INTRODUCTION TO SANDWATCH:
AN EDUCATIONAL TOOL FOR SUSTAINABLE DEVELOPMENT

ADDENDUM: CLIMATE CHANGE ADAPTATION THROUGH SANDWATCH

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United Nations Educational, Scientific and Cultural Organization

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Introduction

As the world confronts the growing threat of climate change, Sandwatch presents an opportunity to help people and ecosystems respond to present and future changes in a practical manner. Beaches are among the ecosystems most at risk from climate change as they face rising sea levels and increased storms. By contributing to ecosystem health and resilience, Sandwatch can help people from all walks of life learn about climate change and how their actions can contribute to the adaptation process.

In 2007 the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) compiled overwhelming evidence to show that the earth's climate is changing mainly as a result of greenhouse gases caused by human activities. Partly as a result of this report and the award of the 2007 Nobel Peace Prize to the IPCC and former US Vice-President, Al Gore, climate change became a worldwide concern. Sandwatch, which already had the objective of building ecosystem resilience, was identified as a programme ideally suited to building capacity in climate change adaptation. In 2008, a "Sandwatch and Climate Change" video competition was held, a training workshop was conducted to provide Caribbean Sandwatch groups with the communication skills to effectively convey information on climate change to a general audience, and a dedicated climate change section was established on the website.

Contents of the Addendum

This Addendum contains a new Chapter 13 on climate change. Following this, specific climate change information and activities have been added to Chapters 3, 4, 5, 6, 7, 8, 9, 11, relating specifically to sea level rise, ocean acidification, rising temperatures, and increases in extreme events. Finally two new chapters have been added: Chapter 14 Creating your Sandwatch network, and Chapter 15: Taking action and undertaking a Sandwatch project.

New Chapter 13 Climate change

> *"Many Small Island Developing States (SIDS) comprise small, low-lying islands with limited land and freshwater resources. They are likely to be severely impacted by the projected rise in sea levels and the increase in extreme weather events caused by global warming. SIDS are also likely to be among the first countries confronted by the devastating social and human consequences of climate change – such as the forced migration of entire populations away from islands as they become uninhabitable. Faced with these risks, there is an urgent need to develop appropriate educational materials on climate change for SIDS. This means helping small island communities learn to manage their natural resources and ecosystems in a more sustainable way. The flagship UNESCO Sandwatch project is an excellent example of what can be achieved in this regard."*
>
> Address by Mr Koïchiro Matsuura, Director-General of UNESCO, International Seminar on Climate Change Education, UNESCO Paris, 27 July 2009

This chapter explores climate change and ways in which Sandwatch can contribute to adaptation through education for sustainable development.

Weather and climate

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

Climate change

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

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

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

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

Climate change predictions

There is a large body of information about climate change in published literature and on the Internet, some of it is sensational, some contradictory and some based on sound science. However, it is very difficult for the lay person to distinguish sound knowledge from misleading information.

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

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

country-specific information. Table 1 provides global projected changes up to 2099 based on the IPCC Fourth Assessment Report (2007).

Table 1 Projected Global Climate Changes by 2099 (Source IPCC, 2007)

Parameter	Projected Change
Temperature	Increase of between 1.1 and 6.4^{o}C
Sea level rise	Increase of between 0.18 and 0.59 m
Ocean acidification	Decrease in pH of 0.14 – 0.35 pH units (resulting in increased acidity)
Snow and ice extent	Decrease in areal extent of ice and snow
Extremes: heat waves and heavy precipitation	More extreme events
Tropical cyclones	Stronger tropical cyclones
Precipitation	Changes vary regionally, some areas getting drier, some wetter.

Activity 13.1 Conduct your own weather measurements

What to measure → Depending on the age of the group, simple or more complex weather characteristics can be observed and/or measured on a daily basis to show how weather changes. Simple weather measurement kits are available, however there are several weather measurements that require no special equipment and are described below.

How to measure→Observe, measure and record the following:

- Cloud cover: clear, partly cloudy (less than half of the sky is covered with cloud), mainly cloudy (more than half the sky is covered with cloud) and completely cloudy;
- Cloud type: descriptors included high and low clouds; cloud colour; cloud type e.g. cumulus, cirrus, stratus clouds;

Simple cloud observations

Partly cloudy, high cirrus clouds;

Completely cloudy, mid-level cumulus clouds.

- Temperature: use a simple thermometer (although be sure to keep it out of direct sunlight);
- Rainfall: collect rainfall in a simple container and then pour the rainfall collected into a graduated cylinder or measuring cup;
- Wind speed and direction: direction from which the wind blows can be estimated by looking at smoke from a chimney or a flag and using a compass to determine the direction; a simple wind meter is required to measure wind speed.

Compile the data into tables and prepare graphs showing how the weather changes (or does not change) from day to day.

When to measure→Conduct the weather observations and measurements daily at the same time of day for a week. Repeat the measurements at a different season, e.g. wet and dry seasons, winter and summer.

What the measurements show→The measurements will show how the weather changes from day to day and there are likely to be quite significant changes between one day and the next. Comparisons of the data taken at different seasons of the year will also show further differences.

Use the data to show how difficult it is to make any statement about climate based on the daily weather pattern, and emphasises the important work of climatologists collecting daily data for decades in order to compile climate records.

Use the global climate change projections in Table 1 to discuss how the projected global changes might change your weather.

As a further activity, ask the students to interview parents and older members of the community about their memories of weather 20, 40, 60 years ago, and compare these findings with the climate records for your area.

Extension of this activity→ set up a permanent weather station at your school.

Responding to climate change

Two main ways to respond to global climate change are through mitigation and adaptation. Mitigation involves attempting to slow the process of global climate change by lowering the amount of greenhouse gases in the atmosphere. Within the framework of the UNFCCC, countries around the world are working to reduce their carbon emissions. There are also many actions that individuals can take, e.g. reducing their own energy consumption, using renewable sources of energy, reducing their use of excess packaging, and planting trees that absorb carbon dioxide from the air and store it in the soil or in their trunks and roots. However, it is necessary to appreciate the inevitable nature of climate change, some aspects of which (e.g. sea level rise) will continue for centuries even if greenhouse gas concentrations were stabilized now.

Adaptation relates to how to live with the degree of global warming that cannot be stopped. It involves developing ways to protect people and places by reducing their vulnerability to climate impacts. Examples of adaptation include building seawalls or relocating buildings to higher

ground to protect communities against increased sea flooding. Other adaptation measures may simply be an extension of sound development practices such as keeping beaches and coastal waters clean.

Activity 13.2 Learning about climate change adaptation and mitigation

What to do→Divide the class/persons into small groups and ask each group to list adaptation and mitigation measures for different levels:

- national level – the country or island, e.g. building sea walls to protect the coastline from rising sea levels (this contributes to adaptation by coping with rising sea levels);
- community level, e.g. starting a recycling programme (this contributes to mitigation by reducing energy usage, and to adaptation by reducing the solid waste dumped in rivers and on beaches, thereby keeping ecosystems more healthy and resilient); and
- individual level, e.g. conserving energy by turning out the lights when no one is in the room (this contributes to mitigation through reducing energy use and greenhouse gases).

After the groups have shared and discussed their lists, ask each person to select one activity from the individual level list, and implement that activity in their home life for a week.

After the week, persons report on their implementation success, problems encountered, and how their family members responded to the activity.

What the activity shows→Participants will learn about mitigation and adaptation actions for different levels of governance and will find that many appropriate actions contribute to both mitigation and adaptation. They can also discuss whether it was easy or difficult to implement the one activity over the course of a week, and whether they intend to continue and involve more of their family members in the activity.

Climate change and beaches

As key recreational sites, beaches are of prime social, cultural, environmental and economic importance and dominate the world's coastlines. They are important ecosystems and also fulfil protective functions safeguarding coastal lands from flooding. Furthermore, beaches are among the most dynamic and fast changing environmental systems.

Climate change is already affecting beaches in a number of different ways. These changes are likely to intensify over time and include:

- rising sea levels, resulting in increased beach erosion, reducing the area of beaches and impacting coastal habitats;
- extreme weather events and changes in cyclone and storm behaviour, producing higher and more powerful waves, increasing beach erosion;
- changing precipitation patterns with more floods and altered freshwater flow to the oceans, affecting beach ecology, sediment budgets and the formation of beachrock;
- rising temperatures, affecting the animals and plants living on and near the beach, e.g. bleaching of coral reefs; and
- acidification of the oceans, negatively affecting marine organisms that need calcium carbonate to form skeletons or shells.

Sandwatch and climate change adaptation

One of the ways in which humans can adapt to climate change is by ensuring that ecosystems are more resilient and healthy not just for today but for the long term. A wide beach backed by a coastal forest and protected by a healthy coral reef can better withstand sea level rise and future high wave events than a narrow beach confined by concrete infrastructure on the landward side and a degraded, dying coral reef on the seaward side. Sandwatch, with its focus on the use of scientific monitoring of beach changes to inform effective action to enhance and care for beach ecosystems, is ideally suited to contribute to climate change adaptation.

In November, 2008, Sandwatch joined with Counterpart Caribbean and other partner organizations to work with Caribbean teachers and youth to learn more about climate change and how they could spread the word to other persons and groups in their countries. Thirty teachers and students worked for three days to improve their communication skills including drama and storytelling, video production and web-based tools. In the six months since the event, the participants reached out to more than 30,000 people through news stories, videos, exhibitions and presentations.

Youth will have to lead the way on climate change adaptation (Logo from Youth and Climate Change Workshop, Barbados, November 2008)

Drama is an effective way of portraying information about climate change (Dramatic presentation at a Youth and Climate Change Workshop, Barbados, November 2008)

Chapter 3 Observing and recording, additional activity on climate change

ACTIVITY 3.3→How will the beach look as climate changes

Using the projected climate changes in Table 1, New Chapter 13 on Climate change, discuss how climate change might impact your beach and how it will look in 10 and 20 years time. Items to consider are:

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

Ask the students to draw the beach as it is now and as it might be in 20 years time, taking into account the possible impacts of climate change.

Chapter 4 Erosion and accretion, addition information and activities on sea level rise

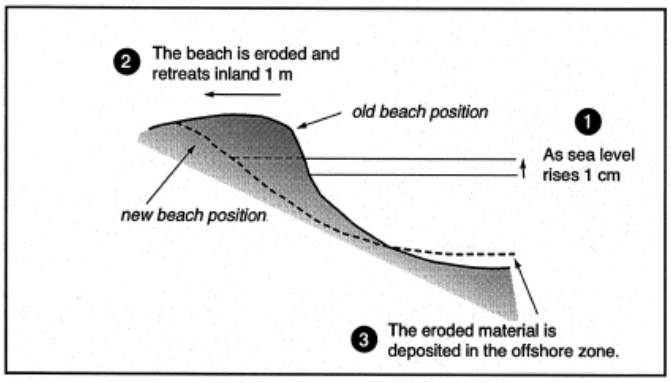
Beach erosion and sea level rise

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

Table 1 (New Chapter 13 on Climate change) shows that global sea level is predicted to rise between 0.18 and 0.59 m by 2099. As new information is coming to light since the IPCC report was published in 2007, it appears that these sea level rise projections are on the low side so higher rates of sea level rise can be expected.

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

Bruun Rule



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

On lowland coasts where the land behind the beach is not developed, it is likely that the beach will reposition itself further inland over time as a response to climate change. However, where the land behind the beach is developed with houses, hotels, roads and other infrastructure, then the beach will not be able to retreat inland, and in these cases it is likely that the beaches will get narrower and eventually disappear over time, unless other measures are taken such as building groynes and offshore breakwaters, and replenishing the beach with sand from another source, either offshore or land based.

As sea level rise, the beach on the left (Culebra, Puerto Rico) will likely reposition itself further inland, while the beach on the right (Barbados) will narrow and eventually disappear unless specific measures are taken to replenish the beach.

ACTIVITY 4.4 Measuring beach changes resulting from sea level rise

What to measure→Before going out to the beach, find out from your national climate change focal point or meteorological office whether measurements of sea level are conducted in your country, and whether national data relating to sea level rise is available.

Have the students do some simple research and calculations:

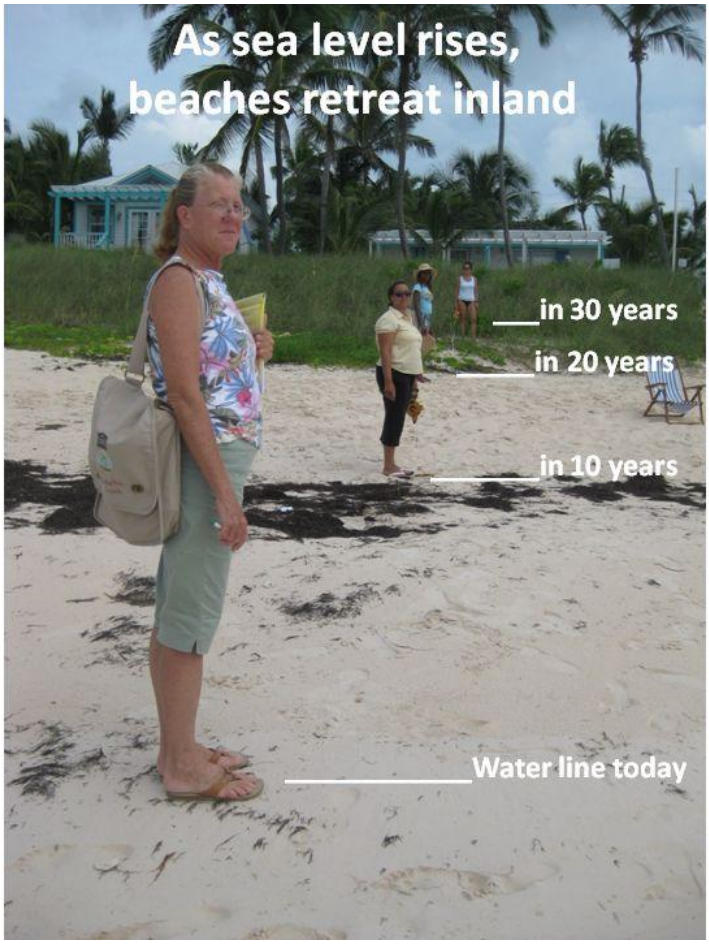
- Determine the annual rate of sea level rise in your country; if no data is available use the uppermost figure in Table 1, Chapter 2 (0.59 m over 100 years = 0.0059 m/year);
- Using this figure calculate the retreat of the high water mark over the next 10 years: 0.0059 m/yr x 10 years x 100 = 5.9 m
- Repeat the calculation for the next 20 years and next 30 years:
  0.0059 m/yr x 20 years x 100 = 11.8 m
  0.0059 m/yr x 30 years x 100 = 17.7 m

Using these figures, let the students determine where the high water mark is today, then using a tape measure, measure 5.9 m landward of that point and make a line in the sand, repeat for the 20 year and 30 year distances.

When to measure→This measurement can be done at any time. It may be useful to take photos with the students pointing out where the new average position of high water mark will be in the future.

What the measurements show→The measurements show the average position of high water mark in 10/20/30 years time and they indicate how the sea will reach further into the land than it does today. If your beach is very narrow and is perhaps backed by a seawall, then you may run

out of space for the 20 or 30 year measurements, in which case it is likely your beach will disappear altogether in the future. Alternatively if the beach is backed by a coastal forest, then all that may happen is that the seaward line of trees will disappear.



Teachers stand where the average high water mark will be in 10, 20 and 30 years time, Hope Town, The Bahamas

Additional activity→Have the students role play a development scenario, with some students playing the role of the developers, and other students representing government officers from planning and environmental agencies, other beach users, owners of neighbouring properties, and environmental organizations.

The following scenario is an example. The developers are planning a resort comprising a large hotel, condominiums, swimming pools and golf course.

Factors the development group might put forward are:

- the new development will bring in more tourists, new jobs and more revenue to the country;
- during the building phase the construction sector will benefit;
- local residents will continue to have use of the beach;

- the development is a real benefit for island X, and if they are not interested the developers will go to island Y.

Points that might be raised by the government officers include:

- a development such as this would need an environmental impact assessment (this is a detailed study of how the development will affect the environment and specific planning measures that can be taken to reduce any adverse impacts);
- the proposed site has experienced erosion problems in past storms, and how do the developers propose to cope with future erosion, including the impacts of climate change;
- beaches are public in this island, so how does the developer propose to maintain free access to and along the beach.

Points that may concern beach users, neighbouring property owners and environmental organizations might include:

- the beach is important for hawksbill turtle nesting, so how will the developers ensure that this activity is not impacted;
- the beach is used during carnival time for an annual sailing race, so will this activity continue?
- neighbouring residents might be concerned about increases in noise and crime;
- will local residents will be able to use the beach at all times of day and night for fishing, picnicking and other activities?

Chapter 5 Beach composition, additional information and activities on ocean acidification

Ocean acidification

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

ACTIVITY 5.4 Exploring ocean acidification

Observe and record→Place some specimens of rock, sea shells, powdered chalk and beach sand in separate glass jars. Cover each specimen with vinegar and let the samples sit for an hour or so, or even overnight. Bubbles will form on the specimens containing calcium carbonate. The vinegar, which contains acetic acid, reacts with the calcium carbonate to produce calcium acetate and carbon dioxide (the bubbles).

Alternatively place an egg in a jar and cover the egg with vinegar. Wait a few minutes and look at the jar. You should see bubbles forming on the egg. Leave the egg in the vinegar for a full 24 hours in the refrigerator. After the 24 hours, carefully pour the old vinegar down the drain and cover the egg with fresh vinegar. Place the glass with the vinegar and egg back in the refrigerator for a full week. One week later pour off the vinegar and very carefully rinse the egg with water. The egg looks translucent because the outside shell is gone. The egg shell is made of calcium carbonate and is dissolved by the acetic acid in the vinegar.

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

- list all the animals on the beach that have shells or skeletons made of calcium carbonate and ask them what will happen to those animals as the ocean acidifies;
- discuss how acidification affect the food chain and the world's fisheries;
- think about how will acidification affect the beach and coral reef.

Discuss what, if anything can be done:

- reducing carbon dioxide emissions;
- improving the health of coral reefs, e.g. by reducing pollution, preventing over-fishing, creating marine protected areas;
- making everyone, from fishermen to politicians more aware about ocean acidification.

Chapter 6 Human activities on the beach, additional information and activities on climate change impacts

Climate change will most likely impact many of these activities, e.g. if there is a coral reef that is popular with divers and snorkelers, then increased sea surface temperatures may impact the reef, bleaching it so that it is no longer an attractive place for them. Many people associate time on the beach as fun-time when they are outdoors and exposed to the sun, however, increased exposure to ultra violet radiation, linked to climate change impacts (although not directly caused by climate change), may cause more serious skin and eye conditions for human beings.

Activity 6.3 Finding out how climate change will affect beach users

What to measure→Brainstorm with the students how they think climate change will affect their beach. Some suggestions include:

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

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

Categorise the users of the beach:

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

How to measure→Design a questionnaire to find out how the beach users at your beach will respond to one or two of the most relevant climate change impacts. An example is given below. Your questions will depend on the particular climate change impacts that are most important at your beach and the type of beach users.

Sample Questionnaire

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

1. Are you a resident or a tourist?

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

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

- would you still come to this beach if it were 50% smaller? Yes No
- would you look for a different beach? Yes No

- would you select a different holiday destination? Yes No
- would you stop going to the beach altogether? Yes No

4. If there were no trees at this beach:
- would you still come to this beach? Yes No
- would you look for a different beach with shade? Yes No

5. When you visit this beach do you go:

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

6. Where do you live?

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

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

Many beach users like to shelter from the hot sun under the shade of a tree, climate change may result in fewer trees (Johhny Cay, San Andres, Colombia).

Chapter 7 Beach debris, additional information on climate change

Beach debris and climate change

One of the best ways to help beaches cope with the adverse impacts of climate change, such as sea level rise, ocean acidification and an increase in storms and cyclones, is to maintain beaches, and associated systems (rivers, dunes, wetlands, coral reefs, seagrass beds), in a clean state so that the entire ecosystem – the plants, animals and their habitat – remain healthy. This is sometimes referred to as building resilience. So activities such as keeping the beach, and dunes and nearshore waters clean, and making everybody aware of the need for a clean environment are especially important.

Chapter 8 Water quality, additional information and activities on rising temperatures

Water quality and climate change

As climate changes water quality is also impacted. As sea surface temperatures rise, coral reefs are damaged. This phenomenon, known as coral bleaching, has been widely reported in tropical waters since the early 1980s. The high sea surface temperatures cause corals to expel their microscopic symbiotic algal cells and as a result coral colonies turn brilliant white. Corals may recover when more normal conditions return, but they may be permanently weakened with lower growth rates and reduced reproductive ability. If bleaching is prolonged, or if sea surface temperature exceeds 2°C above average seasonal maxima, many corals die. This then impacts beaches as reefs provide protection and act as a source of sand for many coralline beaches in tropical regions.

Coral bleaching in Tobago
(photo credits www.buccooreef.org)

Higher water temperatures also reduce dissolved oxygen levels which can then affect marine life. Higher carbon dioxide concentrations in sea water result in oceans becoming more acidic, see discussion in Chapter 5 of this Addendum.

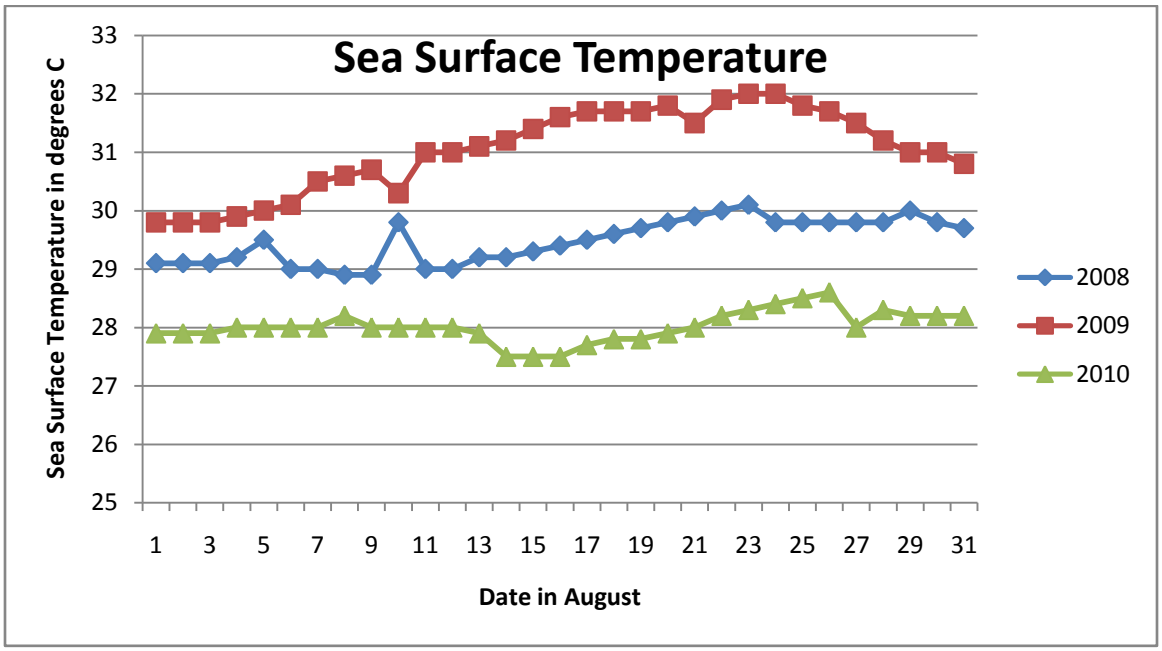
Activity 8.2 Climate change and coral bleaching

What to measure→ If your school and beach is in the Tropics, find out if there is a coral reef at or near the beach. Your measurements will include sea surface temperature and the occurrence of coral bleaching.

How to measure→ Carry out some research into past bleaching incidents. Find out from some of the local beach users e.g. fishermen and divers, or your national Fisheries Department when the last coral bleaching incident occurred If, for instance, it occurred in mid-August two years ago, obtain the daily temperature record from your nearest weather station, for July 1 – September 30 for the last 3 years. Plot the daily temperatures on a graph for each of the three years and determine whether the temperatures were higher during the year of the bleaching, and/or whether there was a prolonged period of high temperatures.

Carry out some present day monitoring. Measure sea surface temperatures daily, or as frequently as possible, during the three hottest months of the year, remember to always measure at the same time of the day. (Seawater surface temperatures often lag behind air temperatures by at least a month, so if July is the month when the highest air temperatures

occur, August may be the month when sea surface temperatures are highest). If it is safe to walk out to a reef, or swim and snorkel over your reef, then do so and observe whether any white patches develop on the corals. If they do, then record and photograph your observations. Compare the occurrences of bleaching with the measured sea surface temperatures. The figure below shows some sample results. For those schools not in the Tropics there are similar exercises relating to sea surface temperature available on the web.



Line graph showing sea temperature variation over time; the high temperatures in excess of 31ºC between August 14-27, 2009 coincided with a period of coral bleaching at the sample beach.

When to measure→The research activity can be carried out at any time. The present day monitoring of temperature and bleaching incidents will have to be done during the three hottest months of the year.

What the measurements will show→The measurements will show that bleaching occurs during periods of very high and prolonged sea surface temperatures, probably over 30ºC, although this temperature may vary in different parts of the world. Discuss with the students what happens when the coral bleaches, whether there is any recovery after the bleaching event and what impacts this might have on the beach.

Chapter 9 Wave characteristics, additional information and activities on extreme events

Waves and climate change

Changing wind systems projected to occur with climate change will have the effect of altering the wave energy felt on coasts around the world. These changes have not yet been fully quantified. However, it is already known that there will likely be more extreme events resulting in coastal flooding as a result of sea level rise, storm surge, and ocean waves. In tropical areas affected by hurricanes/typhoons/cyclones, these are projected to become stronger and more intense. It is during such storms and extreme events that serious damage to the coast and beach occurs.

Activity 9.3 Keeping a beach journal

What to measure→ Keeping an accurate and permanent record of major wave events, storms and other activities that affect your beach can provide useful information for beach managers and others wanting to help the beach become more resilient to climate change.

How to measure→ Visit the beach and take photos after a major weather event and keep a record of significant storms and major beach changes over a period of months or a year. Encourage the students to make the journal entries as detailed and accurate as possible. Drawings and photographs are useful additions to the journal. Sample entries are as follows:

- 24 October, 2009 heavy rains cut a deep channel 10 m wide at the southern end of the beach; by 15 November, 2009 the channel had filled up with sand.
- January 14, 2010, large sea swells more than 3 m high affected the beach for 2 days. No beach users or tourists could go swimming. A lot of sand disappeared and tree roots were exposed, one tree fell down.
- June 4, 2010, a tropical depression affected the island and for 2 days there were high winds, high waves and a lot of rain. Again a lot of sand disappeared and the lifeguard station had to be moved further inland.

When to measure→Observations and entries should be made after a major weather event such as a storm, a period of very high winds or heavy rainfall.

What the measurements will show→The observations and records can provide a permanent record of major weather events and how they affect the beach. This information can be entered in the Sandwatch Climate Change inventory (under preparation) and if your Sandwatch group has set up its own website the journal entries can also be stored there.

You will be surprised how useful such information can be – for beach managers, for coastal engineers and even for persons wishing to develop coastal property. Such information is rarely recorded, so your group may be the first to do so at your beach. Such information also contributes to the growing inventory about climate change and how its impacts ecosystems locally and globally.

Chapter 11 Plants and animals, additional information and activities on ecosystem resilience

Beach ecosystems and climate change

Many of the projected impacts of climate change will adversely affect beach ecosystems, in particular sea level rise, ocean acidification and temperature increases (see Chapters 4, 5, and 7 respectively for more information). Resident and visiting species, e.g. sea turtles, migrating birds, will be affected. Rising sea levels and increased frequency of extreme events with higher waves will increase beach erosion and reduce the area of beach habitat for plants and animals. The most extreme effect would be the total loss of the beach, while alternatively in some areas the beach will be able to retreat inland thereby maintaining the beach ecosystem intact. Within decades, acidification of the oceans will negatively affect marine organisms that need calcium carbonate to form skeletons and shells, such as coral reefs, sea urchins and snails.

Temperature increases will probably change the geographical distributions of some species and the assemblage composition on any shore. Species now living close to their upper thermal limit may be unable adapt and would thus become locally extinct. Survival would depend on migration to cooler areas although such migration for intertidal species may be more difficult than for oceanic species.

Activity 11.2a Increasing beach resilience to climate change

While coastal forests help increase the resilience of most beaches, they do not work in every location – generally they will only work in sandy areas that are not inundated by the sea. Very strong predominant winds will also limit the existence of a coastal forest. On coastlines where there are wetlands it may be more appropriate to investigate other measures e.g. planting mangroves.

What to measure→Record the type of vegetation behind your beach and investigate the potential to strengthen or create a coastal forest. A coastal forest may be a single line of trees, one tree deep, or it may be an extensive forest several trees deep, or it may be part of a coastal wetland. Well established, mature coastal trees will help make the beach more resilient, since the roots naturally trap sand and slow down erosion (although tree roots do **not** stop erosion). The trees enhance the biodiversity by providing additional habitat for animals and birds. They also provide shade for beach users and generally improve the aesthetics of the beach.

- record the type of vegetation behind the beach;
- investigate who owns the land immediately behind the beach.

Determine if a coastal forest is feasible →Consult with the owners or managers of the land as to whether they agree to the idea of planting more trees on the land. You will have to explain how trees will help the beach cope with climate change. Be aware that in some places people may not be in favour of planting more trees since they wish to have an uninterrupted view of the sea. Also be sure to plant native species since these will be more resilient to climate change than species imported from other regions.

Design, implement and monitor your tree planting project →

- look for partners to help with your project, e.g. Agriculture Department, community group, environmental non-governmental organisation;

- design your planting plan (native tree species, numbers of seedlings, space between seedlings, fertilizer needs), this must include a follow-up plan to care for the plants while they are small;
- plant the trees and publicise the activity;
- monitor carefully how many of the seedlings survive over the first 6 months, and care for the trees, particularly providing them with water since the beach is a very harsh environment for new plants.

Sea turtles and climate change→ Because sea turtles use both marine and terrestrial habitats during their life cycles, the effects of climate change are likely to have a serious impact on these endangered species. Sea turtles return to the beach where they hatched, and as beaches get smaller or even disappear with rising sea levels and increased storms, turtle reproduction will come under threat. Another impact is an increase in the temperature of beach sand. The gender of sea turtles is determined by the temperature at which the eggs incubate. With increasing nest temperatures, scientists predict that there will be more female than male hatchlings, creating a potential threat to both reproductive success and genetic diversity. Finally, warmer sea surface temperatures and changing current patterns may change the distribution and abundance of important food sources and this, in turn, may confuse and confound sea turtles as they migrate to feeding grounds that can no longer support them.

Activity 11.3 Monitoring beaches for nesting turtles (This replaces Activity 11.3 in the 2005 manual)

What to measure→Many tropical sandy beaches are used for nesting by sea turtles. There are seven species of marine turtles:

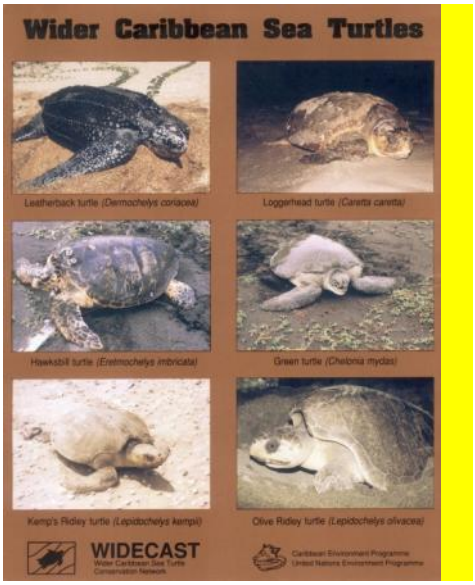
Leatherback turtle (*Dermochelys coriacea*)
Hawksbill turtle (*Eretmochelys imbricata*)
Green turtle (*Chelonia mydas*)
Loggerhead turtle (*Caretta caretta*)
Kemp's Ridley turtle (Lepidochelys kempii)
Olive Ridley turtle (Lepidochelys olivacea)
Flatback turtle (*Natator depressus*)

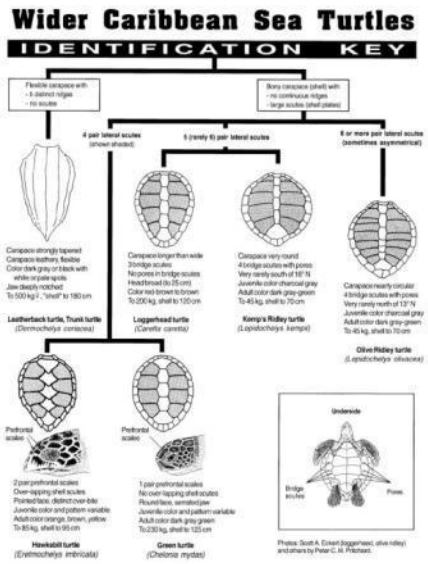
At night-time, female turtles crawl up onto the beach, dig their nests at the back of the beach or in the vegetation behind the beach and lay their eggs in the sand. The period for nesting differs according to the species and the geographical area of the world, e.g. in the Caribbean, most nesting takes place between April and September. After the eggs have been laid, the female covers the nest with sand and returns to the sea. Between 55 and 72 days later the hatchlings emerge and make their perilous journey down the beach to the sea.

Sea turtles are classified as endangered because of over-harvesting in the past; today, many countries have programmes to conserve and protect them.

Left: Turtle tracks at Long Beach, Ascension Island; right: Safeguarding a turtle nest on a busy tourist beach, Bayibe, Dominican Republic.

Monitoring may consist of night-time watches at key nesting beaches, checking beaches early in the morning for evidence of turtle tracks, and watching nest sites for emerging hatchlings. Some turtle conservation programmes, with appropriate training and permission, tag the flippers of sea turtles during nesting. When the turtle is seen again later, her new location, growth rate, etc. provide valuable information to natural resource managers.





Sea turtle identification (Source: WIDECAST, 1991) (See also Annex 4,of the original manual to reproduce for classroom purposes.)

A Sea Turtle Beach Toolkit has been designed to inform and educate coastal communities about how beach dynamics and climate change affect beaches and biodiversity, with a focus on endangered Hawksbill sea turtles[1]. This well-designed and well-illustrated toolkit, available on

[1] Varela-Acevedo, Elda, Karen L. Eckert, Scott A. Eckert, Gillian Cambers and Julia A. Horrocks. 2009. **Sea Turtle Nesting Beach Characterization Manual**, p.46-97. In: Examining the Effects of Changing Coastline Processes on Hawksbill Sea Turtle (*Eretmochelys imbricata*) Nesting Habitat, Master's Project, Nicholas School of the Environment and Earth Sciences, Duke University. Beaufort, N. Carolina USA. 97 pp.

the Sandwatch (www.sandwatch.org) and WIDECAST (www.widecast.org) websites, is particularly useful for groups who are primarily interested in sea turtles and who wish to understand the characteristics of their nesting habitat. The toolkit describes easy-to-use methods to measure beach characterization parameters:

- beach profile;
- beach elevation;
- beach width;
- boundary parameter;
- sand softness;
- sand composition;
- sea defences;
- vegetation;
- predation risk;
- beachfront lighting;
- general observations.

Many of the methods used in the Toolkit are the same as described in this manual. The study of sea turtle nesting habitats is a complex undertaking, so care must be taken to ensure that nests are not damaged or disturbed. Contact local sea turtle experts and/or marine biologists for further information.

The two activities described below: sand softness and predation risk have been adapted directly from the Sea Turtle Beach Toolkit.

Measuring sand softness →This can be measured on the flat/gently sloping section of the beach above the high water mark, and again at the vegetation line. Sand softness has been observed to be an important variable in that it may facilitate (or hinder) the digging of a nest chamber. Beaches characterized by very wet or very dry sand can create difficult digging conditions for a female sea turtle, and successful hatchling emergence has been correlated with nest depth and sand compaction. Sometimes what appears to be a wide, vegetated and attractive nesting beach may be nothing more than a veneer of sand overlaying rubble or cement.

Digging a hole 50 cm deep at the back of the beach to see if the sand is soft enough for sea turtle nesting

Dig a hole 50 cm deep and with a 10 cm diameter. Note whether it is easy or difficult to dig the hole using the following scale of difficulty:

- high difficulty: cannot dig a 50 cm depth hole due to the tough nature of the substrate or obstacles such as gravel, cement or rock;
- medium difficulty: can dig to 50 cm, but struggle to do so;
- low difficulty: can dig to 50 cm with relative ease.

Note any obstacles found while digging, e.g. tree roots, rocks or buried trash.

Measuring predation risk (crab holes per square metre) →Beach crabs (e.g. *Ocypode quadratus*) prey on sea turtle hatchlings and can be a hindrance as the hatchlings journey from the nest to the sea. Other predators could include feral dogs and mongoose. Counting the number of crabs per m^2, and using that number to estimate crab density, can provide an indicator for the number of predators a hatchling might face. Other species may be used in areas where crabs are not a major predator.

How to measure→Make a PVC metre square quadrant by cutting a 5 m length of PVC pipe into four 1 m length pieces. In a well-ventilated area, use PVC glue to attach the PVC elbows to make a square. Randomly toss the quadrant close to a sea turtle nest on the beach. As crabs tend to hide in holes when there is human activity on the beach, proceed to count the number of crab holes within the quadrant in order to estimate crab density in the area. Repeat up to three times and average the number of holes counted. Monitor crab density early and late in the sea turtle hatching season, determine whether it changes and discuss how any changes might affect hatchling survival.

A PVC metre square quadrant

Crab holes on a beach in Barbados

How to get involved in monitoring sea turtles →If sea turtle nesting occurs in your area, contact your environmental agency or local conservation organization and ask whether there are programmes that monitor and conserve turtles.

Observing turtle nesting at night, from a safe distance so as not to disturb the female turtle, can be a very interesting and exciting experience. The same is true for monitoring the nest to see the hatchlings emerge and make their journey to the sea.

In some areas, key turtle nesting beaches are monitored during the turtle nesting season to observe and record turtle tracks and evidence of successful nesting. Often these programmes

need volunteers, and your family, school, Sandwatch group or organization could play a role in ensuring the survival of these gentle marine animals.

Follow-up activities→ If students take part in any aspect of turtle monitoring, there are many areas where they can conduct further work and research; here are just a few ideas:

- conduct research to find out which turtle species nest in your country and how many successful nests are laid. Compare these figures with historical information;
- create a map of sea turtle nesting beaches in your country;
- investigate why sea turtles are endangered and what threats they face;
- discuss within your class or school why sea turtle populations have declined (or increased) in your area. Have threats to their survival increased or decreased?
- interview a Fisheries or Wildlife Officer to find out more about what is being done to protect sea turtles in your country;
- determine what you, your family and your Sandwatch group can do to help conserve sea turtles.

Sandwatch students on Tekaaroa in the Cook Islands show one of their beach signs

New Chapter 14 Creating your Sandwatch network

Background

Sandwatch's greatest strength and asset is that it is an international community of active participants with each team conducting their monitoring and entering their results in the Sandwatch Climate Change Database (under preparation), and sharing their news and photos about Sandwatch activities with the international Sandwatch community and others via the website (www.sandwatch.org) and the newsletter 'The Sandwatcher'.

It is this sense of being a part of a *real community* that has allowed Sandwatch to expand in just a few years from a regional Caribbean project, to a global environmental programme with active teams in more than 40 countries worldwide and still growing.

Of course this new found popularity did not happen by accident or overnight, it took a great deal of planning, hard work and more than a little bit of luck, as various ways of networking, adapting and expanding the approach were tested and implemented.

With the widespread availability of high-speed internet services, inexpensive digital cameras, easy to use video editing software, and popular social networking websites such as Facebook and Youtube, it has literally never been easier for anyone, anywhere to reach a wide audience and involve more school, youth and community groups in Sandwatch.

This chapter sets out to explain how you can share your findings with others, both locally and worldwide, and thereby create your own Sandwatch network.

Establishing a local network→Once you have decided to participate in Sandwatch, there are a few easy steps you can take to build up support for your students' efforts within your school and the wider community.

Involve the school community→Getting school principals and other teachers involved is always a good first step. Demonstrate to other teachers and school principals that:

- Sandwatch is a global project;
- students will “learn by doing” about environmental and climate change issues, and will be able to give something back to the community;
- your school will have a free web presence on the project website;
- articles featuring your group’s activities can be regularly published in The Sandwatcher, which is translated into several languages and distributed globally;
- Sandwatch is perfect for science fair projects, regional environmental contests and school-based assessments;
- opportunities exist for your group to participate in regional and international Sandwatch events, e.g. workshops, seminars and conferences.

By pointing out that participation in the project can bring advantages and recognition to the school, it will be that much easier for you to recruit your colleagues and supervisors and enlist their aid in accomplishing the Sandwatch goals.

Reach out to the wider community→Once you have your project established, organize meetings with other schools, church groups, youth groups, NGOs and community groups. Tell them what you are doing and encourage them to get involved. This will also help with sponsorship and with Sandwatch projects e.g. beach cleanups, signage, protecting turtle nesting sites.

Prepare a PowerPoint presentation→This is an excellent tool to use at a community meeting to show what the project is all about and how it can benefit the local community.

PowerPoint is part of the Microsoft Office Suite that comes preinstalled on most computers. It is basically a computerized slide show and it’s as simple to use as collecting and organizing photos and typing captions for them.

They say a photograph is worth a thousand words, and this is especially so for slideshow presentations. Keep text to a minimum and try to limit the number of photos/slides in your presentation to a maximum of 20.

Making a display→Another common strategy Sandwatch Teams use is presenting the project using cardboard display stands as part of an exhibition. This could be for a local or regional science fair or a community event such as an agricultural fair or similar, but the main thing is to make your presence and contributions known to your community.

The Sandwatch Team from Saint Lucia created this display for a regional Sandwatch workshop

Throughout the year there are several 'Special Events' where you can display your Sandwatch Team efforts, such as, International Coastal Cleanup Day (www.oceanconservancy.org) which is held every third Saturday in September, International Earth Day - April 22nd or World Environment Day - June 5th (http://www.unep.org/wed/2008/english)

By participating in these events and more importantly letting your community know that your team is taking part in them, your efforts can really start to make a difference in changing people's perceptions and behaviours concerning their local environment.

Make use of local media

An extremely efficient and cost-effective way to publicize your project locally and even regionally is to actively involve your local media, newspapers, magazines, TV and radio stations to cover your events such as a presentation from a guest speaker or a successful field trip.

Even if they are unable to assign a reporter to attend your project's latest activity, if you send them press releases or pre-written articles with photos, they are often printed verbatim in local newspapers as a 'free community service'. Getting students to write these articles and press releases themselves is also an excellent way to build their self confidence and writing skills.

Many local newspapers will even grant your project a free page once a month, to showcase your programme's ongoing efforts on behalf of the community, especially if you can guarantee them a regular supply of articles, photos and project updates.

To cut down on the amount of photography and writing all these activities entail, don't be afraid to recycle your work. For example, if you draft a press release with photos for the local media describing your team's efforts at protecting turtle nesting sites, the same text and pictures can be adapted for the website, and for an article in The Sandwatcher.

Another strategy several Sandwatch teams have used effectively is drama. By involving students in writing and producing a short play that can be performed at school and community functions; it can really raise the community's awareness of your activities. Creating a small, dramatic presentation also encourages creativity and participation by students who might otherwise not be active in environmental issues.

Short student performed plays are also perfect for 'taking on the road' to other schools and community events. In addition, if you digitally record the performance you can easily post it online on your web pages, YouTube, Facebook or similar forums.

Establishing a project website

The success of Sandwatch and its website is largely due to its responsiveness to participants.

When information, data or photographs are emailed to the site's webmaster, it is usually posted online within 24 hours, and often less if requested. This allows educators to have a web presence for their students and communities on the internet without necessarily having to set up their own website

Each new group that joins Sandwatch is automatically given their own personal 'homepage' on the Sandwatch website, where they can display photographs, data, greetings, community news,

press releases or anything else that relates to their Sandwatch and general environmental efforts.

This has proven especially helpful to schools who are engaged in special events, such as science fair projects, or trying to draw local media attention to their specific environmental efforts, such as a beach clean-up campaign, replanting mangroves or a dune stabilization project.

Building a website is a relatively complex task but it is well within the skill sets of most educators and especially senior students with just a couple hours of practice. There is a wide variety of easy-to-build website software programmes available on the internet, many of which are free. An excellent, easy to use starter programme is Microsoft's FrontPage, though there are many other similar, free programmes available on the internet.

Regardless of which programme you use, the ultimate goal is to establish a presence for your project on the internet. In this way you can easily communicate and make contact with other like-minded people and organizations around the world.

Fortunately, many internet service providers such as telephone or cable TV companies offer the establishment of a *free website* to their subscribers, particularly for schools and related community organizations. Their staff can also be an invaluable source of free expert advice in building your website. It is just a matter of seeking them out and asking for their assistance.

Of course publically mentioning their support for the project on your website and newsletter also serves to let their contributions to your project be widely known, and is thus an excellent way of enlisting their continued support, assistance and even sponsorship. Consider recruiting a budding computer scientist from your local high school, college or community. You will often find that they are very eager to help you build a project website as a personal or even school project.

By using Microsoft's FrontPage or a similar website construction programme, it is then only a matter of registering your websites domain name (e.g., www.ourproject.org) with a suitable hosting company, such as your local internet service provider, or other hosting companies.

Creating a newsletter


The Sandwatcher - Special Issue

The Sandwatch & Cool Youth Climate Change Workshop

The Sandwatcher newsletter, The Sandwatcher, has proven to be an extremely useful tool for strengthening a global sense of community, sharing information worldwide and generating local and international publicity.

Newsletters can be a great way to publicize your Sandwatch and other environmental activities. This can be easily accomplished by using Microsoft's MS-Publisher programme that comes as part of Microsoft's Office Suite. (It may be necessary to manually install MS-Publisher from the CD).

The Sandwatcher newsletter is produced several times in several languages.

By using MS-Publisher's pre-installed 'newsletter templates' all you have to do is cut and paste your students' own stories and photographs into the pre-made newsletter document formats, and within minutes you can create a very professional-looking publication.

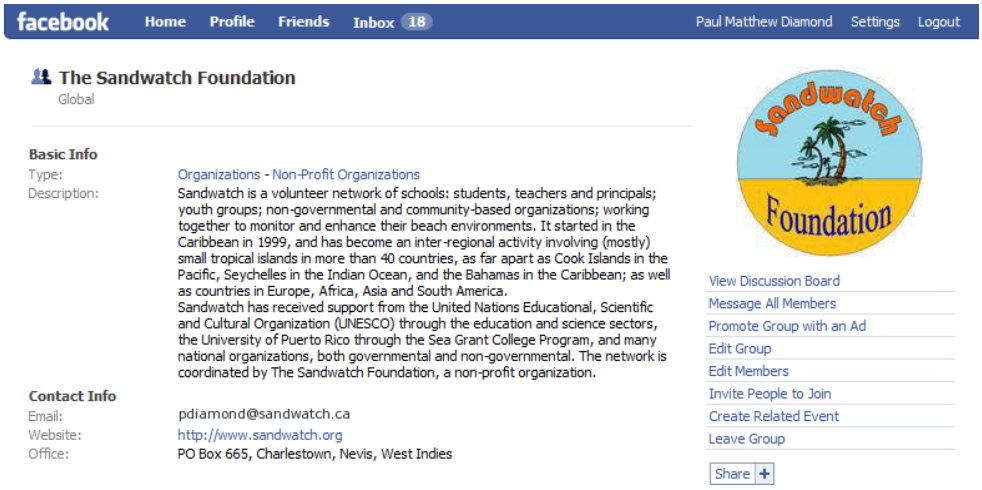
Teachers have found that by encouraging their students to write and edit the stories themselves, the students markedly improved their reading, writing, spelling and comprehension skills as a result. Students are also often excited and inspired by viewing the finished newsletter and seeing their words in print. If a student is not a gifted writer, making him/her a 'staff photographer' can have the same inspirational effect.

Social networking websites

As an alternative to actually creating your own dedicated website, you may consider utilizing one (or more) of the so-called social networking websites, such as Facebook, and MySpace that have become extremely popular worldwide, especially with students, as they are both easy to use and totally free.

Given the popularity and ease of use of these websites, Sandwatch is committed to finding ways to utilise this new communications medium.

A Sandwatch Foundation Forum has been established on Facebook and this is proving very popular particularly with the young Sandwatchers.



If you are a member of Facebook, or are considering joining the website (and membership is free) then simply do a Facebook search using the phrase 'The Sandwatch Foundation', and the forum will pop up on your screen. Then you click on the dialog box that asks you if you would like to join this group.

Once a member of the Sandwatch forum you can post photos, web links, ask questions, communicate with other members globally, and be regularly updated on Sandwatch events and activities. You can even post short videos.

Making and posting videos online

A similar application to Facebook or MySpace is YouTube, and though this is more of a video sharing website than a social networking site, there is a lot of overlap. For example, Youtube videos and links are routinely added to member's personal Facebook and MySpace pages.

The great thing about Youtube is that it allows anyone to easily post their home made videos online, advertise them, tell their friends about them, and get feedback.

The Sandwatch Foundation successfully used Youtube to host and promote the 2008 'Coping with Climate Change: Sandwatch Leading the Way Video Competition'. The video competition was open to Sandwatch Teams worldwide, with the conditions that the submitted videos be a maximum of 3 minutes long, and that they be amateur productions. Of the more than a dozen primary and secondary schools worldwide that entered the contest, none had previously made or edited a video.

Learning to use a video camera at a workshop in Barbados

"*Fourth Grade Sandwatchers" Winning Video from Good Hope School, St. Croix, US Virgin Islands*

Fortunately, creating and editing a video is fairly easy using the free 'Windows Movie Maker' software that comes pre-installed on all Windows XP and Windows Vista computers.

If for some reason your Windows computer doesn't have this program pre-installed, you can download from the Microsoft website at:
www.microsoft.com/windowsxp/downloads/updates/moviemaker2.mspx

If you can make a PowerPoint Presentation then you can use Movie Maker, as they are almost identical in format and structure. In PowerPoint you add a series of photos and text to make a presentation, and in Movie Maker you add together video clips and audio to make a short movie…in almost exactly the same way!

Getting started with Window's Movie Maker

To help you get started and learn the basics, there are a series of excellent step-by-step instructions on the Microsoft Movie Maker website. Many of the instructions are accompanied by short video clips, showing you exactly what they are demonstrating.

By following these easy steps and watching the short videos, you can learn how to create and edit a pretty good video within about half an hour. Then it's just a matter of experimenting with your own video clips to make your first simple video, suitable for posting on the Sandwatch website, Youtube or your own school website.

Sandwatch teachers reported that by using this online tutorial method they were able to learn the basics of the programme in about 20-30 minutes, and then it took about another hour and half to experiment with editing together some video clips into a rough movie. So in about two hours, they had made their very first movie ready for posting online. It really is that simple!

Once you have taken the time to learn the basics of the programme, you may be surprised to learn that you are inspired to become very creative with your own movies and use them far beyond the goals of Sandwatch.

It is recommended that if you have one or two computer-savvy students, that you encourage them learn how to use the Movie Maker programme and experiment with taking and editing short video clips, as students seem to grasp the concepts of video editing even faster than their teachers.

For Mac Users: We have been told that Macs come pre-installed with a similar programme to Movie Maker, called "I-Movie", which we have been reliably informed is even easier to use that Movie Maker.

Video conferencing

One of the best ways to build a community like Sandwatch is to hold meetings, conferences, fairs and student exchanges. In this way teachers and students from different countries meet, exchange ideas and projects, and often make lasting friendships. For example, a student exchange programme between Trinidad and Tobago and Brazil in 2008 was extremely productive.

Unfortunately, the high cost of travelling (and especially air travel's large carbon footprint) makes such events very expensive. However there is a simple and cost effect alternative available to most Sandwatch participants; that of video conferencing.

An excellent and free utility to use for Sandwatch and other projects is the free Voice-Over-Internet Programme (VOIP), called Skype (www.skype.com). Using simple web-cameras that come preinstalled on most new computers, it is fast and simple to hold real time video conferences between schools, even if they in different parts of the world.

As long as your internet connection is reasonably fast (faster than dial-up) such DSL or Cable modem, and both you and your partner classrooms have web-cams, then setting up a free video conference between your students is as simple as sending an email.

Both parties simply register their user names with Skype, exchange these names via email, then conduct a search on Skype for the name. When your partner's name is found, you add it to your Skype contact list.

Now that you are both listed as contacts, you just click on the persons name to start a free long distance call. Then once a successful voice connection has been established, Skype will

automatically detect if a web-cam is installed on your computer, and will ask you if you wish to start a video call. It's that simple and costs absolutely nothing.

If your school is fortunate enough to own a digital projector that can be plugged into your computer and projected on to a wall or screen, then you and your students can really have fun, asking each other questions and showing each other what their classrooms look like. The only problem Sandwatchers have reported with using Skype is co-ordinating the different time zones between countries.

Video conferencing in St. Croix

Other free web-based resources

It is doubtful whether Sandwatch would have been so successful without the use of email. It has been the backbone of the entire project: allowing for recruiting participants, finding sponsors, updating the website, creating the newsletters, organizing and coordinating regional workshops and conferences and so much more.

Email can be used to keep in touch with each other, locate new partners and sponsors, pass along information and ideas. As simple as this concept may be for many people, some still do not appreciate the power of email, literally at your fingertips.

Do not be hesitant to email a person, a website or even a large organization and ask for advice or assistance on a specific issue. Even if they cannot help you they may well surprise you by suggesting something or someone who can.

Networking and making contacts has been of significant importance to the overall success of Sandwatch, so you can make it work for you.

Google Earth (http://earth.google.com) is another useful, free programme that allows teachers to view their country, island and even school yard from satellite images. This can be an extremely useful if you are studying local or regional geography or even the effects of deforestation on hill sides or the destruction of local wetlands. You can also view the beach you have adopted for Sandwatch and compare the satellite image(s) before and after a major storm or hurricane for example.

This chapter has attempted to show you some different ways to share your Sandwatch activities both locally and worldwide. The wide availability of inexpensive computers, peripheral devices, software and free 'online services', can all be significant assets to your Sandwatch activities and the creation of your own Sandwatch network. Providing students and youth with the opportunity to acquire and expand their skills also gives them a sense of self confidence and recognitions as a valued member of a larger community.

Students in Bequia, St. Vincent and the Grenadines, undertaking a Sandwatch project to clear a coastal drain and reduce pollution at the beach and in marine waters.

New Chapter 15 Taking action and undertaking a Sandwatch project

The fourth step of the Sandwatch methodology (**M**onitoring, **A**nalysing, **S**haring, **T**aking action) consists of designing, implementing and evaluating a beach-related project to fulfil one or all of the following criteria:

- addresses a particular beach-related issue;
- enhances the beach; and
- promotes climate change adaptation.

This fourth step is what distinguishes Sandwatch from other environmental monitoring activities, and makes it an example of education for sustainable development. The Sandwatch "Taking action" component is based on science and consultation with others.

Designing a Sandwatch project→ Based on the results and analysis of the monitoring activities and the feedback received when sharing you findings with other persons and groups, brainstorm ideas for beach related projects. This might be a good time to return to the sketch map of the beach that you prepared when you were starting Sandwatch.

- List the ideas received, and try and keep each suggestion simple so that it focuses on just one activity;
- discuss each idea with the group and identify how the suggestions fulfil one or all of the three criteria listed above;
- prepare a shortlist with just two or three suggestions that can be implemented by your group;
- make a selection.

Examples of Sandwatch projects

- Tree planting behind the beach.
- Planting and conserving sand dunes.
- Beach beautification activities.
- Beach and underwater clean-ups.
- Promoting recycling at the beach.
- Placing informational signs at the beach
- Preparation and distribution of educational brochures and videos to specific target groups.
- Murals, dramatic presentations and exhibitions to create awareness among the general public.
- Influencing tourism developers about the fragility of the beach.
- Relocating endangered species, e.g. iguanas threatened by development.
- Conserving sea turtles, e.g. monitoring nesting activity and protecting nests.

Planning a Sandwatch project→

- Define the project's objective(s): be specific and identify what you hope to achieve at the end of the project;
- list the project's activities and place them in a consecutive and logical order;
- estimate the time frame for project implementation;
- determine if the project requires support or funding from outside the group; if so, identify the nature of the support required and likely sources to approach;
- prepare a simple table (see table on next page) showing for each activity the time frame, participants and resources required.

Evaluating a Sandwatch project→ Evaluation is a very important step that will help the group determine the effectiveness of the activity.

- Review the project objectives and determine whether they were fulfilled;
- identify the activities that went well;
- identify the activities where improvement is needed;
- write up the results of your project for the Sandwatch website, and your own web page.

Examples of Sandwatch projects from The Bahamas

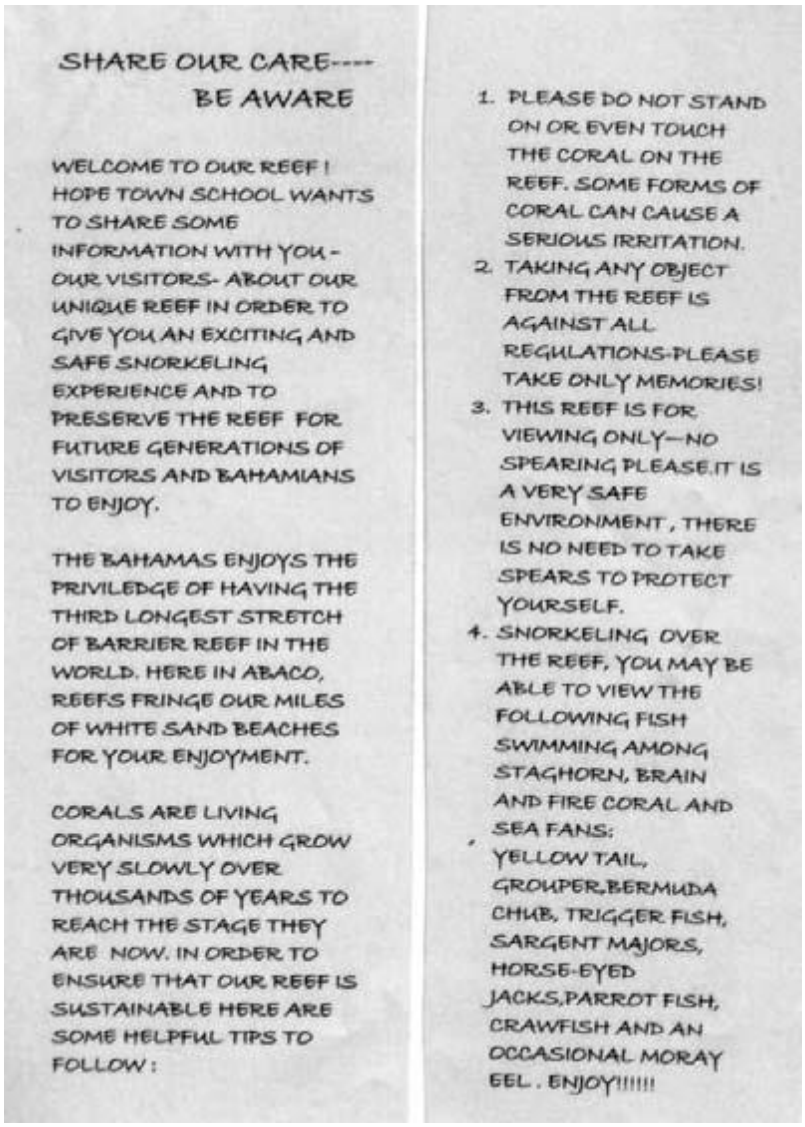
Over a four-year period, students aged 10-11 years from Hope Town Primary School in Abaco, Bahamas, have implemented a series of Sandwatch projects that have fulfilled the three criteria. First of all they spent several months in measuring various beach characteristics and how they changed over time. They interviewed beach users and recorded their activities: walking, swimming, sunbathing and snorkelling. They observed the different types of boats and found that sport fishing and tourist rental boats were the most common. They measured the width of the beach and observed how it was eroded and virtually disappeared during the 2004 hurricanes. They used a simple kit to measure water quality. After recording and counting the different types of beach debris they used their art classes to make decorative items with the discarded material.

Action	Time Schedule	Persons Involved	Activities and Resources Needed	Expected Outcome
1. Plan and design the content of the mural	January - February	Class 4 students and teachers for science, art, language, woodwork	a. Visit to beach to assess potential sites	a. Storyboard showing what the mural will display and the message it intends to convey; b. Sketch map and photos of beach showing where the mural will be placed. c. List of materials needed to construct the mural.
2. Consult with land owners, beach managers and other persons in authority to obtain permission to place the mural	March - April	Teachers for class 4 and school principal arrange meetings with: a. Government departments responsible for beaches, planning and environment b. Leaders from communities using the beach	Discuss the project and obtain permission for the mural.	Written permission from relevant authorities to prepare and construct the mural.
3. Prepare and place the mural	May to June	a. Identify funding and sources for materials to construct the mural. b. Prepare the mural itself.	Materials to make the mural and paint.	Hold an official "opening" and related public awareness activity.
4. Sandwatch students assess the impact of the mural	July to August	Class 4 students conduct a questionnaire survey among beach users to determine the impact of the mural, and based on the results design further awareness or follow-up activities.	Research, consultation with local experts	Evaluation of the project and lessons learnt.

Sample Project Action Plan
Project to create awareness about beach health and climate change resilience with a beach mural

After graphing and analysing their data they concluded that one of the main issues was that visiting tourists were damaging a small reef located about 20 m from the beach. They had observed visitors standing on top of the coral reef to adjust their masks, breaking off pieces of coral to take as souvenirs and even spear-fishing close to the beach.

Their first project addressed this particular issue that of unwise user practices destroying a reef. They designed a questionnaire to find out how visitors viewed the reef. After discussing the results of their questionnaire survey with the rest of the school, their parents and a local environment group, they decided to try and educate the tourists by designing a brochure on proper reef etiquette. Copies of the brochure were placed in hotels and nearby rental properties and were very well received by visitors.



SHARE OUR CARE----
BE AWARE

WELCOME TO OUR REEF ! HOPE TOWN SCHOOL WANTS TO SHARE SOME INFORMATION WITH YOU - OUR VISITORS- ABOUT OUR UNIQUE REEF IN ORDER TO GIVE YOU AN EXCITING AND SAFE SNORKELING EXPERIENCE AND TO PRESERVE THE REEF FOR FUTURE GENERATIONS OF VISITORS AND BAHAMIANS TO ENJOY.

THE BAHAMAS ENJOYS THE PRIVILEDGE OF HAVING THE THIRD LONGEST STRETCH OF BARRIER REEF IN THE WORLD. HERE IN ABACO, REEFS FRINGE OUR MILES OF WHITE SAND BEACHES FOR YOUR ENJOYMENT.

CORALS ARE LIVING ORGANISMS WHICH GROW VERY SLOWLY OVER THOUSANDS OF YEARS TO REACH THE STAGE THEY ARE NOW. IN ORDER TO ENSURE THAT OUR REEF IS SUSTAINABLE HERE ARE SOME HELPFUL TIPS TO FOLLOW :

1. PLEASE DO NOT STAND ON OR EVEN TOUCH THE CORAL ON THE REEF. SOME FORMS OF CORAL CAN CAUSE A SERIOUS IRRITATION.
2. TAKING ANY OBJECT FROM THE REEF IS AGAINST ALL REGULATIONS-PLEASE TAKE ONLY MEMORIES!
3. THIS REEF IS FOR VIEWING ONLY—NO SPEARING PLEASE.IT IS A VERY SAFE ENVIRONMENT , THERE IS NO NEED TO TAKE SPEARS TO PROTECT YOURSELF.
4. SNORKELING OVER THE REEF, YOU MAY BE ABLE TO VIEW THE FOLLOWING FISH SWIMMING AMONG STAGHORN, BRAIN AND FIRE CORAL AND SEA FANS: YELLOW TAIL, GROUPER,BERMUDA CHUB, TRIGGER FISH, SARGENT MAJORS, HORSE-EYED JACKS,PARROT FISH, CRAWFISH AND AN OCCASIONAL MORAY EEL . ENJOY!!!!!!

Tourist brochure produced by students at Hope Town Primary School

There following several severe hurricanes that eroded the beach and dunes. The government scraped sand from the sea bottom to restore the sand dunes. Their second project focused on enhancing the beach and making the dunes more resilient to future storms and hurricanes as they worked with other groups to replant the damaged dunes with sea oats.

Planting the restored sand dunes with sea oats.

Four years later the restored sand dune stabilised with sea oats

As their third project they prepared a short video showing viewers how their activities to protect their beach and nearshore reefs were keeping their beach healthy and thereby more resilient to climate change (visit the Sandwatch youtube channel to view the video).

Final comments

This example from the Bahamas provides a glimpse of Sandwatch in practice, and there are many other examples from countries around the world documented on the Sandwatch website. Sandwatch has the potential to become a worldwide movement for change – taking effective action to care for the beach environment and thereby building its resilience to climate change.

Visit www.sandwatch.org and become a part of the change.