Impact case study (REF3b)

Institution: The University of Edinburgh

Unit of Assessment: B7 – Earth Systems and Environmental Sciences

Title of case study: ECONOMIC BENEFITS AND POLICY FORMATION RELATED TO MONITORING SUB-SAHARAN FOREST DEGRADATION

1. Summary of the impact

Impacts: I) Economic benefits derived from carbon credit and land-use schemes in sub-Saharan Africa. II) Multi-national developments in public-policy related to Reducing Emissions for Deforestation and Forest Degradation (REDD). III) Recommendation for launch by the European Space Agency (March 2013) of the first ever forest-specific monitoring mission.

Significance and reach: Public policy developments have occurred over the period 2011 - June 2013 in Malawi, Mozambique and Gabon. Increases of more than 20% in the level of rural employment pre and post 2008 have been documented for one project in Mozambique.

Underpinned by: Research into quantifying tropical forest biomass stocks and their degradation, undertaken at the University of Edinburgh (2004 onwards).

2. Underpinning research
Numbered references refer to research outputs in Section 3.

Key researchers
The start and end dates of continuous employment in the School of GeoSciences, University of Edinburgh, are shown along with the most recent / current position of each researcher.

Williams, Chair of Global Change Ecology (2000 onwards)
Grace, Professor (1970 – 2010; 2013 onwards)
Mencuccini, Professor of Forest Science (1997 onwards)
Woodhouse, Professor of Applied Earth Observation (1999 onwards)
Ryan, Lecturer (2009 onwards)
Mitchard, PhD student (2007-11) and NERC Fellow (2011 onwards)

Research overview and context
Forest degradation is recognised as a significant but poorly determined component of the global carbon cycle, such that without accurate mapping of degradation actions to preserve forest biomass (e.g. U.N. Reducing Emissions for Deforestation and Forest Degradation, or REDD) are inhibited. Through extensive forest plot networks and linked remote-sensing observations, research by the Edinburgh group (2004-present) has better quantified carbon stocks in a range of African environments, notably miombo woodlands and mangroves, which has led to production of the first digital maps of forest degradation with uncertainty estimates.

Key research findings that underpin the subsequent impact
In 2004, Grace, Williams and Ryan initiated a series of Permanent Sample Plots (PSP) in Mozambique to monitor biodiversity, forest structure and biomass, and soil carbon stocks **[1]**. Further plots were then established in Kenya (2007, Mencuccini) and Tanzania (2011, Williams, Ryan). These plot networks constitute the longest running and most extensive within the 2.7 M km^2 of southern African miombo woodland / mangroves. Experimental fire research on the vulnerability of stems in the miombo has been linked to a forest gap model, in order to characterise fire effects on biomass dynamics. Results from Mozambique, published in 2011, indicate that fire is a major driver of biomass loss in woodlands and that fire management to reduce intensity and likelihood of loss of large stems is a potentially viable method to enhance carbon stocks **[2]**. Field campaigns led by Mitchard between 2007-2012 in tropical forests in Cameroon, Uganda and Gabon set up and re-measured PSPs (including a plot in Uganda first measured in 1932), which revealed significant changes in vegetation structure. In 2009 Mitchard published the first study comparing

radar backscatter-biomass relationships across multiple sites in the tropics, showing significant similarity in the fit across four different forest-savanna boundary and woodland sites **[3]**. Mitchard also played a key role in a subsequent NASA-led study that produced a pan-tropical biomass map at an unprecedented 1 km resolution **[4]**. Work published by Ryan and the Edinburgh team in 2012 showed how radar data allows landscapes to be characterised for forest degradation **[5]**. Research involving Mencuccini has extended these techniques into mangrove ecosystems, which are notoriously difficult to restore after degradation, with a 2010 publication showing the positive impact of species diversity on mangrove ecosystem recovery following deforestation **[6]**.

3. References to the research
Comments in bold on individual outputs give information on the quality of the underpinning research and may include the number of citations (Scopus, up to September 2013) and/or the 2012 Thomson Reuters Journal Impact Factor (JIF). The starred outputs best indicate this quality.

[1]* Peer-reviewed journal article, 40 citations, JIF: 2.8
Williams M., Ryan, C. M., Rees, R. M., Sambane, E., Fernando, J., and Grace, J. (2008) 'Carbon sequestration and biodiversity of re-growing miombo woodlands in Mozambique', *Forest Ecology and Management* 254, 145–55, DOI: 10.1016/j.foreco.2007.07.033

[2] Peer-reviewed journal article, >10 citations, JIF: 5.1
Ryan, C.M., and Williams, M. (2011) 'How does fire intensity and frequency affect miombo woodland tree populations and biomass?', *Ecological Applications* 21, 48–60, DOI: 10.1890/09-1489.1

[3]* Peer-reviewed journal article, >30 citations, JIF: 4.0
Mitchard, E. T. A., Saatchi, S. S., Woodhouse, I. H., Nangendo, G., Ribeiro, N. S., Williams, M., Ryan, C. M., Lewis, S. L., Feldpausch, T. R., and Meir, P. (2009) 'Using satellite radar backscatter to predict above-ground woody biomass: A consistent relationship across four different African landscapes', *Geophysical Research Letters* 36, L23401, DOI: 10.1029/2009GL040692

[4] Peer-reviewed journal article by a NASA team with Mitchard, >100 citations, JIF: 9.7
Saatchi, S. S., Harris, N. L., Brown, S., Lefsky, M., Mitchard, E. T. A. , Salas, W., Zutta, B. R., Buermann, W., Lewis, S. L., Hagen, S., Petrova, S., White, L., Silman, M., and Morel, A. (2011) 'Benchmark map of forest carbon stocks in tropical regions across three continents', *Proceedings of the National Academy of Sciences* 10, DOI: 1073/pnas.1019576108

[5]* Peer-reviewed journal article, >10 citations in one year, JIF: 6.9
Ryan, C. M., Hill, T. C., Woollen, E., Ghee, C., Mitchard, E. T. A., Cassells, G., Grace, J., Woodhouse, I. H., and Williams, M. (2012) 'Quantifying small-scale deforestation and forest degradation in African woodlands using radar imagery', *Global Change Biology* 18, 243–57, DOI: 10.1111/j.1365-2486.2011.02551.x

[6] Peer-reviewed journal article, >10 citations, JIF: 2.9
Huxham, M., Kumaral, M., Jayatissa, L. P., Krauss, K. W., Kairo, J. G., Langat, J., Mencuccini, M., Skov, M. and Kirui, B. (2010) 'Intra and inter-specific facilitation in mangroves may increase resilience to climate change threats', *Proc. Phil. Trans. Roy. Soc. Lond. B* 365, 2127–35, DOI: 10.1098/rstb.2010.0094

A further metric of research quality is given by the peer-reviewed grants that have contributed to the preceding outputs, which include:
- *National Centre for Earth Observation, Carbon Theme* (2008-2013), sponsor: NERC, value: £400k, awarded to Williams.
- *GEOCARBON – Operational Carbon Observing System* (2011-2014), sponsor: EU FP7, value: €240k, awarded to Williams.
- *BIOMASS Level 2 Product to Flux* (2010-2011), sponsor: European Space Agency, value: €100k, awarded to Williams.

4. Details of the impact

Lettered references relate to corroboration sources in Section 5.

Economic benefits derived from carbon credit and land-use schemes

Pathway: The research team has been actively involved in advisory work with carbon and land-use certification schemes, as well as developing tailored research outputs for a range of end-user organisations. Ryan and Mitchard have advised, reviewed, and redrafted a land-use standard for the technical committee of the UK 'Plan Vivo Foundation' **[A]**. The work on fire in miombo woodlands has resulted in a Tanzanian partnership with the NGO Mpingo Conservation and Development Initiative (MCDI) and LTS International to develop a new Voluntary Carbon Standard for fire-prone tropical woodlands **[B]**. Research on the impacts of timber harvesting on Kenyan mangroves was instrumental in developing a new carbon offset payment scheme, launched in 2011 with funding from Aviva, as can be corroborated by their Head of Environment and Climate Change **[C]**. Finally, Mitchard has generated specific biomass and deforestation rate models for several African REDD projects over the period 2008 – July 2013.

Significance and reach:
- One of the development projects that uses the Plan Vivo standard to sell carbon credits, the Sofala community in Mozambique, occupied 1,500 farms and 100 km^2 of forest as of 2009 and has led to voluntary carbon market credit sales worth $1.3M over the period 2003 – 2009. Additional benefits include increases in rural employment and the fraction of households raising commercial crops (32% and 72% respectively in 2008, up from values of 8% and 23% when previously audited in 2004). All of these statistics are sourced from a 2010 Case-Report in the journal *Carbon Management* **[D]**.
- One of the projects for which Mitchard supplied biomass and deforestation data, the RSPB Gola Forest Project in Sierra Leone (data supplied in 2011), covers over 71,000 ha.

Formation of land-use / management policy

Pathway: Governments, NGOs and companies have made extensive direct use of the research outputs in developing land-use policies and strategies. Other pathways include: I) a sabbatical year (2010 - 2011) by Woodhouse that provided capacity building training in remote sensing techniques within the Governmental Forest Research Institute (GFRI) of Malawi, as corroborated by senior forestry research officials **[E]**, and II) Mitchard being an official member of Gabon's delegation to the COP15 UN Framework Convention on Climate Change meeting.

Significance and reach:
- A workshop and conference based on the research at the GFRI of Malawi (June 2011) led to a Policy Briefing to the Malawi Director of Forestry **[E,F]**.
- The research is cited in the following policy-relevant NGO reports: I) the 2010 International Institute for Environment and Development report on REDD in southern African woodlands **[G]** and II) the Observatory for the Forests of Central Africa report on *The Forests of the Congo Basin - State of the Forest 2008*.
- The Government of Mozambique uses the Edinburgh research as evidence in 2012 planning documents related to preparation of REDD strategies **[H]**.
- The biomass mapping informed the Gabonese Government in its policies and publications at COP meetings 2009 – 2011 and the countries land-use plan for 2013.
- In 2009, the research underpinned a POSTNote briefing for UK parliamentarians on the needs of African nations in REDD, the drivers of deforestation and possible solutions **[I]**.

Approval of the BIOMASS satellite mission

Pathway, significance and reach: Building on the radar derived research, the Edinburgh group have been key players in developing the BIOMASS satellite proposal (estimation of biomass stocks from space has only been possible at the coarsest levels), through the European Space Agency (ESA). In March 2013, ESA recommended BIOMASS for development and launch as one of three

Earth Explorer missions. The influence of the Edinburgh research in this decision is corroborated in the Report for Selection **[J]**. This is the first ever forest-specific monitoring mission, with a preliminary budget of €420M that will include large investments in satellite technologies.

5. Sources to corroborate the impact
Where two web-links are given, the first is the primary source and the second an archived version.

[A] List of members of Plan Vivo Technical Advisory Group (May 2010)
http://tinyurl.com/B7-5-S5-XA3 or http://tinyurl.com/B7-5-S5-A1 Provides evidence of the research-led expertise of Ryan and Mitchard contributing to the development of professional practice.

[B] International Co-ordinator for the Mpingo Conservation and Development Initiative
Can corroborate the role of Ryan and Williams in the Tanzanian partnership with MCDI and LTS International to develop a new Voluntary Carbon Standard for fire-prone tropical woodlands following the work on fire in miombo woodlands.

[C] Head of Environment & Climate Change at Aviva PLC
Can corroborate the funding by Aviva of the Kenyan offsetting scheme.

[D] *Carbon Management* **Case Report article on the Sofala project, Mozambique (2010)**
Grace J., Ryan C. M., Williams M., Powell P., Goodman L. and Tipper R., (2010) 'A pilot project to store carbon as biomass in African Woodlands', *Carbon Management* 1(2), 227-235, DOI: 10.4155/CMT.10.22, http://tinyurl.com/B7-5-S5-D Provides evidence of the quoted scope, credit sales and employment statistics for the Sofala project and the role of the Plan Vivo system.

[E] Senior Forestry Research Officer, Forest Research Institute of Malawi
Can provide corroboration of the research-led training and capacity building delivered by Woodhouse and the influence of the Edinburgh research on the June 2011 Workshop.

[F] Documents from the Forest Governance Learning Group (FGLG), Malawi (2011)
I) FGLG Narrative Report 2011 http://tinyurl.com/B7-5-S5-XFA or http://tinyurl.com/B7-5-S5-FA Provide evidences of the June 2011 workshop and the policy briefing paper produced (Pages 10-11) and the briefing of members of the Department of Forestry, achieved through II) Malawi Policy Brief No. 4. "Channelling REDD+ finance toward sustainable rural livelihoods in Malawi" (July 2011) http://tinyurl.com/B7-5-S5-XFB or http://tinyurl.com/B7-5-S5-FB.

[G] 2010 report by the International Institute for Environment and Development (IIED)
REDD+ in dryland forests: Issues and prospects for pro-poor REDD in the miombo woodands of southern Africa, Bond, I. et al., (2010), Natural Resource Issues No. 21, IIED, London, http://tinyurl.com/B7-5-S5-XG or http://tinyurl.com/B7-5-S5-G Provides evidence of the use of the Mozambique case study (Page 26) and other Edinburgh research (Pages 7, 76-80) in an international NGO report designed to influence environmental and development policy.

[H] Readiness Preparation Proposal (R-PP) for REDD, Government of Mozambique (2012)
http://tinyurl.com/B7-5-S5-XH or http://tinyurl.com/B7-5-S5-H Provides evidence of citation of research output [2], Section 3 (Page 129) and other aspects of the Edinburgh research (Page 60,68,122,133) in the Gov. of Mozambique's REDD strategy preparation.

[I] "Deforestation", POSTNOTE Number 344 (2009), Parliamentary Office of Science and Technology, London http://tinyurl.com/B7-5-S5-XI1 or http://tinyurl.com/B7-5-S5-I
Ryan's preparation of the briefing is acknowledged at the end of this policy briefing document.

[J] Report for Selection: BIOMASS satellite mission, European Space Agency (May 2012)
http://tinyurl.com/B7-5-S5-XJ2 or http://tinyurl.com/B7-5-S5-J corroborates that Williams was a member of the Mission Advisory Group (page 4) and the citation of research outputs [4,5], Section 3 (e.g. Pages 24, 27, 28, 30, 36, 144) in the scientific basis for mission selection.