Institution:

University of Leeds

Unit of Assessment:

7, Earth Systems and Environmental Sciences

Title of case study:

Case study 3: Forest-climate research has resulted in improved forest management

1. Summary of the impact (indicative maximum 100 words)

We conducted research on the impact of land-use change that has resulted in international action to improve forest management. Our research demonstrated that clearing forests to grow crops for biofuels leads to large carbon emissions. In light of these findings, the UK Government amended its biofuel policy to include mandatory sustainability criteria. Leeds researchers co-established with a number of businesses the charity United Bank of Carbon, resulting in the investment of £1.5 million and the protection of 200,000 hectares of forest. Our research underpinned a forest-based climate mitigation scheme resulting in the investment of an additional £440k in forest protection.

2. Underpinning research (indicative maximum 500 words)

The world's forests influence climate through a complex set of physical, biological and chemical processes that affect the planet's energy balance, atmospheric composition and hydrological cycle. In turn, climate change impacts upon forests leading to interlinked interactions and feedbacks between forests and climate. **Dominick Spracklen** has led research to improve the understanding of these processes, and this research has subsequently allowed a land-use policy to be crafted that effectively mitigates climate change.

Whilst there are numerous observations of carbon storage in lowland tropical forests, observations in tropical mountain ecosystems are limited. In 2005, a project led by **Spracklen** reported some of the first observations of carbon storage and sequestration in tropical mountain forests in Ecuador **[1]**. This involved direct measurement of trees in Ecuadorian forests and subsequent accurate estimation of total biomass, upon which the calculations were based.

In 2007, **Spracklen** co-authored a study in *Science* contrasting the carbon mitigation potential of using land to grow crops for liquid biofuels against protecting and restoring forests **[2]**. The paper demonstrated that the carbon sequestered by protecting and restoring forests is considerably greater than the carbon emissions avoided through the use of liquid biofuels. The paper was the first to highlight the large land-use carbon emissions that result if forests are cleared to make way for biofuel crops. In 2008, **Spracklen** was the lead author of a policy review of the impacts of forest management on climate mitigation **[3]**.

The research also aimed to quantify the non-carbon effects of forests on climate. Previous studies concluded that boreal forests (those at high latitudes) warm the climate due to absorption of the Sun's heat by the dark forest canopy but ignored the impacts of forests on atmospheric aerosol. In 2008, Leeds researchers **Spracklen** and Kenneth Carslaw (Lecturer 1999-2006 and Professor 2006-present of Atmospheric Science in the School of Earth and Environment) led a study that used a global atmospheric model to show that through emission of organic vapours boreal forests double regional cloud condensation nuclei concentrations, increasing cloud reflectivity and causing a strong cooling impact on climate **[4]**.

Climate change will also impact forest ecosystems. In 2009, **Spracklen** led a project that calculated that climate change over the period 2000 to 2050 is likely to cause a 50% increase in forest wild fire across the western United States **[5]**. The research was based upon historical data on the relationship between weather patterns and forest fires, and the predicted weather patterns that are likely to arise as climate change proceeds.

In 2012, Leeds researchers **Spracklen** and Stephen Arnold (Lecturer 2003-2011, Senior Lecturer 2011-2013 and Associate Professor 2013-present of Atmospheric Composition in the School of Earth and Environment) used satellite observations of tropical rainfall and a model of atmospheric

air flow patterns to demonstrate that forests substantially increase downwind rainfall **[6]**. This was the first study to use observations to demonstrate this effect at the pan-tropical scale.

Key researcher:

Dominick Spracklen, Research Fellow (2005-2008); NERC Advanced Research Fellow (2008-2012) and Associate Professor of Biosphere, Aerosol and Climate (2012-present) in the School of Earth and Environment, University of Leeds.

3. References to the research (indicative maximum of six references)

1. **Spracklen**, D.V. *et al*. (2005). *Carbon storage and sequestration in tropical montane forests of Southern Ecuador*, World Land Trust Technical Report.

   Paper reporting carbon storage in tropical montane forests in Southern Ecuador.

2. Righelato, R. and **Spracklen**, D.V. (2007) Carbon Mitigation by biofuels or by saving and restoring forests?, *Science*, **317**, 902. DOI: 10.1126/science.1141361.

   Paper was the first to highlight the substantial land-use carbon emissions that occur if forests or other natural ecosystems are cleared to make way for biofuel cultivation.

3. **Spracklen**, D.V., Yaron, G., Singh, T., Righelato, R., Sweetman, T., and Caldecott, B. (2008). *The Root of the Matter: Carbon sequestration in forests and peatlands*, Policy Exchange.

   This is a policy review of the impacts of forest management on climate mitigation. Available at http://www.policyexchange.org.uk/publications/category/item/the-root-of-the-matter?category_id=24

4. **Spracklen**, D.V., Carslaw, K.S. and Bonn, B. (2008) Boreal Forests, Aerosols and the Impacts on Clouds and Climate, *Philosophical Transactions of the Royal Society A*, **366**, 4613-4626. DOI: 10.1098/rsta.2008.0201.

   Paper challenges the notion that boreal forests lead to a warming of climate.

5. **Spracklen**, D.V.**,** Mickley, L.J., Logan, J.A., Hudman, R.C., Yevich, R., Flannigan, M.D. and Westerling, A.L. (2009) Impacts of climate change from 2000 to 2050 on wildfire activity and carbonaceous aerosol concentrations in the western United States, *Journal of Geophysical Research D: Atmospheres*, **114**, D20301. DOI: 10.1029/2008JD010966.

   Paper was the first to quantify the impacts of future climate change on wildfire and aerosol air quality over the United States.

6. **Spracklen**, D.V., Arnold, S.R. and Taylor, C., (2012) Observations of increased tropical rainfall preceded by air passage over forests, *Nature* **489**, 282-285. DOI: 10.1038/nature11390.

4. Details of the impact (indicative maximum 750 words)

Research conducted in Leeds has had an impact on environmental and government policy and has led to improved management of the world's forests. The research provided critical knowledge that enabled the establishment of forest climate mitigation schemes, has facilitated private sector philanthropy and has provided an influential impact that altered the UK Government's biofuel policy.

Forest climate mitigation impact

The research that quantified carbon storage in tropical mountain forests **[1]** enabled the World Land Trust (WLT) to establish a forestry-based climate mitigation scheme **[A]**. Over the period 2006 to 2010, the scheme has resulted in the investment of over £440k in forest protection and reforestation activities across Ecuador **[B]**.

To ensure impact from the research, the University of Leeds co-established the United Bank of Carbon (UBoC, www.unitedbankofcarbon.com). Originally a partnership between the University of Leeds, the Bettys and Taylors Group and Deloitte LLP, UBoC is now a registered charity (1133285) that brings together business, non-governmental organisations and academia to support climate change mitigation through protection of the world's forests and their peoples. The role of the University of Leeds is to provide underpinning scientific rigour to the charity's activities based on a sound foundation of academic research in climate change and climate mitigation **[C,D]**. In

collaboration with over 40 national and international non-governmental organisations, UBoC has established a database of forest protection projects, which is used to match UK businesses to forest protection projects. Researchers at Leeds support a detailed assessment of these projects against community, climate and biodiversity criteria. This thorough academic assessment lends confidence to private sector investment in forest protection **[D]**. In its first two years (2009-2011), UBoC worked with more than 20 UK businesses to bring about the investment of £1.5 million in forest protection, resulting in improved management of over 200,000 hectares of rainforest in Tanzania, Peru, Malawi, Kenya, Uganda and India resulting in avoided emissions of at least 620,000 tonnes of carbon dioxide **[C]**. The charity has also achieved notable successes and awards in the UK including the Yorkshire Pride 2011 award for the most meaningful philanthropic initiative by a business, organisation or leader. Collaboration with UBoC has resulted in demonstrable benefits to UK companies: Deloitte LLP was ranked 16th in 2012 Sunday Times Best companies to work for with a top 10 result for environmental protection which was directly attributed by the newspaper to the company's work to preserve Tanzanian rainforest, which is being done in collaboration with UBoC **[E]**.

Biofuel Policy Impact

The underpinning research has impacted UK biofuel policy. After the paper in Science **[2]** was published, **Spracklen** was invited to provide expert advice to the House of Commons Environmental Audit Committee in 2007, where he argued that UK biofuels policy needs to account for land-use change emissions from biofuel production. The report on this session of the committee concluded that "*The stimulation of biofuels production by the Government and EU is reckless in the absence of effective mechanisms to prevent the destruction of carbon sinks internationally. The Government must ensure that carbon sinks are effectively protected before providing incentives for the use of biofuels*" **[F]**. In 2008, **Spracklen** was invited by the think-tank Policy Exchange to write a policy report detailing land use emissions from biofuels **[3]**. Media coverage of these reports **[2,3]** was extensive (including BBC, Guardian, Telegraph, New Scientist) and helped disseminate findings of the research and contributed to wider public awareness of the issue. In 2009, **Spracklen** and Policy Exchange submitted joint written evidence to the Environmental Audit Committee on deforestation. The Leeds-led research influenced policy debates of the sustainability of biofuels within the United Nations, the Food and Agriculture Organisation and the United Nations Environment Programme documented in a range of publications and reports **[G,H]**. In total, research by **Spracklen [2,3]** was cited by over 250 policy relevant publications. The above research evidence and debate contributed to a decision in December 2011 by the UK Government to amend the Renewable Transport Fuel Obligation (RTFO) to include mandatory sustainability criteria which would for the first time address carbon emissions from land-use change **[I].** Under the amendment, fuel suppliers must account for land-use change emissions and be able to demonstrate that cultivation of biofuel feedstocks do not damage areas with high carbon stocks. This policy amendment will ensure that biofuel use in the UK does not result in the clearance of natural forests and grasslands worldwide.

5. Sources to corroborate the impact (indicative maximum of 10 references)

Letters **[C]**, **[D]** and **[I]** are on file and are available upon request.

A. World Land Trust Restoration Ecology Annual Report 2007. Report demonstrates clear link to research carried out at the School of Earth and Environment at the University of Leeds and details investment in forest carbon mitigation in 2007 (page 8). Available at http://www.worldlandtrust.org/documents/2007-eco-services-annual-report.pdf and on request.

B. World Land Trust Restoration Ecology Annual Report 2010. Report details investment in forest carbon mitigation in up to and including 2010 (page 11). Available at http://www.worldlandtrust.org/documents/2010-eco-services-annual-report.pdf and on request.

C. Letter from the United Bank of Carbon. Letter confirms role of University of Leeds researchers within the United Bank of Carbon (Dated 27/02/2013). Available on request.

D. Letter from Bettys and Taylors of Harrogate. Letter confirms the role of University of Leeds researchers lends confidence to private sector investment in UBoC (Dated 01/03/2013). Available on request.

E. Web article confirms that Deloitte's high ranking in the 2012 Sunday Times 'best companies to work for' league table was in part attributed to the company's work to preserve rainforest in Tanzania (which is being done through the UBoC). Available at http://www.bestcompanies.co.uk/more_information.aspx?CompanyID=49947&SurveyID=93 and on request.

F. Report from the House of Commons, Environmental Audit Committee, *Are biofuels sustainable?* Published 15 January 2008 (page 18). Available at http://www.publications.parliament.uk/pa/cm200708/cmselect/cmenvaud/76/76.pdf and on request.

G. *Towards Sustainable Use and Production of Resources: Assessing Biofuels*, United Nations Environment Programme, 2009 (page 77). Available at http://www.unep.org/pdf/Assessing_Biofuels-full_report-Web.pdf and on request.

H. *FAO (Food & Agriculture Organization of the United Nations), Bioenergy policy, markets and trade and food security*, Technical Background Document (page 7). Available at ftp://ftp.fao.org/docrep/fao/meeting/013/ai788e.pdf and on request.

I. Letter from Chairman of the Environmental Audit Committee "Are biofuels sustainable?" and Chair of the Energy and Climate Change Select Committee. The letter confirms the impact of research by Spracklen on the Environmental Audit Committee inquiry "Are biofuels sustainable?" and subsequently on Government biofuel policy (Dated 24/05/2013). Available on request.