

Geography Level 8

Chapter 1 — Water in the world

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Is water renewable? The water cycle, and how moving water links and reshapes places

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In this section

Water covers most of the planet, yet a town can still run short on a hot day. That puzzle is what this section is about. Water is usually classed as a **renewable resource** because the **water cycle** keeps refilling it — but the refill is not spread evenly, and some stores refill far more slowly than others. The same flows of water that refill rivers and dams also tie places together: what one place does with water is felt by the next place along the river.

In this section you will learn:

- how resources are sorted into **renewable**, **non-renewable** and **continuous** groups, and where water fits;
- why geographers still **debate** calling water renewable;
- the forms water takes as a resource — **available** (groundwater, soil moisture, surface water) and **potential** (salt water, ice, water vapour) — and how the water cycle connects them;
- how flows of water **connect** places, from upstream to downstream;
- how those flows **change** places: the Snowy Mountains Scheme, the Ord River, erosion and valleys;
- why a **river basin** is one connected system, in the Murray–Darling Basin, the Nile and the Tigris–Euphrates.

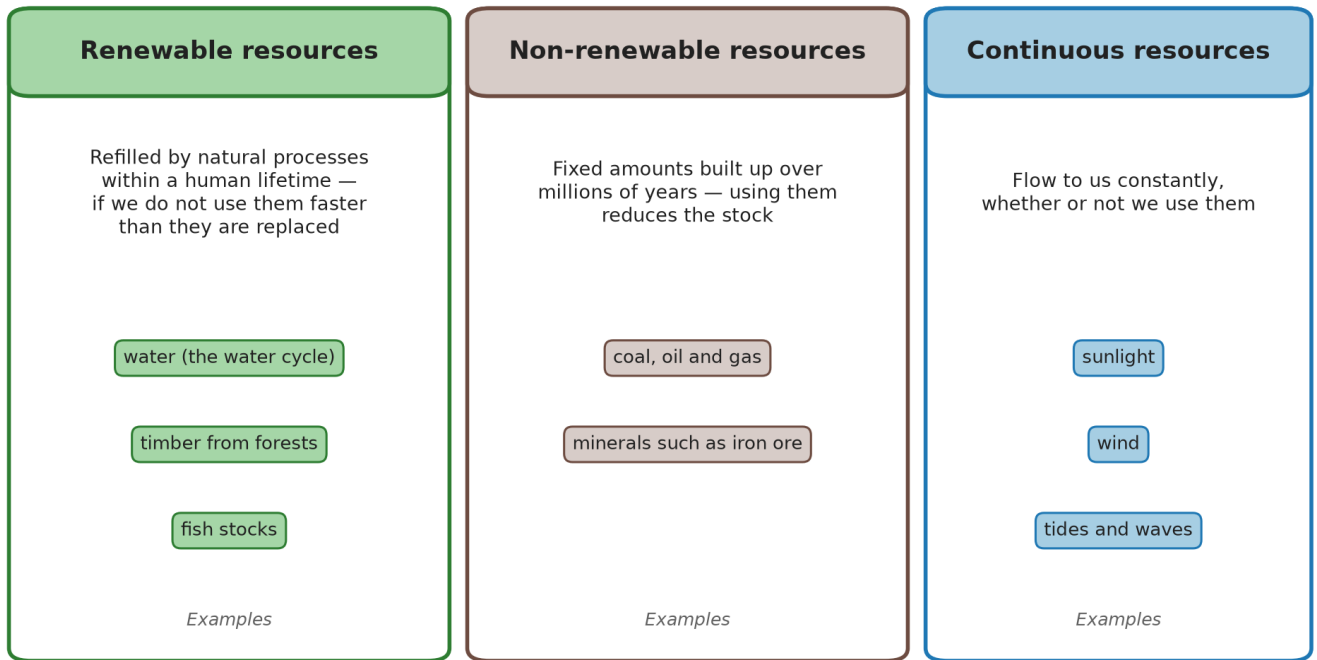
Key words to learn: renewable resource, non-renewable resource, continuous resource, water cycle, evaporation, transpiration, condensation, precipitation, infiltration, runoff, groundwater, aquifer, soil moisture, green water, blue water, surface water, river basin, catchment, upstream, downstream, irrigation, diversion, erosion.

1. Sorting resources: renewable, non-renewable, continuous

A **resource** is anything people take from the environment and use. Geographers sort resources into three groups by one test: *how (and whether) nature replaces them*.

Working definitions (as used in this book): a **renewable resource** is refilled by natural processes within a human lifetime — *if* we do not use it faster than it is replaced. A **non-renewable resource** exists in a fixed amount built up over millions of years, so using it reduces the stock. A **continuous resource** flows to us constantly, whether or not we use it.

Three ways to classify resources



Where does water fit? Turn the page to the debate.

Three panels classifying resources. Renewable resources are refilled by natural processes within a human lifetime, with examples water, timber and fish stocks. Non-renewable resources are fixed amounts built up over millions of years, with examples coal, oil and gas and iron ore. Continuous resources flow constantly whether or not we use them, with examples sunlight, wind, and tides and waves

So where does water fit? Most of the time it sits in the renewable column: the water cycle refills rivers, lakes and underground stores again and again. But the word *renewable* carries a condition — “if we do not use it faster than it is replaced” — and that condition is why geographers debate the label.

Is water always a renewable resource? The two strongest cases

YES — water is renewable

The water cycle never stops: the sun drives evaporation, and rain refills rivers, lakes and soil moisture again and again.

Water is not used up — it changes form and moves between places, then comes back.

On a world scale the amount of water on Earth changes very little.

NOT ALWAYS — it can run out locally

If a town pumps groundwater faster than rain refills it, the store drops and may take thousands of years to recover.

Pollution can make local water unusable.

Droughts can cut river flows for years.

A resource is only renewable while use stays within what nature replaces.

Geographer's verdict

Water is renewable because the water cycle recycles it — but only while we manage it so that use does not outrun refill. That is why Chapter 1 ends on sustainable management.

Debate diagram with two panels. The yes panel argues water is renewable because the water cycle never stops and refills rivers, lakes and soil moisture, and the total amount of water on Earth changes very little. The not-always panel argues a place can still run out: groundwater pumped faster than rain refills it can take thousands of years to recover, pollution can make local water unusable, and droughts can cut river flows for years. A verdict band concludes that water is renewable only while use stays within what nature replaces

Both sides of that debate are correct, and holding them both in mind is exactly what a geographer does. On a world scale, water is renewable. In one valley, one town or one river, it can still run short. **Renewable describes the cycle, not a guarantee for every place.**

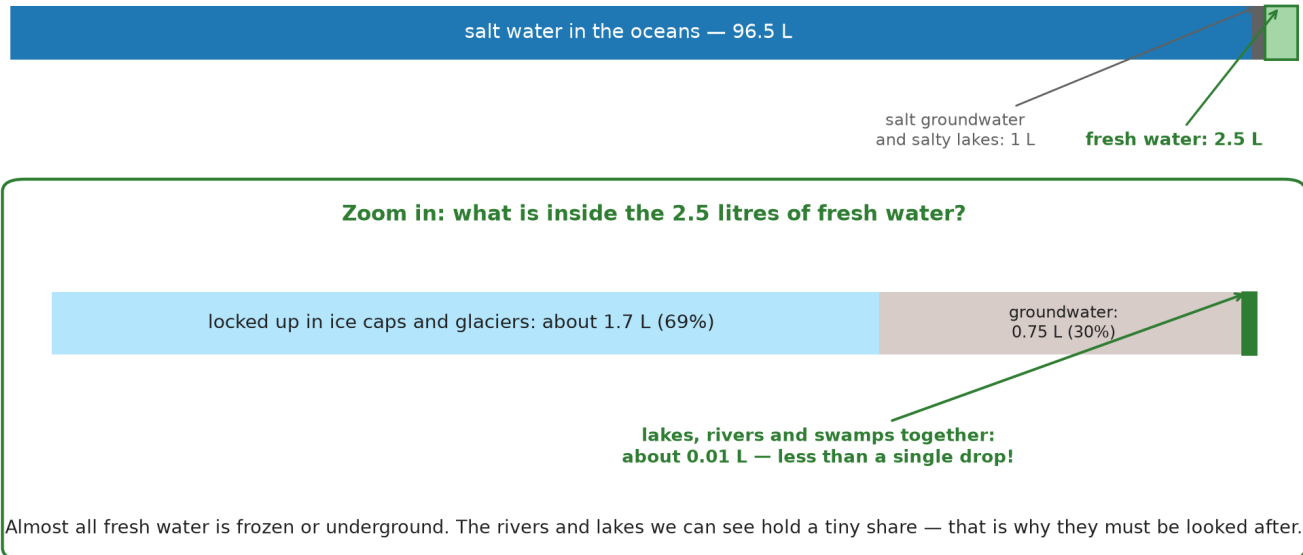
2. Where is Earth's water? Available and potential resources

If all of Earth's water were poured into 100 bottles of one litre each, the split would look like this.

Where is all Earth's water? (If the total were 100 litres)

Rounded estimates from the USGS, the United States water-science agency

All Earth's water = 100 L



Bar model of all Earth's water as 100 litres: 96.5 litres of salt water in the oceans, 1 litre of salty groundwater and salty lakes, and 2.5 litres of fresh water. A zoom panel splits the 2.5 litres of fresh water into about 1.7 litres locked in ice caps and glaciers, 0.75 litres of groundwater, and about 0.01 litres in lakes, rivers and swamps together — less than a single drop on this model

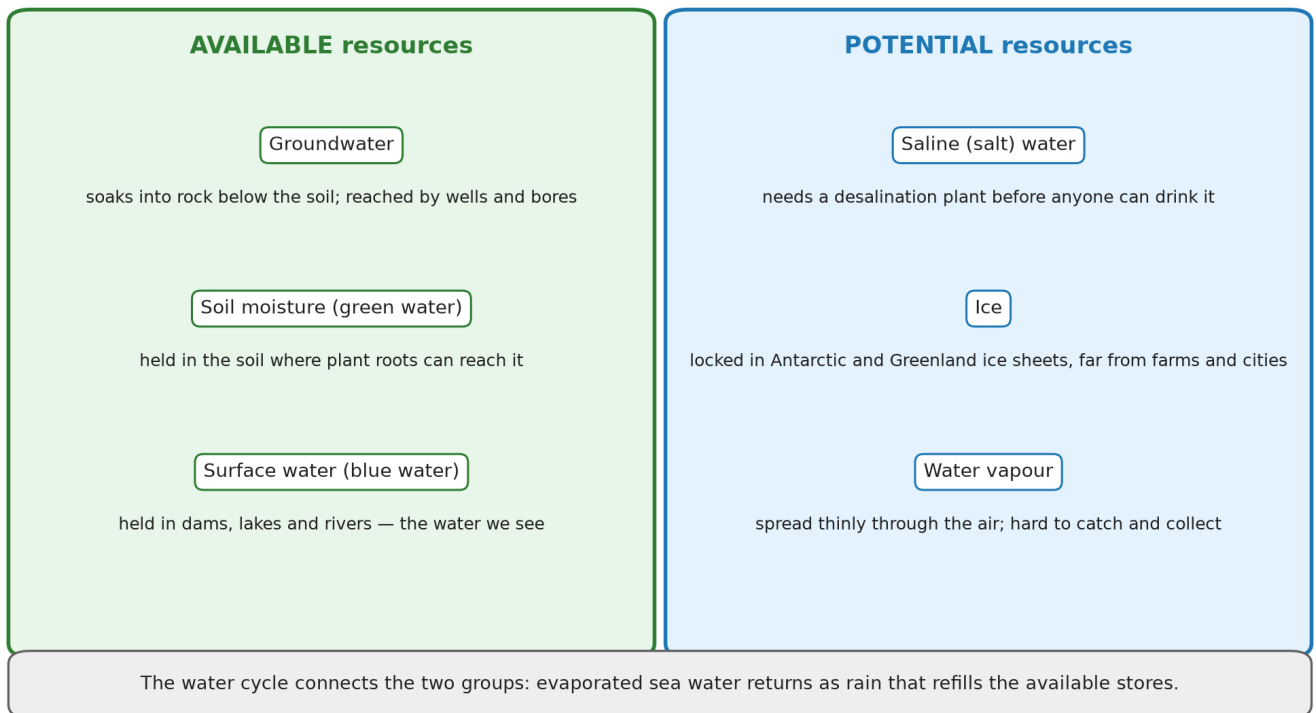
Source: United States Geological Survey (USGS) Water Science School, "Where is Earth's water?" — oceans hold about 96.5% of all water; fresh water is about 2.5%; of the fresh water, ice caps and glaciers hold about 69%, groundwater about 30%, and lakes, rivers and swamps about 1%, retrieved 25 August 2026.

Only fresh water is easy to use, and most fresh water is frozen or hidden underground. That is why geographers split water as a resource into two groups.

- An **available resource** is water we can use with today's tools: **groundwater** reached by wells and bores, **soil moisture** held in the soil for plant roots, and **surface water** held in dams, lakes and rivers.
- A **potential resource** is water we cannot use (yet): **salt water** (it needs costly desalination first), **ice** locked in polar ice sheets far from farms and cities, and **water vapour** spread thinly through the air.

Two groups of water as a resource

available = we can use it with today's tools · potential = we cannot use it (yet)



Two-panel diagram. Available resources: groundwater reached by wells and bores, soil moisture (green water) held where roots reach it, and surface water (blue water) held in dams, lakes and rivers. Potential resources: saline water that needs a desalination plant, ice locked in polar ice sheets, and water vapour spread thinly through the air. A band notes that the water cycle connects the two groups, because evaporated sea water returns as rain that refills the available stores

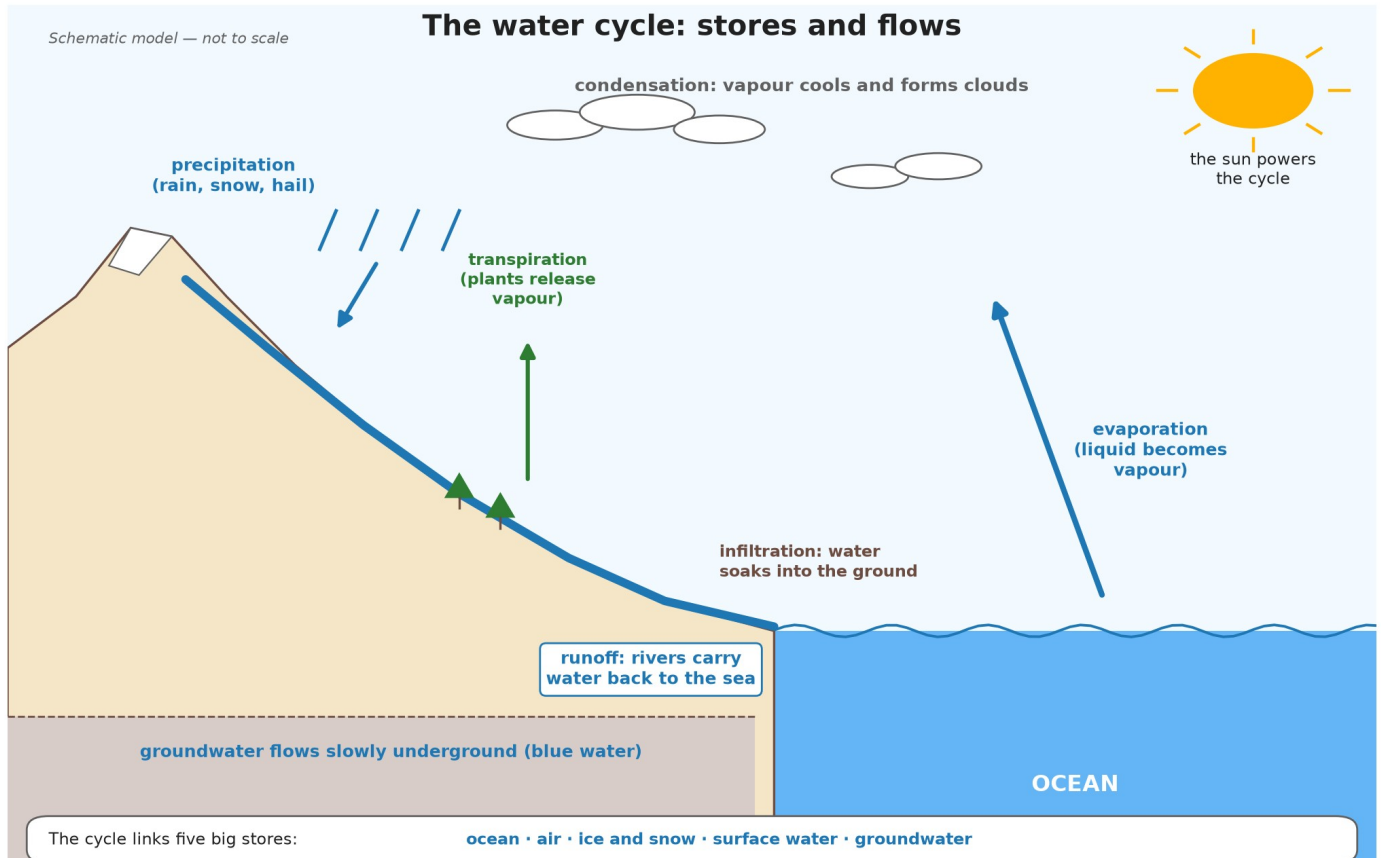
The two groups are not sealed off from each other. The water cycle turns potential into available: sea water evaporates, falls as fresh rain, and refills the rivers, lakes, soils and aquifers we depend on.

3. The water cycle: stores and flows

The **water cycle** is the endless movement of water between five big stores — the ocean, the air, ice and snow, surface water, and groundwater. The sun supplies the energy. The flows between the stores each have a name:

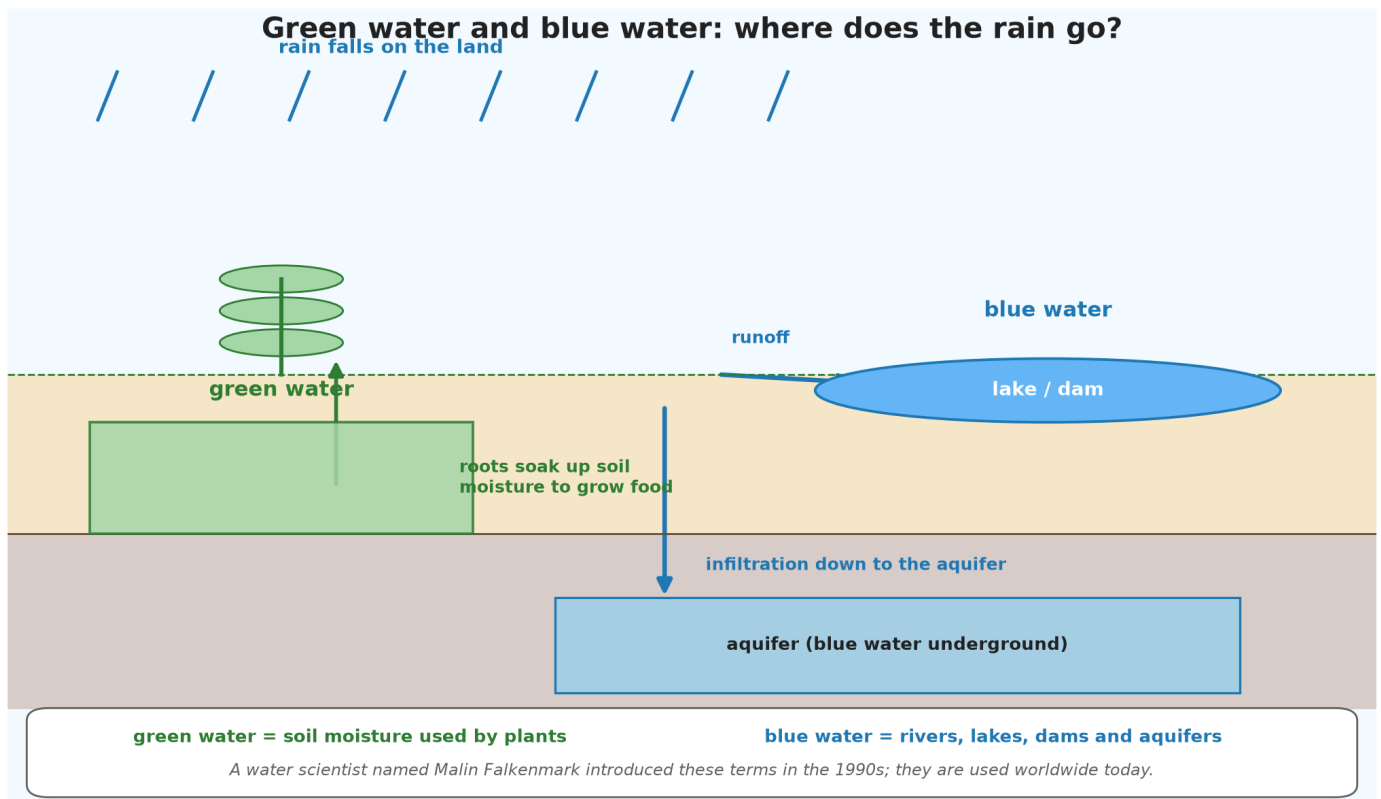
- **Evaporation** — liquid water heated by the sun becomes vapour and rises (mostly from the ocean).

- **Transpiration** — plants release water vapour through their leaves.
- **Condensation** — rising vapour cools and forms clouds.
- **Precipitation** — water falls back to Earth as rain, snow or hail.
- **Infiltration** — water soaks into the ground, topping up soil moisture and groundwater.
- **Runoff** — water that does not soak in runs downhill in creeks and rivers back to the sea.



Labelled schematic cross-section of the water cycle. The sun drives evaporation from the ocean; plants add transpiration; condensation forms clouds; precipitation falls on a snow-capped mountain; runoff carries water down a river to the sea; and infiltration soaks water into groundwater that flows slowly underground. A strip along the bottom lists the five big stores the cycle links: ocean, air, ice and snow, surface water and groundwater. Schematic model, not to scale

Water scientists also split the fresh water on land into two colours. **Green water** is the soil moisture that plants draw up and grow with. **Blue water** is the water we can see and store: rivers, lakes, dams and aquifers. The terms were introduced by the water scientist Malin Falkenmark in the 1990s and are now used worldwide.

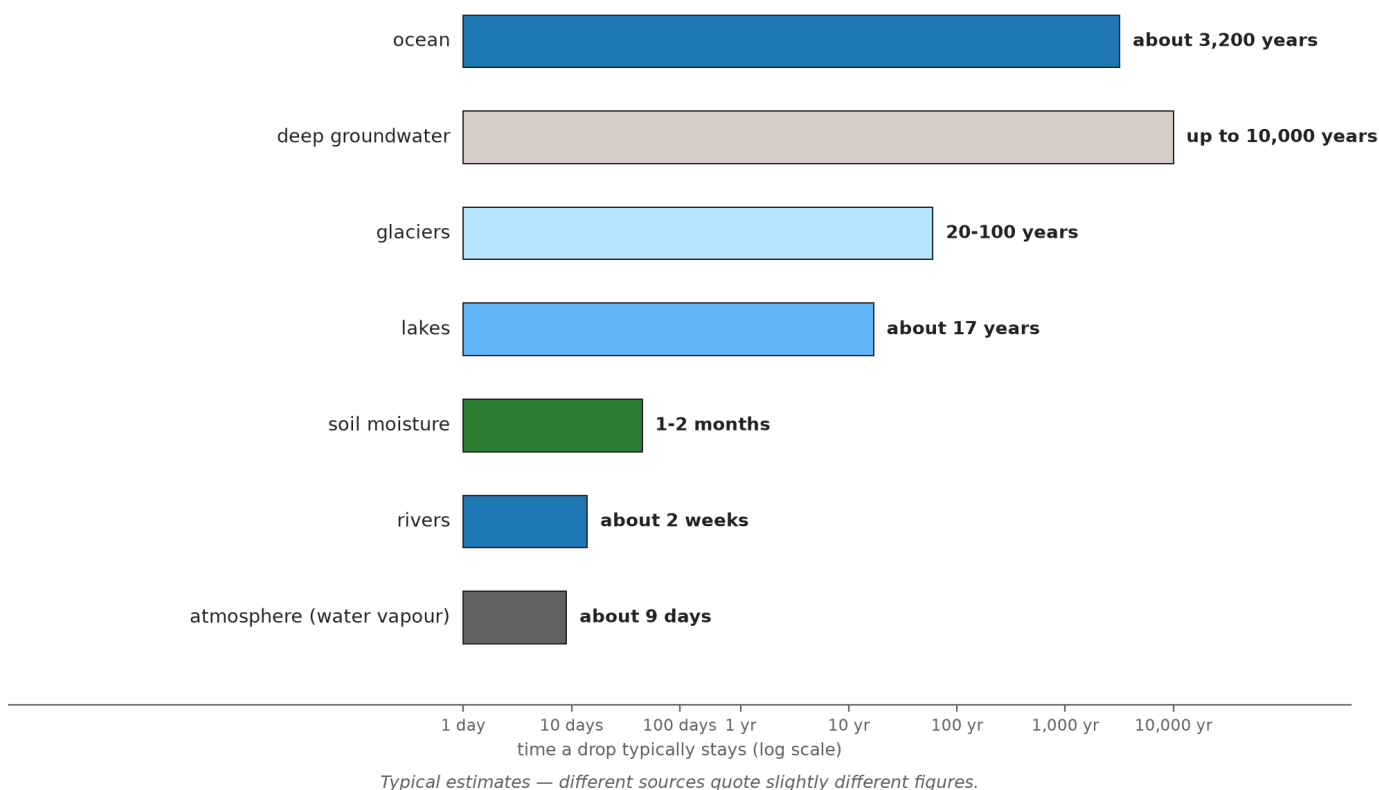


Schematic landscape showing where rain goes. Green water is the soil moisture roots soak up to grow food; blue water is runoff into a lake or dam plus infiltration down to an aquifer underground. A legend defines green water as soil moisture used by plants and blue water as rivers, lakes, dams and aquifers, and notes the terms were introduced by water scientist Malin Falkenmark in the 1990s

How fast does each store refill? A drop of water stays a different length of time in each store, so the stores renew at very different speeds.

How long does a drop of water stay in each store?

Deep groundwater can take thousands of years to refill — treat it slowly and it acts almost like a non-renewable store.



Horizontal bar chart on a log time scale of how long a drop of water typically stays in each store: atmosphere about 9 days, rivers about 2 weeks, soil moisture 1–2 months, lakes about 17 years, glaciers 20–100 years, the ocean about 3,200 years, and deep groundwater up to 10,000 years. A note warns that deep groundwater refills so slowly it acts almost like a non-renewable store

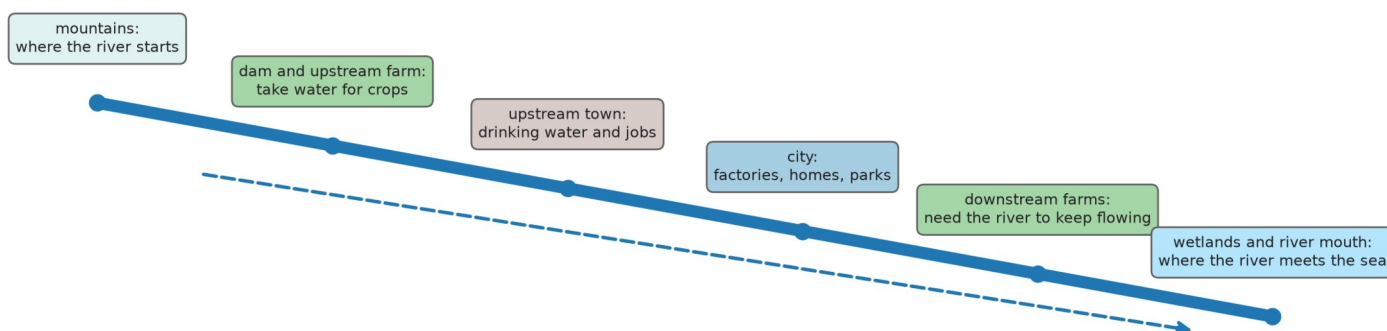
Source: USGS Water Science School, residence-time estimates for water in the atmosphere, rivers, soil, lakes, oceans and groundwater, retrieved 25 August 2026.

Read the chart against the definitions in part 1. Rivers and soil moisture refill within weeks or months — comfortably renewable. Deep groundwater can take thousands of years to refill, so a town that pumps it fast is using a store that behaves **almost like a non-renewable resource**. The water cycle makes water renewable *on average*; each store has its own refill speed.

4. Flows of water connect places

Because water flows downhill, every place along a river is connected to every other place along it. Geographers call the direction of that connection **upstream** (towards the source) and **downstream** (towards the mouth). The shared land that drains into a river is its **river basin** (or **catchment**).

One river, many places: how flowing water connects them



What happens in one place flows on to the next:

taking water upstream leaves less downstream · pollution upstream travels downstream · soil washed in upstream builds deltas downstream
The shared land that drains into the river is called its river basin (or catchment).

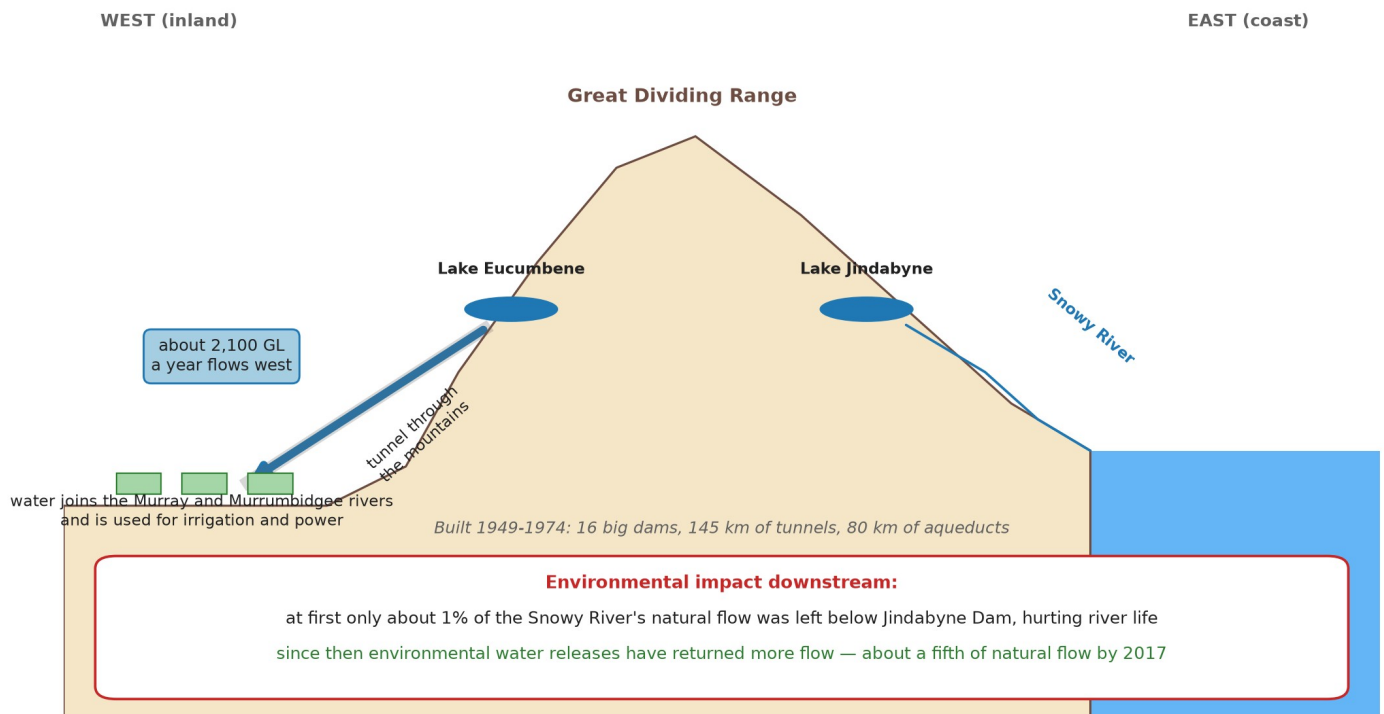
Schematic diagram of one river flowing downhill from mountains to the sea, connecting six places in order: mountains where the river starts, a dam and upstream farm taking water for crops, an upstream town using it for drinking water and jobs, a city with factories, homes and parks, downstream farms that need the river to keep flowing, and wetlands where the river meets the sea. A panel explains that what happens in one place flows on to the next: taking water upstream leaves less downstream, pollution upstream travels downstream, and soil washed in upstream builds deltas downstream

This is the concept of **interconnection** in action. A river basin is one connected system, so a choice made in one place — a dam, a pump, a pollution spill, a cleared hillside — travels with the water and becomes another place's problem or gift. That is also how flows of water **change** places, as the next three parts show.

5. How flows change places: two Australian stories

The Snowy Mountains Scheme — an environmental impact. The Snowy River rises in the Great Dividing Range, and its waters once ran east to the Tasman Sea. Between 1949 and 1974, the Snowy Mountains Scheme built 16 big dams, 145 km of tunnels and 80 km of aqueducts to divert much of that water *west*, into the Murray and Murrumbidgee rivers, for irrigation and power. About 2,100 GL a year now flows west through the ranges (GL stands for gegalitres — one GL is one thousand million litres).

The Snowy Mountains Scheme: moving water from east to west



Schematic cross-section of the Snowy Mountains Scheme. Water stored in Lake Eucumbene and Lake Jindabyne on the Great Dividing Range is sent through a tunnel west to join the Murray and Murrumbidgee rivers for irrigation and power, while the Snowy River itself flows east to the Tasman Sea. An impact panel notes that at first only about 1% of the Snowy River's natural flow was left below Jindabyne Dam, hurting river life, and that environmental water releases had returned about a fifth of natural flow by 2017. Caption: built 1949–1974, 16 big dams, 145 km of tunnels, 80 km of aqueducts

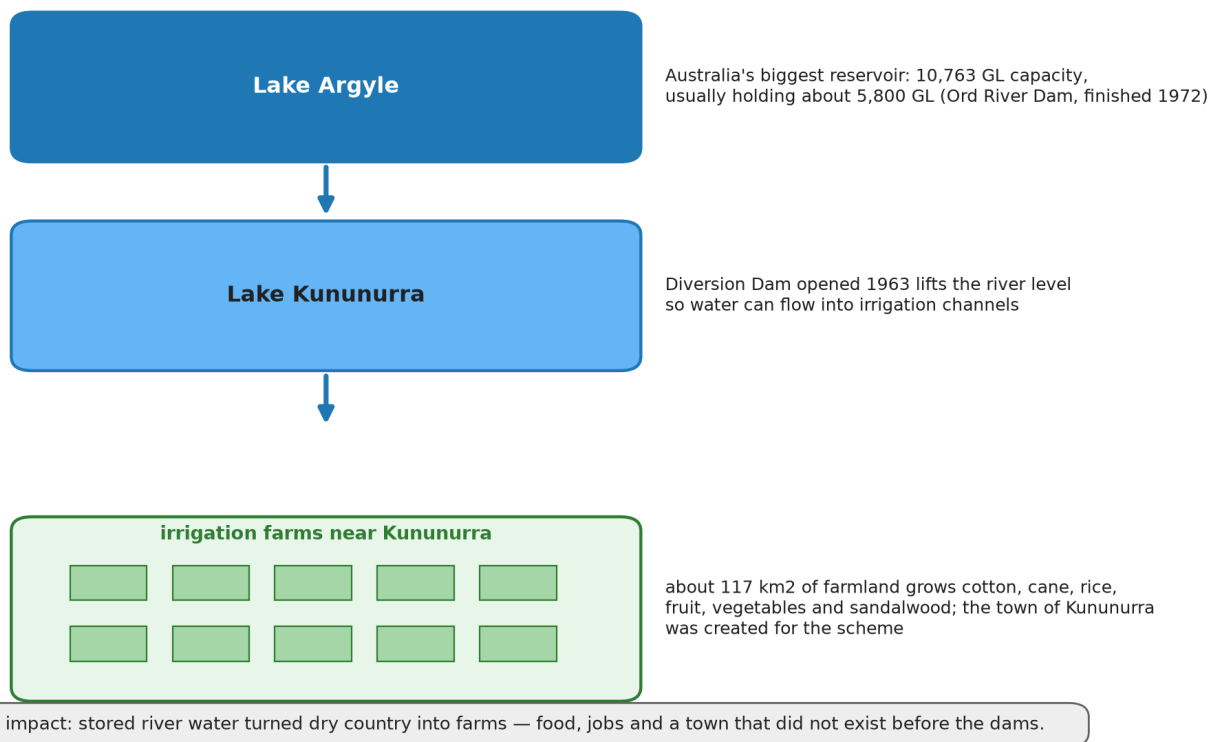
Source: Snowy Hydro Limited — scheme facts (built 1949–1974; 16 dams; 145 km of tunnels; 80 km of aqueducts; about 2,100 GL diverted west each year) and Snowy River flow figures (about 1% of natural flow left below Jindabyne Dam at first; about a fifth restored through environmental releases by 2017), retrieved 25 August 2026.

The west gained water for farms and power. The east lost most of its river: at first only about 1% of the Snowy River's natural flow was left below Jindabyne Dam, and river life suffered. Later, environmental water releases returned more flow — about a fifth of natural flow by 2017. One engineering choice changed two places at once, and the repair is still underway.

The Ord River Scheme — an economic impact. In the dry East Kimberley of Western Australia, the Ord River Dam (finished 1972) created Lake Argyle, Australia's biggest reservoir, with a capacity of 10,763 GL and usually holding about 5,800 GL. Below it, the Diversion Dam (opened 1963) lifts the river level at Lake Kununurra so water can flow into irrigation channels.

The Ord River, Western Australia: from dam to farm

East Kimberley region — one of the driest parts of Australia



Flow diagram of the Ord River scheme, Western Australia. Lake Argyle, Australia's biggest reservoir with 10,763 GL capacity and usually holding about 5,800 GL behind the Ord River Dam finished in 1972, releases water to Lake Kununurra, formed by the Diversion Dam opened in 1963, which feeds irrigation channels. About 117 square kilometres of farmland near Kununurra grows cotton, cane, rice, fruit, vegetables and sandalwood, and the town of Kununurra was created for the scheme. A strip summarises the economic impact: stored river water turned dry country into farms, bringing food, jobs and a town that did not exist before the dams

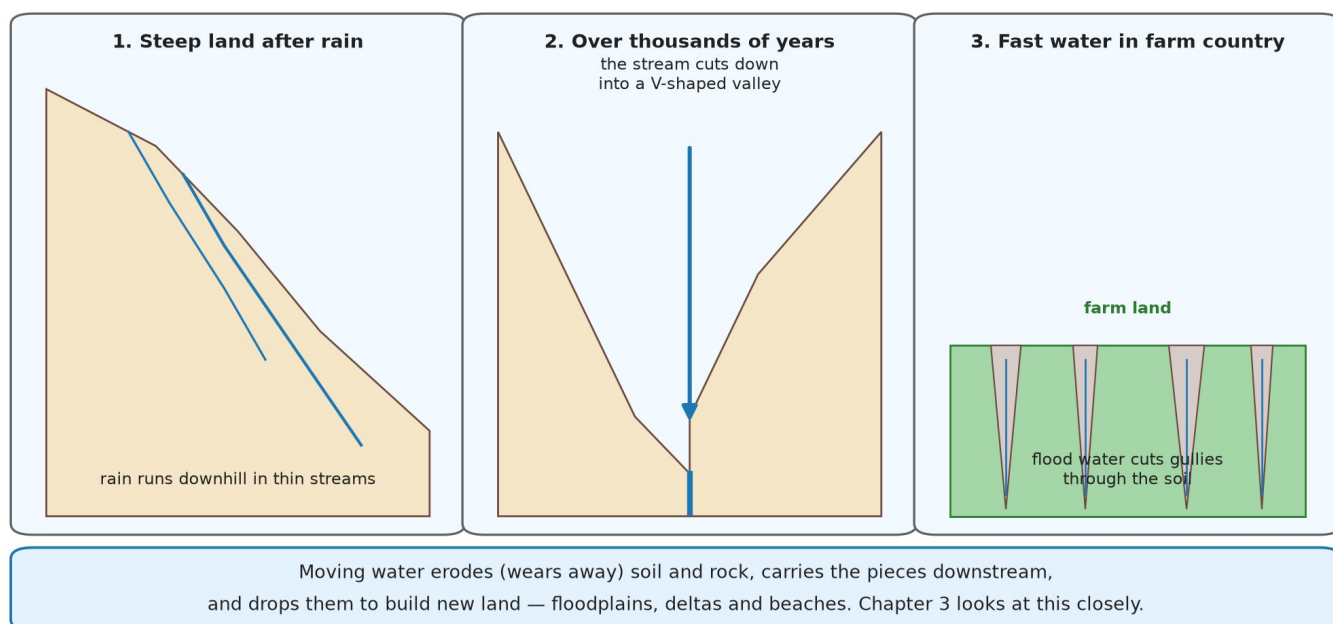
Source: Government of Western Australia, Ord River irrigation scheme facts — Lake Argyle capacity 10,763 GL, Ord River Dam completed 1972, Diversion Dam opened 1963, about 117 km² of irrigated farmland near Kununurra, retrieved 25 August 2026.

Here the impact is economic: stored river water turned dry country into about 117 km² of irrigated farmland growing cotton, cane, rice, fruit, vegetables and sandalwood, and created the town of Kununurra. Stored and diverted water can build a local economy — which is the same as saying it can re-make a place.

6. Moving water changes places: erosion

Flows of water do not only connect places; they re-shape the land itself. **Erosion** is the wearing away of soil and rock by moving water (or wind). Rain running downhill picks up loose soil; fast streams grind away their beds and banks; over thousands of years a stream cuts down into a mountain until a **V-shaped valley** forms. The same process, sped up by floods on bare farm soil, cuts deep **gullies** in a single wet season.

Moving water changes places



Three-panel diagram of how moving water changes places. Panel 1: rain runs downhill in thin streams over steep land. Panel 2: over thousands of years the stream cuts down into a V-shaped valley. Panel 3: on farm land, flood water cuts gullies through the soil. A band explains that moving water erodes soil and rock, carries the pieces downstream and drops them to build new land such as floodplains, deltas and beaches

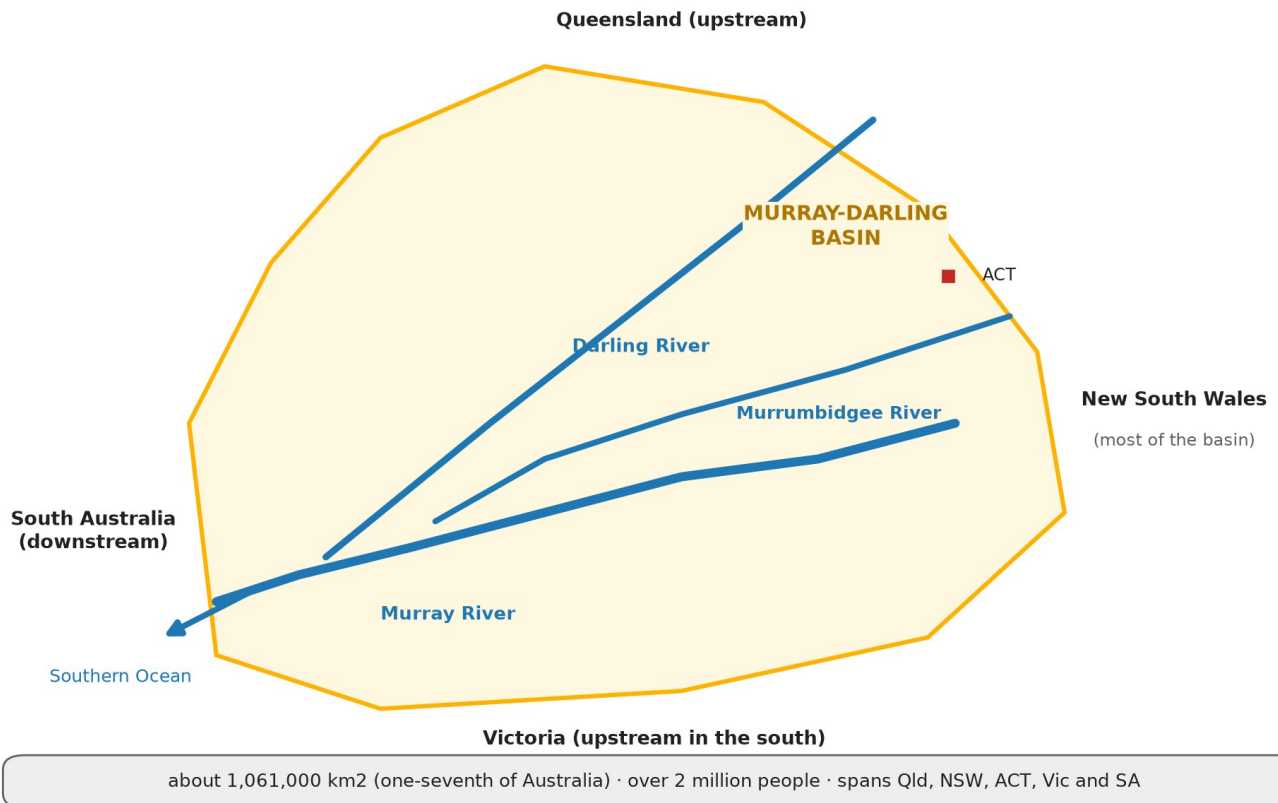
Notice the other half of the story in the last panel's band: what water erodes in one place, it **deposits** in another, building floodplains, deltas and beaches. Chapter 3 studies these landform processes in detail; here the point is that the same flows that make water a renewable resource also make it a landscape-builder and a landscape-cutter.

7. River basins: upstream choices, downstream consequences

The biggest scale of water interconnection is the river basin. Australia's largest is the **Murray–Darling Basin**, about 1,061,000 km² — one-seventh of the country — home to over 2 million people and spanning Queensland, New South Wales, the ACT, Victoria and South Australia. The Darling and Murrumbidgee join the Murray, which flows south-west and reaches the Southern Ocean in South Australia. On that map, Queensland, New South Wales and Victoria sit upstream, and South Australia sits downstream of them all.

The Murray-Darling Basin: who lives upstream, who lives downstream

Schematic map — shapes simplified, not to scale



Schematic map of the Murray–Darling Basin. The Darling, Murrumbidgee and Murray rivers flow south-west through the basin to the Southern Ocean in South Australia. Queensland is labelled upstream, New South Wales covers most of the basin, the ACT is marked, and Victoria is labelled upstream in the south, with South Australia downstream. A strip gives facts: about 1,061,000 square kilometres, one-seventh of Australia; over 2 million people; spans Queensland, New South Wales, the ACT, Victoria and South Australia. Schematic map, shapes simplified, not to scale

Source: Murray–Darling Basin Authority — the basin covers about 1,061,000 km² (one-seventh of Australia), is home to over 2 million people, and spans Queensland, New South Wales, the ACT, Victoria and South Australia, retrieved 25 August 2026.

The same upstream–downstream logic plays out in the world’s great basins.

Three big river basins, one shared story

	Murray-Darling Basin (Australia)	Nile River (Africa)	Tigris-Euphrates (West Asia)
Where the rivers rise	Slopes and mountains of Qld, NSW, the ACT and Victoria	Lake Victoria region (White Nile) and Lake Tana in Ethiopia (Blue Nile)	The mountains of Turkey
Where they flow	West and south to the Southern Ocean in South Australia	North through Sudan and Egypt to the Mediterranean Sea	South-east through Syria and Iraq to the Gulf
Upstream water use	Farms and towns in Qld, NSW and Victoria take water for irrigation	Countries along the upper river build dams for power and water	Dams in Turkey store a lot of the river water
Downstream effects	Less flow reaches South Australian farms, towns and wetlands	Egypt gets almost all of its fresh water from the Nile	Syria and Iraq report lower river flows than in the past

The same lesson three times: a river basin is one connected system.

When upstream places take, store or pollute water, downstream places feel it.

Comparison table of three river basins with rows for where the rivers rise, where they flow, upstream water use and downstream effects. Murray–Darling Basin (Australia): rises on the slopes and mountains of Queensland, New South Wales, the ACT and Victoria; flows west and south to the Southern Ocean; upstream farms and towns take water for irrigation; less flow reaches South Australian farms, towns and wetlands. Nile (Africa): rises in the Lake Victoria region (White Nile) and Lake Tana in Ethiopia (Blue Nile); flows north through Sudan and Egypt to the Mediterranean; countries along the upper river build dams for power and water; Egypt gets almost all of its fresh water from the Nile. Tigris–Euphrates (West Asia): rises in the mountains of Turkey; flows south-east through Syria and Iraq to the Gulf; dams in Turkey store much of the river water; Syria and Iraq report lower river flows than in the past. A band concludes: the same lesson three times — a river basin is one connected system, and when upstream places take, store or pollute water, downstream places feel it

Source: FAO AQUASTAT country water profiles for the Nile and the Tigris–Euphrates (river sources, routes and upstream dam-building; Egypt’s near-total dependence on the Nile), retrieved 25 August 2026.

Three basins, three continents, one pattern: upstream storage and pumping give upstream places water security, power and food — and leave downstream places with less. Egypt depends almost entirely on a river it does not control; Syria and Iraq record lower flows as upstream dams fill; South Australian farms, towns and wetlands feel every extra pump upstream. **A river basin is one connected system, and water is the connection.**

Worked demonstration 1 — The 100-litre model: how much water can we actually use?

Let us reason with the USGS figures from part 2, using the 100-litre model.

Step 1 — Start with everything. All of Earth’s water = 100 L.

Step 2 — Remove the salt. The oceans hold 96.5 L, and salty groundwater and salty lakes hold about 1 L. Fresh water left: $100 - 96.5 - 1 = 2.5$ L.

Step 3 — Split the fresh water. Ice holds about 69% of it (about 1.7 L), groundwater about 30% (about 0.75 L), and lakes, rivers and swamps together about 1% of 1% — roughly **0.01 L**, less than a single drop on this model.

Step 4 — Ask what is available. The 1.7 L of ice is a potential resource (locked far away). Much of the 0.75 L of groundwater is deep and slow to refill. So the water people lean on most — rivers, lakes, dams, soil moisture and reachable groundwater — is a tiny share of the 100 L.

Geographer's conclusion: water is renewable *and* scarce at the same time. The cycle refills the small available stores again and again, which is exactly why using them faster than they refill — or dirtying them — matters so much. Renewability is real, but it lives in a very small bucket.

Worked demonstration 2 — Who gains, who loses? Following the Snowy's water

Let us use real figures to reason about interconnection on the Snowy.

Step 1 — What was done. Built 1949–1974, the scheme diverts about 2,100 GL of water a year west through the Great Dividing Range, into the Murray and Murrumbidgee rivers.

Step 2 — Who gained. Western irrigation farms and power users gained a reliable supply inland, where Australia's food is grown. That is a large, lasting economic gain for those places.

Step 3 — Who lost. Below Jindabyne Dam, the Snowy River was left with only about 1% of its natural flow at first. A river at 1% cannot carry its sediment, keep its pools cool, or support its fish — the downstream environment on the eastern side paid the cost of the western gain.

Step 4 — What changed later. Environmental water releases had returned about a fifth of natural flow by 2017 — an admission that the first split took too much, and a repair that is still only partial.

Geographer's conclusion: the same 2,100 GL was a gift in one place and a loss in another, because the two places share one water system. That is interconnection, and it is why river decisions are always negotiations between upstream and downstream.

Practice — scaffolded

1. Classify the resources. Copy the table and place each resource in a column: sunlight, coal, fish stocks, iron ore, wind, timber from a regrowing forest. For each, add one reason using the words “replaced”, “fixed stock” or “constant”.

Resource	Renewable / Non-renewable / Continuous	Reason
sunlight		
coal		
(continue for all six)		

2. Match the flows. Match each flow word to its meaning: evaporation, transpiration, condensation, precipitation, infiltration, runoff.

- a) water vapour cooling into cloud · b) plants releasing vapour · c) water soaking into the ground · d) liquid becoming vapour in the sun · e) rain, snow or hail falling · f) water running downhill to the sea.

3. Available or potential? Sort these into the two groups from part 2, with one reason each: water in a farm dam; sea water off the coast; the Antarctic ice sheet; moisture in a paddock after rain; water vapour in a cloud; water drawn from a bore.

4. Read the residence chart. Using the chart in part 3: (a) which store holds a drop for the shortest time, and which for the longest? (b) about how long does a drop stay in a lake? (c) explain in one sentence why a town built on deep groundwater should pump slowly.

5. Read the basin map. Using the Murray–Darling map in part 7: (a) name the ocean the Murray River reaches; (b) list the states and territory labelled upstream, and the one labelled downstream; (c) in one sentence, explain why a dry year in Queensland can matter to a farmer in South Australia.

6. Fieldwork watch — where does the rain go here? After the next heavy rain, walk the school ground (with your teacher). In a two-column table, record: where water pooled or ran, and one sign of soil moving (a muddy streak, a small fan of dirt, a blocked drain). Sketch one arrow on your sketch showing the direction of runoff. Keep this table — it is the same “observe the flows” skill this section used at world scale.

Practice — unscaffolded

7. “Water is renewable, yet a place can still run out.” Explain this sentence in your own words, using one store from the residence chart and one named Australian place from this section.

8. Distinguish green water from blue water, and give one Australian example of each (a named place or landscape, not the diagram’s labels).

9. Choose one basin from the comparison table in part 7. Using named places, explain how upstream water use changes a downstream place.

10. “Moving water is a cutter and a builder.” Justify this claim with two pieces of evidence from part 7’s band text or part 6, naming the landform each piece of evidence produces.

Extended response

“Water is a renewable resource, so Australia can never run out of water.” Do you agree or disagree? Write a response of 150–200 words that states your position and supports it with evidence.

Your response must:

- use **at least two figures** from this section (name them, e.g. “the residence chart”);
- refer to **at least one named Australian place** (e.g. the Snowy River, Lake Argyle, the Murray–Darling Basin);
- use at least four key words from the list at the start of this section;
- end with one sentence on what **sustainable management** of water means, given your position.

Check your work against the definition box in part 1: did you treat “renewable” as a guarantee, or as a condition?

Teaching notes (for the teacher)

- **Sequence.** One teaching sequence: classify (part 1) → locate the water (2) → explain the cycle and refill speeds (3) → scale up to interconnection (4) → see flows changing places (5–6) → consolidate at basin scale (7). The two worked demonstrations model the reasoning the tasks then ask for: proportional reasoning with real data (WD1) and upstream–downstream reasoning with real figures (WD2).
- **Scope decision (§2A of the series plan).** VC2HG8K01 . E04 is drawn on in trimmed form: the environmental impact (Snowy Mountains diversion) and the economic impact (Ord River irrigation) only. The elaboration’s third, social example is excluded from this book by the series scope decision; do not teach it or substitute equivalent content here. The environmental/economic pair carries the elaboration in full.
- **Contested terms.** “Renewable resource” is operationalised in the definition box and then genuinely debated (figure 2): both the yes-case and the not-always-case are steelmanned before the verdict. Green/blue water is attributed to Malin Falkenmark (1990s) at first use.
- **Source method.** Every figure carrying real data cites its source with a retrieval date (25 August 2026): USGS Water Science School (water distribution and residence times), Snowy Hydro Limited (scheme and flow figures), the Murray–Darling Basin Authority (basin facts), FAO AQUASTAT (Nile, Tigris–Euphrates), and the Government of Western Australia (Ord facts). Where sources disagree on a figure (for example, the count

of Snowy power stations), the figure is omitted rather than guessed. Model the same habit: have students check one figure against one source as a class.

- **Skills weave.** Task 6 is a short fieldwork-watch that rehearses observation of runoff and erosion at school scale; task 5 and WD2 rehearse map- and data-led upstream–downstream reasoning. Representation conventions (BOLTSS) are treated in Chapter 5 sections; schematic maps here are labelled “not to scale”.
 - **Assessment pointer.** The extended response targets, at an entry level, the standard’s expectation that explanations weigh environmental, economic and social factors; full-depth sustainable-management argument is carried by 1C and 1D, so accept a one-sentence management close here.
-

Glossary

- **Aquifer** — underground rock or sediment that holds groundwater and can supply bores.
- **Blue water** — the water we can see and store: rivers, lakes, dams and aquifers.
- **Catchment** — see river basin.
- **Condensation** — water vapour cooling and forming cloud.
- **Continuous resource** — a resource that flows constantly whether or not we use it (sunlight, wind).
- **Diversión** — moving water from its natural course into tunnels, channels or another river.
- **Downstream** — in the direction a river flows, towards its mouth.
- **Erosion** — the wearing away of soil and rock by moving water or wind.
- **Evaporation** — liquid water becoming vapour, driven by the sun.
- **Groundwater** — water held underground in soil and rock, reached by wells and bores.
- **Green water** — soil moisture used by plants.
- **Infiltration** — water soaking into the ground.
- **Irrigation** — watering farmland with river, dam or bore water instead of relying on rain.
- **Non-renewable resource** — a resource in a fixed stock built over millions of years (coal, minerals).
- **Precipitation** — water falling from cloud as rain, snow or hail.
- **Renewable resource** — a resource refilled by natural processes within a human lifetime, if use stays within refill.
- **Reservoir** — a lake, natural or built, that stores water (often behind a dam).
- **River basin** — all the land that drains into a river and its tributaries.
- **Runoff** — rain that does not soak in and runs downhill into creeks and rivers.
- **Soil moisture** — water held in the soil, available to plant roots.
- **Surface water** — water held in dams, lakes and rivers.
- **Transpiration** — the release of water vapour by plants.
- **Upstream** — in the direction a river comes from, towards its source.
- **Water cycle** — the continuous movement of water between the ocean, air, ice, surface water and groundwater.
- **Water vapour** — water in its gaseous form in the air.

Why water matters: five ways people value it

For the teacher — what this section owns. Code: VC2HG8K02 (Geographical Knowledge and Understanding · Water in the world · Levels 7 and 8 band, Victorian Curriculum 2.0). Scope per TOC §2A: the CD's First Nations clause is not taught in this book (CONTENT_POLICY Rule 1) and nothing stands in for it; the Asia-region half of the clause stays live and is taught here (the Asia priority; TOC chapter 1 note). **Draws on:** VC2HG8K02.E01 · VC2HG8K02.E02 · VC2HG8K02.E04 · VC2HG8K02.E05. VC2HG8K02.E03 is excluded outright: not taught, not paraphrased, not referenced in any student-facing text. **Scored against the band achievement standard (stated at the end of Level 8):** the Big task at the end of this section is scored against that standard.

Words we use

- **environmental flows** — water that is kept in rivers and wetlands for the environment, and is not taken out for people to use. The Murray-Darling Basin Authority plans and delivers these flows in the Basin.
- **gigalitre (GL)** — one billion litres of water. One GL would fill about 400 Olympic-size swimming pools.
- **consumed water** — water that is used and not returned to a river or the sea. The ABS measures it in the Water Account, Australia.
- **irrigation** — bringing water to farms through channels and pipes so crops and pasture can grow.
- **World Heritage listing** — a listing by UNESCO, the United Nations body that protects the world's nature and culture, saying a place is so special it belongs to everyone on Earth.
- **national park** — land or sea set aside by a government, kept mostly wild, and open for everyone to visit.
- **aesthetic value** — the value a place has for its beauty: how a waterscape looks and feels.
- **moksha** — in Hindu belief, the freeing of the soul from the cycle of being reborn.
- **recreational value** — the value a place has for fun activities, like swimming, fishing, boating and walking by the water.

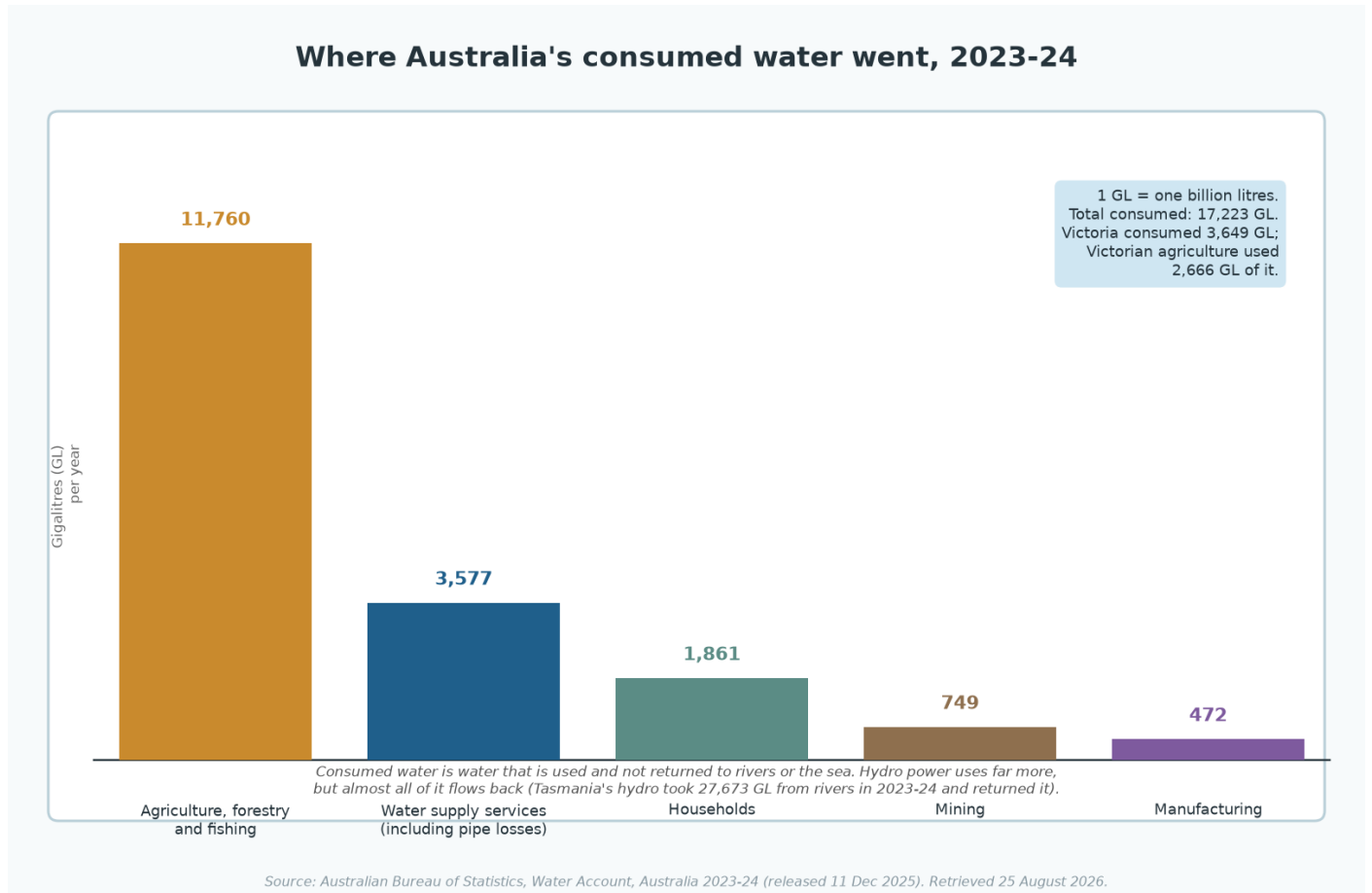
For the teacher — defined terms and the contested question (house rule, CONTESTED_TERMS.md). The CD's five value words are the curriculum's own (WORD_LEVEL_POLICY Rule 2 exemption 1) and are given student-level meanings in Figure 1B-1 and in "Words we use"; *aesthetic* is defined at first use because it is the least familiar of the five. The genuinely contested question in this section is *who should get the water* — environmental flows or irrigation. Neither side is presented as a straw man: Figure 1B-7 gives each side its strongest case on real 2023-24 data before students are asked to judge (Rule 4 symmetry), and the Big task asks students to restate both cases before giving their own view. Belief language about the Ganges, the Kumbh Mela and Songkran is attributed to the communities who hold it (Britannica; UNESCO) and is never asserted as fact by the book. *Environmental flows* is defined at first use with the MDBA's framing — water kept in, not taken out — which is also the framing the assessment tasks use.

For the teacher — teaching sequence. One sequence, six steps; each step pairs with one figure. **Step 1 — Five values.** Show Figure 1B-1. Read the five column heads (the curriculum's five value words) and the meaning line under each. Ask students to add one more example of their own to any column. Key idea to say aloud: *the same river can hold all five values at once*. **Step 2 — Economic value, national then Victorian.** Show Figure 1B-2, then Figure 1B-4. Teach the consumed/returned split using the chart's bottom note: hydro takes enormous volumes but returns almost all of them, so it is not a big *consumed* bar. Then land the Victorian story: one in five litres consumed in Australia is consumed in Victoria, and about three-quarters of that grows food and fibre through irrigation. **Step 3 — Environmental value.** Show Figure 1B-3. Key move: the river itself is a *user* of water. Environmental flows are a use, not a loss — 397 of the 482 GL came back to the system. Read the report card and ask what an "A" for waterbirds is evidence of. **Step 4 — Aesthetic and cultural value.** Show Figure 1B-5. Note that E04 asks for Australia *and* countries of Asia side by side; the table does exactly that. Ask students which sites hold both aesthetic and cultural value (the mauve rows). **Step 5 — Spiritual value in Asia.** Show Figure 1B-6. Model respectful, attributed language: *Hindus regard the Ganges as the holiest of rivers* — we describe the belief accurately without judging it. **Step 6 — The contested question.** Show Figure 1B-7. Read both panels at full strength, then launch the Big task. Do not preview your own view before students draft theirs.

The teacher shows how

Show 1 — reading the ABS water chart

Show the national water chart.

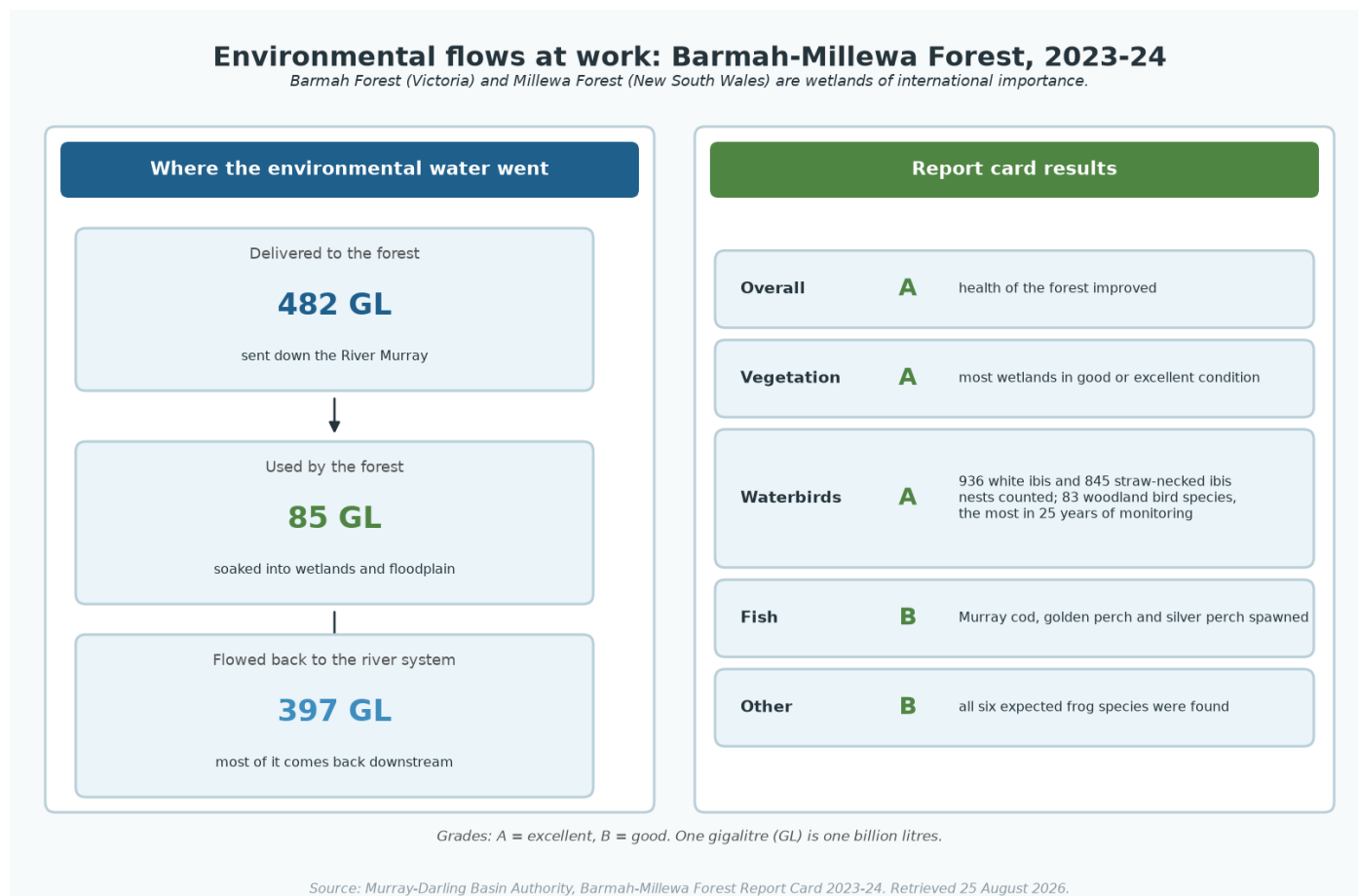


A bar chart of Australia's consumed water in 2023-24: agriculture 11,760 gigalitres, water supply 3,577, households 1,861, mining 749 and manufacturing 472, with the total 17,223 gigalitres

Think out loud: I start with the title: this chart is about **consumed** water — water used and not returned. The tallest bar is agriculture, forestry and fishing: 11,760 GL. Next to it I read the note: the whole country consumed 17,223 GL. So how big a share is farming? 11,760 out of 17,223 is roughly two out of every three litres. I check the small bars: households, 1,861 GL, is less than a sixth of the farm share. And I check the bottom note: hydro power takes far more water than any bar, but it gives it back, so it is not consumed water. Conclusion: in 2023-24, the biggest economic use of Australia's water was growing food and fibre. That is the **economic value** of water — it earns a living.

Show 2 — why environmental flows are a use of water

Show the Barmah-Millewa figure.



A two-panel figure: 482 gigalitres of environmental water delivered to Barmah-Millewa Forest, 85 used by the forest and 397 flowing back; and a report card grading vegetation, waterbirds, fish and frogs A or B

Think out loud: Someone might say environmental water is wasted water — it flows past farms and out to sea. I test that against the numbers. 482 GL was delivered to the forest. The forest used 85 GL. So 397 GL flowed back into the river system for other users further down. The water was borrowed, not lost. Now what did the loan buy? The report card: waterbirds A — 936 white ibis nests and 845 straw-necked ibis nests counted at one swamp; 83 woodland bird species, the most in 25 years of monitoring; Murray cod, golden perch and silver perch all spawned. Conclusion: leaving water in the river for the environment is an **essential use**, not a waste, because without it the forest, the fish and the birds lose their home — and the report card shows the flows working.

Tasks together

Task 1 — read the water chart. Use the national water chart from Show 1.

1. Which user consumed the most water in 2023-24?
2. List the five users from largest to smallest.
3. About how many times larger was agriculture's share than households' share? Show your working.
4. Hydro power took 27,673 GL in Tasmania alone, more than any bar. Why is it not the tallest bar on this chart?

Task 2 — match the value. Match each sentence to the best value word: *environmental, economic, cultural, spiritual, aesthetic, recreational*.

1. In Thailand, families pour water over the hands of elders at the new year.
2. Visitors at the Twelve Apostles stop and stare at the limestone towers.
3. Hindus bathe in the Ganges to wash the soul clean.

- Water is left in the river so the red gums, fish and waterbirds can live and breed.
- A vineyard buys water to grow grapes for sale.
- On hot days, families swim and picnic at the river.

Task 3 — the Barmah numbers. Use the Barmah-Millewa figure from Show 2.

- Fill in: 482 GL delivered = ____ GL used by the forest + ____ GL that flowed back.
- What overall grade did the forest score in 2023-24?
- Name two living things that did well because of the flows.

Task 4 — two protected waters. Use the protected-waters table.

Waters protected for their beauty and meaning <i>Bays, rivers, waterfalls and lakes given World Heritage or national-park protection because of their beauty and cultural worth.</i>				
Water place	Where	What kind of water	Protection	Why it is valued
Great Barrier Reef	Queensland, Australia	Coral reef and sea	World Heritage (listed 1981)	Outstanding natural beauty
Port Campbell National Park	Victoria, Australia	Southern Ocean coastline	National park	Twelve Apostles rise 45 m from the sea
Wilson's Promontory National Park	Victoria, Australia	Coast, sea and mountain streams	National park	Wild beaches and granite peaks
Jiuzhaigou Valley	Sichuan, China	Waterfalls and mountain lakes	World Heritage (listed 1992)	Exceptional scenery
Ha Long Bay	Quang Ninh, Vietnam	Bay with thousands of islands	World Heritage (listed 1994)	Dramatic sea scenery
Kii Mountain Range	Honshu, Japan	Streams, rivers and waterfalls	World Heritage (listed 2004)	Sacred to two religions; beauty and faith together
Bali Cultural Landscape	Bali, Indonesia	Rivers, springs and rice terraces	World Heritage (listed 2012)	Water temples guide a shared system

Teal marks aesthetic value; mauve marks cultural value. Many sites hold both.

Sources: UNESCO World Heritage List; Parks Victoria. All retrieved 25 August 2026.

A table of seven bays, rivers, waterfalls, lakes and coasts in Australia and Asia, with where each is, its protection as a World Heritage site or national park, and why it is valued

Pick one site in Australia and one site in a country of Asia. For each, write: what kind of water it is; what protection it holds; and in your own words, why people value it.

Task 5 — the spiritual value of water in Asia. Use the three case studies.

Why water is sacred: three case studies from Asia

In many Asian cultures, water is not only useful - it is holy. These three examples show what that looks like.

The River Ganges, India 2,510 km long and drains one quarter of India 'The holiest of rivers' for Hindus, who may scatter the ashes of the dead into it Bathing is believed to cleanse the soul, helping it towards moksha - freedom from the cycle of being reborn	The Kumbh Mela, India The world's largest public gathering and festival Four river sites including Prayagraj, where the Ganges and Yamuna rivers meet In 2019, over 200 million people visited at Prayagraj, and 50 million bathed on the single most important day	Songkran, Thailand The Thai New Year festival, celebrated every April Listed by UNESCO in 2023 as part of the world's living heritage Water is poured over Buddha statues, monks and elders. UNESCO says it stands for 'cleansing, reverence and good fortune'
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Sources: Britannica (Ganges; Kumbh Mela); UNESCO (Songkran; Bali). All retrieved 25 August 2026.

Three cards on the spiritual value of water in Asia: the River Ganges and the Kumbh Mela in India, and the Songkran new year in Thailand

1. Which river do Hindus regard as the holiest of rivers?
2. How large was the Kumbh Mela gathering at Prayagraj in 2019? Use two numbers from the card.
3. According to UNESCO, what does pouring water stand for at Songkran?
4. Songkran shows two of the five values at once. Name them and give a reason for each.

Task 6 — recreation tally. Water has **recreational value** too. At a water place you visit (or while your teacher shows pictures of one), tally four uses for ten minutes: swimming, fishing, walking by the water, boating. Draw your tally as a bar chart on grid paper, then write one sentence: *The most common use was ..., which shows the water's recreational value because ...*

Tasks on your own

Task 7 — explain environmental flows. In two or three sentences, explain why water left in rivers for the environment is an essential use, not wasted water. Use one number from the Barmah-Millewa figure as your evidence.

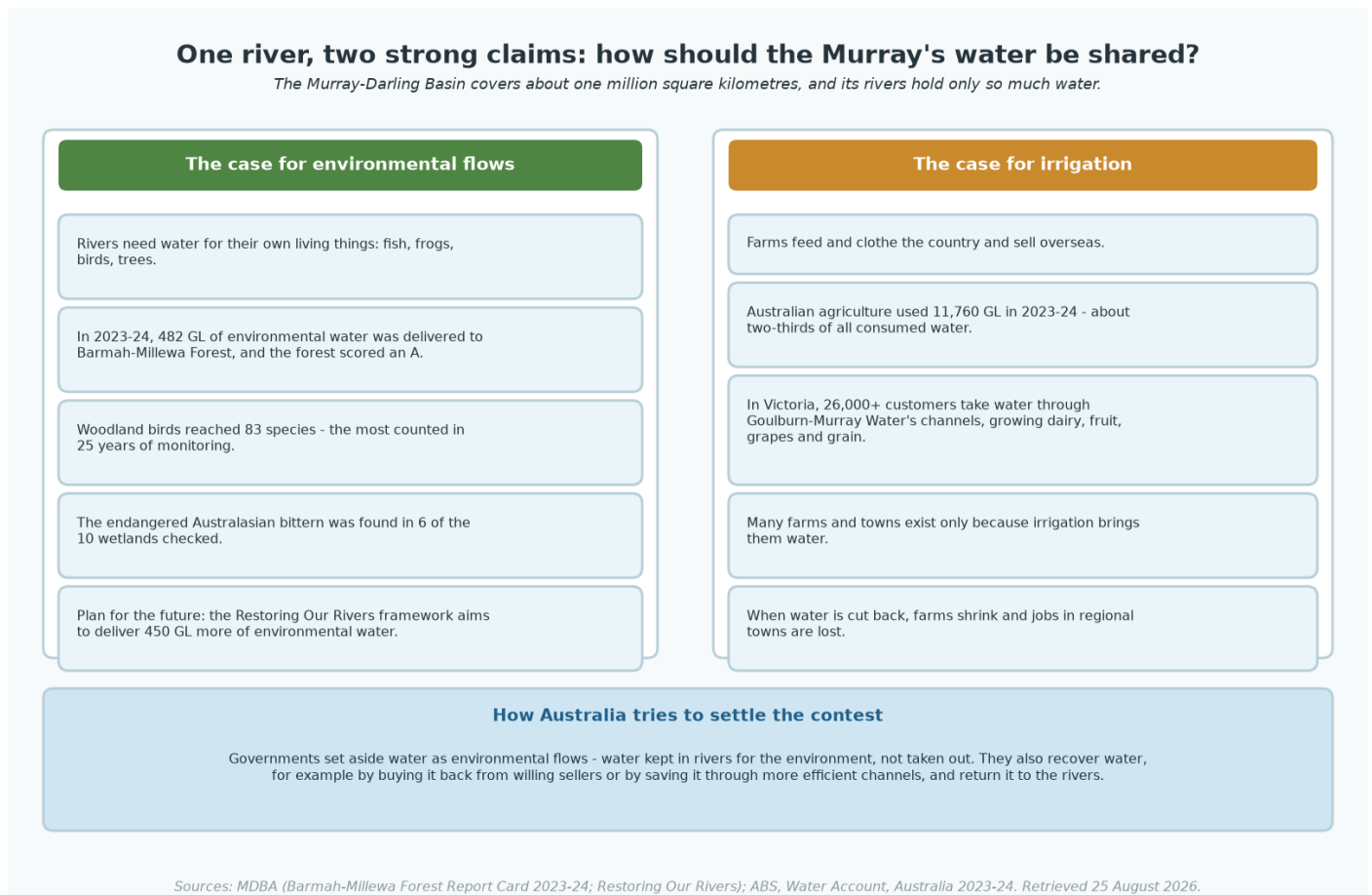
Task 8 — describe aesthetic value. Choose one site from the protected-waters table. Describe what a visitor sees and feels there. Use the words *aesthetic value* correctly in your answer.

Task 9 — compare two values. Water in the Ganges is used for bathing on holy days, and the same water is used for farming and drinking. In two or three sentences, explain how the river's spiritual value is different from its economic value.

Task 10 — two true comparisons. Using the national water chart, write two true comparison sentences about Australia's consumed water in 2023-24. Start one with *Agriculture ...* and one with *Households ...*

Big task — one river, two claims

Show the contested-question figure.



Two panels giving the strongest case for environmental flows and the strongest case for irrigation, with a strip below showing how governments set water aside for the environment

The River Murray holds only so much water, and both the environment and the farms want it. Write a reasoned response (about one page, or a two-minute speech) to this question:

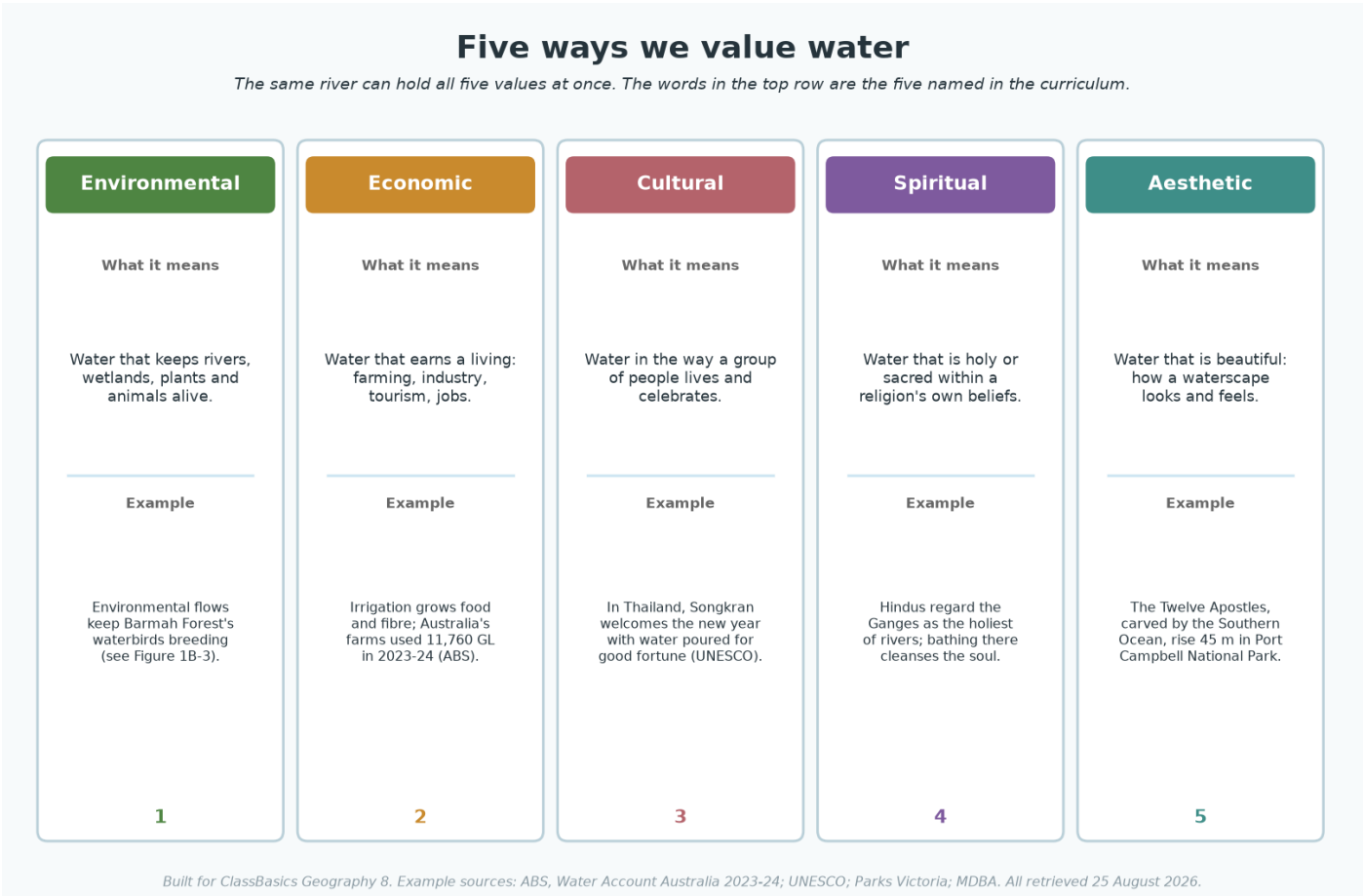
How should the Murray's water be shared between environmental flows and irrigation?

Your response must:

1. give the strongest case for **each** side in your own words;
2. use at least **one piece of evidence for each side** from this section's figures or charts (say which figure);
3. give **your own reasoned view**, and name one impact your view would have on people, places or the environment.

For the teacher — scoring the Big task. Listen for and tick: | The student ... | matches the band achievement standard's ... | |—|—| | restates both claims accurately and at strength | *weighing ethical values on a geographical issue* | | links each claim to evidence from a figure (Barmah report card; ABS water account; GMW facts) | *grounding findings in appropriate sources* | | refers to environmental **and** economic factors in reaching a view | *explaining a response while weighing environmental, economic and social factors* | | explains how the flows, the farms and the river system affect each other | *explaining how people, places and environments interconnect* | | names one impact of their chosen share | *draw reasoned conclusions* | A student who presents orally has still met the task: spoken response is a full assessment channel (TOC §2 D9).

The five values on one page



A chart of five columns named environmental, economic, cultural, spiritual, aesthetic, each with a plain meaning and one real example of that way of valuing water

Use this chart to check your answers to Tasks 2 and 9. The same river can hold all five values at once.



Three panels on Victoria's water economy: how the state's 3,649 gigalitres split between agriculture and other users, facts about Goulburn-Murray Water, and the foods the water grows

Use this chart to check your answers to Tasks 1 and 10, and your evidence in the Big task.

Notes for teachers

Sources (real, named, retrieved 2026-08-25):

- Australian Bureau of Statistics, *Water Account, Australia, 2023-24* (released 11 December 2025), abs.gov.au — national and Victorian consumed-water volumes (17,223 GL; 11,760 GL agriculture; 3,649 GL Victoria; 2,666 GL Victorian agriculture; 1,861 GL households), hydro extraction and return, and the 174 kL household average. Figures 1B-1, 1B-2, 1B-4; Shows 1-2; Tasks 1, 7, 10.
- Murray-Darling Basin Authority, *Barmah-Millewa Forest Report Card 2023-24* and *Restoring Our Rivers — Framework for delivering the 450 GL* (via web archive), mdba.gov.au — the 482/85/397 GL water budget, the A/B report card, the bittern and bird counts. Figures 1B-1, 1B-3, 1B-7; Show 2; Tasks 3, 7.
- Goulburn-Murray Water, corporate facts, gmwater.vic.gov.au — largest rural water corporation, 10,000 km of channels, 26,000+ customers, 23 storages holding ~11,400 GL, 68,000 km² service area. Figure 1B-4.
- Parks Victoria, *Port Campbell National Park* and *Wilson's Promontory National Park* park notes, parks.vic.gov.au — the Twelve Apostles rising 45 m above the Southern Ocean; the Promontory as the southernmost tip of the mainland. Figures 1B-1, 1B-5; Task 8.
- UNESCO World Heritage Centre, World Heritage List entries — Great Barrier Reef (1981), Jiuzhaigou Valley (1992), Ha Long Bay (1994), Sacred Sites and Pilgrimage Routes in the Kii Mountain Range (2004), Bali Cultural Landscape and the Subak System (2012); and the 2023 inscription of Songkran on the Representative List of the Intangible Cultural Heritage of Humanity, whc.unesco.org / ich.unesco.org. Figures 1B-5, 1B-6; Tasks 4, 5.

- Encyclopaedia Britannica, entries *Ganges River* and *Kumbh Mela* — 2,510 km length, one quarter of India drained, “the holiest of rivers”, 200+ million 2019 pilgrims at Prayagraj. Figure 1B-6; Task 5.

Scope notes:

- Aboriginal and Torres Strait Islander content is excluded (CONTENT_POLICY Rule 1; TOC §2A). VC2HG8K02 . E03 is not taught and is never paraphrased; the CD’s First Nations clause is not taught and nothing stands in for it. Source pages that also carry First Nations material (the Barmah report card’s First Nations partners; the Port Campbell Aboriginal cultural landscape statement) are used only for their environmental and physical facts.
- The Asia-region half of the CD stays live: E04’s Asia sites (Jiuzhaigou, Ha Long Bay, Kii Mountain Range, Bali) and E05’s Asian-culture investigation (Ganges/Kumbh Mela, with Songkran and Bali as comparators) are all taught.
- Every real-world number in student-facing text carries a traceable source above; every figure carries its source line and the retrieval date 25 August 2026. Figures are built from primitives, never traced from copyrighted maps (SOURCE_USE D6).
- Belief claims (the Ganges as holy; bathing and moksha; Songkran’s meanings) are attributed to the communities and sources that hold them (CONTESTED_TERMS), and the water-sharing contest is steelmanned on both sides before students judge (Figure 1B-7; Rule 4 symmetry).
- Vocabulary: every student-facing word sits at or below Yr8 on the house ladder, except the curriculum’s own words (the CD’s five value words and terms from the retained elaborations, WORD_LEVEL_POLICY Rule 2 exemption 1) and the subject terms defined at first use in “Words we use” (exemption 2). Verified by `gate_1b.py` in this folder.
- Spelling is en-AU throughout (litres, kilometres, fibre, metres).

Australia's water: unevenly spread, highly variable, and facing climate change

Geography 8 · Chapter 1 — Water in the world · Section 1C Owns VC2HG8K03. Draws on elaborations .E01, .E02, .E03, .E04 and .E05.

Theory

Teaching sequence (teacher note — not assessed student text)

1. Open with the balance sheet *where does the rain go?* (Figure 1) and teach the three fates of rain before any mapping.
2. Map the distribution (Figures 2–4): have students state the wet-edges, dry-middle pattern from the figures before reading the prose, then draw out what it means for people, including rural and remote towns (.E02).
3. Variability (Figures 5–7): *when* the rain arrives, how hard inflows swing between decades, and why drought lingers after rain returns (sponge effect).
4. Keep *observed* change (Figures 8–9) and *forecast* change (Figures 10–11) strictly separate in class discussion; the words “measured” and “forecast” must not blur.
5. Teach the confidence words before Figure 10. Present forecasts as careful statements that carry their confidence out loud; note that scientists argue about the *size* of future change (some say the models run hot, some say they run cool) and that the confidence words show where the evidence is strongest. Assess students on how they handle evidence and confidence words, not on which side of the argument they land.
6. Close with Q11 as the CD assessment task. What Australia *does* about its water — the management side — is carried at full depth in Section 1D; keep this section to distribution, variability and forecasts.

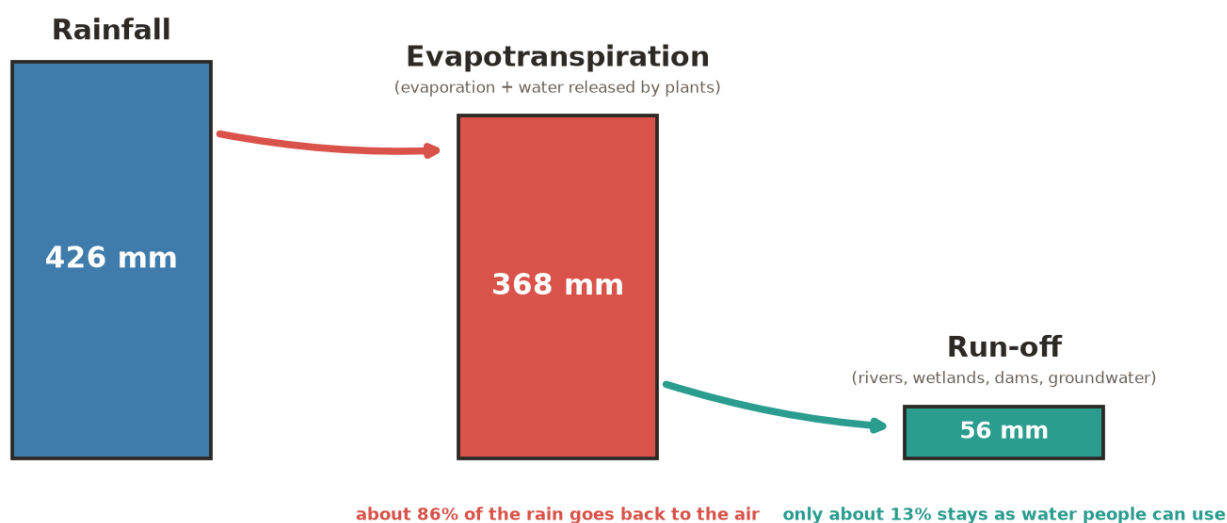
1. The water balance: three places the rain can go

Rain is Australia's only new water — everything else is recycled by the water cycle (Section 1A). But the rain total does not tell us how much water people can actually use. For that we keep a **water balance**: a record of the water coming in and the water going out.

When rain lands on the continent, three things happen to it. The sun turns much of it back into vapour — it **evaporates**. Plants drink some and release it from their leaves. Together these two losses are called **evapotranspiration** (evaporation + water released by plants). Whatever is left **runs off** into rivers, wetlands, dams and groundwater — the water held underground in the gaps in soil and rock.

Where the rain goes: Australia's water balance

An average year over the whole continent, 1911-2012. All amounts in millimetres of water.



Australia is the driest inhabited continent on Earth.

Across the continent, about 85-95% of the rain returns to the air and only about 5-10% becomes run-off.

Data: Bureau of Meteorology, Australian Water Resources Assessment 2012 - National Overview, checked 25 August 2026.

Australia's water balance as three bars: rainfall 426 millimetres, evapotranspiration 368 millimetres, and run-off 56 millimetres, with a note that Australia is the driest inhabited continent on Earth.

Source: Bureau of Meteorology, Australian Water Resources Assessment 2012 — National Overview, long-term record 1911–2012 (read via an archived copy), checked 25 August 2026.

So in an average year about 426 mm of rain falls on the continent, about 368 mm goes back to the air, and only about 56 mm runs off — roughly 13% of the rain. Across the continent as a whole, about 85–95% of the rain returns to the air and only about 5–10% becomes run-off.

That small run-off share is why Australia looks so different from other continents (.E01). Australia is the driest inhabited continent on Earth: its rainfall averages only 457 mm a year (1900–2020). And its rivers are among the most changeable in the world — the third most variable in a study of 1 221 rivers across 36 countries. Where a wetter continent gets the same rain, more of it stays in the rivers and less evaporates.

Because the run-off share is small, Australians have built a lot of storage to hold wet-year water: more than 500 major surface-water storages (each holding at least 1 GL), about 81 000 GL in total. A **gigalitre** (GL) is one billion litres. That is a lot of stored water *per person* by world standards:

Country	Surface-water storage per person
Australia	3.25 ML
United States	2.26 ML
South Africa	0.75 ML
China	0.57 ML
India	0.185 ML

(ML = megalitre, one million litres. A megalitre of stored water is not a megalitre of rain — it is water already caught and held.)

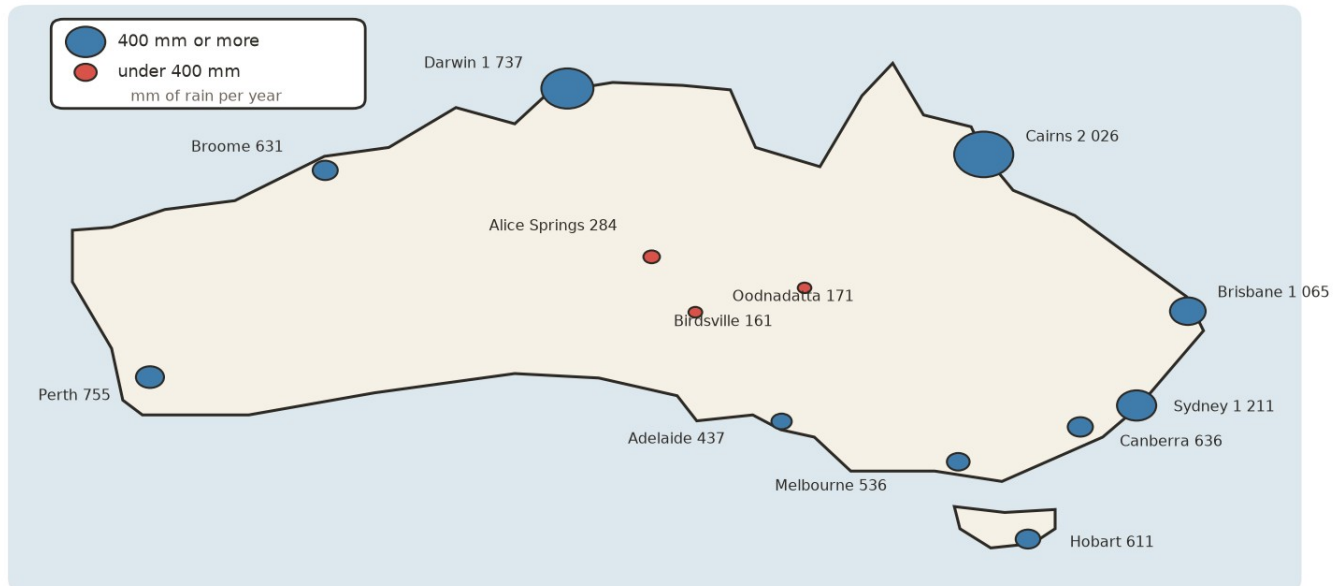
Much more water is stored *under* Australia than in its dams. The **Great Artesian Basin** — one of the biggest underground freshwater stores in the world — lies beneath about one-fifth of the continent, and it is the water that many inland towns and properties lean on.

(A data note: 426 mm and 457 mm are two long-term averages from two different government records, using different methods and year ranges. They differ a little and tell the same story.)

2. Where the water is: wet edges, dry middle

Rain per year at thirteen measuring stations

Each dot is a Bureau of Meteorology rainfall station. A bigger dot means more rain each year.



Wet edges, dry middle: Cairns gets about 2 026 mm a year; Birdsville gets about 161 mm - roughly 13 times less.

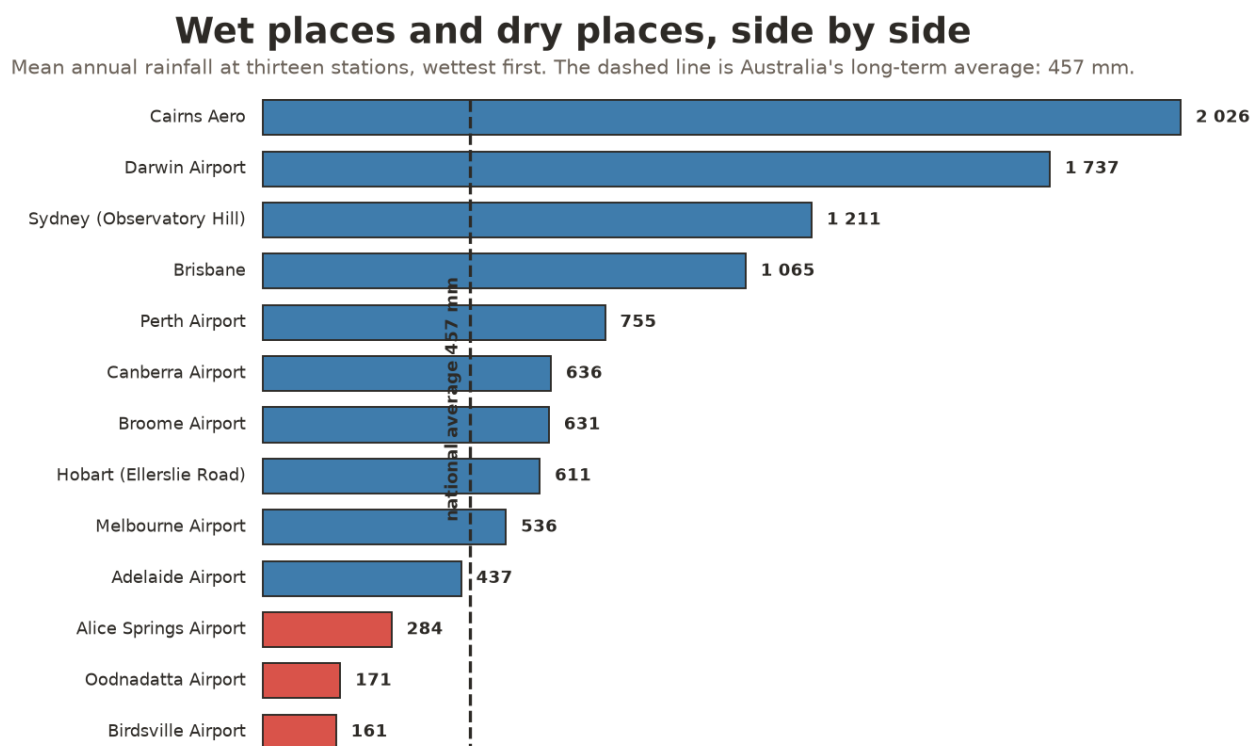
The wettest places are near the north and east coasts. The dry middle covers most of the continent.

Data: Bureau of Meteorology climate averages tables, checked 25 August 2026.

The coastline is simplified, and dots are placed near each station's position. Not for navigation.

A simplified map of Australia with 13 Bureau of Meteorology rainfall stations shown as dots sized by rainfall: large blue dots such as Cairns (2 026 millimetres) near the north and east coasts, and small red dots such as Birdsville (161 millimetres) in the dry middle.

Source: Bureau of Meteorology climate averages tables, 13 stations, checked 25 August 2026.



Nine of the thirteen places get more rain than the national average - and the three driest are all far inland.

mm of rain per year

Data: Bureau of Meteorology climate averages tables and Australia State of the Environment 2021, checked 25 August 2026.

A horizontal bar chart ranking the same 13 stations from Cairns Aero at 2 026 millimetres down to Birdsville Airport at 161 millimetres, with a dashed line at the national average of 457 millimetres.

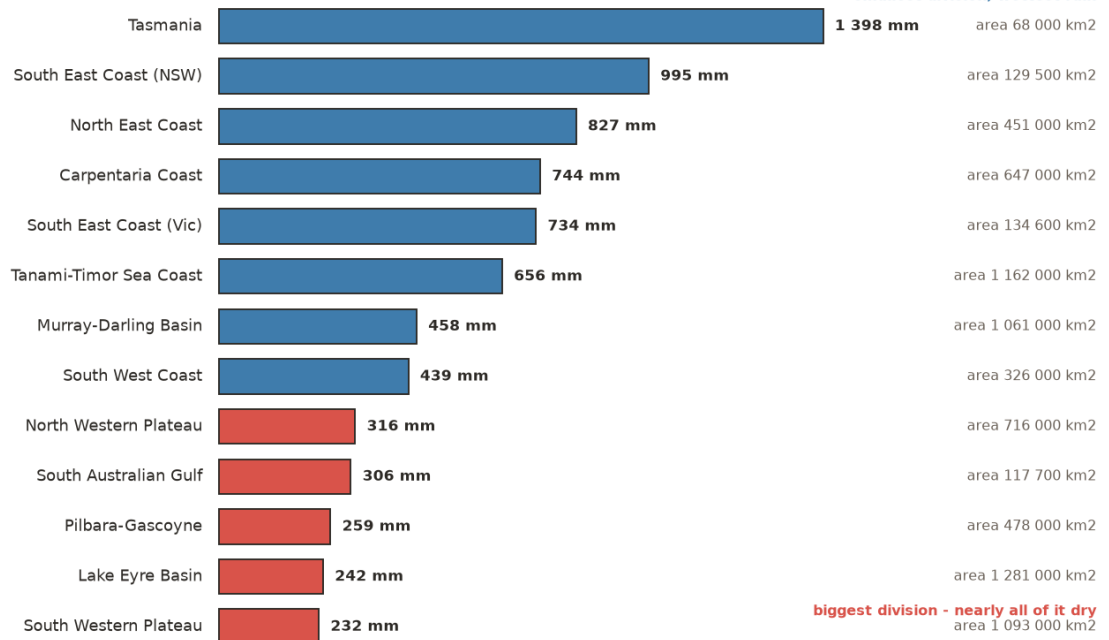
Source: Bureau of Meteorology climate averages tables and Australia State of the Environment 2021, checked 25 August 2026.

The pattern is quick to see: the wet places ring the edges — above all the north and east — while the middle is dry. Cairns gets about 2 026 mm in a year and Birdsville about 161 mm: roughly 12.5 times less, on the same continent, in the same years.

Geographers also read the map through 13 **drainage divisions** — big areas whose rain drains into the same river systems.

Thirteen drainage divisions: how big they are, how wet

A drainage division is all the land whose rain collects into the same river systems. Bars show mean annual rainfall; the grey text gives each division's area. **smallest division, wettest rain**



Size and rain do not match: the Lake Eyre Basin is the biggest division, yet it gets only 242 mm of rain a year.

It only fills after rare, huge rains: in early 2019, two heavy rainfall events sent run-off flowing into the basin.

Data: Australia State of the Environment 2021, inland water - drainage divisions table, checked 25 August 2026.

A horizontal bar chart of the 13 drainage divisions ranked by rainfall, from Tasmania at 1 398 millimetres to the South Western Plateau at 232 millimetres, with each division's area printed beside it.

Source: Australia State of the Environment 2021, inland water — drainage divisions table, checked 25 August 2026.

Notice what the divisions show: size and rain do not match. The Lake Eyre Basin is the biggest division on the map, yet it gets only 242 mm of rain a year — and it only fills after rare, huge rains, as in early 2019, when two heavy rainfall events sent run-off flowing into the basin.

What does the pattern mean for people? (.E02) Most Australians live where the water is: every state capital sits on or near the coast, in the wetter ring. In rural and remote Australia the picture is harder — a town in the dry middle gets a fraction of a coastal city's rain, so its access to water is limited: it cannot simply take more from a river. Inland communities lean on what they can store, on groundwater such as the Great Artesian Basin, and on careful rationing in dry years. The distribution of the rain is also the distribution of the choices.

That mismatch is the start of this chapter's management argument: where water is far from the people, or does not arrive when it is needed, people must store it, move it or save it — and the forecasts at the end of this section tighten that argument. (The strategies themselves — how societies answer scarcity — are Section 1D's story.)

3. Why the water varies: five factors

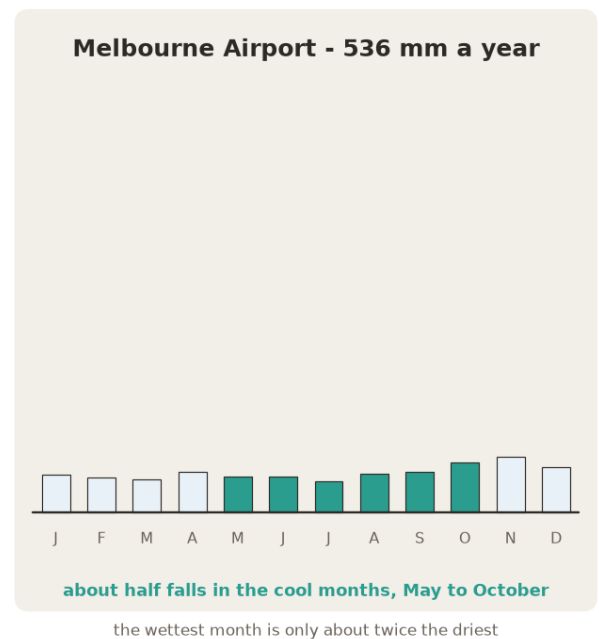
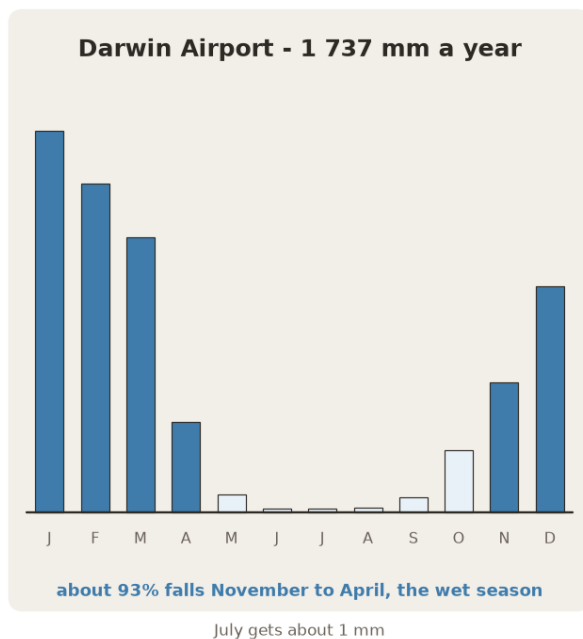
Australian water varies from place to place and from year to year. Five factors drive that variability (.E03):

- **Location.** Near the coasts, and in the north, rain is plentiful; far inland it is scarce (Figures 2–4).
- **Climate and its drivers.** Shifts in the oceans and winds around Australia swing whole years between wet and dry, so a “normal” year is hard to find.
- **Topography** — the shape of the land. When moist sea air is forced up over a range such as the Great Dividing Range, it cools and drops its rain on the coastal side, leaving the inland side drier.

- **Seasonality** — *when* the rain arrives during the year. The north and the south keep almost opposite rain calendars:

When the rain arrives: two very different rain calendars

Mean rainfall for each month of the year. Seasonality means **WHEN** a place gets its rain.



Northern Australia waits for the summer wet season; southern Australia leans on cool-season rain.

Data: Bureau of Meteorology climate averages tables (Darwin Airport 1941-2026; Melbourne Airport 1970-2026), checked 25 August 2026.

Two monthly rainfall bar charts: Darwin Airport, with about 93% of its 1 737 millimetres falling November to April and a near-dry July; Melbourne Airport, with its 536 millimetres spread across the year and about half falling May to October.

Source: Bureau of Meteorology climate averages tables (Darwin Airport 1941–2026; Melbourne Airport 1970–2026), checked 25 August 2026.

- **Evaporation.** Hotter places and hotter years return more water to the air, so less runs off — which is why a dry, hot year starves the rivers twice over.

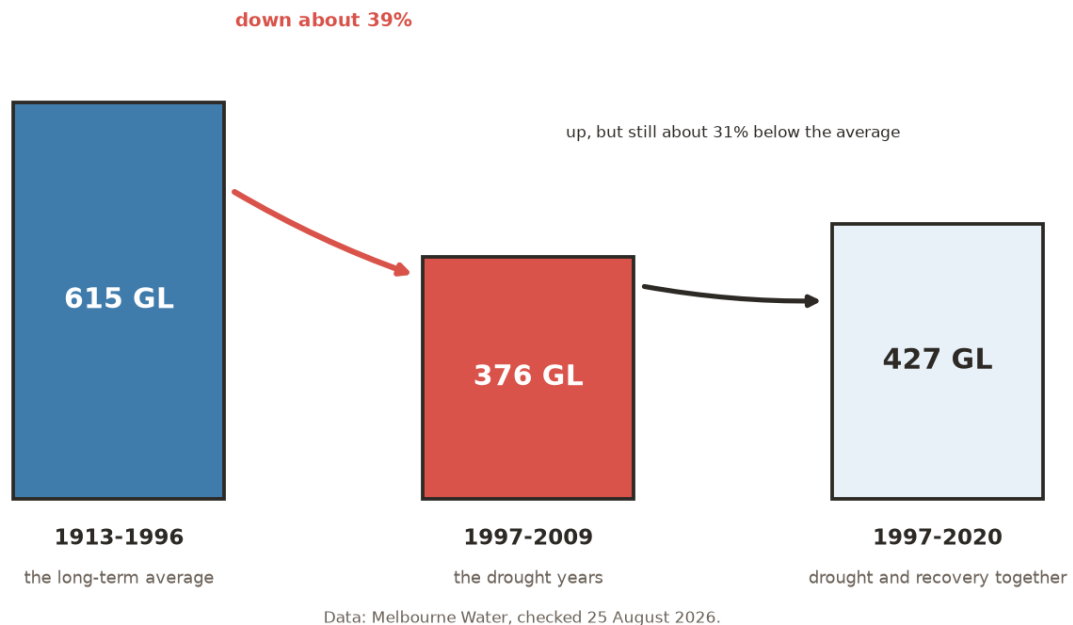
The year-to-year swing is not small. Melbourne's storages show it:

Same dams, different decades

Average water flowing into Melbourne's storages each year, in gigalitres (GL). One GL is one billion litres.

The dams did not move and the city did not shrink - the rain did the changing.

During the 1997-2009 drought the same catchments delivered about two-fifths less water, every single year.



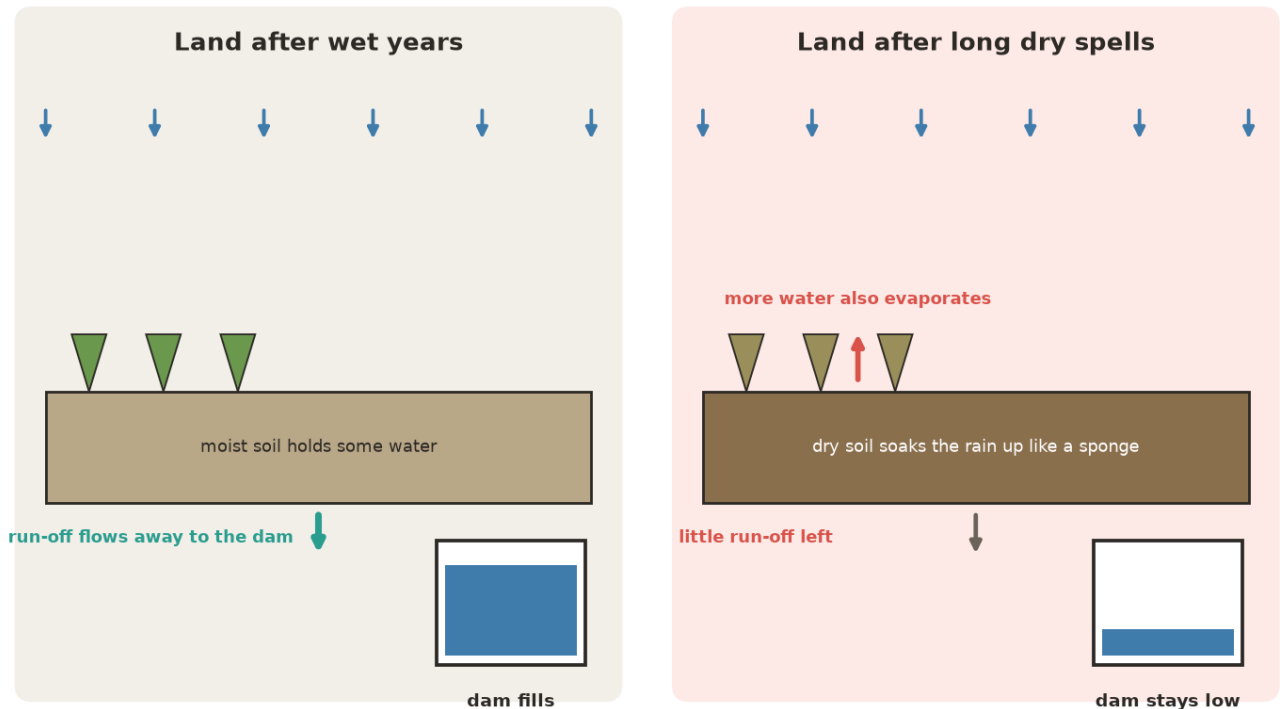
Three bars of average inflow into Melbourne's storages: 615 gigalitres a year over 1913–1996, 376 gigalitres in the drought years 1997–2009, and 427 gigalitres across 1997–2020.

Source: Melbourne Water, checked 25 August 2026.

The same dams, the same city — but the rain changed, and inflows fell about 39% in the drought years. And a drought does not end the day rain returns. A dry catchment (the land that drains into a river or dam) behaves like a dry sponge:

Why dams recover slowly after dry years: the sponge effect

The same rain falls on two landscapes. Dry land soaks it up like a dry sponge, so less reaches the dam.



After a drought, the first rains refill the soil, not the dam - so water supplies stay short even when rain returns.

The process as described by Melbourne Water (The Sponge Effect), checked 25 August 2026.

A two-panel schematic of the sponge effect: the same rain falling on land after wet years, where moist soil lets run-off reach a filling dam, and on land after long dry spells, where dry soil soaks the rain up and the dam stays low.

Source: the sponge effect as described by Melbourne Water, checked 25 August 2026.

So variability is not only “some years are dry”. It is also “the wet years and the dry years stack up”, and “the first rains after a drought are swallowed by the soil”.

4. Change already measured

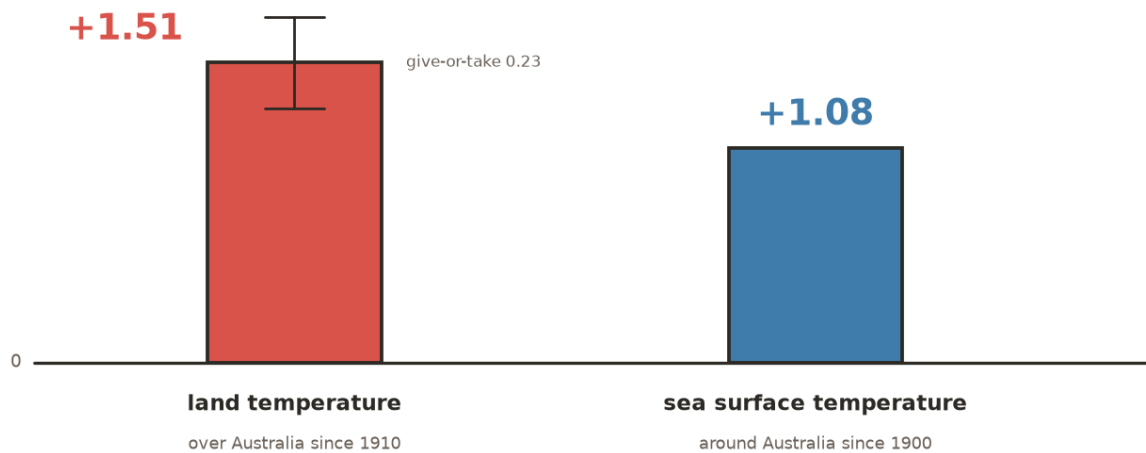
The water balance above is a long-term average — and the climate that produced it has already shifted (.E04). Two changes are measured, not forecast:

The measured change: Australia has warmed

How much temperatures have risen since official records began, in degrees Celsius.

A warmer land loses more water to the air.

Heat speeds up evaporation from soil, rivers and storages, and warmer air can hold more water vapour - both squeeze the water balance.



Data: Bureau of Meteorology and CSIRO, State of the Climate 2024, checked 25 August 2026.

Two bars with uncertainty whiskers on the first: land temperature over Australia up 1.51 degrees Celsius (give-or-take 0.23) since 1910, and sea surface temperature around Australia up 1.08 degrees since 1900.

Source: Bureau of Meteorology and CSIRO, State of the Climate 2024, checked 25 August 2026.

A warmer land loses more water to the air: heat speeds up evaporation from soil, rivers and storages, and warmer air holds more water vapour. The warming squeezes the water balance before any change in rain.

Rain is changing - but not the same way everywhere

Changes already measured in Australia's cool-season rain (the rain that fills rivers and dams in the south).



River flows have also fallen at most measuring stations in the south since 1970.

Less rain AND less river water: the drying shows up twice in the record.

Data: Bureau of Meteorology and CSIRO, State of the Climate 2024, checked 25 August 2026.

Three cards of measured cool-season rainfall change: south-west Australia down 16% since 1970 (20% in the wettest months), south-east Australia down 9% since 1994, and parts of northern Australia up since the 1970s.

Source: Bureau of Meteorology and CSIRO, State of the Climate 2024, checked 25 August 2026.

River flows tell the same story twice: since 1970, flows have fallen at most measuring stations in the south. Yet the change is not uniform — rain and flows have *risen* in parts of northern Australia since the 1970s. The drying is a southern pattern, not a national one.

5. Forecasts, with the confidence words left in

A **forecast** is a careful statement about the future, and scientists attach a confidence word to it so readers know how strong the evidence is (.E04, .E05). Forecasts are not promises and not guesses. Scientists disagree about the *size* of future change — some argue the models run hot, some argue they run cool — and the confidence words are how they show which claims the evidence backs most strongly. In this section you are assessed on how you use the evidence and the words, not on which side of that argument you end up on.

The Murray–Darling Basin Authority did exactly this for the continent’s biggest river system — about 1 million square kilometres, about 2.4 million people, 16 wetlands of international importance:

Forecasts for the Murray-Darling Basin - and how sure scientists are

The Basin is Australia's biggest river system: about 1 million square kilometres, about 2.4 million people, 16 wetlands of international importance.

The Basin gets hotter	virtually certain
Heavy rainfall events become more intense	very likely
Less run-off and less water available, especially in the south	very likely
Droughts become more frequent and more severe, and possibly longer	very likely
Cool-season rainfall falls in the southern Basin	very likely
Cool-season rainfall falls in the northern Basin	likely
Year-to-year rainfall becomes more variable	likely
Large floods get higher and last longer, while moderate floods become less frequent	likely

How to read the chips:

the Authority's own confidence words, strongest on top.

virtually certain	very likely	likely
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A forecast is a careful statement about the future, with its level of confidence stated out loud.

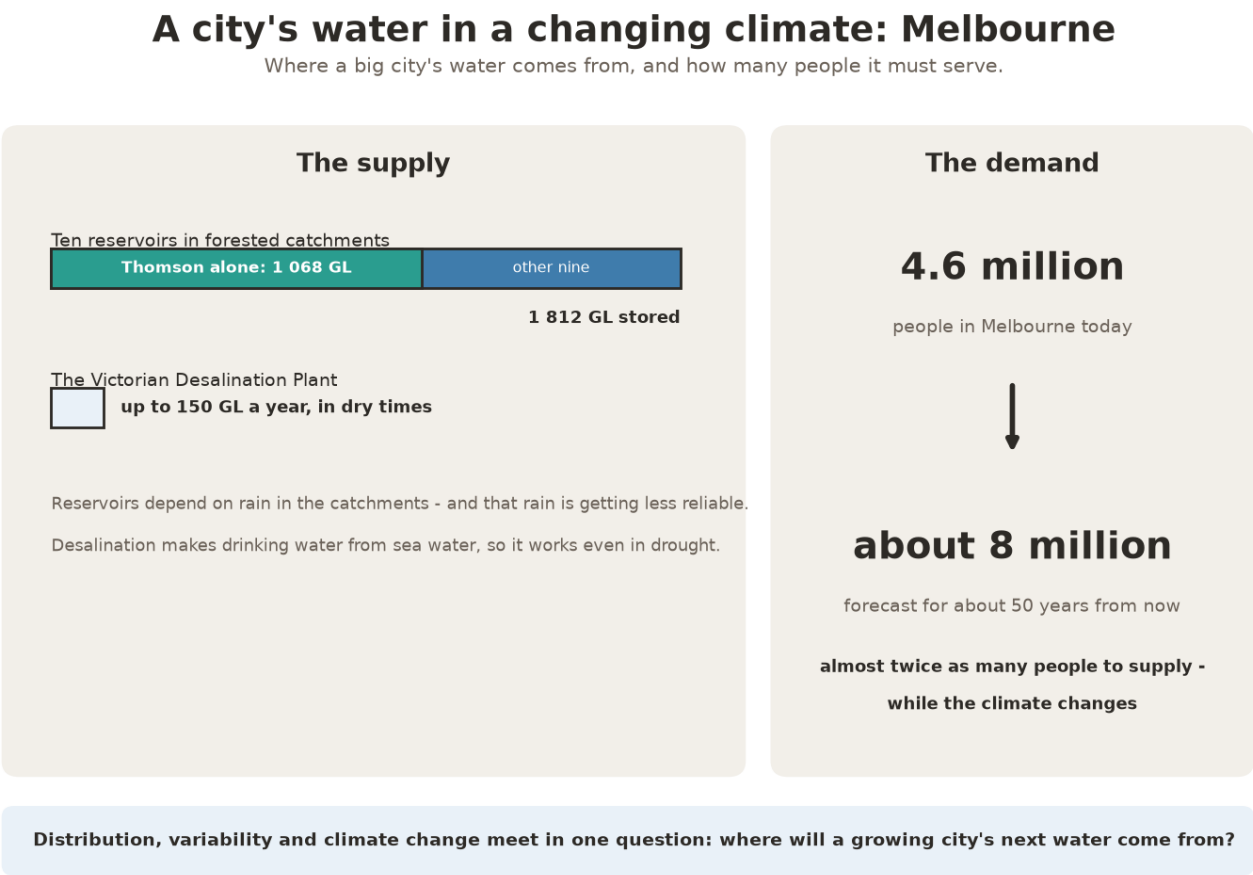
Data: Murray-Darling Basin Authority, Sustainable Yields 2025 - insights and findings, checked 25 August 2026.

Eight forecast statements for the Murray-Darling Basin, each paired with a confidence chip: the Basin gets hotter (virtually certain); heavy rainfall events more intense, less run-off and water available especially in the south, droughts more frequent and severe, and cool-season rain falling in the southern Basin (all very likely); cool-season rain falling in the northern Basin, more variable year-to-year rain, and larger but less frequent floods (all likely).

Source: Murray-Darling Basin Authority, Sustainable Yields 2025 — insights and findings, checked 25 August 2026.

Read the chips and the picture is consistent: hotter, more variable, and — especially in the south — less run-off and less water available, with droughts biting harder.

Now set those forecasts against a real city’s water book (.E05):



Working	Comment
Evapotranspiration 2011–12: $567 - 83 = 484$ mm (report says 483 mm).	About 85% of even a flood year returns to the air. ✓

Demonstration 2 — scaffolded (.E04)

A what-if for a southern city, built from *observed* numbers. Melbourne’s storages received 427 GL a year across 1997–2020. Suppose a future drought cut inflows by the same share as the 1997–2009 drought (about 39% below the 615 GL long-term average).

Working	Comment
Loss = $427 \times 0.39 \approx 167$ GL a year.	The same percentage fall, applied to today’s lower baseline.
Left = $427 - 167 \approx 260$ GL a year.	Compare the 615 GL the dams once averaged: less than half of it.
$167 \div 1\,812 \approx 0.09$, about 9% of everything the reservoirs can hold — lost in one year.	Using the storage size (Figure 11) makes the loss real.
Caution: this is arithmetic on past percentages, a thought experiment — not a model forecast.	Real forecasts carry confidence words, as in Figure 10. ✓

Practice questions

Scaffolded

Q1 (.E01). Figure 1. (a) How many mm of rain fall on Australia in an average year? (b) Which is larger: the water that returns to the air, or the water that runs off? (c) Show that the run-off share is about 13%.

Q2 (.E01). The storage table in Section 1. (a) Which country stores the most surface water per person? (b) About how many times more does Australia store per person than India? (c) Give one reason Australia has needed to build so much storage.

Q3 (.E02). Figures 2 and 3. (a) Name the wettest and the driest station, with each one’s total for a year. (b) Which three stations sit far inland and get under 300 mm a year?

Q4 (.E02). A remote town in the dry middle and a capital city on the coast both need water every day. Using one number from Figure 2 or 3, explain why the remote town’s access to water is more limited.

Q5 (.E03). Figure 5. (a) Which months make up Darwin’s wet season? (b) About what share of Darwin’s rain falls in those months? (c) Which half of the year does Melbourne lean on?

Q6 (.E03). Figures 6 and 7. (a) How many GL a year below the 615 GL average were the drought-year inflows? (b) About what percentage fall is that? (c) Use the sponge effect to explain why the dams recovered slowly after the drought.

Un scaffolded

Q7 (.E02). Figure 4. “Size and rain do not match.” Explain this sentence using two named divisions and their numbers, and suggest one reason the biggest division is so dry.

Q8 (.E03). Choose two named stations from Figure 2 — one wet, one dry. Explain the difference between them using two *different* factors from the list of five in Section 3.

Q9 (.E04). Figures 8 and 9. Describe two changes already *measured* in Australia’s climate, and for each, explain how it squeezes the water balance in the south.

Q10 (.E05). Figure 10. (a) In your own words, what is the difference between “virtually certain” and “likely”? (b) Some people argue the climate models run hot; others argue they run cool. Explain why the Basin Authority still attaches confidence words to each forecast instead of a single yes-or-no answer.

Evidence-based response task

Q11 (.E01–.E05). Your town has asked for a one-page briefing: *What should we expect for our water over the next 50 years?* Choose Melbourne or any Victorian town you know.

Write 250–350 words that:

- use at least **three** figures from this section as evidence, each naming the number **and** its source;
 - include at least one *measured* change and one *forecast* change, kept clearly separate;
 - use at least one confidence word from Figure 10 correctly;
 - close with one sentence on what your town’s evidence means for the people who live there.
-

Answers

- Q1.** (a) about 426 mm. (b) The water that returns to the air (368 mm against 56 mm). (c) $56 \div 426 \approx 0.13 \approx 13\%$.
- Q2.** (a) Australia (3.25 ML per person). (b) $3.25 \div 0.185 \approx 17.6$, about 18 times. (c) Any one: because so little of the rain runs off (about 13%), and because the rivers vary so much, wet-year water must be held for dry years.
- Q3.** (a) Cairns (about 2 026 mm) and Birdsville (about 161 mm). (b) Alice Springs (284 mm), Oodnadatta (171 mm), Birdsville (161 mm).
- Q4.** Any answer tying a number to limited access, e.g. Birdsville gets about 161 mm a year against 2 026 mm at Cairns, so a remote town has little river water to draw on and must lean on groundwater and what it can store.
- Q5.** (a) November to April. (b) about 93%. (c) The cool months, May to October (about half its rain).
- Q6.** (a) $615 - 376 = 239$ GL a year. (b) $239 \div 615 \approx 0.39$, about 39%. (c) After long dry spells the dry soil soaks up the first rains like a sponge, so run-off stays low and the dams refill slowly even once rain returns.
- Q7.** Pattern: the Lake Eyre Basin is the biggest division (1 281 000 km²) yet gets only 242 mm, while the smallest, Tasmania (68 000 km²), gets the most rain (1 398 mm). Reason (any one): far from the sea; hot, with high evaporation; no wet coastal side.
- Q8.** Any two stations with two different factors correctly applied, e.g. Darwin is wet because of location (northern, close to the wet-season winds) and seasonality (summer wet season); Alice Springs is dry because of location (far inland) and topography/distance from moist sea air.
- Q9.** Any two measured changes with a balance link, e.g. land temperature up 1.51 °C since 1910 → more evaporation from soil, rivers and storages; cool-season rain down 9% in the south-east since 1994 → less rain arriving when southern dams usually fill.
- Q10.** (a) “Virtually certain” = the evidence is as strong as it gets; “likely” = more likely than not, but with real doubt left. (b) Because the evidence differs in strength from claim to claim; the words show where the science is solid and where it is less so, and honest scientists say so out loud instead of pretending to one sure answer.
- Q11.** See the sample response in the worked solutions.
-

Fully-worked solutions

- Q1.** (a) 426 mm. (b) Returns to the air: 368 mm > 56 mm of run-off. (c) Run-off share = $56 \div 426 \approx 0.13$, so about 13% of the rain becomes water people can use.
- Q2.** (a) Australia, 3.25 ML per person. (b) $3.25 \div 0.185 \approx 17.6$ — about 18 times India’s 0.185 ML. (c) Sample: *Only about 13% of Australia’s rain runs off, and the rivers swing hard between wet and dry years, so Australians built big storages to hold wet-year water for dry years.*
- Q3.** (a) Wettest: Cairns, about 2 026 mm a year; driest: Birdsville, about 161 mm. (b) Alice Springs (284 mm), Oodnadatta (171 mm) and Birdsville (161 mm) — the three far-inland stations.
- Q4.** Sample: *Coastal Cairns receives about 2 026 mm of rain a year while Birdsville, far inland, receives about 161 mm (Bureau of Meteorology). With so little local rain, a remote town has little surface water to take and must depend on groundwater and small storages — its access to water is simply more limited.*
- Q5.** (a) November to April. (b) About 93%. (c) May to October, the cool months — about half of its year’s rain.
- Q6.** (a) $615 - 376 = 239$ GL a year below average. (b) $239 \div 615 \approx 0.39 \approx$ a 39% fall. (c) Sample: *The sponge effect: after long dry spells the soil and plants soak up the first rains, so little run-off reaches the storages — which is why inflows across 1997–2020 averaged only 427 GL, still about 31% below the old average, even after rain returned.*
- Q7.** Sample: *The Lake Eyre Basin covers 1 281 000 km² — the biggest division — yet averages only 242 mm of rain, while Tasmania, the smallest division at 68 000 km², averages 1 398 mm. The biggest division is so dry because it lies far inland, where moist sea air never reaches and hot, flat country loses what little rain it gets to evaporation.*

Q8. Sample: *Darwin (1 737 mm) is wet because of location and seasonality: it sits in the north, where the summer wet season dumps about 93% of the year's rain between November and April. Alice Springs (284 mm) is dry because of location and topography: it sits far inland, behind the ranges and far from moist sea air, so most rain falls before it arrives.*

Q9. Sample: *(1) Measured: land over Australia has warmed 1.51 °C since 1910 — more heat means more evaporation from soil, rivers and storages, so less water stays in the system. (2) Measured: cool-season rain in the south-east has fallen 9% since 1994 — and that is the rain that fills southern rivers and dams, so inflows shrink. Both squeeze the balance from a different side.*

Q10. Sample: *(a) “Virtually certain” is the strongest chip — the evidence leaves almost no doubt; “likely” means more likely than not, with real uncertainty left. (b) Scientists disagree about the size of future change, and the evidence is stronger for some claims (warming) than others (floods). The confidence words keep that honesty visible: each forecast is rated by its own evidence, and readers can see exactly how sure the scientists are. That is why a forecast here is a careful statement, not a guess — and why your marking in this section rewards how you use the words, not which camp you join.*

Q11. Sample response (about 300 words, Melbourne):

Water outlook briefing — Melbourne

Melbourne's water story starts with distribution. The city sits in the wetter southern ring of the continent, but its catchments still depend on cool-season rain — and that rain is changing.

First, the measured changes. Australia's land temperature has risen 1.51 °C since 1910 (Bureau of Meteorology and CSIRO, *State of the Climate 2024*), and warmer air pulls more water back out of soils, rivers and storages. Cool-season rain in south-east Australia has already fallen 9% since 1994 (same source). Melbourne's own records show what variable rain can do: inflows averaged 615 GL a year over 1913–1996 but only 376 GL in the drought years 1997–2009 — a fall of about 39% from the same catchments (Melbourne Water).

Second, the forecasts. For the Murray–Darling Basin — the south's great river system — the Basin Authority rates less run-off and less water available, especially in the south, as “very likely”, and a hotter basin as “virtually certain” (Murray–Darling Basin Authority, *Sustainable Yields 2025*). “Very likely” is not certainty, but it is strong enough to plan on.

Third, the demand side. Melbourne must supply about 8 million people in about 50 years, against 4.6 million today (Melbourne Water). Its ten reservoirs hold 1 812 GL, and the Victorian Desalination Plant can add up to 150 GL a year in dry times (Victorian Government) — but the reservoirs still depend on rain that is measured as falling and forecast to keep falling in the south.

For Melbourne's people, that means the next 50 years will be planned around less reliable rain: every source matters, and every litre saved counts twice.

Sources (all checked 25 August 2026)

- Bureau of Meteorology, *Australian Water Resources Assessment 2012* — National Overview (long-term water balance 1911–2012: 426/368/56 mm; 2011–12: 567/483/83 mm; 85–95% and 5–10% shares; read via an archived copy).
- Bureau of Meteorology and CSIRO, *State of the Climate 2024* (warming of 1.51 °C since 1910 and 1.08 °C seas since 1900; observed cool-season rainfall falls; river-flow trends; northern increases).
- Bureau of Meteorology, climate averages station tables (13 stations' mean annual rainfall; Darwin Airport 1941–2026 and Melbourne Airport 1970–2026 monthly averages).
- Australian Government, *Australia State of the Environment 2021* — Inland water (457 mm mean 1900–2020; driest inhabited continent; river-flow variability, McMahon et al. 2007, 1 221 rivers in 36 countries; 500+ major storages and 81 000 GL; per-person storage vs AQUASTAT 2017; Great Artesian Basin; drainage divisions table; early-2019 flows into the Lake Eyre Basin).
- Melbourne Water (storage inflows 615/376/427 GL; the sponge effect; ten reservoirs, 1 812 GL, Thomson 1 068 GL; population 4.6 million growing to about 8 million).

- Murray–Darling Basin Authority, *Sustainable Yields 2025* — insights and findings (Basin forecasts with confidence words; Basin facts).
- Victorian Government, desalination plant pages (up to 150 GL a year in dry times).

Water scarcity: why places run short, and what people do about it

Curriculum focus — Victorian Curriculum 2.0, Geography, Levels 7 and 8 band, strand *Geographical Knowledge and Understanding*, sub-strand *Water in the world*. This section owns content description VC2HG8K04 and draws on elaborations VC2HG8K04.E01 · VC2HG8K04.E02 · VC2HG8K04.E03 (cross-curriculum priority: Sustainability). Case regions: **Australia** and **West Asia** (the series default).

In this section

Water is a **renewable resource**: the water cycle keeps refilling rivers, lakes and underground water. But the refill is not spread out evenly. Some places get far more water than they need, and some places get far less. When a place cannot get enough fresh water for its people, its farms and its environment, we say it faces **water scarcity**.

In this section you will learn to:

- define water scarcity and tell apart its two forms — **physical** and **economic** scarcity;
- read real data to work out which places are short of water, and why national averages can mislead;
- explain the three causes of water scarcity (VC2HG8K04.E01);
- explain why water is one of the hardest resources to manage (VC2HG8K04.E02);
- describe six strategies for overcoming water scarcity, and **evaluate** each one for **effectiveness** and **sustainability** (VC2HG8K04.E03);
- apply all of this to real places in **Australia** and **West Asia**.

Key words to learn: water scarcity, physical scarcity, economic scarcity, renewable, groundwater, aquifer, reservoir, desalination, brine, stormwater, recycling, virtual water, irrigation, water stress.

Defining our terms: what “water scarcity” means here

“Water scarcity” is a debated term: different organisations measure it in different ways, and their measures are not interchangeable. The curriculum does not fix one definition, so this section states the one we will use.

Working definition. A place faces **water scarcity** when it cannot get enough usable fresh water to meet the needs of its people, its farms and its environment — that is, when demand for water is greater than the usable supply.

The guide lines we use. In 1989 the Swedish water researcher Malin Falkenmark proposed a simple measure: count a country’s **renewable fresh water** (the water nature replaces each year) **per person** each year, in cubic metres (m³). Her guide lines are still widely used:

Renewable fresh water per person each year	What it means
more than 1,700 m ³	little or no water stress
1,000 to 1,700 m ³	water stress: shortages from time to time or in some places
less than 1,000 m ³	water scarcity
less than 500 m ³	absolute water scarcity

Another measure exists. The United Nations also tracks water stress as the share of renewable supply that a country takes out each year (withdrawals divided by renewable supply). A country can pass the per-person test yet still take out more than nature replaces — which is why this section shows you *both* measures. Where you see the term “water scarcity” in this section, it means the working definition above unless we say otherwise.

1. Two ways a place can run short of water

Scarcity can come from two different directions, and the difference matters because each kind needs a different fix.

Physical scarcity means there is simply not enough water in the place. Little rain, few rivers and high evaporation mean demand is bigger than what nature provides. Much of inland Australia and much of West Asia sit in this group.

Economic scarcity means the water *is* there, but people cannot get it. There is not enough money, and the dams, pipes and treatment plants have not been built to capture, clean and deliver it. A place can have good rain yet still have dry taps.

Two ways a place can run short of water

Physical scarcity

There is simply not enough water in the place.

Little rain, few rivers,
high evaporation.

Demand is bigger than
what nature provides.

Examples: inland Australia,
much of West Asia.

Economic scarcity

Water is there, but people cannot get it.

Not enough money, dams,
pipes or treatment plants.

The rain may be fine,
yet taps still run dry.

Examples: some wet regions
with poor water works.

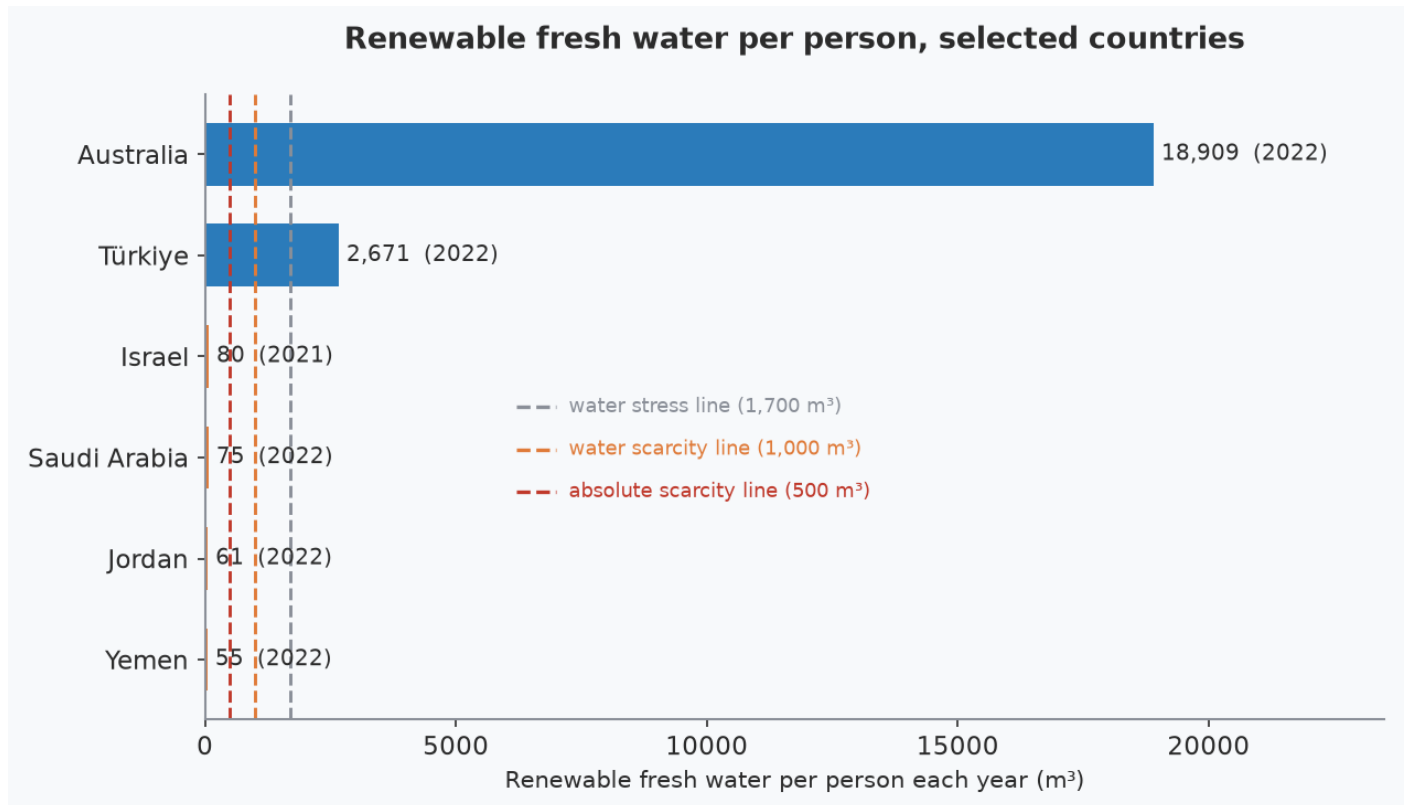
Original diagram for this section (Geography 8)

Two labelled panels showing physical scarcity, where there is not enough water in the place, and economic scarcity, where water exists but cannot be captured or delivered

The fix for physical scarcity is to make or save water (new supplies, careful use). The fix for economic scarcity is development: build and maintain the water works. In real places the two kinds often sit together.

2. Who is short? Reading the data

Now let us test the guide lines against real data for Australia and West Asia.



Bar chart of renewable fresh water per person each year in cubic metres: Australia 18,909, Türkiye 2,671, Israel 80, Saudi Arabia 75, Jordan 61 and Yemen 55, with guide lines drawn at 1,700, 1,000 and 500 cubic metres

Source: World Bank indicator ER.H2O.INTR.PC — renewable internal freshwater resources per person (FAO AQUASTAT), latest year for each country, retrieved 25 August 2026.

Australia as a whole is **water-rich**: about 18,900 m³ per person each year, far above every guide line. Türkiye sits above the stress line but not by a wide margin. Then look at West Asia: Israel, Saudi Arabia, Jordan and Yemen all sit far below 500 m³. On Falkenmark's guide lines, that is **absolute water scarcity** — the most serious category.

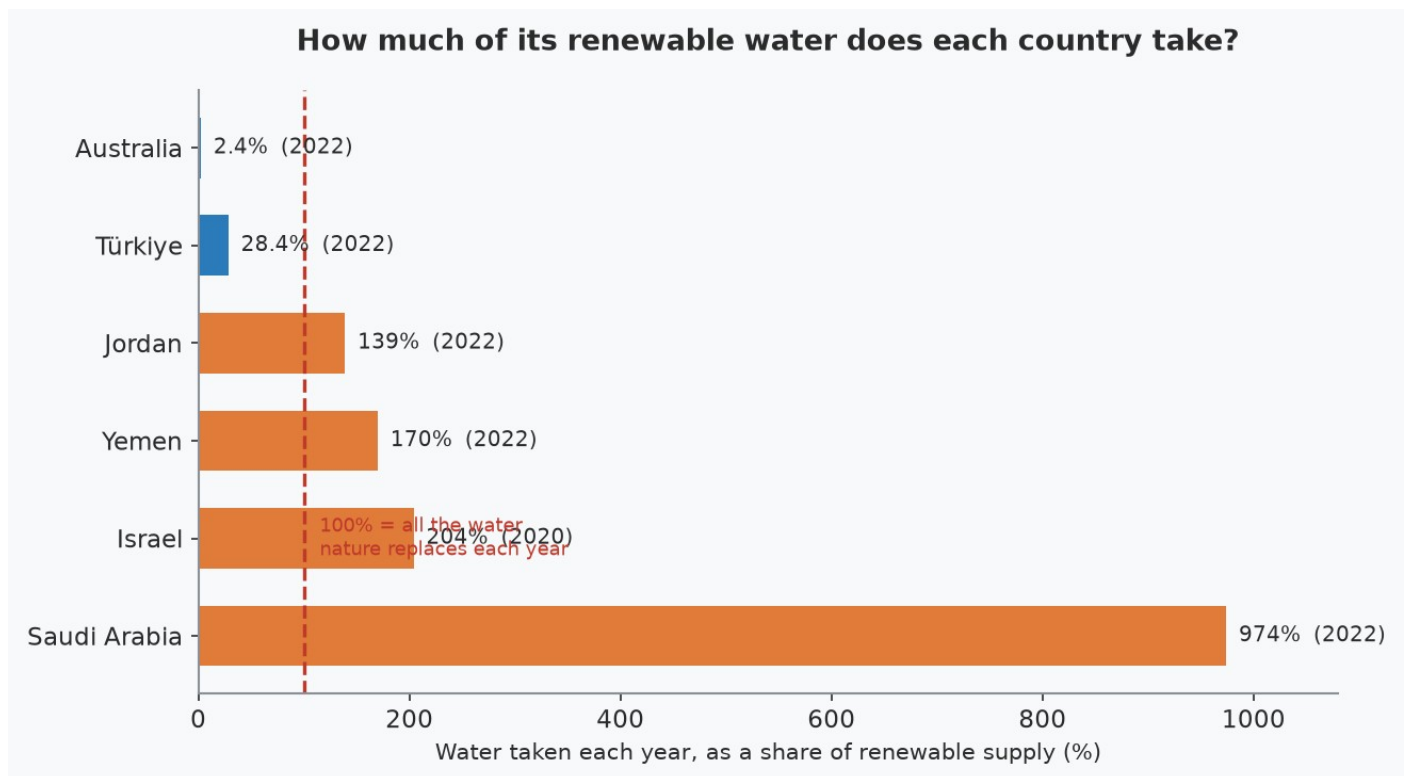
But a per-person average hides a lot. Rainfall explains part of the story:

Country	Average rainfall per year (mm)
Türkiye	593
Australia	534
Israel	435
Yemen	167
Jordan	111
Saudi Arabia	59

Source: World Bank, average precipitation in depth (FAO), 2020, retrieved 25 August 2026.

Notice that Australia's average rainfall (534 mm) is close to Israel's (435 mm), yet their scarcity looks completely different. Why? Australia is the driest lived-in continent: much of its rain is lost to **evaporation**, only a small share runs off into rivers, and the rain arrives unevenly and changes a lot from year to year. **Rainfall alone does not tell you how much water a place can use.**

The second measure — the share of renewable water taken each year — shows the pressure from the other side.



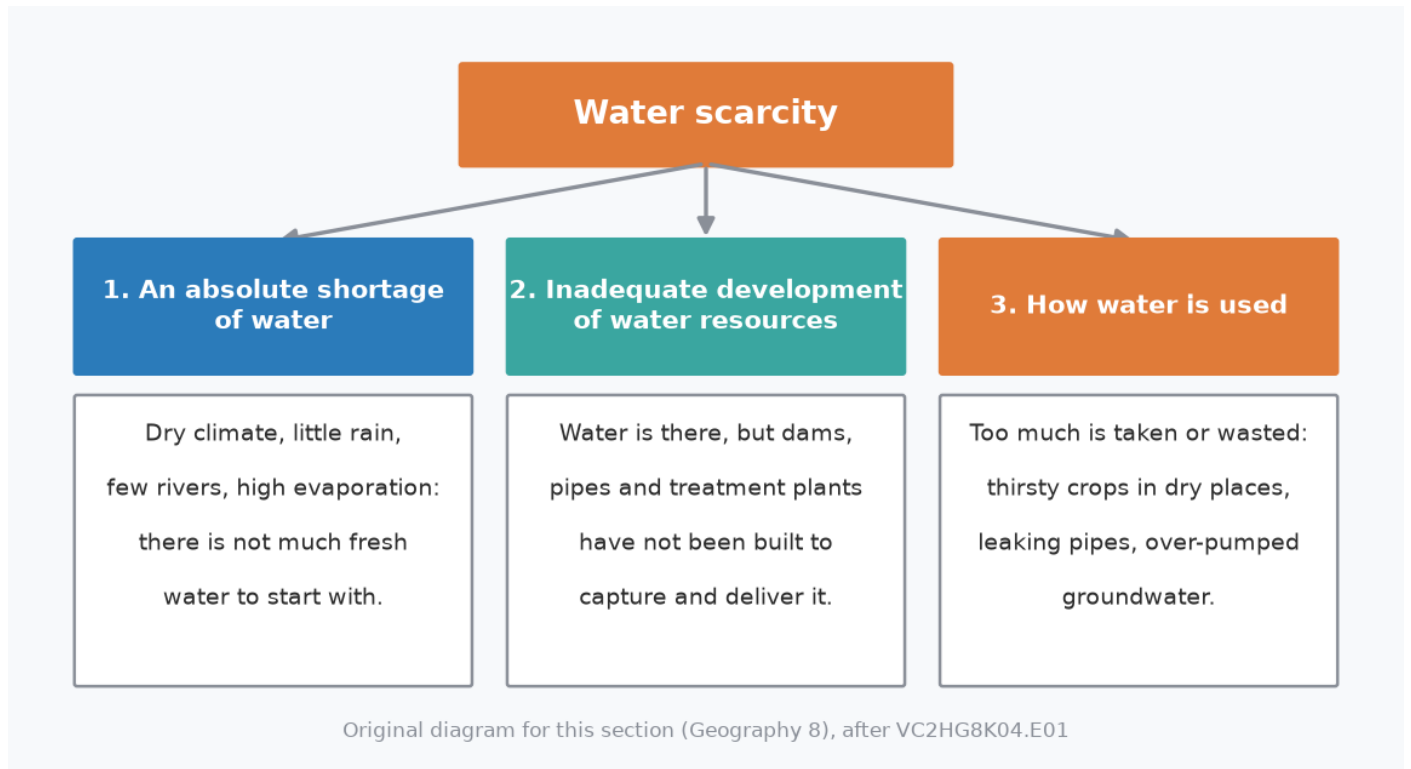
Bar chart of water taken each year as a share of renewable supply: Australia 2.4 percent, Türkiye 28.4 percent, Jordan 139 percent, Yemen 170 percent, Israel 204 percent and Saudi Arabia 974 percent, with a guide line at 100 percent

Source: World Bank indicator ER.H2O.FWTL.ZS (FAO AQUASTAT), latest year for each country, retrieved 25 August 2026.

Australia takes only about 2.4% of its renewable water in a year. Jordan, Yemen, Israel and Saudi Arabia all take **more than 100%** — they take out more water than nature replaces. They can only do this by making new water (desalination, recycling) or by pumping out old **groundwater** that built up over thousands of years. Taking water faster than it is replaced cannot keep going for ever.

3. What causes water scarcity?

The curriculum groups the causes of water scarcity into three (VC2HG8K04 .E01).



Concept map with water scarcity at the top branching to three causes: first, an absolute shortage of water; second, inadequate development of water resources; third, how water is used

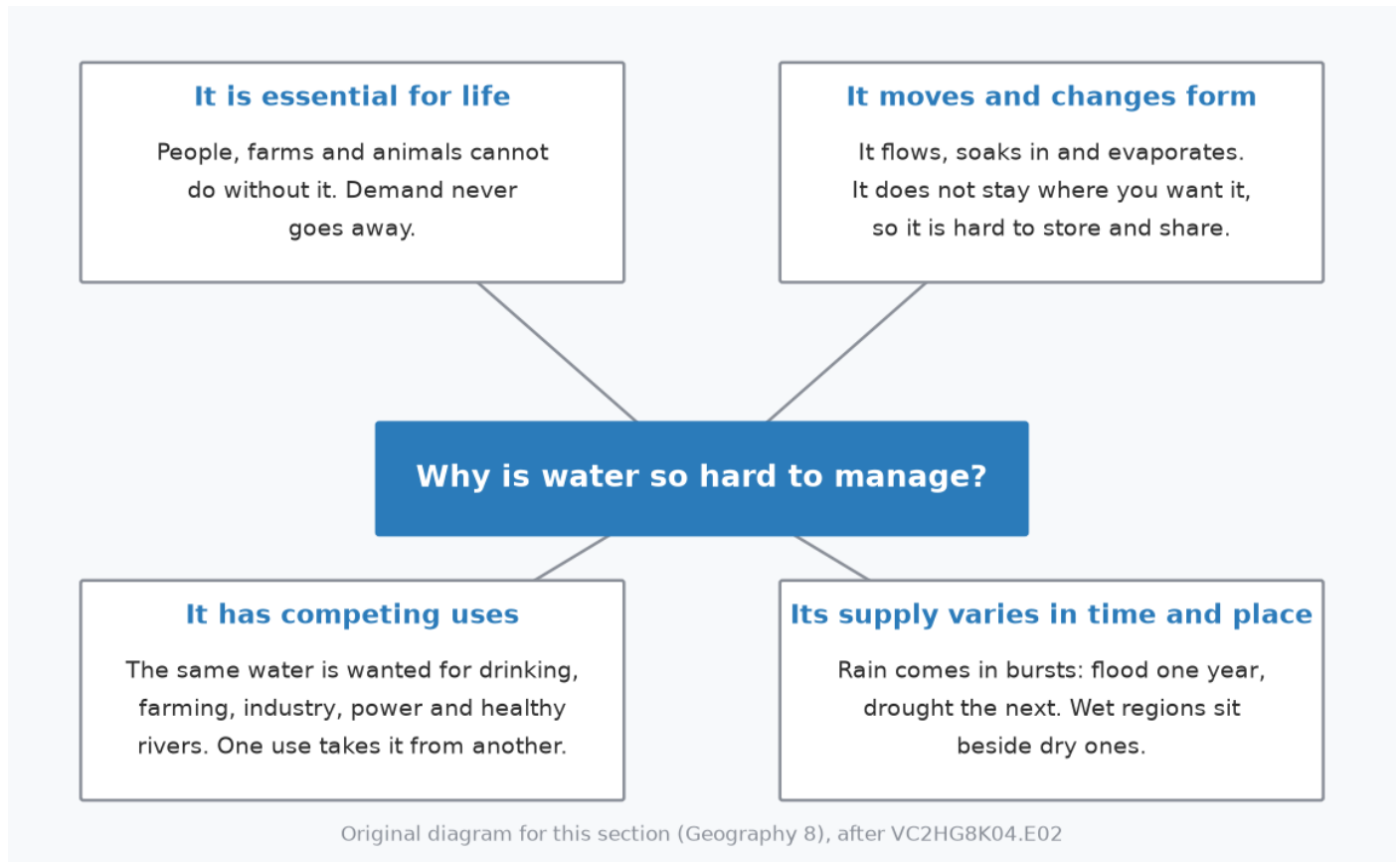
1. An absolute shortage of water. A dry climate with little rain, few rivers and high evaporation means there is not much fresh water to start with. This is the root of physical scarcity in West Asia and inland Australia.

2. Inadequate development of water resources. Water may be present, but if dams, pipes and treatment plants have not been built, people cannot get it. This is the root of economic scarcity.

3. How water is used. Growing thirsty crops in dry places, leaking pipes, and pumping groundwater faster than it refills all make a supply run short — even where the climate is not extreme. This cause matters for Australia, because it is the one cause a place can fix by changing how it behaves.

4. Why is water so hard to manage?

Water is one of the hardest resources to manage, for four connected reasons (VC2HG8K04.E02).



Concept map with the question why is water so hard to manage in the centre and four boxes: it is essential for life; it moves and changes form; it has competing uses; and its supply varies in time and place

It is essential for life. People, farms and animals cannot do without it, so there is no “go without” option and demand never goes away.

It moves and changes form. Water flows down rivers, soaks into the ground and evaporates into the air. It does not stay where you want it, so it is hard to store and hard to share in a fair way between places.

It has competing uses. The same water is wanted for drinking, farming, industry, power and healthy rivers. Giving water to one use takes it from another.

Its supply varies in time and place. Rain comes in bursts: a place can flood one year and face drought the next, and wet regions sit beside dry ones. This makes planning very hard.

Keep these four reasons in mind: every strategy in the next topic is really an attempt to beat one or more of them.

Worked demonstration 1 — Is Australia running out of water?

Let us reason like geographers, step by step, from the data.

Step 1 — The per-person chart. Australia averages about 18,900 m³ per person, far above the 1,700 m³ stress line. *So:* as a whole country, Australia does **not** have a physical shortage of water.

Step 2 — The rainfall table. Australia’s average rainfall (534 mm) looks moderate, but much is lost to evaporation, and the rain is spread unevenly and changes a lot from year to year. *So:* the water is not where or when people need it.

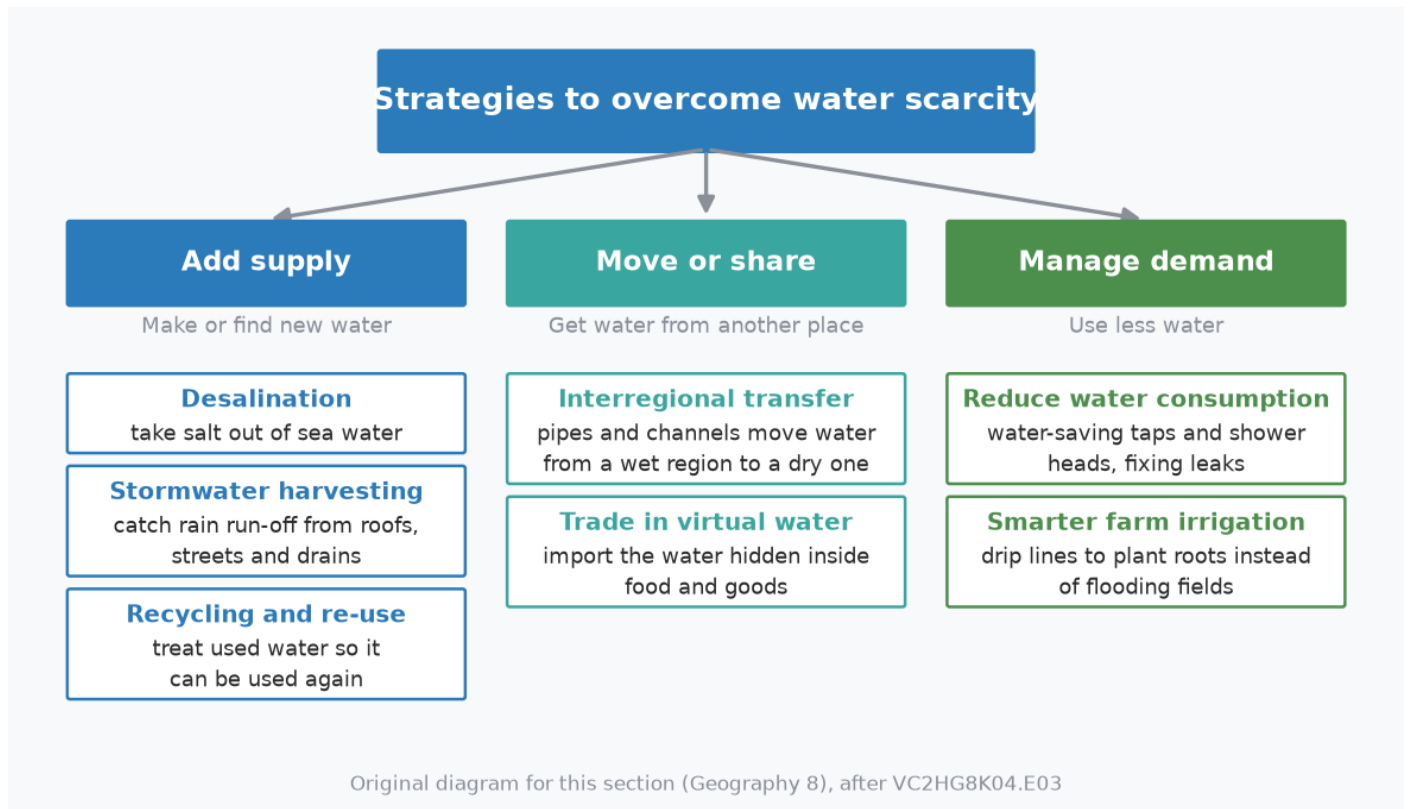
Step 3 — The withdrawals chart. Australia takes only about 2.4% of its renewable water in a typical year. *So:* at the national level, demand is small compared with supply.

Step 4 — Put it together. Australia as a whole is water-rich, **but** most Australians live in cities far from the big rivers, and long droughts — such as the Millennium Drought from the late 1990s to 2009 — can cut supply sharply. Melbourne’s storages fell below one-third full in the worst of it.

Geographer’s conclusion. Australia does not have a national shortage; it has a **matching problem** between where water is and where people are, and drought makes the problem bigger. That is why Australia still plans for scarcity even though its national average looks comfortable.

5. Strategies to overcome water scarcity

The curriculum lists six strategies (VC2HG8K04 .E03). We can sort them into three jobs: **add supply** (make or find new water), **move or share** (bring water in from another place), and **manage demand** (use less).



Tree diagram sorting six strategies into three jobs: add supply (desalination, stormwater harvesting, recycling and re-use), move or share (interregional transfer, trade in virtual water), and manage demand (reduce water consumption, smarter farm irrigation)

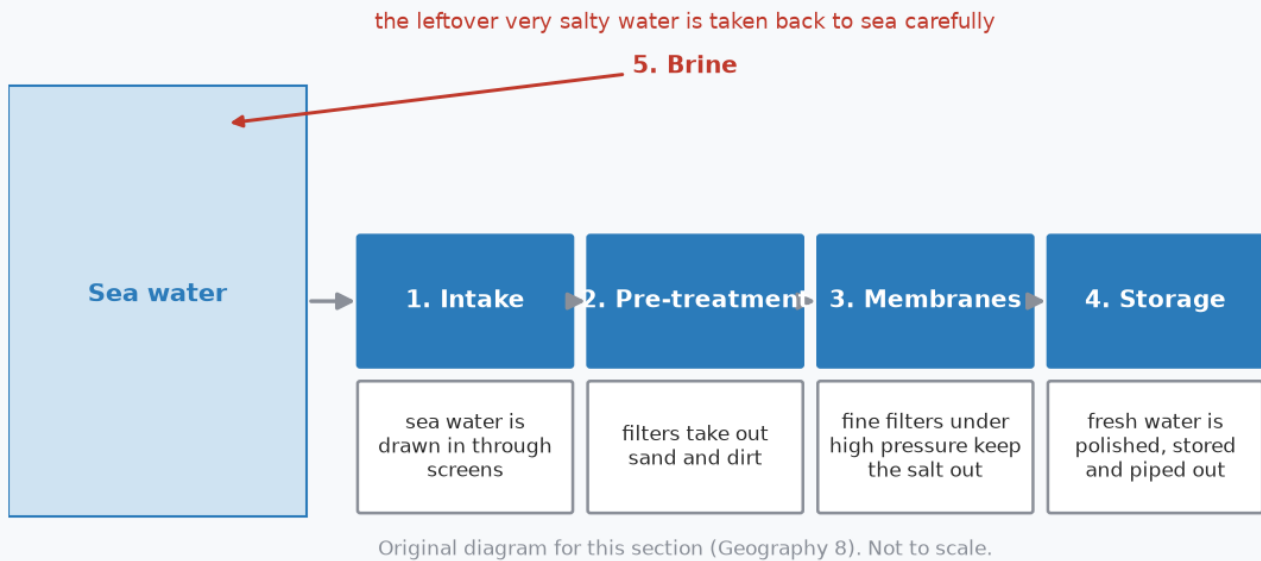
Reduce water consumption means using less: water-saving taps and shower heads, fixing leaks, watering gardens at cool times, and efficient farm irrigation. It is usually the cheapest strategy, and it works in every season.

Recycling and re-use means treating used water and using it again — often on farms, parks and industry. It stretches the same water further.

Stormwater harvesting means catching the rain that runs off roofs, streets and drains and storing it for later use, instead of letting it run to the sea.

Desalination means taking salt out of sea water to make fresh water. It works in any season and does not depend on rain — but it costs a lot of money and energy, and it leaves behind very salty water called **brine**, which must go back to sea carefully.

How a sea-water desalination plant makes fresh water

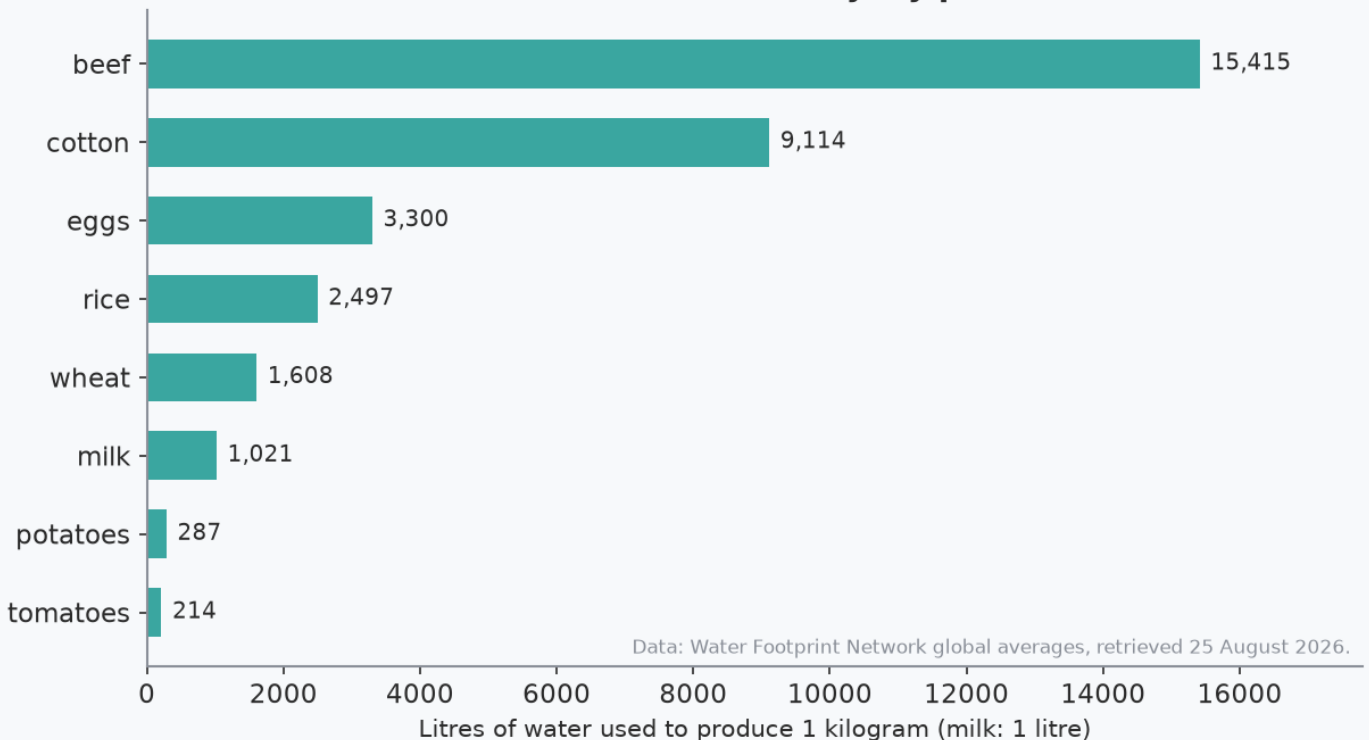


Cross-section of a sea-water desalination plant with five labelled stages: intake screens, pre-treatment filters, membranes that keep the salt out under high pressure, storage and delivery of fresh water, and careful return of the brine to the sea

Interregional transfer means moving water from a wet region to a dry one through pipes and channels. It can secure water for a city or farm region, but it is expensive to build and it takes water from the river it draws on.

Trade in virtual water. **Virtual water** is the water used to grow or make a product. When a dry country imports thirsty goods — like beef or cotton — instead of producing them at home, it is “importing” the water hidden inside them, and saving its own.

The hidden water in everyday products



Bar chart of the hidden water in everyday products in litres per kilogram: beef 15,415, cotton 9,114, eggs 3,300, rice 2,497, wheat 1,608, milk 1,021, potatoes 287 and tomatoes 214

Source: Water Footprint Network global averages, retrieved 25 August 2026.

Notice the spread: one kilogram of beef hides about 15,400 litres of water, while one kilogram of tomatoes hides about 214. A dry country that imports the thirsty goods and uses its own water for things it does well is trading in virtual water.

The debate: build new water, or use less?

People who plan water supplies disagree about the best way forward, and both sides have real evidence. Before we take a position, let us state each side as strongly as its own supporters would put it — then test both.

The two strongest cases in the water debate

Each side is stated as strongly as its own supporters would put it - then both are tested.

Case 1: build new water supplies

Rain cannot be counted on. Desalination and recycling give water in any season, whatever the climate does.

Cities and farms need sure supply. One bad drought can empty dams in a few years.

The technology is proven: Israel already runs most of its drinking water on it.

Case 2: use less water instead

Saving water is the cheapest option. Fixing leaks and wasting less costs far less than building a new plant.

New supplies cost energy and can harm the sea (brine) or rivers (transfers).

Demand keeps growing. If we do not manage it, every new supply will be used up too.

Original diagram for this section (Geography 8). The evaluation follows in the text.

Two panels showing the two strongest cases in the water debate: build new water supplies, and use less water instead, each with three supporting reasons

Testing the cases.

- *Does saving water cost less than building new supplies?* Mostly yes: fixing leaks and wasting less is usually the cheapest option. But savings have a limit — a city cannot save more water than it uses.
- *Do new supplies harm the environment?* They can: desalination takes energy and makes brine, and transfers take water from rivers. The harm can be managed but not wished away.
- *If demand keeps growing, will new supplies last?* This is the strongest point for the “use less” side: if demand is not managed, every new supply will be used up too.

To judge the six strategies in a fair way, we need the same tests every time. We will use two criteria:

1. **Effectiveness** — does the strategy get enough water, reliably, including in a drought?
2. **Sustainability** — can it keep going without unacceptable harm to the environment, the economy or people?

The scorecard below is a model. Your job in the practice questions is to test its judgements with evidence, not to copy them.

Strategy scorecard - a model for judging the six strategies

Strategy	Adds new water?	Works in a drought?	Cost	Pressure on energy and environment
Reduce water consumption	no - it saves water	yes	low	low
Recycling and re-use	a bit - it stretches water	yes	medium	medium
Stormwater harvesting	yes - it catches run-off	only after rain	low to medium	low
Desalination	yes - it makes new water	yes	high	high (energy, brine)
Interregional transfer	no - it moves water	only from wet regions	high	medium (rivers affected)
Trade in virtual water	no - it saves water at home	yes	low	depends on the goods

Model table for this section (Geography 8). Judgements are typical, not exact: your task is to test them with evidence.

Scorecard table judging the six strategies on four tests: whether they add new water, whether they work in a drought, their cost, and their pressure on energy and the environment

Worked demonstration 2 — Two water-scarce neighbours, two strategy mixes: Israel and Jordan

Israel and Jordan sit side by side in West Asia, and both face absolute water scarcity on the per-person measure (80 and 61 m³). Yet they have built very different strategy mixes. Let us **evaluate** each mix against our two criteria, weighing environmental, economic and social factors.

Two water-scarce neighbours, two strategy mixes

Israel		Jordan	
about 86%	of drinking water comes from sea desalination (2022)	139%	of its renewable supply is taken each year - more than nature replaces
about 90%	of used water is treated and used again, mostly on farms	Disi pipeline	pumps old groundwater that does not refill, 325 km to Amman (2013)
drip irrigation	water goes straight to plant roots, so little is wasted	2021 deal	Jordan will buy about 200 GL a year of desalinated water
since 1964	water is piped from the north to the dry south	recycling	treated used water is re-used on farms

Sources: Israel national water figures; Jordan Ministry of Water and Irrigation; World Bank (FAO AQUASTAT). Retrieved 25 August 2026.

Two panels comparing Israel and Jordan: Israel gets about 86 percent of drinking water from sea desalination, re-uses about 90 percent of used water, uses drip irrigation and pipes water north to south; Jordan takes 139 percent of its renewable supply, pumps fossil groundwater 325 km to Amman, buys desalinated water under a 2021 deal, and recycles water on farms

Sources: Israel national water figures; Jordan Ministry of Water and Irrigation; World Bank (FAO AQUASTAT). Retrieved 25 August 2026.

Israel: make and re-use. Since 1964 Israel has piped water from its wetter north to its dry south. Today about 86% of its drinking water comes from sea-water desalination (2022), and about 90% of its used water is treated and used again, mostly on farms. Its farmers use **drip irrigation** — pipes that deliver water straight to plant roots, so little is wasted. *Effectiveness:* high — the supply no longer waits on rain. *Sustainability:* mixed — recycling and drip irrigation score well, but desalination takes energy and makes brine, so it depends on cleaner power and careful brine handling.

Jordan: borrow time and buy water. Jordan takes 139% of its renewable supply each year. Its Disi pipeline, opened in 2013, pumps **fossil groundwater** — water that built up thousands of years ago and does not refill — about 325 km north to the capital, Amman. In 2021 Jordan and Israel announced a deal in principle for Jordan to buy about 200 GL a year of desalinated water made in Israel. Recycling on farms is growing. *Effectiveness:* the mix keeps the taps running today. *Sustainability:* weak — a supply built on fossil water is a countdown, because the aquifer does not refill. Jordan's long-term fix must be new water (desalination, trade) plus tight demand management.

Geographer's conclusion. Both countries prove the key idea: **no single strategy is enough**. Israel's mix works because it makes new water *and* re-uses *and* saves at the same time. Jordan's mix shows what happens when a country must buy time while it builds the long-term fix. When you evaluate a strategy mix, judge each part against the criteria, then ask how the parts work together.

6. Australia close-up: Melbourne's water shield, and a river system under pressure

Australia's national average hides real scarcity risk. Two Australian examples show how the strategies land in practice.

Melbourne's water shield. Melbourne stores rain in ten reservoirs with a combined capacity of 1,812 **gigalitres** (GL) — a gigalitre is one billion litres — collected from protected forest **catchments** (the hills that collect the rain). In the

Millennium Drought those storages fell sharply, so the city built a second line of defence: the **Victorian Desalination Plant** at Wonthaggi, which can make up to 150 GL a year. For July to December 2025, 50 GL was ordered, entering the system at Cardinia Reservoir. Recycling, stormwater harvesting and permanent water-saving rules round out the shield, so the city does not depend on rain alone.

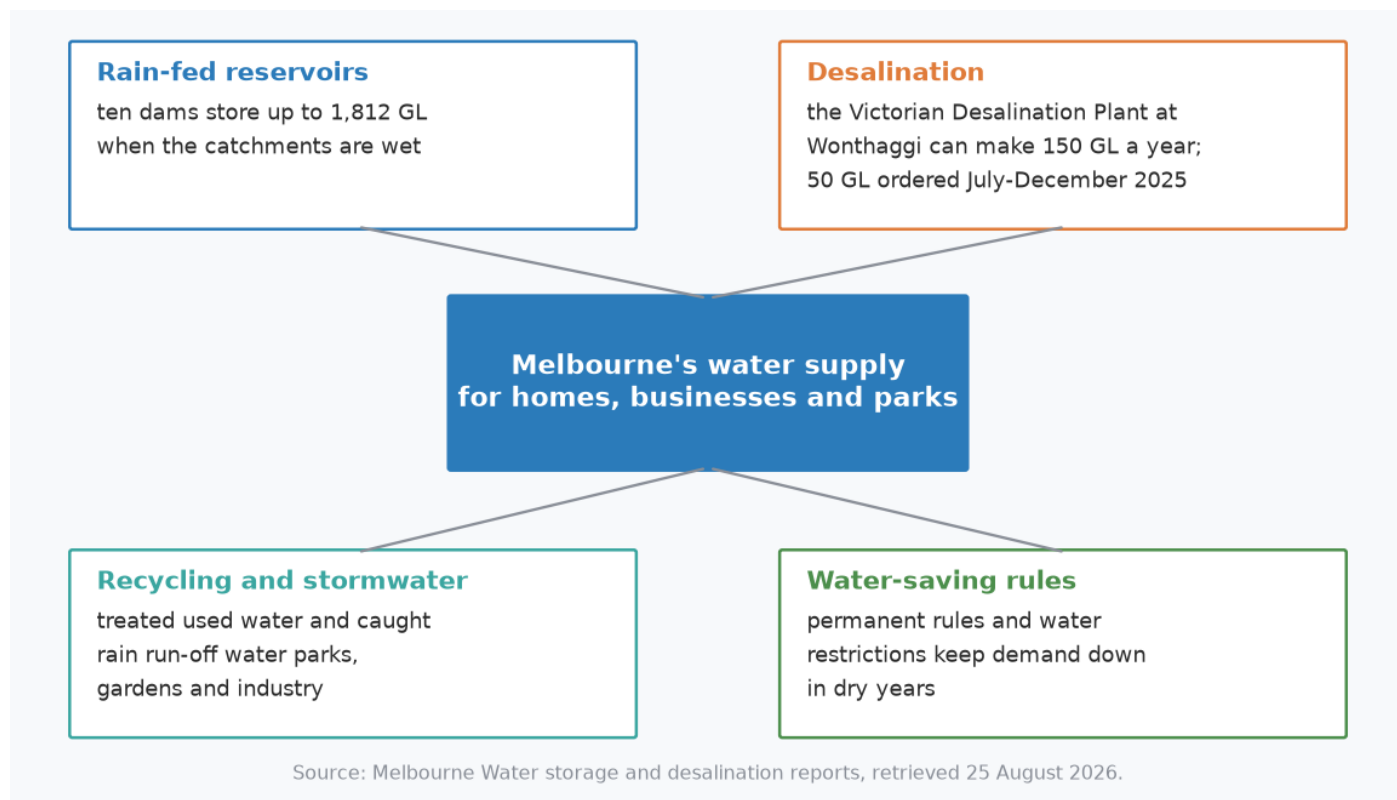


Diagram of Melbourne's four-part water supply: rain-fed reservoirs storing up to 1,812 gigalitres, the Victorian Desalination Plant at Wonthaggi making up to 150 gigalitres a year, recycling and stormwater for parks and industry, and water-saving rules for dry years

Source: Melbourne Water storage and desalination reports, retrieved 25 August 2026.

Perth has gone further along the same road: it now gets close to half of its drinking water from sea-water desalination (Water Corporation). Two big southern cities now treat the sea as a water source — a sign of how real the matching problem is, and of what Australia is doing to beat it.

The Murray–Darling Basin: competing uses. The Murray–Darling Basin in south-eastern Australia covers about one million square kilometres, is home to about 2.4 million people, and grows a large share of Australia's food. The same river water is wanted for farms, for towns, and for the rivers and wetlands themselves. In drought years there is not enough for everyone, so hard choices are made about who gets water — and the rivers get less. In 2020–21 about four in every five litres of water consumed in Australia went to agriculture (ABS, Water Account Australia). The Basin is Australia's clearest example of scarcity caused by **how water is used** — cause 3 from topic 3 — and of the “competing uses” problem from topic 4.

Practice — scaffolded

Q1. Define **water scarcity** in your own words, then name its two forms and say how they differ.

Q2. Use the per-person chart in topic 2. (a) Which country shown has the most renewable fresh water per person? (b) Which has the least? (c) Which countries sit below the 500 m³ absolute scarcity line?

Q3. The withdrawals chart shows Jordan at 139%. (a) In one sentence, explain what a share above 100% means. (b) Name two ways a country can keep taking out more water than nature replaces.

Q4. Match each cause of scarcity to one example: (i) a desert country with almost no rain; (ii) a town beside a river, with no treatment plant or pipes; (iii) a farm district pumping groundwater faster than it refills. (Causes: absolute shortage; inadequate development; how water is used.)

Q5. Pick two of the four reasons water is hard to manage, and for each give one example of a problem it creates for a water planner.

Q6. (a) From the virtual water chart, which product hides the most water per kilogram, and which hides the least? (b) Explain in two sentences how importing the thirsty product can help a dry country.

Q7. *Fieldwork link (connects to chapters 5B and 6C):* for one week, keep a log of water use at home or school. Record one use you could cut without losing anything important, and one use that cannot be cut. Bring your log to class and compare with a partner.

Practice — unscaffolded

Q8. “Australia as a whole is water-rich, yet parts of Australia still face water scarcity.” Explain how this claim can be true, using evidence from at least two figures in this section.

Q9. Jordan sits at about 61 m³ per person and takes 139% of its renewable supply. Evaluate Jordan’s strategy mix (the Disi pipeline, the 2021 water deal, and recycling) for effectiveness and sustainability. Weigh environmental, economic and social factors in your answer.

Q10. Choose any two strategies from the scorecard. Compare them on both criteria, then recommend one for a dry West Asian city of one million people. Justify your choice and name one drawback you would have to manage.

Q11. Melbourne built a desalination plant after the Millennium Drought, and Perth now gets close to half of its drinking water from desalination. Some people say this money is well spent; others say saving water is cheaper and cleaner. State each side as strongly as you can, then use evidence from this section to reach your own judgement.

Q12. The Murray–Darling Basin shows water with competing uses. Identify two users that want the same river water, and explain what happens to each in a drought year.

Extended response

Q13. “Desalination is the best answer to water scarcity in Australia and West Asia.”

Evaluate this claim. Write about 250–300 words. Your response must:

- use at least **two** figures from this section as evidence, and name their sources;
- weigh **environmental, economic and social** factors;
- test the strongest case on **each side** of the debate before reaching your judgement;
- state whether your judgement is the same for Australia and West Asia, or different, and why.

Marking guide. Marks are awarded for the reasoning steps below, not for the side you land on.

Marks	Reasoning shown
3–4	Claim tested on both sides with named evidence (figures and sources); environmental, economic and social factors each referred to; judgement justified with criteria (effectiveness, sustainability) and any limits of the claim stated
1–2	One side argued with some evidence; at least one factor referred to; a judgement stated but not fully justified
0	No evidence used, or the response states a conclusion without reasoning

Teaching notes (for the teacher)

Placement. This section delivers VC2HG8K04 at Level 8 depth: it carries the chapter’s management argument at full depth (with 1C), and its evaluation tasks use the standard’s evaluative verbs. It assumes 1A’s treatment of renewable resources and the water cycle, and 1C’s treatment of supply variability; it feeds the fieldwork and data threads of 5B and 6C via Q7.

Case regions. Australia and West Asia per the series default (decision D12). North Africa, which the content description also permits, is not developed here.

Contested term. The curriculum does not define “water scarcity”. The section’s defining block states the working definition, attributes the per-person guide lines to Malin Falkenmark (1989), and flags the UN withdrawals-share measure as a different, non-interchangeable convention. Both measures are then used (the per-person and withdrawals charts), which models why definitions matter.

Evaluation model. The two-sides debate figure and the scorecard model the reasoning the extended response asks for. The scorecard’s judgements are presented as “typical, not exact” so students test them rather than copy them; the marking guide awards reasoning, not position.

Volume. One teaching sequence; two worked demonstrations with real cited data; seven scaffolded tasks; five unscaffolded tasks; one evidence-based written response. Twelve original figures; every figure carries a source line, all retrieved 25 August 2026.

Vocabulary. All student-facing text (including figure text) sits at or below Year 8 level, checked with the series vocabulary gate. Exempt words are curriculum terms taken from VC2HG8K04 and its elaborations, subject terms defined at first use, and proper nouns, per decision D4.

Content policy. No Aboriginal and Torres Strait Islander content is included in this section, per Rule 1 of the series content policy.

Sources and retrieval dates

All figures in this section are original drawings from the data below, retrieved 25 August 2026.

- World Bank, indicator ER.H2O.INTR.PC — renewable internal freshwater resources per person (FAO AQUASTAT), latest year for each country.
 - World Bank, indicator ER.H2O.FWTL.ZS — annual freshwater withdrawals as a share of internal resources (FAO AQUASTAT), latest year for each country.
 - World Bank, average precipitation in depth (FAO), 2020.
 - Water Footprint Network, global average water footprints of products (Mekonnen and Hoekstra).
 - Melbourne Water, water storage levels and desalination orders, including the 50 GL order for July–December 2025 via Cardinia Reservoir; Victorian Desalination Plant capacity up to 150 GL per year.
 - Israel national water figures, including about 86% of drinking water from desalination (2022) and about 90% of used water treated and re-used; National Water Carrier since 1964.
 - Jordan Ministry of Water and Irrigation, including the Disi pipeline (opened 2013, about 325 km, fossil groundwater to Amman) and the November 2021 deal in principle to buy about 200 GL a year of desalinated water from Israel.
 - Water Corporation (Western Australia), Perth drinking water supply from sea-water desalination.
 - Australian Bureau of Statistics, *Water Account Australia* 2020–21 (cat. 4610.0), share of consumed water used by agriculture.
 - Murray–Darling Basin Authority, basin area (about one million square kilometres) and population (about 2.4 million people).
 - Malin Falkenmark (1989), per-person water guide lines (1,700 / 1,000 / 500 m³).
-

Glossary

Absolute water scarcity — less than 500 m³ of renewable fresh water per person each year, on the Falkenmark guide lines. **Aquifer** — underground rock or soil that holds groundwater. **Brine** — the very salty water left over when sea water is desalinated. **Catchment** — the land that collects the rain and sends it to a river or storage. **Desalination** — taking salt out of sea water to make fresh water. **Drip irrigation** — delivering water to crops through pipes that drip it straight to plant roots, so little is wasted. **Economic scarcity** — water exists, but money, dams, pipes or treatment plants are lacking, so people cannot get it. **Fossil groundwater** — groundwater that built up over thousands of years and does not refill at today's climate. **Gigalitre (GL)** — one billion litres. **Groundwater** — water stored underground in soil and rock. **Interregional transfer** — moving water from a wet region to a dry one through pipes and channels. **Irrigation** — supplying water to crops. **Physical scarcity** — there is simply not enough water in the place to meet demand. **Recycling (water)** — treating used water so it can be used again. **Renewable fresh water** — the fresh water nature replaces each year through the water cycle. **Reservoir** — a lake, natural or built, used to store water. **Stormwater harvesting** — catching rain run-off from roofs, streets and drains and storing it for later use. **Virtual water** — the water used to grow or make a product. **Water scarcity** — demand for usable fresh water is greater than the usable supply. **Water stress** — pressure that begins when water per person falls below about 1,700 m³ a year.

Droughts, storms, floods and cyclones: causes, impacts and the human response

Geography 8 · Chapter 1 — Water in the world · Section 1E

Curriculum focus: VC2HG8K05 (Victorian Curriculum F–10 Version 2.0, Geography, Levels 7 and 8, VCAA).

This section draws on VC2HG8K05.E01, VC2HG8K05.E02, VC2HG8K05.E03 for MCQ and coverage linking.

Theory

Start with what you know

You have met hazards before. In Levels 5–6 you studied how climate hazards such as bushfires and heatwaves affect Australian communities, and you saw that the same event can be a big deal for one town and almost missed by another. This section takes that same way of thinking and applies it to the hazards that arrive through the air and the water cycle: **droughts, severe storms, tropical cyclones and floods** — the four named by the curriculum for this study.

Australia is a good place to study them. It is the driest inhabited continent on Earth, its rain comes in bursts, and its north coast sits in one of the world's busiest cyclone zones. When the weather and the water turn on people, the results make the news most summers. Geographers ask three questions about every one of these events: what causes it and where and when it happens (VC2HG8K05.E01), what it does to people and places (VC2HG8K05.E02), and what communities and governments do about it (VC2HG8K05.E03). Those three questions are the shape of this section.

Defining the terms first

atmospheric and hydrometeorological hazard — a hazard driven by the atmosphere (the air and its weather) or by the movement of water through the weather cycle. Say it as *hydro-meteor-ological*: water–weather–study. Droughts, severe storms, tropical cyclones and floods all belong to this family, and all four are studied here.

hazard versus disaster — this section uses these words the way the United Nations disaster risk office (UNDRR) does. A *hazard* is something that *could* harm people, property or places. It becomes a *disaster* when it actually does, and the community affected cannot cope on its own. A Category 5 cyclone over empty ocean is a hazard; the same cyclone over a city can be a disaster. Other meanings of both words exist; these are the ones used here.

drought, and its three types — a long run of below-average rain that dries out soil, rivers and dams. Geographers split it into *meteorological* drought (the rain itself is short), *agricultural* drought (soil is too dry for crops and pasture) and *hydrological* drought (rivers and dams run low). The three usually arrive in that order, months apart.

tropical cyclone — a huge spinning storm that forms over warm ocean water near the tropics, with violent winds, heavy rain and big seas. Australia rates them from Category 1 to Category 5 by their strongest wind gusts; a Category 5 brings gusts over 280 km/h.

flood types and catchment — a *river flood* (or riverine flood) builds over days as a river rises and spills across its floodplain; a *flash flood* builds in hours or less when heavy rain races down a steep, narrow *catchment* — the area of land that drains into a creek or river.

1. One family, four hazards

The four hazards in this section look different, but they belong together for one reason: all of them are powered by the atmosphere and the water cycle. The sun heats the sea, water evaporates and rises, air moves — and somewhere in that engine a drought, a storm, a cyclone or a flood is made. What tells them apart is how fast they arrive.

The four members of this section's hazard family

All four are driven by weather and water. What differs is how fast each one starts — and that shapes how we respond.

Hazard	What it is	What starts it	Where in Australia
Drought	A long run of below-average rain that dries out soil, rivers and dams	Rain shortfalls building over seasons or years, plus hot, dry air	Every state — but inland south-eastern Australia is most exposed
Severe storm	A thunderstorm bringing damaging winds, large hail or very heavy rain	Warm, moist air rising quickly into tall storm clouds	All states; most common in spring and summer
Tropical cyclone	A spinning storm with violent winds, heavy rain and big seas	Warm ocean water (about 26–27 °C or warmer) feeding rising moist air	The north-west, northern and north-east coasts; season Nov–Apr
Flood	Water covering land that is normally dry	More rain than the ground and rivers can carry away	Along rivers, on coasts and in low parts of towns and cities

Onset speed: drought = months to years · flood = hours to days · cyclone = days of forecast warning · storm = minutes to hours

Table of this section's four hazard family members — drought, severe storm, tropical cyclone and flood — with columns for what each one is, what starts it and where in Australia it happens, and a footnote comparing how fast each one starts

Notice the onset speed. A flash flood can be on a town in under an hour. A drought builds so slowly that people argue about whether it has started. That difference in timing decides how much warning people get — and warning time, as you will see in Section 5, is one of the biggest protectors of life.

2. Causes: weather and water at work

Drought starts with a rain shortfall that lasts long enough to drain the soil, then the rivers, then the dams. Australia is built for drought: the continent averages only about 419 mm of rain a year, about 80 per cent of the land gets less than 600 mm, and half gets less than 300 mm. One poor year is normal; several in a row becomes a drought. Hot, dry air makes it worse by drying soil and storages faster.

Severe storms start the other way round, with too much rising moisture at once. On a warm day, moist air can rise quickly into tall storm clouds, bringing damaging winds, large hail or very heavy rain in a small area. Most Australian storms last under an hour, but a line of storms can unload enough rain to flood streets and creeks — and the June 2021 storm in Gippsland, Victoria, killed two people and left 160,000 properties without power, some for more than four days.

Tropical cyclones have the biggest engine of the four. They need sea water of about 26–27 °C or warmer, which is why they form in the warm months and die quickly over land or cool water.

What powers a tropical cyclone

1. A warm sea

Sea surface about 26–27 °C or warmer — usually late summer to autumn

2. Moist air rises

Warm water evaporates; the warm, moist air rises, cools and forms tall storm clouds

3. Low pressure forms

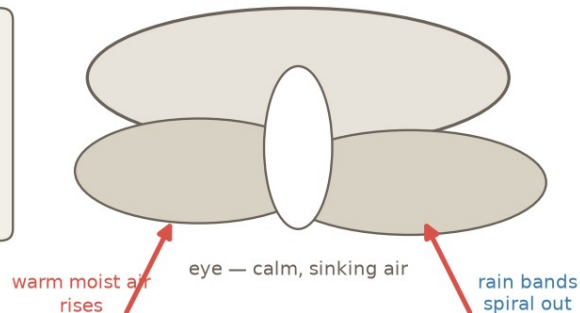
Rising air leaves less air at the surface; air rushes in and, because Earth spins, it curves

4. An organised storm

Winds circle the calm eye; rain bands spiral out; over warm water the storm can grow

In the southern hemisphere the winds spin clockwise.

Australia rates cyclones from Category 1 to 5 by wind gusts:
Cat 1 gusts 91–124 km/h ·
Cat 3 gusts 167–224 km/h ·
Cat 5 gusts over 280 km/h.



warm sea surface (26–27 °C or warmer)

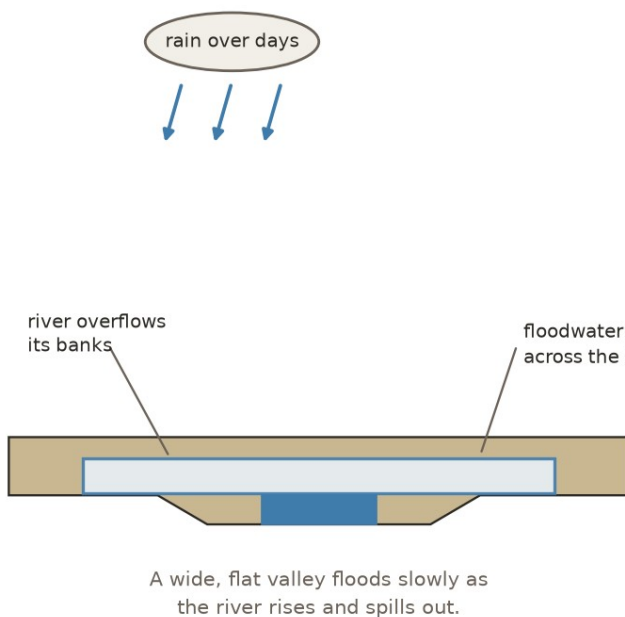
Over warm water a cyclone keeps its fuel. Over land or cool water it weakens fast — but it can still dump huge rains inland.

Step diagram of what powers a tropical cyclone — a warm sea, moist air rising, low pressure forming and an organised storm — with a schematic of a mature cyclone showing the eye, rain bands and clockwise spin in the southern hemisphere, plus the Australian category bands by wind gust

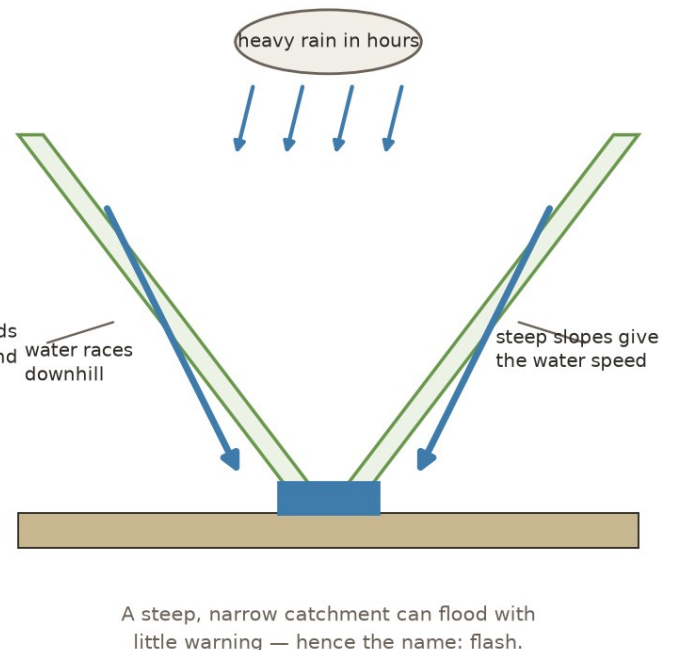
Floods happen whenever more rain arrives than the ground and rivers can carry away. The two types work in different ways, and the difference matters for warnings.

Two ways land gets flooded

River flood — builds over days



Flash flood — builds in hours or less

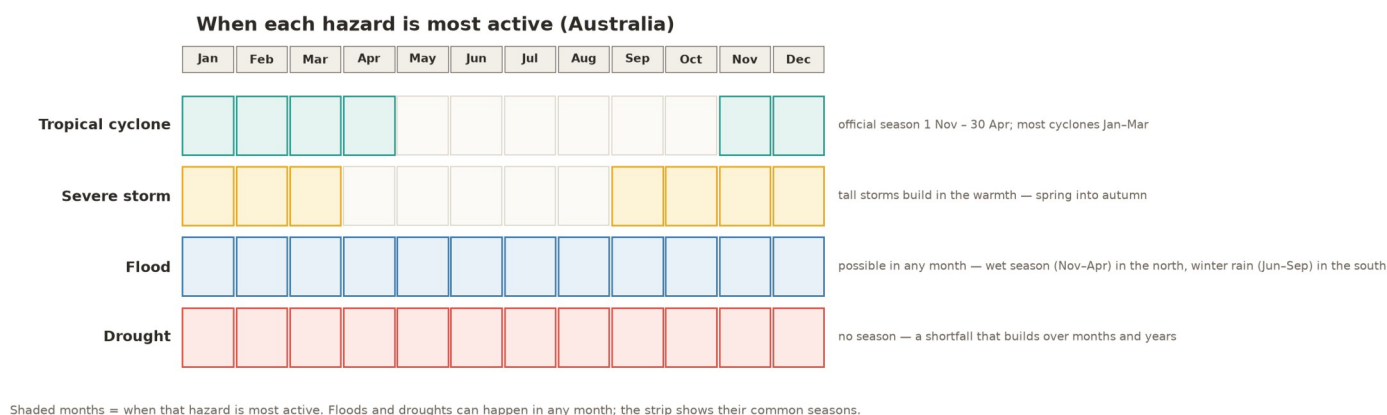


Cross-section diagrams of the two flood types: a river flood building over days as a river overflows its banks across a wide flat valley, and a flash flood racing down a steep narrow catchment with little warning

Causes also connect: a cyclone can cause a flood (its rain swells rivers), and the same climate drivers that bring drought to one coast can bring floods to another, as Section 3 shows.

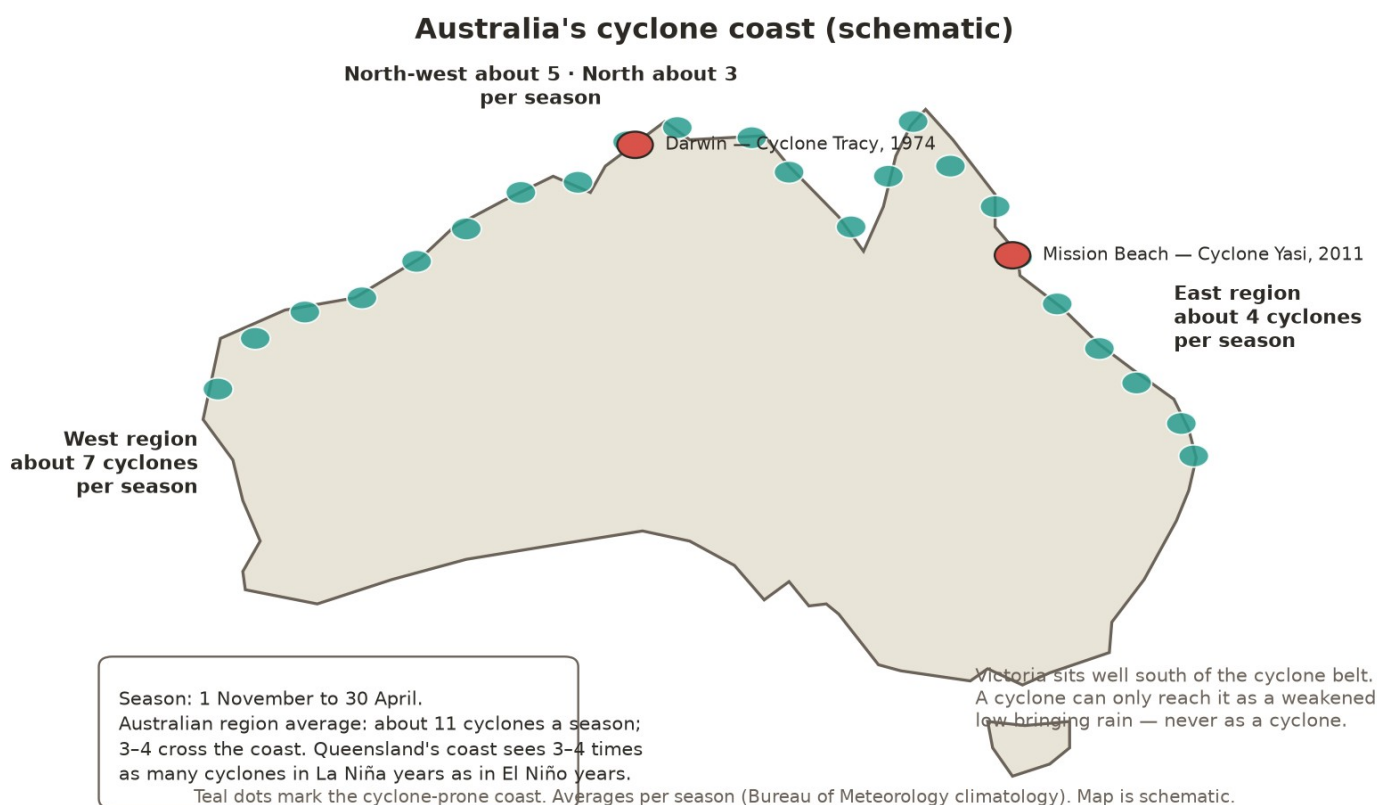
3. When and where: temporal and spatial patterns

Temporal means “to do with time”; *spatial* means “to do with space” — where things happen. Both patterns are clear for this hazard family.



Month-by-month strip showing when each hazard is most active in Australia: tropical cyclones from November to April, severe storms from spring into autumn, and floods and droughts possible in any month

The cyclone pattern is the sharpest. The official Australian cyclone season runs from 1 November to 30 April, and most cyclones form between January and March, when the sea is warmest.

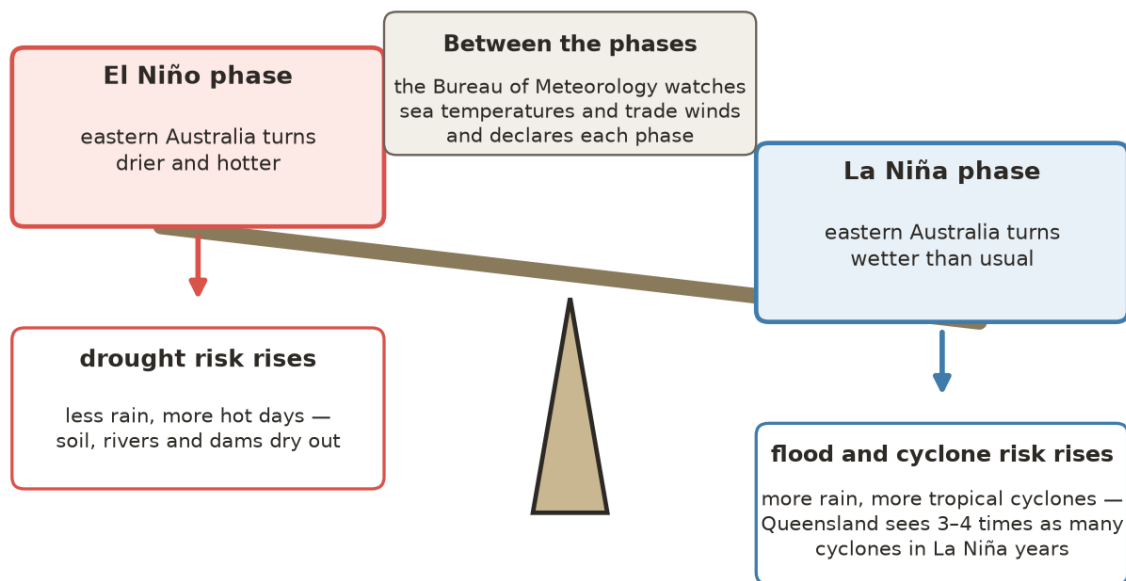


Schematic map of Australia showing where tropical cyclones track and make landfall — the north-west, north and north-east coasts — with average cyclone counts per region, markers for Darwin and Mission Beach, and a note that Victoria sits far from cyclone tracks but has its own storms and floods

Read the map with the numbers: an average season brings about 11 cyclones to the Australian region and 3–4 make landfall, and the north-west coast carries the heaviest share. Victoria sits far from the cyclone tracks — but not far from floods and storms, as the worked examples and questions in this section show.

Behind many of Australia's wet and dry years is a see-saw in the Pacific Ocean called the **El Niño–Southern Oscillation (ENSO)**. The Bureau of Meteorology watches sea temperatures and trade winds and declares which phase is running.

The El Niño–Southern Oscillation: Australia's wet-dry see-saw



Many of Australia's biggest floods came in La Niña years; many of its worst droughts in El Niño years.

See-saw diagram of the El Niño–Southern Oscillation: in the El Niño phase eastern Australia turns drier and hotter and drought risk rises; in the La Niña phase it turns wetter than usual and flood and cyclone risk rises, with Queensland seeing three to four times as many cyclones in La Niña years

This see-saw explains why floods and droughts often come in runs. The 2010–11 and 2022 flood years were La Niña years; several of the worst drought years, including the start of the millennium drought, came with El Niño. It is also why two hazards can strike different parts of the country in the same year: a wet north and a dry south, or the reverse.

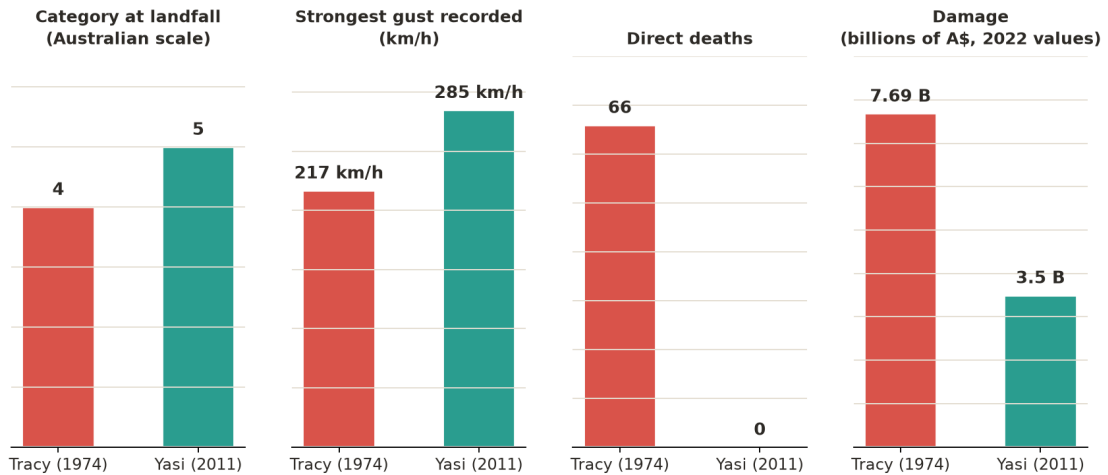
4. What shapes the impacts

Impacts come in three kinds, and this section's events supply real examples of each.

- **Economic:** the 2010–11 Queensland floods cost the economy about A\$14.1 billion; the 2022 eastern Australia floods about A\$9.6 billion; Cyclone Tracy's A\$837 million bill in 1974 money is about A\$7.69 billion in 2022 values. Droughts cost just as quietly — the millennium drought pushed Melbourne's water storages to about 26 per cent and led Victoria to build a A\$3.1 billion desalination plant.
- **Environmental:** in the millennium drought the River Murray fell to its lowest flows in more than 90 years of records, and wetlands dried out. In the 2022 floods, more than 30 locations recorded over 1,000 mm of rain in a few weeks — Mt Glorious, Queensland, passed 1,770 mm — scouring rivers and spreading debris and mud far downstream.
- **Social:** lives lost (66 in Cyclone Tracy; 33 in the 2010–11 Queensland floods; 27 in the 2022 floods; 2 in each of the January 2011 Victorian floods and the 2021 Gippsland storm), homes flooded (more than 23,400 in 2022; over 3,000 in Lismore alone), people evacuated (35,362 from Darwin after Tracy; about 30,000 from Cairns before Yasi), and whole regions left without power, as Gippsland was for days.

Yet the size of the event does not decide the impact on its own. Compare Tracy and Yasi in the figure below: the weaker storm killed 66 people and the stronger one killed nobody directly. The difference was what stood in the path — *exposure*, geographers call it — and what those people had in place. Darwin in 1974 was a fast-growing city whose houses were not built for cyclones and which had never rehearsed for one; Mission Beach and Cairns in 2011 sat behind modern warnings, building codes and evacuation plans.

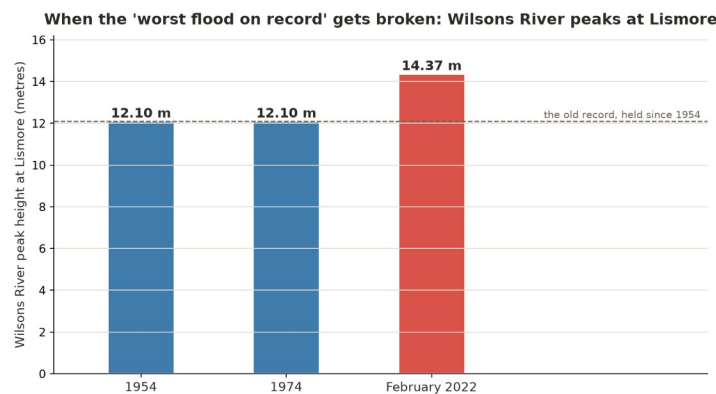
A weaker cyclone killed 66 people; a stronger one killed none directly.
Cyclone Tracy, Darwin, 25 December 1974 · Cyclone Yasi, Mission Beach (Qld), 3 February 2011



Yasi had a modern warning system, rehearsals and evacuations behind it; Tracy hit a city that had never practised for a cyclone. Damage values converted to 2022 dollars for a fair compare.

Four paired bar charts comparing Cyclone Tracy at Darwin in 1974 with Cyclone Yasi at Mission Beach in 2011: category at landfall 4 versus 5, strongest recorded gust 217 versus 285 km/h, direct deaths 66 versus 0, and damage of 7.69 versus 3.5 billion dollars in 2022 values

The same lesson comes from flood records. Lismore, on the Wilsons River in New South Wales, planned for its worst flood on record — 12.1 m, set in 1954 and matched in 1974. February 2022 brought 14.37 m, more than two metres higher, and flooded thousands of homes that had sat “above the record”.



In February 2022 the river rose to 14.37 m — more than two metres above the worst floods of 1954 and 1974, which had stood as the record for nearly 70 years. Over 3,000 homes in Lismore were affected. Towns that plan for the old record can still be surprised.

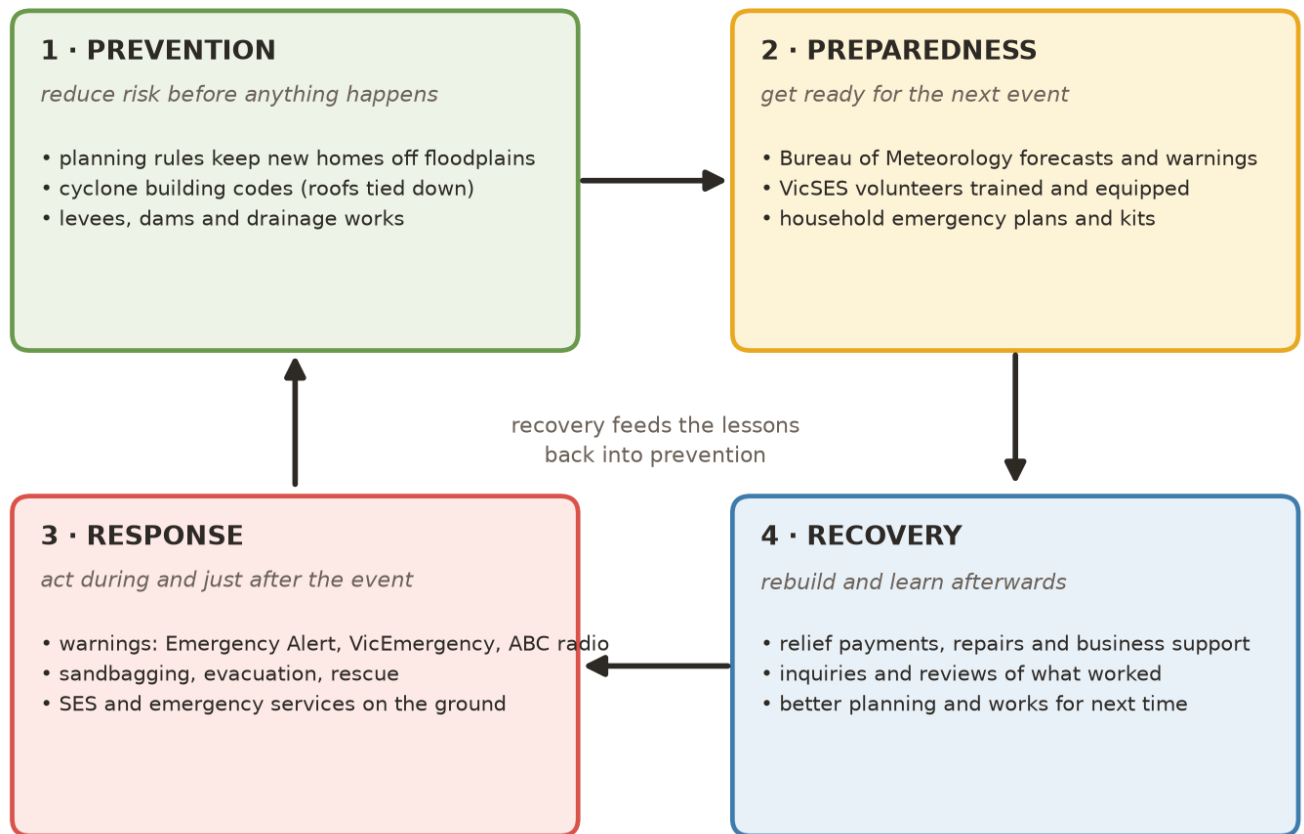
Bar chart of Wilsons River peak flood heights at Lismore: 12.10 m in 1954 and again in 1974, then 14.37 m in February 2022, with a dashed line marking the old record held since 1954

So the impacts of a hazard event are set by two things together: the physical event itself, and the people, buildings and choices in its path. (How a warming climate is changing Australia’s water patterns is a separate question — that study lives in Section 1C; this section keeps to the causes named by the curriculum.)

5. Responses: the four-stage cycle

Australia manages hazards with a four-stage cycle the curriculum names directly: **prevention, preparedness, response and recovery**. The cycle runs for communities and for governments alike, and each stage feeds the next.

The four-stage cycle: reducing the impact of hazards

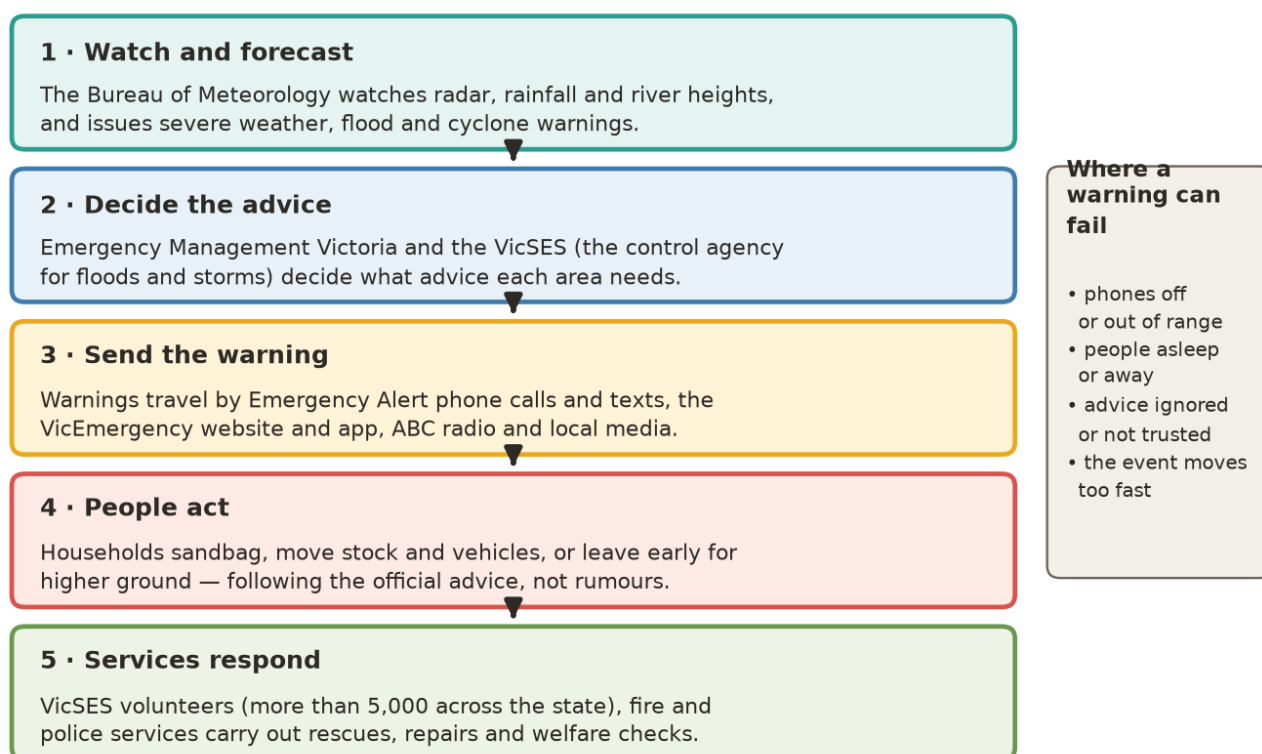


The four-stage prevention–preparedness–response–recovery cycle drawn as a loop, each stage carrying Australian examples such as planning rules and building codes, Bureau of Meteorology warnings and VicSES training, sandbagging and evacuation, and relief payments and reviews

- **Prevention** is mostly government: planning rules that keep new homes off floodplains, cyclone building codes that tie roofs down, levees and drainage works.
- **Preparedness** is shared: the Bureau of Meteorology watching and forecasting, the VicSES — Victoria's control agency for floods and storms, with more than 5,000 volunteers — training and equipping its crews, and households writing emergency plans and packing kits.

- **Response** is what the warning chain sets in motion.

How a flood or storm warning travels in Victoria



Flow chart of how a flood or storm warning travels in Victoria, from Bureau of Meteorology watches and forecasts, through Emergency Management Victoria and the VicSES deciding the advice, to Emergency Alert calls, the VicEmergency website and app and ABC radio, then people acting and services responding, with a side box listing where a warning can fail

- **Recovery** runs for months or years: relief payments, repairs, support for people and businesses, then inquiries that ask what worked — and the answers feed straight back into prevention. After Cyclone Tracy, Darwin was rebuilt to a new cyclone building code, and the warning system was overhauled. That single recovery decision is one reason Cyclone Yasi, a stronger storm, killed nobody directly 36 years later.

The cycle also shows where responses fail. The side box in the warning-chain figure lists the usual breaks: warnings that do not reach people, or are not trusted, or arrive too late. Every practice that increased the effectiveness of Australia's responses — rehearsals, tied-down roofs, phone alerts, a named control agency — exists because one of those breaks once cost lives.

Worked examples

Example 1 — scaffolded

Compare Cyclone Tracy (1974) and Cyclone Yasi (2011), then explain why the weaker cyclone had the worse human cost.

Question

1. When, where and how strong was each cyclone at landfall?

Working

Tracy: about 3:30 am on 25 December 1974, at Darwin, Category 4 on the Australian scale, with a recorded gust of 217 km/h. Yasi: about midnight on 3 February 2011, near Mission Beach (Qld), Category 5, with gusts to 285 km/h.

Question	Working
2. Read the impacts from the figure.	Tracy: 66 deaths (45 on land, 21 at sea); over 70 per cent of Darwin's buildings destroyed and 94 per cent of its houses left unliveable; 35,362 people evacuated in the following week; A\$837 million of damage (about A\$7.69 billion in 2022 values). Yasi: no direct deaths (one person died later from generator fumes); about 30,000 people evacuated from Cairns beforehand; about A\$3.5 billion of damage.
3. Which cyclone was stronger?	Yasi — Category 5 beats Category 4, and 285 km/h beats 217 km/h. So strength alone cannot explain the deaths.
4. Use exposure and the four-stage cycle.	<i>Exposure:</i> Tracy struck a city that had grown fast, with many houses not tied down and no cyclone shelters; Yasi crossed a coast where building codes had been cyclone-rated since Tracy. <i>Preparedness and response:</i> Darwin in 1974 had little warning and had never rehearsed; Yasi was tracked for days, warnings went out early, and evacuations moved tens of thousands of people before landfall.

Conclusion: category sets the *possible* impact; exposure and preparedness set the *actual* impact. That is VC2HG8K05.E02 and .E03 in one comparison: the same physical hazard, two very different outcomes, because of what people had in place.

Example 2 — scaffolded

Trace the January 2011 Victorian floods through the four-stage cycle.

Stage	What happened in this event
1. Prevention	Long-term planning and levees existed in some towns, but many of the flooded places — Horsham, Charlton, Kerang, Rochester, Echuca — sit on river flats that always did flood, so prevention could only shrink the risk, not remove it.
2. Preparedness	The Bureau of Meteorology tracked a very wet January (it became Victoria's wettest January on record) and issued flood warnings; the VicSES and councils pre-positioned crews; communities readied sandbags.
3. Response	Heavy rain fell on 12–14 January 2011; rivers such as the Wimmera, Loddon, Campaspe, Avoca and Goulburn flooded more than 51 communities; over 1,730 properties flooded, more than 17,000 homes lost power, and two people died. Around 200,000 sandbags were laid, and evacuations and rescues ran for days.
4. Recovery	The Victorian government released about A\$7 million in immediate relief; roads, bridges and homes were repaired over months; the damage bill reached about A\$2 billion; and the reviews that followed fed better flood plans into the next cycle.

Conclusion: one real event, all four stages — and the recovery stage did not end the story; it funded and informed the prevention and preparedness stages for the floods that followed in later La Niña years. The cycle is a cycle.

Practice questions

Scaffolded

- Q1.** In your own words, write this section's working definitions for: (a) hydrometeorological hazard; (b) the difference between a hazard and a disaster; (c) a catchment.
- Q2.** Name the four members of this section's hazard family. For each one, write one sentence saying what starts it.
- Q3.** Using the two flood cross-sections: (a) which flood type builds over days, and which builds in hours or less? (b) why does a steep, narrow catchment flood so fast? (c) which type gives emergency services more time to warn people, and why?
- Q4.** Using the cyclone engine figure: (a) what does a tropical cyclone need from the sea to form? (b) which way do cyclone winds spin in the southern hemisphere? (c) list the gust ranges for Category 1, Category 3 and Category 5.
- Q5.** Using the seasons strip and the cyclone map: (a) what months make up the official Australian cyclone season? (b) which part of the coast averages the most cyclones, and about how many per season? (c) can Victoria expect tropical cyclones? Which members of the hazard family does it get instead?
- Q6.** Using the ENSO see-saw: (a) which phase turns eastern Australia drier and hotter? (b) which phase raises flood and cyclone risk, and what happens to Queensland's cyclone count in those years? (c) who declares which phase is running?
- Q7.** Copy this table and sort each action into one stage of the cycle (prevention, preparedness, response or recovery): (a) planning rules stop new houses being built on a floodplain; (b) a household packs an emergency kit and learns its evacuation route; (c) residents sandbag their doors while a flood warning is current; (d) the government pays relief grants and repairs flooded roads; (e) an inquiry reviews a flood, and its lessons change the next flood plan.

Un scaffolded

- Q8.** "A weaker cyclone killed 66 people; a stronger one killed none directly." Explain this sentence using the Tracy–Yasi figure and the ideas of exposure and preparedness.
- Q9.** Choose a real Victorian place you know (a town, a suburb, a farming district). Which two or three members of this section's hazard family could reach it, and why? Use what Sections 2 and 3 say about causes and patterns — and name one member that is unlikely to reach it, with a reason.
- Q10.** A classmate claims: "*Nobody should be allowed to build a home on a floodplain.*" Put that claim in its strongest form, then put the opposing view in its strongest form (think about Lismore, and about why river flats got built on in the first place). Use evidence from this section to say which view the evidence supports better — and remember the mark is for the quality of both steelmanned views, not for which side you land on.
- Q11.** Two farming towns of the same size get the same river-flood warning on the same day. One has a recent flood plan, rehearsed SES crews and raised sheds; the other has let its plan lapse. Explain, using the impact ideas from Section 4, why the impacts would differ even though the flood is the same.

Extended response — evidence-based written task

Q12. *Explain the causes, impacts and responses for one hazard of the atmosphere or the water cycle, using Australian evidence.*

Write about one page. Your response must:

- choose **one** hazard from this section and describe its physical cause and its temporal and spatial pattern in Australia (VC2HG8K05.E01);
- use **two** real Australian events from this section (for example Cyclone Tracy, Cyclone Yasi, the 2010–11 Queensland floods, the January 2011 Victorian floods, the 2022 eastern Australia floods or the millennium drought), covering economic, environmental and social impacts (VC2HG8K05.E02);
- run at least one of those events through **all four** stages of the cycle, naming a real community or government action at each (VC2HG8K05.E03);
- refer to at least one figure from this section and one entry from the source list;
- finish with a sentence stating which stage of the cycle you think matters most for Australia, and why.

Success checklist: cause and pattern explained with a named place and season; both events described accurately with dates and at least one number each; all three impact kinds covered; all four stages named with real actions; a figure and a source referred to; a reasoned closing choice.

Answers

Q1. (a) A hazard driven by weather and the water cycle — droughts, storms, cyclones and floods. (b) A hazard *could* harm people; a disaster is when it does and the community cannot cope on its own. (c) The area of land that drains into a creek or river. **Q2.** Drought (a long run of below-average rain); severe storm (warm moist air rising fast into tall storm clouds); tropical cyclone (warm ocean water feeding rising moist air into a spinning storm); flood (more rain than the ground and rivers can carry away). **Q3.** (a) River flood over days; flash flood in hours or less. (b) Steep slopes give the water speed, and a narrow catchment funnels it into one creek at once. (c) The river flood — it rises slowly enough to watch, forecast and warn. **Q4.** (a) Sea water of about 26–27 °C or warmer. (b) Clockwise. (c) Cat 1: 91–124 km/h; Cat 3: 167–224 km/h; Cat 5: over 280 km/h. **Q5.** (a) 1 November to 30 April. (b) The west coast, about 7 per season. (c) Very unlikely — Victoria sits far from cyclone tracks; it gets severe storms, floods and droughts instead. **Q6.** (a) El Niño. (b) La Niña; Queensland sees 3–4 times as many cyclones in La Niña years. (c) The Bureau of Meteorology. **Q7.** (a) Prevention. (b) Preparedness. (c) Response. (d) Recovery. (e) Recovery (feeding prevention). **Q8–Q11.** See fully-worked solutions for what a good answer contains. **Q12.** Marked against the success checklist.

Fully-worked solutions

Q8. Model answer: Tracy (1974) was Category 4 with a recorded gust of 217 km/h; Yasi (2011) was Category 5 with gusts to 285 km/h — yet Tracy killed 66 people and destroyed most of Darwin’s housing, while Yasi killed nobody directly. The difference was exposure and preparedness: Darwin was a fast-growing city of untied houses with no rehearsal and short warning, while the Yasi coast sat behind cyclone building codes written after Tracy, a modern warning system and mass evacuations of about 30,000 people. A good answer states the comparison, then names exposure (what stood in the path) and preparedness (what was in place) as the deciding factors, not category.

Q9. Model answer (a Wimmera town such as Horsham): Drought reaches it — the Wimmera is inland south-eastern Australia, the region the hazard family table names as most drought-exposed, and Horsham flooded in the same wet January of 2011 that broke records across Victoria, showing river floods reach it too (the Wimmera River ran through the January 2011 floods). Severe storms reach it, as they reach every state. Tropical cyclones are the unlikely one: Horsham sits far south of the cyclone tracks shown on the map. Marks are for choosing hazards that genuinely fit the place and giving the cause or pattern reason for each.

Q10. Strongest form of the claim: floodplains are known hazard zones — Lismore’s 2022 flood beat its 1954 record by more than two metres and flooded over 3,000 homes — so every home built on one is a preventable risk, and planning rules are the one cheap moment to refuse it. *Strongest form of the opposing view:* river flats got built on for real reasons (flat land, water, rich soil, transport), whole towns already stand there, moving them is beyond any budget, and the workable path is managing the risk — levees, warnings, raised floors, rehearsed evacuations — while keeping *new* building out of the worst spots. The evidence supports the second view as the more workable one, but borrows from the first: Lismore shows that planning for the old record is not enough, so the claim is rightest about new building. Marks are for the quality of the two steelmanned views and the evidence used.

Q11. Model answer: the flood is the same, so the difference must come from what stands in its path and what is in place. The prepared town has lower exposure in the right places (raised sheds, stock moved early), faster and trusted warnings from a rehearsed plan, and crews who have practised the response — so fewer losses, fewer rescues, a quicker recovery. The lapsed town has the same water but none of that: more property in the path, slower action, and a recovery that takes longer and costs more. A good answer walks through exposure, warning response and recovery speed for both towns, not just one.

Q12. Model structure: Paragraph 1 defines the chosen hazard and gives its cause and pattern with real geography (for example: tropical cyclones — warm sea of 26–27 °C or more; season 1 November to 30 April; heaviest on the north-west coast with about 7 per season). Paragraph 2 runs event one through its impacts across all three kinds (for example Tracy 1974: 66 deaths social; A\$837 million then / about A\$7.69 billion in 2022 values economic; 94 per cent of houses unliveable social again — and for environmental, pair with a flood event’s rain totals or the Murray’s record-low flows). Paragraph 3 runs event two through all four stages with real actions (for example the January 2011 Victorian floods: levees and planning as prevention, BOM warnings and sandbag readiness as preparedness, 200,000 sandbags and evacuations as response, A\$7 million relief and reviews as recovery). Paragraph 4 names the figure and source used. Closing sentence picks a stage with a reason — preparedness is a defensible pick for Australia, because most of our hazards arrive with some warning time, and warning time is what turns a hazard into a managed event instead of a disaster.

Sources used in this section

- VCAA, *Victorian Curriculum F–10 Version 2.0*, Geography, Levels 7 and 8 — VC2HG8K05 and elaborations, via the VCAA export of 2026-07-29.
 - Bureau of Meteorology, tropical cyclone climatology and the Australian cyclone scale (season 1 November to 30 April; about 11 cyclones per season with 3–4 landfalls; regional averages of about 7 west, 5 north-west, 3 north and 4 east coast; Category 1 gusts 91–124 km/h through Category 5 over 280 km/h; Queensland seeing 3–4 times as many cyclones in La Niña years), accessed via the BOM tropical cyclone pages and the Wikipedia articles *Tropical cyclones in Australia* and *Australian region tropical cyclone* (some BOM pages were not retrievable as static pages on 2026-08-25); retrieved 2026-08-25.
 - Wikipedia, *Cyclone Tracy* (landfall about 3:30 am, 25 December 1974, near Fannie Bay, Darwin; Category 4; recorded gust 217 km/h; 66 deaths — 45 on land, 21 at sea; over 70 per cent of buildings destroyed and 94 per cent of houses unliveable; 35,362 evacuated 26–31 December; A\$837 million, about A\$7.69 billion in 2022 values) and *Cyclone Yasi* (landfall about midnight, 3 February 2011, near Mission Beach; Category 5; gusts to 285 km/h; one indirect death; about 30,000 evacuated from Cairns; about A\$3.5 billion); retrieved 2026-08-25.
 - Wikipedia, *2010–2011 Queensland floods* (December 2010 to January 2011; 33 deaths; over 78 per cent of the state declared a disaster zone; Brisbane City gauge peak 4.46 m on 13 January 2011; about 29,000 homes and businesses flooded; property damage A\$2.39 billion; total economic cost about A\$14.1 billion); retrieved 2026-08-25.
 - Wikipedia, *2022 eastern Australia floods* (23 February to 7 April 2022 across NSW and Qld; 27 deaths and one person missing; Brisbane record 3- and 7-day rainfall totals; Mt Glorious over 1,770 mm and more than 30 locations over 1,000 mm; more than 23,400 homes flooded; about A\$9.6 billion) and *Lismore, New South Wales* (Wilsons River peak 14.37 m in February 2022 against the 12.1 m record of 1954 and 1974; over 3,000 Lismore homes affected); retrieved 2026-08-25.
 - Wikipedia, *2010–2011 Victorian floods* (rain 12–14 January 2011 in Victoria’s wettest January on record; more than 51 communities flooded; over 1,730 properties flooded; more than 17,000 homes lost power; 2 deaths; the Wimmera, Loddon, Campaspe, Avoca and Goulburn rivers among those flooded; about 200,000 sandbags; about A\$7 million in immediate relief; about A\$2 billion in damage) and *Victoria State Emergency Service* (control agency for floods and storms in Victoria; more than 5,000 volunteers); retrieved 2026-08-25.
 - Wikipedia, *Millennium drought* (began in the late 1990s and broke with the 2010–11 La Niña rains; Melbourne storages fell to about 26 per cent; the River Murray at its lowest in more than 90 years; the Water Act 2007 and new desalination plants, including Victoria’s A\$3.1 billion, 150 GL plant, among the responses) and *Climate of Australia* (national mean rainfall about 419 mm a year; about 80 per cent of the land under 600 mm; about half under 300 mm); retrieved 2026-08-25.
 - Wikipedia, *List of floods in Australia* (Gundagai 1852, 89 deaths; Clermont 1916, 65 deaths; Yarra River 1934, 35 deaths) and news summaries of the June 2021 Gippsland storms (2 deaths; 160,000 properties without power, some for more than four days; about 200 homes evacuated), reproduced via Wikipedia’s 2021 articles; retrieved 2026-08-25.
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Teaching sequence (teacher note — not student-facing)

1. **Hook and terms (1 lesson).** Open on the Tracy–Yasi chart: “the weaker cyclone killed 66 people; the stronger one killed none — how?” Define the boxed terms; use the hazard family table to settle what belongs in the family and why (atmosphere and water-cycle driven), and lean on the hazard concept from VC2HG6K05 (Levels 5–6) rather than re-teaching it (D1).
2. **Causes and patterns (1–2 lessons).** The cyclone engine; the two flood types; the drought rainfall stats; then the temporal strip, the cyclone map and the ENSO see-saw as the E01 pair — *when* and *where*. Worked Example 1 lands here if the class needs the exposure idea earlier. Q2–Q6.
3. **Impacts (1 lesson).** The three impact kinds with the real numbers; the Lismore record-break as “exposure surprises planners”; the exposure reasoning that Section 4 closes with. Q8, Q9, Q11. Q10 is the section’s steelman task — run it as a structured discussion before writing.
4. **Responses and assessment (1–2 lessons).** The four-stage cycle; the Victorian warning chain (VicSES as control agency); Worked Example 2 (the January 2011 Victorian floods run through every stage); Q1, Q7. Q12 is the assessed evidence-based response — the CD’s three demands (causes, impacts, responses) made visible as a checklist.

Links: 3E mirrors this section exactly (causes and distribution → impacts → prevention, preparedness, response, recovery), so the hazard reasoning built here transfers to the geomorphological study; the hazard concept itself is assumed from VC2HG6K05 (Levels 5–6), not from any Level 7 book (D1). The skills CDs are *not* taught here (D11); climate-change impacts on water belong to 1C and are referenced once, not taught. **§2A:** no exclusions apply to VC2HG8K05; no First Nations material is used or required. **Coverage keys:** VC2HG8K05.E01, VC2HG8K05.E02, VC2HG8K05.E03.