MANGROVES OF THE KENYAN COAST

IT TAKES A VILLAGE TO SAVE THE MANGROVES

THE POWER OF MANGROVES

Deep in the Indian Ocean on December 26, 2004, about 1000 kilometers of the interface of the India and Burma plates shifted, causing roughly a ten meter displacement of the sea floor. While that doesn't sound like much, it was enough to displace hundreds of cubic kilometers of water, which resulted in the devastating tsunamis that hit coastal areas all along the Indian Ocean basin.

The tsunamis are blamed for the deaths of more than 175,000 people, the injury and displacement of hundreds of thousands more, and the destruction of entire towns and villages. In looking at the areas hardest hit, people noticed that areas with intact mangrove and reef systems, natural protections against an unpredictable sea, suffered less loss of life and property damage than areas that had been cleared for development. The mangroves acted like a shield.

Once regarded as muddy, mosquito-infested swamps, removing the scrappy, gnarled mangrove trees seemed like a step toward progress and development. But now, the devastating tsunamis of 2004 have brought to the public's attention what coastal ecologists and marine scientists have been saying for years: Don't mess with the mangroves. Not only do the mangroves provide an important natural barrier, absorbing the energy of wind and waves and protecting coastal areas from erosion, but they also provide nursery sites for fish and prawns and habitat for endangered species. Additionally, if managed properly, they can be a profitable timber resource.

However, these extremely valuable ecosystems are fast disappearing. Not that long ago, mangrove forests lined three-quarters of all tropical and subtropical shorelines, but today less than half remain. The remaining mangroves are under siege, as more than 3 billion people live within 200 kilometers of a coast, and 13 of the 16 fastest-growing cities are coastal. The many long-term benefits of mangroves cannot match the lure of quick cash that can be made from chopping them down for firewood and for the rayon industry, clearing them for farming or tourist

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GOOD ROOTS

Certain species of mangroves exclude salt from their systems, while others actually excrete the salt they take in via their leaves, roots, or branches. In salt-excluding mangrove species, the mangrove root system is so effective in filtering out salt that a thirsty traveler could drink fresh water from a cut root, though the tree itself stands in saline soil.

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development, or transforming them into shrimp ponds.

An often overlooked and hard to quantify value of mangroves is their impressive ability to sequester or store carbon. Like all trees, mangroves absorb carbon dioxide, storing the carbon and releasing the oxygen. With greenhouse gases like carbon dioxide increasing in our atmosphere, the ability of mangroves to sequester a lot of carbon is becoming increasingly important as a way to take carbon dioxide out of the atmosphere. Cars are some of the largest contributors of carbon dioxide to our atmosphere. Measurements indicate that 1 hectare of mangroves can sequester 1.36 metric tons of carbon per year, roughly equivalent to the amount of carbon dioxide six cars emit in one year (assuming, in American terms, 225 miles per week, 22 miles per gallon). With millions of cars on the road, the planet needs millions of hectares of trees and plants to absorb the carbon. As nations work toward reducing greenhouse gases, they may look to mangrove restoration as a valuable bargaining chip in carbon emissions trading.

For Dr. Mark Huxham (*School of Life Sciences at Napier University*, Edinburgh) and his colleagues Dr. James Kairo (*Kenya Marine and Fisheries Research Institute*), and Martin Skov (*University of Wales*), herein lies the challenge.

THE MANGROVES OF GAZI BAY, KENYA

Eight species of mangrove trees grow on the shoreline at Gazi Bay. With their sturdy trunks and their roots set firmly in the sand, the mangroves help protect this coast from the dangers of the rising sea, rough waves, and erosion. The mangrove forest provides sheltered homes for crabs, mollusks, birds, insects, oysters, young fish and much more. Like rainforests, mangrove forests are incredibly productive ecosystems, providing food and homes for a huge variety of animals and plants.

Today, much of Gazi Bay's mangrove forest has been cut down or degraded, leaving the bay muddy and the shores vulnerable to erosion. Where the mangroves remain, the people of Gazi village rely on them for much in their day-to-day life. Mangrove trees are their main source of wood and they use the timber for building beds, serving dishes, houses, roof supports, canoes, paddles, firewood, insecticides, and as remedies for fever, to name only a few uses. Fish are abundant in the mangroves and the many families who fish there receive much needed protein in their diet. When families need money, they turn the wood of mangroves into charcoal, which they then sell to other villagers.

RESTORING THE MANGROVE FORESTS

Huxham and his colleagues are addressing the problem of mangrove deforestation in Gazi Bay. His goals include restoration of the mangrove forests and deeper understanding of how the mangrove ecosystem works. In the summer of 2004, Huxham, along with a team of researchers, volunteers, and the local community of Gazi, began what will be a five-year project. A central goal of the project is to replant the mangroves and test their effectiveness in preventing coastal erosion. Another goal is to study how the richness of species within an ecosystem affects the ability of that system to provide "goods and services" back to the environment, a question of fundamental ecological interest. Goods and services might include clean water, food sources such as clams, fish, and crabs, protection against high tides or water damage, and so on. Finding out how the species diversity in the ecosystem affects the systems' ability to provide these things will help researchers understand more about these ecosystems work. Another important goal of the research in Gazi is to involve local people so they will become an essential part of a long term, sustainably managed local resource.

During their first field season, Huxham and his team planted mangrove trees of four different species: *Sonneratia alba, Ceriops tagal, Avicennia marina*, and *Bruguiera gymnorrhiza*. A successful planting of the trees was one of the primary objectives of this first phase. Planted in two separate areas where mangroves once grew, Area 1 will be used to test the different ecosystems that are created within the different mix of tree

species, while Area 2 will be used to test the effects of mangroves on **sedimentation** and erosion.

Within area 1, the trees were planted in groups of varying combinations of one to four of the different species. This method of varying the species planted near each other will test the success of **intercropping** in mangroves, a theory that suggests that mixing two or more species of trees can make the forest more productive. The different combination of species within the blocks will also show how the diversity of tree species affects other functions of the ecosystem, such as the ability to absorb carbon dioxide. In Area 2, where erosion is the issue, monitoring will test how quickly replanted trees can establish an effective coastal barrier.

Over the next five years, both replanted areas of mangroves will be closely monitored and tested. In Area 1, scientists will focus on what is in the sediment to see how tree species diversity affects sediment quality. Samples of sediment will be taken from each plot in Area 1, a low energy, muddy area with extensive areas of bare, clear-felled soil, to test the amount of oxygen, carbon, silt, water, and nutrients within the sediment. To measure oxygen in the soil, researchers insert a redox probe, a small device that looks like a large, plastic thermometer, to depths of 15 and 30 cm. Sediment cores will be taken and tested in the lab for measuring the other variables. The temperature will also be taken at 20 random points. Temperature has been shown to vary significantly between areas of mangroves with different tree density, and may affect sediment chemistry and **biota**.

Area 1 will also be tested for crab diversity and abundance using binocular and burrow counting methods at ten randomly chosen points. The abundance and diversity of the benthic macrofauna will also be tested at ten randomly chosen points. Samples of the sediment will be taken to the lab where each will be preserved in 90 percent ethanol, stained with rose bengal, a red stain that stains live cells, and sieved over a 1 mm mesh to remove all **macrofauna**. Researchers will identify the macrofauna to see what kinds of animals live in this ecosystem at various stages of restoration.

Over the next five years, Area 2 will be monitored for tree survival and recruitment. "Recruitment" is the term that refers to trees that have grown up naturally within the area. Scientists will track the survival and growth of 160 mangrove trees in this area. Tree growth will be measured by the diameter of the stems. Through visual inspection, any signs of insect attack will be recorded, in particular *Salagena discata*, a wood-boring moth present in Gazi. If a tree dies, it will be replaced with a new one.

To monitor erosion in both areas, six erosion stations have been established at random locations in each experimental plot. These consist of two 2 meters long, 5 centimeter diameter stakes, buried to 1 meter depth 1.5 meter apart. Sediment height at the midpoint between these stakes will be recorded by measuring down from a horizontal cross bar. During each field season, researchers will measure the height of the sediment to see how much erosion has taken place.

Throughout the five years the tests will remain the same, with the exception that during the fourth field season, fish and shrimp (called "prawns" in Kenya) use of the replanted areas will be assessed using stake nets, 3 x 3 meters long, 2 meters high with 2 centimeter mesh. Using this method of fishing, scientists can take samples in mangrove forests, and estimate how many fish and shrimp are using the replanted areas.

PLANTING THE TREES

In the first field season, 6,077 trees were planted in 46 experimental plots, and scientists and volunteers collected baseline data from all of them. Volunteers came from around the world and from the local village to help plant the trees in both research areas and collect the initial baseline data on **biotic** variables such as crab diversity and abundance, and abiotic variables such as sediment salinity (salt content), carbon

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content, and the different grain sizes of the sand and dirt particles, also known as granulometry.

Many of the trees survived the critical first two months of establishing themselves. With an overall mortality rate at 5.2 percent, *Bruguiera gymnorrhiza* so far has shown the greatest mortality, while *Sonneratia alba* has shown the least.

Dr. James Kairo, one of Huxham's colleagues on the project, is a resident of Gazi. For the past ten years, Kairo, in his role at the Kenya Marine and Fisheries Research Institute, has worked to replant mangroves in Kenya and around the world. He has helped establish community involvement in mangrove restoration in Gazi. The mangrove seedlings for the experiment were started in nurseries with the help of local people, and over the next four years, five people will be employed to work on mangrove management, with additional occasional work for other villagers in preparing nurseries for future plantings. For this project to be successful at restoring the coastal mangroves, the community needs to be committed and involved in restoring them – the local community will reap the benefits of the restoration, so there is high motivation for them to work with researchers toward this goal.

The project is off to a great start, and has received recognition from Kenya's Ministry of Environment, Natural Resources, and Wildlife. Wangari Matthai, a deputy minister in the Ministry and famous for organizing the Green Belt Movement, a project that paid women for planting millions of trees across Africa in the 70s, visited this project in 2004. As Huxham noted, "She had never planted mangroves before, so was very interested to see the similarities and differences between our work and the terrestrial community forestry that she has been so influential in. And she was more than happy to put on rubber boots and to get her hands dirty planting trees." Wangari Matthai won the 2004 Nobel Peace Prize.

SPREADING RESULTS AROUND THE WORLD

The information gathered from the *Mangroves of the Kenyan Coast* project will be used for local, national, and international purposes. On a local level, the people of Gazi will learn first-hand how to maintain, use, and rebuild mangrove forests so that their resource of wood and a productive fishing environment will always exist. In the future, all plots in the Gazi Bay experiment will become mangrove resources for local people. In Kenya, a country that suffers from a severe shortage of woodland, there is an urgent need to develop a better mangrove management plan. Along the coasts, mangroves are often the major woodland resource. Kairo has been asked to lead a group developing a national management plan.

As the destruction of mangrove forests is a global problem, these experiments in Kenya, if successful, will help demonstrate the benefits of restoring and protecting mangrove forests rather than cutting them down and clearing them out. Already, the Kenya Marine and Fisheries Research Institute is using the project as a showcase of mangrove restoration.

GLOSSARY

***biota* –** the total complement of animals and plants in a particular area.

***biotic* –** used to describe the features of a natural system that are living.

***intercropping* –** to grow different crops in the same field, usually in alternate rows, or to plant a crop between the rows of another crop.

***macrofauna* –** animals large enough to be seen with the naked eye.

***sedimentation* –** the process by which particles in a liquid suspension form sediment.

FIND OUT MORE

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Web Sites

East African Mangroves
www.specola.unifi.it/mangroves

Mangrove Action Project
www.earthisland.org/map

Key Words

mangroves, mangrove forests, shrimp farming, coastal development, East Africa, tsunami

Volunteers have joined this project through Earthwatch Institute. Read more about this study and other scientific field research at www.earthwatch.org.

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