3.4 Water management

In nature plants and animals get water from rain, rivers and natural stores such as lakes. Indigenous Australians are able to find underground stores of water by using their observations of plants, birds and other animals. In modern society, water is needed for cities, industry and agriculture. To meet the needs of modern society, water resources have to be managed differently. This management changes the movement of water through the water cycle.

INQUIRY science 4 fun

Ants and water

Can ants help locate a water source?

Yes

Collect this ...

shallow container for water

Do this ...

1 Fill the container with water.
2 Place it on a path or on the grass in a partially shaded part of the garden.
3 Leave the container undisturbed for about an hour.

Record this ...

Describe any change in the behaviour of ants in the area.

Explain why this happened.

Traditional water use

Indigenous Australians are able to live in some of the driest parts of Australia because they can find and manage water resources. One technique to find water is to observe the vegetation. In the middle of a dry area, Ghost Gum trees (such as the one in Figure 3.4.1) indicate where there is underground water. Ant trails also lead to underground water and dingo tracks lead to rock pools and waterholes.

Figure 3.4.1 A mature Ghost Gum has a thick trunk that is covered in very white bark, giving it its name. It grows to about 20 m in height.

Traditional methods used by Indigenous Australians to obtain water include creating shallow wells and digging tunnels to reach water deeper underground. The mouth of the well or tunnel is covered to reduce evaporation and to prevent animals from drinking the water and polluting it.

In the past, the location of water sources determined the routes Indigenous Australians used to travel around the country. In this way they were sure to have reliable sources of water.

There are many **springs** where water from the Great Artesian Basin comes to the surface. One is shown in Figure 3.4.2. These springs are a major source of water for Indigenous Australians and for native plants and animals. Some European explorers and early settlers learned how to find water from the Indigenous people and so they too could get their water from springs.

Figure 3.4.2 Springs from the aquifers of the Great Artesian Basin were used by native animals and later as watering points for cattle.

1 p111

Storing water in dams

Australia is the driest permanently inhabited continent. The rain that does fall is not distributed evenly over the country. Dams are built to capture and store the rain.

Most farms in Australia have dams. The water collected is used for cattle to drink and may be used to irrigate crops. There are also many much larger dams such as Wivenhoe Dam near Brisbane. You can see this in Figure 3.4.3. These large dams collect and store water to be used by industry and households in the cities.

Figure 3.4.3 Large dams like the Wivenhoe Dam are needed to collect enough water for the needs of cities.

SciFile

All ice, no water!

Australia might be dry but the continent of Antarctica is even drier! This is because all of its water exists as ice. The constant freezing temperatures never allow the ice to melt.

All dams interrupt the water cycle because water stored in them does not flow down the river and into the ocean. Water from the surface of the dam evaporates and is returned to the water cycle. However, in a very deep dam some water may not be available for evaporation for a very long time.

SciFile

That's big!

The tallest dam in the world is the Nurek in Tajikistan in the Himalayan Mountains. The dam wall is 300 metres high. In 2014 when the Jinping-I Dam in China is completed it will be taller at 305 metres. Compare this with Wivenhoe Dam on the Brisbane River (Figure 3.4.3). It is just 50 metres high!

Irrigation

Most of the farm crops grown in Australia have been introduced here from other parts of the world. This means that they do not have characteristics that allow them to grow with only small amounts of water. These crops need continuous supplies of water and farmers provide this water through irrigation. **Irrigation** is a practice used in agriculture that provides water to crops using pipes and ditches.

There are two ways farmers irrigate their land:

- spray irrigation
- flood irrigation.

Spray irrigation

You can see spray irrigation in Figure 3.4.4. In **spray irrigation** a pump forces small droplets of water into the air. The water falls on the soil and percolates down to the roots of plants. The water then moves up through the plant and is eventually lost back to the atmosphere through transpiration.

Figure 3.4.4 Spray irrigation is like having rain fall on the crop whenever it is needed.

There are some differences between spray irrigation and rain. When it rains there are usually clouds in the sky and the air is very humid. These factors reduce the rate of evaporation. Spray irrigators may be used on hot days when there is bright sunshine. The tiny droplets of water produced by the spraying equipment evaporate quickly in hot, dry air. Water landing on the leaves also evaporates more quickly than in a natural rain storm. Therefore a significant amount of water that would normally percolate into the soil evaporates into the atmosphere.

Flood irrigation

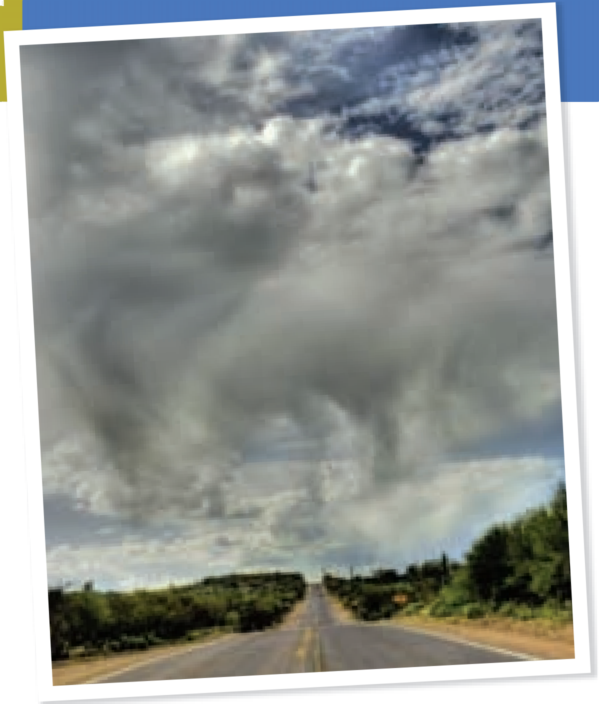
In **flood irrigation**, water is released into channels between the crop plants. This is shown in Figure 3.4.5. The water percolates into the soil to the plant roots. However, the water will evaporate quickly if the soil and irrigation channels are not shaded.

Figure 3.4.5 With flood irrigation the water reaches the roots. However, if there is not a good cover of vegetation much of the water will evaporate.

SciFile

Raining or not?

Not all precipitation reaches the ground. Virga is rain or snow that evaporates somewhere between the clouds and the Earth. It appears as a torn curtain hanging half way to the ground under the clouds.



Moving water around

Dams and pipes can be used to move water from an area where there is plenty of water to areas where there is not enough. The Snowy Mountain Scheme was a very ambitious project that began in 1949 and was completed in 1974. Figure 3.4.6 shows part of the scheme's dam and pipelines. Most of the scheme is underground. The Snowy River in New South Wales is fed from melting snow and rain in the Snowy Mountains. Its position can be seen in Figure 3.4.7. The dams and pipes divert the water from the Snowy River. Only 1% of the water that once flowed in the Snowy River now flows down it and out to sea.

Figure 3.4.6 The Snowy Mountain scheme is one of the largest irrigation projects in the world, with about 225 km of tunnels and pipelines.

Now a large proportion of the water from the Snowy River is diverted through tunnels and dams. It is used to irrigate large farming areas in the Murrumbidgee Irrigation Area, shown in Figure 3.4.8. Irrigation has enabled this area to become one of the main wine and food producing parts of Australia. Water that once flowed very quickly into the ocean is spread across land that is naturally dry.

Figure 3.4.7 Map showing the positions of the Snowy Mountain Scheme and the Murrumbidgee Irrigation Area.

Figure 3.4.8 The main use of the water from the Snowy Mountain Scheme is to generate electricity. It is also a major source of water for the Murrumbidgee Irrigation Area.

The water used for irrigation is returned to the atmosphere through transpiration and evaporation from soil. Irrigation water also percolates through the soil into the ground water. Eventually the excess water flows via the Murray River into the ocean on Australia's southern coast.

Cities

Building cities replaces pervious soil with impervious concrete and bitumen surfaces. Water that lands on soil percolates about 15 mm into the ground before there is any run-off. Water that falls on roofs, roads and footpaths runs off immediately. The water flows into stormwater drains (like the one in Figure 3.4.9) and out to the ocean.

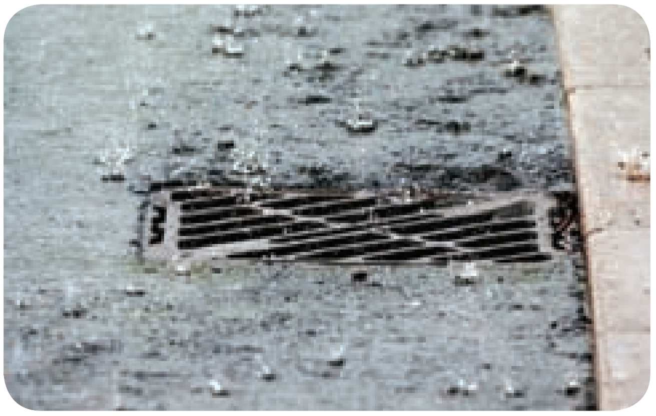


Figure 3.4.9 Water flowing off roofs, streets and other impervious city surfaces goes straight into stormwater drains. From there it goes directly to rivers and the ocean.

In many parts of Australia, attempts are being made to use stormwater. In some Sydney suburbs, stormwater is being collected in tanks and pits. Harmful substances are removed from the water and then it is used to irrigate parkland and sports fields and to water trees in the city.

In the city of Orange in New South Wales some of the water that flows into Blackman's Swamp Creek during storms is captured and then transferred to a nearby dam. Figure 3.4.10 shows how much water flows out during such a storm. All this stormwater is now collected, increasing the water supply for the city.

2 p112

Figure 3.4.10 A large amount of water flows along Blackman's Swamp Creek during a storm.

Changing vegetation

When trees are cut down and replaced with grass or bare soil, the movement of water over the land surface is changed. Trees, shrubs and long grass slow the rate at which water can flow over the ground. This means that there is more time for the water to soak into the soil.

In the absence of vegetation, water moves quickly over bare ground and often carries large amounts of soil with it as it flows into streams and rivers. Figure 3.4.11 shows the effect of this fast-moving water.

Figure 3.4.11 These channels in the soil (known as **rills**) have been created by fast-flowing water.

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HUMAN ENDEAVOUR

Use and influence of science

Using stormwater

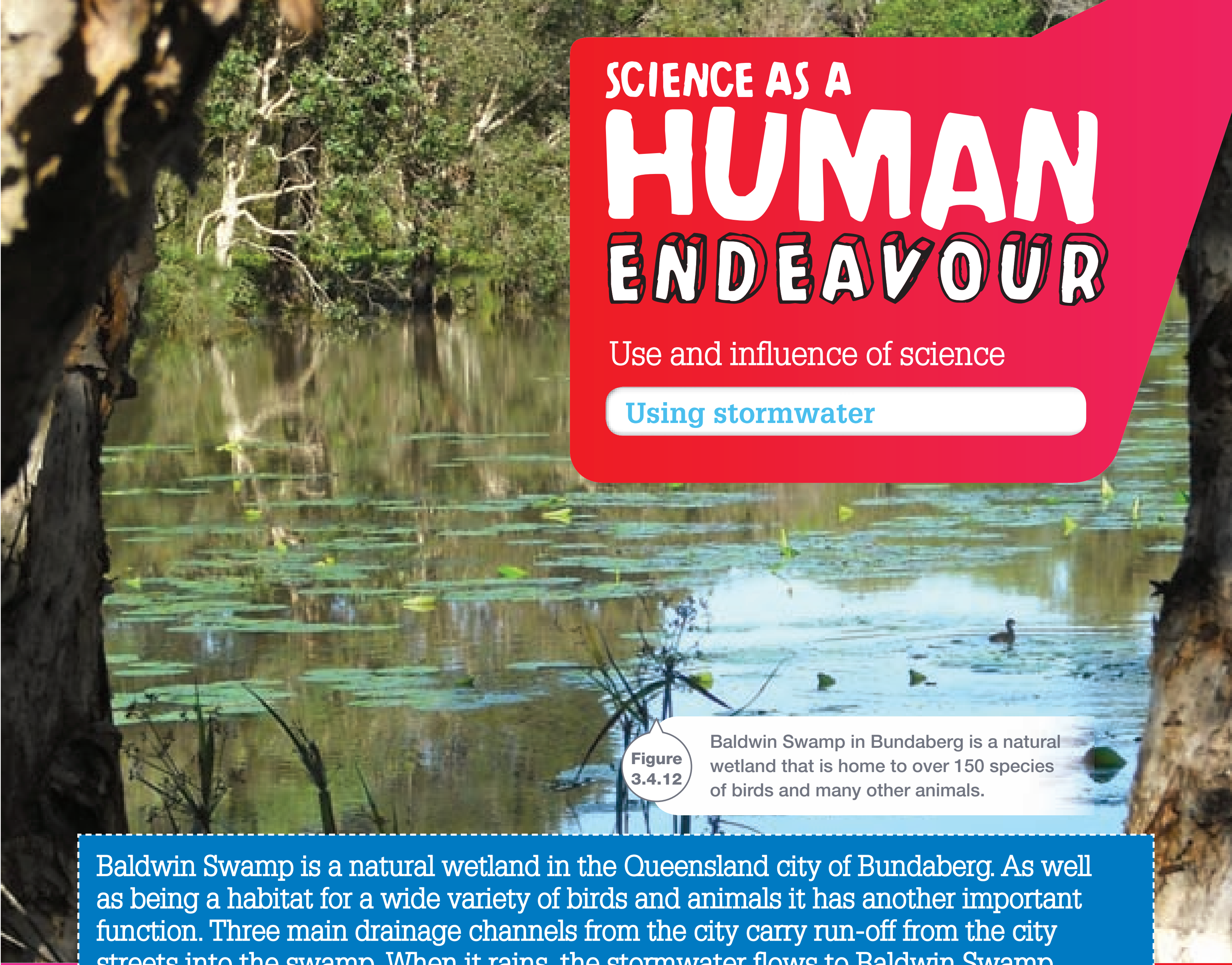

Figure 3.4.12 Baldwin Swamp in Bundaberg is a natural wetland that is home to over 150 species of birds and many other animals.

Baldwin Swamp is a natural wetland in the Queensland city of Bundaberg. As well as being a habitat for a wide variety of birds and animals it has another important function. Three main drainage channels from the city carry run-off from the city streets into the swamp. When it rains, the stormwater flows to Baldwin Swamp, carrying with it rubbish and pollutants. The rubbish has to be collected by City Council workers. Natural processes in the wetland absorb pollutants from water and improve the quality of the water before it flows out into the river and ocean.

The ability of wetlands to clean water has been used by city councils and land developers in a variety of ways.

On a big scale

Albert Park Lake in Melbourne (shown in Figure 3.4.13 on page 108) is visited by over 6 million people each year and is popular for sailing and rowing. In dry periods water levels in the lake decrease and people cannot sail or row on it. Up until 2005 water from the City of Melbourne's drinking water supplies was used to top up the level of the lake. This used up to 200 million litres of drinking water each year.

In 2005 the Victorian Government established a system that used stormwater to replenish the lake. Because stormwater is a major source of pollution for rivers and lakes, pollution control ponds had to be built as part of the system. This system has allowed the lake to continue to be used for sailing, and for model yacht and rowing clubs.

Rain gardens

Rain gardens are a much smaller scale way of dealing with stormwater. Figure 3.4.14 on page 108 shows how rain gardens slow down the rate of flow and clean pollution from the stormwater before it enters creeks and rivers.

Figure 3.4.13 Albert Park Lake is a popular place to go sailing and rowing.

Stormwater is channelled into the rain garden bed. In the garden bed is a layer of sand that filters the water. The filtered water is similar in quality to the water in undisturbed streams. It is not drinking quality but it is suitable for irrigation.

Rain gardens can be landscaped into suburban gardens as well as city parks, school yards and large nature strips that divide freeways. Figure 3.4.15 shows a rain garden in action.

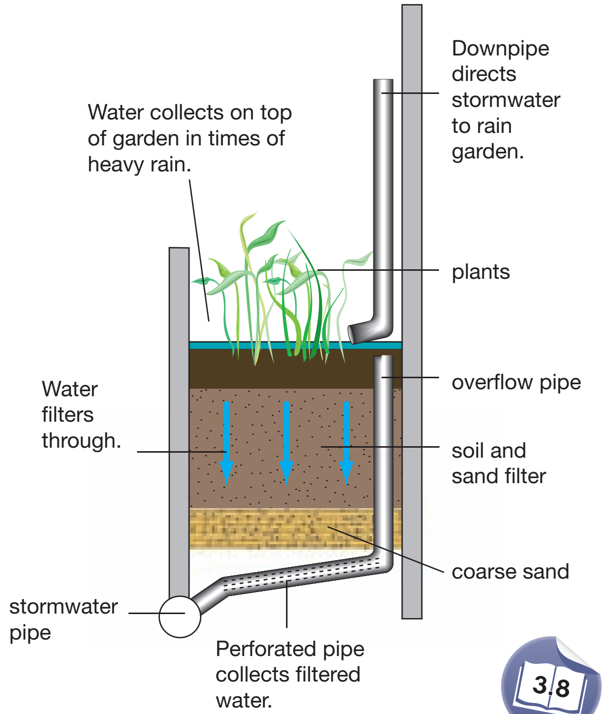

Figure 3.4.14 A rain garden cleans stormwater before it enters creeks and rivers.

Figure 3.4.15 Rain gardens are attractive to look at and they also serve a very useful function.

Rain gardens are currently being built at a new housing estate near Caloundra on Queensland's Sunshine Coast. Here the rain gardens are called biopods. The stormwater in this estate is channelled towards a network of biopods, in which the water is collected. Small trees and other smaller plants growing in the biopods filter the water. The water does not flow out of the biopods to a river or creek but is stored and used later to water gardens. In the newest parts of the housing estate there is a biopod on each street corner.

3.4 Unit review

Remembering

1 **Recall** two observations Indigenous Australians use to help them find water sources.

2 **List** three ways that human actions change the water cycle.

3 **Name** two types of irrigation.

Understanding

4 **Explain** why dams are built near large cities.

5 **Explain** how a dam interrupts the water cycle.

6 At the end of winter the snow in the Snowy Mountains melts and the water flows into streams and rivers.
   a **Describe** what would have happened to that water before the Snowy River Scheme was built.
   b **Describe** what happens to the water from the Snowy Mountains now.
   c **Describe** the benefits that have resulted from the Snowy River Scheme.
   d **Describe** any disadvantages the scheme may have brought to the environment.

7 **Describe** two ways that run-off from cities is being reduced.

Applying

8 Figure 3.4.16 represents an area where part of a forest has been cut down. **Apply** your understanding of the water cycle to **explain**:
   a how and why the humidity of the air at points A and B would be different
   b how and why the rate of flow of water over the surface at points C and D would be different.

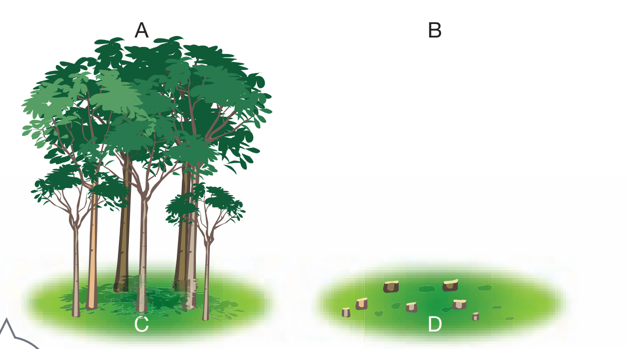

Figure 3.4.16

Analysing

9 **Compare** spray irrigation and flood irrigation by focusing on the effect they have on the water cycle.

10 **Compare** spray irrigation and a natural shower of rain.

Evaluating

11 A severe storm passes over Darwin.
   a **Explain** what happens to the rain that falls on the city.
   b **Deduce** what would have happened to the rain before the city was built.

12 Figure 3.4.17 shows a valley that has been flooded by the construction of a dam. **Deduce** the major change that the presence of the dam will have on the water cycle in that area.

Figure 3.4.17

Creating

13 Imagine a city block in the middle of a large city such as Sydney or Melbourne. **Construct** a diagram of the water cycle for that city block.

14 **Design** a project that would reduce the run-off from your school grounds and would make better use of stormwater.

Inquiring

1. Research the Aboriginal Dreamtime story of the Rainbow Serpent and find out how it relates to the current scientific understanding of the Great Artesian Basin.
2. Research any projects in your area that are designed to reduce the amount of stormwater flowing directly to rivers and oceans.
3. The construction of the Snowy River Scheme reduced the flow of water in the Snowy River by 99%. Research the effects the loss of water had on the environment of the river. Find out if there are any plans to address these effects.
4. The Aswan High Dam (shown in Figure 3.4.18) was built on the river Nile in Egypt between 1960 and 1970. Research the dam and answer the following questions.
   - **a** Identify the reasons for the dam being built.
   - **b** Compare the flow of the river before and after the dam was built.
   - **c** Describe the effect that any changes have had on the environment downstream of the dam.

Figure 3.4.18 Aswan High Dam, Egypt

3.4 Practical activities

1 Water from leaves

Purpose

To investigate water loss from leaves.

Materials

- plastic bag approximately the size of an A4 piece of paper
- string
- access to trees with low branches
- marker pen
- 100 mL measuring cylinder

Procedure

1. Write your name on the plastic bag.
2. Select a twig on your tree that has healthy-looking leaves.
3. Carefully place your bag over the twig so that a number of leaves are enclosed as in Figure 3.4.19. The twig should still be attached to the tree.

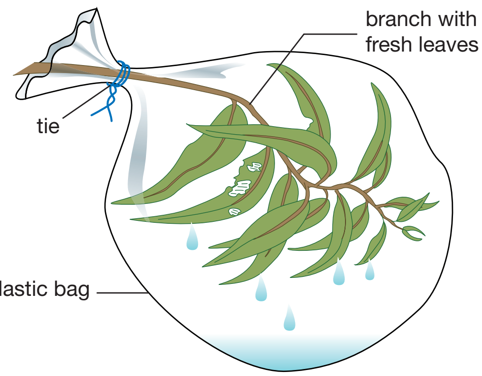

Figure 3.4.19

4. Use the string to tie the bag on tightly.
5. Leave the bag in place for 24 hours.

Results

1. After 24 hours remove the bag from the twig. Be careful not to lose any of the water.
2. Carefully pour the water into the measuring cylinder.
3. Record the amount of water collected.

Discussion

1. **Explain** how the water got into the bag.
2. **Deduce** how the humidity inside the bag would have changed during the 24 hours of the experiment.
3. **Propose** how this change in humidity could have affected the amount of water collected.
4. **Demonstrate** how the information you have collected relates to the water cycle.

3.4 Practical activities

2 Run off or soak in?

Purpose

To observe the percolation of water through different surfaces.

Materials

- 3 × 250 mL beakers or other transparent containers
- quantity of very fine gravel to half fill the beaker
- quantity of sand to half fill the beaker
- quantity of clay soil to half fill the beaker
- 100 mL measuring cylinder
- water
- marker pen

Procedure

1. Label the three beakers: *gravel*, *sand* and *clay*.
2. Fill the gravel beaker with gravel until it is half full. Gently tap the side of the beaker to settle the contents. Add more gravel if necessary.
3. Fill the sand beaker with sand in the same way.
4. Add some clay soil to the clay beaker and push it down firmly. Add more clay soil and push it down again. Repeat this process until the beaker is half full.
5. Measure 100 mL of water and pour it onto the top of the gravel beaker. Pour it over the whole surface, not just in one place. Observe what happens for five minutes.
6. Repeat Step 5 for the other two beakers.

Results

1. Record your observations of the way the water percolates through the three different materials.
2. Record whether any of the materials had water lying on the top after five minutes.

Discussion

1. **Propose** why it was necessary to push the clay soil down firmly instead of just tapping the side of the beaker.
2. **Identify** the material through which percolation occurred most quickly.
3. **Identify** the material through which percolation occurred most slowly.
4. **Explain** why the different rates of percolation occurred.
5. a **Identify** the material from which run-off was most likely to occur.
   b **Justify** your response.