HOW TO BECOME A GREENZ CLIMATE CHAMPION

An interactive climate change toolkit for schools in Grenada, Carriacou and Petite Martinique

All material (teaching manual with worksheets, student passport, stickers and posters) can be downloaded from: www.gov.gd or www.iccas.gd

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Foreword

In 2013, a survey on "*Climate Change Knowledge, Attitudes and Behavioural Practices in the OECS*" indicated overwhelming support for the suggestion that children should be taught about climate change in school, with more than 95.3 percent of Grenadian respondents lending their support to the proposal.

Our science, geography and social studies curriculum includes the topic of climate change. However, let us admit, it is not an easy topic to teach, especially at primary school level. The greenhouse effect, ocean acidification or renewable energies - these can be complex concepts. We had realized that only limited resources are available for educators to break down these concepts and to get students actively and creatively involved in the topic of climate change

In the 21st century, our small island state needs citizens who can innovate and creatively address climate change challenges – and we need to start at an early age! Our primary schools play a crucial role in generating these strengths in students, who can then move into careers delivering sustainable solutions for society, essential in times of a changing climate. Let us provide our students with hope and enthusiasm for a climate-resilient future.

This activity-based climate change toolkit – comprised of a teaching manual, worksheets, and templates for a student passport, stickers and posters – aims to engage students between the ages of 7and11 years in discussing eight different climate change related topics, and to explore these in an interactive and practical manner.

We are personally inspired by the activities proposed, which range from a scavenger hunt in mangrove forests and a fishing game, to building your own solar oven or shopping bag. The Toolkit suggestions serve as an inspiration for after-school clubs, but can also be integrated with existing curriculums.

We congratulate the Environment Division in the Ministry of Agriculture, Lands, Forestry, Fisheries and the Environment and the Curriculum Department in the Ministry of Education and Human Resource Development for initiating and supporting the development of this toolkit which our future leaders can use now. We commend the material authored by the Integrated Climate Change Adaptation Strategies Programme in Grenada (ICCAS), in particular the Environment Division and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), to all primary level educators, particularly those in after-school clubs in Grenada, Carriacou and Petite Martinique.

Last but not least to our teachers: Be the best teacher you can be! Educate yourselves about climate change, its causes and its impacts on Grenada, Carriacou and Petite Martinique and how to best adapt. The toolkit will assist you in sharing these findings with your students in a creative way which will enable them to become Greenz Climate Champions!

Hon. Minister Roland Bhola
Minister for Agriculture, Lands, Forestry,
Fisheries and the Environment

Hon. Minister Anthony Boatswain
Minister for Education and Human
Resource Development

Acknowledgements

The authors would like to sincerely thank colleagues from the Environment Division of the Grenada Ministry of Agriculture, Lands, Forestry, Fisheries and the Environment, in particular Martina Duncan and Trevor Thompson for their overall guidance and thorough editing of each teaching unit. In addition, a great thank you to the members of the sounding board, including Dennis Baptiste, Maria Charles-Viechweg, Lloyd Panchoo and Richard Pierre for their valuable comments and input to this teaching manual and their support in mobilizing teachers throughout Grenada, Carriacou and Petite Martinique. The authors would like to recognize Grenada Fund for Conservation Inc., Marvellous Mangroves Australia and the Grenada Market Access and Rural Enterprise Development Programme (MAREP) for the permission to use some of their resource materials. The authors would like to acknowledge the support of the permanent secretaries of the Ministry of Agriculture, Lands, Forestry, Fisheries and Environment, and of the Ministry of Education and Human Resource Development. Their important collaboration facilitated the teamwork between the climate change and education departments in developing this toolkit and ensuring its roll-out in primary schools.

Finally, the authors would like to express their very special thanks to the almost 50 teachers who participated in piloting and testing the teaching manual, student passports and the accompanying material with their students. Their open-mindedness, honest feedback and enthusiasm was invaluable and a great motivation for this project.

Welcome teachers!

"I believe that the study of climate change is relevant to a great many of the subjects our children undertake, and that by increasing their understanding of the issue they will see the relevance of such disciplines anew. Indeed, as their understanding of the issue develops I believe that they will start seeing the world in a new way, a way that most of us have not possessed. That may seem like a large claim, but as we move to address climate change, so many aspects of our world will alter that it will be little short of a revolution" (Tim Flannery. 2007. Thinking About Climate Change – A Guide for Teachers and Students).

Teachers can make a difference in their students' lives by informing, challenging and nurturing their development. This guidance provides teachers the skills and resources for teaching climate change in a rapidly changing ecological environment.

There are many different approaches to teaching students about the complex issues surrounding climate change. This toolkit builds knowledge, skills, attitudes and values appropriate for primary students in Grenada, Carriacou and Petite Martinique (7 to 11-year-olds). It is best used for after-school club activities but can also be used for teaching climate change in science, geography or social studies classes.

This teacher's guide provides interactive units, discussion questions and prepared worksheets to aid the teacher in delivering the climate change curriculum for the 21st century.
Each unit contains information for the teacher's own learning, and integrates key words, climate change facts and teaching tips. All units are activity and discussion based. At the same time, the teach's guide is a "light" document that leaves sufficient room for individual adjustments and changes.

Be the best teacher you can be. Educate yourself about climate change, its causes and its impacts on Grenada, Carriacou and Petite Martinique, and how best to adapt. The guide will assist you in sharing these findings with your students in a creative way, which will enable them to become Greenz Climate Champions!

How to Use the Climate Change Toolkit

In this guide you will find a series of eight units, each with interactive exercises and corresponding worksheets.

- **Unit 1:** What is Climate Change? "Time in a Bottle"
- **Unit 2:** Weather & Climate "Who Wants to be a Meteorologist?"
- **Unit 3:** Ocean Pollution "Storm Drain Stenciling"
- **Unit 4:** The Greenhouse Effect "Feeling hot, hot, hot…"
- **Unit 5:** Energy "Light up my Life"
- **Unit 6:** Mangrove Preservation "Magnificent Mangroves"
- **Unit 7:** Waste Reduction "Make your own Shopping Bag"
- **Unit 8:** Sustainable Fishing "Let's go Fishing"

Start at the first unit and work through the toolkit to foster the student's learning. Units one and two should be introduced first to provide the students with a basic understanding of climate change. Units three to eight can be used in the suggested order but this is not essential. It is suggested to cover three units per term. In term three, CPEA (Caribbean Primary Exit Assessment) students should receive guidance in their project work. Each unit can take up to two hours and can be spilt into two sessions. **Teachers are encouraged to adjust the units to their needs and circumstances!**

If you want to introduce the units during after-school activities, choose a day and location for your "Greenz Climate Champions Club" and mobilize students.

Structure and Resources

Each unit is divided into two parts. The first part is an exploratory session that introduces the topic by using thinking tools and discussion questions. Students are encouraged to reflect critically on the unit's content. The second part involves students in a creative activity which requires them to share any connections they have made in their homes or neighborhoods related to the topic of study. For example, when looking at energy: What types of light bulbs do you use in your homes? Have you seen any sources of renewable energy in your neighborhoods? Some units require a secondary activity, which will be presented by the teacher.

Worksheets

Each unit is accompanied by a corresponding worksheet, which can be found at the end of the manual. Check the unit numbers to ensure you are using the correct worksheets.

Thinking Tools

The teaching methods and unit activities enable the students to critically examine the issue of climate change through active engagement. Classroom discussions accompany each unit. The purpose of

the thinking tools is to generate critical thinking skills and to engage students fully in the issues surrounding climate change and adaptation.

Discussion Questions

Teachers are provided with introductory discussion questions for each unit. The responses to the questions will give the teacher a good understanding of the students' basic knowledge of each topic. After the completion of each unit time is allotted for reflection through the use of a student passport and classroom discussion. Reflection questions can be used at the conclusion of each unit to assess the students learning.

Tips for Teachers

Each unit contains pertinent information for the teacher. Before each unit, read these tips and reflect upon them. They will help you to lead the discussion and guide the students' reflections.

Key Words and Facts

Each unit of study includes key words and key facts that support group discussions. The key facts may also enhance your own knowledge of each topic. Remember: preparation is the key to being a successful teacher! Prepare yourself for each unit by reading the key words and facts. Combine this basic knowledge with your own self-taught concepts and research on each topic.

Student Passports & Stickers

Students receive a climate change passport, with stickers to insert for each unit they complete. The passports should be collected by the teacher after each unit and only given to students upon completion of the eight units. TThe passport contains questions that should encourage the students to reflect on the unit, and its impacts on themselves and their surroundings. Sufficient time should be provided for the students to fill in their passports. The passport and stickers can be downloaded at www.gov.gd or www.iccas.gd.

Additional Resources

This teaching guide provides you with a list of online resources and contact details. Please use these to familiarise with the subject matter yourself before delivering the units. If your school has Internet access as well as a computer, videos would also be a great teaching tool for students. You can also download videos before a class if your school does not have a stable Internet connection. If you want to use videos, make sure that they are suitable for children. They should not be too long, and they should have a decent audio quality.

Introduction to Thinking Tools

Many schools across the world now use a technique called "critical thinking". In this method students are asked to think for themselves, rather than be given answers to their questions by teachers to the questions. Students are encouraged to "think like a scientist or to think like a historian". Teachers urge students to look at an issue from multiple perspectives. In fact, research suggests that instruction in critical thinking may make students smarter, more independent and more creative. Teaching critical thinking is a skill that teachers have to acquire. In this guide you will find discussion and reflection questions that should help you use this method.

Here are five critical thinking tools that you could use during at each unit to start a discussion with the students:

"5 whys": This technique is known as root cause analysis. Ask why the problem occurred, then continue to ask why that happened (five times as a rule of thumb). The most important question to ask students exploring these eight different climate change units is "Why". It is important not to settle for the first response to these questions, as it may not identify the root cause of the problem. After a student responds to one of the discussion questions, the teacher should react with another "why" question, to which the student again responds. The teacher meets each response from the students with a further "why" question, up to five times. This process compels students to consider their responses deeply and question the assumptions in their responses.

My tea was cold

(1) Why was my tea cold?	→ The kettle didn't heat the water
(2) Why didn't the kettle heat the water?	→ No power - the fuse in the plug was blown
(3) Why was the fuse in plug blown?	→ An incorrect rated fuse was fitted
(4) Why was an incorrect rated fuse fitted?	→ The required fuse was not specified
(5) Why was the correct fuse not specified?	→ There was no specification for fuses

A-Z Brainstorm: Write out the letters A to Z on the black board or a sheet of paper. Ask the students to generate as many ideas as they can about the topic. These are recorded either in table groups or on the board. No answer is wrong! Let the students brainstorm.

Cause and Effect: Students identify causes and effects and show in a table, flow diagram or other chart. Why are we having global warming? Global warming is stated as an effect. What is the cause? The sea level is rising is stated as effect? What is the cause? Etc.

Introduction to Thinking Tools

Graffiti Wall: Ask students the discussion questions. Have them write their responses on a blackboard on pieces of paper taped together to create a graffiti wall of ideas and responses.

- **Option 1 -** Write one discussion question on each piece of paper, have students (single or group) rotate and write down their responses. This can be timed or not timed.
- **Option 2 -** Group students and distribute one sheet to each group. Have them write a discussion question.
- **Option 3 -** Leave the paper up for the week and allow students to write responses over a period of time.

KWL Chart: A KWL chart is a graphical organizer designed to help in learning. The letters KWL stand for 1) what students already KNOW, 2) what they WANT to know, and 3) what they have ultimately LEARNED. A KWL chart is divided into three columns titled "Know, Want and Learned". In the worksheet section you can find a sample KWL chart. Before the students begin their research they should fill in the first two columns. They then fill in the last column after completing the unit. KWL charts assist teachers in activating students' prior knowledge of a subject, and they encourage curiosity, active discussion and research. The charts can also serve as an assessment of what students have learned during a unit of study.

- "What do I **know** about the topic?"
- "What do I **want** to know about the topic?"
- "What have I **learned** about this topic?"

What is Climate Change? - "Time in a bottle"

Teacher Tips/ Key Facts

- Over the lifetime of the planet, the climate has changed naturally and temperatures have varied significantly, causing climate events such as 'ice ages'. However the global climate has never changed as fast as it is currently changing.
- Currently, around the world, temperatures are getting hotter (which is sometimes referred to as "global warming") and weather patterns are changing. In the past century, temperatures have risen on average around the world by 0.74°C, with most of this increase happening over the last 40 years.
- Temperatures are predicted to continue rising by another 1.8-4.0°C this century. These changes to the climate could have a severe impact on humans and human activities (such as agriculture), and on plants and animals around the planet.
- January-March 2016 was the hottest start of the year ever recorded in human history.The first 15 years of the 21st century, up to and including 2015, were among the 16 warmest years on record.
- Most scientists and governments now agree that this latest climate change has been caused by human activities and that action is needed to stop climate change.
- Climate change could affect EVERYONE and EVERYTHING in the world.
- Some of the changes could be good, but many of the changes could be bad!
- Small-island states, like Grenada, are particularly vulnerable to the negative impacts of climate change although they have contributed only very little to global warming.

Key Words

Climate: Describes conditions over the long term and over an entire region. It is sometimes understood as the "average weather" over a period of typically 30 years, as defined by the World Meteorological Organization (WMO). Climate is the big picture. It is the big picture of temperatures, rainfall, wind and other conditions over a larger region and a longer time than weather. For example, the weather was rainy in Carriacou last week. But this island usually gets a lot less rain than Grenada. So the climate in Carriacou is drier than in Grenada. Southern California in the United States of America (USA) has a very dry, desert climate, whereas Florida in the USA has a wetter climate, because it rains there a lot. (Adapted from NASA Climate Kids: http://climatekids.nasa.gov/climate-change-meaning/)

Weather: Weather is local and temporary. Weather happens at a particular time and place. Rain, snow, wind, hurricanes etc. — these are all weather events. We cannot control weather. The best we can do is to try to predict the weather. Is that big black cloud going to bring rain over St. George's, or wait until it gets to Grand Etang? Will that new storm forming in the Atlantic Ocean turn into a hurricane? Weather can be directly perceived by people. In contrast, climate cannot be directly perceived by people. (Adapted from NASA Climate Kids: http://climatekids.nasa.gov/climate-change-meaning/)

Climate change: A change of climate, attributed directly or indirectly to human activity, which

alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. (United Nations Framework Convention on Climate Change, UNFCCC)

Climate change adaptation: Adaptation refers to adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. It refers to changes in processes, practices, and structures to moderate potential damage or to benefit from opportunities associated with climate change. (UNFCCC)

Climate change mitigation: Human intervention to reduce the sources or enhance the sinks of greenhouse gases. Examples include using fossil fuels more efficiently for industrial processes or electricity generation, switching to solar energy or wind power, improving the insulation of buildings, and expanding forests and other "sinks" to remove greater amounts of carbon dioxide from the atmosphere. (UNFCCC)

Carbon cycle: The term used to describe the flow of carbon (in various forms, e.g. carbon dioxide) through the atmosphere, ocean, terrestrial biosphere and lithosphere (Intergovernmental Panel on Climate Change - IPCC)

Activity Overview

This unit is a basic introduction to climate change. Students engage in a discussion about what climate change is and how they know it is occurring. They learn about its potential impacts. This unit could be split into two sessions of one hour each. The students initiate the discussion using the KWL (**K**now - **W**ant to know – **L**earn[1]) chart. With the guidance of the teacher, students discuss and research the consequences of humans and industry-induced threats to the global climate. A time capsule exercise is introduced which will help students understand that a change in climate can be measured over time.

Discussion Guide *(Week 1)*

Procedure

- Use a blackboard or chart paper to design the KWL chart (Worksheet 1A).
- Ask the KWL questions below and record student responses on the chart paper. The students will learn from each other.
- Use the key facts to guide the students in their responses. Student responses will vary depending on their level of background knowledge.

Question 1: "What do you **know** about climate change?"
Sample responses from children:

- The weather is changing.
- Ice is melting because the North Pole is getting hotter.
- Humans are causing it because of increase in factories, burning, transport, pollution

[1] *See Introduction for more details about this thinking tool.*

Questions 2: "What do you **want** to learn about climate change?"
Sample responses from children:

- Is climate change happening on other planets?
- How long has climate change been happening?
- Will the world ever get so hot that humans go extinct?
- What will the Earth look like in 200 years?

- Initiate a group discussion about climate change to start generating ideas from students. Questions might include:

  a. How do we know climate change is occurring and when did it start?

  b. What are some of its potential impacts?

  c. Have you heard your family members or friends talking about the climate changing? What do they observe?

  d. Do you think Grenada, Carriacou or Petite Martinique are affected by climate change?

  e. Should we be concerned? Why? Or why not?

  f. Do you already know what you and your family can do against climate change? The answers to this question will become apparent in the course of the next seven units of study.

Discussion Guide

The year 2013 provided more clarity about human-generated climate change than ever before. On 27 September 2013, the United Nations Intergovernmental Panel on Climate Change (IPCC) released a report which is categorical in its conclusion: climate change is real and human beings are the main cause!

- At the end of Unit 1, ask the students to think about the following question during the coming week: "What will the Earth look like in 2050?" Tell the students to be prepared for the next lesson by thinking of items to put in a time capsule to reflect on the current state of the planet.

Activity Procedure *(Week 2)*:

- Start the lesson by asking the students: "What does the earth look and feel like today? What do you predict it will look and feel like in 2050?"

- Introduce them to the "Time Capsule" exercise and explain to them: "You and your partner have been asked to prepare a secret document about the current state of the planet. This document will be placed in a time capsule for future generations."
- Give students Worksheet 1B.
- Ask them to imagine they are teenagers living in the year 2200 and they and their friends stumble upon the secret documents while swimming at the beach.
- Ask them what they would like to do with the bottle(s). Make sure they are not thrown away or buried.

Materials Needed

Week 1

- KWL chart – draw chart on blackboard or chart paper (see Worksheet 1A)

Week 2

- Clear plastic bottle
- "Time in a bottle" Worksheet 1B

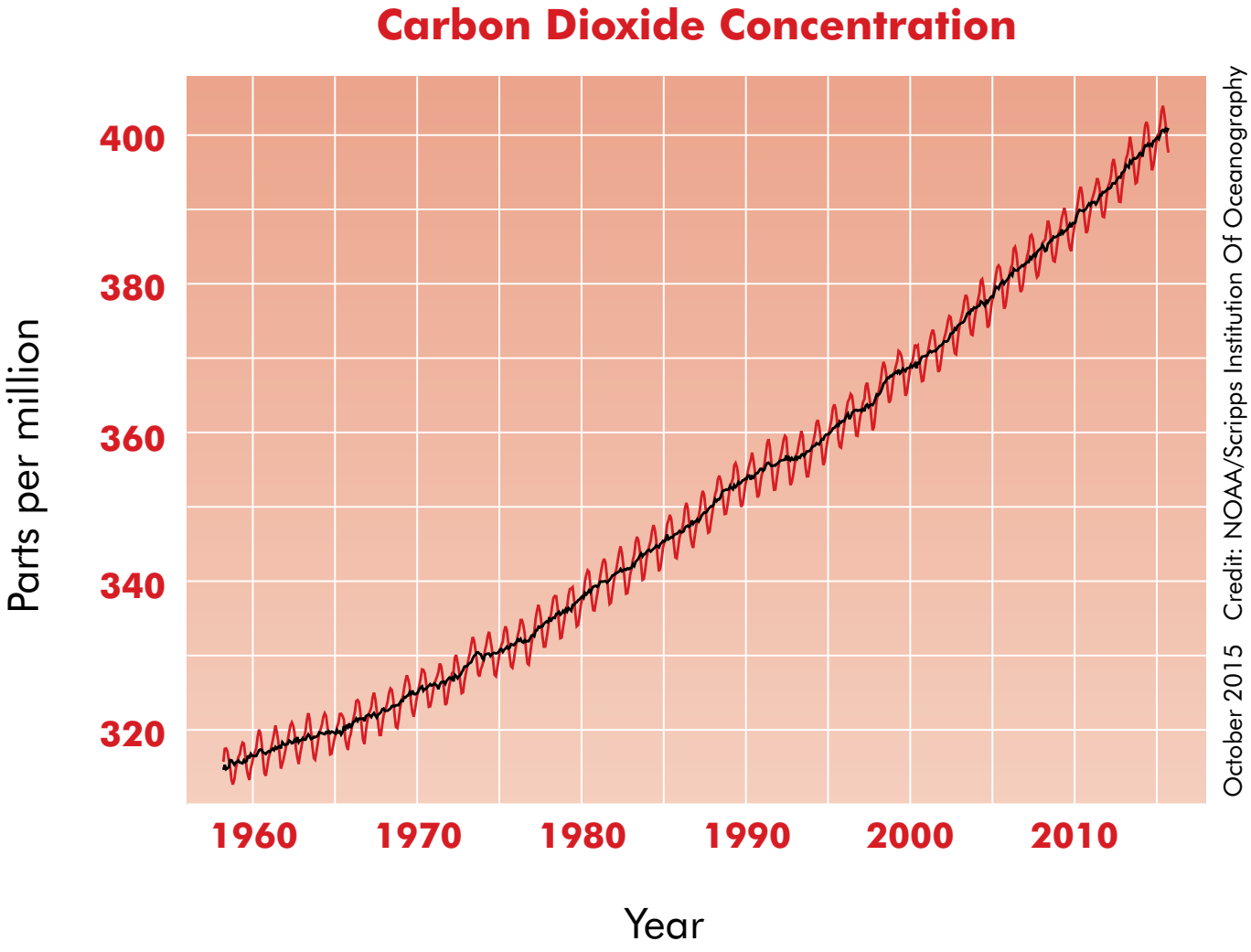
Reflection/Follow Up Work

- Explain to the students how carbon emissions have risen in recent decades and discuss this with them. Humans have increased atmospheric CO_2 concentration by a third since the Industrial Revolution began. The acidity of the oceans' surface waters has also increased about by 30 percent.

Table: Increase in greenhouse gases in the atmosphere since 1750

Gas	1750 Level	Current Level	Increase
Carbon dioxide (ppm)	280	390[3]	110
Methane (ppb)	715	1,774	1,059
Nitrous oxide (ppb)	270	319	49

(ppm = parts per million; ppb = parts per billion)



- Explain some of the changes that result from this rise in carbon emissions. Examples include global temperature rise, warming oceans, shrinking ice sheets, declining arctic sea ice, glacial retreat, extreme weather events (like torrential rainfall leading to floods, dry spells, stronger hurricanes) and sea level rise. To learn more about these facts go to: www.climatenasa.org

Further Useful Resources

On the Internet there is plenty of material about climate change specifically for teachers. Take the time to browse a little. YouTube is also a great source for videos, which are sometimes easier to digest. Below is a small list of useful resources, but do not shy away from exploring other sources!

YouTube videos on climate change in Grenada/Caribbean

- "Can't do this alone" by Swipe, Eclipse and Avonni: https://goo.gl/akQml0
  Grenada's first climate change music video. The song was written by three young Grenadian artists and the video was shot in Grenada.

- "Grenada: Combating water shortage": https://www.youtube.com/watch?v=qT4GTE6WI54
  This video explores the link between climate change and water in Grenada and Carriacou.

- "Grenada adapts to climate change. NOW!":
  https://www.youtube.com/watch?v=XE42IeXOMRA
  A short TV clip to raise awareness about the impacts of climate change in Grenada.

- "Paradise worth saving": https://www.youtube.com/watch?v=XE42IeXOMRA
  Another short Caribbean-specific video explaining the link between climate change, pollution and biodiversity.

- "1.5 STAY ALIVE": https://www.youtube.com/watch?v=ckMVASFRxUk
  Combining several genres like documentary, music video and nature film, this film presents Caribbean contrasts, from Haiti and Trinidad to Florida and New Orleans. It gives both researchers and victims a voice and also shows how musicians and singers interpret the problem of climate change in different stylistic ways. Duration: 54 minutes

Websites

- United States Environment Protection Agency. A Student's Guide to Global Climate Change. URL: http://www.epa.gov/climatestudents/basics/index.html.
  This is a great introduction to the basics of weather, climate and climate change for students and teachers.

- National Aeronautics and Space Administration (NASA) Climate Kids. Weather and Climate. URL: http://climatekids.nasa.gov/menu/weather-and-climate/
  This is another great website with many child-friendly explanations.

- National Aeronautics and Space Administration (NASA). Global Climate Change – Vital Signs of the Planet. URL: http://climate.nasa.gov/
  This is a great resource for adults. The site is filled with facts, solutions and resources all related to climate change.

Want to get inspired, or to add different material to your units? Check out these teaching manuals on climate change from other countries:

- Pacific Islands: http://www.spc.int/cc-project/
- Vietnam: http://goo.gl/Tfl4IF
- Mauritius: https://www.undp-aap.org/sites/undp-aap.org/files/MANUAL%20PRIMARY.pdf
- Australia: http://www.environment.nsw.gov.au/sustainableschools/teach/climatechange.htm

Contact person (as of 2016): Grenada UNFCCC Climate Change Focal Point, Ms Martina Duncan, Environment Division, Ministry of Agriculture, Lands, Forestry, Fisheries and the Environment

Happy exploring!

Weather & Climate - "Who wants to be a meteorologist?"

Teacher Tips

Making the connection – weather, climate and climate change

Weather happens at a particular time and place. Climate, on the other hand, refers to the average weather conditions in a certain place over many years. For example, the climate in Grenada is tropical all year long, and the climate in New York is cold and snowy in the winter.

Mark Twain said once:

"Climate is what we expect, weather is what we get."

When we discuss global climate change, we are talking about the average climate around the world, and the change that is happening over many years. One of the most important trends that scientists look at is the average temperature of the earth, which has been increasing for many years. This is called global warming. The rising temperature is leading to many other changes all around the globe, such as melting glaciers, more frequent droughts, torrential rainfalls or stronger hurricanes. One example: when air temperatures rise, the oceans absorb more heat from the atmosphere and become warmer. Warmer oceans, in turn, can cause stronger storms. (Adapted from "A students Guide to Global Climate Change": http://goo.gl/qOj8sM)

Key Facts

- The climate in Grenada, Carriacou and Petite Martinique is tropical. Since Carriacou and Petite Martinique receive much less rainfall each year than Grenada, their climate is drier than that of mainland Grenada.
- On average
  - July is the warmest month.
  - January is the coolest month.
  - November is the wettest month.
  - March is the driest month(See also Worksheet 2B "Average temperature and rainfall in Grenada").
- As of 2016, the tri-island state has one weather station – the Meteorological Office – which is located at Maurice Bishop International Airport in Point Salines, Grenada. For the CARICOM region, the Caribbean Meteorological Organization is the specialized agency that coordinates the joint scientific and technical activities in weather, climate and water-related sciences in 16 English-speaking Caribbean countries. It is based in Trinidad.
- Grenada, Carriacou and Petite Martinique are faced with the following climatic changes:

- Projected increase in the mean annual temperature by between 0.7 and 2.6°C by the 2060s, and between 1.1 and 4.3°C by the 2090s
- Decrease in annual rainfall (up to 21 percent)
- Changes in the frequency, intensity, duration and timing of extreme weather events
- Increases in the frequency of days and nights that are considered 'hot'
- Increase in ocean surface temperature
- Sea-level rise (conservative estimate: 50cm)
- Distinction between the dry and wet seasons reduced

Source: C. McSweeney, M. New and G. Lizcano. 2008. UNDP Climate Change Country Profiles: Grenada, Oxford.

Key Words

Please note: Some of these key words were already introduced in Unit 1

Climate: Describes conditions over the long term and over an entire region. It is sometimes understood as the "average weather" over a period of typically 30 years, as defined by the World Meteorological Organization (WMO). Climate is the big picture. It is the big picture of temperatures, rainfall, wind and other conditions over a larger region and a longer time than weather. For example, the weather was rainy in Carriacou last week. But this island usually gets a lot less rain than Grenada. So the climate in Carriacou is drier than in Grenada. Egypt has a very dry, desert climate, whereas the United Kingdom has a colder and wetter climate because it rains there a lot. (Adapted from NASA Climate Kids: http://goo.gl/ddU9k0).

Weather: Weather is local and temporary. Weather happens at a particular time and place. Rain, snow, wind, hurricanes etc. — these are all weather events. We cannot control weather. The best we can do is to try to predict the weather. Is that big black cloud going to bring rain over St. George's, or wait until it gets to Grand Etang? Will that new storm forming in the Atlantic Ocean turn into a hurricane? (Adapted from NASA Climate Kids: http://goo.gl/hzJkvR).

Meteorologist: A scientist who studies and predicts the weather. Meteorologists use sophisticated equipment, like computers, but they also rely on old-fashioned sky watching (Adapted from Weather Wiz Kids: http://www.weatherwizkids.com/weather-words.htm#M

Global warming: The progressive gradual rise of the Earth's surface temperature thought to be caused by the greenhouse effect and responsible for changes in global climate patterns. See enhanced greenhouse effect, greenhouse effect, climate change (United Nations Framework Convention on Climate Change glossary: http://goo.gl/Jk4mUk).

Climate change: A change of climate attributed directly or indirectly to human activity that alter the composition of the global atmosphere, which is in addition to natural climate variability observed over comparable time periods (United Nations Framework Convention on Climate Change).

Rain gauge: An instrument used to measure the amount of rain that has fallen. Measurement is done in hundredths of inches (Weather Wiz Kids: http://www.weatherwizkids.com/weather-words.htm#R).

Thermometer: An instrument that measures temperature (Weather Wiz Kids: http://www.weatherwizkids.com/weather-words.htm#T).

Activity Overview

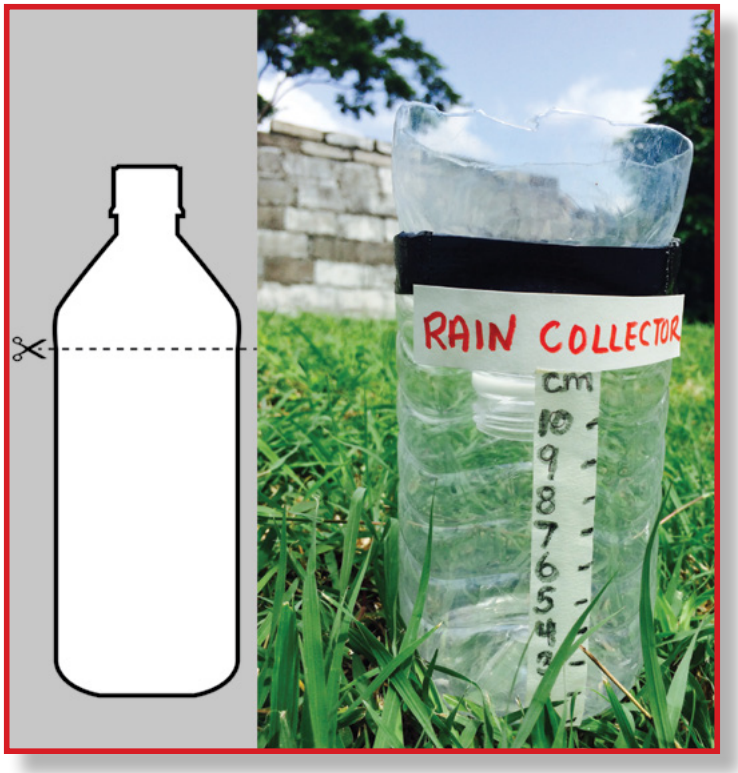
This unit enables students to learn the difference between weather and climate. It takes at least one session (one hour) to conduct activities. Students collect local weather data and compare this with the long-term climate data for Grenada, Carriacou and Petite Martinique. It is a good idea to conduct this unit during the rainy season, i.e. the first school term. Data collection should take place for at least one month, but a period of several months or even the entire school year. The longer the data collection period, the better students will be able to observe rainfall and temperature variations.

Discussion Guide

- What different types of weather do you know?
- In your opinion, what is good weather and what is bad weather? What kind of weather concerns you?
- What is the difference between weather and climate?
- How is climate change affecting our weather and climate?

Activity Procedure

- Tell the students: "We are going to create a rain gauge." To do this you will need to locate an open area. Make sure the rain gauge is in a secure place away from people and animals.
- To create the rain gauge together with the students follow the steps below (see image):



Step 1: Find a 2-litre soda bottle, clean it and remove the lid.

Step 2: Cut off the top of the bottle to make a funnel.

Step 3: Take a ruler and measure in millimeters along the side.

Step 4: Secure the funnel at the top of the plastic bottle.

Step 5: Measure the amount of rain collected in your apparatus. Be sure to use the same measuring device each day. Let the students track the data on Worksheet 2A "weather data".

Step 6: Agree on who is responsible for collecting the data every day and for how long data should be collected.

- Now tell the students: "We are going to create a temperature station."

Step 1: Take thermometers to the same spot each day.

Step 2: Be sure to collect data at the same time every day.

Step 3: Wait five minutes until registering the temperature and record the data on your Worksheet 2A "weather data".

Step 4: Agree on who is responsible for collecting the data every day and for how long data should be collected.

Materials Needed

- Thermometer
- 2 liter soda bottle
- Knife/scissors
- Ruler
- Funnel
- A copy of the daily weather data Worksheet 2A "weather data"
- Pencils

Reflection/Follow Up Work

At the end of both activities, bring the students back together as a group and discuss what they have learned. Worksheet 2B "Average temperature and rainfall in Grenada" could provide a good starting basis for reflection. You could also ask the following questions:

- How is climate change affecting our weather?
- Imagine a drought is coming, what can you do to prepare? How would you conserve water in Grenada, Carriacou or Petite Martinique?
- Imagine a hurricane is coming, what can you do to prepare? Where would you go to seek shelter?

Further Useful Resources

United States Environment Protection Agency. A Student's Guide to Global Climate Change. URL: http://www.epa.gov/climatestudents/basics/index.html
This is a great introduction to the basics of weather, climate and climate change for students and teachers.

National Aeronautics and Space Administration (NASA) Climate Kids. Weather and Climate. URL: http://climatekids.nasa.gov/menu/weather-and-climate/
This is another great website with many child-friendly explanations.

National Aeronautics and Space Administration (NASA). What's the Difference Between Weather and Climate? URL: http://www.nasa.gov/mission_pages/noaa-n/climate/climate_weather.html
This website has useful information on explaining the difference of weather and climate.

World Bank. Climate Change Knowledge Portal. Grenada. URL: http://goo.gl/Ox8Gnp
This is an interactive map that lets you to further research temperature and rainfall trends for Grenada, Carriacou and Petite Martinique.

Contact person (as of 2016): Mr Hubert Whyte, Manager of Meterology, Grenada Meteorological Service, Maurice Bishop International Airport, St. George.
This could also be a field trip option.

Ocean Pollution - "Storm drain stenciling"

Teacher Tips

Making the connection - climate change and ocean pollution

Healthy oceans and healthy coastal ecosystems, such as coral reefs and mangroves, are essential for Grenada, Carriacou and Petite Martinique to adapt to climate change. Coral reefs and mangroves are our first line of defence against climate change! They act as natural defences against wave action, storm surges and sea-level rise, thereby reducing the risk of coastal erosion while at the same time providing important economic income for fishermen and their families. However, these important ecosystems are under threat. The coral reefs of the Eastern Caribbean are already among the most severely damaged and endangered marine ecosystems in the world. In the last 30 years, they have declined by over 30 percent. From 1980-2005, mangrove forests in Grenada declined by 28 percent, from ca. 295ha to ca. 215ha. Amongst other factors, the degradation is also caused by adverse human activity, such as land-based pollution that ends up in the ocean. 80 percent of pollution to the marine environment comes from the land. What can we do? It is simple: if we want our mangroves and coral reef structure to continue to buffer our shorelines against the negative impacts of climate change, an important step is to reduce pollution both at land and on sea.

Key Facts

- 80 percent of pollution to the marine environment comes from the land.
- Healthy coral reefs can reduce wave energy by 97 percent, which is critical in times of climate change when more frequent and stronger storms are expected.
- In Grenada, the largest ocean pollutant comes from agricultural chemicals that run off into the ocean.
- During the 1980s, many shallow reefs around Grenada & the Grenadines were degraded and became overgrown with algae, presumably resulting from a combination of sewage, agro-chemical pollution and sedimentation caused by coastal development (Smith et al 2000).
- To identify sources of water pollution in the Moliniere-Beausejour Marine Protected Area a water quality analysis was conducted in April 2015. Findings revealed that residues of fertilizers are being washed out and entering the water body. These nutrients end up in the Moliniere-Beausejour Marine Protected Area leading to increased algae growth. This has a negative impact on the health of the protecting reef system in the marine park.
- Most of the houses in Grenada use an on-site system for sewage disposal, and it is only parts of St George parish which have sewers. The raw sewage is discharged into the ocean of Point Salines, Grenada.
- Whilst the National Water and Sewage Authority (NAWASA) has the right to extract water, there is no state agency responsible for managing rivers.
- A "plastic soup" of waste floating in the Pacific Ocean is growing rapidly. Scientists are not 100 percent sure of its size but estimate it to be between 700 000 and 15 000 000 km^2. The United States of America is almost 10 000 000 km^2 in size.

Key Words

Storm drains: These are the drains along side our roadways. Unfortunately, people pour motor oil and throw litter and other debris into storm drains, thinking they are "sewers" and that the contents go to a treatment plant. There are different kinds of storm drains. In Grenada, Carriacou and Petite Martinique our storm drains go directly into the sea with no filtration or treatment. This can pollute our water supply and threaten marine life.

It is our responsibility to let only rainwater go down the storm drains.

Runoff: This is rainwater that has not been absorbed into the soil (infiltrated), or evaporated, but has instead made its way from the ground surface into places where water collects. Runoff can cause erosion, and it can carry chemicals and substances from the ground into the rivers where the water ends up, thereby causing water pollution. Therefore, as much rainwater as possible should be absorbed by the soil or be collected in rain water storage systems. As little as possible should go down the drain (Adapted from eSchoolToday: http://goo.gl/eENlPk).

Wastewater: This is the very polluted water that comes e.g. from toilets and which ought to be treated in septic tanks or wastewater treatment plants. Grey water is lightly polluted wastewater from sinks or showers, which could be re-used without a lot of treatment, e.g. for irrigation purposes.

Sanitary sewer system: A system that transports wastewater to a wastewater treatment plant.

Sewage: The part of wastewater that is contaminated with faeces or urine.

Wastewater treatment plant: A plant that removes solid waste and treats water so that it meets legal requirements and can be discharged into a water body or reused for a specific purpose. Grenada, Carriacou and Petite Martinique do not have treatment plants.

Septic systems: The systems used in Grenada, Carriacou and Petite Martinique the can vary. We have either septic tanks or pit latrines (outhouses). If septic systems are not installed or maintained properly, raw sewage can leak into surrounding watersheds.

Agro-chemicals: The term for chemical products used in agriculture, such as pesticides and synthetic fertilizers. They are toxic and can pose environmental and/or health risks.

Eroded sediment: This is another source of ocean pollution. Sediment in rivers increases their turbidity. Another problem is that agro-chemicals are bound to the sediment and end up in the water bodies. In other words, the sediment is a transport mechanism for the agro-chemicals.

If not indicated otherwise, key words were taken and adapted from the United States Environmental Protection Agency.

Activity Overview

This unit should ideally be split into two sessions. Students learn about the impacts of land-based pollution on the health of our oceans and about how healthy oceans help us to adapt to climate change. For example, in Grenada, Carriacou and Petite Martinique, storm drains, rivers and streams all carry debris directly into the sea without being treated. This debris can include agricultural pesticides, household cleaners, motor oil and other non-biodegradable chemicals. Students stencil and paint fish on the drains. The purpose of this is to remind students, residents or visitors to our islands that whatever goes into our storm drains does not disappear, but continues into the sea, affecting all life, marine and human. The fish stencils will send a message to residents and visitors that ocean protection begins on land.

Discussion Guide

- When it rains in Grenada, Carriacou and Petite Martinique, where does the rain flow to?
- What does the rainwater carry with it to the sea when it rains?
- Do you know what happens after you have flushed the toilet? Where does it go? This provides an option to explain sewage waste treatment plants, which many other countries have.
- In your family, what happens to household chemicals (e.g. bleach, washing power or dishwasher detergents) once used?
- What happens to used motor oil in Grenada, Carriacou and Petite Martinique? Do we have recycling for this?

Activity Procedure *(Week 1)*

- Use the "Cause and Effect" chart from the "Thinking Tools" section in the Introduction to outline discussion questions.
- Use key words and key facts to lead the discussion.
  - Cause: When we flush the toilet where does the water go? Effect: Students answer.
  - Cause: When it rains, where does the soil go that is being washed away? Effect: Students answer.
  - Cause: When we throw food wrappers and litter in a storm drain, where does it end up? Effect: Students answer.
  - Cause: When our oceans get polluted, what does this mean for our reefs, fish, seagrass beds and mangroves? Effect: Student answer.
  - Cause: When our reefs are not healthy, what will happen during a storm? Effect: Student answer.
- Get the children to create awareness posters. For some inspiration, have a look at the "resources" section (Resource No. 1: "Clean Ocean Action's 10 Tips Series") and/or use Worksheet 3A "8 Tips When on the Ocean or at the Beach").The posters can also include information collected from your "Cause and Effect"discussion. These posters can be hung in the school, local shops or churches.
- Begin preparations for painting/stenciling the fish. Ask the students to think about various locations

for painting the fish.
- Call your local paint store and explain your project. Ask if they will donate a can of paint to your cause.

Activity Procedure *(Week 2)*

- Follow up discussion with children:
  - What have you seen in your neighbourhood that makes you concerned about ocean pollution?
  - Do you know any beaches that seem to be getting smaller?
  - Is there a reef close to where you live? How does it look? Have you, your parents or neighbours noticed any changes to the reef?
  - Have you spoken to any people or feel that you have made an impact on the situation?
- Use Worksheet 3B, if no fish template is available yet.
- Decide on the final locations around the school and in the neighbourhood to paint the fish. Head out and have fun!

Materials Needed

- Paint brushes or sponges
- Fish template (Worksheet 3B "Fish Template")
- Can of paint (for example, donated from local paint store)

Reflection/Follow Up Work

- What can you or your family and friends do to reduce ocean pollution?
- Below are a few examples of simple actions. Through a discussion, try to steer students to come up with these or similar actions:
  - Don't litter. Anything you throw on the ground can end up in our waterways.
  - Pick up trash from the sidewalks and streets around your home. Picking up loose trash and disposing of it properly reduce the amount of trash that ends up on your neighbourhood streets and that finds its way into the storm drains, sewers and waterways.
  - Encourage your school to become involved in beach and mangrove clean-ups.
  - When your family goes shopping, purchase reusable shopping bags or reuse older paper or plastic ones for your next shopping trip. If you or your family only have a couple of items to purchase, say "No" when the merchant asks you if you want a bag.
  - Harvest rainwater.
  - Do not discharge sewage from boats into coastal waters.
  - Report any dumping you may see. Note the date, time and location of the incident.
  - Don't pour motor oil in the toilet or drainage system.

Further Useful Resources

- Clean Ocean Action. Clean Ocean Action's 10 Tips Series. URL: http://goo.gl/eGfbAm
  This organisation has developed a series of "tip cards" to educate distinct groups of people. These cards teach people how they can minimize their contribution to ocean pollution.

- National Oceanic and Atmospheric Administration (NOAA). National Ocean Service Education. URL: http://goo.gl/h54M9R
  This website provides education resources on oceans for teachers and students.

- United Nations Environment Programme. Wastewater, Sewage and Sanitation. URL: http://goo.gl/bgub9q
  This website provides various examples of wastewater, sewage and sanitation systems in the Caribbean.

- National Geographic. I Didn't Know That – Where Does Your Sewage Go? URL: https://goo.gl/ttTny1
  This two minute video teaches students what a sewage treatment plants is and what it looks like.

- United Nations Department of Economic and Social Affairs. 2012. Climate Change Adaptation in Grenada: Water Resources, Coastal Ecosystems and Renewable Energy. URL: https://goo.gl/NL8uJH
  A study that focuses on three areas: water resources, coastal ecosystems and renewable energy systems. Chapter 3 assesses the quantity and quality of water in the Northern Grenada watersheds.

Contact person (as of 2016): Mr Lazarus D. Joseph, Marine Surveyor, Grenada Ports Authority (Department of Maritime Affairs).

Field-trip opportunity

- Fisheries Division of the Ministry of Agriculture, Lands, Forestry, Fisheries and the Environment (site visit options: Moliniere-Beausejour Marine Protected Area, Woburn-Calivigny Marine Protected Area) or Ministry of Carriacou and Petite Martinique Affairs (site visit option: Sandy Island Oyster Bed Marine Protected Area)
- National Water and Sewerage Authority (NAWASA)
- Grenada Solid Waste Authority
- The international Coastal Clean-up takes place on the third Saturday of September each year. Why not plan a beach clean-up? Just get some gloves and bags and you are ready to go! If you don't have these, get in touch with the Environment Division of the Ministry of Agriculture, Lands, Forestry, Fisheries and the Environment. They will be happy to assist you!

The Greenhouse Effect - "Feeling hot, hot, hot..."

Teacher Tips

Making the connection - the greenhouse gas effect and climate change

The US National Aeronautics and Space Administration (NASA) explains the link in very simple, child-friendly terms: *"A greenhouse is a house made of glass. It has glass walls and a glass roof. People grow tomatoes and flowers and other plants in them. A greenhouse stays warm inside, even during winter. Sunlight shines in and warms the plants and air inside. But the heat is trapped by the glass and can't escape. So during the daylight hours, it gets warmer and warmer inside a greenhouse, and stays pretty warm at night too. Earth's atmosphere does the same thing as the greenhouse. Gases in the atmosphere such as carbon dioxide do what the roof of a greenhouse does. During the day, the Sun shines through the atmosphere. Earth's surface warms up in the sunlight. At night, Earth's surface cools, releasing the heat back into the air. But some of the heat is trapped by the greenhouse gases in the atmosphere. That's what keeps our Earth a warm and cozy 15°C, on average. You might think 15°C is pretty cold. It depends on what you are used to. That temperature would melt all the Arctic ice. Yes, it's colder than 15 °C in a lot of places, and hotter than 15°C in a lot of places, but 15°C is the average of all of the places. The point is, if the greenhouse effect is too strong, Earth gets warmer and warmer. This is what is happening now. Too much carbon dioxide and other greenhouse gases in the air are making the greenhouse effect stronger."* It is these small changes in the average temperature that can lead to potentially dangerous shifts in our climate.

Source: Climate Kids – NASA's eyes on the Earth: What is the greenhouse effect?
http://goo.gl/WgWUZM/

Key Facts

- Earth, like the other planets, absorbs the Sun's rays and radiates the heat back out into space. However, there are gases in the atmosphere surrounding Earth that trap the heat and reflect it back. This is called the greenhouse effect.
- The greenhouse effect is important. Without the greenhouse effect, the Earth would not be warm enough for humans to live on. But if the greenhouse effect becomes stronger, it could make it warmer than usual. Even a little extra warming of the Earth could cause problems for humans, plants and animals.
- The Industrial Revolution saw the introduction of new manufacturing processes, from about 1760 to sometime between 1820 and 1840. Hand production methods were replaced by machines, machine tools and the use of steam power. Coal and other fossil fuels were used instead of wood to produce energy to run the machines. Since the Industrial Revolution, by burning coal, natural gas and oil for manufacturing and transportation, humans have produced and released massive amounts of carbon dioxide and other greenhouse gases into the atmosphere.

- Major greenhouse gases are:
  - carbon dioxide (CO_2) – A colourless, odourless gas. Carbon dioxide enters the atmosphere through the burning of fossil fuels (coal, natural gas and oil), solid waste, trees and wood products, and also as a result of certain chemical reactions (e.g. the manufacture of cement). carbon dioxide is removed from the atmosphere (or "sequestered") when it is absorbed by plants as part of the biological carbon cycle.
  - nitrous oxide (N_2O) – A gas emitted by agricultural and industrial activities, and through the combustion of fossil fuels and solid waste.
  - methane (CH_4) – Methane is emitted during the production and transport of coal, natural gas and oil. Methane emissions also result from livestock and other agricultural practices and by the decay of organic waste, e.g. in municipal solid waste landfills. (Taken from US Environmental Protection Agency)
- There is more carbon dioxide in the atmosphere today than at any point in the last 800,000 years.
- In 2014, the largest emitters of carbon dioxide were China and the United States of America.
- A stronger greenhouse effect leads to global warming, which is causing climatic patterns to change. For Grenada, Carriacou and Petite Martinique the following changes have been projected:
  - Temperature increase of between 0.7 and 2.6°C by the 2060s, and between 1.1 and 4.3°C by the 2090s
  - Decrease in annual rainfall (by up to 21 percent by 2090)
  - Changes in the frequency, intensity, spatial extent, duration and timing of extreme weather events (such as storms, hurricanes, torrential rainfall, droughts etc.)
  - Increases in the frequency of days and nights that are considered 'hot'
  - Sea level rise (conservative estimate: 50 cm)
  - Distinction between the dry and wet seasons may be reduced
  - Increase of ocean surface temperature

Key Words

Greenhouse: A building made of glass panes in which heat and humidity can be regulated in order to grow plants. For example, a greenhouse is used to grow vegetables when the outside temperature is below freezing, for example in Northern Europe, Russia or Canada.

Greenhouse gases: Carbon dioxide is the most important greenhouse gas emitted by humans, but several other gases contribute to climate change, too. Greenhouse gases come from all sorts of everyday activities, such as using electricity that comes from fossil fuels, heating or cooling our homes, driving around town with a car or a bus, airplanes, livestock, deforestation or factories.

Atmosphere: The layer of air and gas that surrounds objects in space, like stars and planets; or the air around any given location.

Greenhouse effect: When the Earth's atmosphere becomes thick with gases and substances that trap the Sun's radiation, making the Earth warmer.

Global warming: The continuing gradual increase in the Earth's average temperature due to a stronger greenhouse effect, which leading to potentially dangerous shifts in our climate.

Industrial Revolution: The Industrial Revolution was the transition to new manufacturing processes in the period from about 1760 to sometime between 1820 and 1840. This transition included going from hand production methods to machines, new chemical manufacturing and iron production processes, the increasing use of steam power, the development of machine tools and the rise of the factory system. It also included the change from wood and other bio-fuels to coal. (Source: Wikipedia)

Stewardship: The careful and responsible management of something entrusted to one's care.

Activity Overview

This unit can be completed in one session. Students deepen their knowledge about the greenhouse effect and how it relates to global warming and climate change. They have already learned some aspect of this in Unit 1 and Unit 2. In this session, students use a bowl to simulate the greenhouse effect, and they use creative dramatics to act out the greenhouse effect and discover how it contributes to the warming of the Earth.

Discussion Guide

- Have many of you have ever seen a greenhouse? Can you describe it? How does it look?
- Who uses greenhouses and why?

Activity Procedure *(Part 1)*

At the beginning of the activity, take the students outside. They place a thermometer on the ground and measure the temperature. Then they should place the thermometer under a glass bowl, leave it for a few minutes and come back to check the temperature. This is an easy exercise to simulate the trapping of heat in the atmosphere that leads to global warming.

Activity Procedure *(Part 2)*

- In a large area, such as the classroom or a field, gather the students together and assign them "roles" to act out the greenhouse effect.
- Ten students play the "heat" and five play be the "greenhouse gases".
- If they make sure there are twice as many "heat" actors as "greenhouse gases".
- Hand out nametags for the students to wear.
- Label one end of the room "Sun" and the other end "Earth".
- "Heat" students should stand at the "Sun" end of the room while the "greenhouse gases" students stand in the middle of the room. If there are more students, ask them to sit and watch. (They will get a turn in part 2)
- Remind the students that the Sun produces heat that reaches the Earth's surface. Now ask the "heat" students to walk from one side of the room to the other, demonstrating heat travelling from the Sun to the Earth. Explain that some heat escapes back into space while gases in the atmosphere trap some of the heat. These "greenhouse gases" allow the Earth to stay warm, which enables life to flourish. To demonstrate this, tell the "heat" students to travel back to the other side of the room, but this time ask each of the "greenhouse gas" students to trap one "heat" person, keeping them on the "Earth" side of the room, but allowing the others to "escape". Students need to be aware that the greenhouse effect is a beneficial, natural process and that without it the Earth would be too cold to sustain life.
- Now introduce the idea of global warming: get all the remaining students to put on the "greenhouse gases" name tags and have them join the other "gases" in the middle of the room. Ask the students to predict what would happen if more greenhouse gases were added to the atmosphere.
- Again, ask the original group of "heat" students to travel from the "Sun" side to the "Earth" side of the room/field. Then ask them to move back to the other side. All, the "greenhouse gas" students should again trap one "heat" student each. Since there are many more greenhouse gases, more "heat" will be trapped on Earth, with very little, if any, "heat" escaping. This is how global warming happens.

Credits: Learning to Give. The Greenhouse Effect and Global Warming,
URL: http://goo.gl/p0suwQ

Materials Needed

- Bowl
- Thermometer
- Name tags "heat" and "greenhouse gases". If no name tags are available, use small pieces of paper to write names on. Attach to the students, shirts with either tape or a pin.

Reflections & Follow Up

At the end of the activity, bring the students back together as a group and discuss what they have learned. You could start the discussion with a short video clip (see "Resources" for kids-friendly clip).

Ask the students:

- What does the greenhouse effect have to do with global warming and climate change?
- Why should anyone care about global warming? Make students understand that if the temperature increases it will become difficult for plants, animals and people to live.
- How can a stronger greenhouse effect be avoided? Is it everyone's responsibility to care for our climate? Include reasons why.
- Does anyone know what "stewardship" means? Motivate and guide students to become climate stewards. Ask what they can do for their country to minimize the greenhouse effect.
- Hand out Worksheet 4 ("Feeling hot, hot, hot...") and give the students 20 minutes to fill it out (two tasks). The solution for task 1 is (from top to bottom): 7-5-1-8-2-4-3-6. This provides a good summary of the session.

Further Useful Resources

- Learning To Give. The Greenhouse Effect and Global Warming.
  URL: http://learningtogive.org/lessons/unit372/lesson1.html
  Permission has been granted to use this creative drama activity to demonstrate the greenhouse effect
- Schlumberger Excellence in Education Development. The Greenhouse Effect: Warming the Earth.
  URL: http://www.planetseed.com/laboratory/greenhouse-effect-warming-earth
  This site includes excellent resources, activities and teacher guides.
- US Environmental Protection Agency. A Student's Guide to Global Climate Change: Greenhouse Gases. URL: http://www.epa.gov/climatestudents/basics/today/greenhouse-gases.html
  This site includes interesting pie charts related to greenhouse gases.
- US Environmental Protection Agency. Overview of Greenhouse Gases.
  URL: http://www3.epa.gov/climatechange/ghgemissions/gases.html
- Government of Grenada. Grenada's Initial Communication to the UNFCCC (2000).
  URL: http://unfccc.int/essential_background/library/items/3599.php?rec=j&priref=2734#beg
  This is Grenada's first report to the United Nations Framework Convention on Climate Change (UNFCCC) and includes, among other information, facts about Grenada's greenhouse gas emissions.
- Short kids-friendly video clips:
  - Deutsche Welle. What is the greenhouse effect? Global Ideas: https://youtu.be/BPJJM_hCFj0
  - US Environmental Protection Agency. The Greenhouse Effect: https://youtu.be/VYMjSule0Bw
  - Smart Learning for All. Greenhouse Effect for Kids: https://youtu.be/x_sJzVe9P_8

Contact person (as of 2016): Mr John Auguste, Senior Energy Officer, Energy Division, Ministry of Finance

Energy - "Light up my life"

Teacher Tips

Making the connection - energy and climate change

Greenhouse gas emissions associated with the provision of energy services are a major cause of climate change. An increase in the average global temperature is highly likely due to the increased concentration of human-induced (anthropogenic) greenhouse gases released into the atmosphere (Intergovernmental Panel on Climate Change). In 2010, the energy supply sector was responsible for approximately 35 percent of total anthropogenic greenhouse gas emissions. Between 2000 and 2010, emissions from this sector increased by 3.1 percent per year. Global energy demand is expected to increase by 56 percent between 2010 and 2040 (International Energy Agency)! If the share of fossil fuels in the energy mix is not reduced, this would lead to a major increase in greenhouse gas emissions. At the same time, many countries around the world are aiming to reduce the amount of greenhouse gases they release into the atmosphere. Different strategies are available, for example:

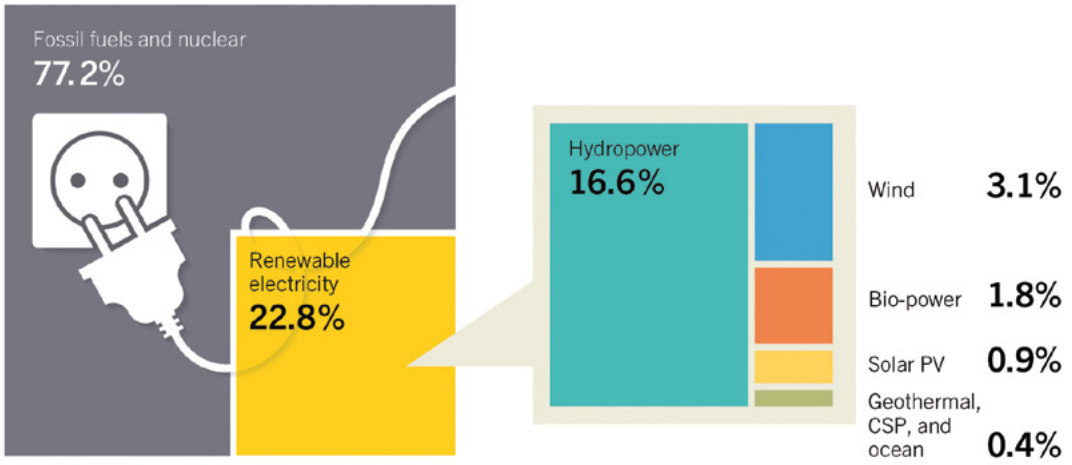
- Developing renewable, environmentally friendly energy sources. Electricity is often produced through burning fossil fuels (such as coal). Many countries around the world are developing ways to produce electricity without releasing greenhouse gases, for instance by using energy from the wind, waves, dams, sunlight and the heat in the ground.
- Developing more energy efficient technology. Electricity is used a lot around the world and producing it releases greenhouse gases. By developing technology (such as more energy efficient TVs, computers etc.) that uses as little electricity as possible, less greenhouse gases are emitted.
- Energy efficient behaviour. Individual behaviour, like turning the lights off when leaving a room, not running the air-conditioning below 22°C and turning off devices on standby can also save a lot of energy (and money!)
- Developing better public transport systems. When a lot of people travel in separate vehicles a lot of greenhouse gases are produced. If better public transport systems are available (such as buses, trains and subways), people will use the same vehicle (not their own) which will release less greenhouse gases.
- Reducing deforestation (i.e. cutting down of trees, such as mangroves) and increasing tree replanting. Trees remove carbon dioxide from the atmosphere, so the more trees planted the more CO_2 is removed from the atmosphere.

Key Facts

- As of 2012, Grenada is still almost completely reliant on petroleum products for its energy supply. Renewable energy accounts for approximately 2 percent of the electricity supply.[1]
- Currently, Grenada's greenhouse gas emissions look like this: electricity accounts for 48 percent; transport for 39 percent and waste for 10 percent (averages for the years 2010 - 14).
- Grenada's total emissions are not significant in the global context with 251,649 tonnes of CO_2 released in 2010 – 0.0005 percent of total global emissions. However, in a global comparison of per capita emissions, Grenada ranks 113th out of 209 countries (compared to its position of 183rd on a list of 197 territories ranked according to absolute population size). [2]
- Energy demand in the Caribbean islands, including Grenada, is increasing, and is set to almost double by 2028 (base year 2010).[3]
- Grenada plans a 30 percent reduction in emissions from its electricity production by 2025 (with an indicative reduction of 40 percent by 2030). 10 percent is to be achieved through the use of renewables and 20 percent from energy efficiency measures.
    - 10 percent renewable energy in the form of 10MW solar, 15MW geothermal and 2MW wind.[4]
    - 20 percent emissions reduction through energy efficiency actions, including retrofitting of all buildings, policies for energy efficiency building codes for all building sectors, and the implementation of energy efficiency in hotels.
    - Tidal and wave energy could also be used in Grenada, Carriacou and Petite Martinique. However, the technology is not yet properly developed or economically viable.
- Globally, renewables delivered an estimated 27.7 percent of the world's power generating capacity at the end of 2014, enough to supply around 22.8 percent of its electricity.[5] Wind, solar and hydro power dominated that market.

[1] http://www4.unfccc.int/submissions/INDC/Published%20Documents/Grenada/1/Grenada%20INDC.pdf
[2] http://cdiac.ornl.gov/trends/emis/grn.html
http://data.worldbank.org/indicator/EN.ATM.CO2E.PC
http://www4.unfccc.int/submissions/INDC/Published%20Documents/Grenada/1/Grenada%20INDC.pdf
http://www.tradingeconomics.com/grenada/co2-emissions-metric-tons-per-capita-wb-data.html
[3] https://www.irena.org/DocumentDownloads/Publications/Grenada_RRA.pdf
[4] http://www4.unfccc.int/submissions/INDC/Published%20Documents/Grenada/1/Grenada%20INDC.pdf
[5] http://www.ren21.net/Portals/0/documents/e-paper/GSR2015KF/index.html#/6

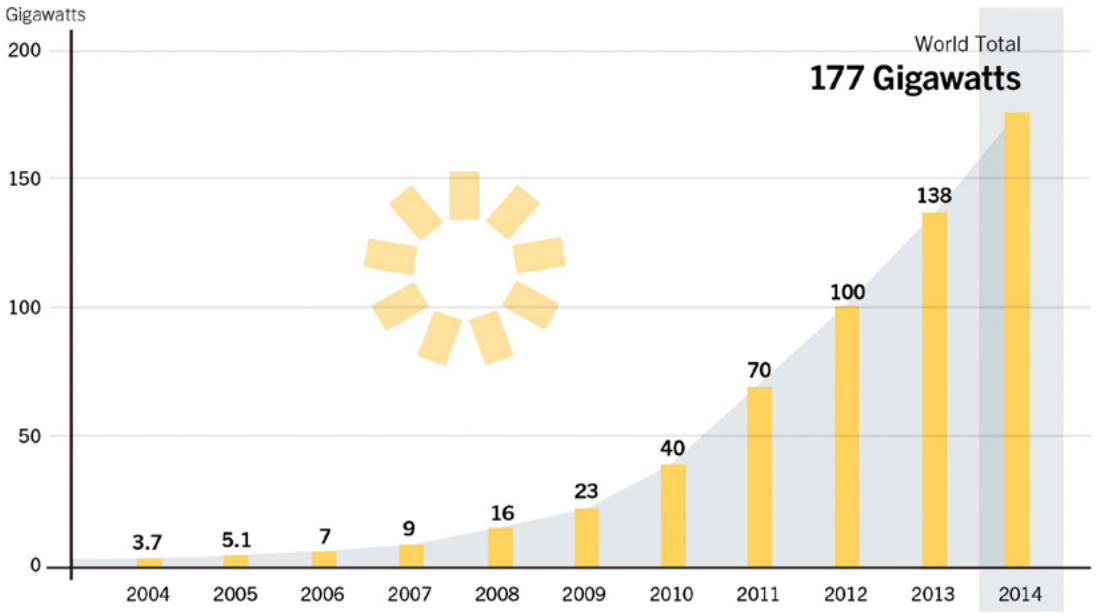
Estimated Renewable Energy Share of Global Electricity Production, End-2014



Based on renewable generating capacity in operation at year-end 2014.

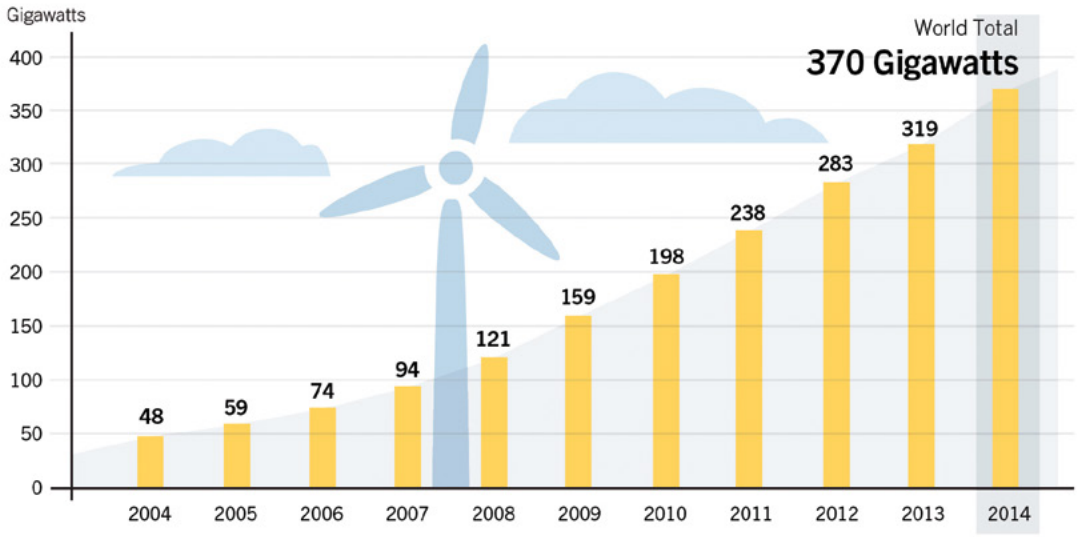
REN21 *Renewables 2015 Global Status Report*

Solar PV Global Capacity, 2004–2014



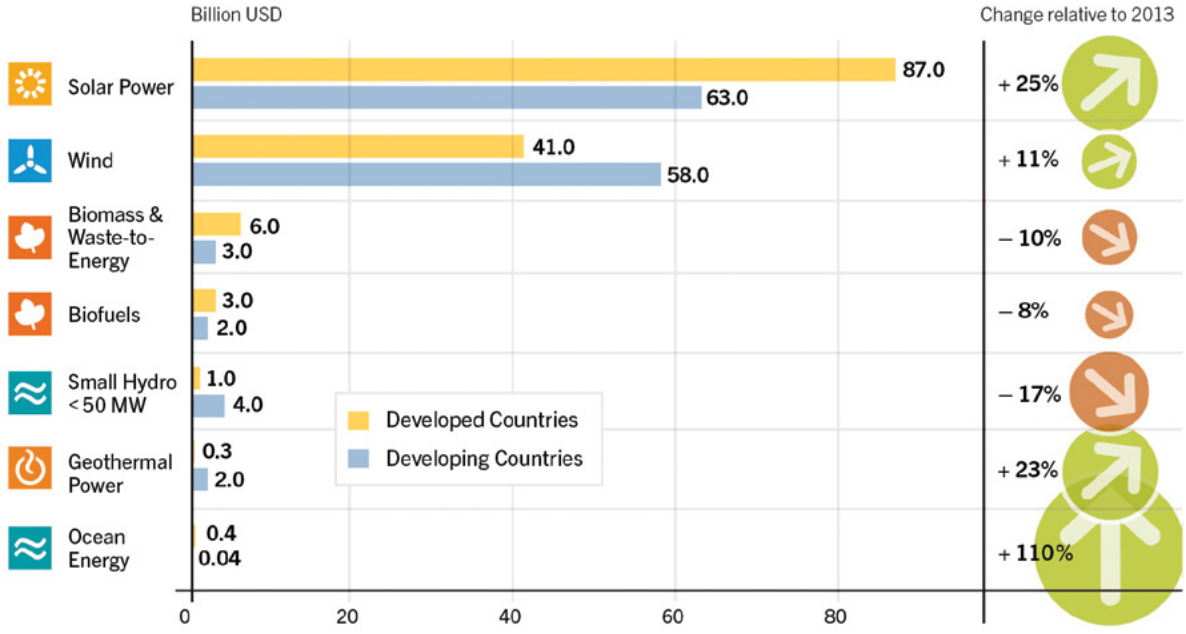
REN21 *Renewables 2015 Global Status Report*

Wind Power Global Capacity, 2004–2014



REN21 *Renewables 2015 Global Status Report*

Global New Investment in Renewable Energy by Technology, Developed and Developing Countries, 2014



REN21 *Renewables 2015 Global Status Report*

Source: Frankfurt School–UNEP and BNEF

Key Words

Climate change mitigation: A human intervention to reduce the sources or enhance the sinks of greenhouse gases. Examples include using fossil fuels more efficiently for industrial processes or electricity generation, switching to renewable energies, improving the insulation of buildings, and expanding forests and other sinks to remove greater amounts of carbon dioxide from the atmosphere. A synonym is greenhouse gas mitigation (UNFCCC definition).

Greenhouse gases (GHGs): The atmospheric gases responsible for causing global warming and climate change. The major GHGs are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_20). Less prevalent, but very powerful greenhouse gases are hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF6) (UNFCCC definition)

Non-renewable energy sources: Most of our energy currently comes from non-renewable energy sources. Coal, petroleum, natural gas and uranium are some examples. Non-renewable energy sources are used to make electricity, to heat or cool our homes, to move our cars and to manufacture products. These energy sources are called non-renewable because their supplies are limited. Petroleum, for example, was formed millions of years ago from the remains of ancient sea plants and animals. (www.eia.gov)

Renewable energy sources: This is a term for natural resources and that can be renewed or replenished in a short period of time. Renewable energy is called "clean" or "green" energy because it does not pollute the air or harm the environment as much as non-renewable energy sources. (www.kidsenergyzone.com)

Geothermal energy: The heat energy stored below the Earth's surface. By drilling down into the Earth's crust, much like we drill for oil, we can use the heat to generate electricity. Geothermal energy is a good source of electricity and for heating or cooling homes and buildings. (www.kidsenergyzone.com)

Wind energy: Wind power is collected through massive wind turbines. The machines capture the energy of the wind and transfers the motion to an electric generator shaft. (www.kidsenergyzone.com)

Solar energy: Energy produced by the action of the Sun's light or heat (www.kidsenergyzone.com).

Hydropower: Electric energy made by the conversion of energy produced from running water. Water, which is held behind a dam, is released through a turbine that spins a generator producing electricity. (www.kidsenergyzone.com)

Biomass fuel: Fuels produced from dry organic matter or combustible oils from plants. Such fuels are considered renewable as long as the vegetation producing them is maintained or replanted. They include firewood, alcohol fermented from sugar and combustible oils extracted from soy beans. Their use in place of fossil fuels cuts greenhouse gas emissions because the plants that are the fuel sources capture carbon dioxide from the atmosphere (UNFCCC definition)

Biogas: This typically refers to a mixture of different gases produced by the bacterial breakdown of organic matter in the absence of oxygen. Biogas can be produced from raw materials such as agricultural waste, manure, municipal waste, plant material, sewage, green waste or food waste. It is a renewable energy source and in many cases has a very small carbon footprint.

Energy efficiency: In simple terms, energy efficiency is "using less energy to provide the same service". Saving energy is one of the best ways to conserve natural resources.

Discussion Guide

- Where does your electricity come from?
- How is it generated?
- Do you know of places in Grenada, Carriacou and Petite Martinique where electricity is generated?

Activity Overview

This unit will at take at least one session. Students explore different types of non-renewable and renewable energy sources, including wind, solar, biomass and geothermal.

Activity Procedure 1

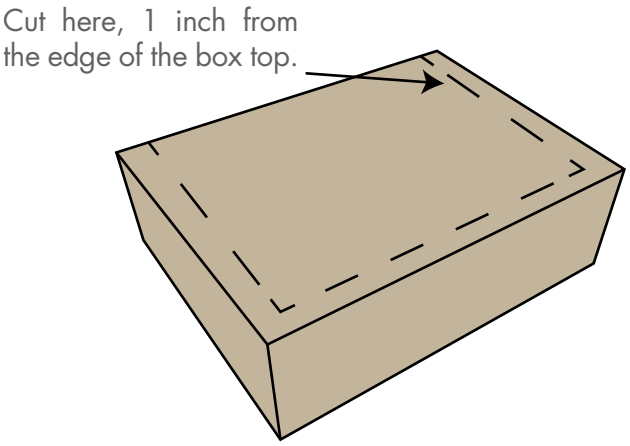
- Ask the students to identify the different types of non-renewable and renewable energy they come into contact with every day (sun, wind, water). Then get them to discuss in small groups (about five students each) examples of each type they can identify in Grenada.
- Use a blackboard or large chart paper to outline the types of non-renewable and renewable energy that each group of students has named. Cluster them (renewable/non-renewable)!
- Let the students discuss why they think some energy sources are called "renewable" and some are called "non-renewable". Give hints and explanation, if necessary!
- Ask them what kind of renewable energy sources could be used in the tri-island state, and where? Ask them where in Grenada, Carriacou and Petite Martinique they have seen some of these energy sources. Places include (list not exclusive):
    - Wind turbines: Mont Toute, BBC Beach, La Tante, Fort Frederick
    - Power stations in Grenada (Queen's Park), Carriacou and Petite Martinique
    - Water power: River Antoine Rum Factory (waterwheel)
    - Solar panels: various homes in Grenada, Carriacou and Petite Martinique; solar plant in Petite Martinique; rooftop of GRENLEC building at Dusty Highway, St. Andrew Anglican Secondary School (SAASS), Le Phare Bleu Marina and Resort and the True Blue Bay Resort and Villas
    - Solar power: Various homes with solar water heaters, Belmont Estate/Grenada Chocolate Company's solar driers.

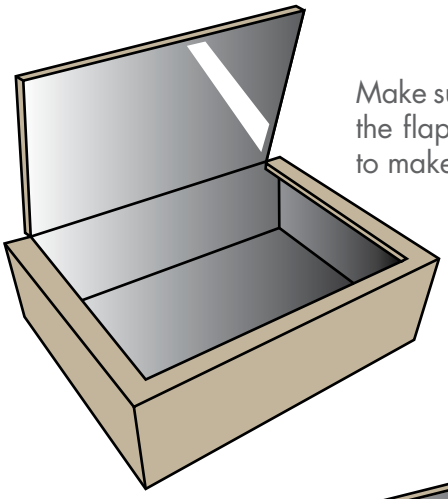
Activity Procedure 2

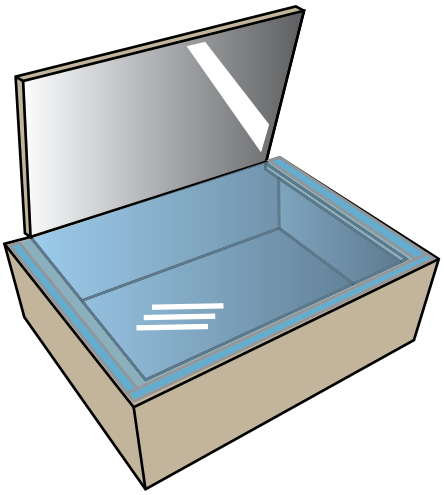
Students harness the energy of the Sun to make their own snacks. The solar oven is a box that traps some of the Sun's energy to make the air inside it hotter than the air outside. The assistance of an adult is required since the exercise involves cutting a box. Hand out Worksheet 5: "How to Build a Solar Oven".

Procedure:

- Using a straight edge as a guide, cut a three-sided flap out of the top of the box, leaving at least a 1-inch border around the three sides.
- Cover the bottom (inside) of the flap with aluminum foil, spreading a coat of glue from the glue stick onto the cardboard first and making the foil as smooth as possible.
- Line the inside of the box with aluminum foil, again gluing it down and making it as smooth as possible
- Tape two layers of plastic wrap across the opening you cut in the lid - one layer on top and one layer on the underside of the lid.
- Test the stick you will use to prop the lid up. You may have to use tape or find another way to make the stick stay put.
- Put the oven to work! Set it in the direct sunlight, with the flap propped up to reflect the light into the box. You will probably have to tape the prop in place. Preheat the oven for at least 30 minutes. You can place a thermometer in the oven to check the temperature. Possible things to heat up: cheese sandwich, a cup of tea, chocolate, a soup, left-overs or anything else you would like to get warm!
- Place a pan/small plate with your snack in the preheated solar oven. Close the oven lid (the part with the plastic wrap on it) tightly, and prop up the flap to reflect the sunlight into the box.
- Enjoy!







For more information and to find this activity online go to NASA's Climate Kids website: http://goo.gl/zk5jep

Materials Needed

- A cardboard box with attached lid. Lid should have flaps so that the box can be closed tightly.
- The box should be at least 3 inches deep and big enough to set a pie tin inside.
- Aluminum foil
- Clear plastic wrap
- Glue stick
- Tape (transparent tape, duct tape, masking tape or whatever you have)
- A stick (about 1 foot long) to prop open the reflector flap. (Use a skewer, knitting needle, ruler or whatever you have.)
- Ruler
- Box cutter (only with adult help!)

Reflections & Follow Up

- Discuss with the students what happened. Explain to them that the heat from the Sun is trapped inside your solar oven, and it starts getting very hot. Ovens like this one are called collector boxes, because they collect the sunlight inside. As it sits out in the Sun, your oven eventually heats up! How does that happen? Rays of light come to the earth at an angle. The foil reflects the rays and bounces them directly through the opening of the box. Once the light has gone through the plastic wrap, it heats up the air that is trapped inside.
- Explain to them that the Government of Grenada aims to increase the number of solar panels over the next years.
- In addition, discuss energy saving with them by asking them how much electricity costs and how much families spend each month?
- What things in your house require electricity? And how can you save electricity?

Further Useful Resources

Kids Energy Zone. URL: http://www.kidsenergyzone.com/teachers/lessonplans/
This website has information for parents, teachers and student activities. It includes videos, games, and colouring sheets. It discusses ways to be a "Super Energy Saver" and talks about renewable energy.

Home Science Tools. Build a Solar Oven. URL: http://goo.gl/j0lPnq
This website provides alternative instructions on how to build a solar oven and includes more pictures.

US Energy Information Administration. Energy Kids. URL: http://www.eia.gov/kids/index.cfm
This website has a thorough "History of Energy" section, complete with timelines for each energy source: coal, electricity, ethanol, geothermal, hydropower, municipal waste, natural gas, nuclear, oil (petroleum), solar thermal, wind and wood. The site would be an excellent aid for a CPEA student's research project.

Government of Grenada. 2015. Intended Nationally Determined Contributions.
URL: http://goo.gl/ZwEPpy

International Renewable Energy Agency (IRENA). 2012. Grenada Renewables Readiness Assessment.
URL: https://www.irena.org/DocumentDownloads/Publications/Grenada_RRA.pdf

Deutsche Welle. 2011. Renewable Energy in the Caribbean. URL: https://goo.gl/Gbcg7v
This six-minute clip argues that, until now, renewable energy has played a negligible role in the region's energy supply, despite the fact that geographical and climate conditions here are ideal. Theoretically, the islands could meet all their electricity needs with geothermal energy and hydropower. Slowly but surely, that switch is happening.

GRENLEC. Saving Tips for your Home. URL: http://goo.gl/7E0GST

GRENLEC. Our Renewable Energy Projects. URL: http://goo.gl/sNFtLl

Contact person (as of 2016): Mr. Leslie Smith, National Ozone Officer, Energy Division, Ministry of Finance.

Mangrove Preservation - "Magnificent mangroves"

Teacher Tips

Making the connection - mangroves, climate change and adaptation

The majority of the population of Grenada, Carriacou and Petite Martinique lives in coastal areas. Many communities rely heavily on nearby resources for their daily sustenance and income. These resources include mangrove ecosystems, which provide local people with various services. One such service is shoreline protection, since mangroves act as biological shields, breaking big waves that approach the shore, for example during a big storm or hurricane, or a tsunami. They can also reduce coastal erosion by trapping sediment and building up land. Moreover, mangroves greatly contribute to the reduction of carbon dioxide in the air, and they act as nurseries for reef fish. However, sea-level rise poses a great threat to mangrove ecosystems. Mangroves can adapt to sea-level rise, but only if a) the rise occurs slowly enough for the plants to adjust, b) they have adequate expansion space and c) environmental conditions are favourable.

Key Facts

- There are 73 types of mangroves worldwide. The four most common species in Grenada, Carriacou and Petite Martinique are red, black, white and buttonwood mangroves (see Worksheet 6B: "Mangrove Identification Cards").
- Mangroves are salt-tolerant trees and large shrubs. They have thick, waxy leaves and salt- secreting pores and glands that help rid the plant of excess salt.
- Between 1980 and 2005, the estimated area covered by mangroves in Grenada, Carriacou and Petite Martinique diminished by 28 percent Mangroves occupy about 3.4 km^2 in the tri-island state.
- Many mangroves were destroyed during Hurricane Ivan, but mangroves were under threat even before Ivan, and they still are today.
- Some of the main threats to mangroves
    - Loss of mangrove swamps for material (including charcoal and firewood), tourism development and jetties
    - Pollution from the dumping of solid waste, oil and sewage
    - Paints on yachts in marinas
    - Cutting of roots for the indiscriminate fishing of oysters
    - Pesticides
    - Sand mining
    - Lack of public awareness

- Mangrove services:
  - They serve as storm buffers by reducing wave energy in shallow shorelines.
  - They are the nurseries of the sea. The tangled roots provide protection and hiding places for invertebrates, crustaceans and juvenile fish.
  - Their leaves provide one of the basic food chain resources for marine organisms, especially crabs. They also serve as roosting and nesting sites for many birds.
  - They assist in protecting water quality and clarity by filtering run-off and trapping sediments and debris from adjacent uplands.
  - They improve air quality and are an excellent carbon sink.
  - Their flowers produce excellent honey.
  - The only mangrove fruits that can be eaten are those from the white mangrove.
- In Sri Lanka, the World Conservation Union compared the death toll from two villages hit by the devastating giant waves of the Indian Ocean Tsunami in 2004. Two people died in one settlement protected by dense mangroves and scrub forest, while up to 6,000 people died in the second village which had no similar vegetation.
- Vietnam has spent approximately USD 1.1 million on mangrove rehabilitation, which has saved the country seven times the amount (USD 7.3 million) every year on dyke maintenance. The green infrastructure – the mangrove forest – has dramatically reduced the pressure on the grey infrastructure – the dykes, since mangroves can absorb 70 to 90 percent of the energy of a normal wave. This is money well spent in times of climate change.

Key Words

Mangrove: A tropical tree or shrub that grows in swampy areas and has tangled roots that grow above the ground; a tidal swamp with a number of these types of trees and shrubs.

Species: A group of animals, plants and other living things that all share common characteristics and that are all classified as alike in some manner.

Ecosystem: A system or a group of interconnected elements, formed by the interaction of a community of organisms with their environment.

Carbon sink: This can be anything that absorbs more carbon than it releases. Forests, soils, oceans and the atmosphere all store carbon. Because of the increase in atmospheric carbon, a lot of emphasis and hope has been put into the ability of trees, other plants and the soil to temporarily absorb the carbon released into the atmosphere by burning fossil fuels.

Activity Overview

This activity involves a field trip. Students travel to the nearest mangrove area and use their observation skills to find forms of wildlife there.

Discussion Guide

A field trip is an excellent opportunity to teach students outdoor etiquette that they can apply for the rest of their lives and pass on to their own families and children. You could discuss the following questions:

- How can you avoid disturbing the wildlife that lives in the mangroves?
- How can you learn more about your environment by observing it in its natural state?
- What can you do to ensure that hiking and going to the beach do not harm wildlife or habitats?
- We will see more if we are quiet.
- We should leave the site as we find it so that the next visitors can also enjoy the plants, wildlife and beauty.

To help students to remember these guidelines, they could learn the following **mangrove pledge,** or make up their own before the trip. Before they leave the school or reach the area of exploration, ask them to raise their right hands in the air, as if swearing in a court of law to tell the truth, and repeat the pledge after you.

Mangroves Pledge

- When I visit the mangroves, I will remember that I am a guest.
- I will move silently and speak quietly.
- If I turn over rocks or logs to look at what lives beneath them, I will carefully put them back where I found them.
- I will have fun and take home memories and leave behind only footprints in the mud or sand.
- I will not chase or scare birds away from their nests.
- I will take actions in my daily life to reduce pollutants that may enter the water, thereby protecting plants and animals that live here and helping the mangrove to protect us from flooding and storm surges.

Credits: "Marvellous Mangroves Australia"

Activity Procedure

- Decide what the objectives of the field trip are.
- Select a date.
- Select a site for your trip, and one alternative site.
- Locate a person in the area who is knowledgeable about mangroves. A person like this may be able to visit your classroom before your visit or even accompany your class to the mangroves.
- Arrange transportation.
- Get students to create a "field journal" (a notebook, or lined paper and a clipboard if available). This will be used for general notes or sketches.
- Show them Worksheet 6B: "Mangrove Identification Cards" and explain the differences between the mangroves.
- Discuss outdoor etiquette/mangrove rules!
- Hand out the Worksheet 6A to students. This sheet includes rules and the scavenger hunt.
- Explain that they have 20 minutes (it will usually stretch longer, and the time needed depends on the students – be flexible) to fill in their worksheets and to make any notes or sketches of interesting things they locate.
- As the teacher, lead them in finding and identifying things.
- When you are sure everyone has had enough time, gather the students together and compare results. Ask each student to report on what he or she has found. See how many different items they have discovered.

- Worksheets 6A and 6B
- Field journals and pens
- Students need to bring: long pants, sturdy shoes, insect repellent, hat, water bottle, plastic bag or container to collect any garbage
- If available, students could also bring cameras so that they can take pictures of wildlife and plants they are unable to identify
- Passports and stickers

Reflections & Follow Up

At the end of the field trip bring the students back together as a group and discuss what they have observed. You could discuss the following:

- Talk about the mangrove. What did the students find interesting about the mangrove forest? What did they notice?

- Talk about any items they observed and their purposes (for example in the food chain).
- Get the students to draw and write the names of the items observed. They can make a booklet titled "Living things in the mangroves".
- Discuss any signs of human influence and how this might affect the mangrove ecosystem. Did they find any cut mangroves? Did the mangroves look healthy?
- At the very end, ask them to answer the discussion questions in their student passports.

Further Useful Resources

Burnett Mary Regional Group. Marvellous Mangroves. URL: http://goo.gl/58V8r3/
The Marvellous Mangroves curriculum has been introduced in eleven countries worldwide and been used by over 1,500 teachers and 250,000 students in the past 15 years. It was developed in Australia. At the bottom of the website you will find different teaching resources all related to the topic of mangroves, including exercises.

The Nature Conservancy. Coastal Resilience – Grenada, St. Vincent and the Grenadines. URL: http://maps.coastalresilience.org/gsvg/
The Nature Conservancy has mapped all the mangrove areas in Grenada, Carriacou and Petite Martinique. It can help you to identify your nearest mangrove site. Just zoom into Grenada or Carriacou or Petite Martinique, press "Map Layers on the left", select Grenada (press "+" button), select "ecological", and then "Dominate Mangrove Vegetation". If required zoom in or out.

SGU Education Conservation Outreach trip to Woburn Mangroves. URL: https://goo.gl/E6Tex1
To celebrate Earth Day and the Caribbean Endemic Bird Festival, the SGU student group Education Conservation Outreach (ECO) organized a trip to the Woburn mangrove wetlands with Grenadian schoolchildren to plant mangrove seedlings, to teach them about the importance of mangroves, and to birdwatch and play in the mud. This a short video.

Champion of the Mangroves: The Nature Conservancy. URL: https://goo.gl/B8kQnk
In this video, a woman from St. Vincent and the Grenadines explains why she fell in love with mangroves after hurricane Ivan.

Contact person (as of 2016): Mr. Gordon Patterson, Senior Forestry Officer, Forestry Department, Ministry of Agriculture, Lands, Forestry, Fisheries and the Environment.

Possible Locations for Field Trips

The Forestry Department and the Environment Division of the Government of Grenada and/or the Ministry for Carriacou and Petite Martinique Affairs can help you identify the nearest and most suitable mangrove forest. Other organizations, like Sustainable Grenadines, the Grenada Fund for Conservation, the St. Patrick's Environmental and Community Tourism Organization (SPECTO), YWF-KIDO Foundation, other environmental/community-based organizations or dive shops could also be a good source of information and assistance.

Overall, 22 mangrove sites have been identified in Grenada and Carriacou. Most are found on the east coast and in the south. Most are small swamps made up of red, black, white and button mangroves.

Some possible sites (list is non-exclusive):

- Levera pond (Grenada RAMSAR[1] site with Platform and watchtower), St. Patrick
- Woburn Bay, St. George (with platform)
- Woodlands, St. George (with platform)
- Westerhall Bay, St. George
- Fort Judy (at entrance), St. George
- Lance aux Epines road (on the way to coral cove cottages the road passes through a beautiful mangrove stand on sandy shore that is easy to see and walk on), St. George
- La Sagesse, St. David
- Conference Bay, St. Andrew
- High North, Lauriston, Mabouya, Tyrrel Bay, Petit Carenage - Carriacou
- Mang Bay - Petite Martinique

Greenz Climate Champions from the west coast might have to travel to the north, east or the south to conduct the mangrove scavenger hunt activity. An alternative could be a mangrove colouring exercise. There are plenty online.

To observe replanting efforts, the following sites could be visited:

- Woburn Bay
- Telescope (Grenville Bay)
- Northern Telescope (near the quarry)
- True Blue Bay (at the Aquanauts Dive shop)

[1]The Convention on Wetlands, called the Ramsar Convention, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. The Convention has several mechanisms to help Contracting Parties designate their most significant wetlands as Ramsar Sites, and to take the steps necessary to maintain their ecosystem components, processes and benefits.

Waste Reduction - "Make your own shopping bag"

Teacher Tips

Making the connection - waste, litter and climate change

Preventing and reducing waste and litter, re-using and recycling material, and buying recycled products all helps in the fight against climate change. Why? Every product has a life-cycle. (Raw materials like trees, metals and oil are harvested or extracted from the Earth, then transported and processed in a factory. From there the product is transported to a warehouse and later to a store). This all generates greenhouse gas emissions. By contrast, the recycling of aluminum cans requires only 10 percent of the energy used in can production from new aluminum ore. In addition, landfills such as those in Perseverance in Grenada and Dumfries in Carriacou also emit greenhouse gases, particularly methane and carbon dioxide which are given off by decomposing waste. If you reduce, reuse and recycle (the 3Rs), you buy less stuff and throw away less. Which means less greenhouse gases are emitted into the atmosphere.

Furthermore, coral reef and mangrove health is affected by litter and pollution. Less litter means less pollution which means healthier coral reefs and mangrove ecosystems. That ultimately means better protection from the negative impacts of climate change for us. As pointed out in Unit 3, coral reefs and mangroves are our first line of defence against climate change. They act as natural barriers against wave action, storm surges and sea level rise, thereby reducing the risk of coastal erosion. They also provide important economic income for fishermen and their families.

Key Facts

- Land-based sources of pollution account for up to 80 percent of marine litter. They include sewage outflows, poor waste management, illegal dumping and littering.
- Coastal areas are most affected by the litter in the sea. Small islands like Grenada are particularly affected because their litter is not properly handled (due to financial reasons, lack of space for proper siting and lack of awareness). It is often dumped in rivers and along the coastline and ends up in the ocean.
- Over one trillion plastic bags are used every year, worldwide (Earth Policy Institute). At least 267 different species are known to have suffered from entanglement in, or ingestion of marine litter, including 86 percent of all sea turtle species, 44 percent of all seabird species, and 43 percent of all marine mammal species. Over the past 25 years, 10 percent of all dead animals found worldwide were entangled in plastic bags (Derraik J.G.B., 2002. The pollution of the marine environment by plastic debris: a review. Marine Pollution Bulletin 44:842-852/ ICC, 2011. Tracking Trash, 25 years of Action for the Ocean).
- Several cities and countries have banned plastic bags and plastic bottles, or have banned supermarkets from throwing away unused food.
- Styrofoam – used for example to produce food containers – is not recyclable, does not degrade and releases toxic fumes in incineration. An alternative to styrofoam containers are cardboard

boxes, which are also available in Grenada.

- More than one quarter of Grenada's waste is organic and could be used for composting.
- In Grenada, Carriacou and Petite Martinique
  - It is estimated that around 15 percent of municipal waste is discarded as litter.
  - Some 20 million plastic bottles are estimated to be imported and used every year in Grenada, amounting to 604 tonnes. Each year, around 30 percent of that amount (181 tonnes) remains unmanaged and ends up littering the land environment and thus potentially the ocean. Only 0.5 percent is recycled.
  - Garbage collected from houses is transported to the Perseverance landfill site for final disposal. This site is located on Grenada's west coast. A second, smaller landfill (Dumfries landfill) operates on Carriacou. In the case of Petite Martinique, contractors ferry waste over to Carriacou for disposal in the Dumfries landfill.
  - The Perseverance landfill is almost opposite the Moliniere/Beausejour Marine Protected Area. Chemicals from the land fill can get into the sea water and kill the reef and fish in the marine protected area. The MPA expert team listed the Perseverence landfill as the number one threat to the health of the Moliniere/Beausejour Marine Protected Area (Nimrod 2013/Appendix 6).
  - The landfill at Perseverance will last for only seven years if waste enters the landfill untreated as usual. We need to come up with alternative strategies, which include reusing and recycling more!

Where does Grenada's waste come from?

Waste categories	%
Organic waste	27.1
Site cleaning waste	21.30
Plastics*	16.4
Paper cardboard	13.6
C&D	11.6
Glass	3.1
Metal	2.4
Textiles	2.3
Tyres	0.90
Household bulky waste	0.70
Street sweeping waste	0.60

**Plastic can take hundreds or even thousands of years to completely biodegrade.*

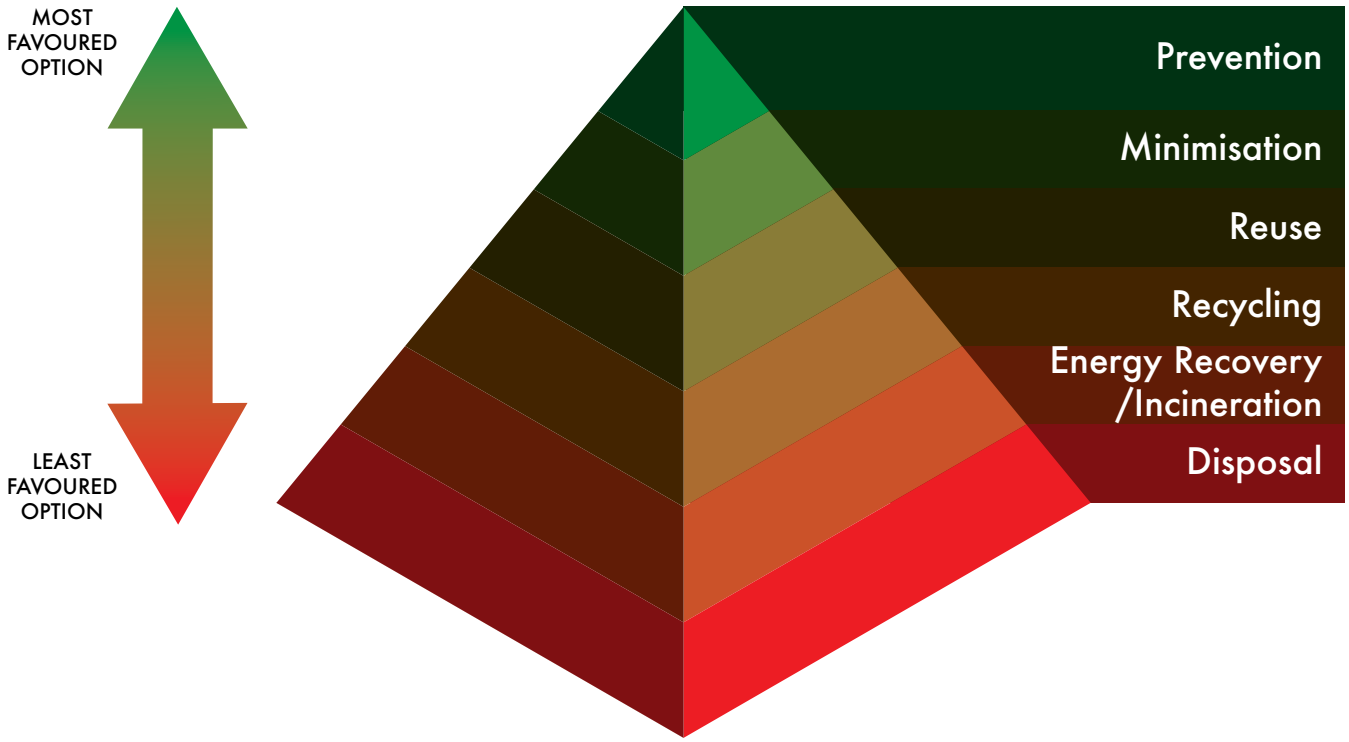
Key Words

Reuse: To use an item again after it has been used. This includes conventional reuse where the item is used again for the same function, and creative reuse where it is used for a different function.

Recycle: In contrast to reuse, recycling is the breaking down of the used item into raw materials which are used to make new items. Many countries recycle old paper, glass, plastic, etc.

Compost: Mixture of various decaying organic substances, such as dead leaves, chipped wood or manure, used for fertilizing soil.

Waste management hierarchy: The waste management hierarchy indicates an order of preference for action to reduce and manage waste, and is usually presented in the form of a pyramid:



Activity Overview

This unit takes at least one session. It can easily be split into two sessions. It introduces students to the 3-R concept for waste reduction (reduce, reuse and recycle). Students investigate the length of time it takes for various items to decompose, including a plastic groceries bag, which takes a very long time compared to organic bags. In a hands-on activity students create their own recycled shopping bags.

Discussion Guide

- Use the poster "waste reduction" to start the discussion. The poster can be found at www.gov.gd or www.iccas.gd. Ask the students what surprises them, and which of the items they and their families use themselves.
- Ask them if they know where the content of the garbage bins goes? Then examine some of the students' own personal activities that create waste which gets added to the landfill. Use the A to Z Brainstorm method, and list the activities as a group on the blackboard or chart paper.
- What are the environmental benefits of reducing, reusing and recycling?

Activity Procedure *(3 different procedures according to age group, see following images)*

Option A: No sewing needed (ages 7 and 8)

- Collect an old heavy cotton T-shirt and turn it inside out.
- Cut the sleeves off.
- Cut the neckline using a kitchen bowl to resemble the scooped neck of a vest/tank top. The shoulder straps will become the handles.
- Decide how deep you want the bag to be, and trace a line across.
- Make a fringe on the bottom edge by cutting about ¾ to 1 inch apart, from the bottom of the shirt up to the line marking the bottom of your bag. Make sure you cut the front and the back layers together, they need to match up for the next step.
- Tie the fringe. Take your first pair of tassles and tie them into a knot, then tie two more pairs. Now if you lift your bag you'll see that, although the pairs are pulling the bag together, as there's a hole between each pair. The next step will close those holes.
- Next, grab one strand from the middle of the set and tie it in a knot with one of the strands on the left set. Then take the other strand from the middle set and tie it in a knot with one of the strands on the right set. And so on and so forth.
- Turn your shirt inside out and voila! You are done.

Option B: Sewn with needle and thread (ages 9 and 10)

- Collect an old heavy cotton t-shirt and turn it inside out.
- Cut the sleeves off.
- Cut the neckline using a kitchen bowl to resemble the scooped neck of a vest/tank top. The shoulder straps will become the handles.

- Decide how deep you want the bag to be and trace a line across. Cut across this line.
- Stich from one side seam to the other. Voila, you're done!

Option C: with a sewing machine (ages 11 plus)

- Collect an old heavy cotton T-shirt or a piece of fabric 1 yard square.
- Cut the sleeves off.
- Cut the neckline using a kitchen bowl to resemble the scooped neck of a vest/tank top. The shoulder straps will become the handles.
- Decide how deep you want the bag to be and trace a line across. Cut across the line.
- Using the sewing machine, place a running stitch from one side seam to the other.
- Miter (= sewing term: reinforcing the bottom of the bag by folding it over about three times before stitching) the lower corners of the bag to add strength and support.
- Turn the bag right side out and place an additional zigzag stich on top of each of the running stitches.
- Add pockets inside or out if desired

Image 1

Image 2 (Cut the neck out and make straps)

Image 3 (Get your needle and thread ready. Turn the shirt/bag inside out)

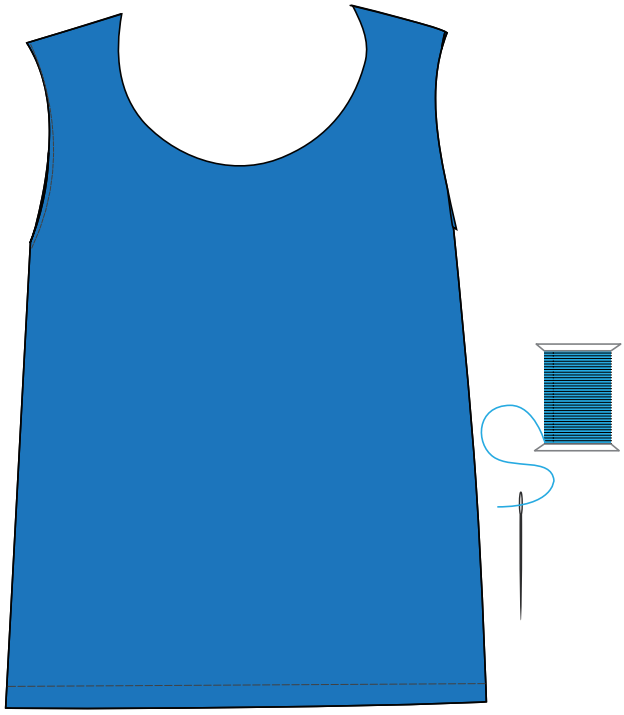


Image 4 (Fold three times to reinforce bag before sewing)

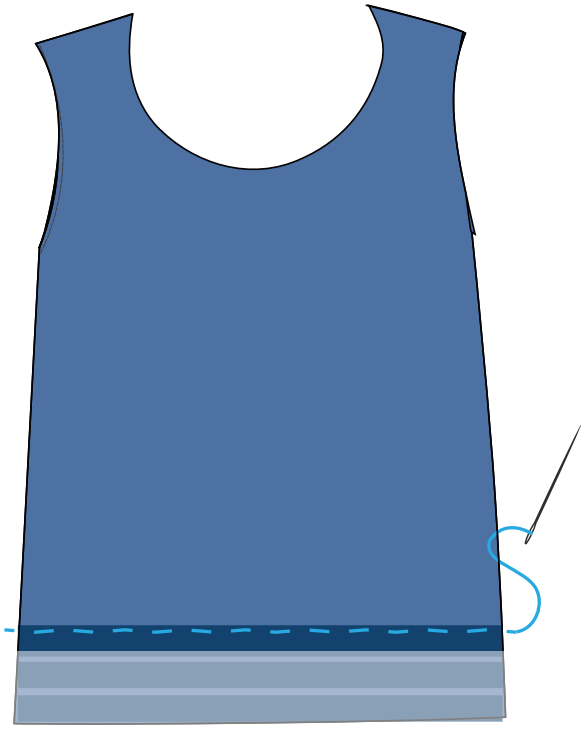


Image 5 (Turn bag right-side out)

Image 6 (… and fill with goodies)

Materials Needed

- Old t-shirt or fabric
- 3-5 straight pins
- Pencil or pen
- Dinner plate or bowl
- Scissors
- Needle and thread, or sewing machine (depending on option chosen)

Reflection/Follow-Up Work

- Which items could be reduced, reused or recycled and how? How can you create awareness in your community ? How can you make you own personal change?
- Create an individual 3R chart, showing the connection between your daily activities and what can be reduced, reused and recycled.
- Discuss if you want to start a recycling centre at your school, home, church or other neighbourhood meeting place.
- Can you start a "litter less lunch" programme at your school? Or what other ideas do you have?

Useful Resources

The Grenada Solid Waste Management Authority can provide a lot of useful information on waste management in Grenada. They are based in Frequente, Industrial Park, St. George, Grenada. The landline number is: Tel (473) 444-2019 or (473) 444-3009.

Grenada Solid Waste Management Authority (GSWMA). URL: http://www.gswma.com/index.htm
Browse the website! It provides pictures of clean-ups and illegal littering, guidance for waste reduction and has link to many other documents.

Government of Grenada. 2003. Final Draft – National Waste Management Strategy for Grenada. URL: http://www.gswma.com/download/National_Waste_Management_Strategy_Grenada.pdf

Rothenberger, Silke. 2015. Waste to Energy Scoping Study for Grenada.
URL: http://goo.gl/KDqBU4
Chapters 4 and 5 provide a great introduction to Grenada's waste management system

United States Environment Protection Agency. A Student's Guide to Global climate Change – Reduce Waste. URL: http://www3.epa.gov/climatechange/kids/solutions/actions/waste.html
This is a child-friendly website with more background information on the topic and guidance on how to apply the 3Rs at school.

RecycleWorks. Setting Up a School Recycling and Waste Reduction Program.
URL: http://www.recycleworks.org/schools/schoolpgm.html
Visit this website for more guidance on how to set up a waste reduction programme at your school.

MommyPotamus. How To Make A No Sew T-Shirt Tote Bag In 10 Minutes.
URL: http://goo.gl/C0gF2u
This is the website that you can refer to for the bags.

Cornell Composting. Composting in schools. URL: http://compost.css.cornell.edu/schools.html
The content of this site is very good and could help you set up a compost point at your school.

Project Learning Tree. PreK-8 Activity 51 - Make Your Own Paper. URL: https://goo.gl/lNcfFZ
This website features a variety of different activities."Make your own paper" is part of the 3Rs plan. A class or whole school can get involved in the activity.

Nature Bridge. Garbology for Students. URL: https://naturebridge.org/garbology/students
This is another good website with activities for young students supported by their teachers. It features a waste assessment process that a class can use to see how much, and what types of garbage they produce during the week. They can then figure out alternatives to throwing it away!

Contact person (as of 2016): Ms. Myrna Julien, Public Relations Officer, Grenada Solid Waste Management Authority.

Possible Locations for Field Trips

- Visits to landfills: A visit of a landfill site gives students a valuable picture of where their waste goes after the garbage man picks it up. A visit like this brings home the fact that the landfill is reaching its capacity. The numbers to call are:
    - Perseverance Landfill – (473) 440-3186
    - Dumfries Landfill – (473) 443-6958

Recycling station	Contact name	Location	Phone number	Email address
Spice Isle Recycling	Mr Ryan Singh	Woodlands, St. Georges	435-5811 438-4747 415-4582	spiceislerecycling@yahoo.com Free collection services for cardboard boxes and plastic bottles. They also purchase metal, copper, brass, aluminium/stainless steel, batteries, old vehicles, old galvanized iron
Earth Wise Recycling	Mr Mark Wilson	Maurice Bishop Highway, Grand Anse, St. George, Grenada	439-9412	wilson.earthwiserecycling@gmail.com wilson.earthwise@hotmail.com Collect/buy all: discarded/ old batteries, electrical motors, compressors, wires, copper by-products including brass, lead-acid batteries
Le Phare Bleu Recycling Center	Ms Jana Caniga	Calivigny Bay, 8001 St. George's, Grenada	444-2400	hotel@lepharebleu.com Le Phare Bleu Marina & Boutique Resort recycles a lot of material, and includes a recycling collection centre, as well as composting and glass recycling facilities. Kindly contact Le Phare Bleu Marina & Boutique resort and ask if a visit is possible.
True Blue Bay Resort and Villas	Mr Russ Fielden	Old Mill Road, True Blue, St. George, Grenada	443-8783	The hotel recycles a lot of material. Kindly contact them and ask if a visit is possible.
Petite Anse Hotel & Restaurant	Ms Annie Clift	Prospect Road, Sauteurs, St. Patrick, Grenada	442-5252	The hotel recycles a lot of material. Kindly contact them and ask if a visit is possible.
Composting	Agronomy Division Extension Division	Ministry of Agriculture, Ministerial Complex, St. George's Grenada	440-2708 440-3078 440-3083	Both divisions can tell you where composting plots have been established in the tri-island state and if a visit would be possible.

Sustainable Fishing - "Let's go fishing"

Teacher Tips

Making the connection - the oceans, fishing and climate change

This unit highlights three key impacts of climate change on oceans:

Impact 1: Warming ocean water, or ocean temperature rise
As in the atmosphere, ocean currents move warmer seawater towards the North and South Poles, while colder water returns towards the equator. Heat exchange also occurs vertically in the ocean, between the surface water and deep water. This change in temperature has an impact on coral reef ecosystems and can lead to coral bleaching and the death of corals. This in turn, has an effect on the other animals that inhabit coral reefs, including many fish species which fishermen depend on for their livelihoods. Other key species that are affected include turtles and invertebrates, e.g. octopus species or "sea cats".

Impact 2: Acidification of ocean water
Each year, the oceans absorb about 26 percent of the carbon dioxide emitted into the atmosphere. That gas reacts with the seawater to form carbonic acid, which is leading to ocean acidification (UN 2015). This changes the chemistry of the water and threatens environments such as coral reefs, which are our first line of defence against storm surges - a defence that is free of charge. The reefs also serve as a habitat for many commercially important species targeted for fishing. It is proven that rising temperatures have accelerated coral bleaching and coral mass mortality over the past 25 years. This has negative effects on food webs and as such, also on fish production and fisheries.

Impact 3: Overfishing combines with climate change to negatively affect Oceans
Our oceans are not only stressed by climate change but also by other factors, including overfishing (or ocean pollution which we discussed in unit 3). In 2012, more than one quarter of fish stocks worldwide were classified by the Food and Agriculture Organization of the United Nations as overfished. This threatens not only the livelihoods of more than 500 million fishermen and fisherwomen and their families (globally), but also our marine ecosystems which are increasingly out of balance. For example, in parts of the Caribbean, overfishing of plant-eating fish (so called herbivores), such as the parrot fish or "Cacabawee" in French Creole, has led to the smothering of coral reefs by plants called algae. The damage to coral reefs by these plants threatens important fish habitat. It also makes the coral reef weaker and less resilient to storm surges and waves. It is all connected!

In short: Marine ecosystems that are already weakened by overfishing become less resilient and more vulnerable to climate change because the changes are happening so rapidly and many marine ecosystems simply do not have sufficient time to adapt. However, if we are able to reduce other stress factors such as overfishing and pollution, our oceans will be more resilient to the warming and acidicfication they face due to climate change.

Key Facts

- If the ocean gets too warm, the plants and animals that live in it must adapt, migrate or die.
- Between 1971 and 2010, the strongest ocean warming has been observed near the surface (upper 75m): 0.11 (0.09 to 0.13) °C per decade (IPCC 2013).
- Caribbean corals have declined by more than 50 percent since the 1970s.
- The fishing industry contributed 1.3 percent of our GDP in 2013, and fish are among the island's main export goods. In 2012, together with nutmeg and cocoa beans, they accounted for almost 70 percent of exports (IDB 2013).
- The closed season for all shellfish is May to August.
- The open fishing season for turtles is from 1 September to 30 April, – except for leatherback turtles. According to Grenadian law (2001):
  - "No person shall fish for, take, sell, purchase, have in his possession or disturb the nest of any leatherback turtle of any size at any time." The consequences can be up to two years imprisonment or/and a EC$5,000 fine."
  - "No person shall disturb, take, sell, purchase or have in his possession any turtle eggs."
- According to a number of seafood guides:
  - these are examples of fish species that are rather overfished: groupers, swordfish, bluefin tuna, lobster, snapper
  - these are examples of fish species which are rather okay to eat: mahi-mahi (also called dolphinfish), lionfish, yellowfin tuna, herrings.
- Marine protected areas, such as Moliniere/Beausejour and Sandy Island Oyster Bed are no-fishing marine areas. The fish in these areas can reproduce without being caught and in this way fish populations grow back, which will then allow for larger, yet sustainable catches within a decade or so. According to the Grenada Fisheries Act (1986):
  - In Grenada, "the Minister may, by Order, declare any area of the fishery waters and, as appropriate, any adjacent or surrounding land, to be a marine protected areas where he or she considers that special measures are necessary a) to afford special protection to the flora and fauna of such areas and to protect and preserve the natural breeding grounds and habitats of aquatic life, with particular regard to flora and fauna in danger of extinction; b) to allow for the natural regeneration of aquatic life in areas where such life has been depleted; c) to promote scientific study and research in respect of such areas; d) to preserve and enhance the natural beauty of such areas; e) to allow for the sustainable use of such areas; or f) to protect and preserve historic monuments and other artefacts of ecological significance"
  - "A person who, in any marine protected areas, without permission granted fishes or attempts to fish; takes or destroys any flora and fauna other than fish; dredges, extracts sand or gravel, discharges or deposits waste or any other polluting matter, or in any way disturbs, alters or destroys the natural environment; or constructs or erects any buildings or other structures on or over any land or waters, is guilty of an offence and liable, on summary conviction, to a fine of one thousand dollars."
- Parrotfish are colorful herbivores and they spend up to 90 percent of their day eating algae off coral reefs. And as a fun fact: they poop sand (up to 200 pounds of it per year), which is good for our beaches.

- Sea urchins or sea eggs are another important species affecting coral reefs. Sea eggs eat plants and algae that can grow on coral reefs. Sometimes the plants and algae grow so strongly on the corals that they smother them and kill the reef. Sea eggs eat the plants and algae and so control their growth. The sea urchin fishery was closed in Grenada in 1995 after a drastic decline of white sea urchins. This caused an immediate indefinite "no-take, no-eat" moratorium on the harvesting of this species. The moratorium has now been lifted. The sea urchin season opens on 1 September and closes 30 September. It is important to note that sea urchin harvesting was never important in Carriacou and Petite Martinique.

Key Words

Overfishing: In simple words, catching too much fish for the system to support, which leads to an overall degradation of the system. Overfishing is a non-sustainable use of the oceans.

Sustainable fishing: This is the idea that fish are caught at a sustainable rate, meaning the fish population does not decline over time due to the fishing practices. It ensures that the stock is healthy for an unlimited time period. By contrast, unsustainable fishing can cause the depletion of fish stocks or lead to unacceptable impacts on the marine environment. Subsequently, it has negative economic and environmental impacts.

Quota: This is a set quantity of fish allocated to all registered fishing companies (fisheries) in a given region. The regulatory body ensures that no one catches more than their quota. There are penalties for companies who do so. Quotas are designed to prevent overfishing and to prevent endangering fish stock.

Marine protected area: "A clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values." (WCPA, 2008) or "… means any confined area within or adjacent to the marine environment, together with its overlying waters and associated flora, fauna, and historical and cultural features, which has been reserved by legislation or other effective means, including custom, with the effect that its marine and/or coastal biodiversity enjoys a higher level of protection than its surroundings." (CBD, COP 7, Decision VII/5 (note 11))

Open/closed season: The times when fishing is permitted/not allowed, for example for turtles and lobsters.

By-catch: Unwanted marine species caught while fishing for another species. Sometimes this catch is used or sold, but often it is thrown overboard or back in the sea to die, or it is already dead.

Activity Overview

If the "fishing game" is well prepared, this unit can be done in one session. This unit familiarizes students with the fishing guidelines in Grenada, Carriacou and Petite Martinique. The students learn how the guidelines help keep the oceans healthy. Through an interactive "fishing" game the students gain a better understanding of what sustainable fishing means and a greater awareness of the need to properly manage marine resources.

Discussion Guide

- Ask children: "Who likes to eat fish?" and "What would happen if there were no more fish in the sea?"
- Ask children to list all the marine species they like to eat.
- Introduce the concept of the Fisheries Division in a child-friendly manner, for example "a group of very important educated people who many years ago created rules to help protect the marine life and to keep our oceans healthy. These rules are meant to protect fish stock so that we can catch fish in the future. These rules are revised regularly as changes occur in our oceans."
- Ask the children to pretend they are working at the Fisheries Division. Either together or in small groups, let them brainstorm what rules they would create to manage fish stocks and protect other marine life, such as turtles, or about ways in which fishing could be less harmful to the marine environment, while also discussing the important role of fishing as an income source for many families in Grenada, Carriacou and Petite Martinique. They can use the "graffiti wall" method from the thinking tools to conduct this exercise!

Activity Procedure

- Tell the students "Now, we are going fishing!" Ask them to go outside and find a stick (or have sticks already available) and let them make their own "fishing rods". You can use a string with a stretched out paper clip (see image 1).

Image 1

- Attach paperclips to the set of "fishing cards" (to be cut out of Worksheet 8). Leave a little space so the hook can go through the hole of the attached paper clip. (see image 2 and image 3)

Image 2

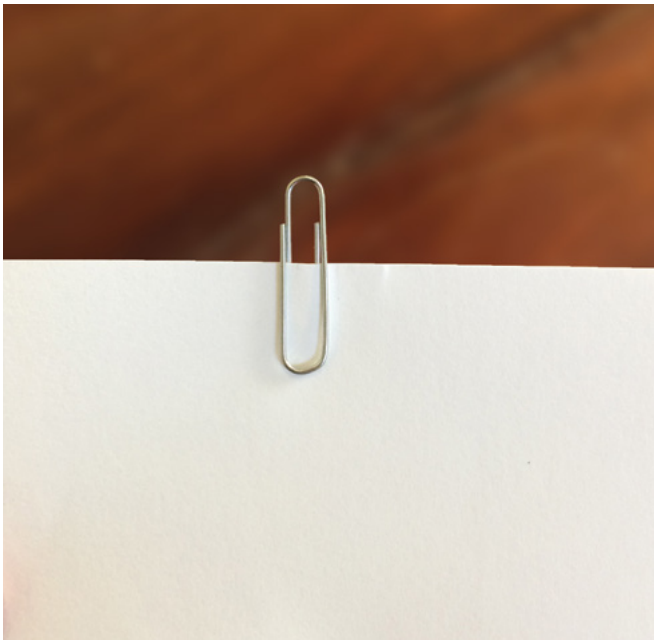
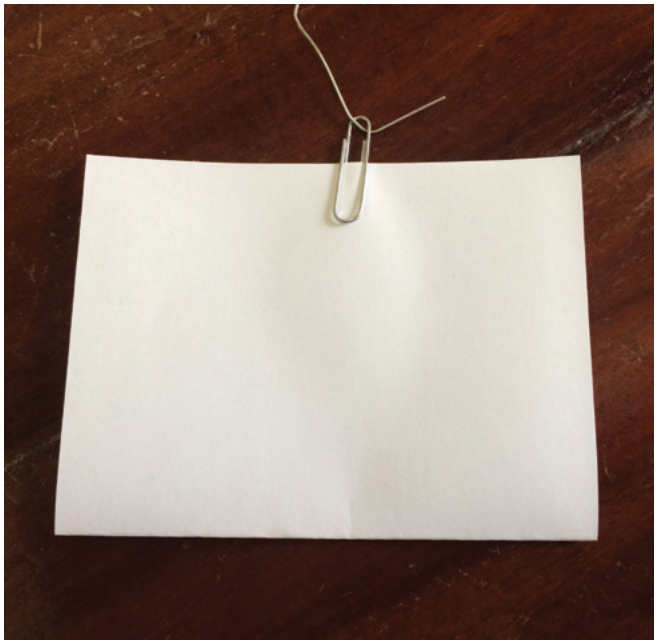


Image 3



- Set up a cardboard box, basket or bowl (large enough to hold the cards) and put the fishing cards inside. Make sure the cards are folded in half so the students cannot see the marine species they are catching.
- Two to four children begin taking turns at fishing. Depending on your group size, you could also set-up several fishing boxes so students can fish in parallel. This would also require printing more copies of Worksheet 8 to have more "fishing cards". Get each student to read his/her fishing card out loud. Allow some discussion and ask them whether it is a positive or negative catch, based on the information provided on the back of the card.
- Children must return the cards back to the "sea". Keep score of the points accumulated on the blackboard. Once sufficient time has passed, end the game and calculate all the scores.

Materials Needed

- Lengths of stick/or string to resemble fishing rods or a long line
- Rulers (used to show children the allowable length of sea urchins and conch shells)
- Large bowl, basket or box filled with shells and rocks to resemble the sea bed
- Paper clips
- Fishing cards cut out of Worksheet 8 "Fishing game" (Remember: Just print one-sided)

Reflection/Follow Up Work

After the fishing game ask the students some follow up questions to provide them with a moment of reflection. For example:

- How can you educate others about overfishing? And what else can you do?
- What can you do to educate the fishermen living in your community about the rules and regulations created by the Fisheries Division?
- Do you know where you can find the marine protected areas in Grenada, Carriacou and Petite Martinique? Have you ever visited one? Show students on a map if they do not know.

Resources

The fisheries biologist of the Fisheries Division in the Ministry of Agriculture, lands, Forestry, Fisheries and the Environment is an excellent source for educational and information material as well as field trip ideas. Also ask if they are offering another free MPA summer camp. Encourage any students who take a deep interest in this unit to sign up for this free camp.

Government of Grenada. 1986. Grenada's Fisheries Act. URL:http://goo.gl/XZ3xOI

Government of Grenada. 2001. Amendment to the Grenada's Fisheries Act.
URL: http://goo.gl/vTA9oO
This amendment relates to turtles in Grenada, Carriacou and Petite Martinique.

Intasave Caribsave. 2012. Partnerships for Resilience: Caribbean Fish Sanctuaries.
URL: https://goo.gl/PyQ94W
This 22min video was produced to increase awareness of the potential benefits that fish sanctuaries (also known as marine protected areas, no-take zones or conservation areas) can generate for the environment, for fisheries and for the local community.

Marine Stewardship Council. Fish and Kids. URL: http://www.fishandkids.org
This is an online education programme that aims to teach children about the importance of marine sustainability. It provides teaching material for kids aged from 5-11.

Wildscreen Arkive. Teaching resources for 7-11 year olds. URL: http://goo.gl/xfUxOI
A variety of free educational resources for 7-11 years-olds, including a game called "dinner at reef"

Conservation International. 2014. Nature is Speaking. Coral Reef Edition.
URL: https://goo.gl/y5FOKA
Famous movie actors joined forces to give nature a voice. This very short 1.5 minute clip is on coral reefs.

Earth Endangered Creatures. Endangered Species Search by Area Selection.
URL: http://goo.gl/A6ynlf
This website provides a comprehensive list of all endangered species in Grenada.

Rhein, M., S.R. Rintoul, S. Aoki, E. Campos, D. Chambers, R.A. Feely, S. Gulev, G.C. Johnson, S.A. Josey, A. Kostianoy, C. Mauritzen, D. Roemmich, L.D. Talley and F. Wang, 2013: Observations: Ocean. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
URL: https://goo.gl/7p4LlA
A rather long paper for a more scientific background

UN. 2015. First Global Integrated Marine Assessment. URL: http://goo.gl/tZHrBm
Again, longer report for a more scientific background

Contact person (as of 2016): Mr Justin Rennie, Chief Fisheries Officer, Fisheries Division, Ministry of Agriculture, Lands, Forestry, Fisheries and the Environment

Notes

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www.international-climate-initiative.com

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CLIMATE CHANGE
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This publication was produced by the Grenada Ministry of Agriculture, Lands, Forestry, Fisheries and the Environment, the Grenada Ministry of Education and Human Resource Development and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH as part of the "Integrated Climate Change Adaptation Strategies in Grenada" (ICCAS) Programme. ICCAS is funded by the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) as part of its International Climate Initiative (IKI). The Programme is jointly implemented by the Grenada Ministry of Agriculture, Lands, Forestry, Fisheries and the Environment, GIZ and the United Nations Development Programme.

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