



Valuing the Arc Programme

Progress report to Leverhulme Trust for 2008

Overview and objectives

Valuing the Arc is an interdisciplinary programme with two broad parts.

Part A – theoretical review. This part of the programme aims to develop and publish a broad conceptual model for undertaking an 'ecosystem services approach' to conservation. This aims to be generic and applicable globally.

Part B – Eastern Arc case study. The second part aims to test the conceptual model across a system that is important for biodiversity conservation and ecosystem service delivery. This part is being undertaken across the Eastern Arc Mountains of Tanzania.

Both parts of the programme will produce high level scientific papers. They will also organize workshops and seminars, develop a web site, and produce technical materials that are being fed into the policy process in Tanzania. The programme is also helping build capacity on ecosystem service conceptualization, mapping and valuation in five British and two Tanzanian Universities and within the WWF network. Ideas developed are being promoted among other key collaborators in the USA-based Natural Capital Project.

Administrative progress

Contracts with Valuing the Arc partners

During 2008 the contracts with the three Tanzanian and five UK partners were administered without problem and funding was provided according to the agreed details in the contracts. All senior Tanzanian staff (seven Professors, three Doctors and two senior technical staff members) continued to participate in the programme throughout the year.

Staffing

In March 2008, the programme hired Professor Shadrack Mwakalila within the WWF Tanzania Programme Office as the Tanzanian Coordinator. Dr Ruth Swetnam – an experienced GIS analyst – was hired in April 2008 by Cambridge, as a replacement for Dr Rouget.

The five other Post Doctoral level staff continued in their employment, but the contract for Dr Andrew Marshall at York ended during the year. He is now writing up the results of his project work, while continuing to work on linked projects in the same geographical

area of Tanzania. In addition, WWF US continued to fund the staff time for Dr Taylor Ricketts, Dr Robin Naidoo and Mr Nasser Olwero to participate in the programme's work. Collaboration also continued with Dr Rob Marchant at the University of York, and two of his PhD students, within the context of his KITE programme.

Dr Sebastian Hess in the Netherlands provided some paid short-term consultancy, in the form of writing up data on Non Timber Forest Products (NTFPs) from the Uluguru Mountains.

PhD students

One of the Tanzanian PhD students partly supported by the programme – Mr Birhanu Zemadim – completed his hydrology PhD at the University of Dar es Salaam and was successfully awarded the degree. The other hydrological PhD in Tanzania – Mr Titus Safari – started his work, but unfortunately dropped out of the programme after nine months. A replacement is now being sought. Two new PhD students were taken on in the UK. Mr Simon Willcock, funded by Valuing the Arc, was recruited to work on the carbon mapping and modelling and started work in October 2008. In addition, a Cambridge University Rothschild Studentship was secured for Mr Jonathan Green to work on biodiversity mapping and modelling at Cambridge in the UK – and factoring 'cost' into conservation planning; he began work in October 2008. Valuing the Arc also became more closely involved with PhD students working in the KITE project in York University, building close collaborations with Ms Antje Ahrends (on vegetation and carbon modeling) and Mr Phil Platts (modeling plant distributions).

Collaboration was also established with Ms Jaclyn Hall, a PhD student in the University of Florida in the USA. She is working with Valuing the Arc on mapping forest cover changes over the past 50 years, and linking that to changes in biodiversity and ecosystem services.

Masters and bachelors students

During 2008 four of the six Tanzanian Masters students supported by Valuing the Arc started their fieldwork: Mr Deo Shirima (working on carbon in woodland habitats), Mr Joseph Makero (timber in the Eastern Arc), Mr Mhuji Kilonzo (NTFPs in the Eastern Arc), Mrs Christina Mohammed (on governance of forests). Two other Masters students are completing course work before starting their field projects. A UK-registered Masters student – Ms Sana Okayasu – was partly funded by the programme to collect data on nature-based tourism in the Eastern Arc Mountains. A team of four Masters students from York University completed their projects on timber volumes and values from the Eastern Arc and surrounding areas.

In 2008 three Cambridge undergraduate students also completed projects of relevance to the programme's objectives (two on management effectiveness and one on the charcoal value chain in eastern Tanzania). At the University of East Anglia a BSc student – Ms Rebecca Wolschner – has been undertaking a project on the spatial mapping of charcoal demand and price in the Eastern Arc.

Two interns in the US office of WWF also worked on the programme during 2008. Mr Mike Roos worked on pole extraction, and Ms Lauren Goers worked on developing

mapped indices of poverty across our study area.

MOUs with related projects

KITE. Our MOU with the KITE programme addresses issues of climate change and patterns of botanical biodiversity that are not funded by Valuing the Arc. The work outlined in the MOU was pushed forward during 2008, with draft outputs now emerging.

Natural Capital Project. Our MOU with the Natural Capital Project began in 2008. Collaboration has included working together to develop a GIS mapping tool for ecosystem services, called InVEST, that we have been field-testing with partners in Tanzania, and to the work on policy issues related to forest carbon and water supplies. Draft reports and scientific papers have been produced.

MOUs for sharing forest data. We have concluded a series of MOUs with six forest data holders, so that we can build carbon storage models for the Eastern Arc region.

MOUs for sharing timber and non-timber forest product data. We have developed draft MOUs with five agencies holding data on timber and non-timber forest products in the Eastern Arc region. As yet only one of these has been signed – with IVM in the Netherlands – and we have produced a collaborative report.

Meetings and workshops

The programme held a series of workshops in the UK and Tanzania. These pushed forward both theoretical and empirical aspects of the programme's work.

Meetings in Tanzania

First ecosystem services mapping meeting, Morogoro, February 2008. Royal Society, VTA and Nat Cap funded an ecosystem services mapping workshop which brought together more than 30 Tanzanian, UK and US-based experts. Significant progress was made in terms of mapping out biodiversity and ecosystem services in the Eastern Arc region.

Second Project Advisory Committee meeting, Dar es Salaam, February 2008. The PAC, chaired by the head of environment within the Vice-President's office, is made up of senior Tanzanian government officials and is one of our main ways of linking our work and findings to the national policy process. We presented a summary of recent progress to this group and comments were received on the way forward.

WWF Tanzania coordination meeting, Dar es Salaam, February 2008. A meeting was held with the key players in the WWF office in Tanzania to ensure that the tasks of the new coordinator (Prof Mwakalila) were well understood.

Second scenarios meeting, Bagamoyo, September 2008. This meeting finalized work begun a year ago on the social scenarios that the project will be using to explore how different policies may impact ecosystem services in the Eastern Arc.

Third Project Advisory Committee meeting, Dar es Salaam, September 2008. This meeting provided very useful feedback on the relevance of the results generated so far by VTA.

Third ecosystem services mapping meeting, Bagamoyo, September 2008. This meeting refined the mapping of ecosystem services within the InVEST GIS mapping programme. The meeting also gathered feedback on the relevance of the results generated so far by Valuing the Arc to the Tanzanian policy process, and guidance was provided on linking project results to Tanzanian attempts to engage in forest carbon markets (Reduced Emissions from Deforestation and Degradation) and Payments for Water Services by downstream users.

Eastern and Southern Africa Katoomba Group meeting, September, 2008. This meeting provided a showcase for some of the initial results of the VTA, for decision-makers coming from Africa and across the world. Many donors supporting the Tanzanian Government – particularly on forest carbon issues – were also present.

Meetings in the UK & USA

VTA coordination meeting, Cambridge, May 2008. This meeting brought together all the partners from the UK and the Tanzanian Coordinator, Prof Mwakalila, to review progress with all modules and to make plans for the coming years.

Second ecosystem services mapping meeting, Stanford University, July 2008. This meeting focused on mapping ecosystem services using the Natural Capital Project's InVEST GIS mapping tool. It was funded by Natural Capital Project, with VTA paying the flight costs for Ruth Swetnam to attend.

Carbon collaboration meeting, York, August 2008. This brought together all the staff working on carbon within the programme. It also provided a briefing for the incoming carbon PhD student, Simon Willcock.

Valuation coordination meetings, UEA. Three one day meetings were held with the valuation staff from UEA, in particular making progress on linkages between the various service-specific modules and the UEA team's work on valuation.

VTA end of year meeting, Cambridge, December 2008. A meeting of all partners in the UK was held in December that to review progress and plan activities and priorities for the rest of the programme.

Progress with Valuing the Arc

Part A - Theoretical review

The review is being led Prof Kerry Turner and Dr Brendan Fisher at the University of East Anglia, with input from Dr Sian Morse-Jones and other members of the Valuing the Arc team. This module continues to make significant headway and has developed the theoretical framework for the Ecosystem Services Approach (ESApp). To date the team has produced 3 peer-reviewed papers and a popular publication from this work.

Within this overall decision support system, ESApp, a novel classification and sequential assessment methodology has been developed. The former adopts the classification system compiled by the Millennium Ecosystem Assessment team in order to tailor it to the needs of an assessment method that yields economic values for final ecosystem services benefits. The distinction made between intermediate and final ecosystem services is fundamental and helps to guard against double counting error. The sequential approach involves a series of steps in the analytical process that results in a set of interrelated estimates of ecological service values. The approach highlights the importance of initiating the natural and social science analysis in a spatially explicit format. On the basis of spatially explicit production and distribution of ecosystem services, the analysis then proceeds to identify environmental changes. To fit into economic cost-benefit frame, the ecosystem transitions that are identified and evaluated must be 'marginal'. Further steps in the assessment method are designed to take account of non-linearities in benefits provision and possible threshold effects. This economic valuation methodology is then encompassed within the overall ESApp framework.

The macro-scale framework includes scenario building and assessment, distributional analysis and the exploration of governance regimes and their influences on ecosystem change and management and livelihood provision. Monitoring and information feedback measures complete the feedback loop with ESApp.

Part B - Eastern Arc case study

The Eastern Arc case study has a number of modules. Progress with each of these is outlined below:

Scenarios. Dr Brendan Fisher has led the development of plausible future socio-economic development scenarios for Tanzania. These have been completed during the year. The collaboration with KITE is also leading to the development of locally relevant climate change scenarios, and working versions of these scenarios were also completed during the year.

Mapping and GIS. Dr Ruth Swetnam has led the mapping work during 2008, working together with Dr Boniface Mbilinyi and Mr Simon Mwansasu in Tanzania, and partners in the KITE (especially Mr Phil Platts, Ms Antje Ahrends and Dr Rob Marchant) and the Nat Cap projects (especially Mr Nasser Olwero and Dr Taylor Ricketts). A detailed and fully

updated GIS system is now available for the study area, and is being used for analyses by VTA and its partners.

We have also begun developing spatially explicit models of potential land cover change, using the socio-economic scenarios developed by the valuation module. These modelled Tanzanian land cover maps will be used in the remaining parts of the programme to test the impact of policy changes on the delivery of the different ecosystem services.

Biodiversity. Prof Kim Howell, Mr Willirk Ngalasson and Mr Chacha Werema at the University of Dar es Salaam have completed draft species times site matrices for mammals and reptiles for all Eastern Arc sites. These are now under review by external experts. Other biodiversity data were reviewed at the meeting in Tanzania in February 2008. A PhD Student (Mr Jonathan Green) has also been funded by Cambridge University to work on the biodiversity data, and deliver the outputs that VTA needs for its synthesis work. He has spent part of his first term using our bird data to look at how to improve relatively crude distribution maps by incorporating habitat preference information (in collaboration with Prof Jon Fjeldså at the University of Copenhagen). Draft papers on the impacts of deforestation on the biodiversity values of the Eastern Arc were also submitted during the year.

Valuation studies for Eastern Arc biodiversity have been designed by Dr Sian Morse-Jones, Dr Andreas Kontoleon and Dr Neil Burgess in the UK, Dr Robin Naidoo in USA and Dr Kassim Kulindwa in Tanzania. The resulting survey of existence value is now being implemented in the UK using an online survey mode; outputs are expected in March 2009. Pending outcomes, the survey may then be extended (with suitable adaptation) to USA and Tanzania.

Carbon. Dr Andrew Marshall and a team of field researchers, with scientific input from Prof Panteleo Munishi in Tanzania, Dr Simon Lewis at Leeds University and Dr Jon Lovett at York University, completed their work to establish a network of 18 long-term carbon plots in the Eastern Arc. A Tanzanian masters student (Mr Deo Shirima) started a project to establish further plots in woodland habitats. Together, these plots will provide vital information on rates of carbon sequestration across different habitat types. A UK PhD student (Simon Willcock) was recruited and visited Tanzania in December to familiarise himself with the plots and the study area. A significant database of 2,800 forest plots and 500 km of disturbance transects has also been compiled through collaboration with KITE, and MOUs have been signed to allow these data to be used to map and model carbon storage across the Eastern Arc region during 2009. Collaboration with the Natural Capital Project has also resulted in simple maps of carbon storage being produced for eastern Tanzania, which are being used to produce draft papers, and to provide preliminary data for several major new projects on carbon offsetting now being developed by the government of Tanzania and international donor agencies.

Valuation of carbon will be in accordance with the market rates on the world's carbon exchanges.

Hydrology. Prof Sue White and Dr Celina Smith in Cranfield have continued their work to develop hydrological models of the Sigi River Basin using the Soil and Water Assessment Tool (SWAT) hydrological model. Parameterising the model has proven challenging and by the end of 2008 there were still issues to be resolved to make a reliable model for this basin. At the same time, we continued to gather data for the other basins in the Eastern Arc, so that these are ready for use when the Sigi Basin model can be made to work. The hydrological team headed by Prof Felix Mtalo in Tanzania continued their work to expand simpler hydrological modelling to broader areas of the Eastern Arc, with work being undertaken by Dr Birhanu Zemadim and Mr Titus Safari.

Meetings have taken place between Cranfield and the valuation team at UEA to review expected model outputs and ways forward. A methodology for valuation has been developed in outline by Cranfield and UEA. A Tanzanian PhD student, Mr Aloyce Hepelwa, from University of Dar es Salaam, supervised by Dr Kassim Kulindwa, began collecting new data on household water use (domestic, irrigation and livestock) in the Sigi basin in 2008; we expect to collect further field data in 2009.

Timber. Dr Ruth Swetnam and Dr Neil Burgess, together with Jonathan Green and Prof Rogers Malimbwi and Prof Panteleo Munishi in Tanzania have georeferenced all available timber inventory data (more than 100 sample points). These data were used by the Tanzanian Masters student (Joseph Makero), and by a team of three Masters students at York University to look at issues of timber distribution and value in the study area.

Valuation studies of timber forest products commenced with the development of a model by Dr Sian Morse-Jones from University of East Anglia, and the application of that model to the available data by one of the Masters students in York. Field data collection is now being planned to fill gaps, in collaboration with WWF Tanzania. Market surveys and expert interviews are expected to commence in Feb/Mar 2009.

Non-timber. Dr Neil Burgess in the UK and Prof Seif Madoffe in Tanzania have compiled the available data on use of non-timber forest products in the Eastern Arc. This is being used as the basis of a masters student project in Tanzania, and was used for a bachelors project in Cambridge and a masters project at York University. Further data for this module, from the Ruvu Basin, was sourced through collaboration with IVM in the Netherlands, and MOUs for additional data-sharing are also being developed with three other projects that are actively collecting data in Tanzania. A PhD student at the University of Dar es Salaam (Aloyce Hepelwa) supervised by Dr Kassim Kulindwa is also collecting new data from the Sigi Basin.

Valuation of non-timber forest products has also commenced, with work being undertaken on charcoal (Bachelors students in Cambridge and UEA), through the work of the PhD student Mr Aloyce Hepelwa in Tanzania, and the synthesis of available data by Dr Sian Morse-Jones and Dr Brendan Fisher in UEA. Further data is being sourced through the development of collaborative MOUs, and by the planning of field work. Market surveys and expert interviews are expected to commence in Feb/Mar 2009.

Nature-based tourism. Dr Doug Yu and Mr Chris Kirkby in the UK worked with Dr Jafari Kidegesho in Tanzania to design a survey of visitor numbers and expenditure within the Eastern Arc Region. A Masters Student from Imperial College in the UK (Sana Okayasu) worked in Tanzania for 6 weeks collecting tourism data from across the Eastern Arc. This work forms the basis of a further Masters student's work, at Sokoine University in Tanzania.

Preliminary valuation of nature-based tourism has been carried out by the UK Masters student, and will be further assessed by a Tanzania Masters student during 2009.

Governance. The map of governance regimes across the area was updated by Dr Ruth Swetnam and Dr Neil Burgess. Dr Burgess has also worked on a related project on forest governance in Tanzania, and collaboration between Valuing the Arc and that project (funded by the Danish Government) is underway. One Tanzanian Masters student is working on forest governance in the Eastern Arc, and a second is planning their project work.

Pollination. Dr Taylor Ricketts (from WWF US) oversaw the collation of the available data on pollination into the InVEST GIS modelling tool. WWF US also funded an intern supervised by Prof Panteleo Munishi in Tanzania, who collected data on agricultural crops across all the wards in the Eastern Arc region.

Timetable – summary of activities and personnel in 2008

Item	Jan-Mar08	Apr-Jun08	Jul-Sep08	Oct-Dec08
Coordination				
MOU with KITE				
MOU with Nat Cap				
MOUs with carbon data providers				
Draft MOUs with NTFP and timber dataholders				
Programme coordinator (Cambridge)				
Programme GIS analyst (Cambridge)				
TZ Coordinator (WWF TZ)				
Theoretical Review				
Staff employed				
Case studies for book				
Conceptual paper				
Definitions paper				
Drafting of book for Earthscan				
Eastern Arc Case Study				
PhD student for biodiversity module (UK)				
Plant biodiversity pattern PhDs x2 (KITE)				
Biodiversity database (TZ)				
Biodiversity existence values (UK)				
Carbon Post doc (UK)				
Carbon PhD (UK)				
Carbon Masters (TZ)				
Hydrology Post Doc (UK)				
Hydrology PhD student 1 (TZ)				

Hydrology PhD student 2 (TZ)				
Timber data georeferenced (UK)				
Timber masters (TZ)				
Timber masters x 4 (UK)				
Non-timber Masters (UK)				
Non-timber Masters (TZ)				
Non-timber Bachelors x 3 (UK)				
Nature-based tourism Masters (UK)				
Nature-based tourism Masters (TZ)				
Governance mapping (UK)				
Governance Masters (TZ)				
Valuation staffing (UK)				
Valuation PhD (TZ)				
Overall Eastern Arc GIS database (UK)				
Landcover map prepared for region (UK and TZ)				
Socio-economic scenarios completed (TZ and UK)				
Climate change scenarios completed (KITE)				

As the above table shows, most of the work in 2008 has been on developing our conceptual understanding of ecosystem services, compiling existing data for the Eastern Arc, and initiating a supplementary programme of field data collection. Much of the biophysical data that the programme needs are now available and the main focus of the work will now increasingly shift to valuation studies, and modelling.

Plans for 2009

Part A – Theoretical Review. We will continue to augment the literature review of ecosystem services research. A textbook on the Ecosystem Services Approach is scheduled for completion during 2009. We will also continue to facilitate the integration of Part A methods and techniques within the fieldwork programme in Tanzania.

Overall goals. By the end of 2009 we will have concluded most of the conceptual work of this project, and will have written up a series of scientific papers. Attention will then be focused on text book and monograph bringing all these elements of work together.

Part B – Eastern Arc Case Study. The programme will continue with the work it has started in the UK and Tanzania.

Overall goals. By the end of 2009 we aim to have produced near-final biophysical models for most of our ecosystem services in Tanzania (some, such as carbon sequestration, will require updating with further field data). At the same time we will spend 2009 gathering data on the values of these services, and on the costs of biodiversity conservation in this region. These will also be made spatially explicit. In addition we will complete the work on mapping out our socio-economic and climate change scenarios so that we can explore how the delivery of services, biodiversity and economic values may change according to these alternative views of the future.

Detailed workplans have been developed and in broad terms these are as follows:

Cambridge – Zoology Department. We will continue to compile and integrate the GIS data on ecosystem services and biodiversity that will form the core of the field-based half of the programme's work. 2009 will also see a focus on developing spatially-explicit versions of our land-use change models, and on beginning to feed the resulting parameters into our service-specific models. Finally the Zoology team will continue to produce papers related to overall results of the programme, to coordinate the programme in Tanzania and the UK, and to maintain the collaborations with KITE and the Natural Capital Project.

Cambridge – Land Economy Department. Dr Kontoleon will conclude his contribution to the work on the existence values of biodiversity.

Cranfield. The hydrology team here will focus efforts on solving remaining challenges in SWAT modelling in Tanzania, and will provide hydrological models for the three focal Basins in the Eastern Arc. This will include substantive improvement to the SWAT model code. In collaboration with colleagues in Tanzania and in the Natural Capital Project, the group will also develop and implement a method for mapping hydrological flows across the entire study area.

University of East Anglia. The UEA economics team will continue with their theoretical review of the ecosystem services approach and finalise and publish a series of papers and contributions to books. As a major part of that, they will also continue working on a monograph on ecosystem services. Their contributions this year to the Eastern Arc work will include analysing data from the tourism Masters student in Tanzania, working on biodiversity existence values, gathering economic data on the values of water, timber and non-timber forest products, and completing work on socio-economic scenarios for the region.

York. The group in York will write a paper from the detailed work on forest sequestration plots and work with the PhD student in Leeds to develop a carbon storage layer for the Eastern Arc Mountains region. The VTA team at York will also collaborate with KITE over the completion of further scientific papers.

Leeds. The carbon group here will produce a carbon storage layer for the Eastern Arc Mountains Region, and will plan field work to re-measure the forests plots and thereby quantify carbon sequestration.

Dar es Salaam. One PhD student will continue his work on NTFPs and their valuation. A plan will be made on how to use the remaining money allocated to the second hydrological PhD student who did not complete his studies. The work on species-by-site matrices for the Eastern Arc's reptiles and mammals will be concluded. Senior staff will continue to have input to the development of the various service models and to scientific papers.

Sokoine University of Agriculture. Eight masters students will continue their work. Input of senior staff to developing models and writing papers will continue.

WWF Tanzania Programme Office. Work on linking programme results to the policy process will continue, with a particular focus on inputs to the development of a mechanism for REDD (Reduced Emissions from Deforestation and Degradation) payments in the country. A policy analysis document will be produced. Input will be provided to the emerging work on REDD in Tanzania being funded by the Norwegian Government. Links will also be maintained to the development of the new Forest Policy for Tanzania, and the implementation of the Water Policy and Water Act.

KITE programme. We will continue to implement the MOU with KITE, supporting the work of two PhD students and benefiting from the work that they are doing on plant biodiversity patterns, forest degradation patterns, and the impacts of climate change. Collaborative papers will be produced on these topics and on the impacts of degradation on forest carbon storage, fire patterns, and the harvesting of poles as building materials from the Eastern Arc forests.

Natural Capital Programme. We will continue to implement the MOU with Nat Cap, working with them to complete and publish the results of 'Tier 1' models of ecosystem services in the Eastern Arc Mountains as provided by their InVEST GIS mapping programme. Collaborative papers will be drafted and joint presentations will be made to international meetings.

Papers and other publications (full list)

2007

Fisher, B. and R.K., Turner. (2007), *Valuing the Arc: Applying Environmental Decision Making Methodology in Tanzania's Eastern Arc Mountains*, **Britain In 2008**, 14.

2008

Turner, R.K. and B. Fisher. (2008). To the Rich Man the Spoils. *Nature* 451, 1067-1068.

Naidoo, R., A. Balmford, R. Costanza, B. Fisher, R.E. Green, B. Lehner, T.R. Malcolm, and T.H. Ricketts. (2008) Global Mapping of Ecosystem Services and Conservation Priorities. *Proceedings of the National Academy of Sciences* 105 (28), 9495-9500.

Fisher, B. and R.K. Turner. (2008). Ecosystem Services: classification for valuation. *Biological Conservation* 141, 1167-1169.

Turner, R.K., S. Georgiou and B. Fisher. (2008). Valuing Ecosystem Services: The case of multifunctional wetlands. Earthscan Publishing, London. 229pg.

Blomley, T., Pfliegner, K, Isango, J., Zahabu, E., Ahrends, A. and N.D. Burgess. (2008). Seeing the wood for the trees: Towards an objective assessment of the impact

- of Participatory Forest Management on forest condition in Tanzania. *Oryx* 42, 380-392.
- Fisher, B. (2008). Review of *Ecology and Ecosystem Conservation* by Oswald Schmitz. *Oryx* 42, 155-156.
- Hess, S., P. van Beukering, G. Kayharara, V. Geoffrey, W. Haider. (2008). *Livelihoods in the Uluguru mountains of Tanzania: survey report and choice model*. Institute for Environmental Studies (IVM), Vrije Universiteit Amsterdam, The Netherlands
- Gunning, A. (2008). Bachelors project on the Non-Timber Forest Products of the Eastern Arc Mountains. Cambridge University.
- Leyland, A. (2008). Bachelors project on the management effectiveness of the reserves in the Eastern Arc Mountains. Cambridge University.
- Okayasu, S. (2008). Masters Project on tourism in the Eastern Arc Mountains. Imperial College of London.
- Jones, I. (2008). Masters project on the harvesting of poles from the Eastern Arc Mountains of Tanzania. York University.

In press

- Fisher, B., R.K. Turner and P. Morling. (2009) A systems approach to definitions and principles for ecosystem services. *Ecological Economics* 68, 643-653
- Turner, R.K. and B. Fisher. (in press) An ecosystem services approach: income inequality and poverty, in Salih, M. (ed) *Climate Change and sustainable development: new challenges and poverty reduction*, Edward Elgar: Cheltenham, in press
- Strassburg, B., R.K. Turner, B. Fisher, R. Schaeffer and A. Lovett, (in press) Reducing Emissions from Deforestation and Degradation (REDD) – a combined incentives mechanism and empirical simulations. *Global Environmental Change*.
- Marshall, A.R. (in press) Valuing the Arc: measuring and monitoring forest carbon for offsetting. In: Kareiva, P., Ricketts, T., Daily, G., Tallis, H., Polasky, S. (eds.) *The Theory and Practice of Ecosystem Service Valuation*. Oxford University Press, Oxford.
- Fisher, B., R.K. Turner and A. Balmford, R. Brouwer, R. Costanza, R. de Groot, S. Farber, P. Ferraro, R. Green, D. Hadley, J. Harlow, P. Jefferiss, C. Kirby, P. Morling, S. Mowatt, R. Naidoo, J. Paavola, B. Strassburg, D. Yu and M. Zylstra. (in press). Integrating Ecosystem Services and Economic Theory. *Ecological Applications*.

Fisher, B., A. Balmford, R.E. Green, R. Trevelyn. (in press). Conservation Science Training: the need for an extra dimension. *Oryx*.

Turner, R.K, T., Luisetti, and D. Hadley. (in press). Valuing coastal and marine ecosystem services, Proceedings of the CIESM Exploratory Workshop 37, in review

Turner, R.K. (in press), Valuing coastal zone natural capital. In: Kareiva, P., Ricketts, T., Daily, G., Tallis, H., Polasky, S. (eds.) *The Theory and Practice of Ecosystem Service Valuation*. Oxford University Press, Oxford.

Burgess, N.D., S. Madoffe and S. Mwakalila. (in press), Non-timber forest products. In: Kareiva, P., Ricketts, T., Daily, G., Tallis, H., Polasky, S. (eds.) *The Theory and Practice of Ecosystem Service Valuation*. Oxford University Press, Oxford.

Submitted

Balmford, A., A.S.L. Rodrigues, R.E. Green, B. Fisher, R. Naidoo, B. Strassburg, R.K. Turner. (submitted). Assessing the economic consequences of losing biodiversity and ecosystems. *Science*.

Bracebridge, C., R. Marchant, R.D. Swetnam and N.D. Burgess (submitted). Spatial and temporal fire distribution in Tanzania: relationships to year, land cover types and land management regimes. *African Journal of Ecology*

Hall, J., B., Mbilinyi, J.C. Lovett and N.D. Burgess. (submitted). 50 years of deforestation in the Eastern Arc Mountains of Tanzania : impacts on the extinction risk of endemic plants. *Biological Conservation*

Mwakalila, S., N.D. Burgess, T. Ricketts, N. Olwero, R. Swetnam, B. Mbilinyi, R. Marchant, F. Mtalo, S. White, P. Munishi, A. Marshall, R. Malimbwi, C. Smith, G. Jambiya, S. Madoffe, B. Fisher, G. Kajembe, S. Morse-Jones, K. Kulindwa, J. Green and A. Balmford. (submitted). Linking science with stakeholders to sustain natural capital. *The Arc Journal*

Morse-Jones, S., R.K. Turner and B. Fisher. (submitted). Ecosystem valuation: a sequential decision support system and quality assessment issue. *The Year in Ecological Economics*

Whitley, H. (submitted). Masters Project on the timber value chain in the Eastern Arc Mountains. York University.

Evans, T. (submitted). Masters Project on timber volumes across the Eastern Arc Mountains. York University.

Proctor, S. (submitted). Masters Project on the timber value chain in the Eastern Arc Mountains. York University.

Web Sites

The Valuing the Arc website (www.valuingthearc.org) has been developed to further disseminate the programme's findings.

Input has been made to the Natural Capital Project's website.
www.naturalcapitalproject.org/tanzania

Seminars where Valuing the Arc papers have been presented

Ruth Swetnam (Cambridge)

"Ecosystem services in the Eastern Arc Mountains of Tanzania". British Ecological Society Conference. London. Imperial College Invited talk in the special session on "Ecosystem Services". September 2008.

"Valuing ecosystem services in Tanzania." Cambridge Conservation Forum Annual Symposium. New Hall, Cambridge. January 2009.

"Valuation of ecosystem services in Tanzania: incorporating spatial and temporal dynamics of change." ESRC seminar series on coastal ecosystem services, invited talk. York University, January 2009.

Sian Morse-Jones (UEA)

"Ecosystem Valuation: A Sequential Decision Support System" at the Royal Statistical Society meeting "Evaluating our Environment: moving from a reductionist analysis to a holistic assessment of ecosystems" London, December 2008.

Andrew Balmford (Cambridge)

"Review on the economics of biodiversity loss: scoping the science". Ecosystem Services and Well-Being Seminar, University of Cambridge, UK. January 2008.

Brendan Fisher (UEA)

"Conservation and Economics: the best of times, the worst of times." Geography Department, University of Oxford. November 2008

"Conservation and Economics: good friends in crazy times." Land Economy, University of Cambridge. October 2008.

"Conservation, Ecosystem Services and Human Well-being: mapping tradeoffs in a biodiversity hotspot." Joint United States-China Consortium on Ecosystem Services (JUCCES), Beijing, China. October 2008.

"Ecosystem Services: linking welfare and conservation in Tanzania." Ecosystem Services and Well-Being Seminar, University of Cambridge, UK. January 2008.

"Social Science Tools for Conservation." Student Conference on Conservation Science, University of Cambridge, Cambridge UK. March 2008.

"Ecosystem Services and Biodiversity Conservation: understanding spatial relationships." International Society of Ecological Economic, Nairobi. August 2008.

"Ecosystem services in the Eastern Arc Mountains of Tanzania". British Ecological Society Conference. London. September 2008

Andrew Marshall (York)

"A holistic approach to conserving primates in the Udzungwa Mountains" - Given at Liverpool University (Guest Lecture to undergraduate course, Dept of Biosciences), University of York Environment Department (departmental seminar), British and Irish Association of Zoos and Aquaria Mammal Working Group meeting, Institute of Zoology (science in conservation seminar series).

Money raised

During 2008 we raised the following co-funding for the programme:

Cambridge University Miriam Rothschild PhD studentship for Jonathan Green, worth a total (including fees) of £70 000.

We also applied for additional funding to the NERC-ESRC and to the Finnish Embassy in Nairobi. The first was rejected and the second is still pending. We are also applying for support for capacity building to the Leverhulme - Royal Society Africa Award scheme.

