Pymble Ladies' College

STEM Teacher Enrichment Academy 2018

Year 7 – Global Water Issues

The Pymble Ladies' College STEM Global Water Issues event involved all of Year 7 and was implemented during a 3-day STEM Festival. This course was staffed by teachers from TAS, Science and Mathematics.

A Launch Event highlighted global issues with water purity, storage and availability and included a challenge to move water from one place to another. It was followed by Workshops to develop the skills necessary to complete their Challenge. The brief was to choose a global water issue, research the problem and existing solutions, explore multiple solutions of their own, prototype a final solution then communicate and persuade others of the value of their solution. They were given 2 days and access to experts to achieve their goals and pitch their idea with the catch-cry that **Great Ideas Need a Voice.**

They developed skills to identify issues relating to water, use data to draw conclusions, build a solution, understand the science behind the solution and enhance and adapt the solution.

They used Adobe Premiere Elements and Tinkercad to prototype and in the Problem – Solution process they used a Creativity Cube. They evaluated good video pitches.

Students investigated types of data, its collection and interpretation. They investigated area and volume formulae, capacity and unit conversions.

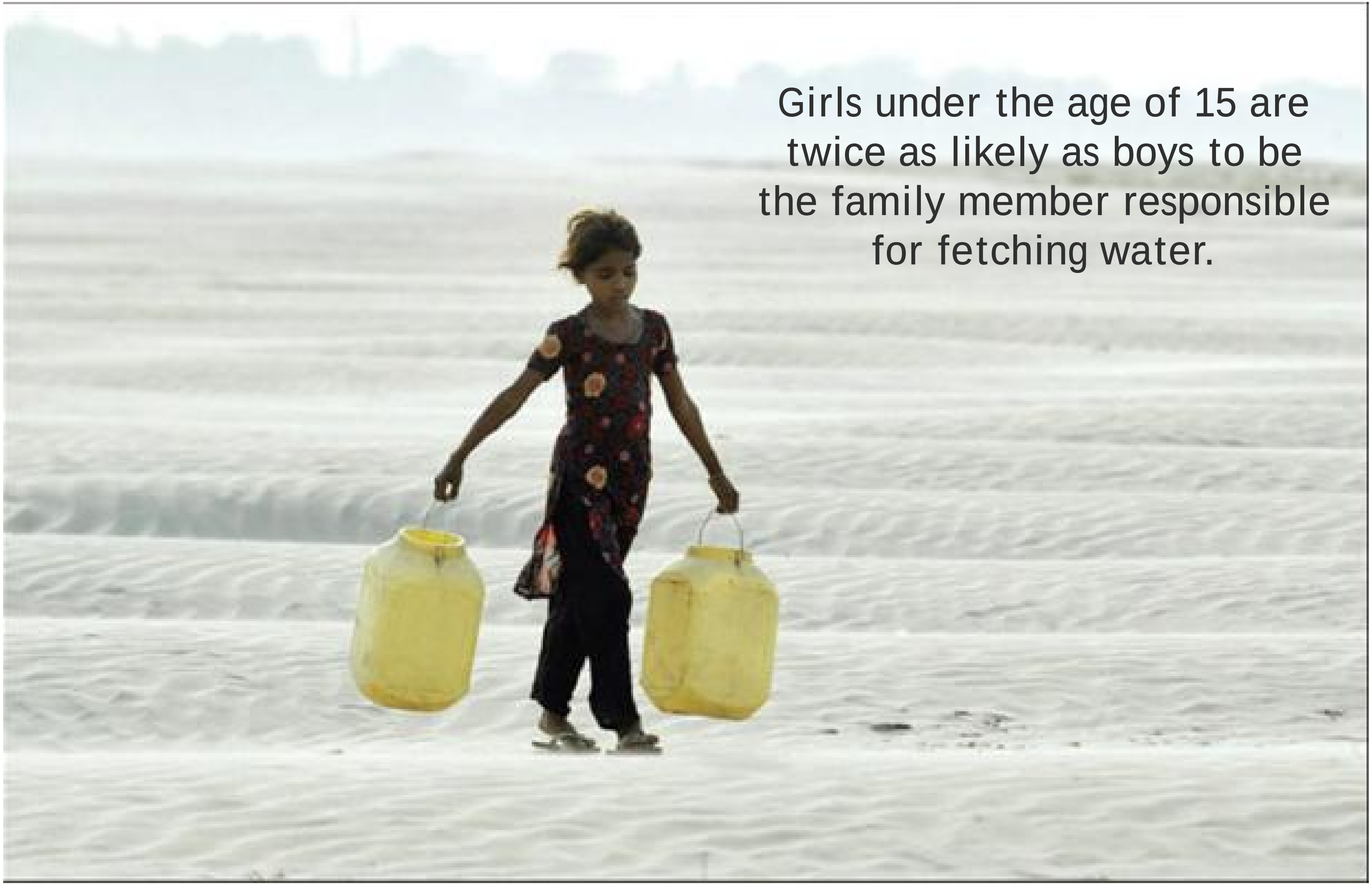
Science outcomes	**SC4-4WS**	**SC4-8WS**	**SC4-9WS**	**SC4-13ES**
Mathematics outcomes	MA4-19SP	MA4-20SP	MA4-13MG	MA4-14MG
TAS outcomes	4.1.1	4.2.1	4.2.2	

Statement of impact

The students were able to make links between the disciplines, develop the STEM skills of Creativity, Problem solving, Synthesis, and Design thinking. They were exposed to authentic and real-world problems and developed skills to apply the design brief and to pitch a solution.

For more information
Amanda Paterson | Pymble Ladies' College
E apaterson@pymblelc.nsw.edu.au

THE UNIVERSITY OF SYDNEY


Girls under the age of 15 are twice as likely as boys to be the family member responsible for fetching water.

783 million people do not have access to clean and safe water. 37% of those people live in Sub-Saharan Africa.

1 in 9 people world wide do not have access to safe and clean drinking water.

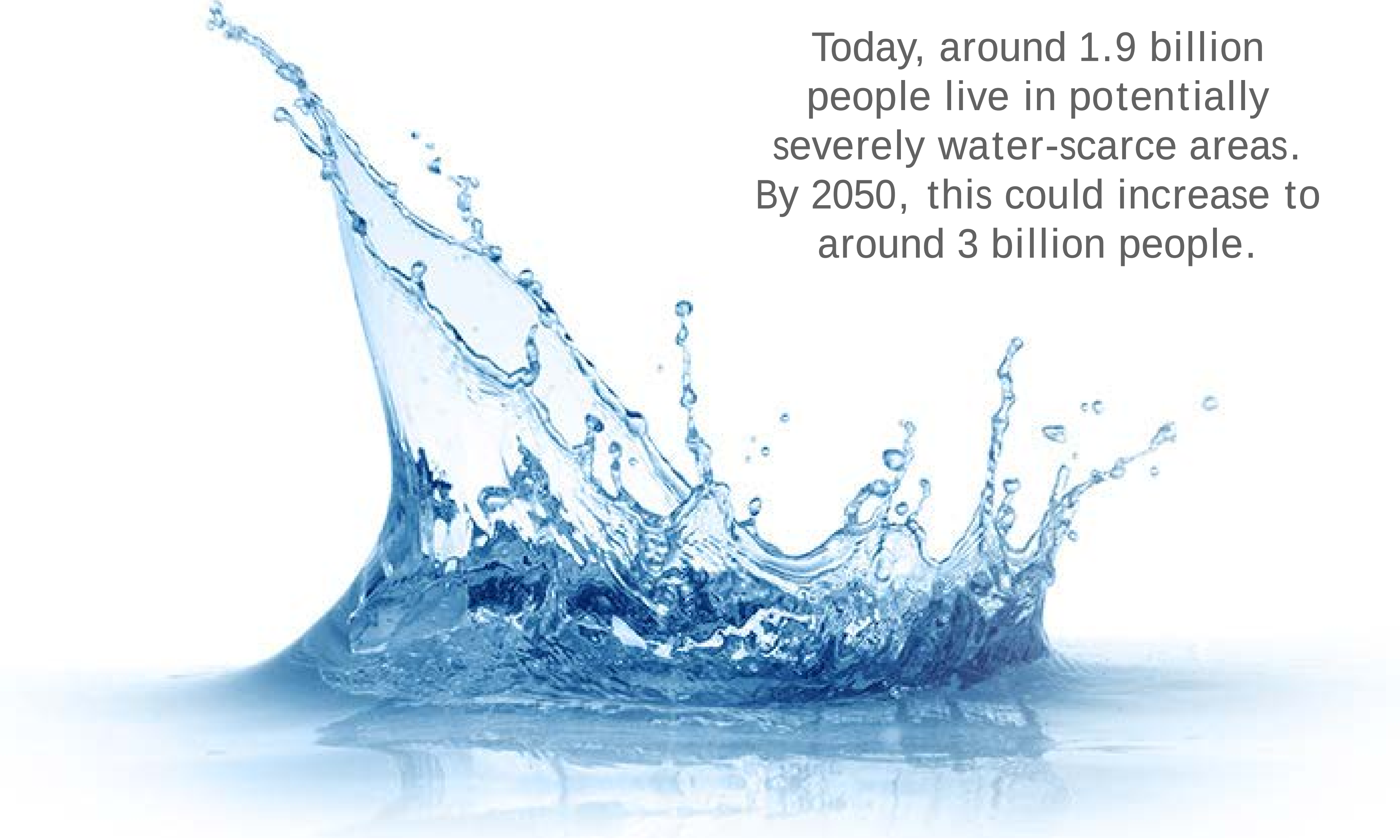

In developing countries, as much as 80% of illnesses are linked to poor water and sanitation conditions.


Millions without a toilet
Over half of the developing world's primary schools don't have access to water and sanitation facilities. Without toilets, girls often drop out at puberty.
© UNICEF/UNI137336/LeMoyne

Compared to today, five times as much land is likely to be under “extreme drought” by 2050.

Less than 1% of the world's water
is fresh and accessible.

By 2050, the world's population will have grown by an estimated 2 billion people and global water demand could be up to 30% higher than today.



Today, around 1.9 billion people live in potentially severely water-scarce areas. By 2050, this could increase to around 3 billion people.

The Brief

Choose a global water issue

Research problem and existing solutions

Explore multiple solutions of your own

Prototype your final solution

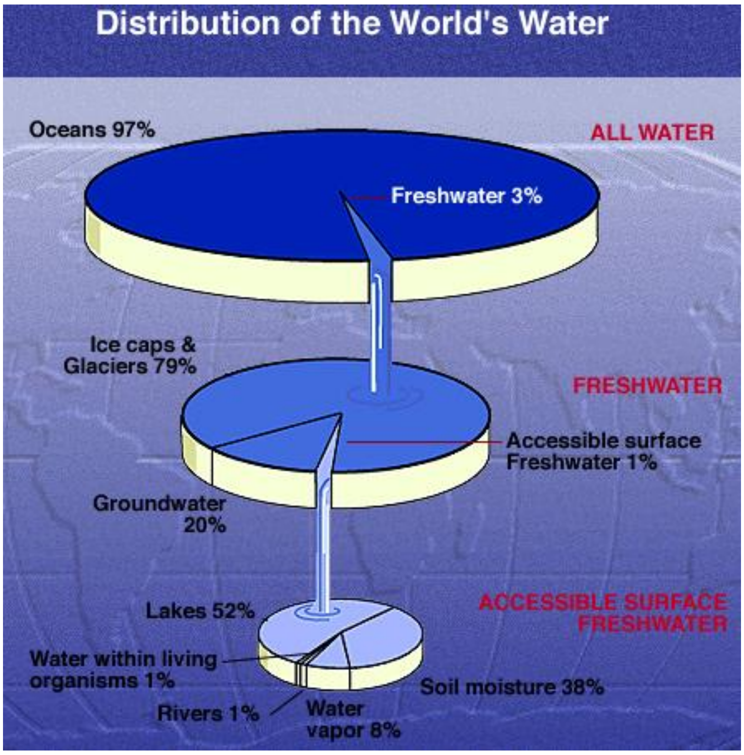
Communicate and persuade others of the value of your solution

WORKSHOPS

SCIENCE

Where is all the water?

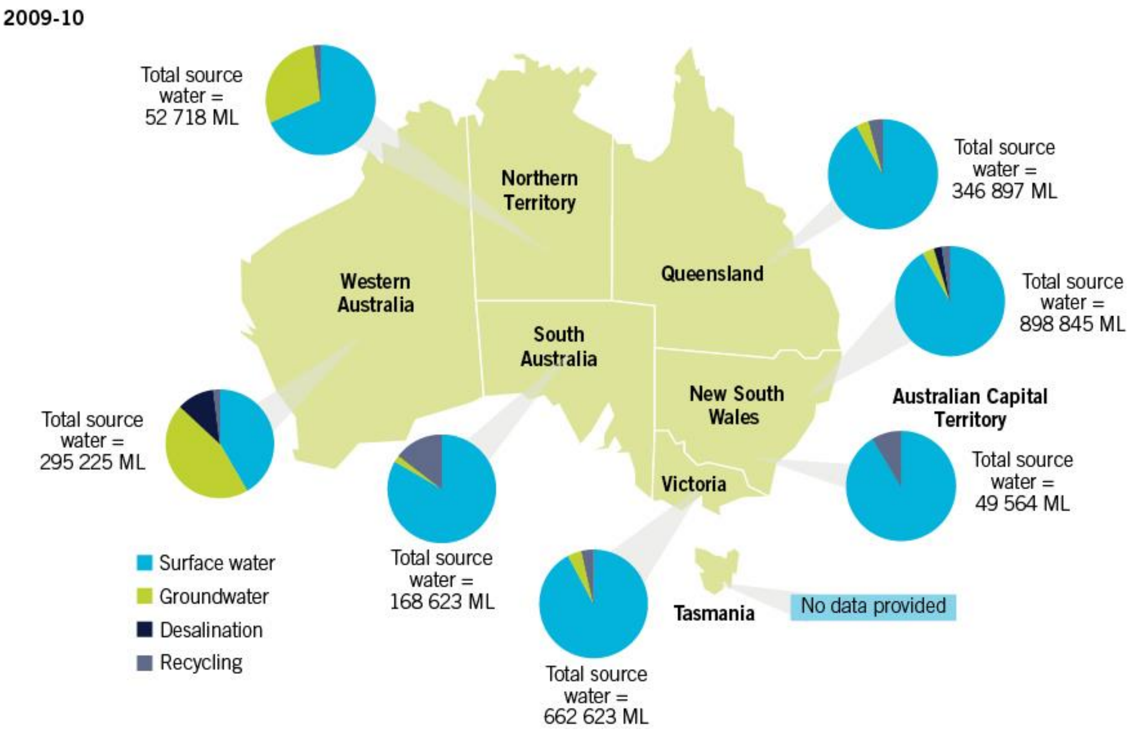
The water on the Earth's surface - **surface water -** occurs as streams, lakes, and wetlands, as well as bays and oceans. The water below the surface of the Earth primarily is **ground water**, but it also includes soil water.



Based on the information in this map

a. Where does the majority of Australia get its water from?

b. Why do you think Western Australia, South Australia and Northern Territory have such different water usage than the rest of Australia?



In rural areas surface water is needed particularly when it is dry. If grass and food is dry, animals need access to surface water.

How can get drinking water when there is no surface water available?

When there is little surface water available to drink, we have to think of other ways to collect water. Even though there is no obvious surface water, we can find water from plants, the soil and if we are desperate enough, our own urine. We are going to build a sill to learn more about how to collect water without depending on surface water.

Making a solar sill

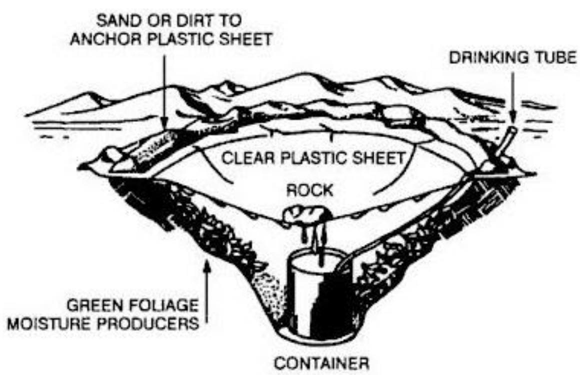
A **solar sill** provides the best way to collect sources of water. It's great for collecting the moisture in a dry streambed or dried-up gorge, in any moist land, at the base of a hill, and of course—urine soaked dirt.

Warning about drinking urine - There are a few known methods for purifying your urine, but even though your urine is mostly water *it is not considered safe to drink*. It's the other stuff in your urine that's harmful, that small percentage of waste products, like nitrogen, potassium, calcium and sodium. When you drink your urine, all of that waste, everything that your kidneys had worked so hard to excrete, comes right back in. So, to avoid the negative aspects of drinking urine, you can collect the water back out of your urine and drink the water, leaving the nasties behind.

The desert is the one place where water is essential, and if by chance you should find yourself alone in the arid lands of a desert, your urine could save your life with the knowledge how to make a solar sill.

Solar sill

This method assumes you are collecting water from soil or plants. (This could be the soil you just urinated in.)



What do you need

- A sheet of plastic - The plastic should be something without tears or small holes, and could be a thin tarp, thin drop cloth, poncho, garbage bag or even a grocery bag if that's all you can find. The bigger the better though.
- A container to catch the liquid - You can use just about anything for the container: a canteen cup, styrofoam cup, small bowl, tin can, cut water bottle... whatever you can find that can collect the water drippings.
- A rock (a small one to create a funnel-like effect in the plastic)

- A shovel (optional)
- A tube (optional—to drink without taking apart the still)

1. **Dig a hole in the soil you have**
   Look for soft soil or sand to dig in. A depression in the land is a great spot, or anywhere rainwater might collect. A place where the sun hits is also needed, hence the "solar" in solar still. You need to dig a big enough hole in relation to the size of plastic and the container being used. The hole should be smaller than your plastic sheet but the bigger the better. If you have green plants around you can use them to add to your source of water by laying some green foliage inside the walls of the pit, which contain added moisture.

2. **Place the Container -** Place your container at the bottom of the hole, in the center. Make sure it is secure. If you want, you can dig another small hole inside that hole to keep your drippings container nice and snug.

3. **Blanket the Hole with Plastic -** Now, stretch out your plastic to cover the entire hole. You're going to need to evenly secure the edges of the plastic, to secure it in place and to keep any air from escaping. Out in the wilderness, you can use the soil that you dug up to lay on the edges of the plastic. You can also you some rocks for extra weight. We will use string around the tub to secure the plastic sheet in place. Make sure the plastic is not drooping down into the pit.

4. **Place the Center Rock -** Find the best sized rock for centering on the spread out sheet of plastic. You may have to try a few out to find the perfect stone. Place it directly over the water container below. This keeps the plastic form moving about more than you want, and it pushes the plastic down into a cone shape. A 45 degree angle is best, and the rock works better if right above the container opening. The cone will point right into the cup, and all the moisture will drip down along the sides of the plastic and right in.

5. **Double-Secure -** Double check that the edges of your plastic our secured and no air can get in or out.

6. **Wait** - This is the time where you let the sun do its magic. This process will take anywhere from 2 hours. The sun heats up the soil around the still, and in turn, creates moisture which saturates the undersides of the plastic. The condensed moisture then drips slowly down the angled sides of the plastic (thanks to the rock), down to the lowest tip and down into to the container.

The Science behind a sill

In this sill, the sun heats up the liquid water trapped in the soil, slowly evaporating a bit of water at a time. The soil and chemicals in the water are not evaporated, which means the water vapour is pure. The water vapour rises and then hits the plastic, where it cools down and is converted back into liquid water. This liquid water dribbles down the surface of the plastic due to gravity and drips into the cup placed under the lower point of the plastic.

Design questions

How might we need the change the design to provide water faster?

How might we need the change the design to provide more water (say for a whole family)?

How could we alter the design to get the water out of the cup without dismantling the whole setup?

DECONTAMINATION
Water, water everywhere but not a drop to drink…

Contaminated water

Watch this **video**

Often there is plenty of water around, but it is just simply not clean enough to drink. Drinking polluted or contaminated water can make someone very ill. Water can be contaminated with chemicals from factory outlets or other pollution. Sewage can mix with fresh water supplies contaminating the water and resulting in the presence of disease-causing microbes which can cause disease such as diarrhoea or cholera.

Often after major natural disasters such as flooding or earthquakes, drinking water can become contaminated, so it is important to know how to make this water safe.

We are going to build a prototype sill to collect clean water from contaminated water. Once you have completed this sill, put the sill in the sun and a small cup under your outlet pipe to collect water. Then move onto the next part of this workshop.

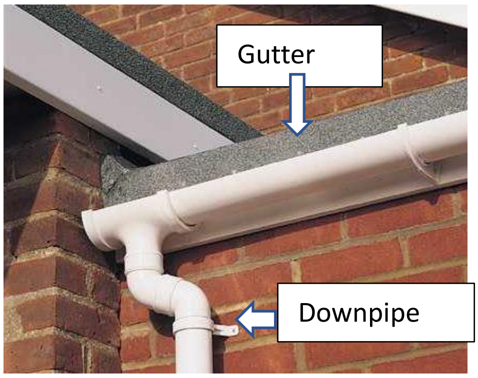
Making dirty water into drinking water

Equipment and Materials

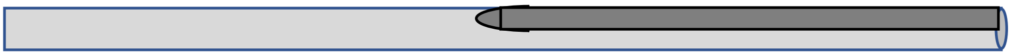
- A sheet of stiff, clear plastic or glass - The sheet should be flat, like an old window or car windscreen. It should not have holes or cracks in it.
- A waterproof tray to catch the water – This needs to be the size of your sheet of plastic or bigger. It needs to be painted black or lined with black plastic. A black tray would be ideal.
- A 1m pipe – this will be your gutter
- Duct tape – the water proof kind
- A plastic bottle – to collect the water at the end of your pipe.

Method

1. **Set up your collection tray -** Lay black plastic into your tray. The black colour ensures than it will absorb enough of the sun's warmth to heat up the water. Your tray needs to sit in a sunny spot on a very slight slope.



2. **Make a gutter -** You have been provided with a cu piece of pipe to make your gutter. The pipe needs to remain as one 1m piece but half so that it can be the "gutter" to collect water and the other half will remain whole to be the "downpipe".

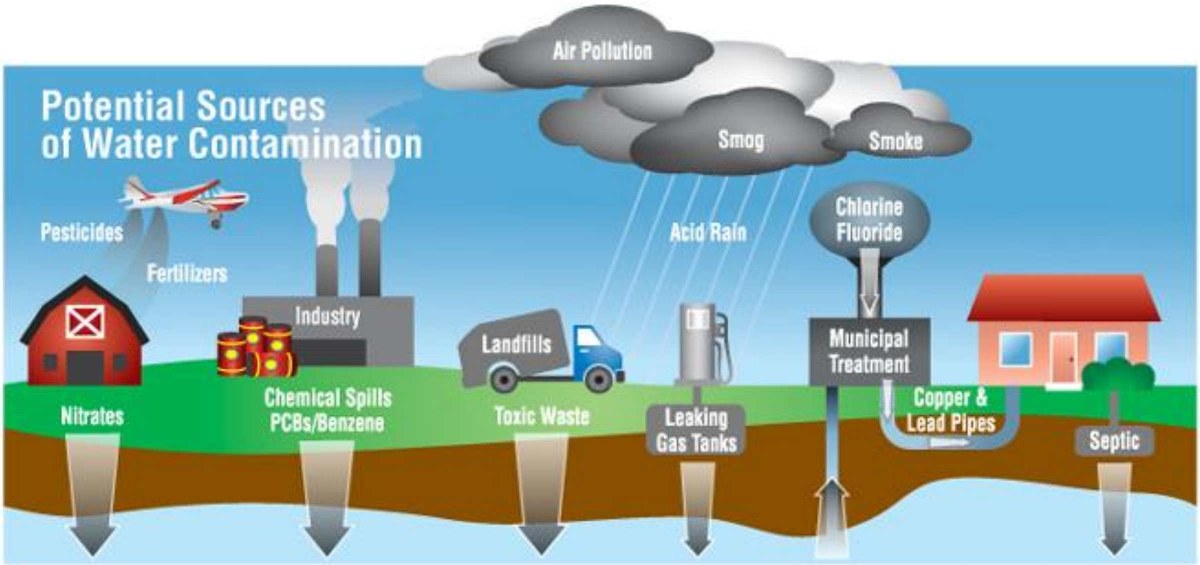


3. **Connect the gutter** - Tape the half-pipe gutter onto the inside of your tray, just below the lip of the tray, on the downhill edge. The downpipe portion will lead to the outside of the tray.
4. **Attach the cover -** Place your transparent sheet over the top of your tray. Use the duct tape to "vapour-proof" your system. This means no air should be able to get in or out without going through the pipe. Try and blow into the pipe **–** this will tell you whether it is vapour-proof. If it gets harder and harder to blow the pipe, you know it is air tight.

5. **Attach the collection bottle** – Secure the water bottle to the end of the down pipe and use duct tape to make it air tight.
6. **Add the water** – lifting one corner of the duct tape to lift the corner of the cover, pour your contaminated water into the tray. Seal up the lid again and set it up in the sun to warm.

The Science behind a decontamination unit

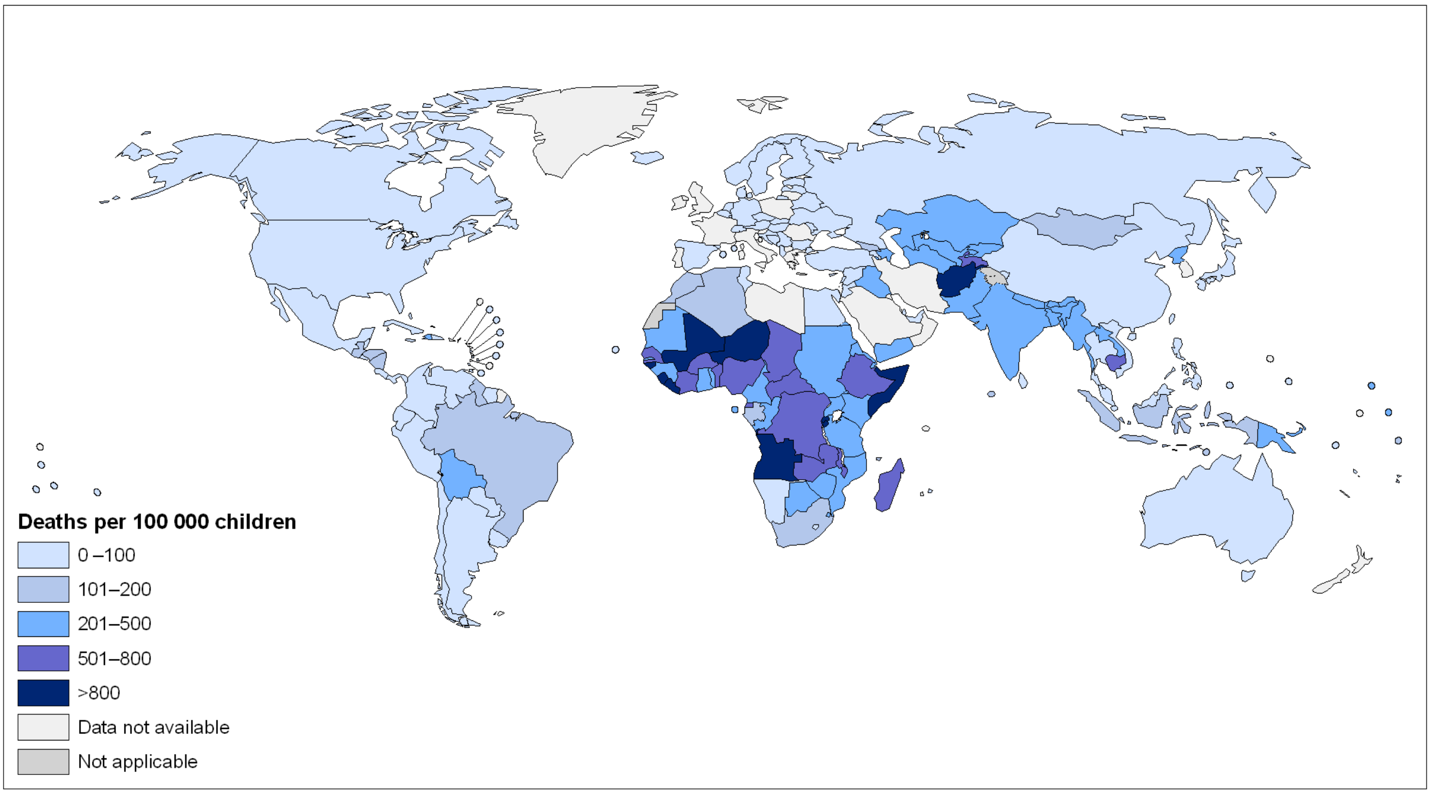
In this sill, the sun heats up the liquid water in the tray, with the black plastic absorbing the heat from the sun. Water will slowly evaporate leaving behind unwanted chemicals, microbes and dirt. The water vapour rises and then hits the clear plastic sheet, where it cools down and is converted back into liquid water. The slope on the setup means the water will run towards the downhill side and drip into the gutter. It will then run down into the downpipe and eventually into the bottle. The only substances that might evaporate out with the water is alcohol and petrol. To ensure we don't drink this water, we always discard the first bit of water that comes out.



Research

Choose 3 water contaminants from the diagram above and use the internet to find out the potential impacts of these contaminants on your health.

Deaths attributable to water, sanitation and hygiene (diarrhoea) in children aged under 5 years, 2004



The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement.

Data Source: World Health Organization
Map Production: Public Health Information and Geographic Information Systems (GIS)
World Health Organization

World Health Organization

Data analysis

Using the map provided, answer the following questions:

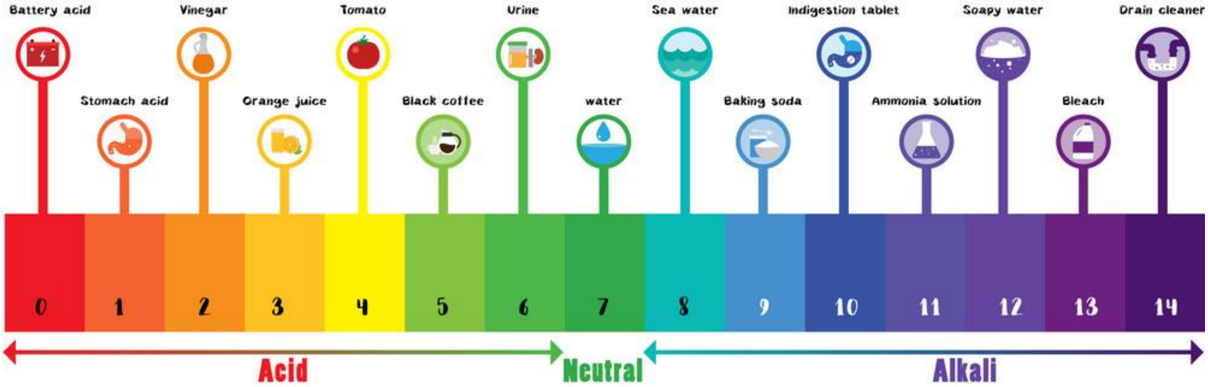
1. Use the graph above to determine the number of deaths due to diarrhoea per year in Australia.
2. Use the internet to find out the name of the 7 countries with more 800 deaths per 100 000 people.
3. Why do you think these countries have more deaths due to diarrhoea than others? Make some educated guesses. You can then find out more about the countries and see if you can make some better guesses.

Scientific experiment

Aim: to determine how effective your sill is at collecting clean water.

Introduction

Using your sill, you are going to take some water contaminated with acid. It will be tested to see how much acid is in the water to start using an "acid-base indicator" which changes colour depending on whether acid is present.



1. Take 10mL of the water provided and add 4 drops of universal indicator. Record the colour and use the card to determine the value of the pH of the contaminated water.
2. Pour 50mL of water into your sill and place it into the sun to decontaminate the water.
3. Collect 10ml of the clean water from your sill and add 4 drops of universal indicator. Record the colour and use the card to determine the value of the pH of the contaminated water.

Conclusion – Compare the pH value of your clean water. Use these results and the scale above to draw a conclusion about the quality of the water collected out of your sill.

More resources on this issue

http://www.who.int/en/news-room/fact-sheets/detail/drinking-water

http://www.who.int/water_sanitation_health/water-quality/en/

http://www.who.int/water_sanitation_health/diseases-risks/diseases/diseasefact/en/

https://www.epa.gov/ccl/types-drinking-water-contaminants

Chemical contamination

https://www.niwa.co.nz/our-science/freshwater/tools/kaitiaki_tools/impacts/chemical-contaminates/causes-of-chemical-contamination

https://www.epa.gov/pfas/basic-information-pfas

DESIGN

Idea Generation and Innovation

90 min Session

Aims:

- extend creative/**innovative thinking**
- tools/scaffolds for **problem solving** and analysing/evaluating **best solutions**
- representing/communicating through **prototypes**

1. Innovative Thinking (15)

(15) ACTIVITY In groups, Ss. work on creating a list of 50 different uses for one of these common items:

- Bucket
- Ladder
- Tea kettle (electric)
- Ruler
- Recycled yoghurt container
-

Goal: to think outside the box

A PLASTIC BUCKET

EMPTY YOGHURT CONTAINERS

LADDER

2. The Problem (30)

(2) SCENARIO: Given to the cohort to "SOLVE" during this session.

Your bucket has a large crack. You need to water the plants by the TAS building. What will you do?

- Pots are heavy
- No hose
- Moving into the summer months

--> Create a video or have a picture on the screen for students to see

(25) ACTIVITY: Groups use the graphic organiser to generate 6 options. The "Creativity Cube" may assist with additional thinking patterns and solutions. Evaluating the solutions through PMIs and explaining the best option for the solution.

RESOURCES: template of 6 choices

3. Communicating through Prototypes (35)

(20) ACTIVITY: Lego activity of describing the final product

In pairs, Ss. work to recreate the intended Lego creation. The Instructor cannot touch the pieces. The Builder cannot see the final image or the instructions. They must obey the verbal instructions.

Goals: to demonstrate the importance of clear communication and the importance of each component being represented to recreate.

RESOUCES: One box of LEGO Classics between two students.

(15) ACTIVITY: time to prototype with a range of materials/methods

- Paper / Paddle pop sticks
- Digital with TinkerCAD
  ** CONSTRAINT: Students have to sign up with accounts prior to the day. Students must be 13years old → Send a letter home to cohort for parents to make an account

Goal: to have an idea of how to prototype and communicate their ideas in the final team video.

Cube Pattern

Cut on solid lines - Fold on dashed lines

Substitute
To replace one thing with another
To change the parts
“What can you use instead?”

Combine
Add/put more things together
“How can you combine different thi ngs or parts to make something new?”

Adapt
To meet other needs
“What will happen if the item is used in a different situation?”

Modify
To change the look/quality
“Can you change the item to another shape?”

Reverse
To turn a thing around
To change to the opposite
“Can you do the opposite”

Rearrange
To change the order
“Can you change the order of items?”

Problem solving scaffold:

Problem –

The plants need to be watered

Option 1:	Option 2:	Option 3:	Option 4:	Option 5:	Option 6:
Positive	Positive	Positive	Positive	Positive	Positive
Minus	Minus	Minus	Minus	Minus	Minus
Interesting	Interesting	Interesting	Interesting	Interesting	Interesting

Which option is the best solution & why?