



FIELD REPORT TEMPLATE

Marketing title

Mangroves of Kenya

PI name

Dr. Mark Huxham

Research site/ region

Gazi Bay, Kwale District

Country

Kenya

Research site latitude/ longitude

4° 25' S, 39° 50' E

Protected area status

None

Date field report completed

21 December 2009

Period covered by this report

From January 2009 to December 2009

Report completed by (name)

Mark Huxham

Edinburgh Napier
UNIVERSITY

A red triangle graphic pointing to the right, partially overlapping the text "Edinburgh Napier UNIVERSITY".

Dear Friends,

I do hope you are all well. I am writing to say thank you once again for your contributions to our project, and to give you a brief up-date on the progress of our work. I am lucky to be PI of this project for many reasons; but one of the most important for me is the quality of the volunteers we have worked with. This season was no exception; Bernard, Joseph, Kairo, Martin and I thoroughly enjoyed working with you all and were very pleased with the results we achieved. Our work this year confirmed some of the encouraging trends we had documented last year.

Do you remember having to measure hundreds of trees (and count thousands of leaves)? How could you forget! Well, the point of all that labour was to document the expanding above-ground biomass of our planted plots. As you can see from the results summarized below, we now have substantial growth in our plots along with clear differences between species; there is no doubt that *Avicennia marina* is the most vigorously growing species at the Kinondo site. But, interestingly, it is not *Avicennia* (*Avicennia marina*) that is recruiting as a wild species into our plots. By counting the 'wildings' we can see that this species is facilitating the growth of others; we hope this will eventually lead to the establishment of mixed natural stands. The hours that you spent measuring the physical variables in the plots - water, salinity, redox and the rest - help us establish why this is the case, as the young trees modify the physical habitat leading to colonization of new seedlings. And what about the below-ground biomass (the roots)? Well, some of you had the pleasure of helping Joseph with his 'root pits' - digging big messy holes in the forest. Despite the importance of roots to the carbon balance of mangroves, no-one knows how quickly they grow and how this root productivity is related to the productivity of the shoots and leaves. This is exactly what those root pits will allow us to discover. Joseph will be measuring the above-ground productivity of his plots for the next two years, and will then dig up your pits and measure all the new roots, giving him a direct measurement of root productivity. We are at an important transitional stage in our work at Gazi. We have established that degraded areas can be restored with mangroves, and that the forests hold substantial amounts of carbon. We now want to extend our work to establish a large scale community-based project showing how mangrove forests can be managed sustainably and attract money for carbon sequestration. Some of your work this year contributed towards this goal. We managed to document 30 forest plots which will act as 'groundtruthing' for the satellite images we are working on. The idea is to use satellite imagery for the whole of the Kenyan coast to come up with estimates of total mangrove forest cover and total carbon content. These figures are essential for national planning of mangrove management, but need good data from the ground to validate them. This year saw the opening of the new school building in Gazi. This was a very proud moment for us - a brand new facility that will benefit the village built entirely from funds raised by Earthwatch volunteers and staff. I am so grateful to all those who have worked with us on this project, including the village committee that oversaw the building. It is a highly visible sign of our continuing commitment to the life of the village and the welfare of our friends and hosts there. Although mangrove science is essential, we have always recognized we need to go well beyond this and make sure our impact in Gazi is positive in as many ways as possible. Everyone in the team has been busy since you left. Joseph (Langat) is working very hard on new experimental plots, measuring fluxes of greenhouse gases. Bernard is examining satellite images of Kenya's mangroves. Martin is developing new lines of research on salt marshes, and Kairo, Bernard and I have been helping to establish a new East African Forum for Payment for Ecosystem Services.

Hoping that we will meet again soon. All best wishes,



Mark

SECTION ONE

Top highlight from the past field season

Mangroves can facilitate growth, survival and ecosystem recovery. This year we established that mangroves can help each other survive and grow. We have been running a number of experiments looking at the effects of density on growth and survival. Our results showed that higher density resulted in lower mortality; this is the opposite of the competitive effects ecologists usually expect, and shows that restoring degraded areas should involve planting high densities of plants (See Figure 1). The biomass of the growing trees is also changing the nature of the sediment substrate, improving its suitability for further mangrove growth (See Figure 2). We have also established the trend we noted last year - that one species of plant is facilitative the recruitment of other species into our restored plots (See Figure 3).

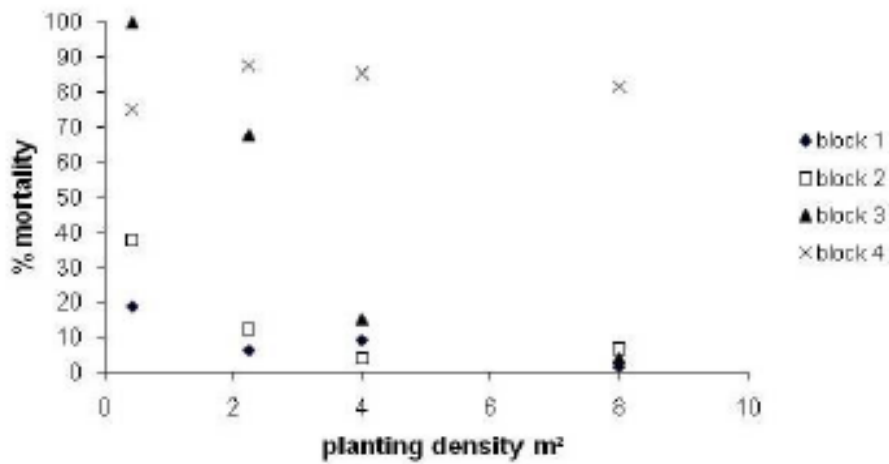


Figure 1. Seedlings that we planted at high density show much better survival than those at low density

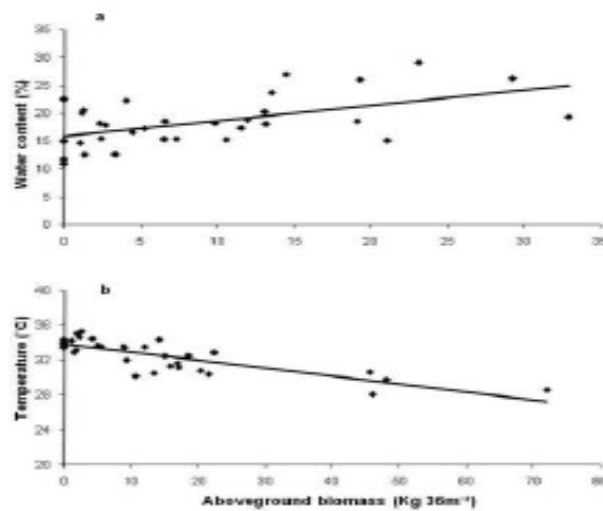


Figure 2. The biomass of the growing trees is changing the nature of the sediment substrate

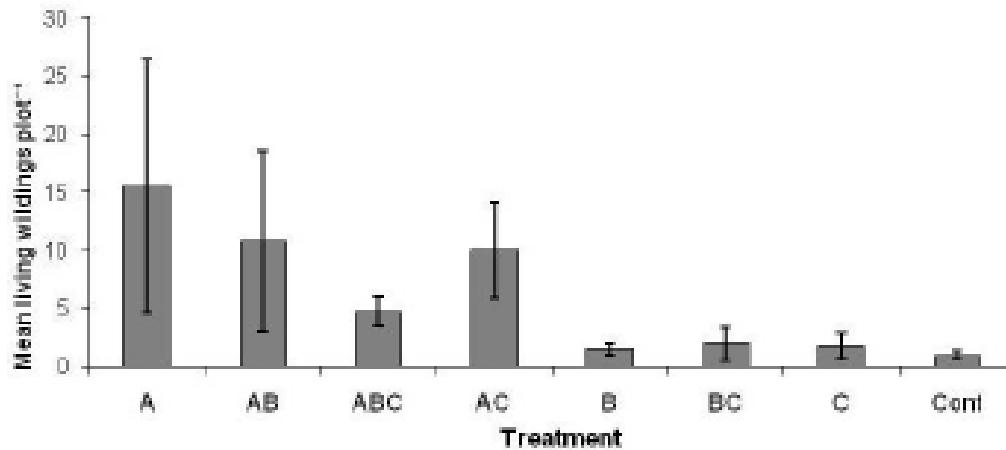


Figure 3. This is allowing new seedlings to recruit into our replanted plots

But while that might be the scientific highlight this year, my own personal one is the opening of the Gazi School building. It was such an honour to participate in the opening ceremony, attended by the village Chairman, the Director and Chair of Kenya Marine and Fisheries Institute, local dignitaries, Earthwatch volunteers and, of course, the children. Even being required to dance did not spoil the occasion for me!

Mangroves are threatened ecosystems - globally they are being lost at between 1-2% per annum. This is of serious concern for many reasons. Mangroves protect shorelines, provide nursery habitat for fish and timber and firewood for local people. It is also becoming clear that they are significant carbon sinks, capturing much greater amounts of carbon than their relatively small global coverage would suggest. So finding ways of restoring and conserving mangroves is important, and our work is contributing to that. We have already shown that restoring some really tough sites - that have not seen any natural regeneration for over 30 years - is possible provided we use the right species and invest liters of volunteer sweat in growing and transporting trees from a nursery. This year we showed how planting these trees closely together can enhance their survival, the opposite effect to that usually expected in forestry. The biomass of the growing trees is also changing the nature of the sediment substrate, improving its suitability for further mangrove growth (See Figure 3).

One of the most important new methods for ensuring the conservation of tropical forests is likely to involve transfers of money from the rich north to invest in forests as essential global carbon stores. We are conducting the research to allow us to apply for this money, for the long term benefit of Kenya's forests and the people who rely on them. This year we began the process of mapping all of the forests using satellite imagery, and complementing this with dozens of plots measured on the ground to 'groundtruth' the satellite data. We hope to go on to use these data to produce a 'carbon landscape' of the Kenyan coast, showing the areas with most carbon and helping policy-makers plan for their conservation and sustainable use

Acknowledgements

All our thanks go to our hosts in Gazi and at KMFRI. In particular, I would like to thank Bwana Twaha Mohammed, Chairman of the Earthwatch Gazi Community Committee, for his hard work organizing the building of the school room. Thanks too to all our great volunteers this year. What a great bunch you were!



Yet more redox measures



A keen Earthwatch volunteer team in the field (Brian Bicknell)



The new school building ready to open
(Photo taken by a volunteer on Team 3)

SECTION TWO

1. REPORTING ON RESEARCH OBJECTIVES

Objective 1

To test how the diversity of mangrove species in replanted stands affects a range of ecosystem functions

Progress against objective

We have established that one of our species (*Avicennia marina*) is much more vigorous at the high tide, high salinity site. This species can act as a 'nurse species' for other more sensitive trees. Total productivity of the stands - both above and below ground - is higher when this species is planted. Although we do not see facilitative effects on biomass by mixing species, we do see facilitation of other seedlings by the physical modifications caused by *Avicennia* (*Avicennia marina*).

Objective 2

To use controlled experiments to test the effects of replanted mangroves on sediment dynamics (in both low and high energy areas), and to measure how these effects change as the trees mature

Progress against objective

We now have significant changes in sediment characteristics (such as moisture content and grain size) caused by tree planting (see Figure1 above). We have also recorded significant elevation of the sediment surface in our planted plots.

Objective 3

To explore the potential for mangroves to act as carbon sinks and protect against the effects of sea level rise

Progress against objective

We now know the rates of above and below ground biomass accumulation for three different species at our high tidal site. We also have good estimates of total stored carbon for the natural forest, including for below ground carbon. Our data are consistent with the emerging evidence for the efficacy of mangroves as carbon sinks. We do not yet have firm evidence of protection from erosion at our low shore sites, although observation suggests this is occurring. The sediment elevation at our high shore sites is consistent with mangroves trapping sediment.

Objective 4

To develop a large scale demonstration project of sustainable mangrove utilization, and to use this to influence the management of mangrove habitats in Kenya and beyond

Progress against objective

We are hoping to achieve this objective over the next year. We are now collecting data on the effects of small scale mangrove cutting on greenhouse gas emissions, with the purpose of

assessing whether the managed removal of trees is likely to result in large emissions. If this is not the case, we propose to include managed cutting as part of an integrated management plan. We are writing a Project Information Note for submission to Plan Vivo, a charity that independently accredits tropic forestry carbon projects. This is the first step in enabling us to market Gazi mangrove carbon to the voluntary market, raising funds for the community and for investment in mangrove conservation. We intend to submit this in early 2010.

2. PARTNERSHIPS

Kenya Marine and Fisheries Research Institute - KMFRI continues to be our key Kenyan partner and is essential in our Gazi work. Gazi/Earthwatch Community Committee - the committee has guided our charitable works and our relationships with the village and has overseen the construction of the new school building. Edinburgh University - we continue to build on our research collaboration with Edinburgh and have a new PhD student registered there who will be working on related topics. Bangor University - we have developed new links on economics with Bangor University.

3. PROJECT DEVELOPMENT

N/A

4. DISSEMINATION

Printed:

Huxham, M., Kumara, M. P., Jayatissa, L.P., Krauss, K.W., Kairo, J., Langat, J., Mencuccini, M., Skov, M.W. & Kirui, B. Intra and inter-specific facilitation in mangroves may increase resilience to climate change threats. *Philosophical Transactions of the Royal Society* (in press)

Huxham, M., Langat, J., Tamoooh, F., Kennedy, H., Mencuccini, M., Skov, M.W. & Kairo, J.G. (submitted). Decomposition of mangrove roots: effects of tree species and tidal height in a Kenyan forest. *Estuarine Coastal and Shelf Science*

Kirui, B., Huxham, M., Kairo, J.G., Mencuccini, M. & Skov, M.W. (2009) Seasonal dynamics of soil carbon dioxide flux in a restored young mangrove plantation at Gazi Bay. *In: Hoorweg J. & Muthiga N. (eds) Advances in Coastal Ecology: People, processes and ecosystems in Kenya*. African Studies Centre, Leiden, Netherlands

Tamoooh, F., Kairo, J.G., Huxham, M., Kirui, B., Mencuccini, M. & Karachi, M. (2009) Biomass accumulation in a rehabilitated mangrove forest at Gazi Bay. *In: Hoorweg J. & Muthiga N. (eds) Advances in Coastal Ecology: People, processes and ecosystems in Kenya*. African Studies Centre, Leiden, Netherlands

Mass media:

Ugandan farmers reaping from carbon trade. Daily Nation, Thursday November 26th 2009

Meetings and conferences:

East African Regional Workshop on Payments for Ecosystem Services, Mombasa, November 12-14th 2009

5. CAPACITY DEVELOPMENT AND EDUCATION

Joseph Langat - Joseph is our full time PhD student based at Gazi. He is making good progress with his studies and has two more years before completion. Fridah Munyi, Bernard Kirui and Alfred Obinga - Fridah is a socio-economist, Bernard an ecologist (the post-doc trained on this project) and Alfred a field assistant. Further funds were obtained for a related study, building on some of the outcomes from the Earthwatch work, for these three African students to come and study remote sensing technology in Edinburgh for three months this year.

6.1. CONTRIBUTIONS TO INTERNATIONAL CONVENTIONS, AGENDAS, POLICIES, MANAGEMENT PLANS

N/A

6.2. CONTRIBUTIONS TO LOCAL, NATIONAL AND REGIONAL CONVENTIONS, AGENDAS, POLICIES, MANAGEMENT PLANS

In November, we established a new regional group, the East African Forum for Payments for Ecosystem Services (EAFPES). This group will help support and co-ordinate efforts within the region to obtain PES to support conservation.

7. ACTIONS OR ACTIVITIES THAT ENHANCE NATURAL AND SOCIAL CAPITAL

Our on-going tree planting at the site continues to enhance natural capital. The building this year of a new school building funded entirely from the work and contributions and volunteers and staff on this project was a major contribution to social capital.

8. LONG TERM IMPACT OF PROJECT

Habitats enhanced, restored or maintained

- 1) Mangrove woodlands
- 2) Plantations in degraded areas
- 3) Around an additional hectare this year
- 4) Areas we plant on are bare and degraded; they are former forest areas that were cut down in the 1970s

Ecosystem services enhanced, restored or maintained

A central focus of our work is to study the enhancement and restoration of ecosystem services. So our replanted stands provide regulating (carbon sequestration, erosion regulation) and supporting (primary production and sediment accretion) services. In the future, they will provide provisioning services (timber and possibly medicines) as well.

Cultural heritage enhanced, restored or maintained

Our main contribution here was the extension of the school building this year.

Livelihoods enhanced, restored or maintained

We directly employ three people full time on this project. In addition, we work with a team of around seven KMFRI casual staff who receive part of their yearly income from us. We also bring income to the village by hiring vehicles based there, buying local food and participating in our annual 'village nights' where we pay local people to host us for meals.