



**Education for Sustainable Agriculture in the Maldives
Facilitators Tool kit**



Live & Learn Environmental Education

Building a Sustainable Future: Education for Sustainable Agriculture in the Maldives

Facilitator Tool Kit

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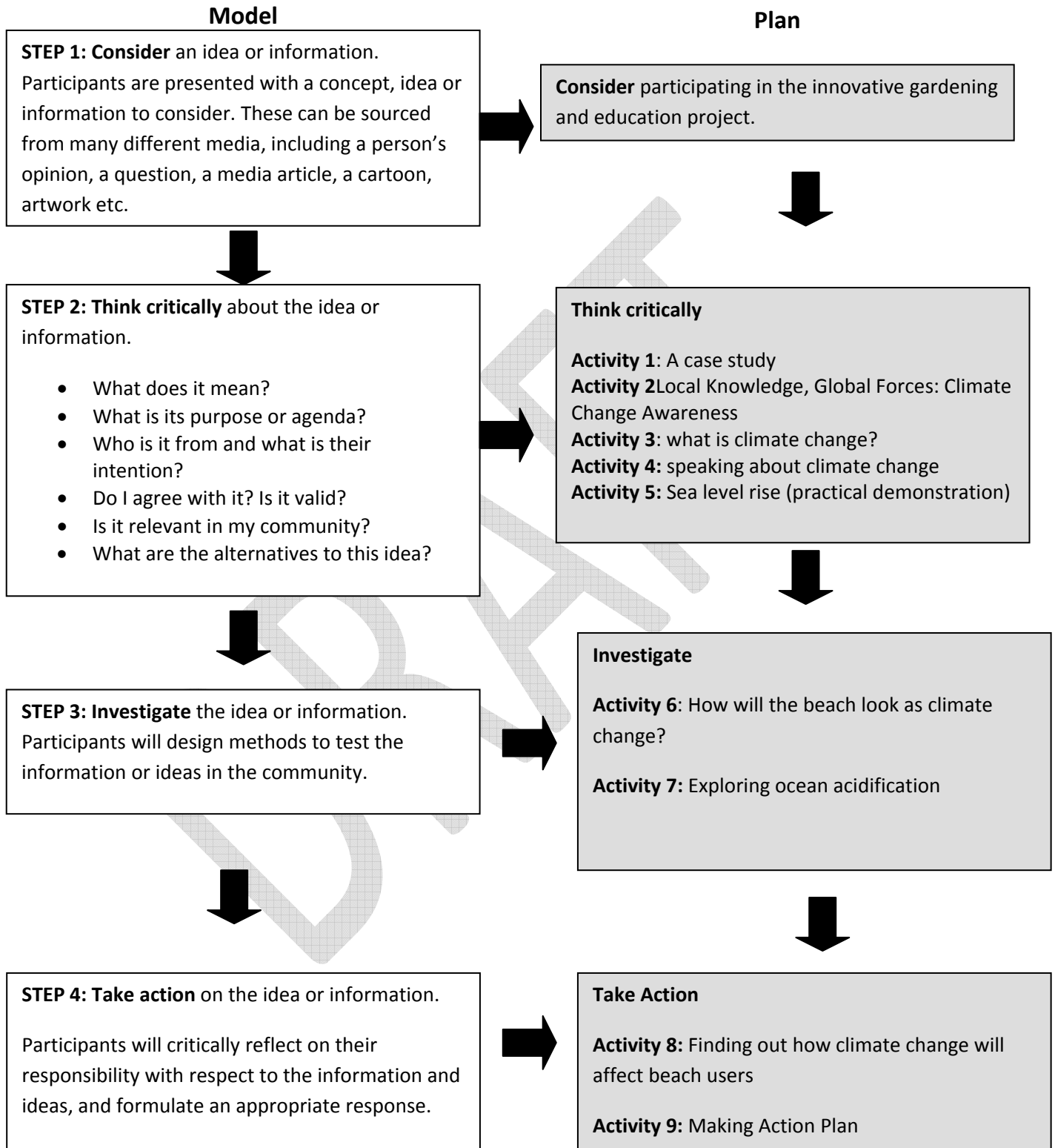
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A Critical Thinking Model



Introduction

The Project has been designed based on the widely accepted premise that global Climate Change represents both the most immediate and most significant threat to coastal resource management in Maldives. While it is true to say that concern and understanding about the causes and consequences of global Climate Change are now well established at the national level within Maldives, at the community level there is much less awareness of the threat posed by Climate Change to individual islands and the actions that could be taken to strengthen community reliance to Climate Change.

The Project's aim is to initiate practical action and ensure future action is planned by Island, Atoll and Provincial stakeholders and in particular by island women, to strengthen community resilience to Climate Change in five islands in Baa Atoll, in the North Province by December 2012.

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Context

The Maldives are a chain of 1,190 small low-lying coral islands grouped into 26 Atolls in the Indian Ocean: 198 islands are inhabited and 80 house tourist resorts. The islands are predominantly coastal entities. The Maldives have a narrow economic base that relies on 2 critical sectors: tourism and fisheries. Unique geography and vulnerability pose key development challenges for the country. The dispersion of the population across the archipelago raises the cost of delivering social services, as economies of scale are difficult to achieve in service provision.

Each Atoll is administered by an Atoll Chief (Atholhu Veriyaa) appointed by the President. Atoll Chiefs administer as directed by the President. The Ministry of Atoll Administration and its Northern and Southern Regional Offices, Atoll Offices (AO) and Island Offices (IO) are collectively responsible to the President for each Atoll's Administration. The administrative head of each island is the Island Chief known locally as the Katheeb, who is also appointed by the President. The Island Chief's immediate superior is the Atoll Chief. The Atoll Chief's immediate superior is the Provincial State Minister; also appointed by the President

Baa Atoll is the southwestern most Atoll in the North Province (see Annex A). There are 13 inhabited islands, 57 uninhabited islands and five resort islands in Baa Atoll. The distance from Baa Atoll and Male' is between 58 and 74 miles. The capital of Baa Atoll is Eydhafushi.

Live & Learn selected Baa Atoll as the location for the MFF Project after conducting consultations with UNDP, EPA and AEC. During these discussion it was decided and agreed that the project will be implemented in Baa Atoll, due to the following reasons;

- Currently there is an ongoing project funded by UNDP in Baa Atoll, which is the AEC project, therefore UNDP stated that it will be easy to monitor 2 projects if they take place in the same region.
- As highlighted by both UNDP and EPA, there is also a livelihood component in the AEC project, which is also in line with MFF.
- These areas are representative of the most diverse terrestrial and non terrestrial environments in the Maldives and the Indian Ocean.

- The selections of these sites were guided by the comprehensive report: Valuing Biodiversity: The economic case for conservation in the Maldives¹.
- Further to this Baa Atoll was selected as a priority through our partnership with UNDP, EPA and AEC as these are representative of important ecosystems under pressure from many interests including tourism, fisheries and island-based subsistence.

Following this decision, the four islands where the Project would be implemented were proposed, once again in consultations with UNDP, EPA and AEC. The four islands selected were Maalhos, Goidhoo, Kudarikilu and Dharavandhoo. During the revision stage of the proposal, Goidhoo was replaced with Kamadhoo and Kihaadhoo, after considering the relatively more easy access and transportation to these two islands, than to Goidhoo, which was the most remote of the four islands originally proposed. Kamadhoo and Kihaadhoo were also included due to the existing agricultural practices on the two islands. As a result the original plan to work in four islands was revised to enable the Project to target five islands in Baa Atoll, Kudarikilu, Kamadhoo, Kilhahdoo, Dharavandhoo and Maalhos in Baa Atoll.

Think critically

ACTIVITY 1: A case study

Purpose: To share some case studies

Time: 45 mints

Materials: Case studies

What to do: Share the case studies with the participants.

Seenu Maradhoo

Being two islands on the same land, Maradhoo and Maradhoo Feydhoo experience similar type of conditions. The land on the North Western side of the island is noticed to erode along the entire coastline. However, this eroding is not considered as an issue of much importance.

According to sources, it is known that the island experienced 'Bodu Vissaara' (meaning heavy rain) during the June – July of the year 1991. During this natural disaster, the island had suffered great losses, such as erosion of a large part of the beach and felling of trees. Hence, it disturbed the natural equilibrium of the beach (eroding and land formation) and suddenly destroyed a large part of the beach which had taken years to form. The incident that occurred in 1991 could have been a possible cause for the continuous erosion of the island at present.

According to the island office, the land in the North West, subject to erosion is said to have had a vast area of land in the past. An estimated amount of 32, 1080 square kilometers have been reported to have been eroded from the area within the past thirty years or so. The area, although famous for its rocky beach (locally called "aanugan'du"), is said to be usually soft.

Hanke'de' and Gauke'de'

This area is a narrow, but quite long stretch of land between the islands Maradhoo and Hithadhoo. The road joining Maradhoo and Hithadhoo runs through these two islands. The narrowness of the island makes it prone to erosion and therefore, puts the road at risk.

The erosion of Gauke'de' is to be taken as a serious issue and efforts have already been made to protect the area. Part of this area had been protected by a revetment wall. The area has been specifically considered to be at risk, as the area that is eroding is about to reach the road. The clearing of trees in

the area, to make way for the road could have been a possible cause for this erosion. Immediate action needs to be taken to conserve this area.

Gan

The largest island in the Maldives, Gan in Hadhdhunmathi atoll comprises of 516.59 hectares and has been divided into three wards for the convenience of administrative purposes. Though vast in terms of land, its width is 1400 metres compared to its length of 6800 metres, making it long and narrow. Therefore, the area lacks thick vegetation, despite its vastness. Until 2007, the island has a small population of only 972 people and land for housing had not been leased under an appropriate land use plan. Gan, where a lot of international companies have invested infrastructure-wise, also has the advantage of being connected to nearby islands such as Kahdhoo, Fonadhoo and Maandhoo. The island was visited to attend discussions on two important environmental issues.

1. Removal of sand from particular areas of the coast for various purposes.
2. Extraordinary erosion of the northern side of the harbour in Gan.

The problem of excessive removal of sand from the beach.

'Thundi' ward of Gan

The most northern ward of the island, known as Thundi ward, is faced with the serious problem of removing sand from the beach. Investigations made by a survey team revealed that there had been huge pits dug in the sand, suggesting that the island has eroded due to excessive removal of sand from the area. Removing sand has become so extreme in the area, due to the illegal trade of sand taken from the beach. **This may be due to the fast development in projects that require a lot of sand these days.** This includes constructing houses, buildings or roads either financed by government aid or that of other international organisations. According to the residents of the island, they were strongly against this.

A pit dug by protestors to block the vehicles that carry sand, in order to stop illegal removal of sand from the beach

ACTIVITY 2: what is climate?

Purpose: To find out what participants already know about climate change and where the gaps are.

Time: 1 hour

Materials: A film about climate, Two sheets of flipchart paper, with:

- 'Climate change – what we know' written in the middle of one and
- 'Climate change – our questions' in the middle of the other

What to do:

Ask the groups to put up their hands if they have heard of 'climate change' or 'global warming', and then brainstorm with them:

- What they know about it
- Our questions

Write the responses up as a connections web on the flipchart paper.

At this stage, accept all their ideas and don't attempt to clarify or explain.

Pin up the two flipchart sheets to add to later.

Show them a film which shows climate change in different areas.

After showing it once, tell them that you are going to play it again. Remind them to note anything that they think is necessary. Ask the class to look out particularly for the **causes** of climate change identified by the film. Take feedback of the main causes onto flipchart paper.

Go back to the flipchart sheets:

- Do you want to add anything?
- Has the film answered any of their questions?
- Has it raised more questions they want to add?

Add anything they say to the appropriate flipchart.

Present the group work.

ACTIVITY 3: speaking about climate change

Purpose: Investigate the causes of climate change and climate change's impact on the local environment.

Time: 90 minutes (Full day if conducting demonstration using the seedlings).

Materials: Two small thermometers or two small seedlings in a small pot (no larger than 5cm diameter), One large clear glass jar, 1 plastic box or bucket, 1 brick or piece of wood the size of a brick that will sit inside the plastic box or bucket, 1 ruler, Large piece of ice or several ice cubes, Water, Blue Tack or sticky tape, World map or drawing of the world including the Arctic and Antarctica, coral bleaching (fact sheet), diagram in the fact sheet

What to do:

Activity summary

In two demonstrations, participants will learn how global warming happens, be able to explain why the climate is changing and understand how climate change will impact on the local environment.

Tuning in:

- 1-Before you begin the activity ask the participants how much they know about different types of weather and climate. Explain the difference in weather and climate: Weather means the daily descriptions of what is happening, i.e. *sunny and hot today, raining and cold tomorrow. Climate describes the long term variations of an area, for example, in New Zealand; there is a winter, which is very cold, and a summer, which is warm.*
2. Ask participants to explain what the weather and climate is like in their area. You could expect to receive answers such as: *We have a wet and dry season, where the wet season has a lot of rain and is very humid and the dry season usually has a lot of sunny and warm days.*
3. Ask participants if they have ever heard of global warming. Ask the participants to refer to fact sheet (what is climate change) show the diagram in the fact sheet and ask participants to have a look. Ask the participants if they think global warming could have an effect on their lives. Ask them to provide reasons for their answers and note down.

Developing understanding

Global warming experiment

1. Discuss how in our daily activities we might add to the amount of bad gases in the atmosphere. Ask participants if they are aware of what we do that does this. Assist participants with their answers.
2. Explain that an increase in these bad gases will cause temperatures to rise and climate to change. Help participants to understand how this happens by using information from the fact sheet (**Gases trapping heat**)

Tell the participants that they are going to undertake a demonstration that aims to simulate global warming.

3. Place two thermometers or two small seedlings side by side on the same kind of surface outdoors. If using the seedlings you should start this activity in the morning, leaving the seedlings for several hours, to see the effects in the afternoon.

4. Explain to the participants that the glass jar will represent the blanket of gases that surround the earth, which is very thick because of the increase in bad gases released into the atmosphere. Ask for a volunteer to then cover one of the thermometers with the large jar. *If you are using seedlings, cover one of them; note, this would have been done in the morning.*

5. If using a thermometer, you do not need to begin this activity in the morning as with the seedlings. Record the readings from each thermometer at the beginning of the experiment, again after 30 minutes and again after one hour. If you are using seedlings describe their appearance after 3 hours and again at the end of school.

6. Discuss the results. What were the differences in temperatures shown on the thermometers? or indicated by the seedlings between the one covered by the 'blanket of gases' (simulated by the jar) and the one that is not covered. Note that the seedlings indicate temperature by the level of wilting.

7. Discuss how the increased thickness or concentration of bad gases causes the Earth to become warmer. In the case of the seedling, the extra heat caused it to wilt more in comparison to the other seedling. Discuss the sorts of impacts that an increased temperature would have on the participants and their surrounding environment.

ACTIVITY 4: Climate Change Awareness and agriculture

Purpose: To critically examine how climate change is affecting island agriculture in the island.

Time: 40 minutes

Materials: Paper and pens

Copies of **Factsheet 1** (Climate Change)

Camera and/or video camera to document activity

What to do:

Divide the participants into three groups. Give each group paper and a pen.

Ask each group to think about agriculture and gardening on the island. Have them divide the paper into three sections (i) things that were grown on the island before; (ii) things that are currently grown; and (iii) why they think the plants grown have changed.

Have each group present their findings to everyone. Encourage discussion about why things have changed.

After all three groups have presented, ask everyone whether they know what climate change is, and to explain it and how it might affect them and their island. If volunteers seem hesitant, give the groups a few minutes to think about it and list answers on their paper; then have them present to the group.

Distribute **Factsheet 1** and give them a few minutes to read it.

Ask everyone if they think climate change may have had an impact on gardening on the island. If so, how?

How does this relate to the gardening project? Why are new gardening techniques necessary?

ACTIVITY 5: Sea level rise (practical demonstration)

Purpose:

Time:

Materials: Flip chart, world map, water, bucket, ice cubes, A 4 papers,

What to do:

1. When you are satisfied that participants understand the concept of global warming, use the following demonstration to show how climate change can affect our world. If you have a world map point to the Poles and ask the participants if they know what the environment is like in these areas. If your participants have difficulty with this, lead them with clues such as: *These areas are further away from the Sun. We are in an area that is close to the Sun...Here we are hot...so there would be...* You should get answers such as cold and dark. Use their answers to expand on what the areas are like, e.g. that they are mostly covered in snow and ice.

Explain to the participants that we are going to see whether an increase in a few degrees (which is what scientists predict will be the effect of climate change) can cause much damage to the world.

Conduct the demonstration:

2. put a piece of wood or stone into the bucket or plastic box. Fix a ruler to the inside of the box with sticky tape or Blue Tack.

3. Put the ice on the block of wood or brick. This represents ice, just the like the ice and glaciers that cover land in the far south and far north of our planet.

4. Ask a participant to pour water into the bucket until the level is just below the top of the block.

5. Get another participant to record the level of water on the ruler. Leave the box to warm up to room temperature, and all the ice has melted. This should only take about 10 minutes.

6. Tell participants to draw a diagram of the experiment and the table (below) in their notebooks. Record the level of the water after the ice has melted.

	Level Before	Level After	Change in level
Land ice Box			

7. After the participants have completed the measurements and entered it into their notebooks, you could generate a discussion with the following questions:

- What causes ice to melt?
- Why did the water level rise in the bucket?
- With global warming, we are expecting the icebergs and ice sheets covering land at the Poles to melt. If the ice melted at the Poles, causing the sea level to rise, how would it affect your coast?

8. Make a list of possible effects to your community (or a coastal community you know) if the sea was to rise by 1 metre.

Reflection

1. Ask your participants to imagine the impacts on their lives if the coral reefs found on their coasts were to disappear because of global warming.

2. Either photocopy or handout the **coral bleaching** (fact sheet) study below for participants to read through or read it out loud to the whole class.

3. After the participants have had read through and think about it, ask them to respond to the following questions by writing it in their not books.

- Why are coral reefs important?
- How do you feel about the threat to coral reefs?
- What would change in your community if you didn't have coral reefs?
- What changes could your community make so that it could survive without coral reefs?
- What do you and your family do that may contribute to the climate change problem?
- What could you or your community do to help address the impact of climate change? (Aim to list 5 to 10 things you can do.) Refer to 'Adaptation: protecting your community' and 'Speaking up about climate change' sections of this booklet to assist participants.

Investigation

ACTIVITY 6: How will the beach look as climate changes?

Purpose: Think how climate change might impact our beach and how it will look in 10 and 20 years time

Time: 1 hour

Materials: A3 papers, markers, pencils, colours

What to do:

Discuss how climate change might impact your beach and how it will look in 10 and 20 years time. Items to consider are:

- Size of the beach: will it be larger or smaller?
- Trees and vegetation behind the beach: will they still exist?
- animals: will the crabs, birds, fish and coral reefs still be as plentiful and healthy as they are now?
- Buildings behind the beach: will they be in the same condition and will there be more buildings?

Ask the participants to draw the beach as it is now and as it might be in 20 years times, taking into account the possible impacts of climate changes and note down the changes that they think will occur after 20years.

ACTIVITY 7: Exploring ocean acidification

Purpose: Discuss how ocean acidification works by showing examples.

Time: 1 hour

Materials: Vinegar, rock, sea shells, powdered chalk, beach sand, egg, glass or jars

What to do:

1. **Observe and record**→ Place some specimens of rock, sea shells, powdered chalk and beach sand in separate glass jars. Cover each specimen with vinegar and let the samples sit for an hour or so, or even overnight. Bubbles will form on the specimens containing calcium carbonate. The vinegar, which contains acetic acid, reacts with the calcium carbonate to produce calcium acetate and carbon dioxide (the bubbles).
2. Alternatively place an egg in a jar and cover the egg with vinegar. Wait a few minutes and look at the jar. You should see bubbles forming on the egg. Leave the egg in the vinegar for a full 24 hours in the refrigerator. After the 24 hours, carefully pour the old vinegar down the drain and cover the egg with fresh vinegar. Place the glass with the vinegar and egg back in the refrigerator for a full week. One week later pour off the vinegar and very carefully rinse the egg with water. The egg looks translucent because the outside shell is gone. The egg shell is made of calcium carbonate and is dissolved by the acetic acid in the vinegar.

Discuss how ocean acidification works→ Carbonic acid in the oceans works in the same way as the acetic acid in the vinegar, it dissolves the calcium carbonate. Ask the participants to:

- list all the animals on the beach that have shells or skeletons made of calcium carbonate and ask them what will happen to those animals as the ocean acidifies;
- discuss how acidification affect the food chain and the world’ s fisheries;
- Think about how acidification will affect the beach and coral reef.
- 4-Discuss what, if anything can be done:
- reducing carbon dioxide emissions;
- improving the health of coral reefs, e.g. by reducing pollution, preventing over-fishing, creating marine protected areas;
- Making everyone, from fishermen to politicians more aware about ocean acidification.

Take Action

ACTIVITY 8: Finding out how climate changes will affect beach users

Purpose: To understand effect of climate change

Time: 1 hour

Materials: A4 papers, pens,

What to do:

1. Brainstorm with the participants how they think climate change will affect their beach. Some suggestions include:
 - beach will erode and get smaller as a result of rising sea levels;
 - rising temperatures will cause coral bleaching and the corals may die;
 - high waves from increased storms and cyclones will undermine the trees and as a result they will fall down and die providing less shade for the beach;
 - a more acidic ocean will result in fewer shells and marine animals;
 - there will be no space or vegetation for the sea turtles to nest;
 - Rising air temperatures will make the beach too hot to visit.

This list contains mainly negative changes likely to affect tropical beaches, but in some parts of the world there may be positive changes, e.g. in temperate climates, the warmer temperatures may make the beach a more attractive environment for visitors and residents.

Categorise: the users of the beach:

- Are users' residents or tourists or both?
- What type of groups use the beach: families, couples, party-goers, fishermen?
- Are the beach users ecologically conscious or not?

How to measure: Design a questionnaire to find out how the beach users at your beach will respond to one or two of the most relevant climate change impacts. An example is given below. Your questions will

depend on the particular climate change impacts that are most important at your beach and the type of beach users.

Sample Questionnaire

The most significant climate change impact at the sample beach is beach erosion.

1. Are you a resident or a tourist?

2. (If you are a tourist) is this your first time to this island (country)? Yes No

3. Climate change is going to erode this beach and it will get smaller:

Would you still come to this beach if it were 50% smaller? Yes No

Would you look for a different beach? Yes No

Would you select a different holiday destination? Yes No

Would you stop going to the beach altogether? Yes No

4. If there were no trees at this beach:

- Would you still come to this beach? Yes No
- Would you look for a different beach with shade? Yes No

5. When you visit this beach do you go: swimming Yes No?

- snorkelling Yes No
- diving Yes No
- walking Yes No
- other (please specify)

6. Where do you live?

7. Is climate change a big issue in your country?

What will the measurements show Tabulate the results of your survey. Discuss the responses with the participants and ask them whether they expected these results. You might like to share the results of your survey with a government environmental department or a tourism agency since this might sensitise officials as to how beach users value the beach resources under threat from climate change.

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ACTIVITY9: Water spectrum

Purpose: To critically examine that all the water used and disposed in houses are not equally contaminated and to understand that some water is not contaminated with bacteria.

Time: 1 hour

Materials: Markers and paper

What to do:

All the water used and disposed in houses are not equally contaminated. Some water is not contaminated with bacteria. For example water containing sewage (toilet flushing) is much more contaminated than dishwashing water. This is because sewage contains dangerous bacteria which are not found in dishwashing water.

In this exercise we will arrange on a spectrum, the most contaminated water to the least contaminated water used and disposed in households.

1 – Divide participants into groups and select a leader

2 - Each group will prepare a spectrum. The types of water and where on the spectrum it comes should be discussed within the group.

3 – Each group then will present their spectrums and discuss the differences with other groups. After this prepare a final spectrum with all groups participating and discussing. Then mark with an arrow, from which level the water is good enough to dispose in to ground for recharging ground water.

Ask the groups to think about the water issue on the island and to come up with a plan to minimize this issue.

ACTIVITY10: Making Action plan

Purpose: To have some ideas of how you can start to plan in your own community.

Time: 1 hour

Materials: A3 papers, markers, colours, rulers, pencils

What to do:

- 1- Divide the participants into three equal groups. Make sure there is equal number of men and women in the committee, including older and younger people. It's important to make sure men, women, younger people and older people in your community are part making an action plan.
- 2- *Gather information:* In separate men's and women's groups write down all the big weather events over the past 30 years – like big storms or flooding. How did your community respond to these events? How did you try to protect the village?
- 3- *Mapping:* While still in groups, draw a map of your village/community including all the houses, water supply, gardens and churches. Have you noticed changing planting seasons or changing winds? Next draw on top of this map all the dangers that might face the community. Where is the sea level rising? Which houses will be hit first by strong winds? Who are the people in the village that might need help in an emergency? Next, think about what resources does your community already have that you could use to help protect against these dangers?
- 4- *Discuss and make a plan:* Once you are finished, bring together the women's map and the men's maps and look at the difference and similarities. Discuss how your community can work together to protect against the dangers faced by climate change.

Fact sheets

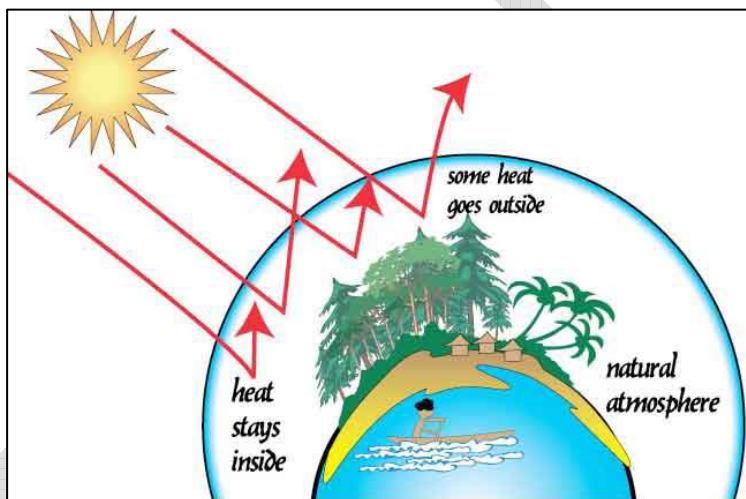
What is climate change?

The atmosphere

The Earth has an atmosphere that covers it like a blanket. The sun shines down on the Earth. Some heat is trapped between the Earth and the atmosphere. Some of the heat goes back out.

The blanket is made up of different gases. One gas comes from water that has floated up from the ocean (evaporation). Water helps to keep heat on the Earth. The heat that stays on Earth is the right amount for people to live and plants to grow.

An increase in the quantity of gases is making the natural blanket of the atmosphere thicker. One of these gases is carbon monoxide which comes from cars.



In the natural atmosphere some heat stays inside and some heat goes outside. There is natural balance that is the right amount for people to live, and for plants to grow.

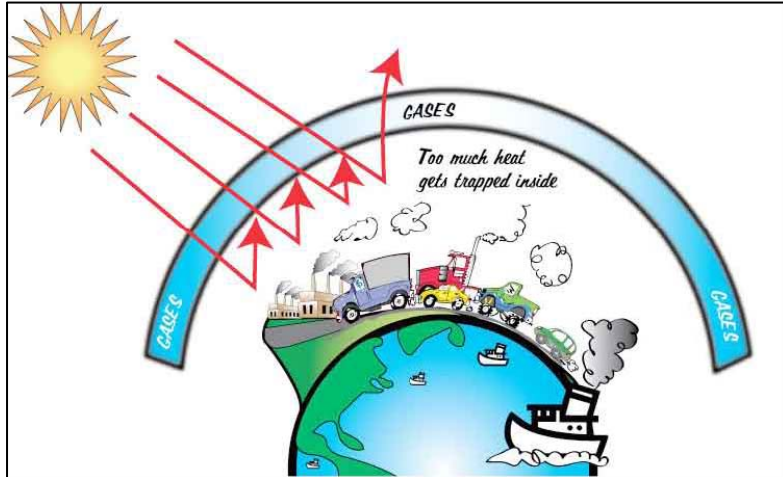
Gases trapping heat

There are other types of gases (like carbon monoxide and carbon dioxide) that also trap heat. These gases are known as *Greenhouse gases* and are produced when fuels such as diesel, or coal are burnt.

These fuels are burnt to power a car or to make electricity. Burning trees also releases these greenhouse gases.

You cannot see the blanket these gases make, because the gases are invisible.

Countries like Australia, the United States and China produce more greenhouse gases than the Solomon Islands. This is because they drive more cars, have more factories and use a lot of electricity in their homes and businesses.



Gases from cars and factories and airplanes make the blanket around the Earth thicker and thicker. This blanket traps heat making the Earth become hotter. This is called global warming.

Global Warming

The gases from cars, factories and airplanes float up into the sky and make the atmosphere thicker and thicker, similar to a blanket. This thick blanket stops heat from leaving the Earth. Over time, more heat will be trapped between the blanket and the surface of the Earth. This thick blanket wrapped around the Earth is causing the Earth to become hotter and hotter. This is called global warming.

Climate Change

The thick blanket of gases in the sky is making the Earth hotter. The warming of the Earth is causing the normal wind and rainfall patterns to change. In Solomon Islands this could change the planting seasons.

Cyclones could become stronger.

Together these changes are called climate change.

Sea Level Rise

The increase in temperature, or climate change, is affecting every country, not just the countries that produce the extra gases.

Many villages in the Solomon Islands have noticed the sea level rising.

This is happening for two reasons. The first reason is melting ice. There is a lot of ice at the bottom and the top of the Earth, known as the North and South poles. As the Earth is warming, this ice is melting.

The melted ice runs into the sea and is making the sea level rise.

The sea is also getting bigger as it gets warmer. This is the second reason why the sea level is rising.

Water takes up more space as it gets warmer. In the Solomon Islands the rising sea is washing away the beaches and coconut trees, covering graveyards and destroying crops.

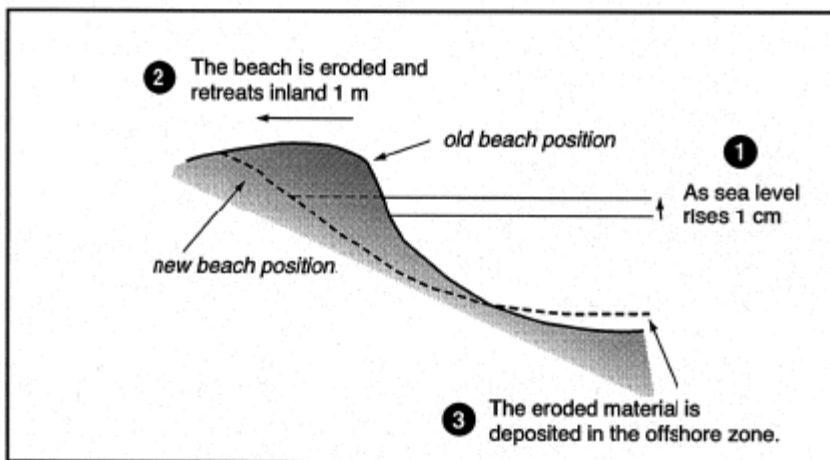
The salt water is also getting into wells and other places where people usually collect fresh water.

Beach erosion and sea level rise

As the temperature rises, the ocean water expands, and this change combined with the melting of the polar ice caps and glaciers, results in a rise in sea level. Rising sea levels result in increased beach erosion, reducing the area of beaches and impacting coastal habitats. Of particular concern is the fact that sea level will continue to raise for centuries, regardless of mankind's efforts to stabilise greenhouse gases. This is because the temperature of deep ocean water changes very slowly, so the process of expansion that has already started cannot be stopped in just a few decades.

Research shows that for every 1 cm of sea level rise the shoreline will retreat inland 100 times that amount. This is known as the Bruun Rule and is essentially an approximation that varies according to the physical characteristics of the particular beach and the offshore slope. However, it is a useful rule of thumb that can be used to illustrate how the predicted global sea level rise of less than a metre will have a major impact on beaches around the world.

Bruun Rule



The Bruun Rule, as shown above, shows that as sea level rises by 1 cm, the position of the beach retreats inland by 1 metre, as sand is transported from the beach to the offshore bottom.

Bad weather

Climate change will increase the strength of cyclones, floods and droughts (long dry time). Tropical cyclones in Solomon Islands cause strong winds, high waves and flooding from heavy rains. Cyclones and strong winds can damage houses and gardens and cause harm to people.

Coral reefs and fish

Global warming will also cause the sea to become warmer, A hotter sea will have a negative effect on fish and corals. Coral reefs are very important in the Solomon Islands. Coral reefs provide a home and food for reef fish and other types of fish. Without the corals, fish cannot survive. Corals also supply sand to beaches and help make reef islands. If the sea becomes too hot, corals will not survive. If the coral gets too hot for a long period of time they turn white. This is called bleaching. Bleaching makes the corals very sick and sometimes they die. Warmer seas have already damaged and killed some coral. More coral may die if global warming is not stopped.

Weather and climate

People talk a lot about the weather, which is not surprising when you consider the impact it has on our mood, how we dress, what we eat and what we do. Weather is a term that describes the current atmospheric condition at a given place and time and includes temperature, moisture, wind speed, and barometric pressure, among other things. Climate is not the same as weather. Rather it is the average pattern of weather for a particular region over a long period of time, usually at least 30 years. So while weather changes from day to day and the changes are easy to see, it is not so easy to detect climate changes, which instead requires long periods of careful measurement. It is impossible to look at short term weather changes for any given area and make valid statements about long-term climate change.

Climate change

Climate on earth has changed continually as the planet has evolved geologically. Natural causes include changes in the amount of the sun's solar radiation reaching the earth, and volcanic eruptions that can shroud the earth in dust thereby reflecting the heat from the sun back into space. Most of the historical changes in climate have occurred on time scales far longer than a human life – centuries, millennia or millions of years.

Natural causes, however, can explain only a small part of the present warming trend that has been observed during the second half of the 20th century. There is now unequivocal evidence that the earth's climate is changing as a result of human activities, principally increased carbon dioxide emissions, since pre-industrial times (1700s). The overwhelming majority of scientists agree that rising concentrations of heat-trapping greenhouse gases in the atmosphere are causing the climate to change.

Energy from the sun warms the earth's surface and, as the temperature increases, heat is radiated back into the atmosphere as infra-red energy. Some of the energy is absorbed within the atmosphere by 'greenhouse gases'. The atmosphere acts in a similar way to the walls of a greenhouse, letting in the visible light and absorbing the outgoing infra-red energy, keeping it warm inside. However, human activities are adding greenhouse gases, particularly carbon dioxide, methane and nitrous oxide, to the atmosphere, which enhances the natural greenhouse effect and makes the world warmer.

Climate change is defined as a change in climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and is observed over long time-periods (many decades).

Climate change predictions

The Intergovernmental Panel on Climate Change (IPCC) is one of the most accurate sources of information on climate change. The IPCC was established in 1988 to provide decision-makers and others interested in climate change with an objective source of information. The IPCC does not conduct any research nor does it monitor climate related data or parameters. Its role is to assess on a comprehensive, objective, open and transparent basis the latest scientific, technical and socio-economic literature relating to climate change. The IPCC consists of thousands of scientists from different disciplines, who work together to produce assessment reports at approximately five year intervals. The IPCC supports the United Nations Framework Convention on Climate Change (UNFCCC), which entered into force in 1994 and provides the overall policy framework for addressing climate change. Whilst the IPCC reports are very technical, they do contain supporting material such as „frequently asked questions“ which help the general reader understand the contents. The IPCC reports are available on the website www.ipcc.ch

Projections for climate change vary regionally and readers are advised to contact local sources such as national meteorological offices and national reports on climate change (see each country’ s national communication available on the UNFCCC website www.unfccc.org) for country-specific information.

Protecting and Planting Trees

Trees are very important for making the clean air we breathe. Trees take in from the air, gases such as carbon dioxide and hold it in their wood. Trees release oxygen for us to breath, and water. Keeping trees in the ground helps to clean the air, but burning trees means more carbon dioxide in the air.

Building a raised garden bed

Some communities who live near the sea are building raised garden beds to protect their plants against rising salt water. There are many ways to make a raised garden bed. One example is making a garden in an old canoe. You can move the old canoe to next to your house. You can decide on which plants to grow in the canoe. You can collect soil from the hills or from the centre of the island to place into the canoe. Lastly you can use pig manure or other types of fertiliser to make the soil rich and healthy inside the canoe. Kastom Gaden Association is working on developing salt-resistant and drought-tolerant crops to support farmers who are experiencing sea level rise and changing weather.

Building a sea wall

Some communities who live close to the sea are now building walls from rocks or cement. In Ughele, Western Province, Segema's father planted an Abalolo (bunyan) tree on top of a stone wall that he built. The roots of the tree help to hold the wall in place. It has slowed down erosion from the rising sea level. The tree helped to protect Segema's house through the 2007 tsunami. If you are planning on building a sea wall you need to remember that the sea water will wash around the wall.

Think about where the sea water will go and perhaps talk to your neighbour and other community members about where the sea will go and what might happen. You may also like to speak with the government or an engineer. *(These information are from some of the Solomon Islands)*

Collecting Fresh Water

Rises in sea level have resulted in saltwater entering freshwater supplies in some parts of Solomon Islands. This means there is less water available to drink and to grow food gardens. Water tanks are important for collecting and storing fresh water.

In Babanga Island, a small low lying Island in the Western Province, the villagers use wells for drinking, washing, cooking, cleaning and gardening. The wells used to be dug beside the houses. But over the last ten years the sea has eaten away the shoreline up to where some houses were built, washing away some houses and making some of the wells salty. The villagers had to move to higher ground up the hill. They now have to buy water tanks to collect rainwater for drinking, bathing and to water their food gardens. Now the wells can only be used for washing and cleaning.

Mangroves

Mangroves are trees and shrubs that live in seawater or brackish water along the coast and tidal parts of rivers and creeks. Mangroves are very important for helping to protect communities from storms and large waves. In this way they work like a natural sea wall. The roots of mangroves hold soil together to stop erosion by big waves and heavy rain. Mangroves also provide food and medicine for people. They also provide a home for fish to live and breed. If mangroves are removed or destroyed, the community will lose the protection from the mangroves, as well as their food and medicine source.

Relocation

The village of Ta'arutona in the West Areare Lagoon had to make a hard decision. In 2006 they became concerned as extreme high tides became more and more frequent. After worsening king tides and coastal flooding at the end of 2008 the community decided to relocate. Many of their homes had been covered with water. Ta'arutona started up their own village relocation committee. They held fundraising drives to raise money for clearing the new site and digging proper drainage. The Climate Change Division in the Ministry of Environment, Conservation & Meteorology conducted an assessment at Ta'arutona to help the community to plan their move to the mainland.

Relocation is difficult and the last choice when no other options remain.

It requires a long process of consultation within your community. If your community is considering relocation, you may want to seek advice from the appropriate provincial Government Department, for example the Disaster Management Office.

Coral bleaching

Coral reefs are very important to the Pacific Islands. They provide food for many of our communities, attract tourists and protect our coasts from storms that come from the ocean. They also provide homes for many animals and plants. Changes in ocean temperature create big problems for coral. Coral reefs are made up of millions of very small animals called coral polyps which are related to, and look like, miniature jellyfish. These polyps live in huge colonies and produce a hard substance known as calcium carbonate, which is the building block of the reef. Each coral polyp has microscopic algae living inside it, which helps the coral create sugars (food) using energy from the Sun. When the sea temperature rises, the corals are forced to spit out the algae. This turns the corals white in a process known as 'coral bleaching'. The coral that have turned white cannot survive for very long without their algae, and will slowly starve to death.

Ocean acidification

As the effects of climate change become apparent, one of the emerging concerns is the impact of ocean acidification. Atmospheric carbon dioxide dissolves naturally in the ocean forming carbonic acid, a weak acid. The pH of the oceans has decreased 0.1 unit compared to pre-industrial levels and the continued increases in atmospheric carbon dioxide are expected to significantly alter ocean pH levels, making them more acidic. The increased acidity will reduce carbonate, which is needed to build the calcareous shells and skeletons of many shellfish and coral reefs, and even some single celled plankton. Besides impacting marine ecosystems this will have significant impacts on beaches, since in many parts of the world beach sand consists of pieces of coral and shell fragments. In this way, coral reefs provide not only important protection for beaches and coasts but also serve as a source of sand.

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