



Ecosystem Services from Managed Landscapes





Introduction

Natural, semi-natural and agricultural landscapes provide a range of ecosystem services, firstly and most obviously for the provision of food, water, fibre, fuel and timber among other products. But beyond this, these systems provide recreational and cultural services such as parklands, nature reserves and the protection of rural livelihoods. Many landscapes also regulate and support environmental services such as water conservation, climate regulation, carbon storage, energy production, nutrient and waste recycling and biodiversity regulation (Idol et al., 2011).

Climate change and biodiversity loss are two of the biggest global challenges in the coming decades, primarily due to their impacts on the provision of ecosystem services. There is an urgent need to find ways both to meet immediate and growing demand for food while managing global biodiversity to assure our capacity to respond to climate and other environmental change. The Natural Resources Institute (NRI) has experience and the capacity to lead and conduct research on the processes that support a range of these ecosystem services, how management and policies affects their provision, and the value they provide to society.

NRI has worked for many years with rural communities who rely on the land for their livelihoods, also advising policy makers and development programmes to help ensure that natural resources are managed and protected for the benefit of future generations and for society as a whole. Integrated natural

and social science expertise is required to facilitate processes of exploring the impacts, costs and benefits of decisions with the multiple and often very diverse stakeholders involved and affected. The multidisciplinary expertise of NRI has been crucial to expanding our global knowledge about ecosystem services and their management for sustaining and improving our growing population's livelihoods while protecting the natural world.

NRI has capacity and experience in the following specific fields:

- Biodiversity services
- Plant biodiversity
- Regulation of pest populations
- Pollination services
- Climate change mitigation
- Farmer decision making and environmental policy
- Payment for ecosystem services.

Biodiversity services

Plant biodiversity provides a resource for multiple production and environmental service objectives (Haggar et al., 1998). Plants are the powerhouses of both natural and agro-ecosystems: they are the primary providers of provisioning services for humanity but also the rest of life. Researchers at NRI have studied how the botanical diversity and structure of an ecosystem to a large extent determines the services; both the immediate products and the external environmental services provided to society (Haggar et al., submitted). Producers then manage these resources for multiple ends, modifying

production systems to meet ecological conditions and production objectives (Hagggar et al., 2004).

Faunal diversity can serve as an indicator of ecosystem health, such as the balance between native and pest rodent species and their role in regulating plant dynamics and productivity. The incidence of pest species, whether rodents or insects, is regulated through predation, antagonism or just competition with other species. The natural regulation of agronomic pests is an important environmental service. There is also a feedback between agronomic management and these services. Integrated pest management strategies aim to achieve a rational minimal use of pesticides to promote processes of natural regulation while also sustaining general faunal and floral diversity which generate other services vital for food production such as pollination. NRI has contributed to the development and implementation of integrated pest management systems in agriculture in Europe and across the developing world which aim to sustain food production while protecting human and environmental health.

Pollination is an essential service on which the yields of many economically important crops depend. The factors influencing effectiveness and efficiency of pollination are varied and include both the biology of the pollinating plants and the physiology and behaviour of the insects. NRI is active in major projects with national and international partners in both areas of research. For example, in

collaboration with Trinity College Dublin and Newcastle University, NRI is investigating the chemistry of *Rhododendron ponticum*, an invasive insect-pollinated plant that produces toxic nectar, to identify and quantify toxins in the nectar in order to explore how this might influence the plant's invasiveness and its impact on native pollinators.

NRI scientists are also collaborating on an insect pollinator initiative project with the Biotechnology and Biological Sciences Research Council and the Department for Environment, Food and Rural Affairs. This asks whether UK agricultural and natural landscapes are sufficiently diverse to meet bees' nutritional needs, how toxins in nectar affect pollinator success or failure, and how these factors relate to recent dramatic pollinator declines in the UK. In addition, researchers at NRI have proven expertise in the behaviour and sensory ecology of pollinating insects, including the influence of flower colour on pollinator preferences and its involvement in floral assemblages in natural landscapes (Arnold et al., 2009; Arnold et al., 2010; Dyer et al., 2006).

Mitigation of climate change

Ecosystems may contribute to, regulate or mitigate greenhouse gas emissions, in many cases depending on their management and resource dynamics. Research has been conducted on tree crop production systems, quantifying carbon stocks (Hagggar et al., submitted), the dynamics of soil and above-ground carbon, and establishing the effects of management on carbon balance (Nonponen et al.,

submitted). This ecosystem carbon balance has then been integrated with the greenhouse gas emissions from the agronomic management to determine the carbon footprint of the contrasting agricultural managements.

NRI is also at the cutting edge of research on climate change and agriculture in developing countries, in particular getting practical mitigation and adaptation strategies that maximise rural livelihoods and agro-biodiversity under changing environmental and economic conditions into use (e.g. Nelson et al., 2010).

Farmer decision making and environmental policy

Provision of ecosystem services requires effective policies and governance arrangements to balance economic development of rural areas with environment and natural resource management at the range of different scales. Users of natural resources (e.g.

farmers) respond to many drivers from policy, markets and environment when making decisions on how to use and manage land and resources. Effective land, natural resource and ecosystem management arrangements which engage directly with land owners and land users are fundamental.

NRI researchers are involved in several initiatives to explore and test ways of encouraging the numerous and often diverse key actors to adapt to and support adaptation to global change while simultaneously encouraging ecosystem services and green economic growth. NRI's expertise includes research into the costs and benefits (including impacts on ecosystem services) of soil erosion mitigation measures for farmers and society in the UK (Posthumus et al., submitted) and into farmer decision making on environmental management and land management, and the role of policy (Prager and Posthumus, 2010).



Payments for ecosystem services

The values of ecosystem services to society are increasingly being recognised. Mechanisms are needed to remunerate land and resource users to guarantee good management and stewardship of land and land resources in order to ensure continued and enhanced provision of ecosystem services. Governments increasingly acknowledge and endeavour to support the multifunctional role of natural and human-influenced landscapes through policies. Alternatively, market mechanisms can be used to address social and consumer concerns about the sustainability and environmental impacts of production processes. NRI conducts research into the feasibility and sustainability of certification schemes and their social, environmental and economic impacts.

The four main markets which can directly support payments for ecosystem services (PES) are climate change mitigation, watershed services, biodiversity conservation and landscape aesthetics. NRI researchers undertook a review of 30 case studies to explore the potential 'PES offer' as a means of encouraging smallholders to farm sustainably (Lamboll et al., in prep.). Key lessons from these existing schemes are being used to inform recommendations on what kind of opportunities exist for using PES to encourage African smallholders to farm sustainably.

Key contact

For more information, please contact:

Dr Jeremy Haggard
Co-ordinator of Ecosystem Services
Research Group
E-mail: j.p.haggard@gre.ac.uk

Key publications

Arnold, S.E.J., Faruq, S., Savolainen, V., McOwan, P.W., and Chittka, L. (2010) FReD: The Floral Reflectance Database – a web portal for analyses of flower colour. *PLoS One*, **5** (12).

Arnold, S.E.J., Savolainen, V., and Chittka, L. (2009) Flower colours along an alpine altitude gradient, seen through the eyes of fly and bee pollinators. *Arthropod-Plant Interactions*, **3** (1), pp.27–43.

Bartlett, D.M.F. (2011) Identifying Issues for the Coppice Industry. *Quarterly Journal of Forestry*, **105** (2), pp.131–134.

Bartlett, D.M.F., and Witts, T (2009) Biodiversity Data, Informatics and Ecologists – The E-Biosphere Conference. *In Practice*, **65**, pp.25–27.

Dyer, A.G., Whitney, H.M., Arnold, S.E.J., Glover, B.J., and Chittka, L. (2006) Behavioural ecology: Bees associate warmth with floral colour. *Nature* **442** (7102), pp.525–525.

Haggard, J., Barrios, M., Bolaños, M., Merlo, M., Moraga, P., Munguia, M., Ponce, A., Romero, S., Soto, G., Staver, C., and Virginio, E. (2011) Coffee Agroecosystem Performance Under Full Sun, Shade, Conventional and Organic Management Regimes in Central

- America. *Agroforestry Systems* **82** (3), pp.285-301.
- Haggar, J.P., Briscoe, C.B., and Butterfield, R.P. (1998) Native Species: A Resource for the Diversification of Forestry Production in the Lowland Humid Tropics. *Forest Ecology and Management*, **106**, pp.195–203.
- Haggar, J., Sosa, M., Diaz, B., Hernandez, G., Contreras, J., and Uc, C. (2004) Adaptation of Agroforestry Systems in SE Mexico Through the Integration of Farmer and Bioeconomic Evaluations. *International Journal of Agricultural Sustainability*, **2** (3), pp.154–166.
- Idol, T., Haggar, J., and Cox, L. (2011) Ecosystem Services from Smallholder Forestry and Agroforestry. In Campbell, B. and Lopez, S (eds.) *Issues in Agroecology: Present Status and Future Prospects*. Springer.
- Lamboll et al., (in prep.). The Potential of Payments for Ecosystem Services in Smallholder Agriculture.
- Nelson, V., Lamboll, R., and Arendse, A. (2008) *Climate Change Adaptation, Adaptive Capacity and Development*. Discussion Paper DSA-DFID Policy Forum. <http://climateanddevelopment.nri.org/papers.htm>
- Nelson, V., Morton, J., Chancellor, T., Burt, P., and Pound, B. (2010) *Climate Change, Agricultural Adaptation and Fair-Trade: Identifying the Challenges and Opportunities*. Natural Resources Institute, Chatham.
- Nonponen, M., Edwards-Jones, G., Haggar, J., Soto, G., Attarzadeh, N., and Healey, J. (submitted) Greenhouse Gas Emissions and Production Efficiency in Coffee Grown with Differing Input Levels Under Conventional and Organic Management. *Agriculture Ecosystems and Environment*.
- Posthumus, H., Rouquette, J.R., Morris, J., Gowing, D.J.G., and Hess, T.M. (2010) A Framework for the Assessment of Ecosystem Goods and Services: A Case Study on Lowland Floodplains in England. *Ecological Economics* **69**, pp.1510–1523.
- Posthumus, H. and Morris, J. (2010) Implications of CAP-reform for Land Management and Runoff Control in England and Wales. *Land Use Policy*, **27** (1), pp.42–50.
- Prager, K., and Posthumus, H. (2010) Socio-Economic and Cultural Factors Influencing the Adoption of Soil Conservation Practices by Land Managers in Europe. In Napier, T.L., (ed.) *Human Dimensions of Soil and Water Conservation*. Nova Science Publishers. (ISBN 978-1-61761-522-1)
- Rouquette, J.R., Posthumus, H., Morris, J., Hess, T.M., Dawson, Q.L., and Gowing, D.J.G. (2011) Synergies and Trade-offs in the Management of Lowland Floodplains: An Ecosystem Services Approach. *Hydrological Sciences Journal* (accepted).
- Singleton, G.R., Belmain, S.R., and Brown, P.R. (eds.) (2010) *Rodent Outbreaks: Ecology and Impacts*. International Rice Research Institute Press, Los Baños, Philippines. <http://snipurl.com/27vrix>



UNIVERSITY
of
GREENWICH

Natural Resources Institute

University of Greenwich
Central Avenue
Chatham Maritime
Kent ME4 4TB

Telephone: 01634 883199

Telephone from outside the UK: +44 1634 883199

E-mail: nri@gre.ac.uk

Website: www.nri.org



FS 54723

ISO 9001



THE QUEEN'S
ANNIVERSARY PRIZES

FOR HIGHER AND FURTHER EDUCATION

2008



This document is available
in other formats on request



Printed on recycled material

University of Greenwich, a charity and company limited by guarantee, registered in England (reg. no. 986729).
Registered office: Old Royal Naval College, Park Row, Greenwich, London SE10 9LS

Every effort has been made to ensure that this leaflet is as accurate as possible.
However, the university reserves the right to amend without notice any information printed here.