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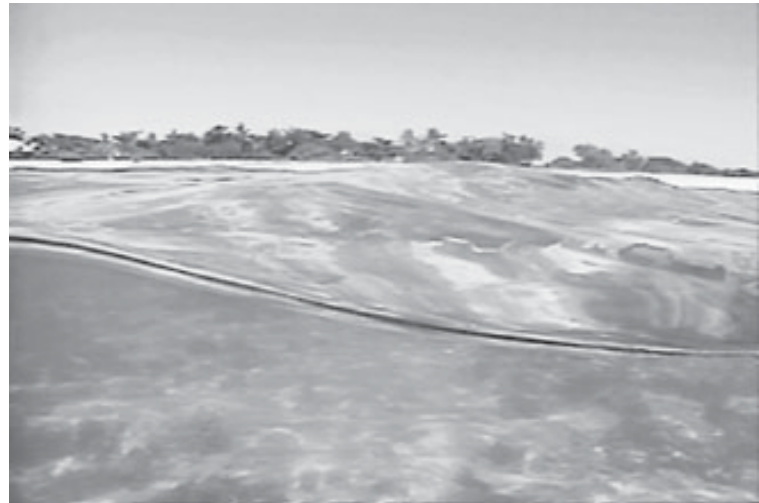
**Turning Down the Heat**

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# RISING waters



## STUDY GUIDE

BY DR. SUSAN POSTAWKO

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ANALYSIS CENTER, UNIVERSITY OF OKLAHOMA

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BULLFROG FILMS

Brook, R.R., R.E. Basher, J.P. Bruce, S.A. Parsons, and M.E. Sullivan. 1991. **The Changing Climate in Paradise**. Published by the Bureau of Meteorology; Melbourne, Australia.

**Forecasting the Future: Exploring Evidence for Global Climate Change**. 1996. A classroom curriculum and activity guide published by the National Science Teachers Association; Arlington, VA.

Kaluwin, C., T.H. Aung, and G.W. Lennon, eds. 1998. **Curriculum Modules for the Pacific Schools, Climate Change and Sea Level Rise. Part Two: Social Science**. Published by the National Tidal Facility at Flinders University of South Australia; Adelaide, Australia.

Kump, Lee R., James F. Kasting, and Robert G. Crane. 1999. **The Earth System**. Prentice Hall; Upper Saddle River, New Jersey

Lobban, Christopher S. and Maria Scheffer. 1997. **Tropical Pacific Island Environments**. University of Guam Press; Mangilao, Guam.

Nunn, Patrick D. 1994. **Environmental Change in the Pacific Basin: Chronologies, Causes, Consequences**. Wiley & Sons; England.

Schneider, S.H. 1997. **Laboratory Earth: The Planetary Gamble We Can't Afford to Lose**. Basic Books; New York.

#### **Web Pages of Interest**

CSIRO Australia

[www.csiro.au/](http://www.csiro.au/)

[page.asp?type=sector&id=Climate%20and%20Atmosphere](http://www.csiro.au/page.asp?type=sector&id=Climate%20and%20Atmosphere)  
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**Enhanced atmospheric greenhouse effect** – refers to the additional global warming believed to be taking place due to the accelerated rate at which carbon dioxide and other greenhouse gases are being released into the atmosphere by human activities.

**Fossil fuels** – fuels that are formed from the organic remains of plants and animals as a result of exposure to heat and pressure in Earth’s crust over millions of years. Commonly used fossil fuels include crude oil, coal, and natural gas.

**La Nina** – the opposite phase of El Nino; during La Nina, the western Pacific Ocean becomes warmer than normal, while the central and eastern Pacific Ocean is cooler than normal.

**Oceania** – the collection of tropical Pacific island nations; does not include very large islands such as New Zealand or New Guinea.

**Tropics** – 1) the area between the subtropical high pressure ridges, which exist near 30° North and 30° South latitudes; 2) the region where monthly sea surface temperature is greater than 20°C all year.

**Typhoon** – similar to a hurricane; an intense tropical cyclone with sustained winds of at least 120 km/hr. Those storms forming to the east of the International Date Line are called hurricanes, while those forming to the west of the Date Line are called typhoons.

## RESOURCES

### Books

Aung, T.H., C. Kaluwin, and G.W. Lennon, eds. 1998.

**Curriculum Modules for the Pacific Schools, Climate Change and Sea Level Rise. Part One: Physical Science.**

Published by the National Tidal Facility at Flinders University of South Australia; Adelaide, Australia.

# Rising Waters: Global Warming and the Fate of the Pacific Islands Study Guide

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## OBJECTIVES

- To illustrate the very real consequences of global warming from the perspective of Pacific islanders.
- To describe the challenges faced by Pacific islanders in attempting to influence international treaties to limit the release of carbon dioxide into the atmosphere.
- To warn that the effects of global warming are not just an issue for islanders, but for people of all nations in the world.

## INTRODUCTION AND SYNOPSIS

Each year many people in the United States of America are affected by natural disasters such as floods, drought, tornadoes and hurricanes. Some people lose everything they own in these disasters, including their homes. Many are unable or unwilling to rebuild their homes in the same area, and are forced to move elsewhere. And yet, it is difficult for most people in the U.S. to imagine losing not just their personal belongings, but to have their entire

country disappear. This is exactly what many islanders around the Pacific Ocean and elsewhere in the world, however, are facing. While scientists study Earth's climate and look for definitive evidence of global warming, people on many of the Pacific islands are coming face-to-face with what they believe are clear indications that weather and ocean patterns across the Pacific basin are changing.

Covering nearly one-third of the Earth's surface, the Pacific basin is one of the most important regions in the world in terms of environmental studies. Although the island nations of the Pacific contribute very little to the greenhouse gases that are increasing in Earth's atmosphere, they are most vulnerable to the resulting climate change effects. The very existence of some low-lying islands would be threatened by even a small rise in sea level, and the underground fresh water supply on nearly all islands would suffer from salt water intrusion. Changes in weather patterns associated with global climate change (e.g. an increase or decrease in tropical cyclones; changes in patterns of major rainfall zones) would, at the very least, affect agriculture and ocean fishery industries. Even the natural climate variability associated with the El Nino-Southern Oscillation (ENSO) phenomenon can have significant impact on the social and economic activities of the islands; many scientists believe that global warming will have an even more disastrous effect.

This documentary explores some of the consequences of global warming from the perspective of Pacific Islanders, with interviews with people from the island nations of Samoa, Kiribati (pronounced "Kiribas"), the Marshall Islands, and Fiji. Interviews with well-known and well-respected scientists provide the audience with up-to-date information on where the scientific community stands on the issue of global warming. Also shown are attempts by

## GLOSSARY

**AOSIS** – Alliance of Small Island States

**Atmospheric greenhouse effect** – the increased warming of a planet's surface due to the absorption and re-radiation of thermal energy by select gases in the atmosphere.

**Atoll** – a ring of coral reefs and islets surrounding, or nearly surrounding, a lagoon. Atolls are the remnants of coral reefs that surrounded a volcanic island that has been eroded away. Most atolls are less than a few meters above sea level.

**Carbon dioxide (CO<sub>2</sub>)** – an odorless, colorless gas found in Earth's atmosphere primarily as the result of respiration by animals and the burning of fossil fuels.

**Climate** – the long-term behavior (over at least 30 years) of weather in a region, including seasonal variations and extreme events; in contrast to **weather**, which is the condition of the atmosphere at any given place and time.

**Coral reef** – formations produced by very large colonies of polyps, which secrete calcium carbonate around themselves for protection. When the polyps die, their empty outer skeletons form layers which cause the reef to grow. Corals are found in the coastal zones of warm tropical and subtropical waters.

**El Nino-Southern Oscillation (ENSO)** – a semi-regular phenomenon where the ocean waters of the central and eastern Pacific Ocean become warmer than normal, while the western Pacific ocean waters become cooler than normal. Along with this shift in sea surface temperature comes a change in atmospheric circulation and precipitation patterns that affect the entire planet.

8. Compile a list of ways that you are producing carbon dioxide. How can each of us reduce the amount of carbon dioxide released in the United States every day?

9. You and your family have just been told that the area in which you are living will soon be under water and you must move. To make things even more difficult, you won't be able to stay in the same neighborhood, or even in the same state, but you must move to another country (the government will choose which country) where people speak a different language and have very different customs. In addition, there is no guarantee that any of your friends or relatives (with the exception of your immediate family) will be able to be relocated anywhere near you (maybe not even in the same country!). The weight of personal belongings you will be able to take with you will be strictly limited (that is, you aren't likely to be able to take everything you own). You will be given some money by the government to help you move, but you will be on your own to learn the language of the country you are being moved to and to find yourself a job. Discuss the problems you would face and how you would feel about this relocation. What would be fair compensation to Pacific islanders that are forced to abandon their islands due to global warming?

10. Start a weather station at your school. A simple station can consist of a maximum/minimum thermometer in an instrument shelter and a rain gauge mounted on a post. Have the students make daily measurements of precipitation and temperature, and graph their data. They can compare their data to data obtained from a nearby National Weather Service office or from the state climatologist's office. A temperature and precipitation record for the school can be kept from year to year. For more information or ideas, there are many programs, such as the GLOBE program, available on the World Wide Web (see the list of web pages at the end of this booklet).

scientists, policy makers, and other special interest groups to come to a global agreement on how best to reduce atmospheric carbon dioxide.

While scientists attempt to approach the problem of global warming from an objective point of view, Pacific islanders are very concerned with losing their homes and their way of life. This film looks not only at life on the islands, but also shows the efforts Pacific islanders are making to convince the large countries of the world to reduce their burning of fossil fuels, in order to reduce the amounts of atmospheric carbon dioxide, believed to be the direct cause of global warming.

## **BACKGROUND INFORMATION**

### **Oceania**

If one was to take the entire land area of our planet and set it down on the surface of the Pacific Ocean, the remaining uncovered water would still equal the combined land area of the U.S. and Australia. Across this vast expanse of ocean are more than 27,000 islands. At the western edge are the islands of Palau, which are farther west than Tokyo, and at the eastern edge is Rapa Nui (Easter Island), which is farther east than Los Angeles. These islands are diverse both geologically and culturally. Life on these islands is so closely tied to the surrounding waters that the land and ocean constitute what is virtually an aquatic continent, often referred to as Oceania.

### **The Atmospheric Greenhouse Effect**

From the beginning of its formation, certain gases have existed in Earth's atmosphere that have the ability to absorb heat that is radiated from Earth's surface, and re-radiate heat back to the ground, making the surface warmer than it would be otherwise. The most important gases in our atmosphere that contribute to this "atmospheric greenhouse effect" are water vapor (H<sub>2</sub>O) and carbon dioxide (CO<sub>2</sub>), with gases such as methane (CH<sub>4</sub>)

playing a minor (although growing) role. In a sense, atmospheric CO<sub>2</sub> and other such “greenhouse gases” act as a blanket around Earth. The thicker the blanket, the warmer the planet. In fact, if it were not for small quantities of these gases in our atmosphere, the average temperature of our planet would be well below freezing and probably not suitable for life to exist.

Over the past 100 years, the level of CO<sub>2</sub> in Earth’s atmosphere has been rising at a rate that appears to exceed natural fluctuations seen in the fossil climate record. The majority of scientists, including world-renowned scientists that are part of the Intergovernmental Panel on Climate Change, are convinced that human activities are the primary cause of the increase in atmospheric CO<sub>2</sub>. It is this enhanced atmospheric greenhouse effect that is of great concern to scientists. While it is nearly impossible for scientists to predict in detail all of the consequences of global warming, many predictions can be made with a high degree of confidence. For example, as Earth becomes warmer not only will glaciers and other land ice begin to melt, but the upper waters of the oceans will begin to expand as they get warmer and warmer. Nearly half of the predicted sea level rise in global warming scenarios is due to this thermal expansion of ocean waters. Warmer ocean waters may also mean an increase in the number or the severity of tropical storms, such as hurricanes. In addition, most scientists predict that precipitation patterns around the world are likely to change as the planet gets warmer, perhaps in much the same way the patterns change during an ENSO (El Niño-Southern Oscillation) event. No place on Earth will be immune to the effects of global warming.

### **El Niño-Southern Oscillation**

This phenomenon, often referred to simply as “El Niño” by the media, is a short-term climatic change that is initiated in the tropical Pacific but has worldwide weather

2. As shown in the film, some people believe we need to wait and collect data for another 25 to 50 years before enacting any policies to decrease carbon dioxide released from fossil fuel burning. What arguments can you give that support or refute this position?
3. As ocean waters warm, many coral reefs will become stressed and die. How would the death of coral reefs affect island life?
4. Find a map that shows the topography of the continental United States. Make sure the map indicates the height of land above sea level. Next, find out from sources such as the National Oceanic and Atmospheric Administration (NOAA) web page what the rise in sea level is predicted to be over the next century. How would this rise affect people living in coastal regions of the U.S.? Even in those coastal areas that would still be above water, how might a rise in sea level affect people living there?
5. Much of our food in the United States is produced on large farms in Midwest states such as Kansas, Iowa, Illinois, and Missouri. Many global warming models predict that this region of the United States will become warmer and drier over the next century if CO<sub>2</sub> production is not reduced. What effect do you think global warming will have on the ability of the U.S. to produce enough food for our population?
6. What is the value of retaining a cultural identity? That is, should we be concerned about the loss of Pacific islanders cultural identity if they are forced to leave their home due to global warming? Why or why not?
7. What role should the United States and other large, industrialized countries play in helping Pacific islanders cope with the changes that may be brought about by global warming?

8. Find out more about hurricanes and typhoons in the Pacific Ocean. During a typical year, how many of these types of storms occur? What are the typical tracks of these storms across the ocean? How does the number of storms and storm tracks differ during an El Niño year? What problems may be caused by hurricanes and typhoons? Can you think of any benefits of hurricanes and typhoons?

## **DISCUSSION AND ACTIVITIES**

### **After Viewing the Film**

1. Divide the students into four groups, and assign each group to represent one of the following:
  - a. people of a small island nation, such as Kiribati
  - b. people of a large industrialized country, such as the United States
  - c. representatives of a large oil company
  - d. representatives of an environmental watchdog group, such as Greenpeace

Each group should prepare arguments either for or against proposals to decrease fossil fuel burning worldwide (they should take the stand that they believe would represent their group's viewpoint in the real world). Arguments could include a discussion of the scientific evidence that exists indicating that global warming is actually taking place; the impact of global warming on their lifestyles; the impact of global warming on various environmental niches; who should take responsibility to compensate groups affected by global warming; etc. Each group should choose a spokesperson to act as their representative in a debate-style presentation. These representatives should be allowed to present their group's point of view as well as support or refute arguments presented by the other groups.

consequences. Many scientists believe that ENSO patterns may become more frequent and/or more intense under global warming conditions.

Under “normal” conditions, the ocean waters in the western part of the tropical Pacific ocean are warmer, and sea level is slightly higher, than on the eastern side of the Pacific ocean. During an ENSO event, waters in the central and eastern Pacific become much warmer than normal, while waters in the western Pacific become cooler than normal and sea level drops. This change in ocean temperature is accompanied by shifting patterns of rainfall and hurricane activity. Islands in the western Pacific that usually enjoy frequent rainfall become drought-stricken, and islands in the eastern Pacific that typically see little rainfall receive many times the normal amount of precipitation. During an ENSO event, hurricanes, which need warm ocean waters to form and strengthen, form further in the central and eastern Pacific, bringing devastating storms to islands that otherwise seldom see severe weather. The exact trigger of an ENSO event is unknown, but the events appear to be getting stronger and more frequent in recent decades. Scientists are unsure whether this is a true change in the pattern of ENSO events, or simply a short-term fluctuation. Nevertheless, many climate models indicate that as the globe gets warmer, the potential for more frequent and stronger ENSO events increases.

## **DISCUSSION AND ACTIVITIES**

### **Before Viewing the Film**

1. Locate the island nations of Samoa, the Republic of Kiribati, the Republic of the Marshall Islands, and Fiji on a map. Assign small groups of students to research each island group in more depth. The student groups should gather information about the islands themselves, as well as about the people that live on them. Have each group present their information to the rest of the class. If you

have a particularly large class, or if you prefer to have students work individually, you could increase the number of groups and have these additional groups gather information about other islands in the Pacific, or elsewhere, such as the Federated States of Micronesia (made up of the island states of Pohnpei, Kosrae, Yap, and Chuuk), Vanuatu, the Cook Islands, the Republic of Palau, the Hawaiian islands, French Polynesia, Tuvalu, the Solomon Islands, or the Galapagos islands (all in the Pacific Ocean); the Seychelles or Maldives (in the Indian Ocean); or the Bahamas (in the Atlantic Ocean)

2. From the library or the World Wide Web, find out how islands form and how islands eventually become coral atolls. Why are coral reefs important?

3. From the library or the World Wide Web, research the history of climate change on Earth. Have there been times in the past when the overall climate of Earth was warmer than it is now? Have there been times in the past when the overall climate of Earth was cooler than it is now? How was sea level affected during these warmer and cooler times? How was life on the planet affected by these warmer and cooler times? This activity can be tailored to fit your class: you can have students research the entire history of Earth, or you can restrict their research to some smaller time period. Individuals or small groups of students can be assigned to research particular times in the past, and present their results to the class. For middle school students, a chart of Earth's climate history could be made and displayed on the classroom wall.

4. What is the atmospheric greenhouse effect? Which gases in Earth's atmosphere contribute to the atmospheric greenhouse effect? Which of these gases are increasing due to human activities?

5. What are the advantages and disadvantages of burning fossil fuels as a source of energy compared to alternative energy sources such as solar power, wind power, nuclear power, etc?

6. Your nearest National Weather Service office or your state climatologist's office should be able to provide you with climate data for your region. The exact type and quantity of data you request will depend on the ages and capabilities of your students. At the simplest, you can request annual average temperatures and precipitation amounts for your region (either for a specified period of time, like the past 30 years, or for the entire period of record). Have the students graph the data and see if there are any trends – that is, is there any indication in the climate record that years are getting warmer, cooler, wetter, or drier? For more advanced students, you can request average monthly temperature and precipitation data (again, for some period of time, or for the entire period of record available). These students should look at the data on a month-by-month basis to see if there are any changes that appear to be taking place during different seasons. Have the students identify which of the years were “El Nino” years, and see if the monthly data from these years is significantly different than from “non-El Nino” years. For students who have a background in statistics, they can test to see if the differences between El Nino and non-El Nino years are significant.

7. As an alternative, or in addition to the above activity, have the students research what, if any, effect ENSO events have on the weather in your region (e.g., Are winters warmer or colder than normal? Are summers wetter or drier than normal?). Then have students speculate how life would be different if the weather changes that take place during an ENSO event became permanent and/or became much more extreme.