WEATHER

WATER

# SCHOOLS FOR A HEALTHY ENVIRONMENT

WASTE

ENERGY

Educational Development Centre

unicef

# 1. ABOUT THE FLIP CHART:

This Flip Chart is designed to be used by teachers and facilitators during relevant school and/or Environment Club activities.

The Flip Chart consists of 4 sections: 1. Weather, 2. Water, 3. Waste, 4. Energy. Each section contains background information which should be read out to students. The sections also include activities relevant to that topic. There are suggested times allocated to each activity to help you plan the lesson.

- On the front of each page is the illustration, visible so the students can find a context for the discussion. The front of the page also contains diagrams for the activities.
- On the back of the pages is a BACKGROUND FOR TEACHERS, which provides you with information to support the lesson. You may want to use some of the facts in your discussion. Also on the back of the pages are the discussion points which you should read out to stimulate class discussion.

## KEY

To make teaching easier, each page has a key based on the following elements:

This refers to discussion points that should be read out and discussed with students

This icon refers to information that needs to be recorded in the student's notebook

Refers to handouts that should be given to students

Observations that students can make continuously in and outside of school time

# 2. BEFORE YOU START:

- Before the class, the teacher should read and familiarize themselves with the Flip Chart.
- Ensure you have all the materials you need to conduct the lesson.
- Organise the students around the Flip Chart, ideally seated in a semi circle. Ensure they all can see the Flip Chart clearly.

# 3. DURING THE CLASS:

- Allow the students time to look at the picture page, and then share some of the relevant theory with the group.
- Make the activity as enjoyable and practical as possible – students remember more when they feel happy.
- Try to get everyone to participate. If they are observing in one activity ensure they are more actively involved in the next activity.

Developed for Educational Development Centre,
Ministry of Education, Republic of Maldives by:

LIVE&LEARN
Environmental Education

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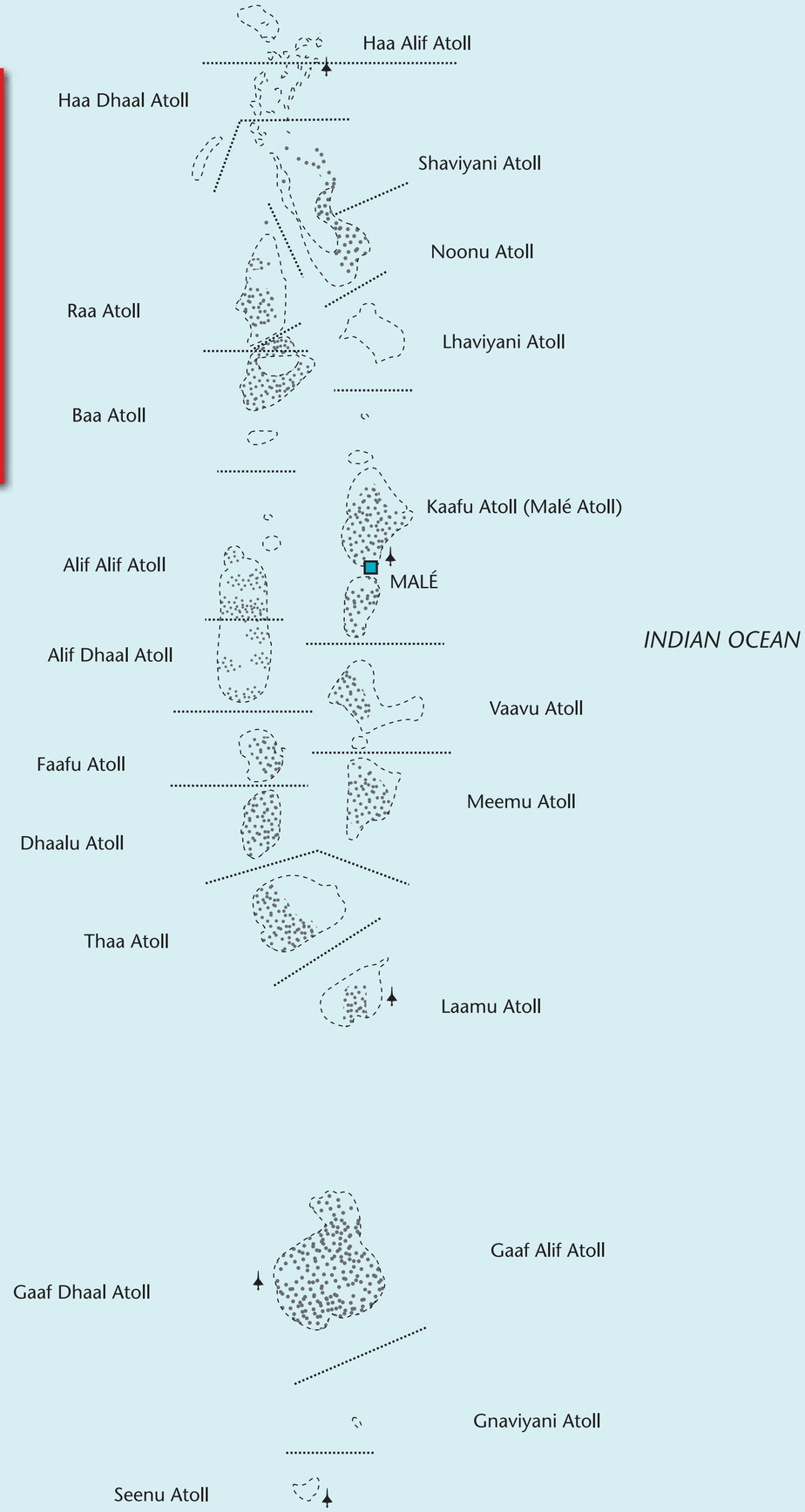
ARABIAN SEA

# THE MALDIVES

- There are approximately 1190 islands in the Maldives with some form of vegetation on them.
- Approximately 200 are inhabited islands.
- Approximately 990 are uninhabited.
- There are 26 distinct geographical atolls. The 26 atolls are divided into 20 administrative regions, with the capital Male' making up a separate administrative unit.
- The Maldives is 860km long and 130km wide.
- Thuraakunu in Haa Alif atoll is the most northerly island, Gan is the most southerly island in Seenu atoll.
- More than 99% of the country is water (115,000km$^2$) with less than 0.3% land (300km$^2$).




INDIAN OCEAN

30minutes

# WEATHER THEORY

Weather is the general term given to the changing conditions of the Earth's atmosphere. It is affected by many factors including temperature, rain, air pressure, humidity, hours of sunshine, types of clouds, and amount of cloud cover. The main factor that allows the earth to have various weather conditions is the sun. The heat of the sun affects the atmosphere to create weather; for instance, heat from the sun causes water to evaporate, which can produce rain. The following activities will help you to better understand the weather by monitoring some of the key factors that affect the weather. It is important that the measurements are taken at about the same time each day so that they can be compared. As such, timing is one of the first things to decide.

## SEASON

Maldives is an equatorial country and does not experience major seasonal differences. However, the early Maldivians carefully studied the patterns of weather and climate which is unique to this equatorial nation. Through their observations and recordings they related these patterns to the movements of the sun during a year. Based on this knowledge, the *Nakaiy* (constellations of stars) calendar was developed by our forefathers to cater for the Maldivian lifestyle. Hence, the Maldives experiences a tropical, monsoon climate with warm temperatures year round and a great deal of sunshine. There are two distinct seasons – the wet (Hulhan'gu or south- west monsoon) and the dry (Iruvai or north-east monsoon).

The wet season runs from May to November. There are 18 'Nakaiy' in this season. It is the wettest period when moderate to rough seas and cloudy days are more common. Frequent gale force winds from the south-west with an average speed of 11-15 Knots[1] per hour occur, and wind gusts of 35-45 Knots and above are occasionally recorded. September and October can be calmer and November is again a transitional period with variable winds swinging towards the north-east. The effects of cyclones from the Arabian Sea can be experienced during the south-west monsoon. The north-east monsoon gradually travels down the Maldives from the north and is ushered in by a fortnight of very strong winds from the north-east with heavy rain squalls. The dry season runs from December to mid-April due to the Northeast monsoon. There are 9 'Nakaiy' in this season. This is the driest period, when hot days, cooler nights and calm seas are more common. There is generally little cloud cover except in the south. Frequent light winds from the north-east and variable sea breezes with an average of 9 Knots are experienced. The transitional period between monsoons begins in April and calm, windless days are more likely to be experienced than any other time of the year. A fortnight of strong winds and rain from the south-west usually ushers in the change of the new season and occasionally the tail end of cyclones from the Bay of Bengal can be felt. By the end of May the winds are predominantly west-south-west.

## STORMS – THUNDER AND LIGHTNING

These two always go hand in hand. Lightning is a massive electrical discharge between one cloud and another, from a cloud into the air, or between a cloud and the ground. Only about one in five lightning strikes are from cloud to ground. The delay between when you see lightning and when you hear thunder occurs because sound travels much more slowly than light. Sound travels through air at about 330-350 metres per second (one kilometre per three seconds). This forms the basis for a rule that we can use to estimate our distance from the lightning (ground stroke).

Next time there is a storm, count the seconds between a flash of lightning and the thunder - every second indicates a distance of about 330 metres. Therefore, a pause of three seconds means that the lightning hit about 1 km away. Seek shelter immediately if a storm is approaching. But do not rest under large trees, as trees are sometimes hit by lightning as they are the highest point on the landscape.

Reference: A Riyaz Jauhary, A I Chamberlain (1998) '*Understanding Fisheries Science 1*' Educational Development Center, Ministry of Education, Republic of Maldives

1. Knot is a unit of speed. 1 Knot = 1 nautical mile per hour = 1.852 kilometres per hour.

## HUMAN EFFECTS ON WEATHER

Our modern life and growth in global population are causing a huge increase in the world's use of energy. Much of the energy we use to power our cars and boats, produce electricity and manufacture products comes from fossil fuels (e.g. oil, coal, diesel, natural gas). When burned, these fossil fuels add large amounts of greenhouse gases, especially carbon dioxide, to the atmosphere. Many scientists believe that the addition of greenhouse gases from human sources is throwing our atmosphere and the natural greenhouse effect out of balance. It would appear that the atmosphere is trapping too much heat and causing the Earth to heat up. This is known as global warming.

Plants help in the absorption of carbon dioxide and they produce oxygen. Some countries are planting extra trees to compensate for the increase in carbon emissions (e.g. recently, the 'two million plants' campaign was carried out in the Maldives). Scientists have identified that our health, agriculture, water resources, plants, wildlife and coastal areas are vulnerable to the changes that global warming may bring. But projecting what the exact impacts will be over the next century remains very difficult. There is the possibility that a warmer world could lead to more frequent and intense storms, including cyclones. Preliminary evidence suggests that, once cyclones form, they will be stronger if the oceans are warmer due to global warming.

## IMPACT OF SEASONS ON FISHING

Different activities related to fishing would be carried out at certain times of the year depending on the *Nakaiy*. For instance *Fura-badhuruva* and *Fas-badhuruva* of Iruvai season are considered to be two good *Nakais'* for fishing. The main reason behind this is that as mentioned above, the wet (southwest) monsoon has high rainfall and rough seas which could be dangerous for sail *dhoanis* to venture out. However, mechanized *dhoanis* can withdraw if the winds are not too strong. The number of reef fish, including bait fish, depends on the productivity of the reef. If the environmental conditions are favourable the fish stocks will increase and the productivity is said to be higher. Productivity depends largely upon the timing of the monsoons. Rough weather associated with the start of the southwest monsoon also affects the distribution of tuna stocks. This is important because it may be difficult for fishermen to find tuna.

## DISCUSSION POINTS

A. Why is weather important (temperature, wind, rain)?

B. What are the effects of bad weather?

C. What are your local seasons? Why is knowledge about seasons important to us?

D. Can human activities affect weather? How?

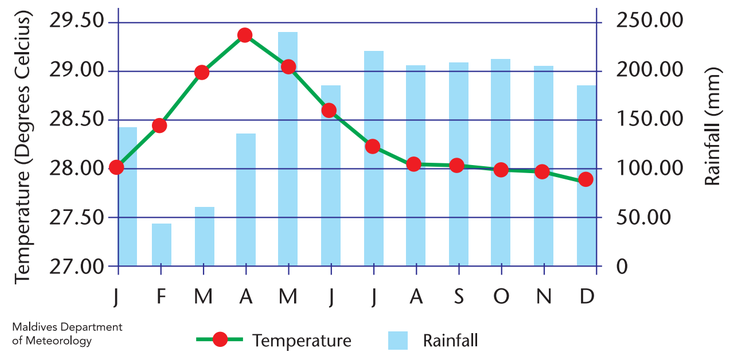
## Nakaiy Calendar

| DATE | NAKAIY | FISHING | WEATHER |
|---|---|---|---|
| **SOUTH-WEST MONSOON – HULHAN'GU MOOSUN** | | | |
| 08 April<br>21 April | Assidha. | Poor. Usually sharks are caught. | Dry and hot. Very little rain. South-west monsoon starts. |
| 22 April<br>05 May | Burunu. | Poor. | Rather dry and stormy with rough seas. |
| 06 May<br>19 May | Kethi | Poor. | Dry with very little rain. Seven storms occur. |
| 20 May<br>02 June | Roanu | Mainly Kawakawa. | Stormy with heavy rain, strong winds and rough seas. |
| 03 June<br>16 June | Miahelia | Poor. | Stormy with rough seas. Not suitable for travelling. |
| 17 June<br>30 June | Adha | Good. Large schools of fish are found. | Calm seas with little rain. Wind blowing from south-west. |
| 01 July<br>14 July | Funoas | Average. | Little rain with strong winds and rough seas. Not suitable for travelling. |
| 15 July<br>28 July | Fus | Good. Schools are very close to coast. | Cloudy with a lot of rain. |
| 29 July<br>10 Aug. | Ahuliha | Good. Schools move away from coast. | Calm and dry with a lot of sunshine. |
| 11 Aug.<br>23 Aug. | Maa | Possible, if no rain. | Generally calm with a lot of rain. |
| 24 Aug.<br>06 Sept. | Fura | Average. Schools are far from coast. | Rainy season ends. Wind starts to blow from north-west. |
| 07 Sept.<br>20 Sept. | Uthura | Average. | Seas are generally calm with very little rain. |
| 21 Sept.<br>03 Oct. | Atha | Good. Schools move closer to coast. | Calm seas accompanied with small storms and a westerly wind. |
| 04 Oct.<br>17 Oct. | Hitha | Average. Schools are seen closer to the coast. | Isolated showers with weak westerly winds. |
| 18 Oct.<br>31 Oct. | Hei | Good. Fish caught are usually large. | Lots of rain with winds generally blowing from west. |
| 01 Nov.<br>13 Nov. | Vihaa | Good. | Calm seas with some rain. |
| 14 Nov.<br>26 Nov. | Nora | Good. Season begins in the north. | Wind blowing from north-west. Currents change to north-east. |
| 27 Nov.<br>09 Dec. | Dhosha | Good. Season begins in the south. | Calm with rain and sunshine. |
| **NORTH-EAST MONSOON – IRUVAI MOOSUN** | | | |
| 10 Dec.<br>22 Dec. | Mula | Good. Live bait is abundant in the north. | Strong winds with rough seas. Wind blows from north-east. |
| 23 Dec.<br>05 Jan. | Furahalha | Good in the north of Maldives. | Strong winds with rough seas. |
| 06 Jan.<br>18 Jan. | Uthura-halha | Average. | Strong winds with rough seas. |
| 19 Jan.<br>31 Jan. | Huvan | Good. Mainly in the east of Maldives. | Rough seas with moderate winds from north-east. |
| 01 Feb.<br>13 Feb. | Dhinasha | Good for shark fishing. | Moderate seas with little blowing. |
| 14 Feb.<br>26 Feb. | Hiyavihaa | Good. Schools closer to the coasts. | Calm seas with little rain. Wind blowing from south-west. |
| 27 Feb.<br>11 Mar. | Fura-badhuruva | Very good. | Small storms accompanied with thunder and lightning. |
| 12 Mar.<br>25 Mar. | Fas-badhuruva | Very good. | Storm on the 3rd or 4th day with moderate winds and thunder. |
| 26 Mar.<br>07 April | Reyva | Good. Mainly in the north of Maldives. | Stormy with gusts of wind from north-west. |

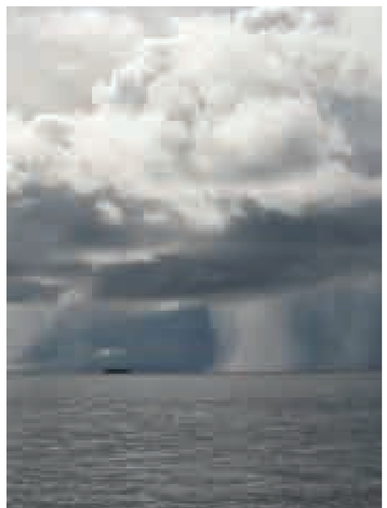
# WEATHER THEORY

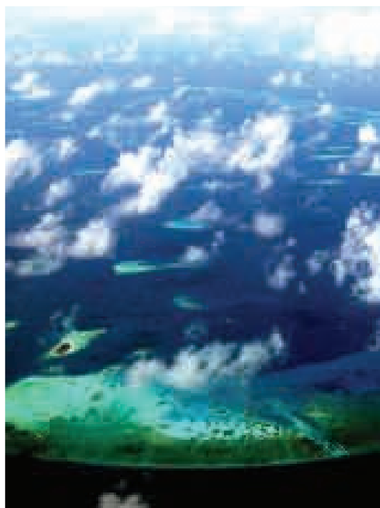
The main factor that allows the Earth to have various weather conditions is the sun.


MONTHLY AVERAGE TEMPERATURE AND RAINFALL




Maldives Department of Meteorology





# WEATHER MONITORING

20 minutes

## SETTING UP THE WEATHER MONITORING STATION

When setting up your weather monitoring station it is very important to consider the following:

1. Place in an open location, so wind and rain can be accurately measured,
2. Align the directions North, South, East and West using a compass,
3. Place it in a secure place so it would not be stolen.

**Note:** For weather activities it is best to try to record the data on a daily basis but if this is not possible then as often as possible. It is also important to collect the information at the same time each day – if you collect temperature readings at 7.30am one day and then 11am the next you will definitely see a difference but it will not help you monitor the local weather over a period of time. It may be useful to have at least two volunteers for each daily reading. The data obtained from the following activities should be recorded daily. This data should be recorded on individual charts for temperature, wind, rainfall and cloud formations. A summary of all this data should then be transferred to the 'Weather Monitoring Chart' on the wall of the classroom, so the whole class can see the daily results and become involved. This will help to keep the class interested. Teachers should prepare a large chart using the format of a 'Weather monitoring Chart' from the 'Weather' section of the Earth Module.

The activities on this page encourage the students to:

1. Observe weather, 2. Measure weather, 3. Record weather, 4. Analyze data, 5. Make graphs to show longer term trends, and 6. Display in class.

Students may want to consider sharing their weather monitoring results with another school in another atoll, to see differences in weather conditions in the Maldives.

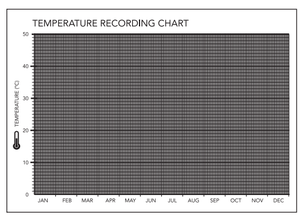
10 minutes then ongoing

## ACTIVITY 1 TEMPERATURE

**Materials:** Thermometer and temperature recording chart (refer to Student Resource Sheet in the 'Weather' section of the Earth Module).

**Action:** As a group get students to check the thermometer and write down the temperature at the same time each day/week. (The teacher should nominate 2 students to do this for a week or more). Record the daily temperature on a graph (*see sample below*) and transfer this data to the graph on the classroom wall. Are the days getting hotter or colder?

**Theory:** When the sun is closer it can heat up the Earth more. Factors such as cloud cover or forest cover can influence the temperature. Large areas of water tend to moderate changes in temperature as water is slower to change temperature than air.




10 minutes then ongoing

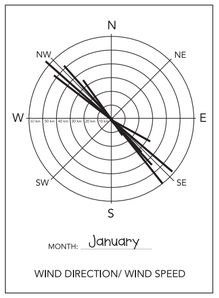
## ACTIVITY 2 WIND

**Materials:** Wind vane, compass and weather monitoring chart (refer to Student Resource Sheet in the 'Weather' section of the Earth Module).

**Action:** Write down the direction and strength of the wind at the same time each day (nominate 2 students to do this for a week or more) and transfer this data to the graph on the classroom wall. When the wind vane is pointing South it means that the wind is coming from the North. Graph the results each month. Is the wind coming from the same direction? Is it getting windy more or less often?

**Theory:** Heat from the sun warms the air, which rises and creates areas of low pressure. Wind is the movement of air from high-pressure areas to low-pressure areas in the atmosphere.

**Note:** It may be helpful to mark out the major compass bearings on the ground, below the weather station, to give the students an easily recognizable sense of direction. e.g. N, S, E, W, SE, SW, NE, NW



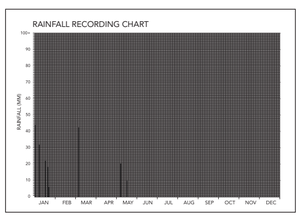

5 minutes then ongoing

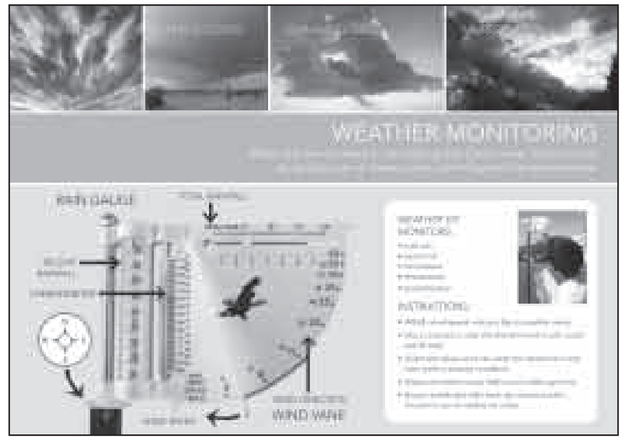
## ACTIVITY 3 RAINFALL

**Materials:** Rain gauge and rainfall recording chart (refer to Student Resource Sheet in the the 'Weather' section of the Earth Module) (*see sample below*).

**Action:** Use the rain gauge to measure the amount of rain each day. (The teacher should nominate a student to do this for a week or more). After measuring, empty the vessel. When the water is less than 10mm then you need to estimate. If the container is already full then note the amount and add a + sign. Record the information on the rainfall recording chart and transfer this data to the graph on the classroom wall. Are you getting more or less rain?

**Theory:** Heat from the sun causes water to evaporate. Transpiration is the movement of water from the ground through the plant roots up into the leaves and out to the air. The moisture in the air, from evaporation and transpiration, accumulates in the atmosphere and can produce rain.



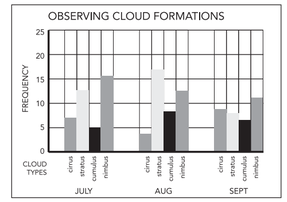

5–10 minutes then ongoing

## ACTIVITY 4 OBSERVING CLOUD FORMATIONS

**Materials:** Weather monitoring chart (refer to Student Resource Sheet in the 'Weather' section of the Earth Module).

**Action:** Observe the sky. What kinds of clouds are present – what do they look like? How high are they in the sky? What shape are they? Record the type of clouds on the weather monitoring chart. Do some clouds link to different weather such as rain or wind? At the end of the month, the data on cloud types can be graphed (*see sample below*).

**Theory:** Clouds are produced when moist air is cooled. They are a visual indicator of moisture cooling in the air: literally clouds are made up of very small liquid droplets. There is a large variety of cloud groups, which are broken into three primary groups depending on where they are in the sky: high clouds, middle clouds and low clouds. The clouds are further defined by their appearances – cumulus clouds have a bubbly appearance, cirrus clouds have a wispy appearance, stratus is sheet-like and nimbus clouds are rain bearing.




Monthly

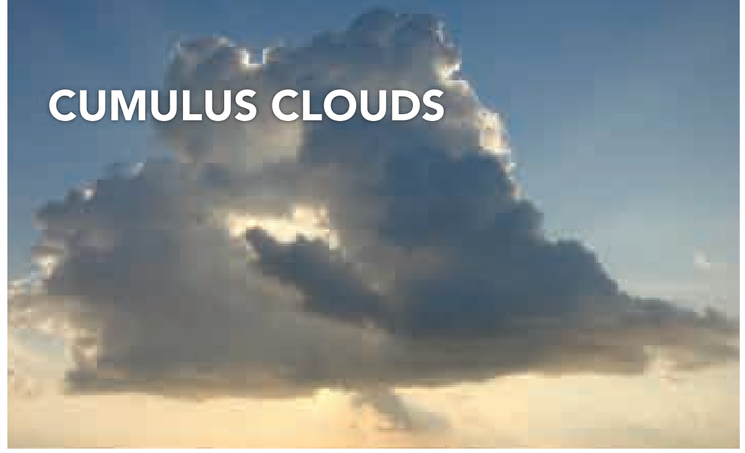
## ACTIVITY 5 SEASONS

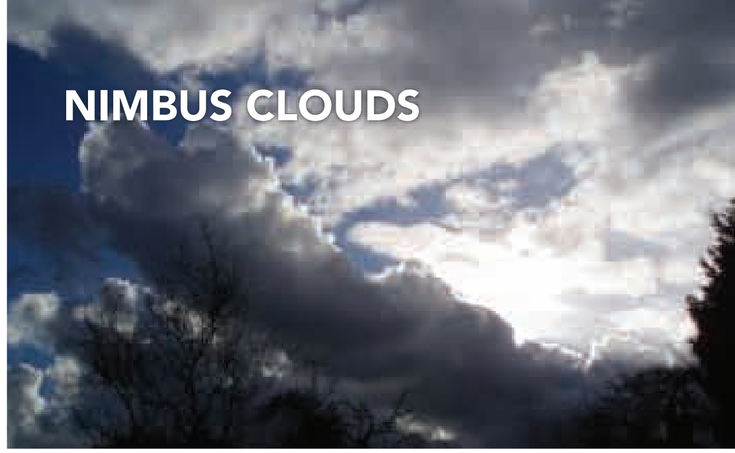
**Materials:** Weather monitoring chart and graphs

**Action:** Compare the graphs from rainfall, temperature, wind, and cloud cover over a few months. Observe patterns between the graphs. Observe seasonal patterns over time.

**Theory:** Clouds, temperature, wind and rainfall all relate to each other, each one affecting the other. By observing the patterns, weather can be predicted and climate defined. Seasons are defined by the weather patterns. Seasons vary based upon the location on the Earth. All areas have seasons but areas that are further from the equator have greater changes in seasons.






# WEATHER MONITORING

When the sun is closer it can heat up the Earth more. Factors such as cloud cover or forest cover can influence the temperature.

RAIN GAUGE

TOTAL RAINFALL

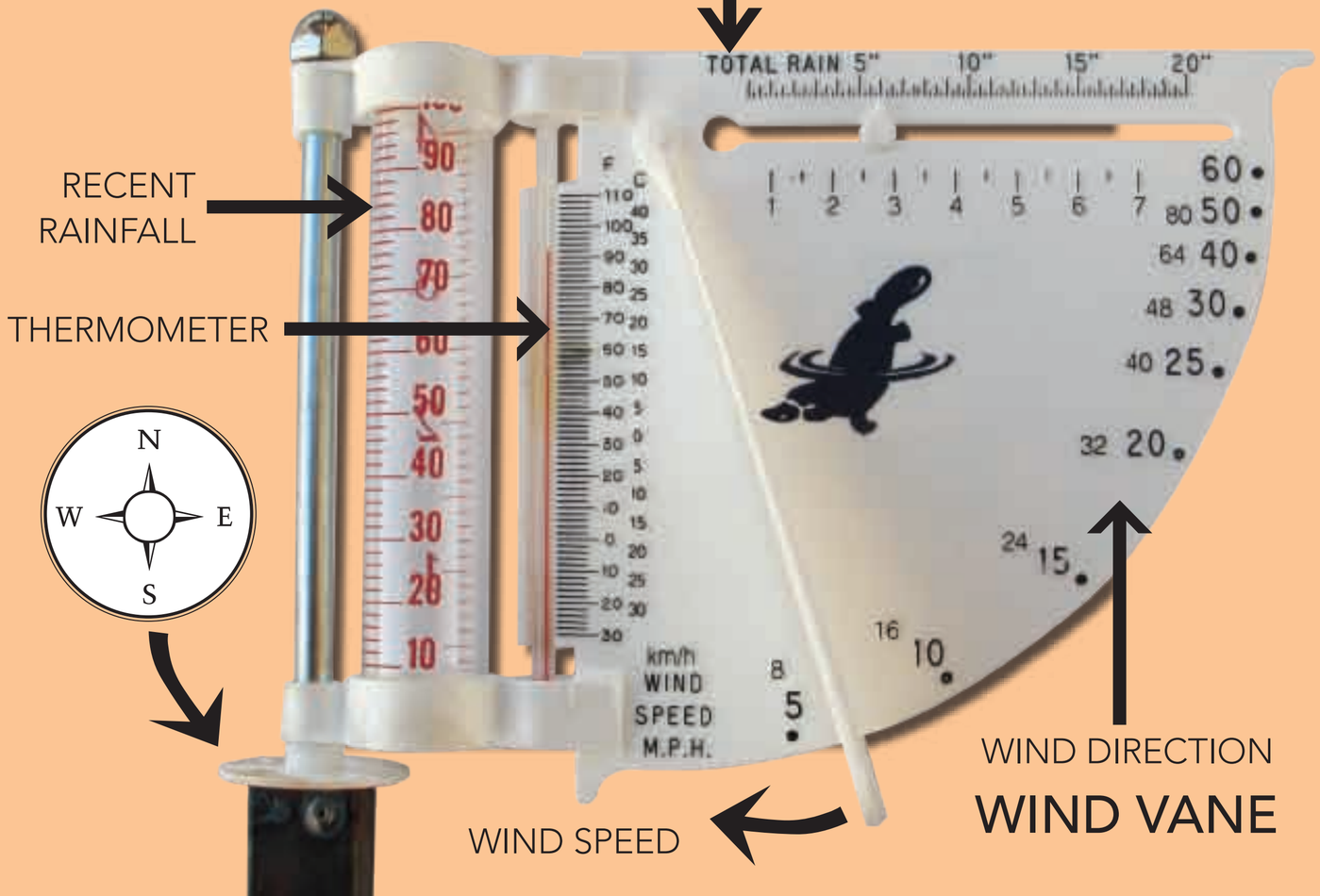
RECENT RAINFALL

THERMOMETER

WIND SPEED

WIND DIRECTION

**WIND VANE**




## WEATHER KIT MONITORS:

- total rain
- recent rain
- wind speed
- temperature
- wind direction

## INSTRUCTIONS:

- Attach wind-speed indicator flap to weather meter
- Use a compass to align the directions with north, south, east and west
- Select site where wind can reach the meter but is safe from theft or adverse conditions
- Make sure meter swings freely and is within eye level
- Empty rainfall tube after each rain and record the amount of rain on sliding rain scale

30 minutes

# WATER CYCLE THEORY

## WATER CYCLE THEORY

Water is one of the most basic of human needs. Without water, life could not exist. It is the most valuable resource on Earth. Earth's water is always in movement, and the water cycle, also known as the hydrologic cycle, describes the continuous movement of water on, above, and below the surface of the Earth. Since the water cycle is truly a "cycle," there is no beginning or end. Water can change state among liquid, vapor, and ice at various places in the water cycle, with these processes happening in the blink of an eye and over millions of years. Rain water that soaks into the ground, runs off the land and flows into streams, rivers, lakes, ponds or into the sea. The sea, oceans or other surface waters are heated by the sun and water (vapour) rises up into the atmosphere to form clouds. When it rains again the process starts all over again. As shown in the illustration, the water cycle consists of the following:

### 1. TRANSPIRATION

Plants draw water in at the roots where it moves up to the leaves and then evaporates. This process is called transpiration and is responsible for much of the water that enters the atmosphere. If plants are removed, particularly trees, then this part of the water cycle is disrupted, there is less transpiration and therefore less rain.

### 2. EVAPORATION

Energy supplied by the sun helps water to rise up (evaporate) from water surfaces such as lakes, seas and oceans, into the atmosphere. (Note that rainwater is always fresh and not salty)

### 3. CONDENSATION AND RAIN

These drops of water in the atmosphere form (condense) into clouds. The sun also provides the energy which drives the weather systems to move the water vapor (clouds) inland (otherwise, it would only rain over the oceans). Once water condenses, it gets heavier, gravity takes over and the water is pulled to the ground as rain water.

### 4. RUNOFF AND INFILTRATION

Rain water runs off the land and flows into oceans, lakes and rivers. Rainwater can also soak into the soil, subsoil and rock to become groundwater. The water moves down into the ground because of gravity, passing between particles of soil, sand, gravel, or rock until it reaches impervious rock. This area becomes filled, or saturated with water. This ground water may be very near the ground's surface or it may be hundreds of feet below. Wells that are sunk in the ground tap into this groundwater, or sometimes groundwater makes its way to the surface and forms a spring.

### 5. GROUNDWATER

Most groundwater is clean, but it can become polluted, or contaminated. It can become polluted from sewage, or when people apply too much fertilizer or pesticides to their fields. When pollutants leak, spill, or are carelessly dumped on the ground they can move through the soil to contaminate the water. Because groundwater is deep in the ground, groundwater pollution is generally difficult and expensive to clean up. Sometimes people have to find new places to dig a well because their own becomes contaminated.

### 6. STORAGE

Huge quantities of water are stored in rivers, oceans, lakes and glaciers.

### WATER FACTS

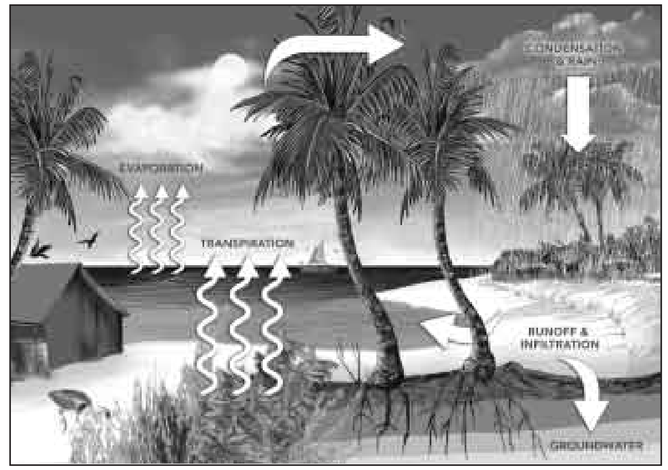
- Water covers 75% of the Earths surface, so we really are a water planet.
- Over 97% of Earth's water is salt water.
- 2% is stored in glaciers and icecaps.
- 1% of the Earth's water is freshwater stored in groundwater or surface water.

## WATER IN THE MALDIVES

The Maldives is a unique island nation surrounded by the Indian Ocean and wherever we look we see water. But ironically, the Maldives has very limited freshwater resources that can be used to sustain human life.

Traditionally Maldivians have relied on rain water and the thin and fragile layer of freshwater that forms a 'freshwater lens' just beneath the ground. Heavy rains may occur during our monsoon periods, but the amount of rain is unpredictable, and the wet times are separated by months of dry weather, limiting the amount of rainwater available. The freshwater lens is accessed through the many wells that we have created. However the freshwater lens is thin and highly at risk to pollution that can seep in through our sandy soils. If we take too much of the freshwater out of the lens it very quickly becomes salty. This is because the sea water that sits underneath it rapidly moves in to fill the space if we take too much out.

Some Islands, including Male', use *desalination*. This technology can turn dirty and salty water into clean drinkable water. Maybe it is the answer? While this water is clean, it is also very expensive and the cost raises some very important questions. Who will pay to produce this water? Can the community afford it? What are the environmental costs of this water? Is it a better alternative than looking after the water that we already have? Is it a solution for everyone?




## DISCUSSION POINTS

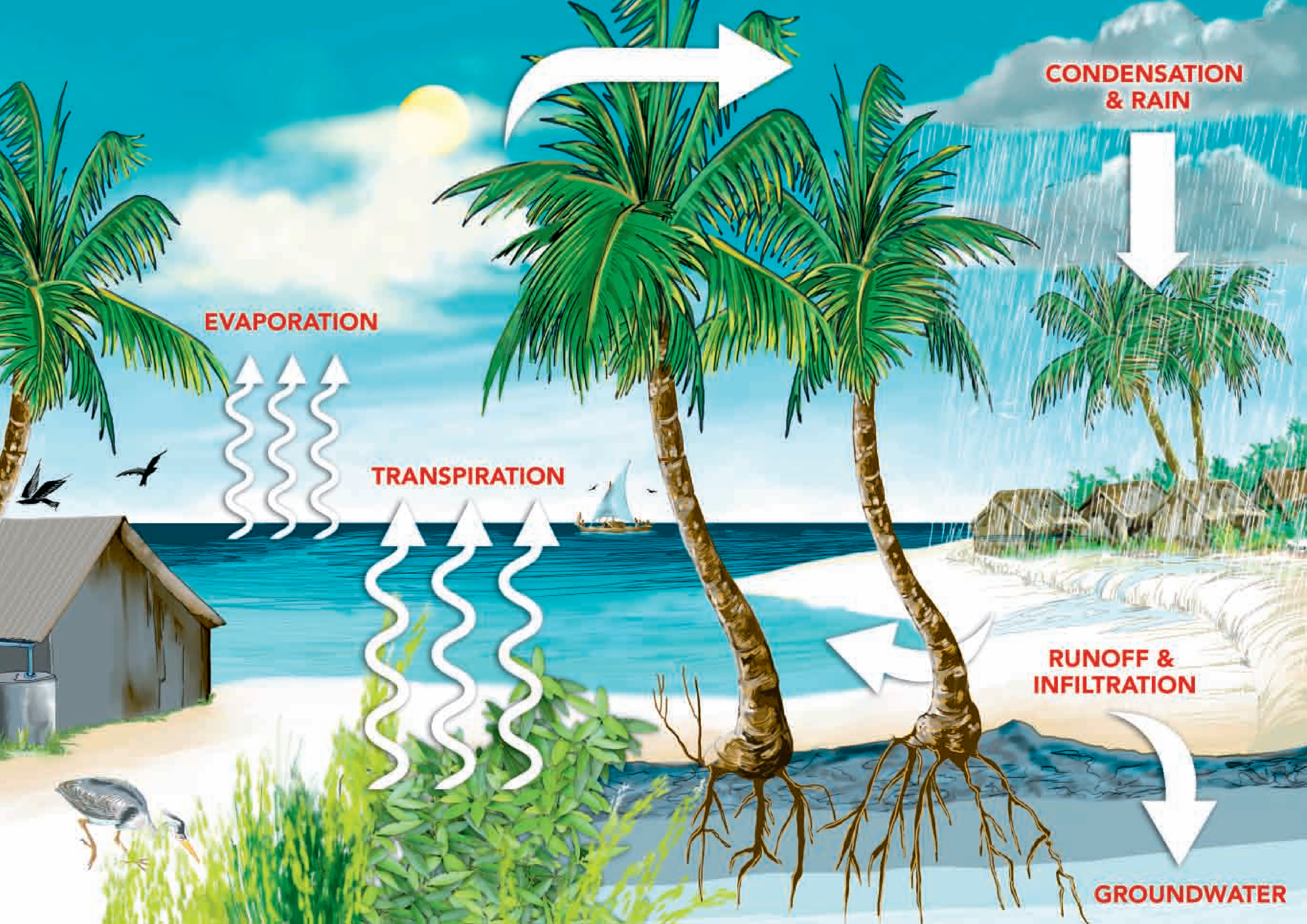
A. How much water is available in the planet?

B. How much of the water available in the planet is fresh water?

C. Why is water important for us and the planet?

D. Where does your drinking water come from?

E. Can human activities affect water quality? How?


CONDENSATION
& RAIN
EVAPORATION
TRANSPIRATION
RUNOFF &
INFILTRATION
GROUNDWATER

30 minutes

# FRESHWATER LENS

A proportion of the freshwater falling as rainfall on an island infiltrates into the sandy soils and accumulates as fresh groundwater. This freshwater, being less dense than saline seawater, floats on the saline groundwater that infiltrates the island from the sea. Because of density differences, a freshwater lens develops, which in general terms is thickest in the centre of the island, where groundwater levels are highest (compared to mean sea level).

### *Why is there fresh water in the ground?*

All small islands are surrounded by the sea which is salty. The rain which falls on the island is fresh. About a third of this rainfall will soak into the ground and infiltrate into the coral sand. This water collects in the sand and forms a body of fresh water. The freshwater is not very thick however (typically 2-7m on smaller islands) and floats on brackish water (mixture of salt water and freshwater) that is underneath it, that has entered the sand below the sea level. The infiltrated freshwater eventually flows to the sea.

### *Why does the groundwater salinity vary across the island?*

The freshwater body or lens is surrounded by the sea. The seawater also tries to get into the islands coral sand, but is pushed out by the freshwater entering from the rainfall. However the nearer you get to the coast the closer you are to the sea, and the easier it is for seawater to come into the land. At the coast there is no freshwater lens so the groundwater becomes salty. The further inland a well is located, the greater the thickness of the freshwater lens and the fresher the water.

## WELL WATER

### *i) When can I drink well water?*

The saltiness or salinity of the well water varies from well to well depending on several factors which are explained below. You can use well water for drinking if it has a salinity reading of 2,500 µS/cm. If it is more salty than this, drinking it will make you sick. You can still use the well water for non-drinking and non-cooking uses though.

### *ii) Why does my well water get more salty during the dry season?*

During the dry season the amount of rainfall is reduced and this means the amount of freshwater entering the freshwater lens is also less. This means the freshwater flows within the groundwater are less and this means that more seawater can enter the island. The freshwater lens then gets smaller. If you live towards the edge of your island, you will notice your well water getting more salty during the dry season.

### *iii) Why are Dhaani wells usually fresher than pumped wells?*

Dhaani wells tend to be fresher than pumped wells for two reasons. Firstly less water is taken from a Dhaani well than a pumped well. This means there is more freshwater left in the ground and so the lens stays fresher. The pumped well takes out more groundwater, which reduces the amount of fresh groundwater available to push out the seawater, and so pumped wells tend to be slightly more salty.

Also pumped wells lower the water level in the well more than Dhaani wells. There is a relationship between the height of the freshwater level above sea level and the amount of freshwater in the lens below sea level. Generally for every 1cm of freshwater above mean sea level there is 20cm below it. So when a pumped well lowers the water level in the well by too much, the freshwater lens thickness below the well reduces and saline water comes up and into the well. This is known as saline-up-coning. The more water you take from your well, the more likely it will become salty.

### *iv) How much water can I take before my well gets salty?*

This is a difficult question to answer. It depends where your house is located on the island, what type of abstraction method you use (Dhaani or pump), whether you put rainwater overflow water in the well, how you operate your pump (continuously or on demand), how much water your neighbours are taking, and how much of the waste water you return back into the ground. If the island has a sewerage system, the whole island may be taking out too much groundwater to the sea. In this situation groundwater may continue to get more salty. MWSA (Maldives Water and Sanitation Authority) can provide a general household guide for abstraction once they have carried out a water resources assessment of the island.

### *v) How can I make my well less salty?*

There are several simple things you can do to make your well water as fresh as possible. These are listed below:

a. Direct your rainwater tank overflow either directly into your well or into the ground next to your well. If you are not collecting all the water off your roof for rainwater harvesting then catch the rest and direct it into the well.
b. Construct your well with small holes in the side of your well wall lining below the water level. This allows very shallow fresh water to enter the well. This will be fresher than water entering the well through its base alone.
c. Use the Dhaani abstraction method in preference to the pump method.
d. Make sure your pump is of as low an abstraction rate as possible. Large pumps will provide your water more quickly but reduce the water level in the well by a greater amount too.
e. Ideally get your pump to feed a water storage tank next to your roof, and pump to it at a constant rate all day and night. The storage tank can then provide your daily supply under gravity. This will minimise the lowering of the well water level.
f. Only take the water you need. Do not waste water.
g. Put your washing water into a catch pit or trench in your household plot (but away from the well). Do not put used washing water into the septic tank or the sewer line. Washed water is freshwater (if it does not contain faeces or urine) and can recharge the freshwater lens. Putting it in the sewer line will send it into the sea and it will be lost from the island.
h. Use smaller flush tanks (small 6 litre tanks) for the toilet as less water is required for flushing than if you use a 12 litre tank.

1.5 hours

## ACTIVITY
## COMMUNITY PROBLEM SOLVING

**Materials:** A map of the island. Notebooks

**Action:** Divide the students into groups and allocate the groups to different sections of the island. In groups, students visit 4 houses in different locations of the island.

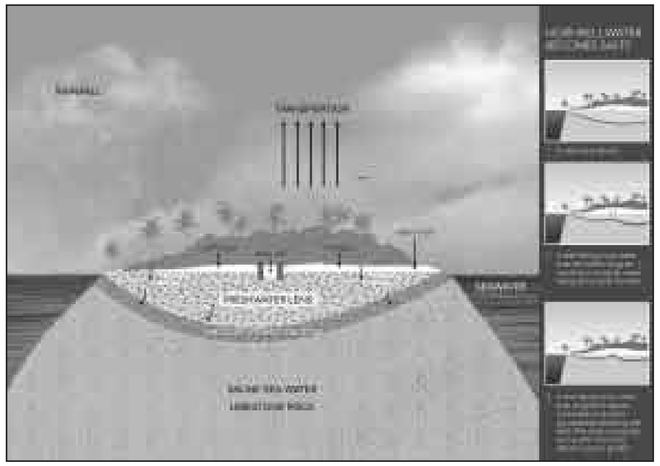
Answer the following questions;

- Section of island (from the island map / or ward name)
- How many wells do the householders use?
- Are there pumps (electrical) connected to the well(s)?
- Is the well water salty?

Follow-up questions

- Does ground water salinity vary across the island? Why?
- How could the householders make their wells less salty?

**Theory:** Students can undertake a field investigation to see the quality of groundwater on their island. This will help to show that the salinity of well water varies across the island and reinforce the message that householders can take measures to make their wells less salty.




## DISCUSSION POINTS

A. When can I drink well water?
B. Why is there fresh water in the ground?
C. Why does the groundwater salinity vary across the island?
D. Why does my well water get more salty during the dry season?
E. Why are Dhaani wells usually fresher than pumped wells?
F. How much water can I take before my well gets salty?
G. How can I make my well less salty?

RAINFALL

TRANSPIRATION

Infiltration

water well

Infiltration

Water table

Recharge

Recharge

SEAWATER

FRESHWATER LENS

BRACKISH TRANSITION ZONE

SALINE SEA WATER

LIMESTONE ROCK

## HOW WELL WATER BECOMES SALTY

1. A well using dhaani

2. A well taking more water than the well in diagram 1, resulting in brackish water rising up towards the well.

3. A well taking more water than diagram 2 results in brackish and saline groundwater entering the well. This most commonly occurs with stop-start electric suction pumps.

30 minutes

# WELL CONTAMINATION

There are a number of factors which affect the vulnerability of your well and therefore the likelihood of your well becoming contaminated. These are:

## 1. CONDITION OF THE GROUNDWATER

- Any cracks in the wall will enable water to enter the well without first passing through the ground.
- Water often gets spilt around the well, when pouring the dhaani into jugs and bowls. This water falls onto the ground and this will infiltrate back into the well. This water may carry contaminants from household activities with it.
- The concrete floor around the well must be free from cracks to avoid contamination of the well from used water.
- Water used after washing often cause puddles around the well if there is no proper drainage channel to direct water away from the well.
- Many wells do not have a cover on them.
- Disposing of faeces or cleaning soiled clothes must not be done near the well. All of these are causes of microbiological contamination of the groundwater.

## 2. SEPTIC TANK DISCHARGE

- Surveys show that the main source of contamination of well water is septic tanks.
- The condition, size and maintenance of the household septic tank are contributing factors to affecting the water quality in your well.
- If the septic tank is cracked or broken then untreated effluent will leak from the tank into the ground.
- If you don't clean out the sludge from your tank then it won't treat the effluent so effectively.

## 3. LOCATION OF THE WELL

- Any well close to the toilet/bathroom, septic tank, washing water soakage pit, waste pile or puddles, will be more likely to be contaminated than one further away.
- Wells located in the garden, near the house and away from the septic tank will be less polluted.
- Talk to your neighbours to agree on the best location for all your septic tanks.

  Ideally the septic tank should be 15m from your well. The further away the better. (*Based on MWSA - Maldives Water and Sanitation Authority -guidelines*)

## 4. ADDITIONAL SOURCES OF CONTAMINATION

- The most significant sources are likely to be fuel oils and chemicals. Some locations, such as the power house will store more of these fluids than others.
- Fuels and chemicals will interfere with the treatment process in the septic tank and enter the groundwater.
- The concrete slab should have a enclosed edge which would enable all the fuel to be held within it should the fuel store leak. Any leak can then be cleared up and removed to the island waste site.
- Washing water will contain detergents. The washing water catch pit can also contaminate your groundwater but to a much lesser extent than the septic tank.

## ACTIONS TO REDUCE WELL CONTAMINATION AND IMPROVE WELL WATER QUALITY

There are some easy steps you can take to improve the protection of your well and therefore improve its water quality. These are listed below:

a. Repair all cracks to the well walls regularly and make sure it is adequately sealed.

b. Remove all debris from around the well.

c. Put a metal well cover with a hinged lid on the top of the well.

d. Build a concrete apron around the well which will direct spills and rainwater away from the well. These can be channelled into a pipe and flow further away from the wellhead.

e. Clean the dhaani, ideally with bleach, once a week.

f. Repair any cracks seen on the septic tank.

g. Make sure the dhaani does not stand on the floor and has a hanger to keep it in the air.

h. Empty the septic tank at least once a year of its sludge and dispose appropriately.

i. If you build a new septic tank make sure it is big enough for your household. MWSA (Maldives Water and Sanitation Authority) can advise you on the design of your septic tank.

j. If you build a new septic tank locate it as far away from your well as possible. Check with your neighbours on the locations of their wells as these might be close to where you intend to put your tank.

k. Move the washing water catch pit away from the well area.

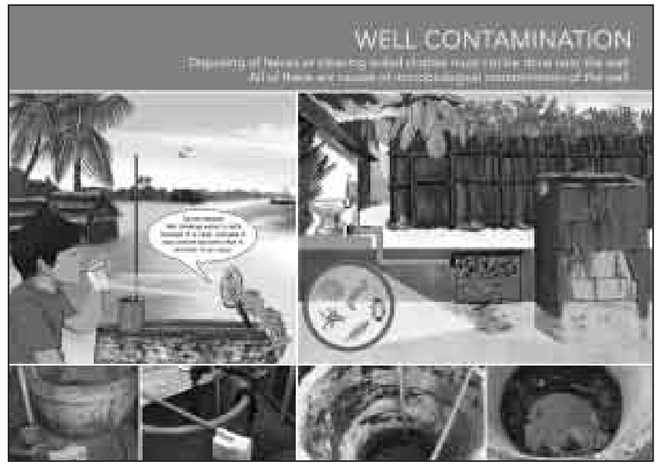
l. Store fuel oils and chemicals away from the well area.

m. If you dig a new well make sure it is near the house and far away from the septic tank.

n. Put the rainwater tank overflow pipe into the well. Rainwater has less salt and bacteria than groundwater and contains no nitrate and ammonia. The rainwater will dilute the groundwater and improve the well water quality. It will also help keep the septic tank effluent in the groundwater away from the well.

o. Do not dispose of waste or excreta near the well (at least 15m).

p. Repair any cracks on the concrete floor around the well.




## DISCUSSION POINTS

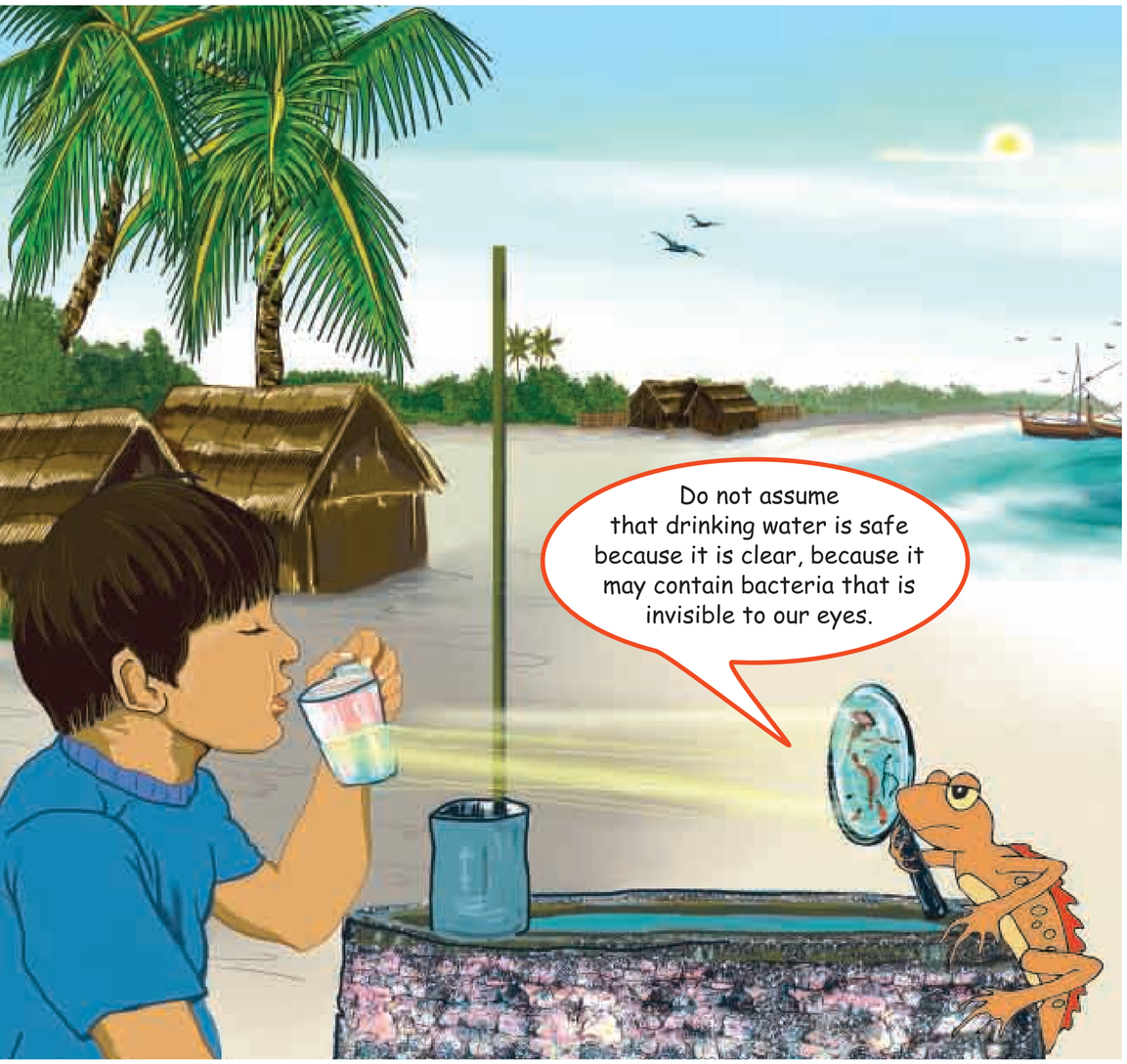
A. What are the most common factors that lead to contamination of well water?

B. What are the consequences of this?

C. How could well water be protected from contamination?

# WELL CONTAMINATION

Disposing of faeces or cleaning soiled clothes must not be done near the well.
All of these are causes of microbiological contamination of the well.




10 minutes

# WATER STORY: WATER, WATER EVERYWHERE AND NOT A DROP TO DRINK

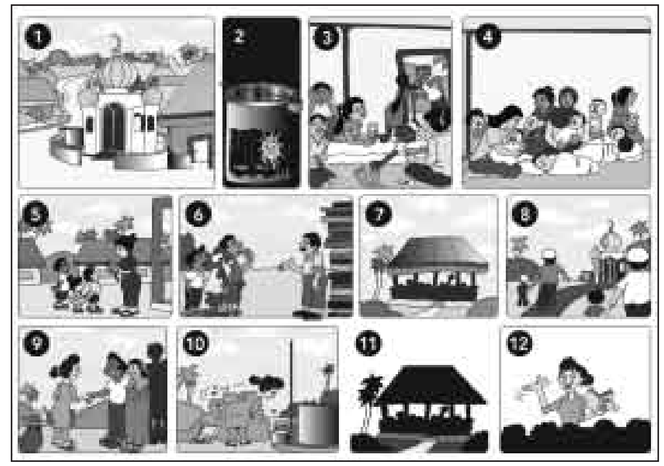
1. The people of Paradise Island lived beside a mosque with a well.
2. They felt so blessed to have so much clean water close by for drinking and cooking… but 'danger' lived in the well too!
3. The people could not understand why so many of them were sickly.
4. Mothers spent so much time tending to their sick children that house work was neglected and families lived in confusion.
5. With so many children getting sick, school work suffered and grades fell…
6. Men lost their jobs because they spent so much time on sick leave.
7. With so many of their bread winners out of work, the island chief called for an emergency meeting to discuss their problem.
8. They also went to the mosque to pray.
9. They even wrote to the government who sent a health worker to the island.
10. She looked in the bushes, she looked in the trees, she sampled the air, she took samples from the mosque well… Then she found what she was looking for…
11. That evening there was a meeting for the island community.
12. Then the health worker told them about contaminated well water which was causing all their problems.

## FACTS ABOUT WATER RELATED ISSUES

Waterborne diseases are spread through the drinking of contaminated water and food. About 80 percent (80%) of all diseases are water-related.

In many cases, sewage gets into the water and spreads disease. Also, an infected person or animal can pass pathogenic bacteria, viruses, or protozoa through their waste into the water.

Because these micro-organisms that cause illness often cannot be seen, smelled or tasted, contaminated water can appear fresh and clean. This is a concern because contaminations often go unnoticed until people start seeing the doctor complaining of diarrhea and other water related diseases.



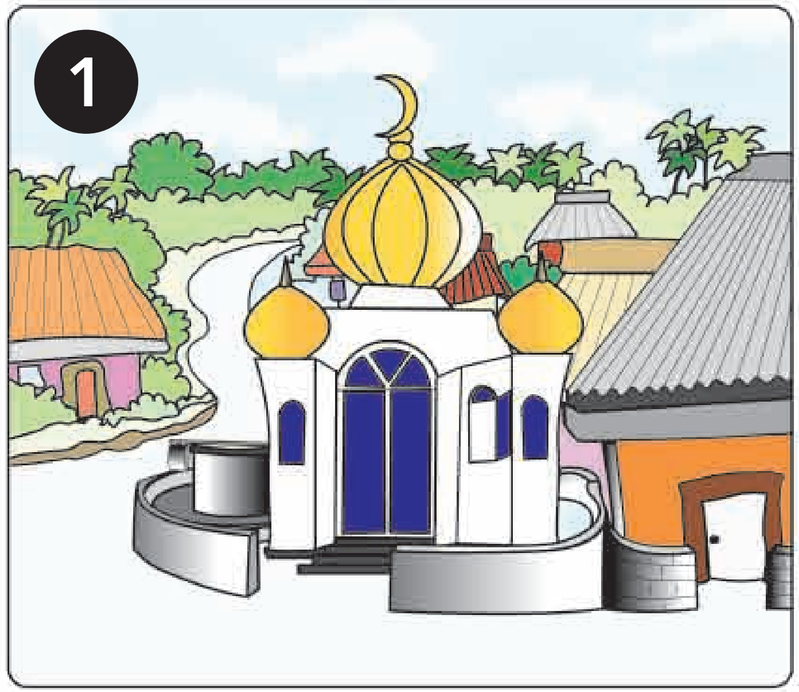

## DISCUSSION POINTS

A. What caused confusion among the community members in Paradise Island?

B. Why did they have difficulty identifying the cause of the problem?

C. What might have led to the contamination of the mosque well?

D. How could you prevent well water from getting contaminated?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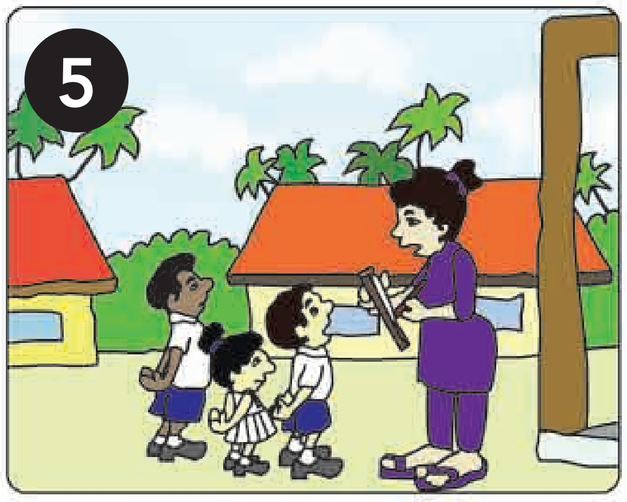
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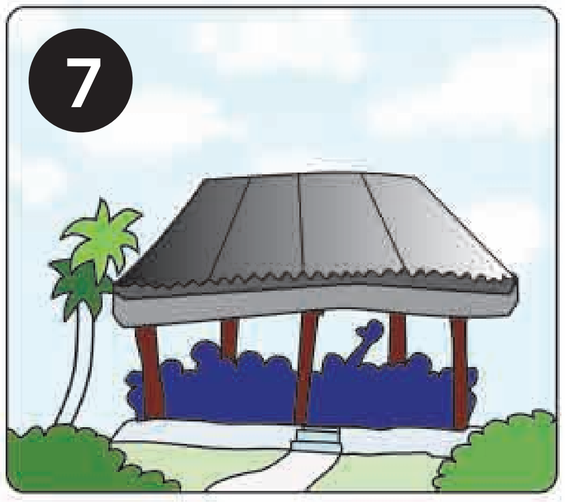
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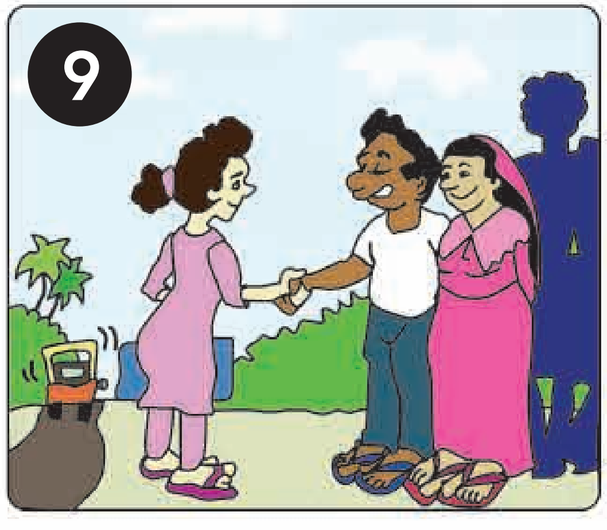
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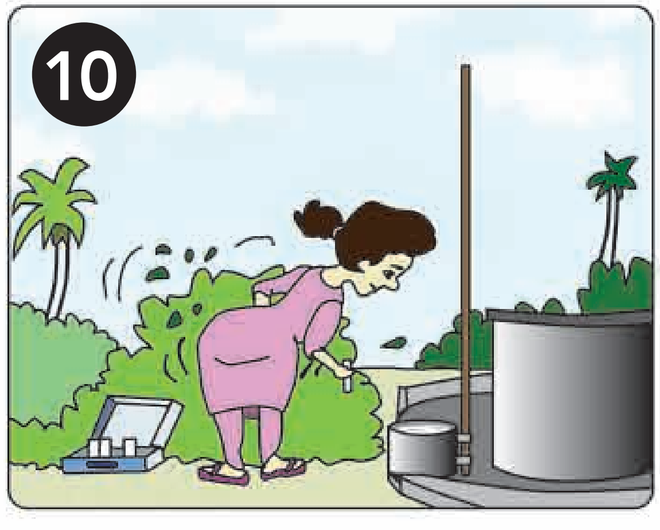
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11


12
Health

30 minutes

# RAINWATER COLLECTION

Rainwater provides the main drinking water supply for 99% of all households in the Maldives outside of Male'. It is the most important water for the family, as it has the most direct effect on family health. Despite this, 70% of all households report their water tanks becoming empty in the dry season, and up to 50% of tanks tested on some islands show poor biological water quality.

- Surveys confirm rainwater is 100 times fresher than groundwater, and 100 times cleaner than groundwater from bacteria.
- Make sure your rainwater harvesting is correctly sized to provide water throughout the dry season, and that you keep the roof and tanks clean. Keeping the rainwater as clean as possible is very important.

## KEEPING THE RAINWATER AS CLEAN AS POSSIBLE

- When rain falls it is very clean and contains no bacteria and very little salt. But when it lands on your house it flows over the roof into the gutters, down the down-pipe and into the tank, it picks up dirt and bacteria.
- You can test your water using the $H_2S$ kit. You should test your rainwater regularly to make sure you are keeping the system clean.

### 1. CLEAN THE ROOF AND GUTTERS

- Reduce the amount of dirt and bacteria going into your tank. Clean the roof once a month, and your gutters once a week.
- Make sure the First Flush valve is open before you wash the roof – as you do not want wash water in the tank.
- Make sure no branches hang over the roof as these will attract birds, bats and insects, and allow rats to jump onto the roof.

### 2. PUT IN A DOWNPIPE FILTER

- Put a small grill over the entrance to the down pipe.
- A filter which allows the water through but no mosquitos will be even better.

### 3. USE A 'FIRST FLUSH' VALVE

- This is a valve which when open prevents the water from entering the tank.
- You should leave this valve open, when it is not raining.
- When it starts to rain, let the water flow off the roof and past the open-valve for a few minutes. This prevents the dust and dirt which may be on the roof entering your tank. Then close the valve and the water will flow into the tank.
- This will stop mosquitoes and other insects getting into the tank through the open end of the First Flush downpipe.

### 4. RAISE THE TANK AND THE TAP OFF THE GROUND

- Raise the tank off the ground by 20-30cm.
- Have the tap not at the very base of the tank, but 10-20cm above it. This prevents the tap from providing water from the very base of the tank, where debris might sink and collect.
- A draining tap can be put at the base of the tank to drain off any sediment collecting at the base of the tank.

### 5. USE A SPILL COLLECTOR

- Construct a small concrete trough under the tap, which collects the spilt water and channels it away from the tank. This will keep the area around the tank dry and clean.

### 6. CLEANING OF THE TANK

- Clean the tank once a year. You will need to get inside the tank and scrub the walls. If you can afford chlorine, then you can mix this with water to clean the tank.
- Keep the top of your tank clear from debris.

### 7. FIT AN OVERFLOW PIPE WITH A FILTER

- Make sure your tank has an overflow pipe, so that when it is full it can fill a second tank or divert water to freshen your well. If the overflow pipe is open to the air (that is if it is not in the next tank) it should be fitted with a filter to prevent insects and small animals getting back into the tank.
- Make sure your tank will not be empty during the dry season: whilst it is important to ensure the water quality in your rainwater tank is of as good a quality as possible, if your tank goes dry you will not have any water at all.

  Given the importance of rainwater to each household and the poor quality of most groundwater in the Maldives, it is important that rainwater collection is maximised. This can be done by:

  i) Adding a gutter to the entire roof area

  ii) Adding a second tank

  iii) Setting up communal tanks

1.5 hours

## ACTIVITY
## COMMUNITY PROBLEM SOLVING

**Materials:** Map of the island. Notebooks.

**Action:** In groups, visit 3 house holds in the island and observe and record how rainwater is being collected.

Write answers to the following questions;

1. Is the rainwater tank covered?
2. Are there over hanging branches above the tank?
3. Is the rain water tank clean?
   - The area surrounding rain water tank is clean?
   - The roof and gutters are clean?
   - Top of the tank is clean?
4. Is there a first flush valve connected to the tank?

Follow-up questions

From your observations, what are the threats to rainwater?

What recommendations would you give to the households to safeguard their rainwater?

**Theory:** Students can undertake a field investigation to see the quality of rainwater on their island. This will help to show that the way rainwater is collected is very important and reinforce the message that householders can take measures to collect rainwater safely.


## DISCUSSION POINTS

A. Why is rainwater fresher than ground water?

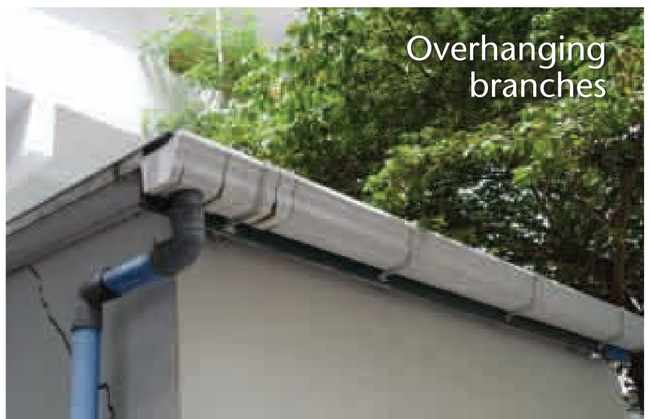
B. What factors lead to rainwater contamination?

C. How could you assist in protecting and managing rain water supply at home and in the school?

# RAINWATER COLLECTION

Rainwater provides the main drinking water supply for 99% of all households in the Maldives outside of Male'.





20 minutes

# WATER MONITORING

## WHAT IS WATER?

Water is a simple molecule that consists of one oxygen atom and two hydrogen atoms. Water molecules like to stick together, but do not like to be squeezed into tight spaces. At different temperatures water has different properties. It is most commonly a liquid but can turn solid (ice) when very cold and when very hot it can become a gas (water vapour).

## WATER QUALITY AND TREATMENT

Water is one of the most basic of human needs. Without water, life could not exist. It is the most valuable resource in the world. We must make every effort to keep this resource clean. Dirty water results in sick people. It is also vital in the environment as it supports our animal and plant life, which in turn supports our livelihood. Water for human consumption can be collected from rivers, lakes, wells or from rain. It is important to check the quality of the water you are drinking regularly as even rainwater can become contaminated. Checking its smell and appearance are simple ways to check the quality. You should compare the taste to bottled drinking water. It is not always possible to determine the quality of drinking water, therefore it is best to purify anyway.

Water pollution has many causes and characteristics. The main cause of water pollution is sewage as a result of poor sanitation systems. Well water polluted with sewage is often the main source of water available on some islands. Waste and chemicals also contaminate water. Wastes that enter water sources can have potential health impacts and cause other environmental problems. Drinking water needs to undergo a process of purification. e.g. boiling constantly for 5 minutes. Other solutions are to protect water sources through the management of human waste, livestock waste, household waste and chemical waste.

## WHAT CAN WE USE THE $H_2S$ TEST FOR?

This test can be used:

- For monitoring of island water supply systems where it may be difficult to conduct conventional testing due to isolation or a lack of appropriate laboratory facilities.
- For routine monitoring of reticulated systems; i.e. water that is distributed through a piped system.
- If a positive result is observed, another sample can be collected for further analysis in the laboratory.
- To determine the cleanliness of water storage tanks and other household storage containers.
- To identify sources of contamination or the point in a piped system where bacteria may be entering the water source.
- To check how effective you have been in disinfecting a water source, or to verify that a well has been properly protected.
- As a tool in health and hygiene education to show people how water becomes contaminated and what they can do about it.
- For monitoring during emergencies and disasters such as during heavy rains when water- borne diseases are more likely to occur and conventional testing is difficult.
- To demonstrate how easily hands become contaminated and how easily they can contaminate food and water. For example, it can be used to demonstrate the effectiveness of washing hands with soap; i.e. to illustrate how faecal bacteria can get from the hands to the mouth and into the body. This is done by pouring clean (boiled and cooled) water over unwashed hands and testing it, and having others wash their hands with soap and repeating the exercise.

one week

## ACTIVITY 1
## EVAPORATION

**Materials:** Two measuring containers

**Action:** Pour 100ml into each of the two containers. Place one container in direct sunlight and the other container inside in the shade and cover this one. Monitor and record the changes in the water level. Note down the differences. You can mark this on the container with a pen. Why do you think this has happened?

**Theory:** As the water heats up it becomes vapour and then rises into the air. The hotter it becomes the more water will evaporate. This is partly how water is recycled in nature. For example, sunlight causes evaporation from seawater or freshwater. The water vapour rises and forms clouds in the sky. When the water vapour in clouds gets cooler, it condenses and forms rain.

20 minutes

## ACTIVITY 2
## TRANSPIRATION

**Materials:** Plastic bags and some string

**Action:** Place a clear plastic bag around some leaves at the tip of a branch of a tree. Tie the end of the bag around the leaves, ensuring that there is air in the bag but that it is sealed so the air cannot get out. It might be interesting to do this activity with a couple of different trees. At the end of the session and again after a week, check the bags. Note down your observations. If there is anything in the bag measure it after a week.

**Theory:** The water that is collected in the bag has travelled through the tree, moving up from the roots through the trunk and stems and into the leaves. The movement of water through the leaves is called 'transpiration' – this is an important part of the water cycle. It is almost like the tree is sweating!

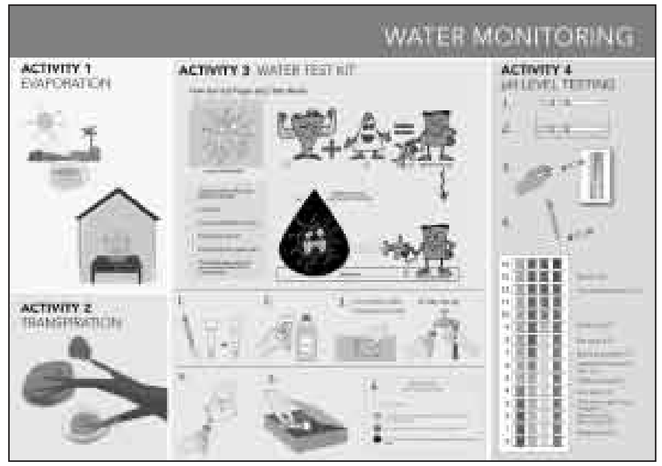
30 minutes

## ACTIVITY 3
## WATER TEST KIT

**Materials:** Ten $H_2S$ water test kits – ($H_2S$ strip in small bottle) and student handout, (refer to Student Resource Sheet in the 'Water Quality Monitoring' section of the Earth Module).

**Action:** Split into two groups with 5 bottles each. Number the test bottles. Take the first bottle and carefully fill it with bottled drinking water – this is the control. Take the other bottles and fill them with drinking water from different sources, such as tank water and well water. Make sure you note down which bottle corresponds with each sample. Check the samples to see if there are any instant colour changes and note this. The samples should then be stored in a dark place and final results obtained after three days.

**Theory:** The strip in the small bottle will make the water change colour to black if there is a specific bacteria (e. coli) in the water. The bacteria is associated with faeces and as such is an indicator that the water is polluted and not good for drinking.




30 minutes

## ACTIVITY 4
## pH LEVEL TESTING

**Materials:** Six strips of pH paper, plus some substances to test: juice from lime, fish sauce, soapy water, sample of pond or swamp water and sample of rainwater.

**Action:** Put the 4 substances as mentioned above in separate containers. Make a sixth mixture using your saliva. Test each solution one by one, by dropping in one small piece of pH paper. Record how the solution affects the pH paper. Record your observations and check the pH level using the color table provided.
***NB: When checking pH of saliva, do not put the pH strip in your mouth!***
Once the test is complete and result recorded, put a cross on the end of the paper, to indicate that it is used. Do not put the pH paper back in the container, it cannot be reused, it should be thrown in the waste bin.

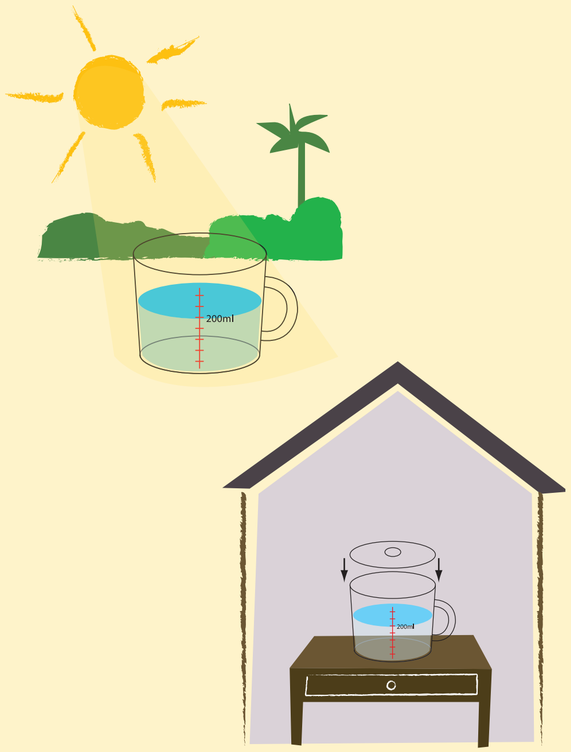
**Theory:** How pH strip works: pH is a numeric scale used to express a solution's acidity or alkalinity. Acidity or alkalinity are terms that refer to a solution's concentration of hydrogen ions. The greater the concentration of hydrogen ions, the more acidic the solution; fewer hydrogen ions and a solution is considered alkaline.

The pH scale ranges from 0 to 14. Seven is the mid-point at which a solution (such as distilled water) is neither acid or alkaline. A pH lower than seven indicates more acidic solutions like vinegar (3.0 pH), sulfuric acid (1.2 pH) or orange juice (3.7 pH). pH values higher than seven represent alkaline or "basic" solutions such as sodium hydroxide (pH 13), ammonia base household cleaners (pH 12), and potassium hydroxide (pH 14).

Strips of paper are impregnated with a chemical indicator. This indicator, when immersed in a sample liquid, turns the paper test strip a specific color. The pH of the sample liquid is determined by visually comparing the color of the test strip to a standard chart that is provided. These indicators are available for every pH range but have limitations to their accuracy. They can be particularly difficult to interpret when dealing with turbid samples.

# WATER MONITORING

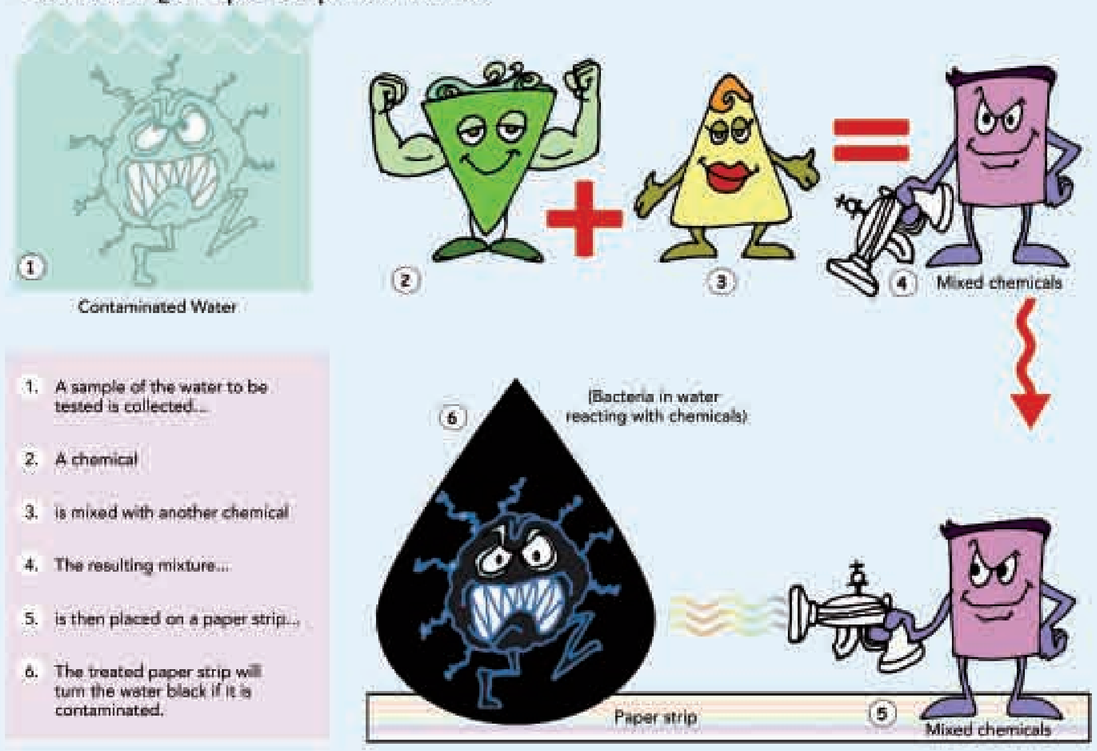
## ACTIVITY 1
EVAPORATION




## ACTIVITY 2
TRANSPIRATION

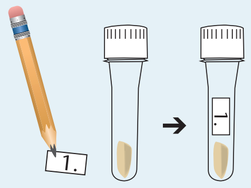
## ACTIVITY 3 WATER TEST KIT

How the $H_2S$ Paper strip Test Works:

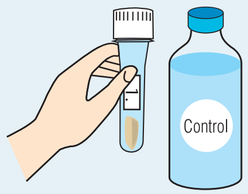



1. A sample of the water to be tested is collected...
2. A chemical
3. is mixed with another chemical
4. The resulting mixture...
5. is then placed on a paper strip...
6. The treated paper strip will turn the water black if it is contaminated.

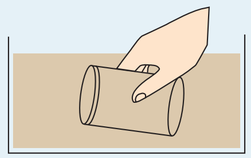
1.



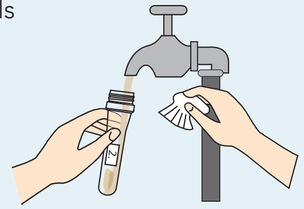

2.




3. from water tanks, boreholes or wells



or from the tap

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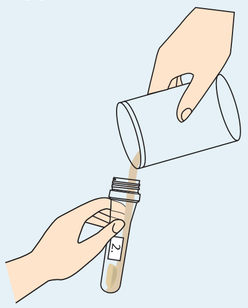
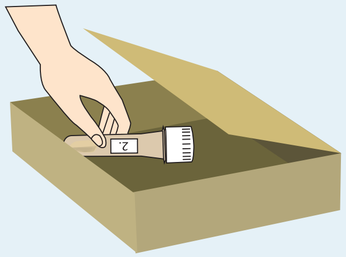



5.



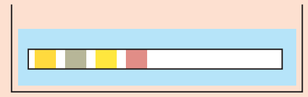

6. Result Card
$H_2S$ Colour Code

- (-) no change.
- (+) slight change, the Paper strip or water sample has turned light brown.
- (++) the Paper strip or water sample is dark brown.
- (+++) the Paper strip and the water sample are noticeably black.

## ACTIVITY 4
pH LEVEL TESTING

1.

2.



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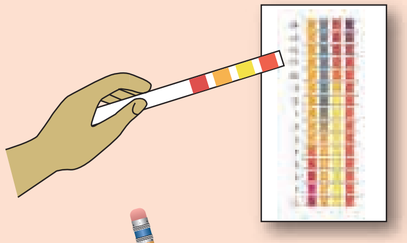

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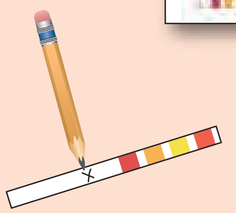
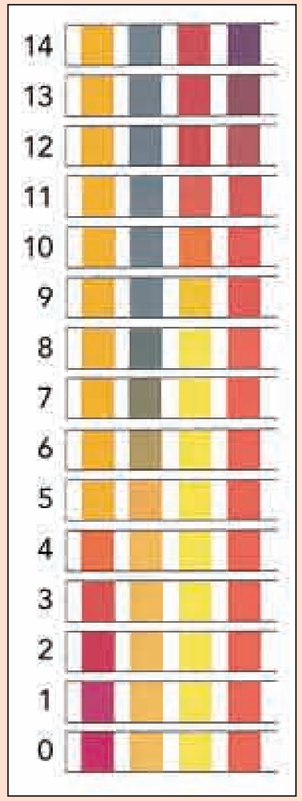





Bleach 12.5

Household ammonia 11.5

Hand soap 9.0

Sea water 8.0

Blood, pure water 7.5

Healthy human saliva, milk 6.5

Coffee and tea 5.0

Acid Rain (<5)

Orange or apple juice
Vinegar 3
Gastric acid 2,
lemon juice 2.4

Battery acid 0.5

15 minutes

# HYGIENE AND SANITATION STORY

## POOR JARAAS – NO PLACE TO LIVE

1. Jaraas and his family lived in an old house on the island of Kunifushi. It was wonderful! Lots of dark corners, thick dust, old waste, cobwebs and dirty, messy places make fantastic hiding places. They can play and grow well there. Then when they are ready they can go and live in children's mouths, throats and stomachs and make them really ill. Like all germs do.

2. As usual Jaraas and his friends were playing hide and seek in the gutter. "Oh, what's that? cried Jaraas. "Dirt left behind by the cat… warm, smelly and sticky and so good to play with and hide in". Jaraas and his family made a dirt castle and buried each other in it. This is fun!

2. Their happy life took a turn when Moosa's family moved in.  Moosa and his family were very clean. They did not like the messy surroundings. "Time to clean up the house" said Moosa.

   "Yes, said Hawwa. "Dirty water and waste help insects and other pests grow. The germs breed with them. Today we'll give those germs a lesson."

4. Their enjoyable moment was interrupted. Moosa was sweeping away the dried leaves and waste on the roof. The gutter was next. "Save yourselves" cried Jaraas as he ran towards the well while others jumped into the water tank.

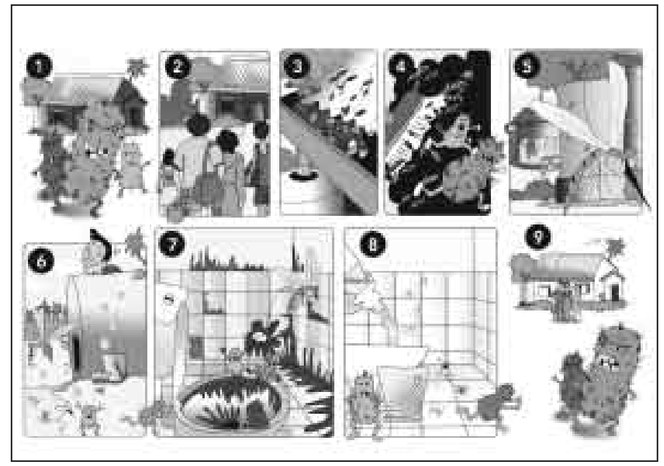
5. Swimming in the dirty water was fun! So was inside the water tank. The water had turned a wonderful sticky green. It had a lovely, stinky smell. Some of his family members slid down the stained walls of the tank while others caught rides on hundreds of mosquitoes buzzing around.

6. At that moment Moosa emptied the water tank and cleaned it with chlorinated water, as he does regularly during the rainy season. All the mosquitoes flew away and so did Jaraas and his family. This time they had to hide in the toilet.

7. Good! No cleaners here! Just dirty slimy water. A perfect home with food at arms length. They could trace pictures in it too… It is fun! But then they heard footsteps. Oh! No! They had to run again.

8. Jaraas and his family are fed up! This house is no good. It is dangerous. Everywhere is being cleaned. "They are using big sharp weapons to catch and destroy us" said the scared and exhausted Jaraas. They ran into the garden.

9. On Friday, Moosa's family dug out the weeds and threw out the smelly water and made a big pit for the dirt. The rats ran out. The mosquitoes all flew away. Jaraas and his family just escaped with their lives. They have been running from the children ever since…. Unless they find a lazy one who does not clean up!




## DISCUSSION POINTS

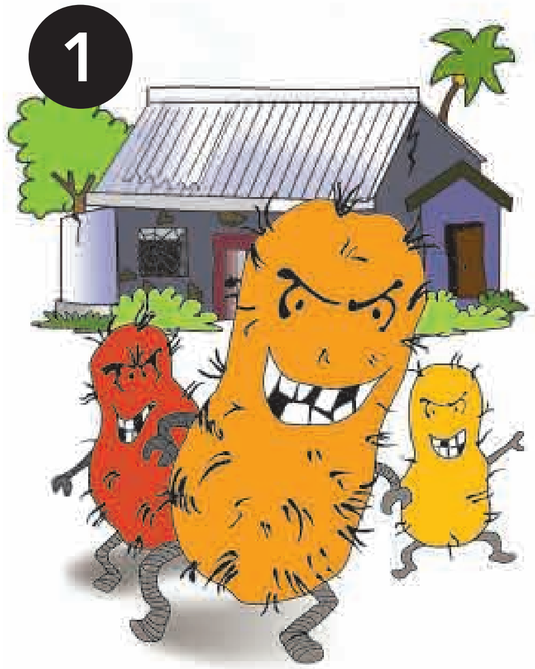
A. What types of places do germs like to live?

B. What can you do to get rid of germs?

C. What can you do to stop mosquitoes breeding around your home?

Story written by Aminath Shakeela and Shirumeen Ahmed

1



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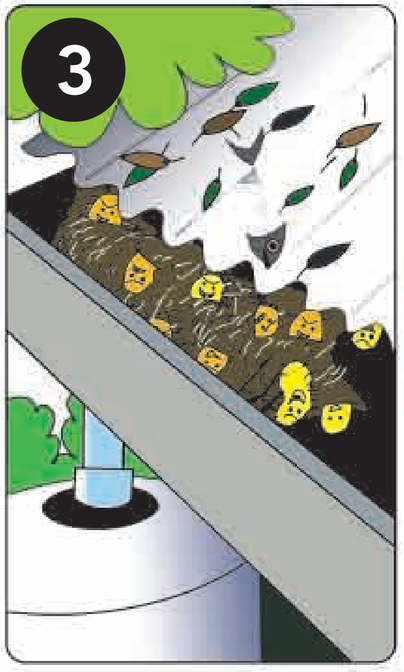

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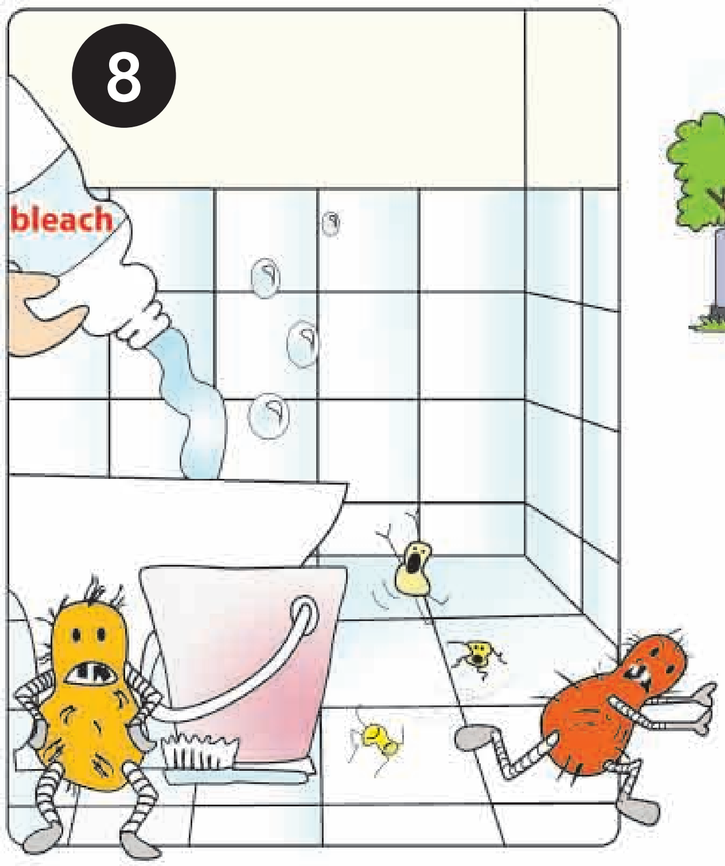


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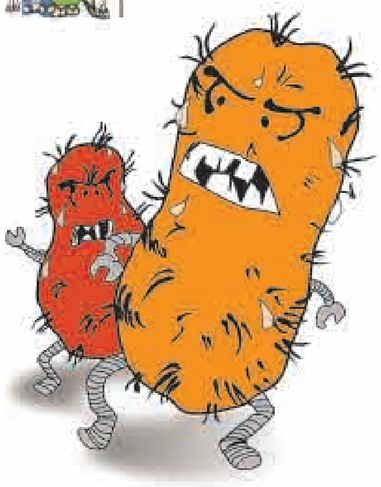


30 minutes

# SAVING WATER

## WATER

Water covers two thirds of the planet, but only 2.5% of that amount is fresh water. Most of that is locked into ice caps and glaciers, leaving only 0.08% of the earth's water available for human use. Water must be used wisely if there is to be enough to meet the needs of future generations. An awareness about the amount of water used in everyday tasks is the first step in developing a responsible approach to water use. Alternative ways of carrying out day to day tasks using less water can then be explored.

In the Maldives, the Maldives Water and Sanitation Authority is responsible for the treatment and distribution of desalinated water to Male', Villingili and Hulhumale' for public consumption. In the islands, the island communities have their own sources of drinking water, such as wells and rainwater tanks. Unlike in Male' the island communities do not have experts regularly checking the water quality and wastewater is not treated or used for any purpose.

## HOW WE USE WATER

We all use water in many ways that include drinking, bathing, washing and watering our plants, but water is a limited resource. That is why it is important that we all find ways to conserve water every day in every way. Children play an important role in making sure that every drop counts and there are things you can do to help your family save water. If everyone saves a little we can save a lot.

## SAVING WATER MAKES GOOD SENSE

The average person uses 190 liters of water a day. If you obtain water from a public water supply, your water bill lets you know that each drop wasted costs you money. Those of us who get our water from private wells are concerned about wells going dry. These simple tips can help us all save money and preserve precious water supplies.

## WHAT YOU CAN DO INDOORS TO SAVE WATER

### Bathroom

- Turn the tap off when you brush your teeth. If you brush your teeth twice a day, for two minutes each time, and leave the tap running, you could be wasting around 12 litres (or just over a bucket) of water a day. That's over 4,300 litres per person, per year.
- Reduce your showering time. Every minute you cut from your shower time could save up to nine litres of water if you have a water-efficient showerhead, and up to 20 litres if you have an older style, conventional showerhead.
- Use the half flush option when possible on dual flush toilets.
- Install a displacement device in the cistern (tank) of single flush toilets, as it can save you a litre of water every flush. You can do this by removing the lid of your cistern and carefully placing a one litre sealed plastic bottle filled with pebbles and water inside in a way that won't interfere with the flushing mechanism.
- Check for toilet leaks by placing a few drops of biodegradable food colouring into the cistern, and wait for 30 minutes. If you have a leaking toilet, you will see coloured water in the toilet bowl and need to contact a plumber. A slow, barely visible leak into your toilet bowl can waste more than 4,000 litres of water a year. Visible, constant leaks (with a hissing sound) can waste 95,000 litres a year.

### Laundry

About 13 per cent of household water is used in the laundry. Conventional top loading washing machines use an average of 120 to 150 litres of water each load.

Wash only full loads laundry. Reduce the number of washing loads in a week and save water by combining smaller loads and only washing when you have a full load.

- Adjust the water level to suit the size of your load and use the economy cycle, if your machine has one.
- If you are buying a new washing machine, choose a water-efficient model with a water conservation rating of AAA (or greater). Front loading machines and some water efficient top loaders will save approximately 50 litres of water per load. They are also gentler on your clothes and require less detergent.

### Kitchen

- Defrost frozen food in the refrigerator.
- Rinse vegetables in a full sink or bucket of water.
- Rinse dishes in a full sink or bucket of water.

## TIPS ON SAFEGUARDING WATER

All of us need clean water to drink. We can go for weeks without food, but only days without water. Contaminated water can be a threat to anyone's health, but especially to young children.

**Use Household Products Properly:** BE CAREFUL... Many things around the home like paint or cleaners can harm you and cause water pollution if they are not handled and disposed of properly.

**Care For Your Vegetables:** Everyone needs to use fertilizers carefully. If too much fertilizer is used, the fertilizer can wash into the sea and cause water pollution.

**Plant Trees and Shrubs:** Trees and shrubs help prevent water pollution by soaking up extra fertilizer (nutrients). Plants also prevent erosion by keeping the soil where it belongs on the land and out of the water. Use mulch around shrubs and garden plants to save soil moisture and reduce evaporation.

**Control Bugs Carefully:** Not all bugs are bad. It's important to read labels and follow directions when using pesticides (bug sprays). Some pesticides can cause water pollution and even kill friendly insects like ladybugs. Staff at your local Health Centre or other relevant authority can teach your family safe, new ways to control pests.

**Control Rainwater:** When lots of rain falls on hard surfaces like paved sidewalks and streets it can run off carrying leaves, waste and car oil into drains. The drains eventually seep into the water lens causing water pollution.

1 hour

## ACTIVITY
## SAVING WATER

**Materials:** Large white paper and colored markers

**Action:** In groups, design a poster on one of the following;

- How water can be saved in school or at home
- The importance of saving water

Display these posters in your classroom or around key locations at your school to remind everyone to save water every day!

**Theory:** We all use water in our homes, schools and offices. Students should be encouraged to reduce water use. Raising awareness signs and posters will help to reinforce this message that we can all play a part in reducing our water use.

## DISCUSSION POINTS

A. Can you think of a way to help rain water soak into the ground?

B. How can you be sure you are using cleaners properly so that it does not pollute the ground water?

C. How can you save water in the garden?

D. If your family gets drinking water from your own well, do you know if your water is safe to drink?

E. How can you save water?

20 minutes

# WASTE THEORY

Waste management is one of the biggest environmental challenges in the world. As populations grow so do waste problems. Many modern wastes are non-organic and societies are not acting to effectively reduce, reuse and recycle these wastes. Effective waste management requires communities to take ownership of waste issues, starting from the household level.

Waste can be divided into 2 major groupings: organic and non-organic. Organic materials are often the bulk of our waste materials. Organic materials are those that break down easily in the environment such as paper, food and plant material. These organic materials can be composted. Non-organic waste may break down, but the process can take a very long time, sometimes thousands of years. When some of these eventually do break down, they breakdown into smaller component parts. Sometimes these components can also cause pollution.

Waste can be a solid (for example bottles or cans), a liquid (e.g. sewerage), or a gas (e.g. fumes from a car). There are 3 main sources of waste:

1. **Domestic Waste** - produced in the home, includes food scraps, unwanted plastic bags and bottles. Hazardous waste is produced as a result of using chemical fertilizers and pesticides.
2. **Commercial waste** - waste from markets, shops, hotels and health clinics. Commercial waste includes unwanted packing materials, wood, glass, plastic and food scraps.
3. **Industrial Waste**- produced in factories, including unwanted chemicals and other by-products generated in the manufacturing of products.

The following techniques can be used to protect people from environmental pollution.

## REDUCE, REUSE AND RECYCLE

- **Reduce** – Using less of things, for example, don't throw away paper unless you have used both sides. Reduce the use of plastics by using a longer life bag or a woven basket. For example when we buy something from a shop which is already packaged in a box or wrapped in paper or plastic, we do not need to put it into another plastic bag. This is a lot of plastic!

  Maldives has a population of about 300,000 people, if everyone used 4 disposable plastic bags each day, it would calculate to 1200,000 plastic bags being thrown away everyday of the year. This lot of plastic!
- **Reuse** – there are many things that we can use again instead of throwing away, for example, use a plastic bottle again for storing pickles or containers for water storage in the fridge.
- **Recycle** - this is the process where recyclable materials (e.g. paper, plastic, glass, metal, aluminum, steel etc.) are converted into new products.

## POLLUTION

Pollution is contamination of the environment with waste people produce. If waste is thrown into the environment it causes pollution. If people do not dispose of their waste correctly it can have serious impacts on the environment and the health of people. If people throw waste into the street, rats and crows will scavenge in the waste and this will spread disease. Never throw waste into the sea or anywhere else in the environment.

## WHY MAKE COMPOST?

Don't throw away materials when you can use them to improve your soil and garden! Compost is one of nature's best mulches and soil amendments, and you can use it instead of commercial fertilizers. Best of all, compost is free. Using compost improves soil structure, texture, and aeration and increases the soil's water-holding capacity. Compost loosens clay soils and helps sandy soils retain water. Adding compost improves soil fertility and stimulates healthy root development in plants. The organic matter provided in compost provides food for microorganisms, this keeps the soil in a healthy, balanced condition. Nitrogen, potassium, and phosphorus will be produced naturally by the feeding of microorganisms.

## HOW DOES COMPOST BREAKDOWN?

Compost is the end product of a complex feeding pattern involving hundreds of different organisms, including bacteria, fungi, worms, and insects. What remains after these organisms break down organic materials is a rich, earthy substance. Composting replicates nature's natural system of breaking down materials on the forest floor. In every forest, grassland, jungle, and garden, plants die, fall to the ground, and decay. These are slowly dismantled by the small organisms living in the soil. Eventually these plant parts disappear into the brown crumbly forest floor. By providing the right environment for the organisms in the compost pile, it is possible to produce excellent compost. We usually want to organize and hasten Mother Nature's process. By knowing the optimum conditions of heat, moisture, air, and materials, we can speed up the composting process. Besides producing better soil faster, making the compost faster creates heat which will destroy plant diseases and weed seeds in the pile.

## COMPOST SITE SELECTION

Any pile of organic matter will eventually rot, but a well-chosen site can speed up the process. Look for a level, well drained area, shelter the pile in a shadier spot so it doesn't dry out too quickly. Build the pile over soil or lawn rather than concrete or asphalt, to take advantage of the earthworms, beneficial microbes, and other decomposers, which will migrate up and down as the seasons change.

## WASTE FACTS

ESTIMATE OF TIME IT TAKES FOR WASTE TO BREAKDOWN

(Depending on weather conditions)

- vegetables - days
- leaves - weeks
- fish - weeks
- stems - months
- orange and banana peel up to 2 years
- cigarette butts 1-5 years
- plastic-coated paper 5 years
- tin cans 50 years
- plastic bags can take between 20 and 1000 years
- aluminum cans 80-100 years
- glass bottles 1 million years
- plastic bottles indefinitely


## DISCUSSION POINTS

A. What is the difference between organic and non organic waste?

B. What happens if we throw non organic waste in waterways and on the ground?

C. What breaks down the quickest, an apple core, a plastic bag, or some paper?

D. Can waste affect human health? How?

# GOOD PRACTICES

'Bring your own cloth bag to the shop and avoid plastic bags altogether'.

**WASTE REDUCTION**

Prevent waste by not creating or generating it in the first place

**RE-USE AND RECYCLING**

Collect, remanufacture, and reuse waste materials

**TREATMENT**

Treat waste to contain harmful substances

**DISPOSAL**

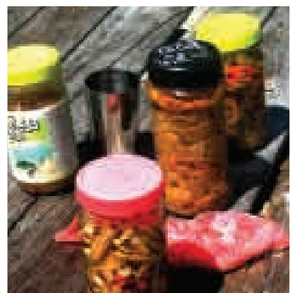
Control pollution by storing or burying waste

Pollution prevention stops waste before it is generated

# BAD PRACTICES

'If every Maldivian used 4 plastic bags each day, it would calculate to 1,200,000 plastic bags being thrown away everyday of the year'.

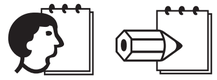




# WASTE ACTIVITIES

30 minutes

## ACTIVITY 1
## SCHOOL AUDIT



**Material:** Large white paper, colored markers and notebooks. School audit sheet (refer to Student Resource Sheet in the 'Managing Waste' section of the Resources from the Environment Module).

**Action:** As a group draw a large map of the school. Mark in special features such as buildings, gates, fences, etc. Then walk around your school ground in groups of 4 and record and collect the kinds of litter in your school yard. (Don't forget to pick it up and dispose of it properly!) Answer the following questions in your notebooks:

1. List the kinds of litter you collect.
2. Record the numbers of each kind of waste. What is the most common?
3. Where does this waste come from? How did it get here?
4. What are the consequences of waste in the schoolyard?
5. Can any of it be reduced, reused or recycled? Write the names of the waste in each column.
6. Who should be responsible for keeping the school clean?
7. What actions can you and your school take to ensure the school is kept clean?
8. Go back into the class and look again at the map you drew. Each group should mark on the map the locations where most waste was found.

**Theory:** It is necessary to first understand what waste is being produced so that you can develop a suitable waste management plan. If you don't know what waste there is, how will you know how to manage it?

This exercise can also be used in other parts of the community.

15 minutes
check weekly

## ACTIVITY 2
## WASTE DECOMPOSITION

**Material:** 4 plastic containers, (can use water bottles cut in half) 4 different waste materials (plastic, paper, fruit waste, peel, skins, vegetables, leaves, etc.)

**Action:** Take a few different waste materials and place one in each container. Leave them in the containers and check them each week. Are some things changing? Which are changing and which are not?

**Theory:** Different materials break down at different rates – some organics (matter derived from living things) can break down very quickly while things like plastic may not break down. With organic materials some have high nitrogen and break down quickly while others have higher carbon and break down slowly.

WASTE FACTS : ESTIMATE OF TIME IT TAKES FOR WASTE TO BREAKDOWN (Depending on weather conditions)

- vegetables - days
- leaves - weeks
- fish - weeks
- stems - months
- orange and banana peel up to 2 years
- cigarette butts 1-5 years
- plastic-coated paper 5 years
- tin cans 50 years
- plastic bags can take between 20 and 1000 years
- aluminum cans 80-100 years
- glass bottles 1 million years
- plastic bottles indefinitely

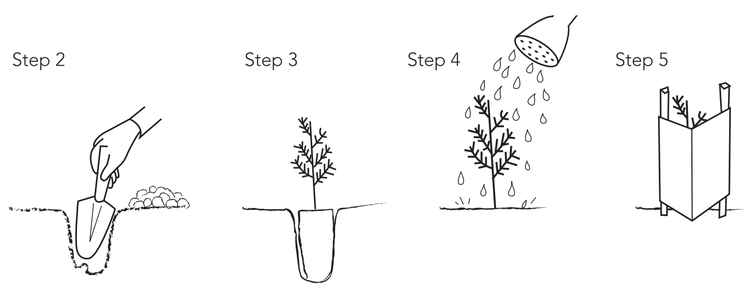
40 minutes
then ongoing

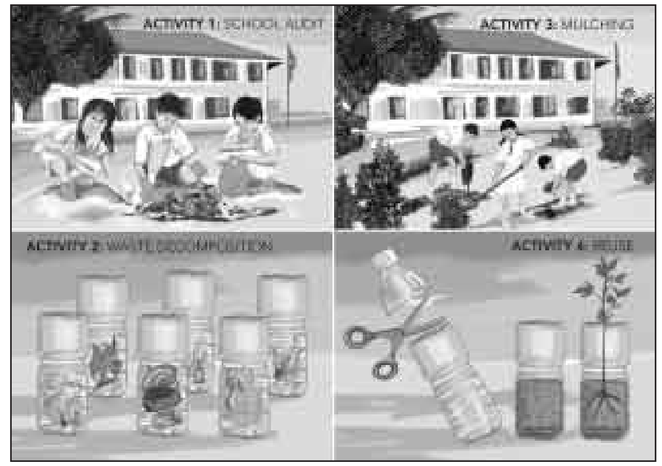
## ACTIVITY 3
## MULCHING

**Materials:** A digging tool, gloves (optional), water, plants or seeds, guard and stakes if required

**Action:**

1. Select your plant and where you would like to plant it in your garden. Remove any mulch away from the surface so that you can see the soil.
2. With your digging tool make a hole the same size as the pot of your plant. Make sure that you keep the soil you remove neatly to the side.
3. Carefully remove your plant from the pot, making sure that you do not pull on the plant and damage the foliage. Only remove the pot when you are close to your hole, so that you do not have to travel with it unprotected. Place your plant in the hole, making sure the top of the plant's soil is level with the ground (as pictured below). Use the soil you removed earlier to fill in any gaps around the plant – make sure you don't leave any big air pockets. Think of tucking someone into bed, and gently firm the soil around the stem of the plant.
4. Now you need to give your plant a drink of water. Make sure you cover the mulch back over the plant as well, that will help to reduce moisture evaporation. You can also collect dried leaves from the school compound to put around the base of your plant. This is an excellent way to reuse organic materials in the garden and help your plant to grow!
5. It may be necessary to guard your plant to protect it from animals, weeds or even humans! If so, place the stakes at even distances around the stem of your plant and carefully cover this with the guard, making sure you protect the foliage of your plant while you are doing it.
6. You have done an excellent job. Now you need to make sure you look after and maintain your plant for the future. Keep adding mulch from time to time to keep the soil moist and your plant healthy!




20 minutes

## ACTIVITY 4
## REUSE

**Material:** Plastic containers, soil, seeds

**Action:** Cut the tops off the plastic containers and put small holes in the bottom of the plastic containers for drainage. Place a piece of paper in the bottom of the container and then fill it with soil. The container is now suitable for planting the seed (note bigger plants need bigger containers). Make sure you keep the soil moist but give it some but not too much sunlight. Take care of the seed and it should grow.

**Theory:** It is better to reuse old plastic containers than buy special new containers to grow plants. By reusing the plastic container, you are effectively reducing the amount of waste that needs to be disposed of. By growing a plant you are also having a positive impact on the environment.


**ACTIVITY 1** SCHOOL AUDIT


**ACTIVITY 3** MULCHING


**ACTIVITY 2** WASTE DECOMPOSITION


**ACTIVITY 4** REUSE

# SCHOOL GARDENS

30 minutes

## ACTIVITY 1
SITE PLAN FOR SCHOOL GARDEN

**Materials:** Paper, pencil, measuring tape

**Procedure:**

1. On a large piece of paper, draw the area of your garden.
2. Mark important landmarks, like classrooms and drinking taps.
3. Using different colored pencils for each different type of plant, color in how you would like your garden to look.
4. Include notes on your map to explain to others why you think this is the best way to plant your garden.
5. Display your maps in your classroom and ask others what they think of your design.

30 minutes

## ACTIVITY 2
DIFFERENT TYPES OF VEGETABLE GARDENS

**Materials:** Notebooks

**Purpose:** To research different types of vegetable gardens

**Procedure:**

1. As a class brainstorm the different types of vegetable gardening techniques. The teacher can introduce hydroponics, soil based gardens, medicine garden.
2. Students in groups research different methods.
3. As a class decide on a method or methods for your school.
4. Research what materials and design you will need for your school, and how you will obtain them.

30 minutes

## ACTIVITY 3
SITE PREPARATION

**Materials:** Mulch, garden fork, bags or buckets to carry weeds away.

**Procedure**:

1. To prepare the area by treating and removing weed species, management of pests and ground preparation.
2. Consider whether your garden is going to be planted in soil on the ground or in planter boxes raised off the ground. If you decide on planter boxes you will need to construct those and fill them with soil. You could use wood for the sides, or weave palm leaves to create the walls. Create circular plots with the soil heaped up to the sides of the wall to form a saucer shape. This will capture moisture and have it run to the centre of the patch.
3. Weed site and loosen soil.
4. Lay mulch on the site to increase the nutrients in the soil. Compost collected through the waste units could be added to the soil.

30 minutes then ongoing

## ACTIVITY 4
SCHOOL GARDENS

Establish a vegetable garden at school to grow vegetables to cook and enjoy.

**Materials:** A digging tool, gloves (optional), water, plants or seeds, guard and stakes if required

**Procedure**:

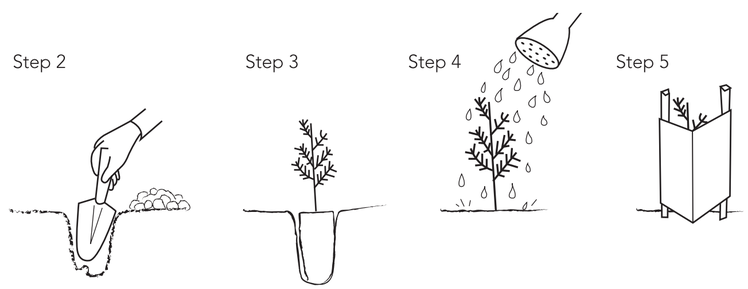
1. Select your plant and where you would like to plant it in your garden. Remove any mulch away from the surface so that you can see the soil.
2. With your digging tool make a hole the same size as the pot of your plant. Make sure that you keep the soil you remove neatly to the side.
3. Carefully remove your plant from the pot, making sure that you do not pull on the plant and damage the foliage. Only remove the pot when you are close to your hole, so that you do not have to travel with it unprotected. Place your plant in the hole, making sure the top of the plant's soil is level with the ground (as pictured below). Use the soil you removed earlier to fill in any gaps around the plant – make sure you don't leave any big air pockets. Think of tucking someone into bed, and gently firm the soil around the stem of the plant.
4. Now you need to give your plant a drink of water. Make sure you cover the mulch back over the plant as well, that will help to reduce moisture evaporation.
5. It may be necessary to guard your plant to protect it from animals, weeds or even humans! If so, place the stakes at even distances around the stem of your plant and carefully cover this with the guard, making sure you protect the foliage of your plant while you are doing it.
6. You have done an excellent job. Now you need to make sure you look after and maintain your garden for the future. Examples of fruits and vegetables to grow in your school garden

### Fruits

| **Common name** | **Dhivehi name** | **Scientific name** |
|---|---|---|
| Coconut Palm | Dhivehi Ruh | *Cocos Nucifera* |
| Papaya | Falhoa | *Carica papaya* |
| Watermelon | Karaa | *Citrullus vulgaris* |
| Guava | Feyru | *Psidium guajava* |

### Vegetables

| | | |
|---|---|---|
| Pumpkin | Baraboa | *Cucurbita moschata* |
| Egg plant | Bashi | *Solanum melongena* |
| Kale | Kopee Faiy | *Brassica olearcea* |
| Tomato | Vilaathu bashi | *Lycopersicum esculentum* |




## DISCUSSION POINTS

A. What are the different types of gardens you can have at your school?

B. What do you like best about your school garden?

C. What do you think about your plan for the school garden? Is there anything you wish to add or change to the garden?

# COMPOSTING ACTIVITY

40 minutes then ongoing

## ACTIVITY
## MAKING COMPOST

**Materials:** Composting handout (refer to Student Resource Sheet in the 'Composting Waste' section of the Resources from the Environment Module).

**Procedure:**

Ask the students to bring in some organic materials e.g. paper, cardboard, fruit and vegetable scraps, leaves, grass etc. The teacher will also need a small knife to chop up large matter, and some water to make the compost heap wet. The compost heap needs to be watered once a day. Every 2-3 weeks you will need to take off the outside grass layer and mix the compost that remains. After mixing put the grass cover back on and water.

**Action:** Discuss the concept of compost with the students. Get them to list down the organic materials that are considered waste. Lay out the materials that have been collected for the heap and ensure that there are also sufficient leaves or dry yard waste. Examine the material and determine which should and should not be placed in the heap.

Now follow the instructions on the composting handout.

**Theory:** Compost not only reduces what is considered waste, it is also a very useful way to recycle this organic material and can help in making more fertile soil without the need for any chemicals. Compost is nature's way of breaking down organic material into usable pieces for plants and animals. It is an important part of the cycle of life.

Almost any organic material is suitable for a compost pile. The pile needs a proper ratio of carbon-rich materials, or "browns," and nitrogen-rich materials, or "greens." Among the brown materials are dried leaves, straw, and wood chips. Nitrogen materials are fresh or green, such as, grass clippings and food scraps and manure.

### CARBON RICH MATERIALS:

Dried leaves and weeds
Wood chips
Palm fronds
Palm leaves
Twigs
Coconut husks
Husks from Indian Almonds.
Tea bags
Egg shells
Sea weed (without salt)
Paper and Newspapers
Card board boxes

### NITROGEN RICH MATERIALS:

Carrot peels
Banana peels
Onion peels
Left over rice
Left over vegetables
Left over roshi
Vegetables and fruit peelings.

**Food Scraps:** Includes carrot peelings, apple cores, banana peels - You can successfully compost all forms of food waste, however, meat, meat products, dairy products, can present problems. Meat scraps and the rest will decompose eventually, but will smell bad and attract pests. All additions to the compost pile will decompose more quickly if they are chopped up before adding.

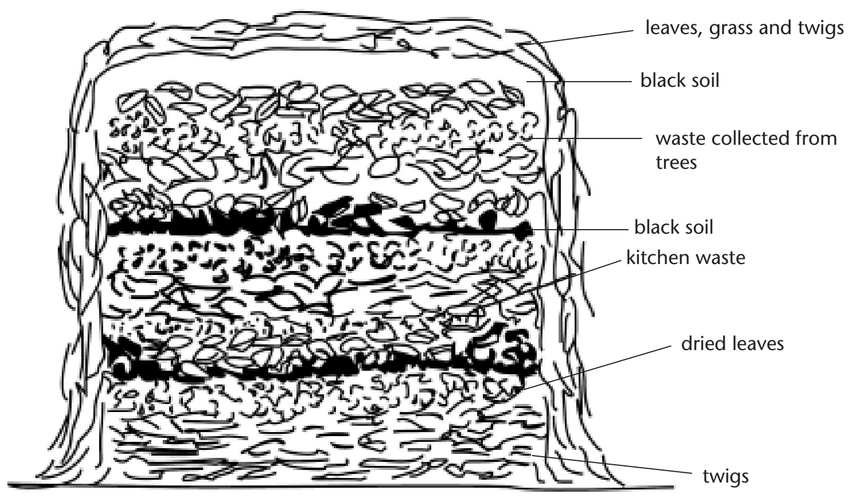
Wood ash from a wood burning stove or fireplace can be added to the compost pile, they are especially high in potassium. Manure is one of the finest materials you can add to any compost pile. It contains large amounts of both nitrogen and beneficial microbes. Manure for composting can come from bats, sheep, ducks, pigs, goats, cows, pigeons, and any other vegetarian animals. As a rule of thumb, you should avoid manure from carnivores, as it can contain dangerous pathogens (disease causing agents). Most manure are considered "hot" when fresh, meaning it is so rich in nutrients that it can burn the tender roots of young plants or overheat a compost pile, killing off earthworms and friendly bacteria. If left to age a little, however, these materials are fine to use.

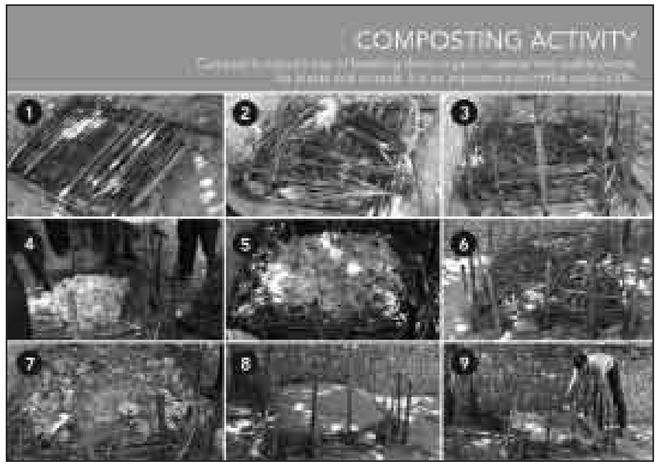
### HOW TO BUILD THE COMPOST HEAP

A compost heap should be built on bare soil and not on a hard surface such as concrete. This is the recommended way to build a compost heap:

1. Firstly make a base 30 centimeters (cm) high and 2 meters (m) wide with coarse plant material such as twigs. This will ensure good air circulation and drainage. (Photo 1)
2. Add a 10cm layer of material that is difficult to decompose such as palm fronds or coconut husks. (Photo 2 and 3)
3. Add a 10cm layer of material that is easily decomposed such as fruit and vegetable scraps. (Photo 4, 5)
4. Add 2cm of animal manure, old compost, if available.
5. Add a sprinkling of soil from the top 10cm of cropped land.
6. Ash and urine can then be lightly sprinkled onto these layers, to accelerate the process of decomposition.
7. Repeat all these layers except the first layer of coarse material, until the heap reaches 1 to 1.5m high. (Photo 6, 7, 8)
8. Then water the whole pile well.
9. The heap should be covered to protect it against evaporation and heavy rain as this will wash away all the nutrients. Sacking, grass thatch or banana leaves are suitable for this. (Photo 9)

Each layer should be laid down by starting at the edge of the pile so that the heap does not collapse. Another way to ensure this is to use a wire mesh (not useful in dry areas because it will allow drying out) or wooden planks around the heap. Air vents, made out of bamboo canes with holes cut in them and placed both vertically and horizontally throughout the heap, will improve the air circulation.




## DISCUSSION POINTS

A. What are the different types of waste you can use in your compost pile?

B. What are examples of wastes that you should not put in your compost pile? Why?

C. Name some examples of carbon rich waste materials?

D. Name some examples of nitrogen rich waste materials?

# COMPOSTING ACTIVITY

Compost is nature's way of breaking down organic material into usable pieces for plants and animals. It is an important part of the cycle of life.









20 minutes

# ENERGY THEORY

What is Energy and why is it important? It's simple – energy is the ability to do work. The sun is the most significant energy source on Earth. Energy from the sun gives us light during the day. It helps plants grow, and then other animals (including us) eat plants and grow and so on. Why do humans need energy? When we eat, our bodies transform the energy stored in the food into energy to do work. When we run or walk, we "burn" food energy in our bodies. When we think or read or write, we are also doing work. Many times it's really hard work! Why do plants and animals need energy? Energy stored in plants is eaten by animals, giving them energy. And predator animals eat their prey, which gives them energy.

Everything we do is connected to energy in one form or another, but most of the time we think of harnessed energy – the energy we use to do things. Energy lights our islands, powers our vehicles, planes and boats. Energy can cool our homes, cook our food, play our music, and transmit pictures on television. Energy powers machinery in factories and dhonis in the ocean. A lot of energy is used by machines, so humans can do less.

## SOURCES OF ENERGY

Energy sources are classified as renewable and nonrenewable. Renewable energy such as solar, wind, geothermal (energy obtained within the Earth), biomass (energy from plant and animal matter), hydro (from rivers) etc, can be renewed through natural processes. Nonrenewable energy sources such as fossil fuels, conventional natural gas, conventional nuclear fission etc, exist in fixed amounts and they cannot grow again or replace themselves naturally.

## SUN – PLANT POWER (PHOTOSYNTHESIS)

Sunlight plays a much larger role in our sustenance than we may expect: all the food we eat and all the fossil fuels (e.g. oil, coal, diesel, natural gas) we use is a product of photosynthesis, which is the process that converts energy in sunlight to chemical forms of energy that can be used by biological systems. **Photosynthesis** (*photo=light, synthesis=putting together*), generally, is the synthesis (making) of sugar from light, carbon dioxide and water, with oxygen as a waste product. It is arguably the most important biochemical pathway known; nearly all life depends on it. It occurs in higher plants, algae and some bacteria. All these organisms convert $CO_2$ (carbon dioxide) to organic material by reducing this gas to carbohydrates in a rather complex set of reactions. Energy for this process is provided by light, which is absorbed by green pigments called chlorophyll.

carbon dioxide + water + light energy ➔ sugar + oxygen + water

## SOLAR POWER – ENERGY FROM THE SUN

The sun has produced energy for billions of years. Solar energy is the solar radiation that reaches the earth. When we hang clothes outside to dry in the sun, we are using the sun's heat to do work – drying our clothes. Solar energy can be converted directly or indirectly into other forms of energy, such as heat and electricity. The major problems of solar energy are: (1) the intermittent and variable manner in which it arrives at the Earth's surface and, (2) the large area required to collect it at a useful rate. Solar energy is used for heating water for domestic use, drying agricultural products, generating electrical energy, etc.

## HUMAN ENERGY - NUTRITION

### Food Groups

There are 3 major food groups, each of which provides nutrients needed for good health.

**1. Energy (carbohydrates)**

Food that provides energy, e.g.: rice, noodles, potato, sweet potato, taro, corn, nuts, bread, coconut flesh, cooking oil, honey etc.

**2. Building (protein)**

Food to help build the body and provide strength, eg: eggs, fish, chicken, red meat, soya bean, lentils, milk, crab, fish, prawns, squid, eel, mussels etc. Two to three servings per day are recommended

**3. Protection (minerals and vitamins)**

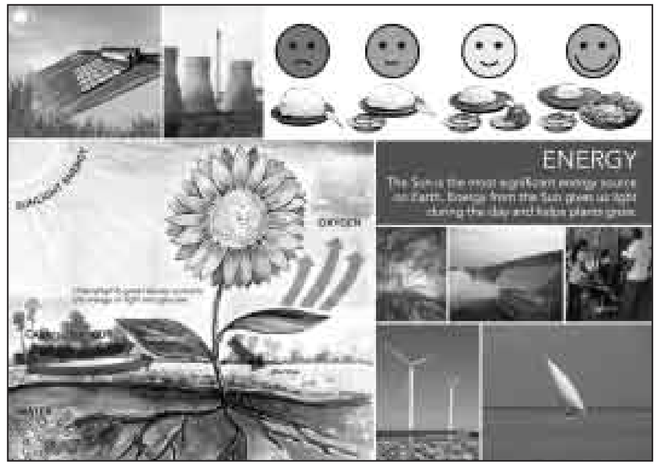
This is what you should eat the most of. Vitamins are found in most fruits and vegetables. They protect the body from harmful viruses and illness. Three to five servings of vegetables are recommended and two to four servings of fruits per day. Minerals also protect you from organic diseases and maintain body fluids (electrolyte). They are found mostly in fruits and vegetables, meat and salt. To maintain health and avoid disease eat a mixture of foods across a range of food types, such as vegetables, fruits, grains, meat and fish. A plate with a variety of colours on it is a simple visual indication of a balanced diet. Variety also means a range of food within the types, e.g. Vegetables can be tomatoes, corn, carrot, cucumber, wax gourd, pumpkin and eggplant. Ideally 20 -30 different types of foods should be eaten within a week. Diversity is the key to a healthy person and a healthy environment.

## WIND ENERGY

Wind is a powerful source of energy. To capture this energy scientists have created wind turbines (see Flip Chart page). In some places wind turbines are grouped together to form wind farms. These are built in places that are exposed to strong winds, such as on the ridges of hills or mountains, or along the coast. Here the turbines capture high levels of energy from the wind and feed it into electricity grids for whole communities to use. In the Maldives, we often get strong gales. In fact a couple of islands (e.g. Baa Goidhoo) are currently experimenting with wind turbines to make energy for their island.

## WATER ENERGY

In some countries people have built dams (called hydro-electric dams) to hold large volumes of water. When this water is released in a controlled way from the dam by a series of gates, the movement of the water creates energy and this can be captured to make electricity for communities to use. This is an example of a renewable energy source, because rainfall will continue to fill up the dam over time.



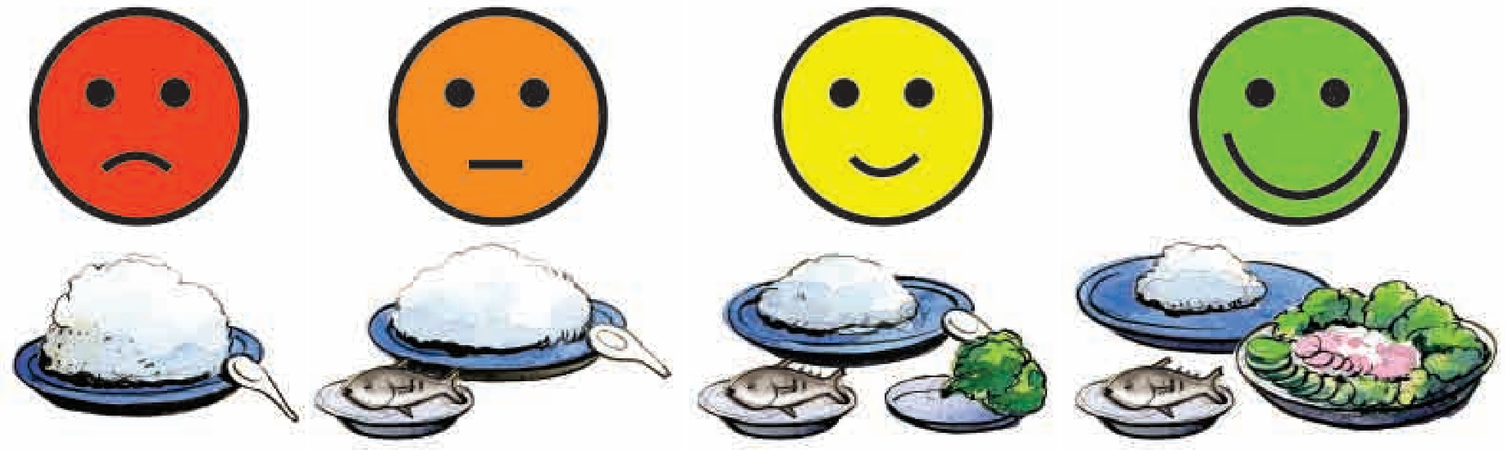

## DISCUSSION POINTS

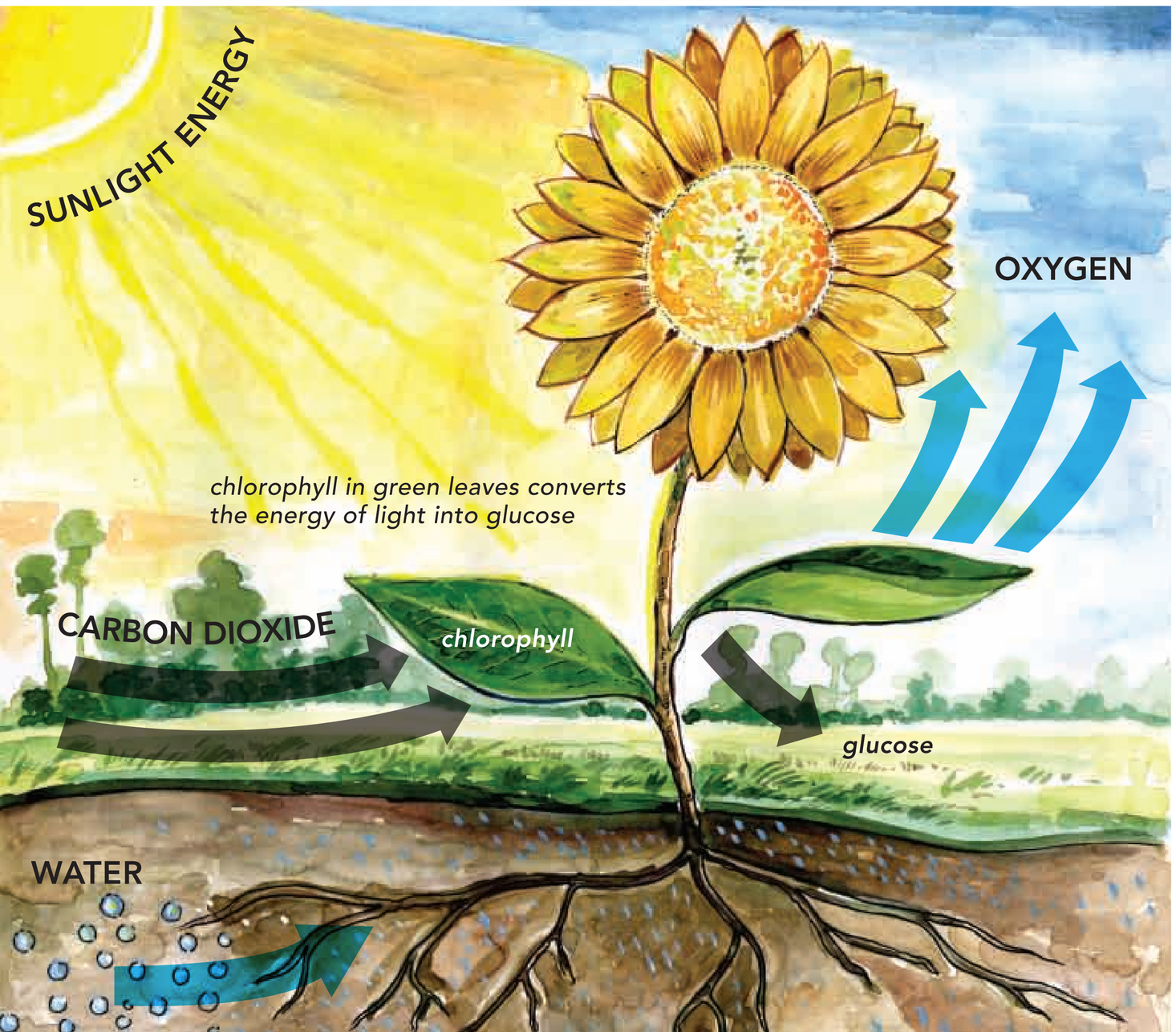
A. How do people get energy for their daily activities?

B. How do plants make energy to grow?

C. What energy do you use at home?

D. Could you reduce your energy use at home (efficiency)?






# ENERGY

The Sun is the most significant energy source on Earth. Energy from the Sun gives us light during the day and helps plants grow.







# ENERGY ACTIVITIES

30 minutes then ongoing

## ACTIVITY 1
## ENERGY AUDIT

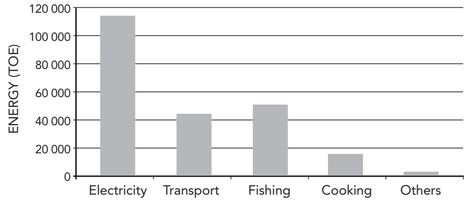
**Materials:** Student resource sheet 2 (school energy audit), student resource sheet 3 (Home energy audit), School energy audit form, Home energy audit form (refer to Student Resource Sheets in 'Energy use at school and at home' section of the Resources from the Environment Module).

**Action:** Ask the students to conduct an audit of the school in small groups. Give a copy of the School energy audit form to fill in. Findings can be similarly graphed and tabled. After this conduct individual household energy audits. Provide the Home energy audit form. Older students can create their own format for a household audit, or can modify the form provided. What kinds of appliances will you need to look at? What kinds of measures will indicate the amount of energy we use?

Students can then graph their home audit information and display it for others to see. Class tallies can be made which will allow comparisons between the different households represented. What is the most popular time of the day for lights to be on? What kinds of lights do most homes use? What are the most commonly used appliances? What is the least used appliance? What is the appliance that is on for more hours than any other appliance? What appliances are least likely to be turned off properly? What mode of transport do most people use?

**Theory:** Energy comes from a variety of sources including food for people and animals. Electricity is made from burning petrol and oil, coal or natural gas. These are non-renewable sources. Electricity can also be made from the movement of water (hydro) and wind, from animal/plant matter (biomass) or from the sun (solar) directly. These are all renewable sources. Nonrenewable sources of energy will run out. Renewable sources will not. Currently most of the world is reliant on non-renewable sources. We need to develop our ability to generate electricity from renewable sources. In the Maldives there are no known reserves of oil, natural gas or coal, so all non-renewable energy producing resources must be imported. Diesel is the most commonly imported source, but petrol, kerosene and LPG are also imported. Electricity in the Maldives is primarily produced by diesel generators. Wind, solar and biogas sources are beginning to be used in pilot locations such as Baa Atoll Goidhoo and Raa Atoll Fainu. Firewood is also burned for energy – cooking, for light etc.

The most common ways of using energy in the Maldives are shown in the table below. Almost 50% of energy is used to make electricity. 43% is used for transport and fishing combined.




*Primary energy usage for different sectors in the Maldives (2002).*
*Graph taken from http://www.meew.gov.mv/energy/*

20 minutes

## ACTIVITY 2
## STATIC ELECTRICITY

**Materials:** Balloons and string

**Action:** Get each group to inflate a balloon and tie it so it stays inflated. Tie a string to each inflated balloon. Rub a balloon on your hair for about 15 seconds. Be sure to rub around the whole balloon. What happens to your hair? What happens when you bring the balloon back close to your hair? Rub the balloon on your hair again and have a friend do the same with the other balloon.
In groups of 2, get students to hold their balloons by the string, letting the balloons hang freely, but without letting them touch anything. Slowly move the 2 'charged' balloons toward each other, but do not let them touch.

What do you see? Do the balloons push away from each other, or do they pull toward each other? Place your hand between the two hanging balloons. What happens? Rub the balloon again on your hair, (this removes some of the electrons from your hair and gives the balloon a slight negative charge), then put the balloon against a wall. It will stick (if the weather is dry) since the negative charges in the balloon will re-orient the atoms of the wall, and a weak electrical force will hold the balloon in place on the wall.

**Theory:** All materials contain millions of tiny particles, called protons and electrons, that have electric charges. There are two kinds of electrical conditions called plus and minus. Protons have positive charges, and electrons negative ones. Usually, they balance each other, but sometimes when two surfaces rub together, some of the electrons rub off one surface onto the other and we can have static electricity. Materials with like charges (all positive or all negative) move away from each other (repel) and those with opposite charges attract each other.

20 minutes

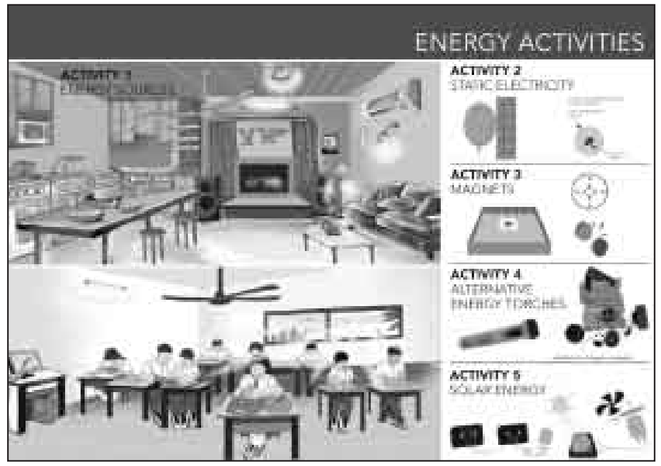
## ACTIVITY 3
## MAGNETS

**Materials:** 2 Magnets and a compass

**Action:** Ask the students to try to get the magnet to stick to different materials – what will the magnets stick to?

Place the magnets near each other – will they stick together in any direction? Place one magnet on a small piece of foam that floats freely in a container of water – does one end of the magnet point in one direction? What happens if you try to make it point in the other direction?

**Theory:** A magnet attracts iron, nickel, cobalt and combinations of those metals. All magnets have North-seeking (N) and South-seeking (S) poles. When magnets are placed near each other, opposite poles attract and similar poles repel each other. Magnets are found in many of our electrical appliances.




30 minutes

## ACTIVITY 4
## ALTERNATIVE ENERGY TORCHES

**Materials**: 2 Magnets, torches and 2 Gyro torches;

**Action:** Ask the students to describe how a torch works. Ask them what powers the torch? If they say batteries ask what powers the batteries? Then get the students to break into two groups. Give each group a magnetic torch and a gyro torch. Ask them to explain how these work if they do not use/need normal batteries.

**Theory:** Everything is made of atoms. Every atom consists of a nucleus, which is surrounded by small moving, negatively charged particles, called electrons. An electrical field surrounds every particle that has an electrical charge. By convention, the lines of the electric field are said to radiate from a (+) particle and move towards a (-) particle. In this case the magnet moves past the field to make electrons. The electrons which move in a current (through the wire) make electricity. The electricity then powers the torch.

20 minutes

## ACTIVITY 5
## SOLAR ENERGY

**Materials:** Solar panel kit.

**Action:** Connect the solar cell and wire with screws and nuts. Connect the solar cell and assemble the solar kit. Use the solar panel to power the fan. Do this outside in the sunlight and then inside in a darker room. Note the difference between outdoors and indoors. When does the fan spin the fastest?

**Theory:** Energy is the power to do work. There are many forms of energy. Energy is neither created nor destroyed - it is simply transferred from one form to another. In this instance, light energy (from the sun) is taken in through the panel and transferred into energy to run the small motor.

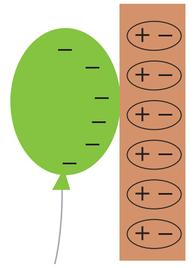
**NOTE:** Do not subject the solar cell module to an excessive heat location, as it will warp the plastic lens. Remember, it is not heat that makes your model function, it is light. A little experimentation will tell you what setting makes your model work best! Please handle all models with care.

# ENERGY ACTIVITIES

## ACTIVITY 1
ENERGY AUDIT IN THE HOME

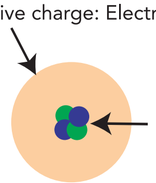
ENERGY AUDIT
IN THE CLASSROOM

## ACTIVITY 2
STATIC ELECTRICITY



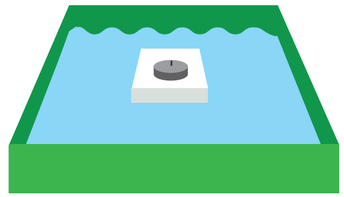
ATOMS - THE BASIC CHEMICAL UNIT
Structure of an Atom

Cloud of negative charge: Electrons



Protons and
Neutrons

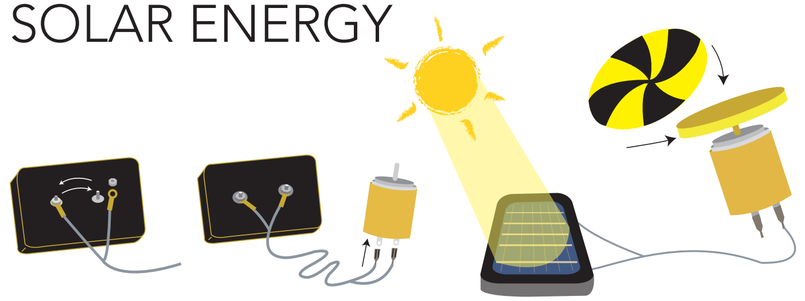
## ACTIVITY 3
MAGNETS

## ACTIVITY 4
ALTERNATIVE
ENERGY TORCHES

Inside the torch, 2 magnets rub together

## ACTIVITY 5
SOLAR ENERGY



30 minutes

# HIGH ENERGY USE/LOW ENERGY USE

Everything we do is connected to energy in one form or another. Plants take energy from the Sun and we take energy from plants. Energy lights our islands, powers our vehicles, planes and boats. Energy can cool our homes, cook our food, play our music, and transmit pictures on television. Energy powers machinery in factories and dhonis in the ocean. However, in recent years we have been using more and more energy and many scientists have been concerned about the impact of all this energy use on the environment and our health. Also most of the fuel that is used by people today comes from non-renewable sources such as oil (ie, we cannot make more of this fuel), so there has been increasing attention on alternative energy sources, such as solar power.

## ENERGY USE IN THE MALDIVES

In the past the Maldives relied mainly on renewable energy sources. All traditional fishing boats were sailboats, the sun helped to dry the tuna and the trees available on the island provided firewood. However, with the development of the Maldives as a major tourist destination, increased standards of living and changes in lifestyle, the Maldives is now a very different place. Now the Maldives uses diesel fuel, a fossil fuel, for transport and electricity generation. However, diesel fuel is made from oil and the price of oil continues to get higher and higher. So the more fuel we use the more expensive it is becoming. Also, the more fuel we burn can cause local air pollution and contribute to global issues, such as global warming.

With the increase in the number of high rise buildings with air-conditioners and other appliances (such as TVs, refrigerators, hot water systems, washing machines, ovens etc) the demand for electricity has been going up significantly in recent years. However, it is not just our homes that consume electricity- it is also non-residential buildings such as schools and offices that use a lot of energy. This is partly due to the use of air-conditioning throughout such buildings.

Also in the Maldives transport consumes a lot of diesel because we need to transport people, food and materials long distances by boat or plane. Also on many islands, especially Male' there has been a huge jump in the number of bikes and cars on the island which has increased local air pollution, energy use and congestion. In 1990 there were only 3000 motorcycles in the Maldives, but by 2003, there were 17,000 motorcycles and 2100 cars! (Ministry of Environment, Energy and Water, 2005)

## ENERGY USE AND GLOBAL WARMING

The atmosphere acts as a natural greenhouse trapping the Sun's heat near the Earth's surface keeping our planet at the right temperature. Without this 'Greenhouse Effect' we would not be able to survive on Earth. However, our modern life and the growth in the global population are causing huge changes to this natural 'Greenhouse Effect'. Whenever we use energy in our cars and boats, we use fossil fuels such as diesel and this adds large amounts of greenhouse gases, especially carbon dioxide, to the atmosphere. These gases are trapping more heat on Earth causing the Earth to heat up- this is known as Global Warming. Many scientists are concerned that increased temperatures will lead to sea level rises and changes to our climate (e.g. some countries may experience drier climates).
In the Maldives such changes may lead to changes in fisheries, as tuna may migrate to places with more favourable temperatures (MoEC, 2004). Also, corals have a limited range of temperatures that they can survive in, so if temperatures rise, the coral reefs may also be affected. This is a major concern for the Maldives.

Although the Maldives is a small country and contributes very little to global greenhouse emissions (0.01%) it is very susceptible to the impacts of global warming (MoEC, 2004). However, the Maldives has played a major role in raising awareness about this issue. In fact the Maldives was the first country to sign the Kyoto Protocol, which is an agreement that 169 of the world's countries have signed showing their commitment to reducing the emission of greenhouse gases.

## HOW TO REDUCE YOUR ENERGY USE

Looking to the future it will be important to design houses and buildings that use less energy. Also where possible we should be using public transport systems and installing alternative energy sources such as wind power and solar power. Some islands in the Maldives already are experimenting with alternative energy sources. Many houses use solar hot water systems and some islands are using wind turbines.

But right now there are many things you can do to reduce your energy use and limit emissions of greenhouse gases. When you buy a new appliance (washing machine/fridge/air conditioner) have a look to see if it has an energy efficiency rating and try and buy the most energy efficient appliance available.

Also, don't forget to switch off appliances (e.g. TVs, lights, stereos) when you are not in the room. Remember to switch off your appliances at the plug, as they are still using electricity in the standby mode. For air-conditioners it is important to choose the right size for your needs. Also temperature control is important to reduce electricity use- most people are comfortable around 24°C. Also don't forget to clean the air filters regularly so the air-conditioner operates efficiently. You can also dry your clothes in the sun, instead of using a dryer, sit in the shade of a tree instead of turning on the fan or air-conditioner, or walk up the stairs instead of taking a lift. Lastly, don't forget that you can ride a bicycle or walk to school instead of catching a taxi or motorbike. With every decision that you make you can choose to be a high energy user or a low energy user! Help to save the environment and save money! Remember it's up to you!

1 hour

## ACTIVITY
## ENERGY REDUCTION

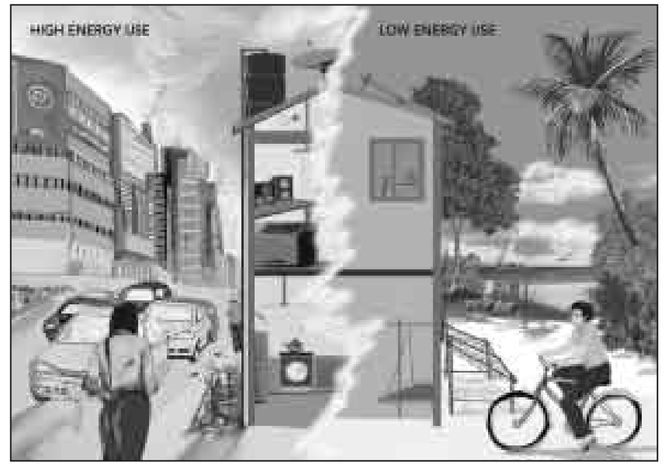
**Materials:** Large white paper and colored markers.

**Action:** As a class discuss ideas for reducing energy use in the classroom. Develop a list of possibilities and conduct a class vote on which changes students would like to make (e.g. voting about turning on lights rather than automatically turning them on).

To support these actions, create an energy reduction ideas chart for display in the classroom.

In pairs students can create signs, prompts and posters for school and home to help each other remember which energy saving actions they are trying to take. These prompts might be signs to be stuck on light switches to remind people to turn them off, prompts on fan controls to check the temperature before turning it on (have a temperature agreed to), prompts to remind people to turn off appliances, etc.

**Theory:** We all use energy in our homes, schools and offices. We can be a high energy user or a low energy user. Students should be encouraged to reduce energy use. Raising awareness signs and posters will help to reinforce this message that we can all play a part in reducing our energy use.




## DISCUSSION POINTS

A. Give 3 examples of high energy use?

B. Give 3 examples of low energy use?

C. How is energy use connected to global warming?

D. How can you reduce your energy usage at home and in the classroom?

References: MoEC (2004) '*State of the Environment Maldives*' Ministry of Environment and Construction
Ministry of Environment, Energy and Water (2005) '*Sustainable Transport Management in Male': Strengthening Maldivian Initiatives for a Long-term Energy Strategy*' MEEW, Male'

HIGH ENERGY USE

LOW ENERGY USE