The Water Story

A Regenerative Science Education Program for Primary – Stage 1

Mulloon Institute and The Scots College

This publication has been co-created by Mulloon Institute and The Scots College

MULLOON INSTITUTE

The Mulloon Institute is a not-for-profit research, education and advocacy organisation. We believe the long-term sustainability of both agriculture and the environment requires balance and working together. We demonstrate innovative land management approaches that create healthier landscapes more resilient to climatic extremes.

Landscape rehydration strategies rebuild soil fertility, fix more carbon in the landscape, restore lost biodiversity and improve water quality and availability. This results in increased agricultural productivity, the production of high-quality nutrient-dense food, improved human health and community cohesion.

The mission of Mulloon Institute is to actively demonstrate, validate and share landscape rehydration, restoration, and regenerative practices to create sustainable and resilient agricultural and environmental systems now and into the future.

THE SCOTS COLLEGE

The Scots College is one of Australia's oldest and most respected Presbyterian day and boarding schools for boys, located in Sydney. The College's programs inspire boys to become principled, compassionate and engaged citizens of their College, community and world. The College enjoys a long and close association with rural Australia. The Scots' boarding community is enriched by generations of families that have worked the land and entrusted their sons' education to Scots.

Scots not only delivers the mandated curriculum but collaborates and partners with educators who are active practitioners in their fields.

The College's active education site, Bannockburn is located on approximately 300 hectares near Culburra Beach on the Crookhaven River. It offers boys at all levels of the curriculum experiential learning in key academic areas such as mathematics, science and agriculture. Bannockburn activities are approached with a sustainable focus, ensuring Scots boys gain a sound ethical and scientific understanding of how they impact the world. These activities encourage them to think critically about how their choices can benefit the planet.

The Scots College is proud to partner with Mulloon Institute. In addition to this innovative curriculum, this partnership sees senior agriculture students visit the Institute annually, where they investigate the rehydration and restoration of land and catchments.

LEAD AUTHORS

Kym McMaster (BSc DipEd) | The Scots College
Dr Laura Fisher | Mulloon Institute

Children's book authors Susan Banki and Josh McConnell from Brave Rhino Books created the four colour illustrations and poem 'Wanda the Water Drop'.

Illustrator Melinda Turnbull created the 'Wanda the Water Drop' face images.

All other images courtesy of Freepik.com unless noted otherwise.

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Mulloon Institute
For environment, farming and society.

The Scots College
Sydney Australia

NSW GOVERNMENT

Australian Government

Foreword by Glenn Morris

Like some sort of miracle, a little stream of water bubbles out of what was once bare ground. It eventually becomes a little stream of water heading to the nearest creek, which will in turn join one of the biggest river systems in Eastern Australia.

Where once there had been no water and no life in a parched landscape there is now life. All sorts of life. A dried-up stream has returned to being a permanent source of water.

What seems like a miracle of nature is in fact a human story of understanding, respect and nurturing. As a farmer, I learned to nurture the natural foundations that provide us with a constant water cycle.

How beautiful is it to see with our eyes wide open how we need nature and nature needs us. How beautiful it is to see the powerful role we can play in rebuilding and connecting healthy landscapes and soils with water cycling through the ground, plants and clouds.

As a farmer who has managed landscapes for improved water cycling for twenty years there are two very important lessons which I have learned and which I would like to share.

The first is that it is vital for our future that we manage every square metre of land for healthy plants and healthy soils. This way, Country can receive, store and cycle the precious water we need to sustain our landscapes in drier times.

The second lesson I'd like to share is that we are all responsible for caring for the land and environment. It's going to take our most dedicated collective efforts to restore healthy water cycling for our future water security on this arid continent.

The Water Story contained in this learning module provides a beautiful opportunity for students to learn how their decisions and actions are interconnected with a healthy water cycle. But more importantly it empowers them to go out into the wider community, share their knowledge and take steps to restore healthy ecosystems well into the future.

Glenn Morris
April 2023

Glenn Morris is an environmentalist and farm manager based in Inverell, NSW. He has been a passionate advocate for regenerative land management and climate change action for 25 years. In 2004 his Masters thesis in Sustainable Agriculture (University of Sydney) highlighted strategies for improving the water-holding capacity of soils. He has managed the Inverell property Billabong since the early 2000s, transforming it from a degraded state to an exemplary regenerative grazing property with high biodiversity. To raise awareness, he has worked with groups like Farmers for Climate Action and Kandos School of Cultural Adaptation and featured in several documentaries created by Grow Love Project and most recently the Department of Primary Industries #ClimateChange Farmer Stories series.

Foreword by Carolyn Hall

The Water Story is a work of collaboration. Two organisations came together with a shared desire to tell the story of water on the earth. At its core this publication is a story of hope that acknowledges the life-giving force of water. Through understanding water and how it moves and cycles we can restore our landscapes and build a more secure future.

The journey of drafting The Water Story began at Mulloon Creek, a special place of stewardship that sparks creativity and imagination. This special place brought Wanda the Water Droplet to life. The joint efforts of The Scots College and Mulloon Institute, led by Kym McMaster and Dr Laura Fisher, have yielded a remarkable resource fit for the challenging times we face now, one that can be shared freely across Australia.

I thank also Susan Banki, Josh McConnell and Melinda Turnbull for their contribution to the characterisation of Wanda. I am immensely proud that we have worked together to empower our students and teachers with vital knowledge of our natural systems, so that all can play their part in healing our landscapes and fostering a more balanced climate.

Carolyn Hall
Chief Executive Officer & Managing Director
Mulloon Institute

Foreword by Kym McMaster

> To position our students so they can confidently flourish and thrive, and not merely survive, we need to design new curricula (programs) that are more innovative, rigorous, relevant, and aligned with our vision of the future, our mission in the world, and are uniquely Australian in character.
>
> **Dr. Ian Lambert**
> *Principal of The Scots College.*

I set out to create The Water Story armed with this provocation and inspired by the release of another innovative curriculum program, The Soil Story – The Road to Regenerative Agriculture, produced by Kiss the Ground and Life Lab in 2020. I was also encouraged by my friend Peter Howarth OAM, The Scots College alumni and a former Director of Mulloon Institute, who shared my vision of empowering the youngest members of our society with regenerative principles so they can be leaders of sustainable change in the future.

Growing up and working in the Australian outback in a farming family, I have first-hand understanding of our environmental responsibility to be 'better stewards of Country'. In developing The Water Story, I drew on my many years of teaching science, geography, and agriculture across all year levels, and the incredibly rewarding role I play coordinating activities at Bannockburn, The Scots College's rural active learning site. The Water Story is the first in a series of programs designed to embed regenerative understandings in education from Years 1 to 10. These programs will focus the students' learning on healthy and replenished soils, increased nutrient density in food production, improved human health, hydrated landscapes, reduced erosion, greater biodiversity, increased carbon sequestration, reduced global warming, and more. We trust it will be an educational program that, as Damon Gameau states in '2040', "makes hope possible rather than despair convincing".

Kym McMaster (BSc DipEd)
The Scots College

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Introduction

THE WATER STORY IS A NEW LEARNING RESOURCE FOR YEAR 2 EDUCATION

It is designed to be a hopeful and empowering resource that shows young people they have a vital part to play in maintaining healthy landscapes. It provides an engaging introduction to the scientific fundamentals of water and different aspects of the water cycle, from the scale of a root in the soil to the weather patterns of the planet. It also investigates how humans interact with the water cycle, through custodianship, farming, regeneration and urban development, highlighting both positive and negative impacts. Ultimately students will learn that if we manage the water cycle and water resources effectively, we can create healthy and resilient ecosystems and mitigate the impact of climate change.

The Water Story is the result of a collaboration between The Scots College and Mulloon Institute. It is part of a series of regenerative science learning resources being created for primary and high school teaching. The Water Story is informed by scientific research and the expertise of staff at Mulloon Institute. A list of relevant scientific references can be found at the end of this document.

Syllabus outcomes

The Water Story has been designed to meet the Australian Curriculum's K-6 learning outcomes and objectives in science, geography and mandatory technology. It comprises 10 lessons and can be taught by itself over a full term.

The key learning outcomes are:

1. The necessity of available clean water.
2. Water's properties and movement.
3. How plants cycle water to maintain stable conditions for life on our planet.
4. How humans have impacted the water cycle.
5. How water "soaks in" and "runs off" and the relationship of these patterns to erosion.
6. The relationship between a disrupted water cycle and climate change.
7. Regenerative practices that can heal landscapes and the water cycle, and provide hope.

In 2021 and 2022, The Water Story was delivered to all Year 2 students at The Scots College.

> This is a significant Science and Technology unit exemplar due to the nature of its design. It allows all students to 'work scientifically' regularly and with experiences and materials that staff may not have naturally drawn upon. It is a wonderfully experiential unit allowing scientific concepts to build gradually. Students are afforded the opportunity to explore and discover knowledge, think deeply, learn new skills and scientific techniques all encountered in various locations to support the depth of learning. This allows purpose, connection, and meaning to be deeper than it might be if conducted solely in the classroom setting.

Lisa Sharpe
Coordinator of Curriculum and Staff Development,
The Scots College

These learning outcomes match the syllabus outcomes outlined in the Science and Technology K-6 Content Strand Earth and Space, Stage One (Year 2):

NESA (NSW Education Standards Authority) Outcomes		
ST1-1WS-S • A student observes, questions and collects data to communicate and compare ideas **ST1-10ES-S** • A student recognises observable changes occurring in the sky and on the land and identifies earth's resources **Content focus** 1. Stage 1 of the Earth and Space strand focuses on the observable changes that occur in the sky and landscape. Students explore how the Earth's resources are used and investigate their conservation. Stage 1 of this strand introduces students to regular atmospheric and astronomical events and their effect on the Earth and develops students' understanding of sustainability. Visit *this link* for further information.		
Australian Curriculum Year 2 Science Content: Earth's resources *(link)*		
CSSUO32	Earth's resources are used in a variety of ways	• considering how Aboriginal and Torres Strait Islander Peoples live in regions with scarce resources or in sensitive environments • identifying the Earth's resources including water, soil and minerals, and describing how they are used in the school • describing how a resource such as water is transferred from its source to its point of use • considering what might happen to humans if there were a change in a familiar available resource, such as water • identifying actions at school such as turning off dripping taps, that can conserve resources
Australian Curriculum Year 2 Design and Technologies *(link)*		
ACTDEK001	Understand how design and technologies works	• identify how people design and produce familiar products, services and environments and consider sustainability to meet personal and local community needs

INQUIRY QUESTION: WHAT ARE EARTH'S RESOURCES AND HOW DO WE USE AND CARE FOR THEM?

Students will:

- Identify and explore the use of a variety of Earth's resources including water and soil (ACSSU032)
- Identify how Aboriginal Peoples care for Earth's resources on Country, with a focus on water
- Plan and implement strategies considering how to conserve resources to address sustainability and to meet personal and/or community needs (ACTDEK001). For example, they will learn about slowing down water, reducing erosion and healing the water cycle.
- Identify how farmers look after the earth's resources, especially regenerative farmers.

The Water Story employs the teaching acronyms WALT (We Are Learning To) and WILF (What I'm Looking For). Teachers interested in these tools can visit this link for more information.

The Water Story's regenerative premise

All life on earth depends on water. There is a finite amount of water in the planet's hydrosphere, present as solid, liquid and gas. Its movement around our planet is driven by plants, which maintain the small water cycle, and major weather systems, which are a function of the large water cycle. The small and large water cycles buffer the powerful waves of solar energy that reach the planet from the sun every day. We thus depend on those cycles to be functional to preserve stable conditions for life on our planet.

Deforestation, urbanisation and agricultural land use have disrupted both the small and large water cycles. The planet has lost a lot of vegetation and healthy topsoil, which are responsible for cycling water within localised watersheds or catchments. This disruption of the water cycle is interacting with the effect of carbon emissions in our atmosphere, due to the burning of fossil fuels. Indeed, climate change, which affects us through increasingly extreme weather events like droughts and floods, is a consequence of both carbon emissions and dysfunctional water cycles. Our landscapes – urban, rural and forested - are struggling to withstand these impacts.

All over the world, people are embracing the principles of regenerative agriculture and eco-restoration to repair the water cycle and create more resilient, sustainable landscapes and land-based livelihoods. If we all understand how the water cycle works, and the critical role played by plants and human management of the land in stabilising our climate, we can support natural systems to recover.

Teaching young people about regenerative practices supports a wholesome understanding of our planet's resources, and the beauty and power of natural systems. It will help them understand their role in the stewardship of those resources and provides a foundation for hopeful action in a rapidly changing world.

USEFUL RESOURCES

Video: Preview to the 2021 documentary "Where there once was water".

Length: 2 minutes

Summary: This is a hopeful, uplifting video made in the US containing compelling statements and footage about the importance of water and good land management. It is a snapshot of many of the themes explored in The Water Story. (Link)

Video: Trailor for 'Rachel's Farm'

Length: 2.23 minutes

Summary: This is a snapshot of a 2023 film that documents Australian actress Rachel Ward's voyage from 'wilful ignorance about the ecological impacts of conventional agriculture to embracing a movement to restore the health of Australia's farmland, food and climate'. The trailor is optimistic and inspiring. (Link)

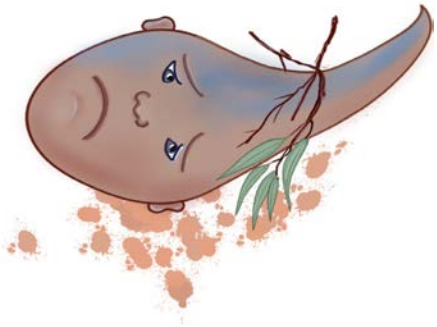
Wanda the Water Drop

The Water Story features a character called Wanda the Water Droplet. A poem that narrates Wanda's journey through the water cycle can be found on the next page. The themes explored in the poem correspond to the term's lesson topics. The Wanda character can be used throughout the term to support learning outcomes.

We recommend dedicating an early lesson to familiarising students with the Wanda poem and character. The poem could be printed out and displayed in the classroom for the whole term. Teachers can do a creative exercise to encourage students to imagine her in a variety of different states (achieving both a science and art curriculum outcome). For example, students could create their own props (such as paddle pop stick puppets) of Wanda in 4 or 5 states and use these props during discussions and learning activities.

Throughout The Water Story, the poem and Wanda props can be used to assist students to perceive water as rain, dew, ice, snow and vapour, and imagine Wanda in different environments: happy, restful, moving fast, or distressed and dirty. She can also be represented in different scales: inside a plant, or as a cluster of raindrops. Teachers can project large landscape images for students to interact with, or the class can create a landscape mural that features Wanda.

Below are some images that could inspire students or could be printed out to create Wanda puppets (larger versions can be found in the Appendix).



Images created by Melinda Turnbull

Wanda the Water Drop

POEM BY SUSAN BANKI

Wanda is a water drop
who loves to dance and play and hop
A happy, helpful little lass,
she lives as solid, liquid, gas
Sometimes she's ice, and then she's rain,
And then she's steam, and back again.
In frozen poles she slumbers deep
For years she's quiet – not a peep.
And then she melts and starts to flow.
In rivers, oceans, on the go.
She'll vaporize into the air
You see, dear Wandas everywhere
She's been around for oh-so long,
in clouds, in plants, in billabong.

'The soil is a snuggly home,
with tunnels, tubes and space to roam
Underground is magic, see
A spongy waterpark for me!
What fun I've had, what friends I've made!
We whisper, tickle, share, and trade
Here's Fred the Fungi, reaching out
to spread some goodies all about
Ruthie Root holds hands with Fred
So Pete the Plant is quite well fed
I climb up high on Tess the Tree
She breathes me out as gas, you see
And then I fall and turn to dew
I glisten in the sunshine too
I help my friends, I'm in demand.
I travel far to lend a hand.'

But sometimes Wanda moves too fast.
She can't reach friends like in the past.
She can't grab on to plants or shoots,
she can't feed worms, or trees or roots.
She's brown and murky, tired, sad.
And to be honest: a little mad.

Print versions of this poem can be found in the Appendix.

Wanda's friends are scared and sick,
they're thirsty, wanting water quick.
Especially during drought and fire,
which, when frequent, are very dire.
You may think floods are somewhat better,
but these don't make the soil wetter.
Wanda rushes by too fast,
it's hard to make the wetness last.

How can we slow Wanda down?
How to turn her clear from brown?
There are some ways, she'll tell you now,
She'll list them with a little bow:

Let's 'slow the flow', so when it rains
Water wanders through the plains
Let's plant to make a green explosion;
let's stop this really bad erosion!
Let's give our livestock room to graze,
but rest the fields on different days.
Let's listen to the land's first folk:
Help the water soak soak soak!

Wanda WANTS to play and hop
This lovely helpful water drop
Make the soil rich and dark
Give her back her water park.

Wanda the Water drop

ILLUSTRATIONS BY JOSH McCONELL

Wanda is a shape-shifter. She changes her state, being a solid (ice and snow), a liquid (rain, flowing streams), and a gas (steam, vapour). She loves cycling around the planet in all these different forms.

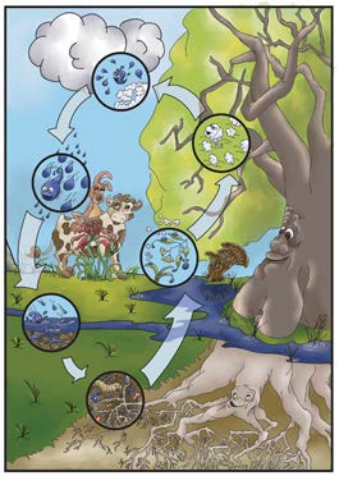
Wanda was once part of a healthy water cycle. She moved through grassy fields, infiltrating deep into the soil visiting earthworms and microbes, falling on rainforests and seas. She trickled down creeks, rested in billabongs, was lapped up by animals who came to waterways to drink. She moved through plants and transpired out of their leaves as vapour into the atmosphere, keeping the landscape cool. She has the odd wild ride in a storm or a volcano, but in general, she moved very slowly, and life was calm.

With agriculture and urbanisation, Wanda's life changed. She's now moving fast all the time and wishes she could slow down. She is sometimes caught up in extreme weather events like intense storms and floods. She wizzes down bare slopes that don't have plants on them. She doesn't see her old friends the worms, the microbes, and the fungi as often because the soil is compacted and water can't infiltrate the surface. She also speeds down cement and asphalt surfaces in the cities. In the rivers and creeks, she moves through muddy murky water because of too much sediment. There's not enough aquatic vegetation and habitat for her water friends either. She's unhappy, stressed, and exhausted as she is part of a disrupted water cycle.

With people learning how to heal the disrupted water cycle, Wanda's life turns around. She travels to a Regenerative Valley where she calmly moves through the water cycle, replenishing the environment, regenerating ecosystems and farm systems, and slowing back down again. This final section of Wanda's story is about inspiring grounded hope and an appreciation of the importance of good custodianship of land.

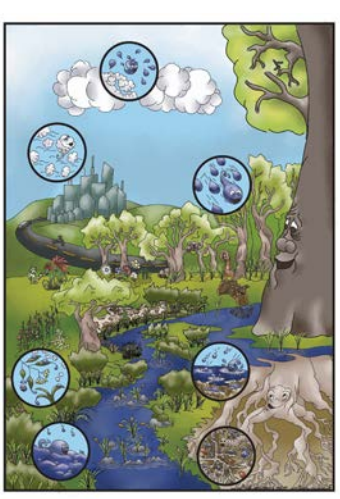
Print versions of this illustrated story can be found in the Appendix.

Wanda was once part of a healthy water cycle



Agriculture & urbanisation change Wanda's life

Wanda is now part of a distrupted water cycle



Good custodianship of land has now changed Wanda's life for the better

Units at a glance

LESSON 1: WATER ON EARTH

Where is water in our lives? Students reflect on personal experience and observation. What are the properties of water, how do we experience it, and can we describe how it behaves?

Engage: Elicit ideas about water
Explore: Where is water found, collected and used? How does it move?
Explain: Water properties, storage, uses, movement
Elaborate: Water flowing versus water soaking
Evaluate: Review understanding

LESSON 2: THE WATER CYCLE

What are the states of water? How does it move between the states? How does water cycle around a landscape?
**Snow + ice *Volcanoes - steam * Rain *Clouds - vapour*

Engage: Pose the puddle mystery
Explore: The states of water. Demonstrate ice melting/boiling/condensing.
Explain: How does water move through these states?
Introduce the Water Cycle and 'atmospheric weather events'.
Elaborate: The changing states of water are a cyclical process.
Evaluate: Review understanding

LESSON 3: SOAKING IN AND RUNNING OFF

Where is water in our lives? Students reflect on personal experience and observation. What are the properties of water, how do we experience it, and can we describe how it behaves?

Engage: Elicit ideas about water
Explore: Where is water found, collected and used? How does it move?
Explain: Water properties, storage, uses, movement
Elaborate: Water flowing versus water soaking
Evaluate: Review understanding

LESSON 4: PLANTS AND THE WATER CYCLE

Movement of water from the soil to the atmosphere and back again through the function of plants.

- Water infiltrates healthy soil & can be accessed by the roots of plants.
- Evapotranspiration: water is drawn up through the plant roots and stem and transpires from the leaves as vapour in the atmosphere.
- Condensation and dew: When the air temperature cools, the vapour turns back to a liquid and water falls to the ground again to hydrate the soil.
- Rain

Engage: How does Wanda move through plants?

Explore: Plant evapotranspiration experiment.

Explain: Recognise many living things rely on a healthy water cycle and impact the health of the water cycle.

Elaborate: Revisit water's change of state from a liquid to vapor (evapotranspiration) and then back to a liquid via condensation and dew.

Evaluate: Experiment conclusion and three positive impacts of plants.

LESSON 5: CARING FOR COUNTRY

Indigenous custodianship/water Dreamings (historical impact of humans). All living things depend on the water cycle. Introduce concepts of caring for our landscapes and our catchments.

Engage: The Rainbow Serpent: Indigenous custodianship of the land (Country).

Explore: How did understanding the water cycle help Indigenous people survive?

Explain: Research: fishing, storing or finding water.

Elaborate: Connecting cultural stewardship and survival.

Evaluate: Why is managing water important?

LESSON 6: HUMANS AND THE WATER CYCLE

Why is water moving too fast? What is erosion? Where does the water end up if it can't soak in? Introduce the idea of a 'broken' water cycle.

Engage: Wanda soaking in and running off.

Explore: Water soaking in becomes groundwater which people in arid parts of Australia access using bores. Water running off creates erosion.

Explain: Reinforce that this is an 'erosion' process because water is moving too fast.

Elaborate: Tote box demonstration:

- The loss of valuable soil, reducing our ability to grow food.
- This dehydration of the landscape reduces plant growth/survival and thus evapotranspiration. The water cycle isn't working.

Evaluate: Reflect on stewardship. How can we care for our landscapes?

LESSON 7: THE WATER CYCLE AND CLIMATE CHANGE

What is a weather extreme?

Engage: Extreme weather events. Evidence that the water cycle is disrupted.

Explore: How have humans impacted where water is 'running off' and 'soaking in'? What is the relationship between a disrupted water cycle and extreme weather events?

Explain: Revisit the 'soak in' and 'run off' concepts. What happens if we don't look after our 'soak in' areas? Drought, Floods.

Elaborate: The cost of extreme weather events.

Evaluate: Can we reduce the intensity of extreme events? How do we slow Wanda down and help her soak in?

LESSON 8: REGENERATIVE PRACTICES

What does 'regenerate' mean and what is regenerative agriculture?

Engage: Wanda storyboard, and/or video. Introduce Mulloon Institute.

Explore: Slowing Wanda down solutions: leaky weir structures, management of animals and humans, plus a replanting program.

Explain: What is regeneration? Define

Elaborate: Four key principles of regenerative agriculture that reduce water speed:

- 'Slow the flow'. Building leaky weirs in waterways.
- Managing animals: where they go and how long they graze.
- Managing human movement and impact on the soil.
- Plant more plants cover bare soil allowing for increased evapotranspiration.

Evaluate: Draw the four principles of regenerative agriculture.

LESSONS 9+10: DEVELOP A HOLISTIC VIEW AND TAKE ACTION

How can you make a difference? Create a holistic mind-map to understand the interconnections between humans, nature and climate. Where do you fit? Plan a regenerative landscape project for your school, garden, local park or family farm.

Engage: Realise that scientific understanding can contribute to the preservation of healthy water cycles.

Explore: Develop a holistic understanding of the relationship between humans, our environment, and our climate

Explain: Plan and implement strategies considering conservation of resources to address sustainability and to meet needs.

Elaborate: Identify technologies and appropriate materials needed to realise designed solutions.

Evaluate: Investigate and explain the needs of an audience in defining a problem.

Lesson 1: Water on Earth

Mulloon Home Farm flooding, 2022

WHAT ARE WE LEARNING TODAY (WALT)?	• Identify earth's resources and why they need to be cared for. • Share our prior knowledge and understanding of Earth's resources. • Deepen our understanding of earth's resources and the impact of our actions by participating in an experiment. • Explore and answer questions through participation in guided scientific investigations.
WHAT I AM LOOKING FOR (WILF)?	Students can: • Use their senses to observe and describe water. • Illustrate different places where water can be found. • Identify and explain how water moves.

BACKGROUND NOTES FOR THE TEACHER

Water covers about 71% of the surface of the planet. 97% of this water is in the oceans, and only 3% is freshwater. Much of this freshwater is locked up in ice, the atmosphere, soil, and deep underground: only 0.5% is available to humans.

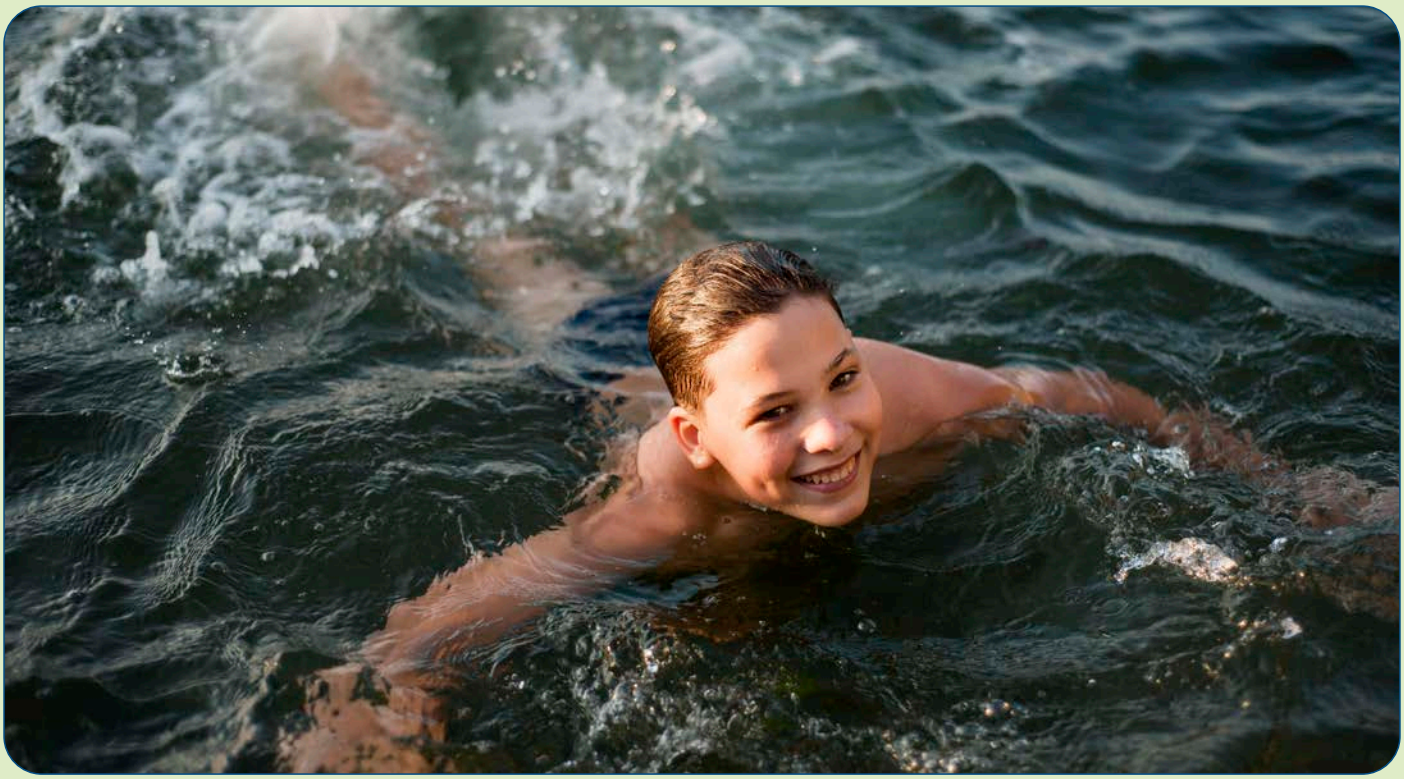
Our bodies are 60% water. Water is required by all living things. It is required for all metabolic functions. It transports vitamins, minerals, nutrients, and dissolved gasses through all living things.

Pure water is a clear liquid that has no taste, smell, or colour. It can form as a droplet and will combine with other droplets and flow to move. Water can exist in 3 states: as a solid (ice, snow, and hail) when cooled below zero degrees, as a gas (vapour, steam) when heated above 100°, and as a liquid when its temperature sits between 0-100°.

The movement of water has shaped the surfaces of our planet over millennia. The landforms we see around us are the result of the patterns and processes created when moving water and ice have encountered rock, silt, clay, vegetation, or other materials. Water is also moving beneath our feet, in shallow and deep aquifers and underground flow paths. Even in healthy landscapes, water is always slowly eroding the land, removing sediment and depositing it downstream. The scientific study of this process is called fluvial geomorphology.

Water is a solvent, which means it is a substance in which other materials dissolve to form a solution. Substances that are water-soluble dissolve in water and can move with the flow of the water. Water can carry nutrients, chemicals, and minerals from one area to another and from one source to another. It transports oxygen and food nutrients in the human bloodstream. In plants, water flows upwards from the root hairs, through the stem to the leaves in a process called transpiration. During this process, water transports minerals and nutrients from the soil that support the plant to grow and thrive. Water can also carry gases, such as nitrogen, from rain clouds down a stream and deposit them into the soils.

Capillary action is an important mechanism by which water moves. It occurs when the forces of adhesion, cohesion, and surface tension cause water to move through porous spaces (such as in soil or in the plant stem). Capillary action enables liquids to flow in narrow spaces and uphill, despite the force of gravity.



LESSON PLAN

LENGTH	60-90 minutes
RESOURCES REQUIRED	• Student Science notebooks. • Large sheets of blank A3 paper for their Water Mind Map. • Coloured crayons. • Standard led pencils. • Experiment 1 set up. Resource Sheet 1. One per student. This sheet is to be stuck into their science book when they have finished.
PREPARATION	Upload the Rain video ready to play (see link below). Bring fruit and vegetables to class. Scales for weighing items. *Prior to the lesson:* Set the classroom up with grouped tables, so there can be 4-5 students in each group. Distribute sheets of A3 paper to each table (1 per group). Have coloured crayons and led pencils available for use. Prepare a plate with an orange cut in half. Prepare one Resource sheet 1, per student. Prepare jars and a jug of coloured water and paper strips ready on the front desk.

USEFUL RESOURCES

Video: Rain
Length: 2 minutes
Summary: This is an atmospheric video showing rain falling in different environments, and water droplets rolling down a variety of surfaces. There is gentle background music, and no talking. (link)

Khan Academy website: Cohesion and adhesion of water
Summary: A clear and concise description of how water molecules behave. A useful resource to help teachers encourage observation and discussion. (link)

ENGAGE

I do: Play the video.

We do: Ask the students and elicit verbal responses: What are they hearing and seeing in the video? Ask them to imagine if this was happening outside the classroom. What would they be feeling, tasting and smelling? What are some sensations of water that they can describe, when it takes the form of rain?

I do: Draw students' attention to today's WALT and WILF.

You do: Ask the students to put their names on the top corner of the A3 sheet at their table. Ask a student at each table to write the title 'WATER' at the top of the page. Then ask all the students to draw water in all the forms they can imagine. Encourage them to use colours appropriate to what they have observed when looking at water in the real world. Ask them to think about large water structures and small water structures. (e.g. lakes, rivers, storms, mist droplets, ice, steam, condensation, etc). They can also think about their own bodies (tears), or the food they eat (watermelon, soup).

I do: Reflect upon the Water mind maps as a class. Invite some students to describe their drawings, and explain their water memories. Provide information if any misconceptions emerge, while still allowing students a broad scope with their imaginings and memories. These drawings will be used for reflection over the next few lessons. Collect the drawings from each table to pin on the sidewalls of the class later.

EXPLORE

I do: Ask students: Where is water found in their home? Where is water found near where they live? Where is water found at school? Where is it found in the world? Write answers on the board. Why do we have so much water around us? Hand out copies of Resource Sheet 1, to each student.

We do/you do: Discuss with students what they use water for and how water is stored or delivered to them. Ask the class to complete the sheet with help with spelling from the teacher's notes on the board.

EXPLAIN

I do: Explain that sometimes water comes in the food we and all animals eat. Squeeze an orange - ask how does the water get into the fruit, how does water move? Ask students for answers.

{Preparing for Experiment 1} Show water being poured as you fill the glasses in the middle of their tables with 3cm of coloured water. Hopefully, you will elicit the response 'water pours or flows'. Write 'Water Flows' on the board, then explain that it can also soak - create curiosity! Explain that plants need to draw water up out of the soil to grow and make the juice in the fruits. See Experiment 1, and explain that we are now doing an experiment to see how water soaks.

EXPLORE

We do: Complete Experiment 1. Choose one group member to carefully and slowly place the strip of paper into the coloured water until the line is just under the surface of the water. Ask everyone to observe what happens (the coloured water starts soaking into and travelling up the paper). After a minute, stop and ask another student to carefully bring the strip out of the water and place it on the table.

You do: Ask the students to draw the strips in their science notebooks and colour them as they have observed. Ask them to draw the line on the paper strip and then explain with annotations what happened. Where did the coloured water move to and how did it move there?

ELABORATE

I do: Explain that water moves by flowing. Water is a liquid, and it flows from one place to another depending on the slope. It can also 'soak in'. Explain that water can move/soak up through a plant, from its roots to its leaves, like it did on the paper. (This is caused by capillary action and the forces of adhesion, cohesion, and surface tension, which cause water molecules to be attracted to each other, and to other molecules. For a summary of how this works, see the Khan Academy webpage listed in the resources above.

We do: Create an exercise to explore the water content of fruit and vegetables: Bring an array of items to class and discuss their liquid content. Slice up and squeeze juice out of a few items and make some comparisons. Ask them to think about how the liquid got into the fruit or vegetable. What is this liquid? Could those plants have grown such juicy fruit if they couldn't access water in the soil?

Options for this exercise:

1. Ask the students to weigh each item and log their weights in their notebooks.
2. Bring a juice maker and paper cups into class, blend a juice that everyone can share. They can weigh their cups, reinforcing that they are measuring the water content of the item.
3. If you have a dehydrator, bring it into the school and dehydrate the sliced items. After 48 hours weigh the items to see the difference in weight.
4. Take the items home and cook in the oven on a low heat for several hours. Return them to school and weigh them with the students.
5. Use the students' recess and lunch items to compare what has the most and least amount of water.

You do: Talk to students about how animals can get their water: by drinking and eating plants. Humans are the same. They can consider how humans survived in very dry climates where they didn't always have access to running water by gaining hydration from edible plants.

We do: To determine students' understanding of the concepts, ask the students to draw an animal eating a juicy plant in their Science books and label it. Ask them to make it a diagram that illustrates how the plant accesses water, and how the animal consuming the plant obtains water from it.

EVALUATE

I do: check for understanding - using any form of quick response assessment ask the students. Ask these kinds of questions:`

1. What is water?
2. What do we need it for?
3. Where does it come from?
4. How does water move? (answer can be it flows due to gravity, it changes state, or moves by capillary action)
5. How is it stored or delivered to us?
6. How does water move from a plant to an animal?

Teachers can capture student responses with Post It notes or see-saw. Reflect on the conclusions written about the experiment, to assess understanding and look for any discrepancies in learning.

EXPERIMENT 1

AIM	To demonstrate water movement (soaking by capillary action) through paper.
RESOURCES	• A clear plastic or glass jar/cup. • Rectangular strips of blotting/butchers/filter paper (1-2cm wide and 5-10cm long depending on the size of the jars) per group. • A jug of water that has had food colouring added.
METHOD	1. Prepare strips of paper as shown and draw a biro line across the paper about 3cm from the bottom. 2. Prepare a jug of coloured water using food dye. 3. Pour approximately 3cm of coloured water into the glass. 4. Add the paper to the water carefully until the line is immersed. 5. Observe what happens to the water. 6. After about a minute take the strip of paper out and lay it on the table. 7. Discuss soaking capillary action- adhesion, cohesion and surface tension.

pics: Kym McMaster

EXPERIMENT 1: RESULTS

LINK TO DOWNLOAD VERSION

WHAT HAPPENED?	
CONCLUSION	
WHY DO YOU THINK THIS HAPPENED?	

RESOURCE SHEET 1

LINK TO DOWNLOAD VERSION

WATER IS USED FOR:	THIS WATER CAN BE STORED IN:
E.G. drinking	E.G. Bottles, taps and creeks

Lesson 2: The water cycle

WHAT ARE WE LEARNING TODAY (WALT)?	• Understand that water is found in three states: liquid (water), gas (water vapor) and solid (ice). • Realise the gaseous state of water is found, mostly, in the atmosphere. • Understand that water moves/cycles between these states around our planet.
WHAT I AM LOOKING FOR (WILF)?	Students can: • Identify the three states of water. • Identify and explain where different states of water may exist in a landscape (including invisible water vapour in the atmosphere). • Demonstrate an understanding of the water cycle.

BACKGROUND NOTES FOR THE TEACHER

KEY TERMS + DEFINITIONS	
PRECIPITATION	Water droplets fall from the atmosphere in the form of rain, sleet, snow or hail.
CONDENSATION	When water vapour in the air cools and turns back into a liquid, forming tiny water droplets in the sky.
EVAPORATION	The process that occurs when heat causes water to change from a liquid to a gas.
TRANSPIRATION	The passage of water vapour from a plant to the atmosphere.
INFILTRATION	The process by which water is absorbed into the soil.
RUN-OFF	Rainfall that is not absorbed by soil and travels to the ocean.
GROUNDWATER	Water that is present underground in saturated zones beneath the land surface.
SURFACE RUNOFF	Water that flows over the land surface and doesn't soak in.
STREAMFLOW	The flow of water in streams, rivers, and other channels.

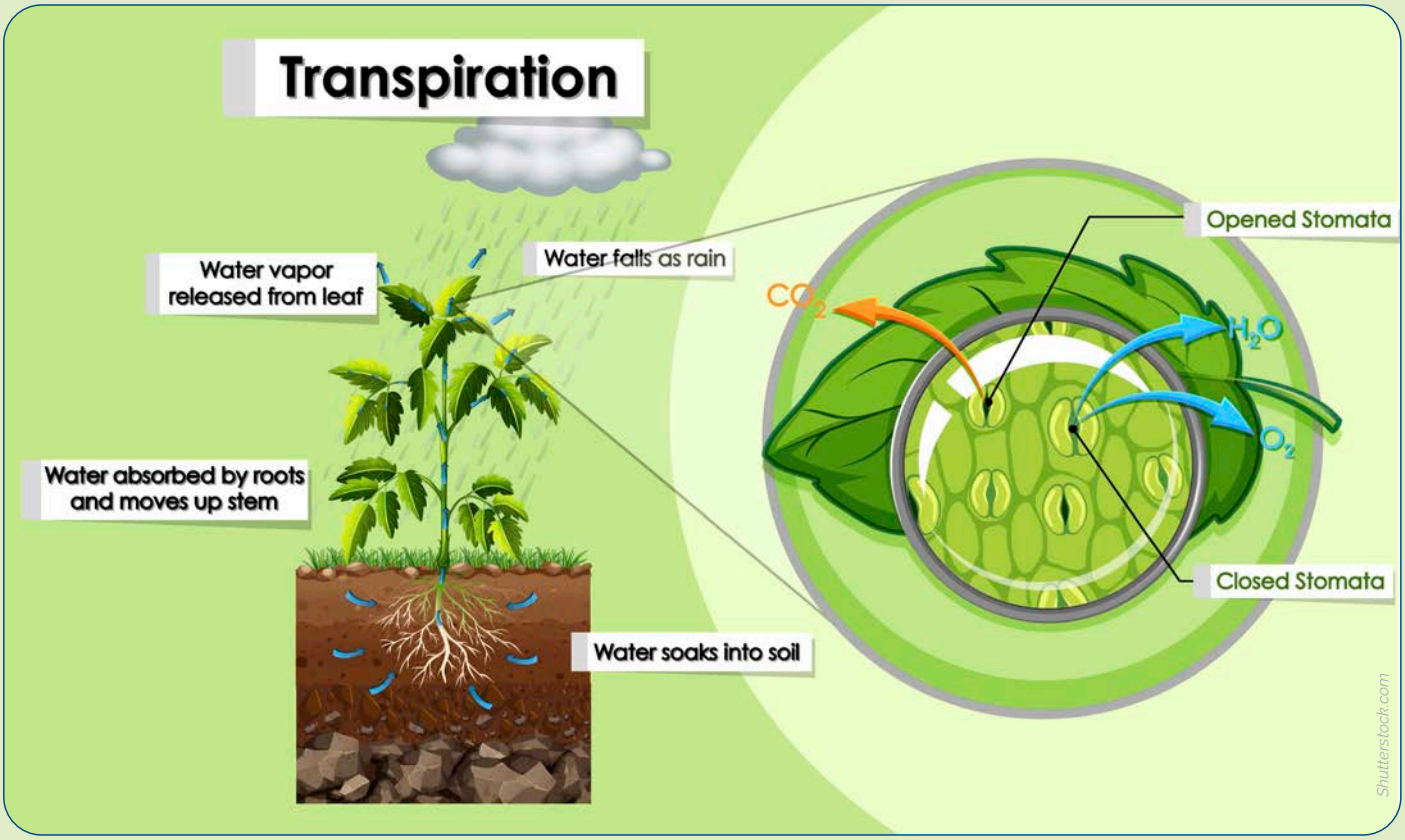
The water cycle is fundamental to life on earth. Not only is the water cycle at the cellular level fundamental to the survival of all living creatures, but it maintains temperatures on planet earth that sustain life. This is because the water cycle is a thermodynamic (energy) driven process. The two forms of energy that drive the water cycle are solar energy from the sun and gravity. The water cycle transfers, transforms, captures, releases, and dissipates energy while within the earth's atmosphere and its biosphere.

The water cycle operates on several scales, from the global and continental scale, where it drives major weather systems, to the microclimates that are created around a garden patch or in a greenhouse, to the microscale of the cell in an organism.

The movement of water from the soil, through the plant's roots and stem, and out of the leaves as vapour is called 'evapotranspiration'. The water is released out of tiny pores on the leaf's surface called stomata. Heat energy is required for water to turn into vapour, roughly 600 calories per 1 gram of water. This means that when water is transpired from plant leaves, the surrounding atmosphere is cooled, with the vapour holding that heat energy as 'latent heat', or humidity. Mature trees can transpire hundreds of litres of water a day. This process of transpiration that all plants do is vital to maintaining what is known as the 'small water cycle'. This cycle maintains moisture levels that sustain the local ecology of a catchment. Deforestation, irrigation, farming practices, and urban development have all disrupted the small water cycle.

The 'diurnal water cycle' refers to what happens between day and night, when vapour is held in the atmosphere during the warmer daytime temperatures, and then condenses and falls as dew when temperatures fall overnight. This dewfall is a critical part of the small water cycle because the dew rehydrates soil and plants.

Perhaps the most important thing to understand about the water cycle is that its energy-moderating effect is what makes the planet inhabitable. Without it, the sun's electromagnetic energy would overheat the surface of the planet during the day and the latent temperature of space would freeze the surface at night. Plants are a critical part of this energy moderating effect. This is due to transpiration as described above, but also because water can achieve such a gravitational force (as we see during floods) it has the power to erode continents to the sea. It is plants, utilising the water, holding the soil together, and providing roughness and fiction to impede surface flows, that prevent this from occurring. Thus, we depend on plant systems and the small water cycle to dissipate the forces of gravity and solar energy, allowing life to survive and thrive. The more we can support plant systems to do their vital work, the better chance we have of lessening the impact and severity of droughts, floods and bushfires.



USEFUL RESOURCES

Video: The Natural Water Cycle
Length: 3:13
Summary: This is made by Sydney Water. It contains clear definitions of features of the water cycle and animated graphics that young children will find engaging, but it may be a bit too technical. (link)

Website: The Small Water Cycle and Global Warming
Length: 3 minute read
Summary: A short description of the significance of the small water cycle to aid teacher understanding. It also has a useful diagram that can be used in class. (link)

Video: Introduction to the Water Cycle for Children
Length: 2:53
Summary: This is a Freeschool video. It is visually engaging and covers technical terms but should still be easy for young children to follow. (link)

Website: Natural Water Cycle
Summary: This site was made by South East Water Corporation in Victoria. It is a learning resource for young children that explains the processes of the water cycle with the help of animated water drops. (link)

LESSON PLAN

LENGTH	60-90 minutes
RESOURCES REQUIRED	'Cloze Exercise' x number of students. • 1 tray of ice cubes. • A couple of plates to place around the room, in sight of the class. For the States of Wanda activity: • Post-it notes, paper or cardboard in 3 colours: light blue, medium blue and white for each child. • Scissors, glue, Blu Tack. • Projector to display the landscape on the whiteboard or print out a large A1 copy of the landscape for display.

I do: draw students' attention to today's WALT and WILF.

ENGAGE

I do: Pose the following riddle (to be considered and answered later):

> *"There is a carrot, a pile of pebbles, a hat, and a scarf lying together in a puddle, in the middle of the playground. How did they come to be there?"*

Answer for later: They are the remains of a melted snowman.

EXPLORE

We do: Ask the students to look at their "WATER" mind maps (A3 posters) and direct them to the types of water they illustrated. Ask them to help you group them into three types or states - solid, liquid, and gas. Then put these headings on the board and get the students to help list all of the types of water that they had drawn under these headings.

I do: Place some ice cubes on the plates. Ask the students what they think will happen to the ice if we leave it there? Ask them to offer some guesses.

EXPLAIN

I do: Ask the students to describe the difference between the three types of water (e.g. hard, flow, cold, hot, particles that move fast or slow, have different uses, and are found in different places). Then tell them that these types are called states of matter. Ask them to consider what might dictate the state of matter that water is in at any point in time? Show this picture of boiling kettles and compare it to ice.

Conclude and write on the board that the water **temperature** determines the state water will be found in.

Inform students of the following rules (list them on the board for reference over the term):

Water can exist in 3 states:

- **ice (solid) when it is cooled below 0°C**
- **vapour (gas) when heated to 100°C (boiled),**
- **liquid**.

EVALUATE

You do: Ask the students to complete the 'Cloze Exercise'

CLOZE EXERCISE

Water can exist in _____ states.

Ice cubes in the freezer are _____ water.

When _____ is boiled it turns into _____ or steam.

Water is a _____ when we can pour it into a glass.

WATER	LIQUID	GAS	SOLID	THREE

We do: check the watch glasses, What has happened to the ice? Ask them if they can now answer the riddle posed at the beginning of the lesson?

Answer: **They are the remains of a melted snowman**.

We do: Discuss where water can be found in the atmosphere. (You can define the atmosphere as the gaseous layer found between the surface of the ground and space that contains the air we breathe, water vapour, and many other gases). Mention that water vapour is often invisible. Ask them to think about when it becomes visible to us (fog, clouds, mist). Invite stories from the class: have they driven through fog in the car, or woken in the early morning and seen that their environment is veiled in mist or fog?

EXPLAIN

I do: Review the student's understanding, then ask them to stick their Cloze exercises into their books. Now that they know that water can change states of matter, discuss how water changes from solid to liquid to gas and back again all the time, all around the world. In fact, water cycles around the planet, changing and moving all of the time.

Show the students this webpage: 'Natural Water Cycle' (the page scrolls through brief illustrations of Evaporation, Condensation, Precipitation, and Runoff). [Link in the Useful resources list above.]

Use a cyclical diagram that shows the water cycle and pin it on the board for later discussions.

ELABORATE

I do: Introduce 'Wanda', the water drop. Read the first part of the narrative. Explain to the students that we will be learning more about 'Wanda' over the next few weeks. Display the 'States of Wanda Activity' landscape on the board, then complete it with the students.

We do: Ask the students to identify where Wanda is a solid, a liquid, and a gas (vapour).

You do: Complete the 'States of Wanda activity' (next page, a larger version for print is in the Appendix).

STATES OF WANDA ACTIVITY

1. Provide students with light blue, medium blue and white Post-it notes, paper or cardboard (light blue, medium blue and white).
2. Ask them to use the paper to draw Wanda in each of the following states:
    - Light blue - gas, vapour
    - Medium blue - liquid, water
    - White - solid, ice
3. Project the landscape image (below) on the whiteboard.

Ask them to place their images on the landscape where each of the states of Wanda might be found. They can use Blu Tack or glue depending on the surface.

- Encourage them to name the state Wanda is in, e.g. hail, sleet, snow, plant cells or rain.

Remember:

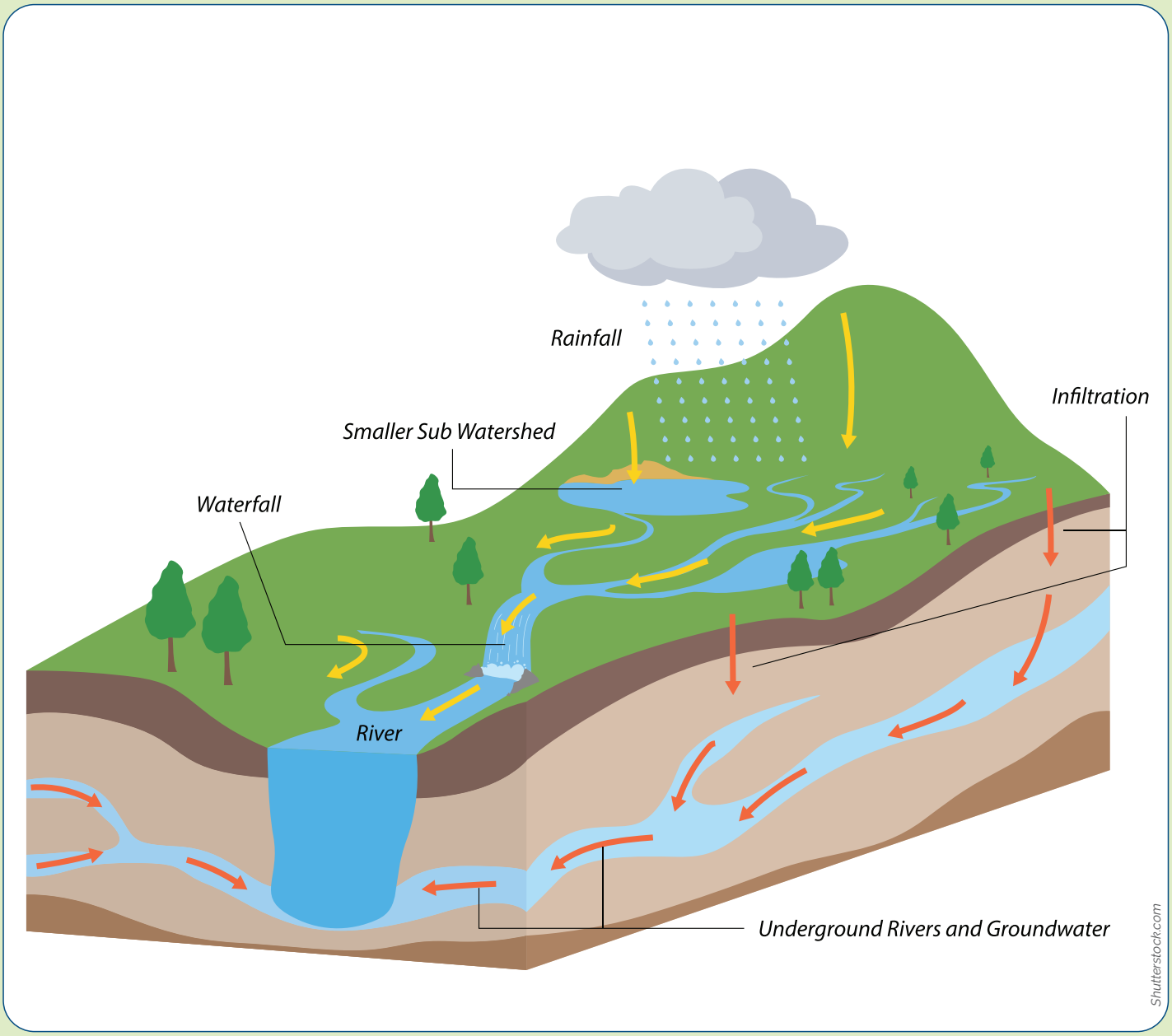
- Liquid water can be found in the soil, on plants as dew, falling from the clouds, and the river,
- Solid water can be found on the mountain as snow, in the clouds as hail, or the river as ice.
- Gaseous water, or vapour, can be found in the air anywhere, in the clouds or rising from the plants.

4. Discuss how Wanda can travel around the landscape in a cyclical fashion (draw some cyclic arrows on the landscape).
5. Leave this activity up (or draw it on the board), to refer to later. A larger version for print is in Appendix.

EVALUATE

We do / I do: check for understanding during the activity and address any misconceptions.

Lesson 3: Soaking in and running off



WHAT ARE WE LEARNING TODAY (WALT)?	• Identify how water moves in the landscape. • Understand that liquid water can 'run off or soak in'. • Understand the impact humans have had on the water cycle.
WHAT I AM LOOKING FOR (WILF)?	Students can: • Explain and illustrate how water moves in the landscape. • Demonstrate an understanding of how humans impact the movement of water.

BACKGROUND NOTES FOR THE TEACHER

When rain falls on the land, some of it is absorbed in the soil and enters the groundwater, some evaporates, some is transpired by plants, and some runs over the surface of the land and enters our waterways. This last process is called 'runoff'.

Runoff replenishes our creeks and rivers, but can also cause pollution, erosion, and damage to infrastructure due to flooding. As so many urban and farming landscapes have been cleared of trees, and Australia is experiencing more extreme weather events due to climate change, runoff has become a serious problem. If our soils can't absorb water because they are unhealthy, or the ground becomes saturated during heavy downpours, the flow of water over the surface of the land becomes very destructive. Heavy runoff can dislodge valuable topsoil and deposit it as sediment in waterways, reducing water quality. Powerful flows of runoff create deep incisions in the landscape, called erosion gullies. Creeks that used to be a meandering series of ponds get carved into deeper channels. This lowers the water table, making it hard for plants in the surrounding landscape to access water in the ground in dry times. Runoff also causes rubbish and chemicals from agriculture to enter our waterways.

One of the most important ways to counteract the impact of runoff is to maintain healthy soils and vegetation. These enable water to 'soak in' rather than 'run off'. Healthy soils are spongy, gluey, and have a porous structure. There are tiny pockets and hollows that can absorb water in the wet times, and then preserve it for plants and other organisms in the dry times. Farmers who farm regeneratively aim to build organic matter and to always keep a living root in the soil. The processes of photosynthesis, transpiration, and decomposition of organic material ensure that there is continuous cycling of carbon, nutrients, and water to support the soil's biology (worms, fungi, bacteria). With healthy soil biology, lots of organic matter, and less disturbance by processes like tillage, the soil's water-holding capacity increases.

Plants protect landscapes from the destructive impact of runoff in multiple ways. Plants use the water they can access in the soil, transpiring it into the atmosphere. Plant roots hold the soil together, which is especially important on steep slopes and riverbanks. Canopy, grasses and the litter created by plants also protect land surfaces from the force of heavy rain.

USEFUL RESOURCES

Video: Reducing Sediment Runoff
Length: 2 minutes
Summary: A concise, optimistic description of a project designed to reduce the impact of runoff on the Great Barrier Reef, with many useful visuals. (link)

Website: Influences on the water cycle
Summary: This is made by the Murray Darling Basin Authority. It is an education resource aimed at Year 7. It is part of five lesson packages they offer about water resources. (link)

Website: What is regenerative agriculture?
Length: 3-page article
Summary: This is part of the website for the Climate Reality Project, an American environmental education and advocacy group. (link)

Video: Rain Sound and Rainforest Animals Sound – Relaxing Sleep
Length: 2 hours, 19 minutes
Summary: A rain and rainforest soundscape video for creating a hydrated mood. (link)

LESSON PLAN

LENGTH	60-90 minutes
RESOURCES REQUIRED	• 1 large plastic box or crate to catch the water. • 1 large dry sponge. • 1 plastic ice cream lid, or covered clipboard (anything that is waterproof). • 1 small jug/container of water. • An A3 map or Google earth image for each group or table with the outline of the school, yards and streetscapes illustrated. • Coloured pencils. • Student's Science notebooks.

EXPLORE

I do: Introduce the concepts of 'runoff' and 'soak in'. Demonstrate the movement of water using the sponge and plastic lid. Pour ½ cup of water into the sponge, see it soaking in, then pour ½ cup of water over the plastic lid and observe it run off. Do this over the plastic box.

Describe how 'running off and 'soaking in' are important parts of the 'water cycle'. Revisit the water cycle drawing from the last lesson, or the Wanda activity, and ask the students to tell you where water is 'running off' and where it is 'soaking in'?

We do: Ask the students to draw in their science books a picture showing the movement of water 'soaking in' and 'running off' any two surfaces. Prompt them to think about when it rains at school, what surfaces does the rainwater soak into and what surfaces does it run off? They can then use some of these ideas in their drawings. Draw their attention to natural surfaces and man-made surfaces.

To create some atmosphere while they are drawing, you can play the 'Rain Sound and Rainforest Animals Sound' soundscape video in the Useful Resources list on the previous page.

ELABORATE

I do: Now ask the students: 'Do you think we have an impact on whether water soaks in or runs off?' Invite them to recognise that 'Yes, we do because we change the surfaces around us. Many surfaces around us are now man-made, not natural.' Ask them to help you list the ways humans can impact water soaking in or running off. Then group the impacts.

Soaking in: grass surfaces, trees, parks, sandy, soil, (natural surfaces that enable soaking in)

Runoff: cement, bitumen roads, pavements, houses/buildings, glass, wood, steel, compacted soil (surfaces that increase runoff)

Remind students that sometimes runoff is helpful, for example when we are trying to fill our dams or tanks, and sometimes we need to increase our soaking in, in the garden, or on the farm when we are trying to grow food. All plants and animals depend on water that has soaked into the soil to grow and survive.

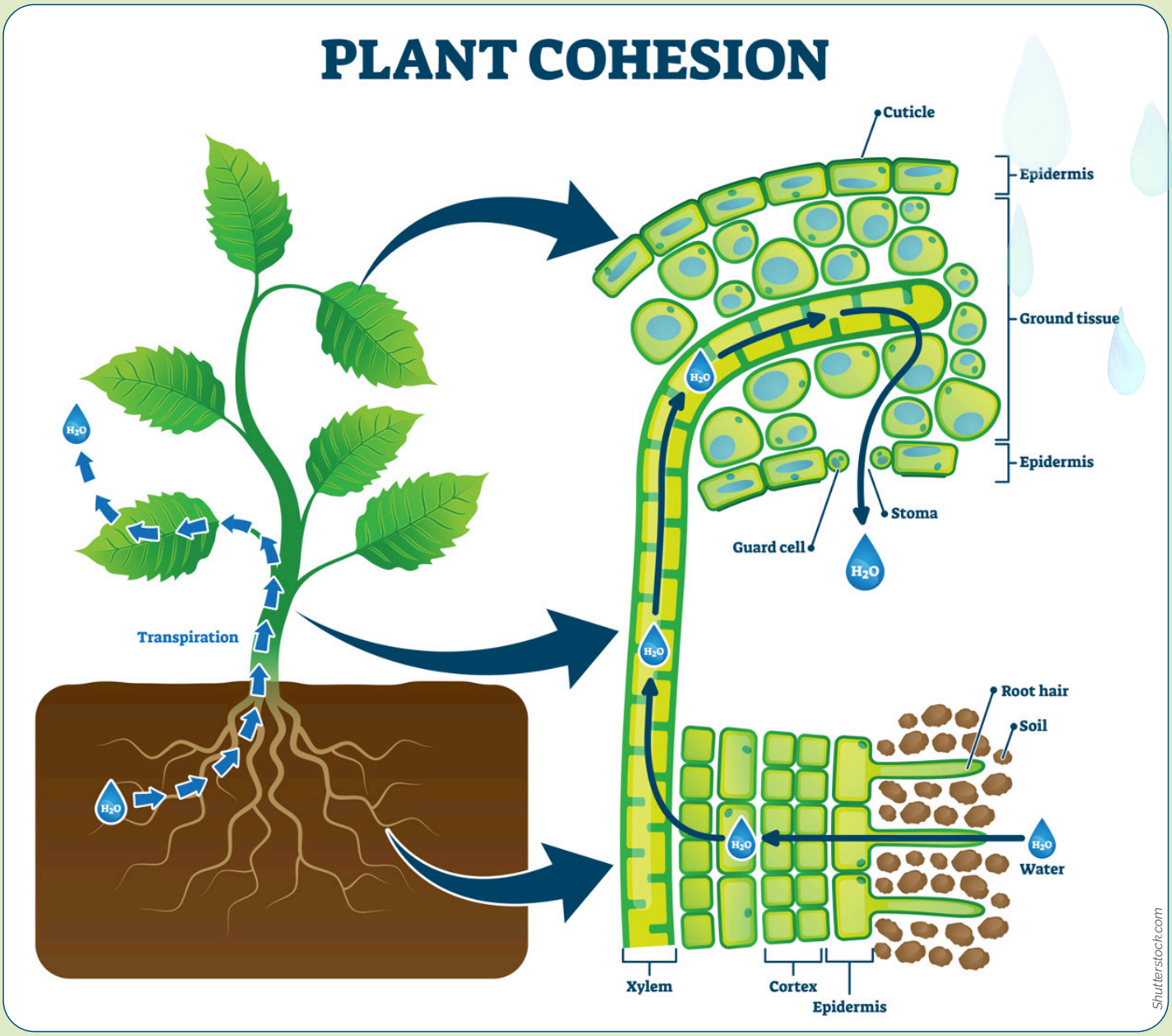
EVALUATE

We do: Organise students into small groups or to work together at their table and provide them with the A3 map of the school. Ask the students 'How could we increase the amount of soaking in at our school?' Ask them to draw or shade in areas on the A3 maps of the school where we could have more 'soak in' areas. Ask 'Are there any areas where some runoff surfaces could be placed to divert water to a collection tank to store water for dry times? Place the marked maps around the room for later discussion or ask each group to 'Show and tell' the others what they decided to do.

I do: check for understanding using any form of quick response assessment:

1. List the 3 states of water?
2. What state does water form when it is really cold?
3. What can water 'soak in' to?
4. Name one impact we have on water's ability to 'soak in'?
5. Why don't we want too much runoff on the land?

Lesson 4: Plants and the water cycle



WHAT ARE WE LEARNING TODAY (WALT)?	• Understand the important function plants have in the water cycle. • Understand transpiration and condensation.
WHAT I AM LOOKING FOR (WILF)?	Students can: • Conduct a transpiration experiment. • Explain how the water cycle is influenced by plants.

BACKGROUND NOTES FOR THE TEACHER

Plants are a vital part of the small water cycle. Transpiration is the process that occurs in every plant when water moves from the soil, through a pipe in the stem called the xylem, and out of the stomata pores on its leaves, at which point it evaporates. Plants hold on to only keep a tiny fraction of this water to support metabolism, photosynthesis and growth, and release around 97% into the atmosphere as vapour. .

As noted earlier, a fascinating thing happens when liquid water turns into vapour. Because heat energy is required for this 'change of state', transpiration cools the air temperature around the plant. For 1 gram of water to turn to vapour, about 600 calories of heat energy is required: this is the energy content of a healthy dinner. It is this remarkable process of transpiration that makes us gravitate to areas with plants and tree canopy on a hot day. It is not just that the area is shaded from the sun that makes it more comfortable, it's that the plants change the temperature of the air around them. This is the reason our planet is hospitable to life, unlike all the other planets in our solar system.

What happens to all the humid air generated by transpiring plants? At night, when the weather changes, or when the vapour moves higher into the atmosphere, it cools down and condenses into a liquid again. It can also lead to the formation of clouds heavy with moisture, and thus rain, or turn into fog and dew. This cycle maintains moisture levels that are vital for all the plants in a catchment: forests, woodlands, pasture, and crops.

Dew is formed when tiny droplets coalesce and become liquid water that collects on various surfaces. Many plant leaves are shaped to capture dew and direct it down the stem of the plant to its root zone. In arid areas and grasslands, dew is a very important source of water for plant life, because it is reliable and gentle. It's important to remember that this process releases the heat energy held by the vapour back into the air, which prevents the landscape from becoming too cold. Plant life contributes to 60% of the water that is cycled on the planet, more than evaporation from the ocean.

The processes described above are intricately connected to photosynthesis. Photosynthesis is how plants convert solar energy into chemical energy, the products of which feed all the other kingdoms of life on planet Earth. Plants are the primary producers in the food chain. The rest of us are consumers. Photosynthesis converts carbon dioxide into glucose, a sugar which then provides the plant with the fuel it needs to build the complex organic molecules needed for it to grow, and for it to feed and nourish the rest of the food chain. While we won't elaborate too much here, it's important to know that the process of photosynthesis both consumes and produces water, and that it is an energy intensive process, which generates heat. A primary function of evapotranspiration is to keep this process cool, so that it operates as efficiently as possible.

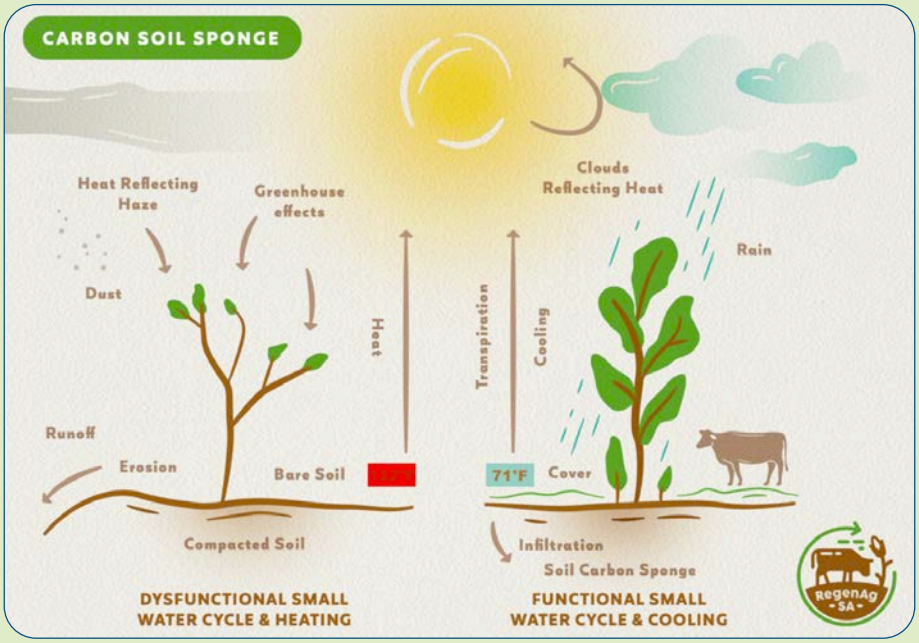


Image supplied by the Regenerative Agriculture Society of Southern Africa (link)
Print version available in the Appendix.

USEFUL RESOURCES

Video: How trees bring water, by permaculture educator Andrew Millison.
Length: 7.15
Summary: In this video, the narrator draws trees and water cycle processes on a pane of glass as he describes the processes by which trees attract and capture water vapour on their surfaces. He describes other aspects of the relationship between plants and water, and how rainfall patterns are affected by deforestation. It is visually engaging and artistic in its approach. A teacher might like to just show a small section of this video. (link)

Video: How trees help create the freshwater supply
Length: 4.18
Summary: American video explaining the role of trees suitable for young children. (link)

Poster: Forests and trees are essential to regenerative agriculture
Summary: An illustrated poster listing the many roles of trees in landscapes. (link)

Article: Morpho-anatomical studies on the leaf reduction in Casuarina: the ecology of xeromorphy
Summary: This scientific article features remarkable microscopic images of the cross-section (a slice) of Casuarina leaves and stems. These images show that plants are like bundles of straws, with many cylinders pumping water up from the soil and out the leaves. (link)

LESSON PLAN

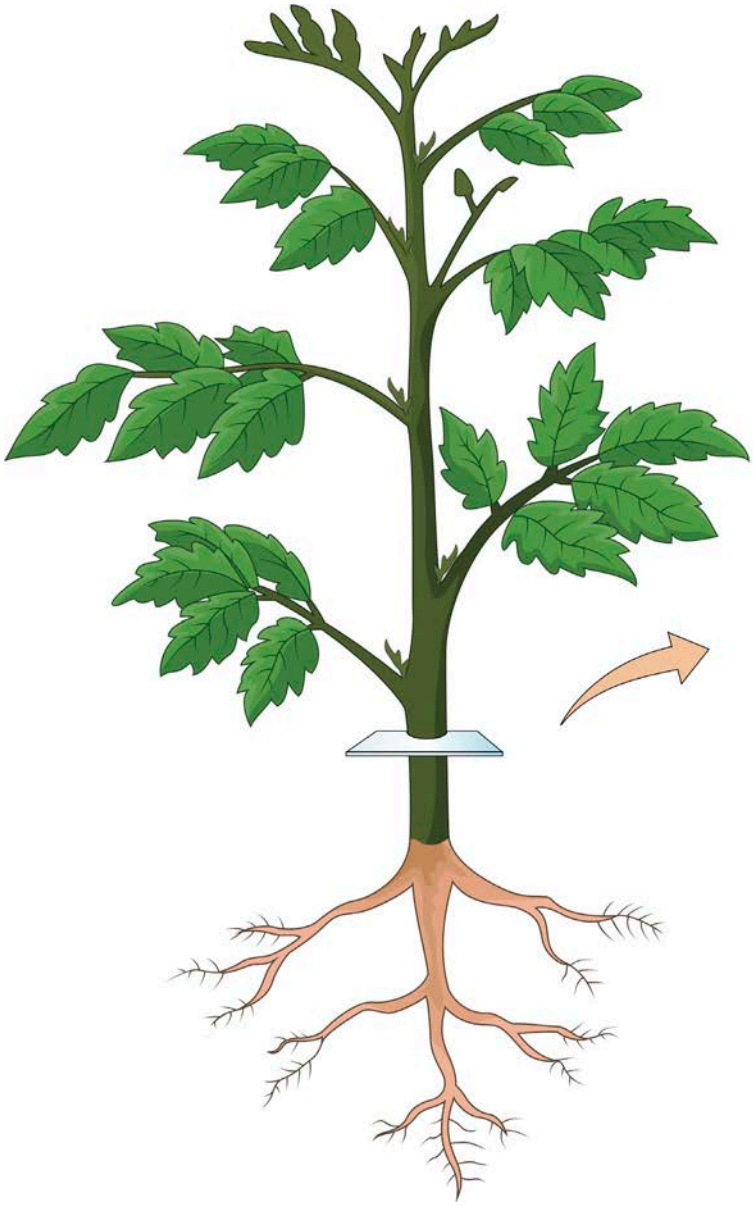
LENGTH	60-90 minutes
RESOURCES REQUIRED	• Equipment listed in Experiment 2. • 'Wanda' book or video. • The poster 'Forests and trees are essential to regenerative agriculture'. • Video: 'How Trees Bring Water' (link).
PREPARATION	• Prepare to show 'How trees help create the freshwater supply' (link). • Print off experiment results page for students.

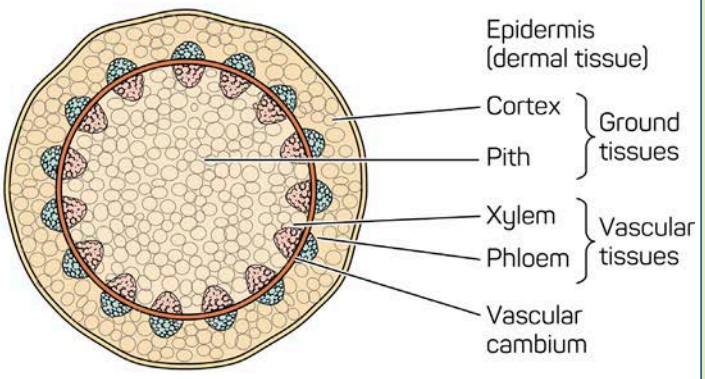
ENGAGE

I do: Ask the students: "How do plants participate in the water cycle? Let us investigate".

Remind the students about the movement/flow of water through humans, animals and plants. Ask them to think about what happens when we breathe out water vapour, e.g. steam on the windows on a cold day in the car, or foggy breath when we are outside on a cold day.

I do: Use the diagram and images of celery and corn stem cross-sections below to explore how plants transport water. Discuss how plants are pumps: their stems are like bundles of straws, which allow them to pump water from the soil to their leaves to transpire. You could show the class a bundle of paper straws in a rubber band to illustrate this. Place the diagram below side by side with the cross-sections and see if students can identify the vascular bundles with the xylem tubes inside them.





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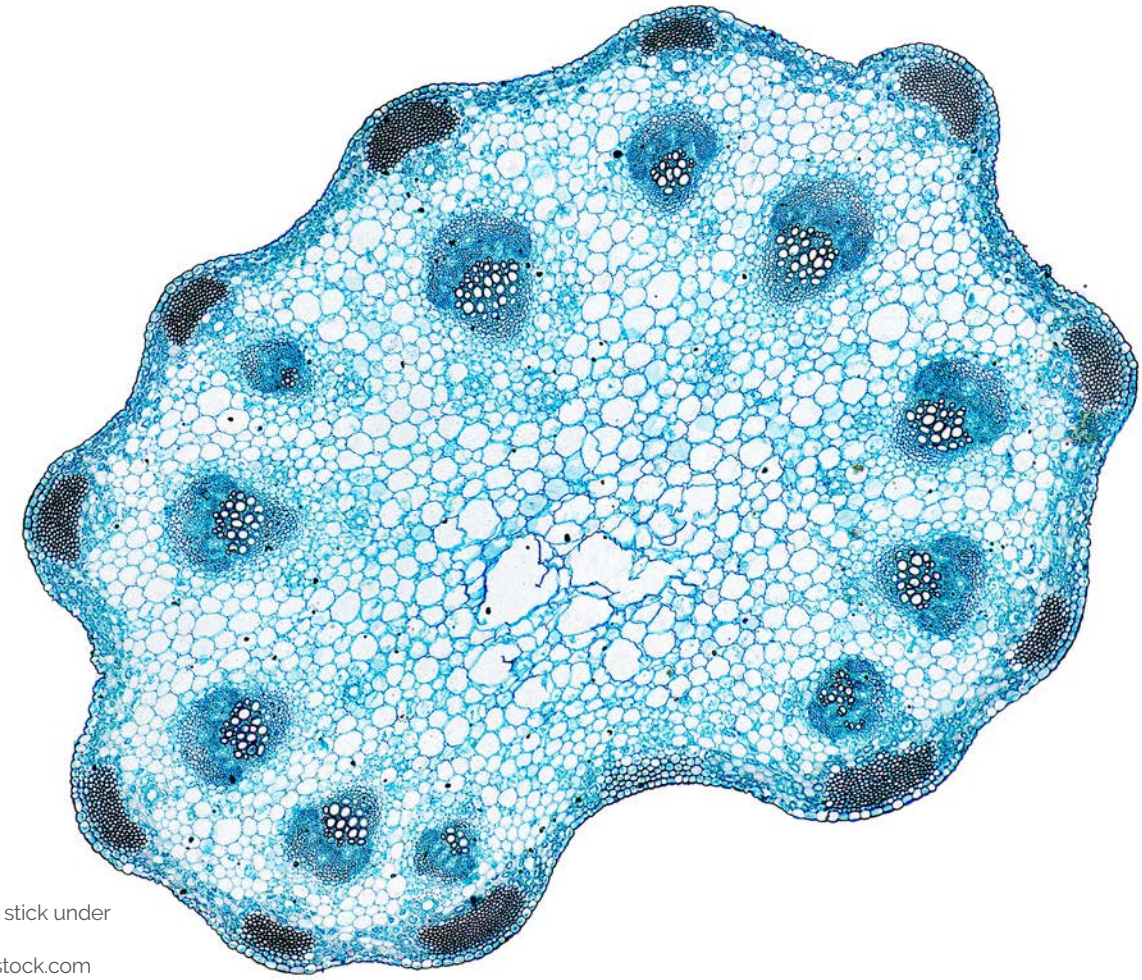
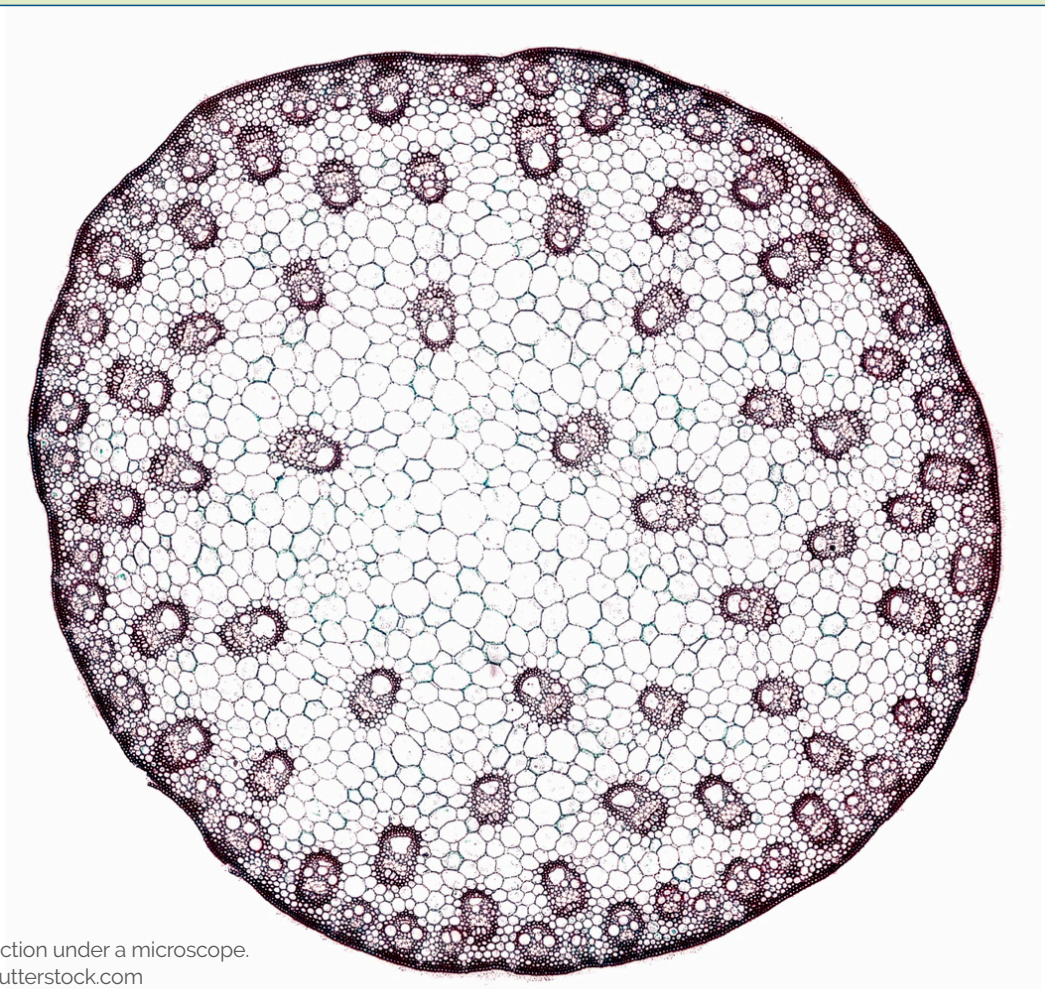


Cross-section of a celery stick under a microscope
Mike Rosecope/Shutterstock.com



Corn stem cross-section under a microscope.
Mike Rosecope/Shutterstock.com

EXPLAIN

I do: Share the intention behind Experiment 2 'Collecting water from plants'.

EXPLORE

We do: Move to the garden or bush area on the school grounds. Find a large branch of leaves (make sure they are within reach of the students). Set up the experiment. Later in the day: complete the experiment.

EXPERIMENT 2

AIM	To collect water from the transpiration process through the leaves of a plant.
RESOURCES	Per group: • 1 photographing technology (phone, ipad, camera). • 1 large clean plastic bag. • 1 piece of string about 30cm in length. • 1 sticky name tag. • 1 measuring beaker. • 1 pair of scissors.
METHOD	1. Organise students into groups of 3 or 4. 2. Hand out the name tags and get them to label their tags with their groups. 3. Distribute the equipment to each group and move to an area where there are bushes or large plants with plenty of leaves. 4. Model how to place a plastic bag over the ends of some branches that have heaps of leaves (bunch the branches together but do not break them off the trunk). Ensure the bag doesn't tear. Tie the base of the bag with the piece of string. Tie the bag in such a way that water can collect in the bottom and not drip out. 5. Students in groups find and bag their leaves, similarly. 6. Leave the bag on the branches for as long as you can over the day. Then ask each group to collect a measuring beaker and a pair of scissors and revisit their branch. Working together, they need to hold the measuring beaker under the bottom of the bag, cut a hole in the bag with scissors and collect the water condensed in the bottom of the bag. 7. Once all of the water is collected in the beaker, ask the students to measure and record the amount of water. 8. Tidy up, remove all of the bags, ties, and equipment and leave the branches as they were. 9. Recycle the soft plastic and clean out the beakers. 10. Compare results in the following table.

EXPERIMENT 2: RESULTS

LINK TO DOWNLOAD VERSION

DATA	EXAMPLE	GROUP 1	GROUP 2	GROUP 3 ETC
TIME BAG WAS ATTACHED	9.35 AM			
PHOTO OF BAGGED LEAVES				
TIME BAG WAS CUT	2.05 PM			
LENGTH OF TIME WATER WAS COLLECTED OVER	4 HOURS AND 30 MINUTES.			
AMOUNT OF WATER COLLECTED	15 MLS			

CONCLUSION

WHAT HAPPENED AND WHY?	

ELABORATE

I do/we do: Remind the students that water can come in 3 states. Ask them: "which are the states?" Encourage them to remember solid, liquid, and gas.

Reflect: Discuss what the students think will happen to the leaves in the bag? "What do you think the bag might be doing?"

Explain that it is there to stop something from leaving the plant and going into the atmosphere. Is it stopping the leaves from breathing? In or out? If they can keep breathing for a few hours (which they can) then what else might we see collected in the bag (water, like us when we breathe out, remember our breath on a cold day, it is foggy because we breathe out water vapour as well as air, so do plants, they 'breathe out' water vapour and oxygen. When plants 'breathe out' water (transpire), they are contributing to the water cycle. You can tell the students that plant life contributes to 60% of the water that is cycled on the planet, far more than evaporation from the ocean (40%). This fact can be related to another important fact: only 30% of the earth's surface is land, and ⅓ of that land is desert or semi-arid (land that has very low rainfall). So the remaining areas of land that can support plants to sustain a stable water cycle are very precious.

Define: Plants transpire, and breathe out oxygen and water vapour, this process is referred to as evapotranspiration. Evapotranspiration is the sum of water evaporation and transpiration from a plant to the atmosphere. As noted above, it relies on the sun's warmth (solar energy).

We do: Discuss the value of plants and ask the students to think about how plants help their environment. Watch 'How trees help create the freshwater supply', Start-stop at 3.26. [Link in Useful Resources list above]

Water and trees working together- to help with cooling their environment, controlling erosion, helping to filter and clean the water, maintaining the cycle of water, and reducing the severity and incidence of drought.

EVALUATE

You do: Make a list of 3 positive impacts that plants have in their environment.

I do: Ask students for their responses and then show the poster [shown on the next page], 'Forests and Trees are essential to Regenerative Agriculture', comparing student responses to those on the poster. We will introduce the term Regenerative Agriculture later, for now just reflect on the value of plants in this poster.

I do: Complete the experiment (later in the day).

EVALUATE

You do: complete the datasheet and conclusion.

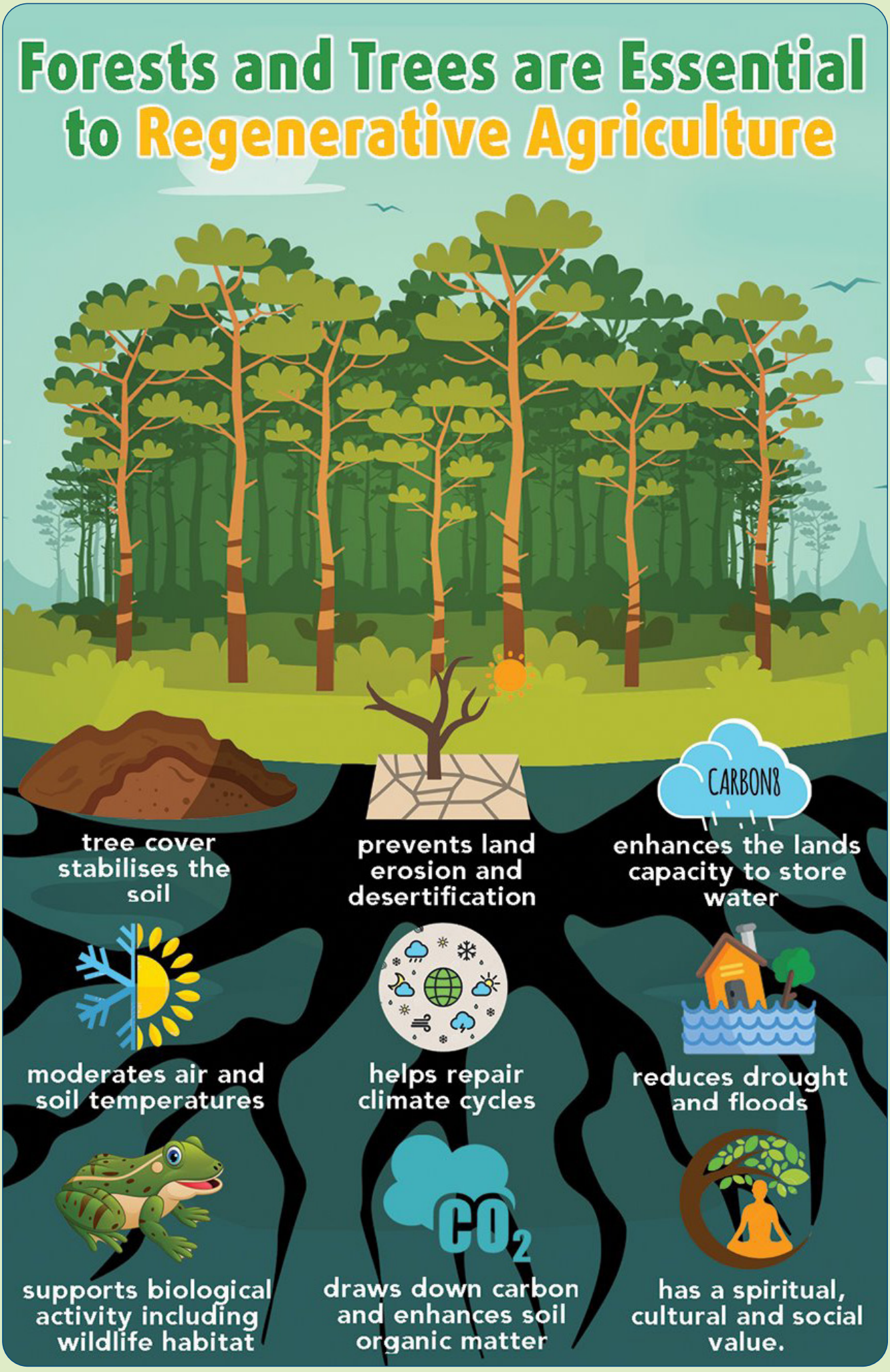


Image sourced from Random Acts of Green. (link).

Lesson 5: Caring for Country

Image by Grow Love Project (link)

WHAT ARE WE LEARNING TODAY (WALT)?	• Identify the ways humans historically have managed the movement of water. • Identify how Aboriginal peoples care for earth's resources (e.g. water) on Country. • Recognise that many living things rely on a healthy water cycle.
WHAT I AM LOOKING FOR (WILF)?	Students can: • Acknowledge the importance of 'caring for waterways' to Indigenous people. • Research a particular story about how Indigenous people used the movement and cycle of water to their advantage. • Identify that our current management of water movement would benefit from understanding Indigenous practices.

THE RAINBOW SERPENT, OR RAINBOW SNAKE, IS AN ANCESTRAL BEING OF GREAT SIGNIFICANCE TO ABORIGINAL PEOPLE ACROSS AUSTRALIA.

As Indigenous historian Shino Konishi (Yawuru people, Broome, WA) writes:

"It features as an important creator figure, guardian of sacred places, bringer of monsoonal rains and storms, bestower of powers upon healers and rainmakers, or a dangerous creature that punishes people who violate laws, or dwells in waterholes threatening to swallow unwary passers-by, to name just a few incarnations. It is also strongly connected with fertility, both human and ecological. In all of its guises and geographies the Rainbow Serpent is associated with water, an essential resource, and the rainbow, whose shimmering light and curved form reflects the scales and body of the snake. The rainbow is also an important bridge between the water and the sky, the sky yet another resting place for the Rainbow Serpent."

From Konishi, S. (2021) 'Friday essay: creation, destruction and appropriation - the powerful symbolism of the Rainbow Serpent' The Conversation. (link)

The Kuninjku people in Arnhem Land revere 'Yingarna', who they see as the first rainbow serpent, and Yingarna's child 'Ngalyod'. According to their lore, all of the ancestral creators came from the body of the first rainbow serpent, journeyed across the land and shaped it as they went. They were then swallowed again and brought into the earth.

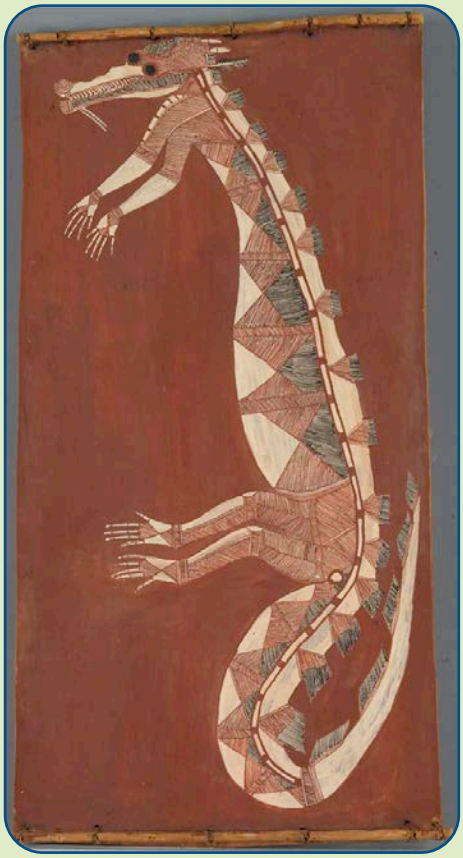
Ngalyod makes herself visible in rainbows in the sky, and lives in billabongs, streams and waterfalls. As art historian Judith Ryan writes: "For Kuninjku, Ngalyod is visible standing in the sky as the rainbow and, similar to the Yawkyawk, is mostly associated with bodies of water such as billabongs, creeks, rivers and waterfalls, where she resides. Therefore she is responsible for the production of most water plants that grow near water, such as waterlilies, water vines, algae and palms. The roar of waterfalls in the Escarpment Country is said to be her voice and large holes in the stony banks of rivers and cliff faces are said to be her tracks. She is held in awe because of her apparent ability to renew her life by shedding her skin and emerging anew."

From Ryan, J (2020) 'Magical transformations: Yawkyawk and Ngalyod become art' Art Journal, 57. (link)

In western NSW the Rainbow Serpent is known as Wawi. As Kamilaroi hydrologist Bradley Moggridge writes, there is deep connection between Wawi 'and both surface water and groundwater, connecting beneath and across landforms'. He quotes from Steve Meredith, "This country was made by the ancestors. Wawi the Rainbow Serpent came up through the springs, he came from Nakabo springs, Ngilyitri country. Wherever he travelled he left ochre to show where he had been. The springs were entry and exit points. He came out of the earth, travelled along its surface, and then back into the earth. Wawi travels and is still there. We know he's still there."

From Moggridge, B. (2020) 'Aboriginal people and groundwater' Proceedings of The Royal Society of Queensland, Vol. 126 (link)

ON THE NEXT PAGE ARE SOME EXAMPLES OF ABORIGINAL ARTWORKS FEATURING THE RAINBOW SERPENT.

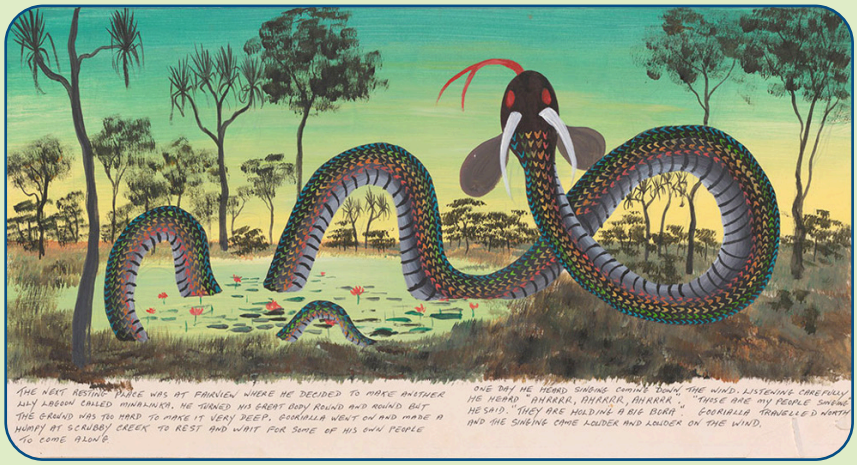


Ngalyod (1981) *(left)*

Bardayal 'Lofty' Nadjamerrek (1926-2009), Kunwinjku People, Western Arnhem Land.

Judith Ryan (see article link on previous page) writes that in this artwork Ngalyod 'has the long snout, scaled backbone and tail of a crocodile, whiskers of a fish and ears, legs and body of a kangaroo'.

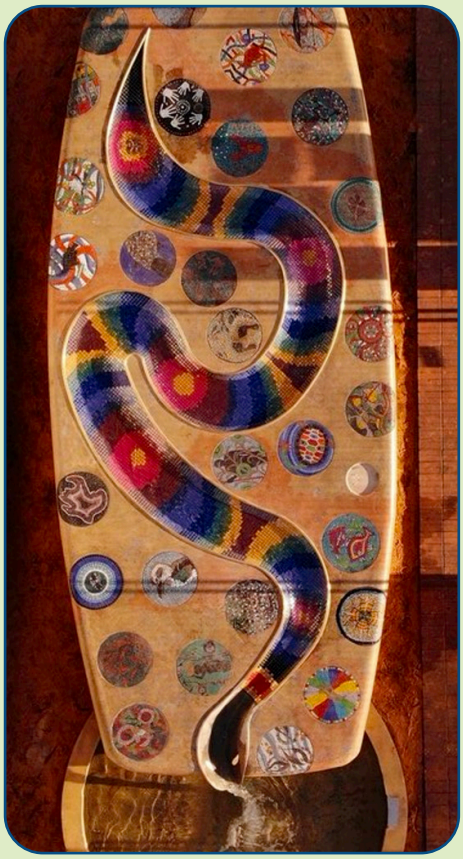
Collection: National Gallery of Victoria.



The next resting place was at Fairview where he decided to make another lily lagoon called Minalinka... (1974) *(above)*

Dick Roughsey, Kunhanaamendaa/Lardil people, Mornington Island

Collection: Fryer Library, The University of Queensland Library.



Rainbow Serpent Water Feature (2020) *(left and below)*

Kamilaroi women Alison Cox, Cindy Foley, Delma Jones, Ellen Draper, Gloria Foley, Janet Wanless, June Cox and Rita Long.

Located in The Civic, Gunnedah, NSW. (link)

USEFUL RESOURCES

Video: The Rainbow Serpent *(picture book read aloud)*
Length: 8 minutes (start at 1.00)
Summary: A classic story of the Rainbow Serpent written and illustrated by famous Indigenous artist Dick Roughsey. (link)

Online article: 'Njabai' and Indigenous fishing.
Length: 3 pages
Summary: A learning resources that describes the Aboriginal fishing methods used by the Widjabul people of the Bundjalong Nation, on the north coast of NSW. (link)
See also this helpful webpage. (link)
Here you can find two PDF articles with poems and images created with Widjabul custodians describing the sacredness of two water catchment areas and the importance of conserving them.
Link 1
Link 2

Online article: Barkindji artist Maddie Gibbs' mural by the Georges River acknowledges Biddegal Country and draws inspiration from Kogarah's name, which means 'place of reeds'.
Summary: This short article can be read by students and features good images of the mural. It provides an opportunity to think about rivers that move through our urban environment, and how Indigenous custodianship values persist in the city through art and other practices. (link)

PDF: How did Aboriginal peoples manage their water resources?
Length: 3 pages
Summary: An article produced by WaterWise Queensland describing Aboriginal traditional knowledge about locating and using water. (link)

3 videos: Watertrails
Summary: This website documents several water-focused art exhibitions from 2022-2023 in the Blue Mountains region under the umbrella of Watertrail. There are 3 videos 2.5 minutes long that describe the themes of the show, and all have a strong focus on Indigenous custodianship, creation ancestors and artworks. Students could interpret them as part of a class activity. (link)

PDF: Aboriginal people and froundwater.
Length: 8 pages
Summary: An account of how Aboriginal people accessed and managed water on our arid content, and associated Dreaming stories, with many interesting examples from different parts of Australia. Written by Indigenous hydrologist Bradley J. Moggridge. (link)
A more in-depth version of this article can be found here. (link)

Website article: Aboriginal people built water tunnels.
Length: 1 page
Summary: An article produced by ABC Science Online describing Aboriginal water management. (link)

Online article: Wallaby-skin water carrier.
Length: 1 page
Summary: Produced by the Australian Museum, the article describes how Aboriginal people used animal skins to carry water in waterless areas. (link)

USEFUL RESOURCES

Video: Aboriginal Fish and Eel Traps
Length: 3 minutes
Summary: A video made at Lake Condah, Western Victoria, describing the Aboriginal fish and eel traps used in the area. (link)

Video: 'Tiddalik the frog'
Length: 6 minutes
Summary: A video created by Museum Victoria designed for children, telling the story of the greedy Tiddalik the frog who drank all the water. (link)

LESSON PLAN

LENGTH	60-90 minutes
RESOURCES REQUIRED	• Rainbow Serpent video [link above] or book • Group activity printouts or links.

ENGAGE

I do: Draw students' attention to today's WALT & WILF. Explain that today we are discovering how Indigenous people cared for their Country by caring for their water. We will be looking at some of the ways water was used and managed by the Australian Aboriginals over the last 60,000 years.

"WATER IS THE MOST PRECIOUS GIFT THAT WE HAVE HAD AND STILL MUST BE USED SPARINGLY TO HELP EVERYTHING THAT LIVES FOR FUTURE GENERATIONS."

*Aunty June, Widjabul Elder. (See '**Njabai' and Indigenous fishing** in the Useful resources list above).*

Then watch 'The Rainbow Serpent' video [link in Useful resources list above] or read a copy from the library. Discuss the Rainbow Serpent's role in making the landscape and the water in it.

EXPLAIN

We do: Discuss how important water was to the Indigenous peoples. It formed their laws, traditions, and culture. Discuss how the spiritual and practical understandings of waterways interconnect in Aboriginal culture. Discuss how on an arid continent like Australia, respect for water was vital for survival.

EXPLORE

We do: Discuss what laws could they have had around water holes and creeks? Some Aboriginal groups stage rituals to mark their arrival at a waterhole and show respect to the site. Why might this have been important? Why were waterholes so regarded? Ask why some paintings of the Rainbow Serpent might feature different plants and animals in the body of the serpent? The serpent embodies not just the water itself but other part of a healthy aquatic ecosystem and provide resources for Aboriginal people and landmarks for navigation; it was important to maintaining the fresh clean water for the next mob coming to visit, or for the animals and plants that relied on it for the ecosystem to stay healthy.

Make an explicit connection between cultural stewardship of the resource and survival. Encourage them to see a waterway not just as a line of water in the landscape, but a whole system. Just like our body, the system has many parts. Aboriginal understandings of water see plants, animals, people and water as deeply interconnected.

GROUP ACTIVITY: INDIGENOUS SURVIVAL DEPENDED ON CARING FOR WATER!

1. In pairs (or 3s) research one of the following:
    - Finding water
    - Storing or carrying water
    - Hunting food from the water
    - Respecting the need to share water

    You can provide groups with printouts or links from the Useful resources list above.
2. Ask each group to focus on why these practices helped Aboriginal people survive.
3. Each group is to find 2 or 3 facts about their chosen story and present an infographic, PowerPoint slide, or Word poster they can use to talk about their story.

EVALUATE

You do: Each student is to consider what Indigenous water management might teach us. Ask the students to (individually) come up with a statement about how we should manage water and prompt them with words like 'caring' and 'sustainable'.

Ask them to imagine they are 'water custodians' or 'water caretakers'. What responsibilities might come with that role? Prompt them to come up with a statement like 'if we care about the water cycle it will continue and we will always have water', or 'If we don't manage water in our country properly then we won't have enough to meet our needs.' Ask some individuals to read their statements out and or check their books to assess understanding.

Lesson 6: Humans and the water cycle

The Scots College onsite at Mulloon Institute

WHAT ARE WE LEARNING TODAY (WALT)?	• Monitoring water movement in the landscape catchment. • Consider human influence on water movement. • Identify the ways humans manage and protect the landscape.
WHAT I AM LOOKING FOR (WILF)?	Students can: • See how erosion happens. • Demonstrate how to slow water down and understand why that is important. • Model how eroded landscapes can be repaired.

BACKGROUND NOTES FOR THE TEACHER

Catchments are areas of the landscape that collect rainfall. Any runoff is carried down the slope into a network of valleys, channels, gullies, streams, creeks, and rivers, before moving out to the sea. One can look at small sections of a catchment or the entire catchment, for example, the entire Murray- Darling catchment (referred to as a 'basin') is 1,061,469 km^2.

EROSION

Erosion is a process that removes soil, rock or dissolved material from one location and deposits it in another location. All the landforms that surround us have been shaped by this process. The shapes of mountains, hills, gorges and other features of the landscape are determined by how gravity, pushing water downhill, has interacted with rock, soil and plants over millions of years.

Erosion and deposition are thus natural processes that occur slowly over time. However intensive land use, and the clearing of trees, has intensified the erosive impact of both rain and wind around the world. Billions of tons of soil are eroded each year and a large proportion of the world's agricultural land is very degraded.

Water erosion makes farmland less productive and damages the wider landscape. The fertility of our soils has been built over millions of years through the growth and decomposition of plants and other living things, and the cycling of water, carbon and nutrients by soil organisms. These interactions create the spongey structure that healthy topsoil has, which allows it to absorb and hold big quantities of water. This valuable topsoil is only about 25 cm deep.

Erosion causes the following problems:

- Valuable nutrients are lost from the soil.
- Topsoil is stripped from the land, leaving behind only subsoil. Plants struggle to thrive when planted in subsoil.
- Eroded soil can become very compacted, so water can't penetrate and there is no room for plant roots and organisms.
- Dams and waterways get filled up with silt. This reduces water quality, both for aquatic organisms but also our drinking water. During floods, lots of sediment gets moved around and causes damage to infrastructure.

HOW CAN WE PREVENT AND HEAL EROSION?

There are different solutions to erosion which are about slowing the flow of water. Some of them enable water to filter through slowly, some encourage water to stop and sink in, and some encourage water to flow in a different direction so that it does not flow over a vulnerable area. Here are some images of these kinds of solutions. All images are supplied by Mulloon Institute.

Brushpacks

Brushpacks

Brushpacks

Contour channel

Westview, 2018

Westview, 2019

Westview, 2020

USEFUL RESOURCES

Video: What is a catchment? A quick lesson.
Length: 1 minute
Summary: A narrated video with a simple, attractive animation that explains how water moves through a catchment. (link)

PDF: My hand as a Catchment
Summary: Created by Victorian-based River Detectives, this one-page PDF illustrates a learning activity inviting students to look at the palm of their hand to visualise a catchment. (link)

Video: QKed Quest: What is groundwater?
Length: 7 minutes
Summary: An entertaining animation that presents facts about groundwater, the water table, aquifers, and how the water cycle interacts with these features of the landscape. It is fun to watch. Note: it focuses on American landscapes. (link)

Video: FreeSchool: How Erosion by Water Shapes Landforms.
Length: 3 minutes
Summary: A visually engaging video explains how water and ice shape the surface of the planet. This video is about erosion as a natural process that happens over long periods of time, rather than the swift destructive erosion that results from land degradation. (link)

Blog post: Westview – a leaky weir diary.
Summary: Featuring a sequence of photos (shown above) of a leaky weir on Mulloon Creek over 3 years. It reveals how the weir was constructed in an eroded creek, and how the creek is regenerating as a result. The images can be used to elicit observations from students about how the landscape has changed. (link)

Video: Berlin is becoming a sponge city.
Length: 3 minutes. Start from 0.56 - 3.00
Summary: A clear explanation of how clever planning and architecture can incorporate absorbent surfaces and natural features into the urban environment. It includes an animation that discusses the water cycle. A German architect speaks about the effectiveness of a particular project. This section is appropriate for Year 2 students. (link)

Video: Constructed wetlands.
Length: 1 minute
Summary: A short animated video that explains how cities can use constructed wetlands to filter water and achieve other benefits. (link)

LESSON PLAN

LENGTH	60-90 minutes
RESOURCES REQUIRED	• 2 or 3 large plastic boxes. If you can't work outside or at a sink area, you can use baking trays that sit within a plastic box, so the spill has somewhere to go. • A bucket of garden dirt. • A large jug of water. • A wedge or block, so that one side of the box or tray can be elevated. • Some natural materials: grass, mulch, leaves, small twigs, pebbles. • Printouts of the erosion sketch for each student (see single page image below). • Wanda props.
PREPARATION	• Prepare to show the videos 'What is Groundwater?' and 'How Erosion by Water Shapes Landforms' or parts of them (both in the Useful resources on previous page).

ENGAGE

I do: Remind the students of what they learnt in lesson 3. Review what water 'soaking in' and 'running off' means. Then review the basic notion of the 'water cycle', reminding students that the cycle is a naturally occurring thing/ event that has been happening on earth for millions of years.

Explicitly refer to today's WALT and WILF.

EXPLAIN

I do: What is a catchment? Watch 'What is a catchment? A quick lesson'. Do the hand as a catchment activity, asking students to make a cup with their hand and imagine how water would flow down the valleys and crevices to the bottom of the basin. Look at Google maps and focus on an area familiar to the students. Discuss what its catchment might be.

REFLECT AND EXPLORE

I do: Remind students of what soaking in means and remind them that soaking in is how plants and soil animals get water from the soil. 'Soaking in' also builds up stores of underground water known as groundwater and aquifers. Watch What Is Groundwater?

Images supplied by The Scots College

In some parts of Australia the landscape is very arid, with creeks that only flow sometimes, very flat land and scarce rainfall. In these places, people and animals can still survive because they can access bore water or underground water. In fact, most inland Australians rely on bore water. The image on the left shows a bore in central Queensland ('Barbara Plains', Warrego region) and the image on the right shows a drain that carries the water from the bore around the property. This bore drain is carrying water to the shearer's quarters where the shearers shower, eat, drink, and sleep. The drain then takes bore water to the shearing shed for the sheep to drink.

ELABORATE

I do: Ask the students 'What is erosion'? Elicit responses and provide a definition: e.g. – the process of breaking down soil and rock and transporting those materials to another spot. Watch the video How Erosion Shapes Landforms.

ENGAGE

I do: Explain that due to the way we have used land and removed trees, we have a lot more land surfaces that don't allow water to soak in. This means there is a lot more runoff in Australia causing serious erosion. This is a more accelerated kind of erosion than what was discussed in the video. Show the following photos of an eroded creek.

We do: Discuss as a class: What has happened here? Why has this occurred? (It has been caused by fast running water moving down a slope where there weren't enough plants to protect the soil. The absence of plants may have been due to grazing animals spending too much time there with their hard hooves, or because people removed trees to make space for grazing). If you are projecting the image on the screen, you can invite students to use their Wanda props to think about the movement of water here. Would she move fast or slow? Would she be clean or dirty? Would she soak in, or run off? Prompt them to look at the exposed roots, to think if plants would like to grow on these surfaces, to think about what might happen to this site the next time it rains (even more soil will be lost), where will water flow (at the bottom of the gully), can the plants at the top access the water all the way down there?

EXPLORE

I do: Ask the students if they think this is a problem? Ask them to justify their answers. Explain that Australia loses valuable topsoil due to erosion every year, this topsoil is what we need to grow our food. Explain that many farmers are trying to stop erosion by growing more plants and managing animal movement more carefully. Remind them that plants are needed in a landscape for a healthy water cycle to be functioning. Without topsoil and plants, the water cycle becomes unhealthy or broken. If there aren't plants transpiring water, there is reduced moisture, and the landscape keeps getting drier. This is how erosion causes the water cycle to break down.

Images supplied by The Scots College

ELABORATE

I do: Demonstrate the movement of water over a landscape under different conditions. This demonstration is best done outside, in a school sandpit or garden bed, or at a sink area.

1. Place the tote box full of garden soil carefully on a small wedge or block so the entire tote box is on a slope- between 10-15 degrees. Pile up the earth to the high side as much as possible.
2. Make sure that beneath the bottom of the tote box there is another tote box, bare ground or a sink area, as water will flow over the edge eventually.
3. Pour the jug of water slowly at the top of the slope and observe what happens to the soil. The water will run down the slope and fall over the edge taking soil with it, leaving a gouged-out channel/gully.
4. Now use the second tote box filled with the same soil as box one, set it up the same way, and this time pour the water faster. be careful as it may splash. Observe the movement of the soil transported by the faster water. You will be able to demonstrate the impact of faster water flow causing soft, unprotected soil to "run off".
5. Ask the students to think about what they could do to slow the water down?
6. Use the final box to ask the students to add natural materials (sticks as logs, grasses, pebbles, or to move the earth around) to see if they can slow water down. These images show how this activity could be done with clay in a bread tray.

We do: Ask the students to discuss what they saw in the demonstration.

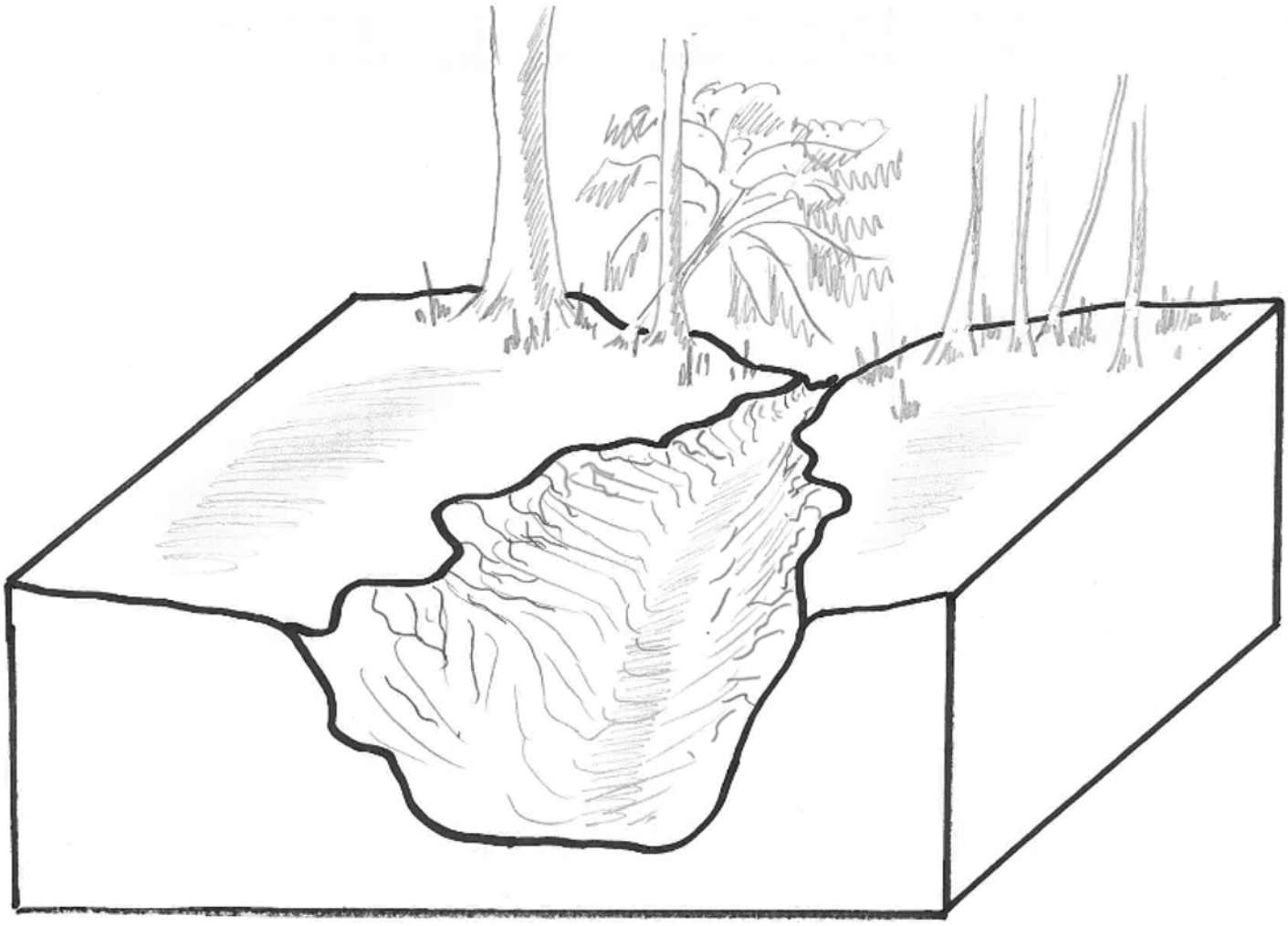
Images supplied by The Scots College

EXPLAIN

I do: Reinforce that the flow of water carries the soil down the slope, cutting a channel in the landscape. This movement of soil from one place to another is called 'erosion'. Also, reinforce that the faster the water flowed, the more soil it carried down the slope and the larger the channel became, due to an increase in erosion.

You do: Hand out the sketch of erosion damage as seen on the next page, printout available in Appendix. Remind them of why the erosion happened. Ask each student to think about how this erosion could be fixed. You can use the images above supplied by Mulloon Institute in this discussion. Ask them to draw their solution on the handout. Encourage them to think about the reasons the erosion happened as a clue to what they might put back into the landscape to help it heal. For example, trees, plants, fencing to keep out animals.

We do: Ask a few students to show their drawings and explain them to the class. Put all drawings on display. Discuss how humans can reduce erosion by using the ideas generated.



Excellent Dream /Shutterstock.com

ELABORATE

I do: Discuss the dumping of soil and rock (local fill) into the creek at Bannockburn, as shown in the photos above. The rocks and soil have been used to fill the channel and slow down the speed of the water coming down the slope. The farmer has also fenced the stock away from this area and has planted more trees so now the water in this creek will be traveling slower and erosion will be reduced.

We do: Watch one or both videos Berlin is becoming a sponge city and Constructed wetlands.

Ask the students to reflect on the grounds of their school. Where are their absorbent surfaces, and where is there lots of concrete or tarmac that water can't penetrate? Have they seen evidence of erosion or flooding? How is the movement of water managed by the school? Where do stormwaters end up (in the ocean?)?

List 3 ways that this has been done? Suggested ideas:

- Cement gutters and curbing.
- Pipes for collecting runoff and taking it to the stormwater drains.
- Grass and trees have been planted in some areas.

ELABORATE

We do: Now ask the students to consider whether they would change anything at the school to reduce "running off" and help water "soak in". You can also ask them about their gardens at home, their local park. You can show images of coir (coconut fibre) logs (matting made from coconut fibres) that are now often used by councils to halt erosion. How do they work?

We do: Brainstorm how we can prevent erosion? Ask students to come up with a list of ways that you can write on the board (e.g. anything that can or does slow the runoff water down):

- Go to the top of the slope (source of the problem) and try to stem the flow (slow the energy) of water there, leave trees and bushes on the slope, near the channels or creeks, plant more,
- Build structures to slow the water down (like speed bumps) out of logs, dirt, brush, gravel or rocks starting at the top of the gully.
- Fence the stock away from the gully to prevent hoof erosion and overgrazing.
- Plant water plants in the creek or gully.
- Reduce tracks travelling beside the creek, man-made or animal-made.

REFLECT AND EVALUATE

I do/we do: Take the students out to the sandpit, divide them into groups and ask them to make a slope, similar to the one you demonstrated in the tote box earlier. Tell them that you will come around with the same water jug/ hose (if possible) and test their slopes. Make it a competition, whichever group's slope has the smallest channelling/ erosion after the rain event (jug pouring) will have saved the most soil from erosion and will be caring (being a good steward) for their landscape the most!!

Lesson 7: The water cycle & climate change

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WHAT ARE WE LEARNING TODAY (WALT)?	• Understand the impact of a disrupted water cycle on a global scale: extreme weather events, floods, droughts, bushfires, and heatwaves. • Develop a solutions-based approach: helping to regenerate the water cycle by slowing 'Wanda' down.
WHAT I AM LOOKING FOR (WILF)?	Students can: • Connect human actions with disruptions in the water cycle. • List a recent extreme weather event and understand its cost. • Understand that people can regenerate the water cycle by slowing down water.

BACKGROUND NOTES FOR THE TEACHER

The disruption of the water cycle around the globe is fundamentally interlinked with climate change. The main way we experience this is through more frequent and severe weather events like droughts and floods. To understand why this is occurring, we should recall the small water cycle, as described in Lessons 2 and 4. As described there, in vegetated landscapes, every day the energy from the sun causes plants to transpire moisture into the atmosphere, creating humid air. When this air cools that moisture condenses and falls again as rain and dew, hydrating the landscape and being once again available to plants in replenished soil. Plants are thus the 'pumps' of a daily hydration cycle. As water moves between being a solid and a gas in this cycle, it moderates the heating and cooling fluctuations of day and night.

Where climate change is concerned, the important thing to understand is that this small water cycle buffered the impact of the larger weather patterns that are caused by bigger forces like seasonal change and ocean temperatures. Australia has always been an arid continent with weather extremes, a 'land of droughts and flooding rains'. By maintaining healthy and biodiverse ecosystems, the smaller water cycle ensured the landscape was resilient to those bigger forces. Our soils were full of organisms that cycled carbon and nutrients and preserved its structure. These soils could hold moisture for long periods, and our landscapes had many swamps and spongy areas that could supply plants with water during droughts. Our forests kept large areas moist and cool and took advantage of the rain when it fell. Our waterways were shaded by plants, and fallen logs and debris slowed the movement of water and created pools and wetlands.

The increase in global temperatures due to the burning of fossil fuels has been accompanied by the disruption of the small water cycle due to the clearing of trees, agricultural land use and development around the world. Far more of the earth's surface is now bare ground without plant cover. In the absence of plants, these surfaces can't buffer the sun's energy through evapotranspiration, which means they heat up. The hotter they get the more evaporation occurs across the landscape. This creates desiccated landscapes and produces high energy patterns in the atmosphere that can drive strong winds and storms. As our soils have deteriorated, as discussed in the previous lesson, they cannot withstand the force of the heavy rains. They erode, or become compacted and non-absorbent, producing more hard surfaces that can't buffer the sun's heat energy.

When the small water cycle is not functioning properly in a landscape, the large water cycle has a more dramatic impact: this often takes the form of droughts, floods, storms and other extreme events. Higher temperatures increase fire danger, and our dryer landscapes are more vulnerable to being burnt. High rainfall events move water through catchments more quickly, causing destructive flooding that impacts the surrounding landscape. As our landscapes become more vulnerable and dysfunctional, they catalyse further disruptions and imbalances in the planet's energy cycles.

In summary, on a global scale, disrupted water cycles have contributed to climate change, and now climate extremes are amplifying the problems (such as erosion) that arise from having a disrupted water cycle. Extreme events are happening with greater frequency, and their impact on our landscapes, homes, livelihoods and communities is more intense.

Another way to understand the significance of the relationship between water and climate change is to remember that the amount of water on our planet is always the same. None is lost to space or gained from space. The earth's rising temperatures, and loss of plant cover is accelerating rates of evaporation in different parts of the globe, and this airborne moisture must eventually fall to the earth's surface again. When it does, it is increasingly happening during weather events that have great intensity and cause natural disasters. Climate change is those moving water around the earth in more volatile and unpredictable ways.

For Year 2 students, a manageable way to present this confronting topic is to point out that climate change is making our weather more unpredictable and generating more frequent natural disasters like floods. Teachers can foster a respectful understanding of the powerful forces that are shaping our planet. They can then build from this realistic perspective to inspire appreciation of, and curiosity about, the extraordinary power of plants to moderate these forces so they have a less severe impact. Growing more plants can make our landscapes more resilient to climate extremes because of the extraordinary way they manage water's movement between the soil, their bodies and the atmosphere. Plants are healers, and ecosystems have powerful mechanisms for regaining balance if we give them space to do so. It is important to convey that we all have a role to play reintroducing plants to parts of the landscape where they've been removed, respecting our natural resources, and coming up with other ways to encourage water to slow down, soak in and regenerate our environments.

USEFUL RESOURCES

Video: Climate Change: The Water Paradigm
Length: 3 minutes
Summary: An animated video showing how broken water cycles contribute to climate change impacts like floods and drought. This is useful for teachers to understand the relationship between the water cycle and climate change but is likely to be too hard for the students to follow. (link)

Video: Kids in NSW Report on the floods - Behind the News (ABC)
Length: 3 minutes
Summary: A compelling video from March 2021 in which 4 children from different towns in NSW speak honestly about the floods affecting their communities, often standing in front of landscapes that have been flood affected. They are brave and engaging to listen to. (link)

Video: Drought Breaking - Behind the News (ABC)
Length: 4 minutes
Summary: Children from the Caragabal in NSW describe the stress of living through drought, but also the relief experienced when the rain finally came. It is both serious and uplifting with lots of great footage. Made in 2020. (link)

PDF: See, Think, Wonder
Summary: This one-page article is a thinking routine from Project Zero, Harvard Graduate School of Education. "This routine encourages students to make careful observations and thoughtful interpretations. It helps stimulate curiosity and sets the stage for inquiry." (link)

Flood images that can be used in the classroom
Summary: A gallery of flood images produced for educational purposes by the SES. (link)

Video: The Bread and flour demonstration with Finian Makepeace
Length: 1.10 minutes
Summary: A concise demonstration of the bread/flour illustration of the Soil Sponge created by Didi Pershouse. (link)

Video: Soil health education – Didi Pershouse of the Soil Carbon Coalition bread and flour demo
Length: 5.25 minutes
Summary: A more elaborate explanation of the bread/flour demonstration with conversation about erosion and other themes. (link)

USEFUL RESOURCES

Video: Soil health education – Didi Pershouse of the Soil Carbon Coalition bread and flour demo

Length: 5.25 minutes

Summary: A more elaborate explanation of the bread/flour demonstration with conversation about erosion and other themes. (link)

Video: Ecosystem restoration for climate
Length: 4 minutes. Watch from 16.55 - 21.15
Summary: Didi Pershouse presents the bread/flour demo and explains the 'soil sponge' and its implications for climate in nice detail. (link)

LESSON PLAN

LENGTH	60-90 minutes
RESOURCES REQUIRED	• 'Flood' and 'Drought Breaking' videos above. • 2 large plastic plates or trays. • A bag of plain flour. • 3 – 5 slices of grainy bread with strong texture, like a sourdough. • A paper cup with holes picked in the bottom (to make rain). • Optional: lego bricks, monopoly houses, small plastic trees, pebbles or toy objects that can be distributed around the plate.
PREPARATION	Watch the short bread/flour demonstration videos (see Useful resource list above). Prepare the two plates: one with a pile of flour, the other with a stack of bread slices. Try to make the two comparable in size. Have the paper cup with holes in it, and cup of water ready to go. *Don't wet either plate yet.*  

ENGAGE

I do: Show one or both ABC Behind the News videos. Ask the students to reflect on natural disasters and how they impact communities. Have they spotted anything in the videos that have been discussed in previous lessons (eg., floodwaters are brown, which mean lots of soil and sediment is being moved down the catchment). Have they experienced or witnessed anything like what the videos show? Encourage empathy with the children in the video. This discussion can be about cultivating a realistic understanding of the impact of natural disasters.

REFLECT / EXPLAIN

I do/we do: Let's reflect upon what we know so far. Remember what happens when we don't look after our 'soak in' areas? What happens when soaking in becomes running off? Point to the student's erosion control drawings placed around the room.

Activity.

Set up the 2 plates on a table so all students can see. You can tell them that the plates contain the same amount of flour.

1. Using the cup with the holes in it, sprinkle some water over the flour plate. Ask the students to observe what is happening. (is the water running off our soaking in? Is the water penetrating the top layer of flour? Is the water that is pooling clear or milky? Why is it cloudy? What is happing on the surface of the flour pile as the water runs down?).
2. Now sprinkle the same amount of water over the bread slices. It should be possible to do the demo so that it takes a long time, or more water to be sprinkled, before it seeps out the bottom. Ask the students to observe and compare to the other plate. (Is the water soaking in or running off? Why has it taken longer for the water to seep out onto the plate than on the flour plate? What colour is the water: cloudy or clear? Why is it clear?).

Ask the students some other questions to get them thinking about soil and biology: what do we add to flour to make bread? (water and yeast). What does yeast do? (it's a micro-organism from the fungi family. It causes the sugars in the flour to ferment, and this leads to gasses being created that causes the bread to become full of little air pockets and rise. In a similar way, micro-organisms in 'dirt' create living 'soil', by breaking down organic matter and carbon and creating biological reactions. These processes create little pockets, and gluey sections that build a spongey texture. It is useful to imagine healthy soil particles as clumping together like a 'bag of peas', with lots of holes for air, water and critters to move through.

Encourage the students to see the slices of bread as a healthy landscape. Invite them to image the grains are like plants and organic matter, mulch, compost. It is the combination of healthy soil, plants and organic matter that is decomposing that make a landscape good for "soaking in". Remind them that plants help because they use the water, absorbing it through their roots. The roots also help the soil have structure.

Now ask the students to imagine each plate is a landscape where people live. If you have the small props (lego blocks, monopoly houses), you can place them around the water-soaked flour and bread. Ask the students to imagine they are homes, schools, bridges, roads. Some questions to ask:

A) if your community was in an area where there is low rainfall, on which plate would you rather live?

B) if your community was in an area where there is high rainfall, on which plate would you rather live?

The idea with these questions is that the students should choose the bread plate for both answers. Spongey, hydrated landscapes where water can 'soak in' are resilient to both droughts and floods.

EXPLORE

I do/we do: Display the drought landscape images (next page). Ask the students to list what they see or don't see (bare, hard landscapes, brown dry grass, no water, few/no plants or animals). This is an opportunity to use a thinking routine to pull out students' prior knowledge and their wonderings: 'See, Think, Wonder' in the Useful resources list above. You can reinforce the following themes:

- By removing lots of plants for farms and cities, we have created land surfaces that are not good for 'soaking in'. This has created drier landscapes.
- The absence of plants means we have less transpiration, less moisture in the air that can fall back to the land as dew or rain.
- There are fewer plant roots to hold the soil together, so they get more compact but also more powdery, like the flour.
- The drier and unhealthier the soil is, the more it is likely to erode when the rain does come. This means we have water 'running off'.

Drought

Erosion

ELABORATE

We do: Print out five images of extreme weather events (or use iPads) and place them on five tables. You can feature a bushfire, a drought and a flood. You can include bird's eye view images of a flooded and drought affected areas, as well as close ups: for example a flood affected stream with debris, erosion and fast moving water, or a dry creek bed in drought.

Organise the students in groups and rotate them to the different tables for a few minutes each. Ask them to think about the cost and impact for communities. Ask them: where's Wanda? Was she there too much, or too little? Ask them to reflect on Wanda's friends described in the poem (plant roots, worms, trees, animals). How might they have been impacted? Did Wanda moving too fast contribute to this situation? How can she contribute to recovery? How can her friends contribute to recovery? Encourage them to think of the different states Wanda might take in each scenario, and to think about Wanda 'soaking in' and 'running off'.

We do: Discuss the images as a group, asking students to volunteer their answers and observations. Invite the students to use their Wanda props to interact with the images as a class.

EVALUATE

You do: List one thing you could do to help repair the disrupted water cycle. For example, plant more plants in your garden. In cities, have less concrete and more absorbent surfaces. Have more wetlands and natural waterways rather than concrete drains. Have they experience playgrounds that are natural earth vs playgrounds that are concrete. How might farmers incorporate more plants into their farms (use trees as windbreaks, have tree borders around the crop fields, fence off areas from livestock.

Lesson 8: Regenerative practices

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WHAT ARE WE LEARNING TODAY (WALT)?	• Understand regeneration. • Learn how regenerative agricultural practices can slow the movement of water and help repair the disrupted water cycle.
WHAT I AM LOOKING FOR (WILF)?	Students can: • Define regeneration. • Understand the four principles of regenerative agriculture. • Draw how the application of these principles can slow water down.

BACKGROUND NOTES FOR THE TEACHER

Regenerative agriculture is an approach to farming that aims to improve the health and resilience of the land. There are many strategies that come under the umbrella of 'regenerative agriculture', but all of them aim to build soil health naturally and contribute to the health of the surrounding environment.

These approaches include:

- Using compost and worms to build organic matter and increase the activity of micro-organisms and fungi in the soil.
- Practicing 'no-till' agriculture, which means choosing not to churn up soil with machinery between harvesting and planting (tillage causes moisture and carbon to be lost and destroys fungi).
- Reducing the use of herbicides and pesticides or eliminate them all together.
- Planting 'multi-species' crops, to create diversity of pasture (more diversity means more resilience above and below ground).
- Creating smaller paddocks, so grazing animals can be moved around in a more considered way, and areas of land vulnerable to erosion and overgrazing are left to rest and recover.
- Fencing off waterways and the land beside them (the 'riparian zone'). This allows farmers to limit animal access to waterways. This enables streams and creeks to have healthier ecosystems, prevents erosion so that the waterways can hydrate the surrounding landscape, and creates cleaner water (no animal waste in the water, and more filtering by plants).
- Creating larger buffer zones between grazing lands or cropping lands and waterways.
- Identifying areas of the farm for conservation and biodiversity, such as native forests, woodlands and wetlands. By creating habitats for birds, animals and insects there is more fertility and nutrient cycling across the landscape.
- Planting tree corridors or 'shelter belts' in strategic locations. These can provide shade for animals, habitat, and act as windbreaks to protect land surfaces from erosive winds.
- Using 'natural infrastructure' to repair degraded sites and slow water flows. These are structures made of natural materials like earth, rock and timber installed in streams, gullies and on slopes.

Practitioners of regenerative agriculture tend to think holistically about the farm landscape. Rather than perceive a farm as being only for production, with other pieces of land being for conservation or wilderness, they consider the farm to be an ecosystem with many interdependent parts. They also aim to balance the need for profit with the need to enhance the wellbeing of rural communities and safeguard our natural resources. A growing number of farmers in Australia and around the world are recognising their role as stewards of our natural resources and recognise that regenerative agriculture provides a toolkit for responding proactively to the problems generated by climate change.

It is important to recognise that transforming a farm is a complex task. The success of the adaptations listed above depends on the landscape, enterprise type (grazing, dairy, cropping, horticulture), the farmer's priorities and their capacity to make changes. Many small farms in Australia struggle to be profitable enough to sustain strong livelihoods and rely on other income sources. On the other hand, there are many large and profitable farms that use technologies to produce at scale. Australia's agriculture sector (including agriculture, fisheries and forestry) exports over 70% to overseas markets. Australian farms supply many overseas markets.

Currently, the agriculture sector is in a state of change, due to climate volatility, shifting consumer expectations, new policies to decarbonise the economy and increased pressure to manage land for biodiversity and water quality. Teachers can explore the principles of regenerative agriculture while also being sensitive to the fact that students in the classroom may come from farming families being directly impacted by these changes.

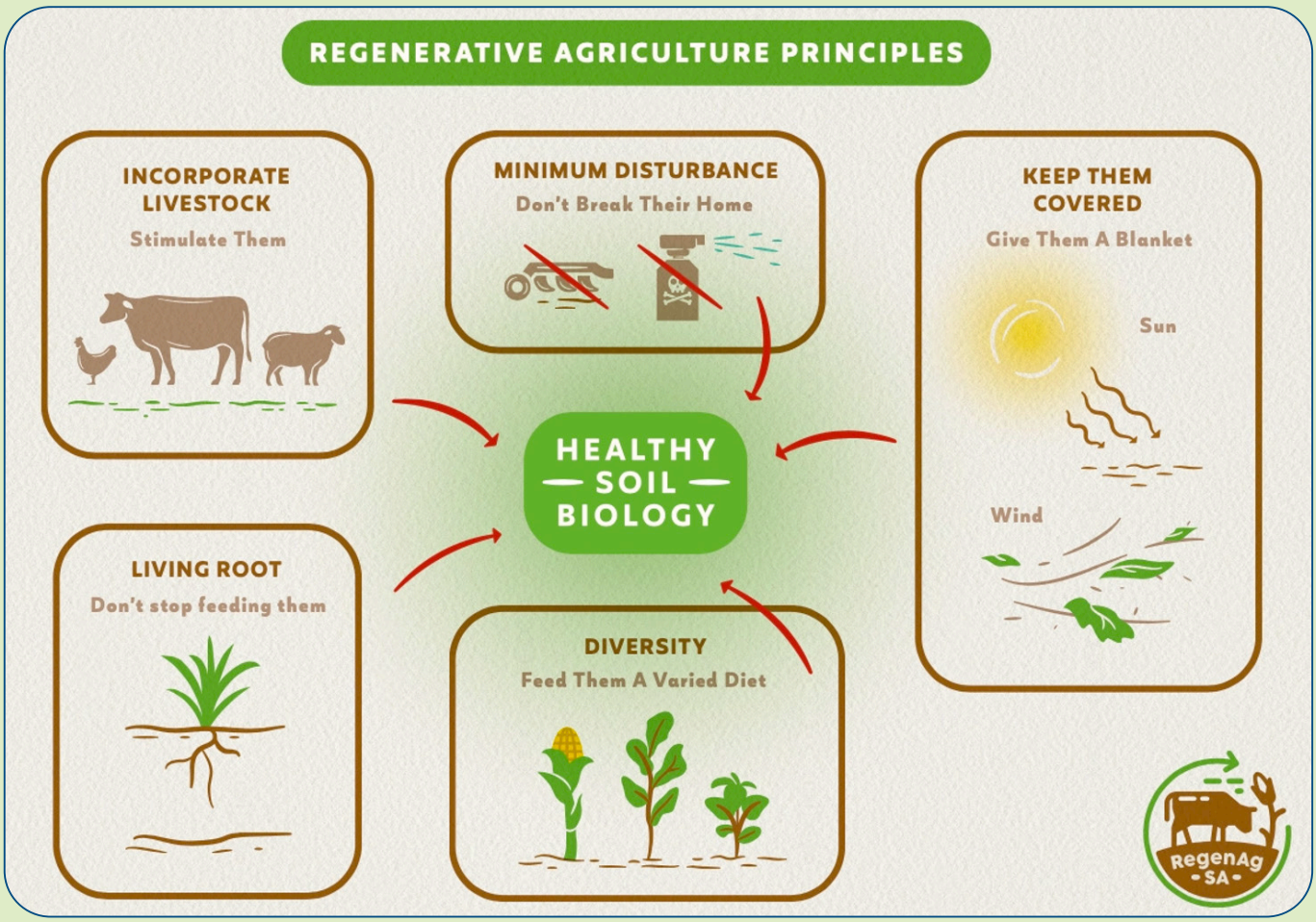


Image supplied by the Regenerative Agriculture Society of Southern Africa (link)

Print version available in the Appendix.

Peter's Pond as part of the regenerating landscape at the Mulloon Institute's Home Farm.

USEFUL RESOURCES

Website: Why regenerative agriculture?
Summary: Part of the Regeneration International website. They are an American non-profit organisation. Provides definitions and explanations. (link)

Video: What is Regenerative Agriculture?
Length: 3.53
Summary: This video explores three different regenerative practices that have great potential both in food production and in healing the land. (link)

Video: Combatting Climate Change
Length: 4 minutes
Summary: Discusses the work of the Mulloon Institute and how rehydrating landscapes and regenerative agriculture can mitigate and even solve climate change issues. (link)

PDF: Ten ways to improve the natural assets on a farm
Summary: A small booklet by ANU Sustainable Farms with many illustrations and diagrams showing how Australian farms can be more regenerative and support biodiversity. The language is easy to understand, and some of the diagrams can be used in the classroom to support discussion. (link)

Video: NSW DPI Climate Smart Farmer Stories: Glenn Morris
Length: 7 minutes. The whole video is recommended for teachers to gain an insight into an individual farmer's journey, but 1.06 minutes – 4.00 minutes is an excellent clip to show students.
Summary: A regenerative farmer describing what he has done to repair and rehydrate very degraded land. There are several shots of the farm in drought, comparing to the present healthy state. Glenn is an excellent communicator and speaks about extreme weather events, climate change, erosion, soil and water cycling in the video. (link)

Podcast: The big shift for small farms
Length: 20+ 30-40 min podcasts
Summary: Produced by the Grow Love Project in collaboration with NSW Local Land Services. Discusses many aspects of regenerative agriculture. (link)

Video: India's Water Revolution #1: Solving the Crisis in 45 days with the Paani Foundation
Length: 9 minutes
Summary: An inspirational story from a village in India that held a competition to build as many water retaining structures in the landscape as possible in a 45-day period. (link)

Video: How we regenerate Australian landscapes – Leaky Weirs
Length: 3:05
Summary: Explanation of how leaky weirs work by Mulloon Institute's Peter Hazel. (link)

LESSON PLAN

LENGTH	60-90 minutes
RESOURCES REQUIRED	• 4 Principles of Regenerative Agriculture handout for the drawing exercise. (link) • Wanda poem and props .
PREPARATION	• Preload two videos from the list above.

ENGAGE

We do: Define 'regeneration'. Ask students what they think it means, inviting them to think about the meaning of words like 'renew', 'restore', 'repair', 'revitalise', 'refresh', 'rejuvenate', 'replenish'. They may have heard these words in connection to health and the body, and you can ask them to think about how this might apply to the land. What do they do to refresh themselves when they've done a lot of exercise or had a big day (rest, eat, drink). You can explore the idea that our body, like the land, expends energy, so it needs resources to regain that energy – all biological systems need to cycle resources to stay resilient and regenerate. You can write these ideas on the board and arrive at a definition along these lines: regeneration is the renewal or restoration of a biological system after a negative impact or as a normal process. You can also show them the image below.

We do: Ask students whether they have heard of regenerative agriculture? Discuss how regeneration might happen in the farm landscape, and whether students can think of ideas from previous lessons. How might regeneration contribute to healing disrupted water cycles? Refer to the Wanda poem, where the second last stanza provides clues to regenerative agriculture principles.

Now show 'How we regenerate Australian landscapes – Leaky Weirs' [link in the Useful resources list above]. Invite reflection. Show the video about the farmer Glen Morris, or one of the other videos listed above and invite reflection.

EXPLORE

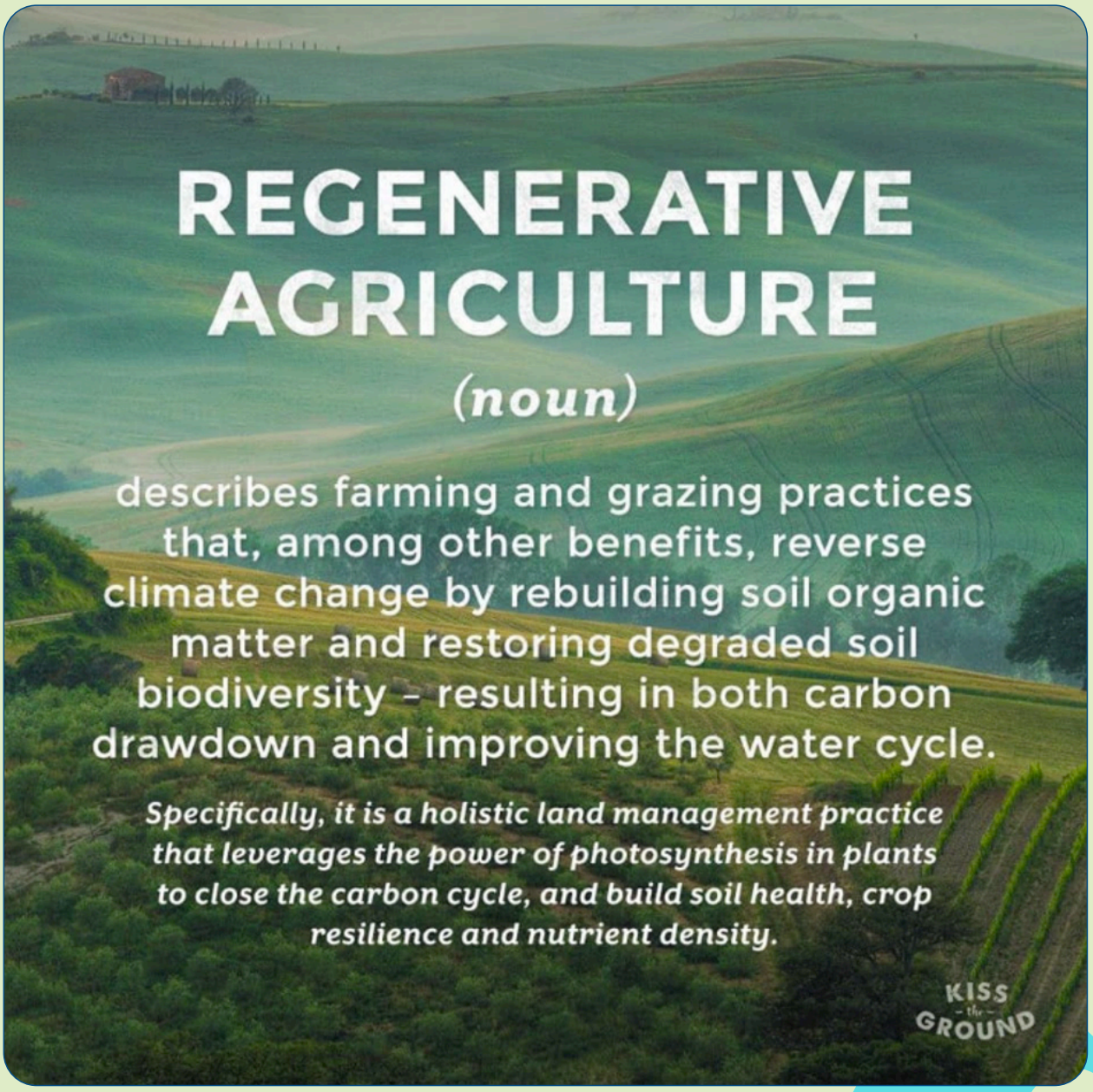
We do: After watching the videos ask the students to discuss some of the solutions that helped repair the disrupted water cycle. Write these solutions on the board. You can structure the suggestions around 4 categories:

1. *Managing plants*. Grow more plants and grow a diversity of plants. Protect wooded areas, wetlands and habitat. Always have a living root in the soil, maintaining a cover of plants and litter. Have as little bare ground as possible).
2. *Managing animal movements.* Reduce their impact on gullies, creeks, wetlands. Use them in dense herds for short bursts as a tool to create disturbance (their hooves, dung and urine stimulate soil biology and cause mineral and nutrient cycling). Don't overgraze. Allow land to rest at times. Create smaller paddocks so you can move animals in a careful way.
3. *Managing human impacts*. Stop clearing trees, reduce tillage, reduce non-absorbent surfaces. Reduce the use of chemicals. Make thoughtful decisions informed by stewardship values. Make different choices as a consumer of the kind of food we buy, manage our expectations of what the land can provide. This may be complex for students. It can be an opportunity to discuss how we can all contribute as a society to land regeneration through our choices and values, rather than just making the farmer responsible. How do our choices at the supermarket impact the land?
4. *Slow water down.* Use natural structures to heal erosion and slow water's movement, as discussed in Lesson 6. Having more plants also creates 'roughness' to create drag and friction that slows water down.

ELABORATE

You do: Provide 4 Principles of Regenerative Agriculture handout for the drawing exercise (link)

We do: Invite students to draw an example of the principles of regenerative agriculture you've discussed as a class, with one drawing linked to each category. Invite them to think about how the water cycle is part of each example, and to feature Wanda in their drawings if they can. Invite some students to share what they've drawn. Reinforce learnings from previous lessons about managing the water cycle to lessen the impact of extreme weather events, to encourage soaking in not running off, to care for the land so that it can support our need for food as well as the needs of other creatures.



Lessons 9 & 10: Taking action

The Scots College at Mulloon Institute, Duralla.

WHAT ARE WE LEARNING TODAY (WALT)?	• Realise that science understanding can contribute to the preservation of healthy water cycles. • Plan strategies that consider the conservation of resources to address sustainability. • Develop a holistic view of the relationship between humans and their environment. • Identify technologies and appropriate materials needed to realise designed solutions. • Investigate and explain the needs of an audience in defining a problem..
WHAT I AM LOOKING FOR (WILF)?	Students can: • Identify that human management of water movement requires a regenerative approach. • Recognise that people, nature and the water cycle are all interconnected and interdependent. .

BACKGROUND NOTES FOR THE TEACHER

The next two lessons are opportunities to assess the student's overall understanding of the water cycle, and to explore more deeply the interconnections between water, humans, plants, animals, landscapes and climate. Teachers can introduce the idea of approaching things 'holistically'. When we take a 'holistic' view of something, we are engaging with it as a whole or a complete system, rather than with the individual parts. We might look closely at a particular element of that system, like plants or erosion, but we never lose sight of the context of that element.

Nature functions as a system in which everything is interlinked. Plants, animals, soil and waterways are all interdependent. Resources (like water, sun energy, nutrients, oxygen, carbon) flow between different parts of the system. Strong social communities work the same way. In a supportive, resilient community, the resources that flow between different parts of a system can include kindness, skills, education, mentoring, food, tools and useful products. The elements of the social system that help these resources to flow include gatherings for sport, culture, recreation, welcoming public spaces, celebrations of history and heritage, local businesses, volunteerism and so on.

There are many elements of contemporary society that are segregated. This happens with the different subjects and departments in schools, universities and government – we create silos to simplify complexity. Those of us who live in cities are separated from the agricultural producers that supply our food, and the mining industries that supply our energy and extract the minerals that ultimately become part of electronic devices like phones, computers and solar panels. This lack of connection sometimes makes it hard for people living in the city and the country to relate to each other. It also means that we forget that we are fundamentally dependent on natural systems, and our choices impact those systems every day. Some of the problems our planet is now facing can be attributed to these patterns of segregation, as it means we don't have a holistic picture of the burden being carried by the earth's natural resources. We also struggle to bring together our communities and our experts from different disciplines to solve problems quickly.

In these last two lessons teachers can guide students to think about these ideas. There are two lesson plans, one focusing on mind-mapping, and one that invites students to map an environment they know well where they can design strategies that will help slow water down and repair a disrupted water cycle. For both exercises you can use the Wanda poem and Wanda props to prompt reflection and memory.

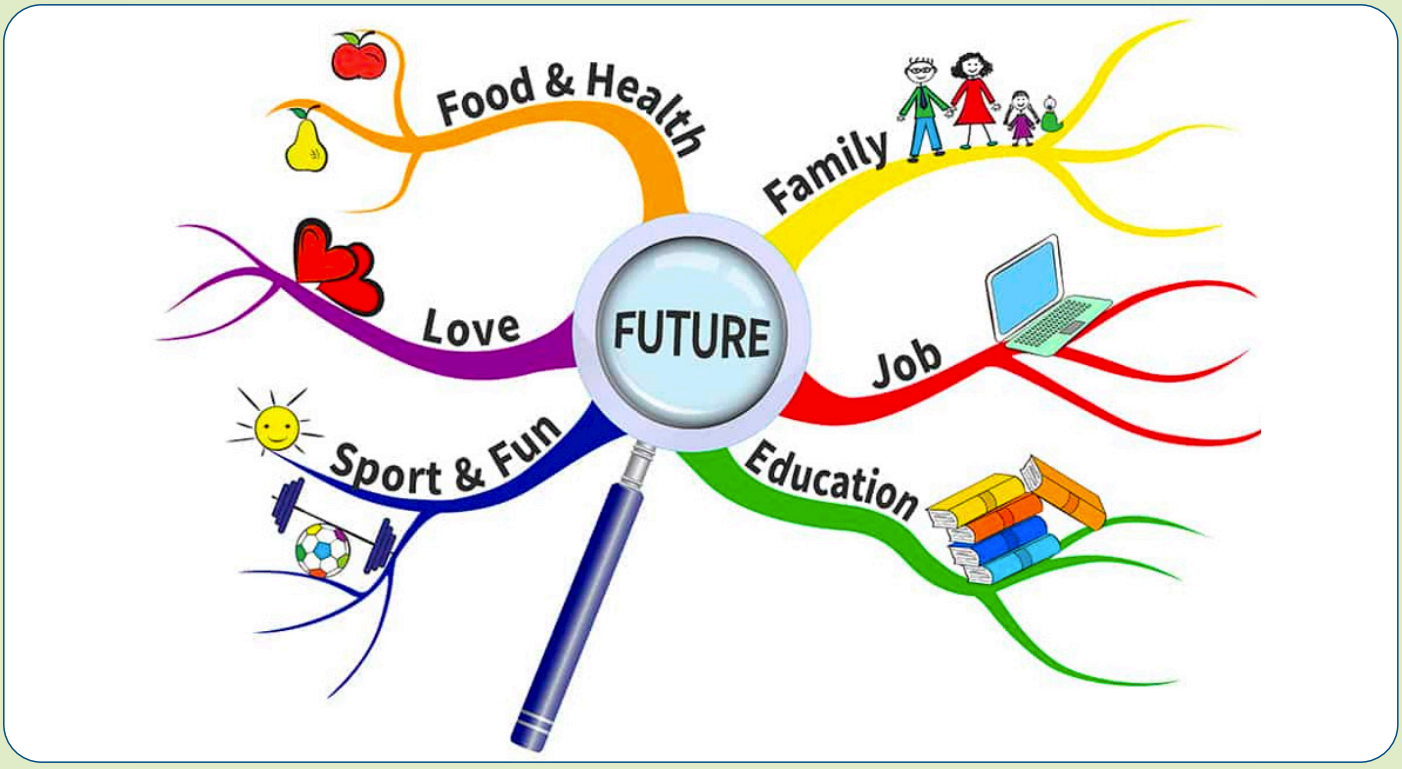
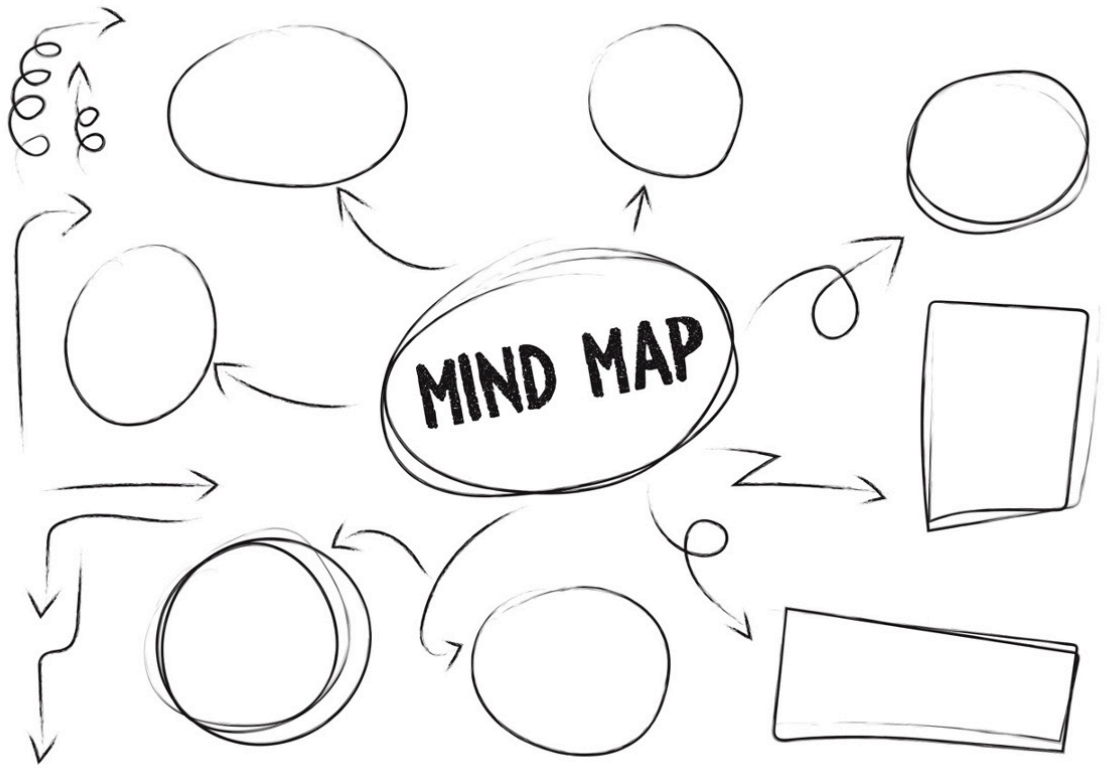


Image: Good Parenting Brighter Children (link)



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Print version in Appendix.

USEFUL RESOURCES

Online article: Johnstons Creek naturalisation
Length: 2 pages
Summary: An article by Sydney Water about plans to 'renaturalise' and improve the health of a creek in Sydney. (link)

Website article: Mind mapping for kids
Summary: A useful description of mind-mapping principles and methods, with examples. (link)

Video: How to mind map
Length: 4.59
Summary: Tony Buzan describes how mind maps foster learning and creativity. (link)

LESSON PLAN 1

LENGTH	60-90 minutes
RESOURCES REQUIRED	• A3 sheets of paper for students to create mind-maps on. • Pencils and textas.
PREPARATION	• Gather images of mind maps created by children online to provide inspiration.

ENGAGE:

Share the idea that all the parts of our lives, and nature, are interconnected. Introduce the concept of taking a 'holistic' approach to things, recognising it as a system with many parts. A simple analogy is a pizza, a 'whole' made up of many ingredients. What are all the parts that make a great pizza?

TASK

Engage the students in a mind mapping activity. You can share online examples of mind maps created by children. To encourage free thought, suggest that it's fine to be messy to get the ideas down. They can use both images and words. They then might want to make a second version with colours that is neater and easier for others to read. Another variation could be to then create large mind-maps as a whole class. This could be done on the whiteboard, or teachers could create a wall display where all the individual mind-maps are collaged together to form one giant mind map.

Mind map 1: Me

Ask students to put their names in the centre circle, and identify all the things that make them feel connected and loved, and that they will need to build a strong future (family, pets, special places, friends, things you love doing, education, skills, favourite events in the year, good health, supportive adults, adventure, a caring community). Can they branch out in more detail? Are there connections and links between the things they've identified?

Mind map 2: The water cycle/Wanda

Ask each student to create a mind-map of the water cycle. They can put Wanda as the central image. Ask them to identify everything they can think of that's connected to water that they've learned about during the term. You could then create a big group mind map on the whiteboard or chalkboard. Ask each student to add 3 things to the group mind map from their individual maps. Encourage them to think about water's different states, different scales from the catchment right down to the plant, and Wanda's journey.

Mind map 3: The water cycle and us

This can be a variation on Mind map 2 that focuses on how humans interact with the water cycle. What aspects of our behaviour impact it? (hard surfaces, tree clearing, pollution). And how do we experience both disrupted and healthy water cycling? (natural disasters, water scarcity, damage to our homes, regeneration of land, flowers in the garden, dew on the grass in the morning, worms and critters in the soil, and healthy food).

LESSON PLAN 2

LENGTH	60-90 minutes
RESOURCES REQUIRED	• A3 sheets of paper for students to do their maps and write their text on.

ENGAGE

I do: Introduce the English/Science Summative Task: Use the Year 2 Curiosity Cycle to provide a solution to a school or local community problem to address sustainability. Show the Johnstons Creek naturalisation link and discuss.

EVALUATE

You do: Choose a site at school, in the community, at your home, or your granddad's farm, etc where you could implement strategies that would help slow water down, reduce runoff and help improve the water cycle.

TASK

HELP SLOW WANDA DOWN

- Students: Draw an aerial map of an area and indicate the problem they are trying to find a solution for. Instruct them to annotate the map clearly, using arrows (an eroded channel, a bare patch of the playground, a cement or paved area)).
- Re-draw the map and highlight the regenerative practices you would implement that would help slow the water down, allowing for more 'soaking in' and 'less running off'.
- Write persuasive text beside your maps explaining what the problem was and how the practices you designed would provide a solution for it.

After the allotted time, invite students to display their tasks and share with the class how they attempted to solve the problem and *HELP SLOW WANDA DOWN*.

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Appendix

PRINCIPLES OF REGENERATIVE AGRICULTURE HANDOUT

EXPERIMENT 1: RESULTS

WHAT HAPPENED?	
CONCLUSION	
WHY DO YOU THINK THIS HAPPENED?	

RESOURCE SHEET 1

WATER IS USED FOR:	THIS WATER CAN BE STORED IN:
E.G. Drinking	E.G. Bottles, taps and creeks

EXPERIMENT 2: RESULTS

DATA	EXAMPLE	GROUP 1	GROUP 2	GROUP 3 ETC
TIME BAG WAS ATTACHED				
PHOTO OF BAGGED LEAVES				
TIME BAG WAS CUT				
LENGTH OF TIME WATER WAS COLLECTED OVER				
AMOUNT OF WATER COLLECTED				

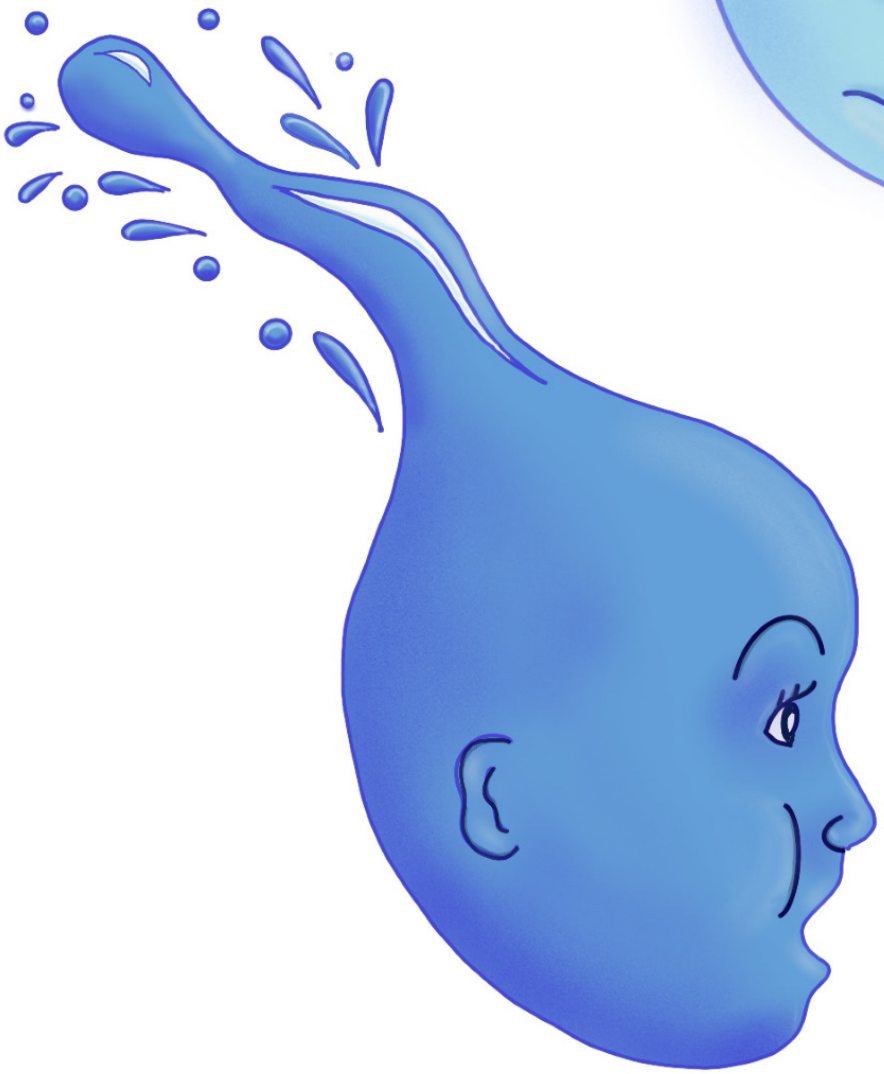
CONCLUSION

WHAT HAPPENED AND WHY?	

WANDA THE WATER DROP

ILLUSTRATIONS BY MELINDA TURNBULL

PRINT UP AT 100%, CUT WANDA OUT AND MAKE PUPPETS WITH ICY POLE STICKS.



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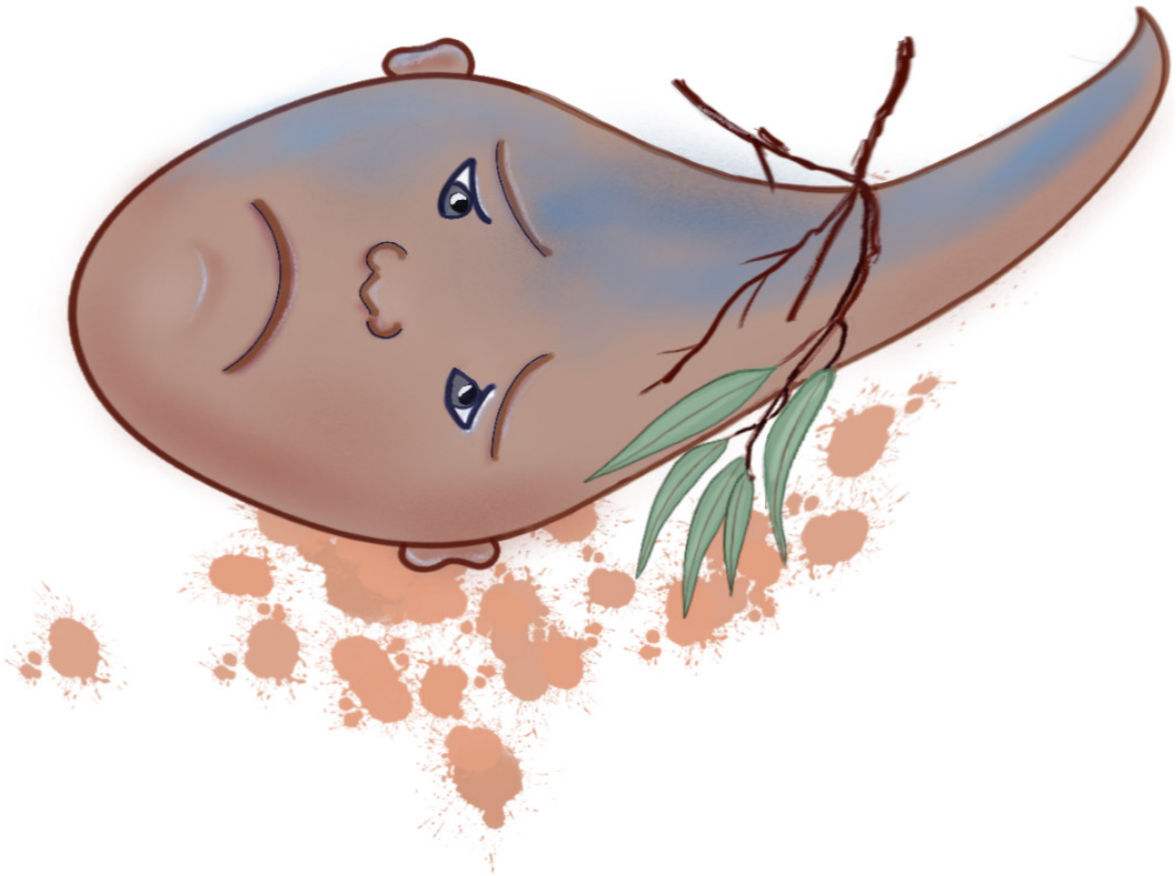

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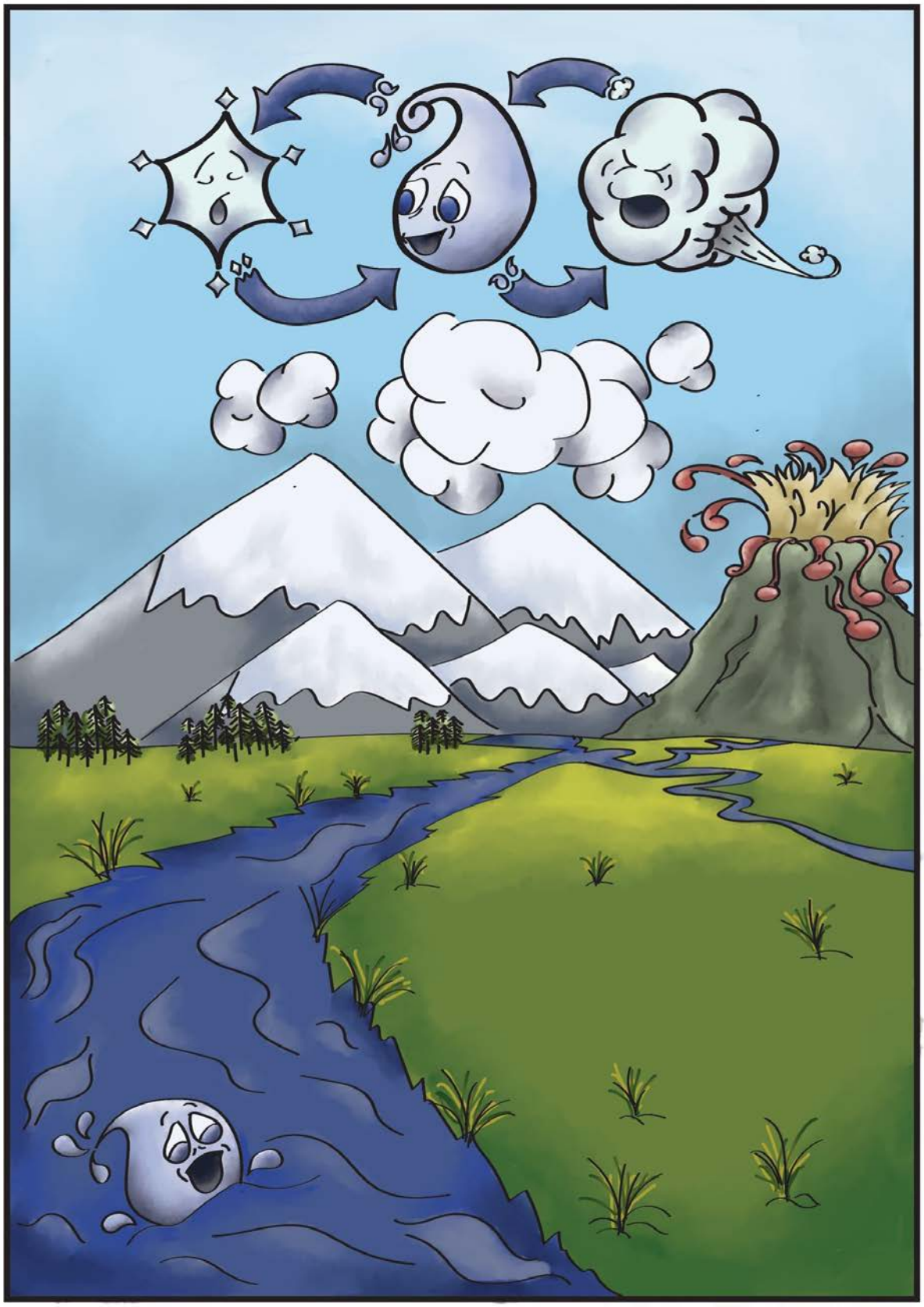
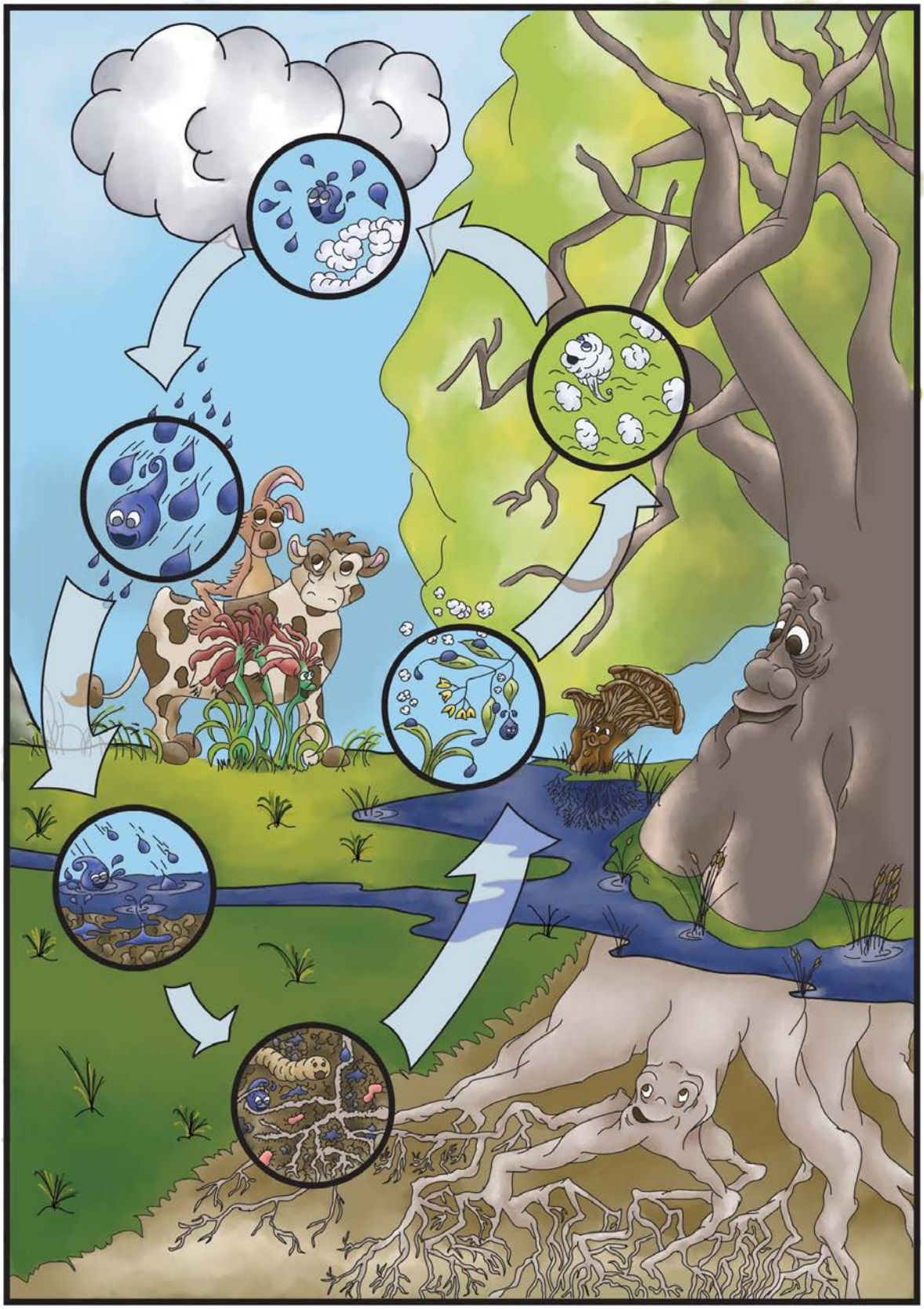


WANDA THE WATER DROP

ILLUSTRATION BY JOSH McCONNELL



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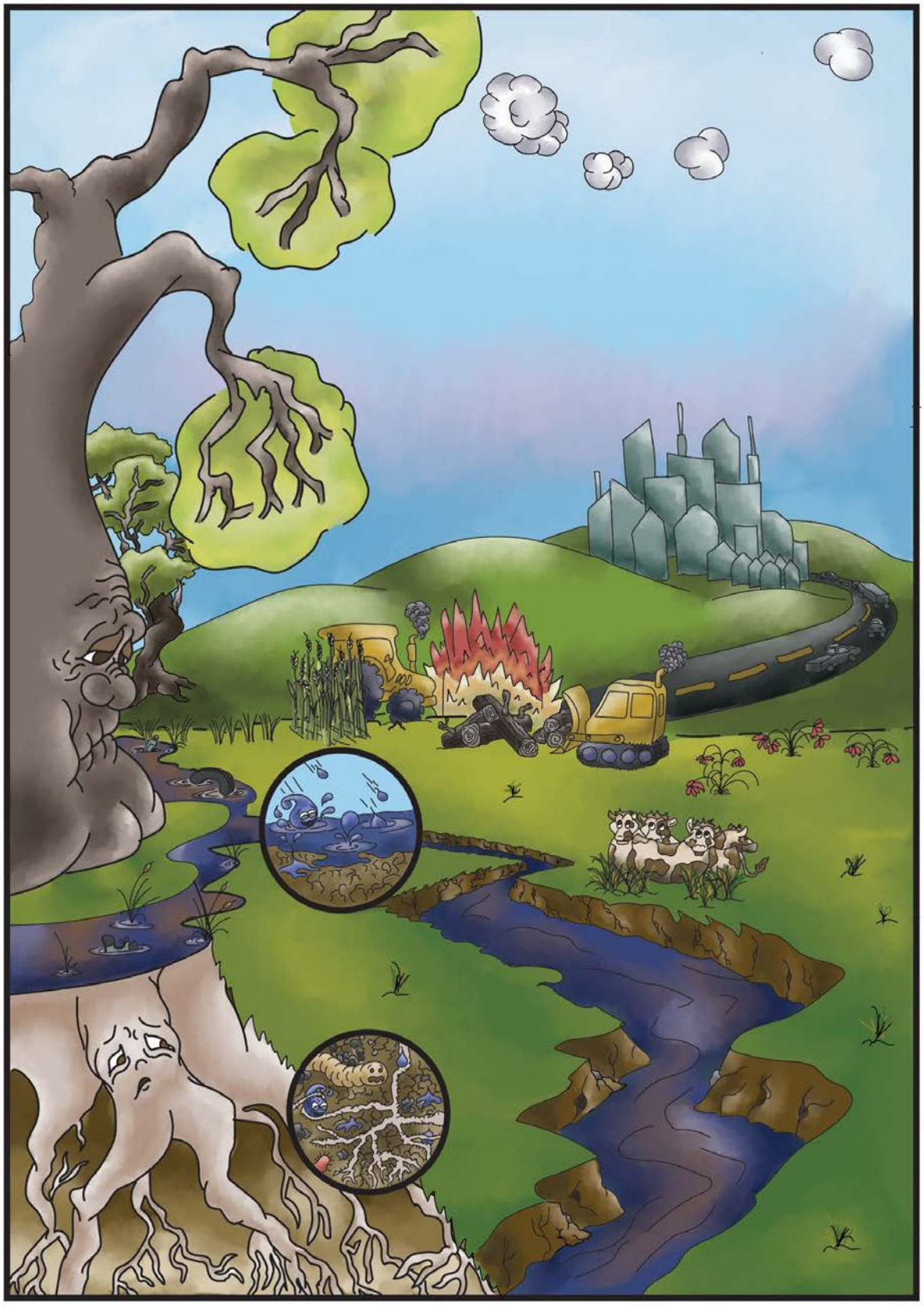

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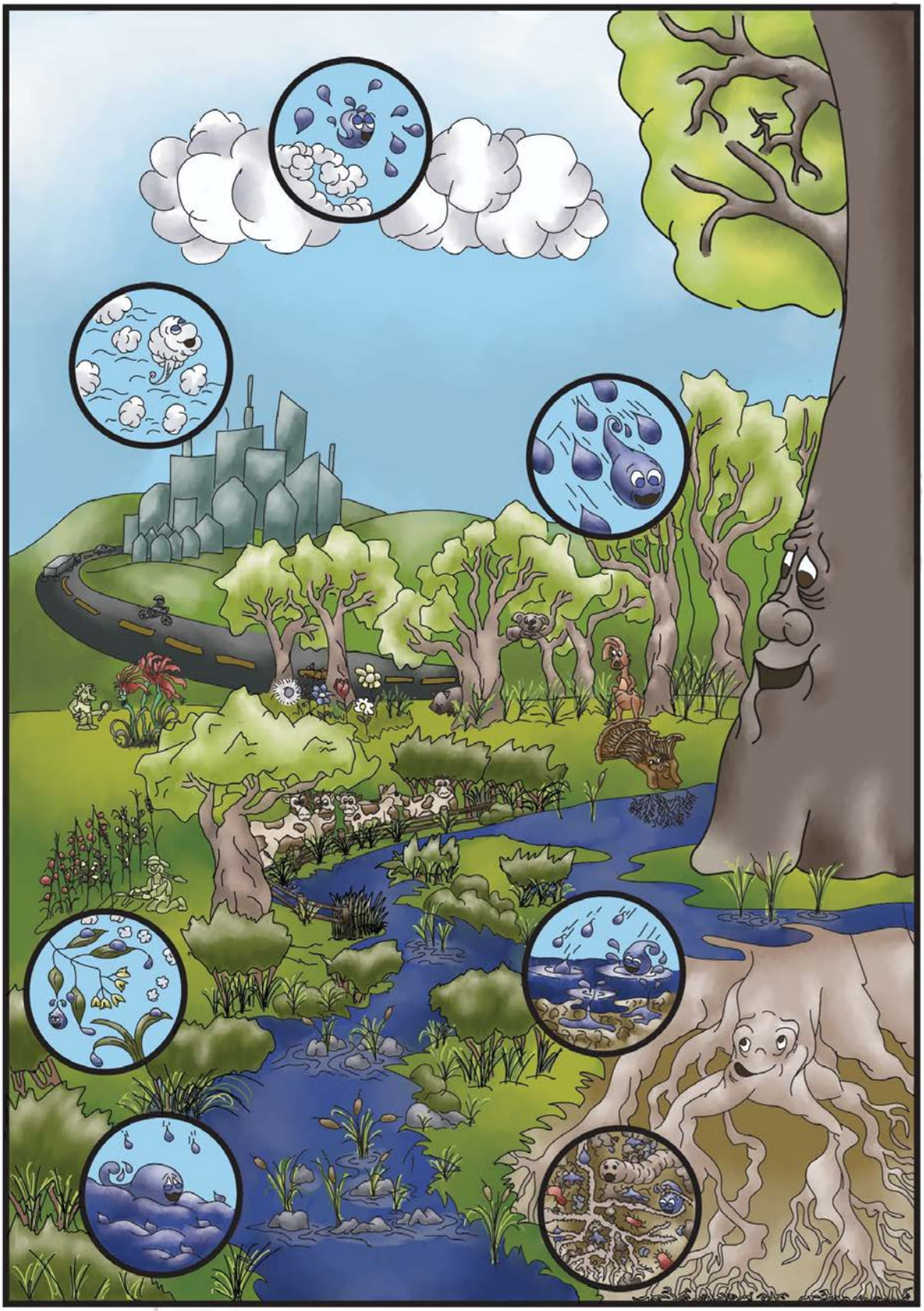


WANDA THE WATER DROP

ILLUSTRATIONS BY JOSH McCONNELL

Wanda is a water drop
who loves to dance and play and hop

A happy, helpful little lass,
she lives as solid, liquid, gas

Sometimes she's ice, and then she's rain,
And then she's steam, and back again.

In frozen poles she slumbers deep
For years she's quiet – not a peep.

And then she melts, and starts to flow.
In rivers, oceans, on the go.

She'll vaporize into the air
You see, dear Wanda's everywhere

She's been around for oh-so long,
in clouds, in plants, in billabong

"The soil is a snuggly home,
with tunnels, tubes, and space to roam

Underground is magic, see.
A spongy waterpark for me!

What fun I've had, what friends I've made!
We whisper, tickle, share, and trade.

Here's Fred the Funghi, reaching out,
to spread some goodies all about.

Ruthie Root holds hands with Fred,
so Pete the Plant is quite well fed.

I climb up high on Tess the Tree
She breathes me out as gas, you see

And then I fall and turn to dew
I glisten in the sunshine too

I help my friends, I'm in demand.
I travel far to lend a hand."

But sometimes Wanda moves too fast.
She can't reach friends like in the past.

She can't grab on to plants or shoots,
she can't feed worms, or trees or roots.

She's brown and murky, tired, sad.
And to be honest: a little mad.

Wanda's friends are scared and sick,
they're thirsty, wanting water quick.

Especially during drought and fire,
which, when frequent, are very dire.

You may think floods are somewhat
better,
but these don't make the soil wetter.

Wanda rushes by too fast;
it's hard to make the wetness last.

How can we slow Wanda down?
How to turn her clear from brown?

There are some ways, she'll tell you now,
She'll list them with a little bow:

"Let's 'slow the flow', so when it rains
Water wanders through the plains

Let's plant to make a green explosion;
let's stop this really bad erosion!

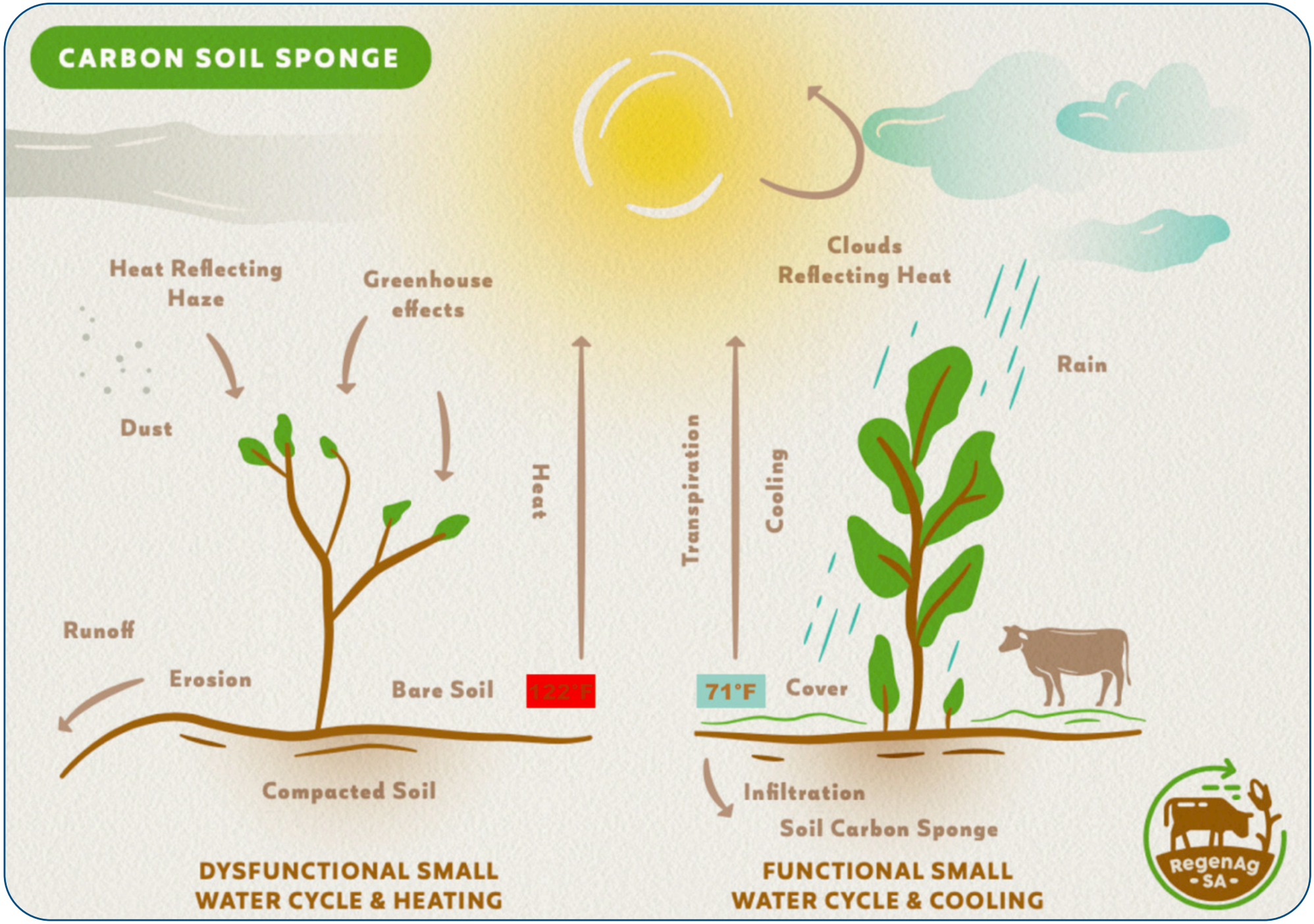
Let's give our livestock room to graze,
but rest the fields on different days.

Let's listen to the land's first folk:
Help the water soak soak soak!"

We CAN reverse the damage done
With efforts made by everyone

Wanda wants to play and hop
This lovely helpful water drop

Make the soil rich and dark
Give her back her water park


CARBON SOIL SPONGE
Heat Reflecting Haze
Greenhouse effects
Dust
Heat
Runoff
Erosion
Bare Soil
122°F
Compacted Soil
DYSFUNCTIONAL SMALL WATER CYCLE & HEATING
Clouds Reflecting Heat
Rain
Transpiration
Cooling
71°F
Cover
Infiltration
Soil Carbon Sponge
FUNCTIONAL SMALL WATER CYCLE & COOLING
RegenAg SA

REGENERATIVE AGRICULTURE PRINCIPLES

INCORPORATE LIVESTOCK

Stimulate Them

MINIMUM DISTURBANCE

Don't Break Their Home

KEEP THEM COVERED

Give Them A Blanket

HEALTHY SOIL BIOLOGY

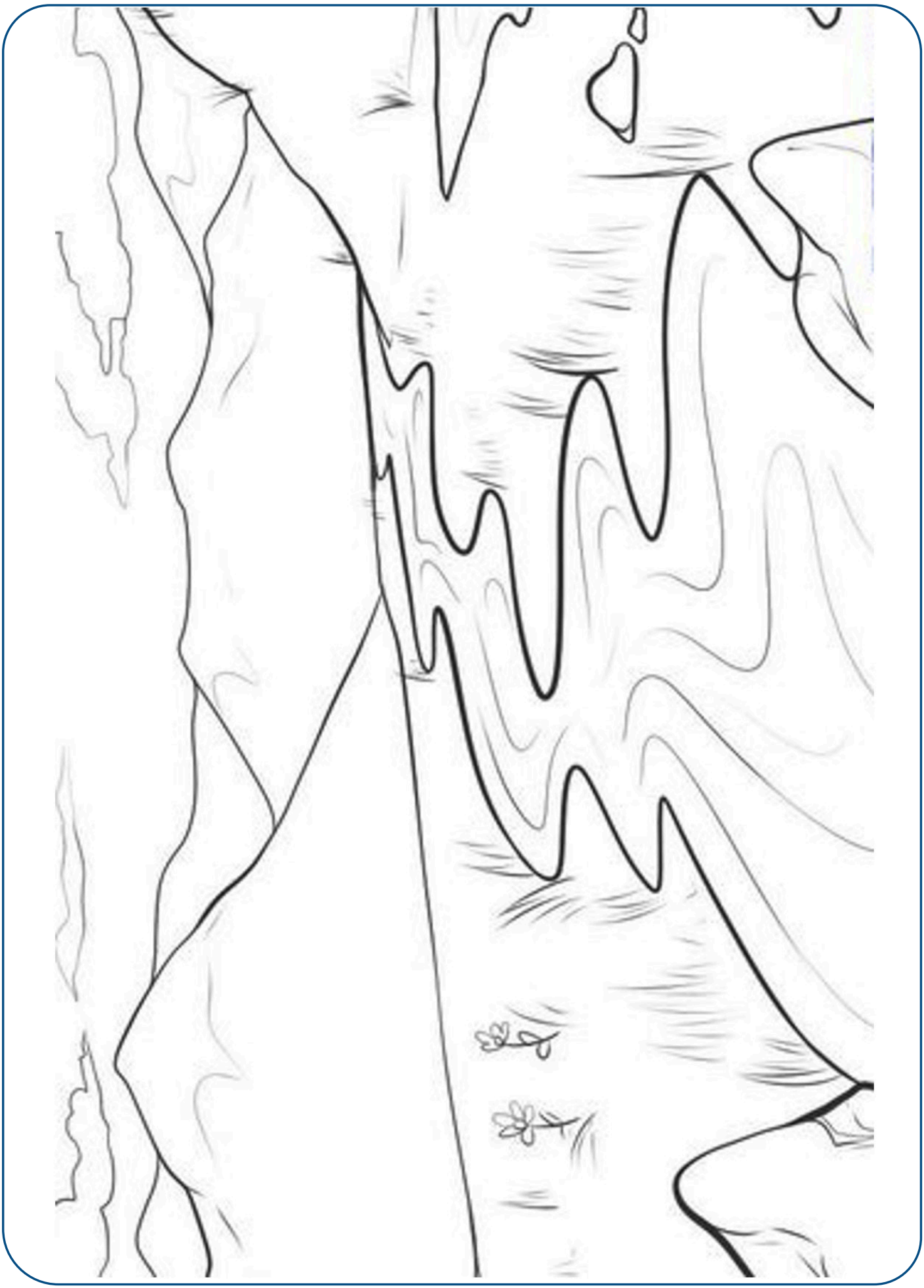
LIVING ROOT

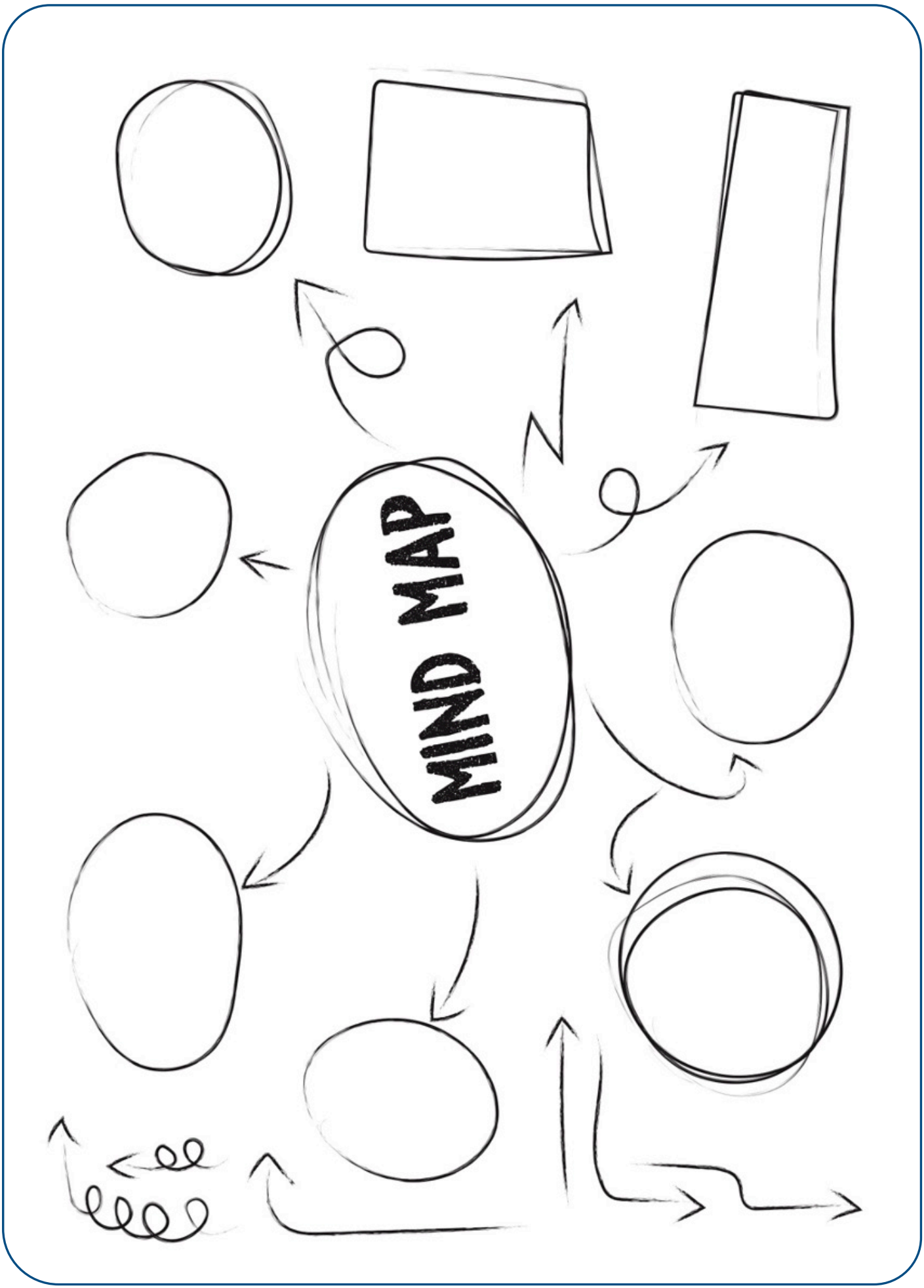
Don't stop feeding them

DIVERSITY

Feed Them A Varied Diet

RegenAg SA




MIND MAP