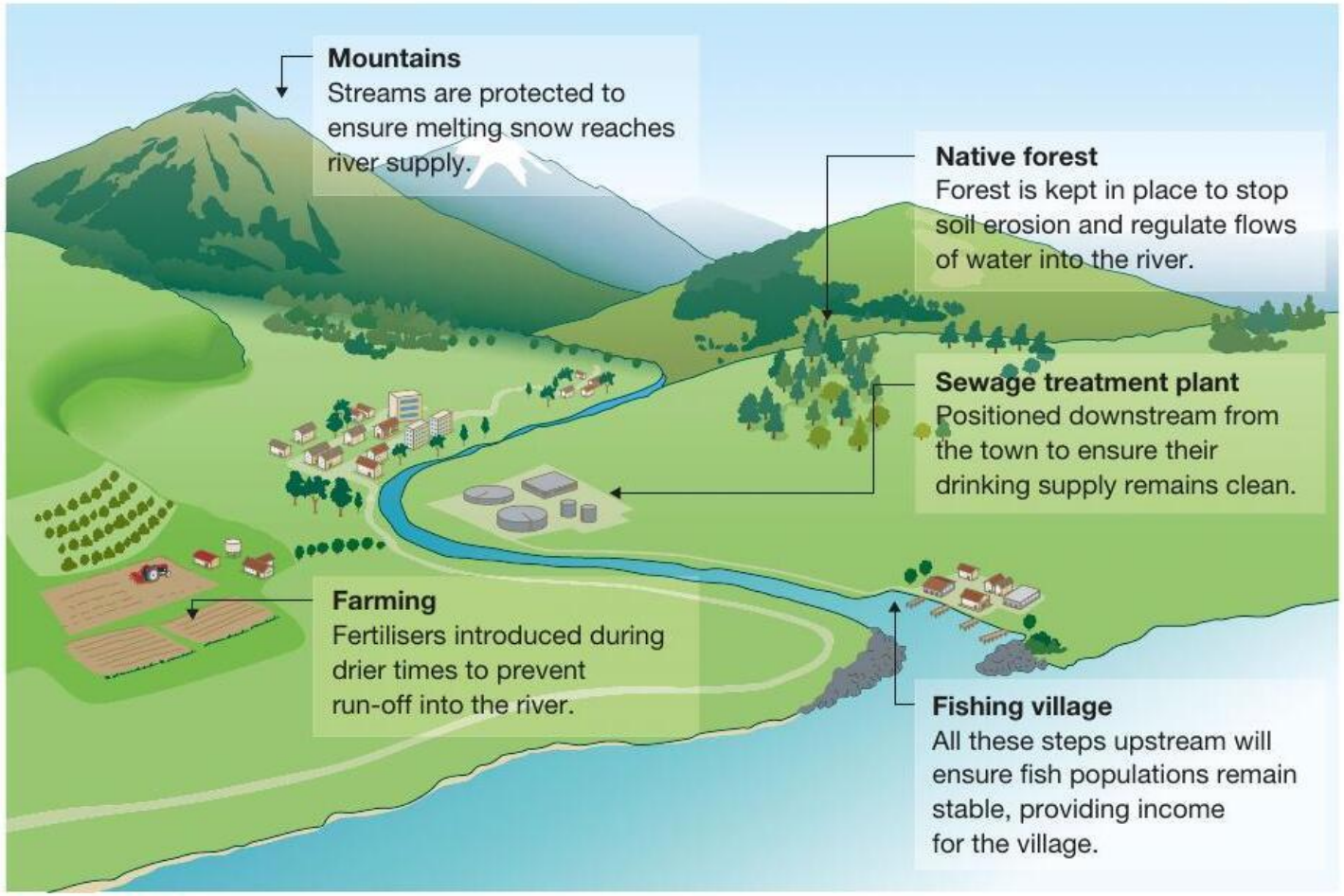
- **The United Nations' Sustainable Development Goal 6 aims to 'ensure availability and sustainable management of water and sanitation for all'.**

- **2018 to 2028 has been declared the International Decade for Action - Water for Sustainable Development.**

- **Governments fund infrastructure like desalination plants (for example in Dubai and Kurnell, Sydney) and recycling programs.**

- **Non-government organisations play a role too: The Water Project funds wells and water infrastructure in sub-Saharan Africa, and the WWF funds water conservation science and sustainable use projects.**

Responses to water scarcity



Source 14.14 Integrated catchment management

Source 14.14 Integrated catchment management. Cambridge Geography NSW Stage 4 7 & 8 (Thompson et al., 2016).

How Aboriginal Peoples manage water sustainably

- **Aboriginal Peoples have managed water sustainably for over 65,000 years.**

- **Methods include channelling and filtering water, covering water sources to reduce evaporation and keep them clean, and building wells and tunnel reservoirs.**

- **Dreaming stories encode real, practical knowledge: the location of permanent water sources, seasonal water availability, and safe travel routes, alongside their cultural and spiritual meaning.**

- **This knowledge is carried through songlines, which connect Freshwater Peoples and Saltwater Peoples across huge distances.**

Case study: Budj Bim and the Brewarrina Fish Traps

- **Budj Bim (Lake Condah, or Tae Rak), Victoria, was returned to the Gunditjmara traditional custodians on 30 March 2008, and listed on the UNESCO World Heritage List in July 2019.**

- **It is considered one of Australia's earliest and largest aquaculture ventures, using an ancient stone channel and holding-pond system for eel farming.**

- **The Brewarrina Fish Traps on the Barwon River, western NSW, were built and are still cared for by the Ngemba Peoples.**

- **Both sites are sophisticated aquaculture systems that sustainably managed a fish food supply, and both still carry deep cultural and spiritual importance today.**

Ways to save water at home and in the garden

Take shorter showers, and turn taps off firmly.

Install a dual-flush toilet, and water-efficient shower heads.

Choose AAA or AAAA-rated appliances when replacing old ones.

Plant local native species that only need rainfall.

Mulch garden beds - this alone can cut evaporation by up to 70%.

Use trickle irrigation rather than sprinklers, and keep a pool cover on when it's not in use.

Check-in: water scarcity and management

1. What is the water stress threshold, in cubic metres per person per year?

A. 1000
B. 1700
C. 500
D. 3000

2. Singapore's water strategy is known as the:

A. Day Zero plan
B. Four National Taps
C. Water Action Decade
D. Basin Plan

Check-in: water scarcity and management - answers

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D. Basin Plan

3. The Value of Water

Water is never just useful. It is valued in different ways by different people

Water has more than one kind of value

- **Economic value - water used for agriculture, industry, power generation and income creation.**
- **Social value - water enabling a healthy lifestyle through recreation and social activities.**
- **Cultural and aesthetic value - traditional practices, admiring the beauty of water, and water inspiring art.**
- **Spiritual value - religious beliefs, ceremonies, and water as a sacred or living entity.**
- **The value of water is subjective. It depends on someone's standard of living, income, culture, location and how they use it.**

Case study: the Murray-Darling Basin

Economic value

The Basin produces around a third of Australia's food supply, with agriculture, especially irrigation, the biggest single user of its water.

Cultural/spiritual value

Aboriginal and Torres Strait Islander Peoples' connection to the Basin's rivers and wetlands goes back tens of thousands of years, and water management today increasingly includes Aboriginal water rights and cultural flows.

Scarcity pressures

Over-allocation between states, drought and climate change have all strained the system, making it a real example of competing water users having to be managed together.

Case study structure based on the Murray-Darling Basin Authority's own school resources, as on revision/water.html

Economic value of water: aquaculture in Australia

- **Aquaculture (or aqua farming) involves breeding and harvesting plants and fish in water environments, using ponds, cages or long lines.**

- **It addresses falling wild fish stocks from overfishing and pollution, and is an important source of income and food security.**

- **Case study: Sea Forest, a Tasmanian company, farms a seaweed called asparagopsis at commercial scale, producing around 7000 tonnes a year.**

- **In 2021, Sea Forest raised $34 million in investment and was a finalist in the 2023 Earthshot Prize 'Fix Our Climate' category, processing seaweed into a cattle-feed supplement that cuts methane emissions.**

Aesthetic and social value of water

- **High aesthetic value water is clear, blue or slightly green, with little odour and no floating debris. Low aesthetic value water is murky, smelly and polluted.**

- **Properties near rivers, lakes or the ocean cost more than those further away, partly because of this aesthetic value.**

- **The Great Barrier Reef generates approximately $6.4 billion a year for the Australian economy through tourism, much of it tied to the beauty of its water.**

- **Water also has huge social value: swimming, kayaking, sailing and other water sports support healthy lifestyles and social connection.**

Aesthetic and social value of water

Source 15.13 A tourist industry has emerged around the beauty of a tropical paradise featuring bungalows and snorkelling.



Source 15.13 A tourist industry has emerged around the beauty of a tropical paradise featuring bungalows and snorkeling. Cambridge Geography NSW Stage 4 7 & 8 (Thompson et al., 2016).

Case study: the value of water at Noosa

- Noosa is about 140 kilometres north of Brisbane, Queensland, at the mouth of the Noosa River.

- Economic value: hotels with water views charge higher prices than those without.

- Aesthetic and social value: the river and beaches help visitors relax, and support activities like cruises, canoeing and kite-surfing that are part of the local culture.

- This shows how the same stretch of water can carry economic, aesthetic and social value all at once, for different people and different reasons.

Water's value for Aboriginal Peoples

- **Water has deep and ongoing cultural value, linked directly to Dreaming stories and Creation stories that explain how the landscape came to be.**
- **Aboriginal identity includes Freshwater Peoples and Saltwater Peoples, whose ceremonies, practices and totem systems vary depending on their geographic connection to water.**
- **This knowledge is carried through songlines, which interconnect Freshwater and Saltwater Peoples and has allowed Aboriginal Peoples to sustain societies in one of the driest countries on Earth.**
- **Some waterholes and rivers are sacred sites requiring a permit or specific cultural protocols before visiting; always check with the local council or community first.**

Remember: this is contemporary knowledge, still practised today, not only historical fact.

Water's value for Aboriginal Peoples

Source 15.16 Water was and still is an essential part of the Aboriginal and Torres Strait Islander peoples' way of life.



Source 15.16 Water was and still is an essential part of the Aboriginal and Torres Strait Islander peoples' way of life. Cambridge Geography NSW Stage 4 7 & 8 (Thompson et al., 2016).

Dreaming stories about water

- **Thutirla Pula (Two Boys Dreaming), a Wangkangurru story, follows two boys crossing the Simpson Desert. The songline records every waterhole in the desert, meaning it could be followed to cross it safely using groundwater.**

- **Bidalinha (the Bubbler), on the Oodnadatta Track, is a Kuyani story about the ancestor Kakakutanha and the rainbow serpent Kanmari, explaining the location of a real bubbling mound spring.**

- **The Brewarrina Fish Traps, built and maintained by the Ngemba Peoples on the Barwon River, remain in use and carry ongoing cultural and spiritual importance.**

- **These stories are not just folklore. They record real, locational knowledge about where water can be found.**

Dreaming stories about water



Source 15.17 Rock art in Namadgi National Park, Australian Capital Territory

Source 15.17 Rock art in Namadgi National Park, Australian Capital Territory. Cambridge Geography NSW Stage 4 7 & 8 (Thompson et al., 2016).

Virtual (embedded) water

- **Virtual water is the water used to produce something, even though the final product contains little or no water itself.**

- **Food carries a large water footprint: water-intensive foods like beef and dairy require far more water to produce than vegetables and grains.**

- **Clothing carries a water footprint too. Fast fashion, which produces large volumes of cheap clothing quickly, has a significant water impact.**

- **This is a hidden form of water use: it does not show up in a household's water bill, but it is just as real.**

Check-in: the value of water

1. Which Aboriginal identity groups are linked to water by songlines?

A. Northern and Southern Peoples
B. Freshwater Peoples and Saltwater Peoples
C. Coastal and Inland Peoples
D. Desert and Tropical Peoples

2. The Brewarrina Fish Traps are cared for by the:

A. Gunditjmara Peoples
B. Kuyani Peoples
C. Ngemba Peoples
D. Wangkangurru Peoples

Check-in: the value of water - answers

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4. Investigating a Natural Hazard

Case study: the February 2022 Lismore floods

What is a flood?

- **A flood is an excessive accumulation of water that overflows from rivers, lakes or the ocean onto land not normally covered by water.**

- **Flash flooding is a rapid rise in water level over a very short period, usually caused by heavy rainfall during storms.**

- **Riverine flooding is slower: rivers burst their banks and can isolate communities for weeks.**

- **A floodplain is flat land next to a river that floods, built up over time by alluvium, a nutrient-rich sediment the river deposits as it slows and meanders.**

What is a flood?

Source 16.5 The suburb of Milton was severely affected by the great Brisbane Flood of 2011.



Source 16.5 The suburb of Milton was severely affected by the great Brisbane Flood of 2011. Cambridge Geography NSW Stage 4 7 & 8 (Thompson et al., 2016).

Different event: this photo is from the 2011 Brisbane flood, included here only to show what a flood looks like. It is not part of the 2022 Lismore case study.

Why does Australia flood?

- A La Nina climate event is often linked to flooding in Australia. Cold waters dominate the eastern Pacific, and the oceans off Australia become warmer than normal.

- This brings more moisture, above-average rainfall, and an increased risk of torrential rain and tropical cyclones.

- Catchment factors make flooding worse or better: land clearing reduces the catchment's ability to absorb water, heavy vegetation slows water reaching rivers, and dams can control how much water is released downstream.

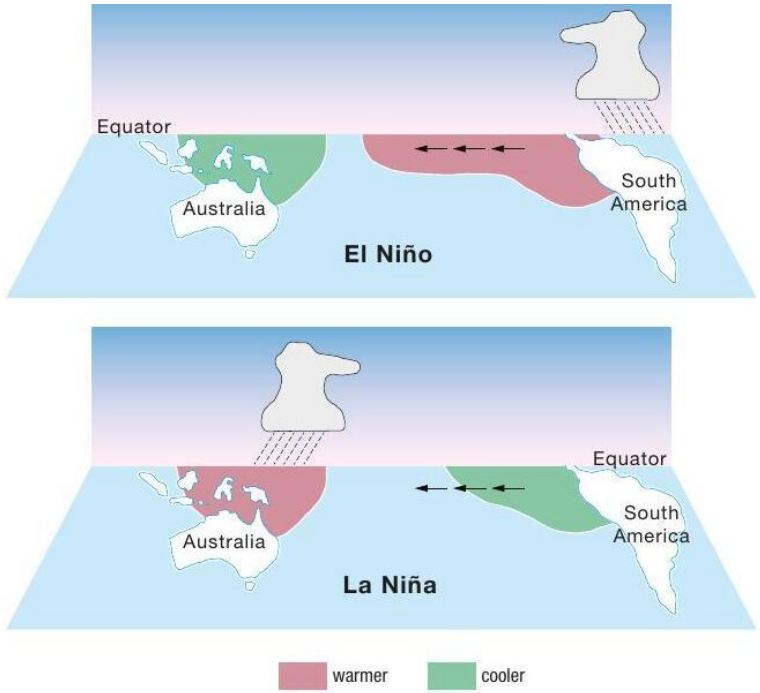
- Urban areas make flooding worse locally, because hard surfaces like roads stop water soaking in, sending it straight into drains and creeks.

Why does Australia flood?



Source 16.4 The cargo ship *Pasha Bulker* is stranded at Nobby's Beach, NSW by a storm in June 2007

Source 16.4 The cargo ship Pasha Bulker is stranded at Nobby's Beach, NSW by a storm in June 2007. Cambridge Geography NSW Stage 4 7 & 8 (Thompson et al., 2016).



Source 16.6 The difference between the El Niño and La Niña weather patterns. El Niño brings drought conditions to Australia and La Niña brings above-average rainfall and increased cyclone events.

Source 16.6 The difference between the El Nino and La Nina weather patterns. Cambridge Geography NSW Stage 4 7 & 8 (Thompson et al., 2016).

Case study: the 2022 Lismore floods

- Lismore sits on the Wilsons River in the Northern Rivers region of north-east NSW, a river catchment with a history of flooding.

- In late February 2022, a slow-moving, intense low-pressure system combined with La Nina conditions to bring record rainfall to the region.

- More than 50 locations across south-east Queensland and north-east New South Wales recorded over 1 metre of rain in the week leading up to 1 March 2022.

- This set up the most extreme flood Lismore has ever recorded.

The flood that broke the record

14.4m

Wilsons River peak height at Lismore, 28 February 2022

- **This was more than 2 metres above the 1-in-100-year design flood level for the town.**

- **It smashed the previous record of 12.11m, which had stood jointly since the floods of February 1954 and March 1974.**

- **A second, smaller flood peak of 11.4m followed in late March 2022.**

Response: the NSW SES

- The NSW State Emergency Service (SES) led the emergency response, coordinating flood warnings, evacuations and rescues.

- On 28 February alone, the SES responded to 1,900 requests for assistance in Lismore, including 862 flood rescue activations.

- Evacuation centres were set up across the region to house displaced residents, many of whom lost their homes entirely.

- The scale of the flood meant some rescues had to happen from rooftops, as the water rose faster than warnings could reach everyone.

Recovery: rebuilding the Northern Rivers

- The Northern Rivers Reconstruction Corporation (NRRC) was established in July 2022 to coordinate long-term recovery and planning.

- In October 2022, the NSW Government announced an $800 million voluntary buyback scheme, funded for around 2,000 properties in the highest-risk flood zones.

- Other strategies being pursued include planned retreat from the most flood-prone areas, and voluntary house-raising for homes that remain.

- Recovery has been slow: rebuilding and relocating a town of this size takes years, not months.

Climate change and future flood risk

- **Climate change is expected to make extreme rainfall events more intense, even in a drier overall climate.**

- **This means floods like Lismore's 2022 event may become more frequent, not less, even as average rainfall elsewhere declines.**

- **For towns like Lismore, built in a flood-prone catchment, this raises hard questions about whether to keep rebuilding in place or to plan a longer-term retreat.**

Managing flood risk: two different approaches

Structural strategies

- Levees, weirs and dams built to physically hold back floodwater.
- Stormwater drains and retention basins that slow and redirect run-off.
- Example: Wivenhoe Dam, Queensland, built after the 1974 floods.

Non-structural strategies

- Voluntary buyback and house-raising schemes, like the Northern Rivers' $800 million program.
- Land-use planning that keeps new development away from flood-prone land.
- Flood warning and forecasting systems that give communities time to act.

Managing flood risk: two different approaches

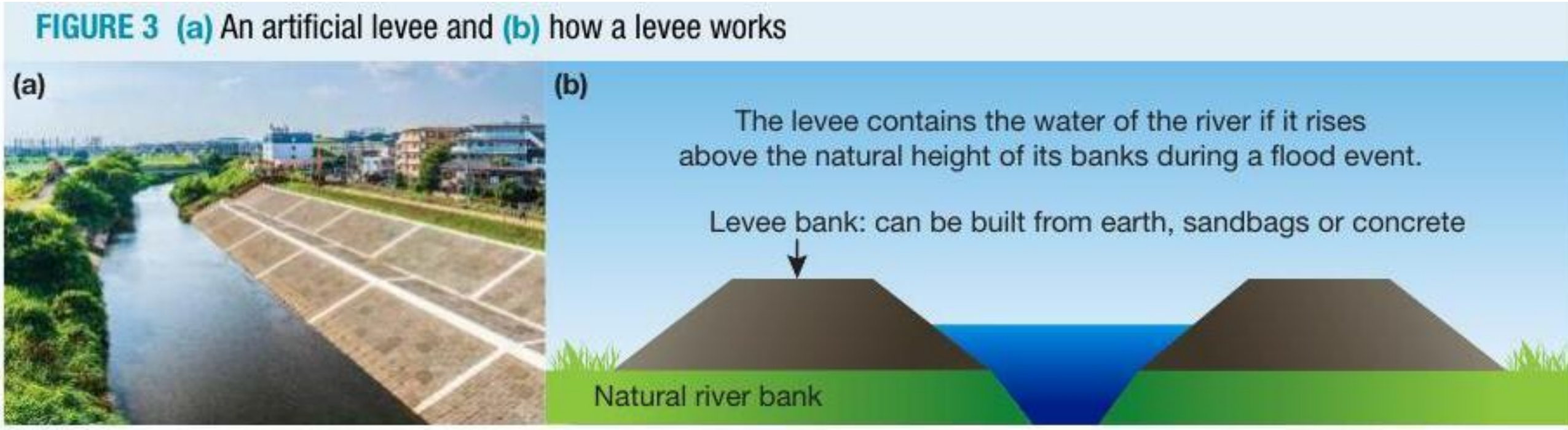


FIGURE 3 An artificial levee and how a levee works. Jacaranda Geoactive 1, Stage 4, Topic 12 (p. 465).

Flood risk closer to home: Narrabeen Lagoon

- **Narrabeen Lagoon, on Sydney's northern beaches, is the largest coastal lagoon in the Sydney region, covering 55 square kilometres.**

- **It is fed by streams from the surrounding suburbs and connects to the sea through a narrow channel that is often blocked by sand movement.**

- **During severe storms, this blockage means the lagoon cannot drain fast enough, flooding low-lying suburbs and roads nearby.**

- **This shows flood risk is not only a regional NSW issue: it can affect suburban Sydney too, wherever drainage is limited.**

Check-in: the 2022 Lismore floods

1. What was the peak height of the Wilsons River at Lismore on 28 February 2022?

A. 11.4m
B. 12.11m
C. 14.4m
D. 9.3m

2. What was the NSW Government's 2022 buyback scheme worth?

A. $350 million
B. $800 million
C. $4.3 billion
D. $160 million

Check-in: the 2022 Lismore floods - answers

1. What was the peak height of the Wilsons River at Lismore on 28 February 2022?

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5. Exam Skills and Key Terms

Tools for describing data and writing a strong response

The PQE method

- **PQE is a method for describing a map or graph in an exam: Pattern, Quantify, Exceptions.**
- **Pattern - describe the overall, obvious trend shown.**
- **Quantify - back up the pattern with real numbers or percentages from the data.**
- **Exceptions - point out anything that breaks the pattern, and suggest why.**

Use it on: any climate graph, choropleth map or statistical table you are given in an exam.

Reading a climate graph

- **Temperature is always shown as a red line graph, read against the left-hand axis.**
- **Precipitation is always shown as blue bars, read against the right-hand axis.**
- **A climate graph with a temperature peak in December-January suggests the southern hemisphere; a peak in June-July suggests the northern hemisphere.**
- **Describe the wettest and driest months, the temperature range, and anything unusual, using the PQE method.**

Key terms: water resources

- **Catchment (or watershed) - an area of land that drains to one point.**
- **Floodplain - flat land next to a river that is covered by water during a flood.**
- **Alluvium - nutrient-rich sediment deposited by a river as it slows.**
- **Aquifer - a body of permeable rock that holds groundwater.**
- **Groundwater recharge - when surface water seeps into the ground and replenishes an aquifer.**
- **Water scarcity - when there is not enough safe fresh water to meet demand.**
- **Water stress - when annual water availability falls below 1700 cubic metres per person.**

Key terms: the value of water

- **Economic value - the worth of water for producing goods and income.**
- **Cultural and aesthetic value - value tied to tradition, beauty and inspiration.**
- **Spiritual value - value tied to religious or sacred meaning.**
- **Country - the land, water, sky, animals, plants and spiritual connections that form Aboriginal identity.**
- **Dreaming stories - narratives about ancestral beings who created the landscape and established cultural law.**
- **Traditional Custodians - Aboriginal and Torres Strait Islander Peoples with ongoing responsibility to care for specific land and water.**
- **Sacred sites - locations of deep spiritual significance that require cultural protocols to visit.**

Key terms: floods and hazards

- **Flash flooding - a rapid rise in water level caused by heavy rainfall over a short period.**
- **Riverine flooding - a slower flood caused by a river bursting its banks.**
- **La Nina - a climate pattern linked to above-average rainfall and increased flood risk in Australia.**
- **Levee - a structural flood defence built to hold back floodwater.**
- **Buy-back scheme - a non-structural response where a government purchases flood-prone properties so people can relocate.**

Mixed revision round 1

1. Which word describes water stored in water-bearing rocks?

A. Catchment
B. Aquifer
C. Alluvium
D. Floodplain

2. In the PQE method, what does the 'E' stand for?

A. Explain
B. Evaluate
C. Exceptions
D. Evidence

Mixed revision round 1 - answers

1. Which word describes water stored in water-bearing rocks?

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Mixed revision round 2

1. Which Australian catchment covers 14% of the country's landmass?

A. The Great Artesian Basin
B. The Murray-Darling Basin
C. The Snowy Hydro Scheme
D. Lake Burragorang

2. Which value of water is Noosa's main case study example of, alongside its economic value?

A. Spiritual value
B. Aesthetic and social value
C. Scarcity value
D. Industrial value

Mixed revision round 2 - answers

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