THE ROYAL SOCIETY

The role of land carbon sinks in mitigating global climate change

Summary

- As evidence for the link between atmospheric greenhouse gases and climate change has increased, international efforts have focused on ways in which anthropogenic emissions of greenhouse gases, particularly carbon dioxide (CO_2), can be reduced. Knowledge that CO_2 is stored within and exchanged between the atmosphere and vegetation and soils has led to the suggestion that soils and vegetation could be managed to increase their uptake and storage of CO_2, and thus become 'land carbon sinks'. Under the terms of the 1997 Kyoto Protocol, signatories can meet part of their obligations to reduce greenhouse gas emissions from fossil fuel consumption by increasing these land carbon sinks. However there have been concerns about the permanence of land carbon sinks and the accuracy with which they can be quantified and verified. This report focuses on the scientific issues underpinning land carbon sinks, particularly in the context of their inclusion in the Kyoto Protocol.

- Terrestrial vegetation and soils are currently absorbing approximately 40% of global CO_2 emissions from human activities. Changes in agricultural and forestry practices and slowing deforestation could increase this, potentially achieving a maximum of 25% of the reductions in CO_2 that are projected to be required globally by 2050 to avoid large increases in temperature. This would however require considerable political will and there is little potential for increasing the land carbon sink thereafter.

- Given that land use changes can make a contribution to reducing greenhouse gases, at least in the short term, we recommend that methods used in the production of forest and agricultural crops should be modified to reflect their potential role in increasing the global land carbon sink. Reform of the European Union's Common Agricultural Policy provides one opportunity to achieve this on agricultural land in Europe. Steps should be taken to ensure that these management changes, along with efforts to reduce deforestation, are compatible with other goals for sustainable development.

- The impact of many management practices on emissions of other trace greenhouse gases such as methane and nitrous oxide is poorly understood and is a priority area for research. Until it is possible to calculate full trace gas inventories we recommend that land carbon sink projects likely to result in significant emissions of trace gases (e.g. the large-scale use of nitrogen-based fertilisers) be avoided.

- There is considerable uncertainty associated with the estimates derived using the techniques that will be required to monitor, quantify and verify land carbon sinks established under the Kyoto Protocol. There is an urgent need to increase the accuracy of these techniques before land carbon sinks are utilised to any significant extent.

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- The permanence of the land carbon sink is uncertain with climate models projecting that future warming could cause its magnitude to increase less rapidly, saturate or even be converted to a source of CO_2 later this century. A greater understanding of the interactions between vegetation, soils and climate that underpin these models is urgently required to improve the accuracy of projections of both future climate change and the permanence of the land carbon sink.

- **There is still considerable uncertainty in the scientific understanding of the causes, magnitude and permanence of the land carbon sink. However, our current knowledge indicates that the potential to enhance the land carbon sink through changes in land management practices is finite in size and duration. The amount of CO_2 that can be sequestered in these sinks is small in comparison to the ever-increasing global emissions of greenhouse gases. Projects designed to enhance land carbon sinks must therefore not be allowed to divert financial and political resources away from the restructuring of energy generation and use (e.g. increased use of renewable energy), technological innovation (e.g. increased fuel efficiency, sequestration of CO_2 at source) and technology transfer to less developed countries. It is these that must provide the ultimate solution to the problem of reducing the concentration of greenhouse gases in the atmosphere.**

The full report examines some of the scientific issues underpinning land carbon sinks including the size of existing land carbon sinks and some of the changes in forestry and agricultural practices that could be used to increase the uptake of carbon dioxide by the land. The accuracy of the techniques that would be used to monitor land carbon sinks have been reviewed together with the evidence relating to the permanence of land carbon sinks under future scenarios of climate change.

Further copies of this summary and the full report are available from the Royal Society free of charge and can also be found at www.royalsoc.ac.uk/policy/.

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