Land use, Bioenergy, Forestry, Mitigation

Around 40% of carbon dioxide emissions over the last two centuries have originated from changes in land use and land management, primarily from deforestation, where the land has been converted for agricultural use. However, as well as being a source of carbon dioxide, terrestrial ecosystems have acted as a sink for about a third of cumulative historical CO_2 emissions (energy plus land use). Thus there is scope for the land biosphere to play a significant role in climate mitigation through reduced emissions from deforestation and degradation (REDD), forest management and afforestation. Once a forest reaches maturity it stops taking up carbon, but production of biomass for energy enables the ongoing use of land to offset fossil fuel emissions in the future.

Science Highlights

- Complex interactions between the economy, land availability and the environment were used to assess the impacts of forestry and bioenergy mitigation scenarios.
- Detailed national forest carbon balances and assessment of mitigation potential informed UNFCCC (United Nations Framework Convention on Climate Change) negotiations. The methodologies have been used by the European Union and the Forestry Commission.
- Forest conservation and management projects established by QUEST demonstrate opportunities and barriers under the Kyoto Joint Implementation mechanism. Novel methodologies and indicators were developed for assessing social and environmental impacts and benefits.
- An analysis commissioned by DECC shows that uncertainties in land use change emissions are not as high as estimated in the IPCC fourth assessment report. Yet the uncertainty does have implications for meeting climate mitigation targets, and is more important for near term target setting than carbon-cycle uncertainty.

Picture 1: Joint Implementation project field trip to logging sites in Archangelsk, Russia. Photo shows an oldgrowth intact forest, concession of Svetloserskle. Photo: Martin Burian

Joint Implementation Forest Projects

- The potential for forestry-based mitigation projects under Joint Implementation (JI) in Europe and the Russian Federation is 40 Gt CO_2-equivalent for afforestation and reforestation and 100 Gt CO_2-equivalent for forest conservation and management. Countries with major opportunities to host JI forestry projects include the Russian Federation, Poland, Ukraine and Romania.
- A review of existing approaches and frameworks highlighted that while there is broad agreement on general principles and criteria, little guidance exists on specific methodologies and indicators for assessing environmental and social impacts of JI projects. Existing standards often lack a requirement for monitoring and verifying such impacts. Yet these would encourage project developers, managers and funders to pay more attention to the social, economic and environmental co-benefits of forestry-based carbon mitigation projects.
- Through establishing real forest projects, QUEST was able to demonstrate robust carbon accounting methods. Novel methodologies and indicators were developed for assessing social and environmental impacts and potential benefits. The methodology has been adopted by the UK Forestry Commission for its Forest Carbon Code.
- QUEST developed a carbon revenue tool to help project developers decide what type of accounting scheme to adopt.

Projects Involved

QUATERMASS (Quantifying the potential of terrestrial biomass to mitigate climate change),
JIFor (Joint Implementation initiative for forestry-based climate mitigation)

Publications

A full listing of QUEST research publications is constantly being updated by the QUEST synthesis team at the University of Bristol. Contact quest-info@bristol.ac.uk for more information.

Cherubini F, Bird ND, et al. (2009) "Energy- and greenhouse gas-based LCA of biofuel and bioenergy systems: Key issues, ranges and recommendations." *Resources Conservation and Recycling* 53(8): 434-447.

House JI (2009) Emissions from LULUCF (Land use, land use change and forestry): Implications of uncertainty for policy targets. *AVOID Report 2* [AV/WS2/D1/R02] 37 pp.

Read DJ, Freer-Smith PH, Morison JIL, Hanley N, West CC and Snowdon P (eds.) (2009). Combating climate change – a role for UK forests. An assessment of the potential of the UK's trees and woodlands to mitigate and adapt to climate change. *The Stationery Office*, Edinburgh.

Smith P, Gregory PJ , van Vuuren D, Obersteiner M, Havlik P, Rounsevell M, Woods J, Stehfest E, and Bellarby J (2010), Competition for land. *Philosophical Transactions of the Royal Society B-Biological Sciences*, 365(1554), 2941-2957.

QUEST Policy Briefing: The potential for forestry-based climate change mitigation projects under Joint Implementation in Europe and the Russian Federation.

JIFor forest project methodologies are approved and available on the QUEST web site: http://quest.bris.ac.uk

Forestry Commission Forest Carbon Code: http://www.forestry.gov.uk/carboncode

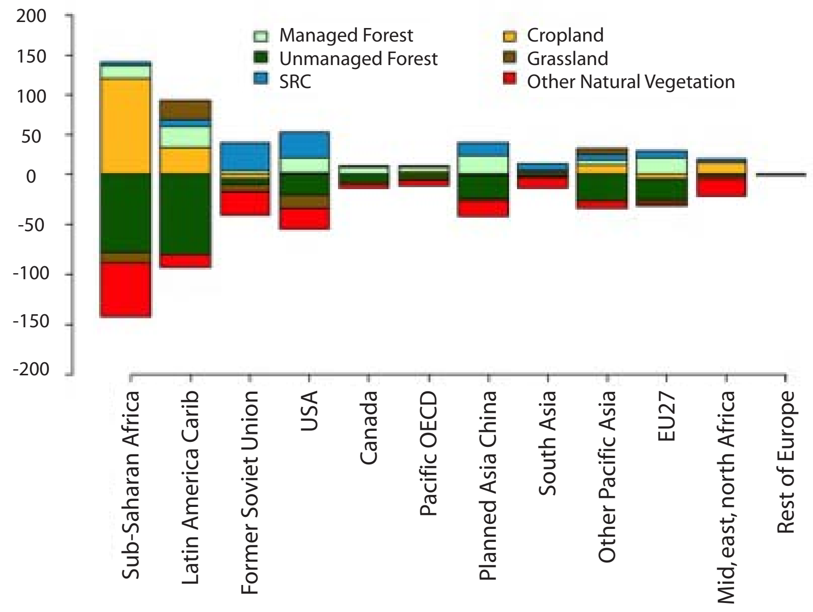
GLOBIOM: www.globiom.org

QUEST Quantifying and Understanding the Earth System

NATURAL ENVIRONMENT RESEARCH COUNCIL

Bioenergy and Competition for Land

- Assessments of the potential for bioenergy and forest activities in the past have relied on estimating "available" land and calculating the potential of activities on this land. As a result of extensive consultation with policy and other user communites, QUEST used an approach that assumes all land is providing some kind of service. It presumes that one type of land use change does not happen in isolation of other changes (e.g. using land for bioenergy may displace agricultural activities onto forest land). Case studies provided information on the realistic potential, environmental and socio-economic impacts and barriers to implementation.



- Land availability is a critical issue. According to the European Commission's POLES scenarios, the global population is predicted to increase by 1.4 billion by 2030, meaning that the demand for bioenergy, heat and electricity will double from 19 to 42 EJ. To meet the demand for food, feed and bioenergy, areas of cropland and short rotation coppice are projected to expand into unmanaged forest (Figure 1). If production of liquid biofuels for transport is increased from 0.5 to 9 EJ, an additional 22% of land will be required.

Figure 1 (above). Cumulative change in land cover of various regions from 2010 to 2030 to meet demand for food, feed and bioenergy. Most of the change shown by the model occurs in sub-Saharan Africa, driven by population growth. From the POLES scenario, implemented in the GLOBIOM model.

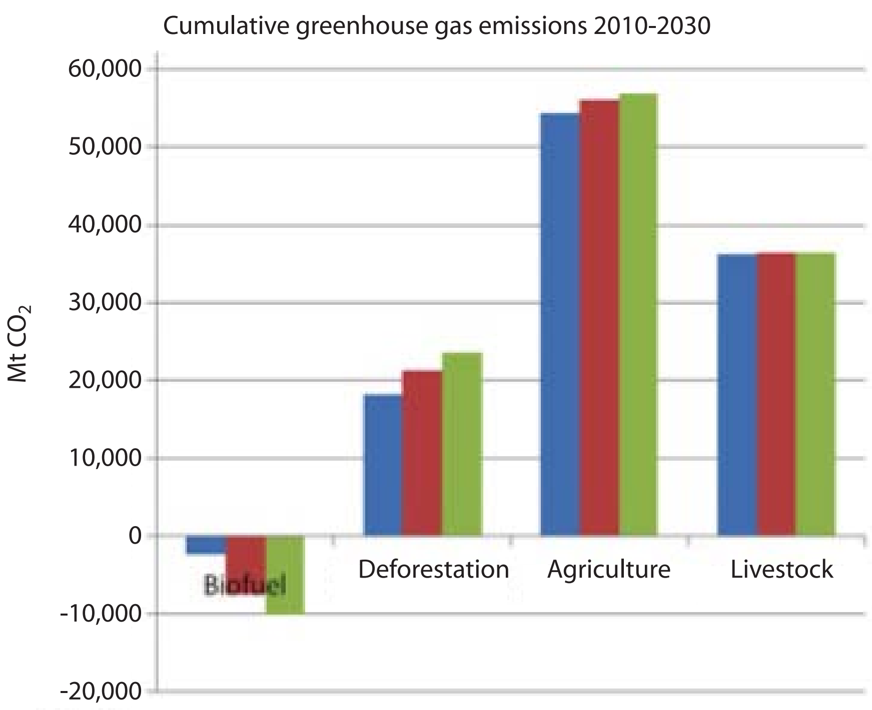


Figure 2. Cumulative greenhouse gas emissions and savings in different sectors from 2010 to 2030. The graph shows the effects of different levels of total bioenergy and additional biofuel (liquid fuel for transport) production, based on the POLES scenario, implemented in the GLOBIOM model.

- By progressively reducing deforestation rates to 10% of their current levels by 2030, we can protect 135 Mha of forest, with land use change shifting to grasslands and other natural vegetation. It is more beneficial not to assess "available land" but rather the implications of different land use change (LUC) on different land types. All land provides some kind of ecosystem service.

- Increasing bioenergy production leads to greenhouse gas savings in the energy sector. When increased bioenergy *causes* deforestation there are net CO_2 emissions in the short term (Figure 2). However, if increases in bioenergy happen *through* deforestation, , the net effect is that emissions rise (short term balance shown in Figure 2). Where deforestation occurs, the net greenhouse gas balance remains adverse for the medium term.

Forest Mitigation Potential Kyoto Accounting

- Under the UNFCCC, countries report their emissions from Land Use, Land Use Change and Forestry (LULUCF). QUEST demonstrated the importance of accounting for forest age class structure when estimating both the potential for forest activities and for setting baselines against which to measure new activities (Figure 3). This analysis was carried out for all Annex I countries at the request of DECC, to inform negotiations at Copenhagen. UK results contributed to the Forestry Commission's report 'Combating Climate Change - a role for UK forests'.

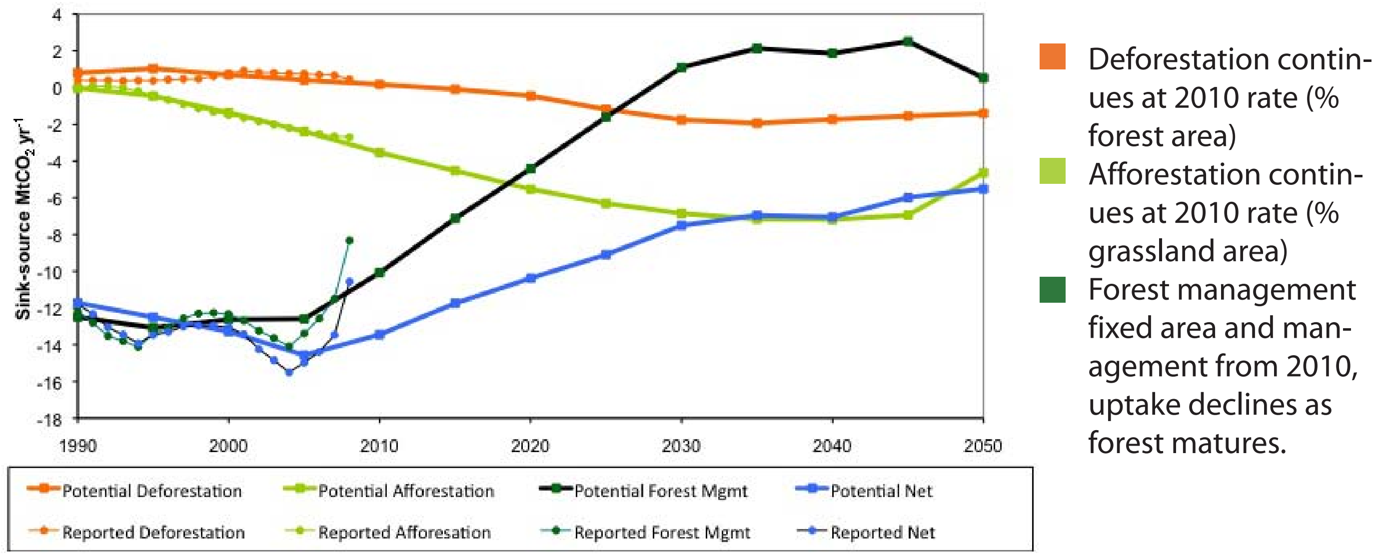


Figure 3. Carbon fluxes due to Land Use, Land Use Change and Forestry (LULUCF) activities in the UK, as reported to the UNFCCC and projected using the CARBINE forest model.

Picture 2. This photo was taken on a field trip to logging sites in the Dvinsky forest, Archangelsk, Russia. It shows the chess-like clear cut logging approach used here. This is where one of the QUEST JIFor climate projects sets aside a 69,500ha concession for as a 'Climate Protection Concession'.

Photo: Martin Burian