Integration of Geodiversity into Ecosystem Services Frameworks (Ref IAP2-18-108)

Heriot-Watt University, Institute of Life and Earth Sciences, Lyell Centre
In partnership with British Geological Survey and the Scottish Geodiversity Forum

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Overview

Background

Geodiversity is defined as the assemblages of, and processes within, the geological, geomorphological and soil / sediment features of a landscape – factors which fundamentally underpin biologically-based ecosystem services such as biodiversity (Figure 1). However, geodiversity is often ignored within the ecosystem approach (which, by definition, should be all-encompassing), and when assessing ecosystem services provided by a given habitat.

Each geological feature within a landscape provides a different environmental condition than the surrounding landscape. Distinct geological surfaces will be able to support different ecosystems, creating a 3-dimensional mosaic of habitats. The inter-relationships, dynamic processes and complex feed-back mechanisms between the physical, geological and biotic systems is well reported, but quantifying the complexity of relationships in the context of ecosystem services has yet to be adequately achieved. Geodiversity is now recognised as an important factor underpinning wider environmental policy issues, with substantial economic, social, cultural and environmental benefits for society. For example, geodiversity provides essential goods and services, e.g. non-renewable minerals, aggregates and fossil fuels, as well as additional 'knowledge' benefits, e.g. records of past climate changes and understanding of how Earth systems operate (see Gordon et al 2012 and Gordon & Barron 2011). The direct links between biology and geodiversity and their role in supporting ecosystems is a key area of active research.

Figure 1. Geodiversity and biodiversity are two critical ecosystem services in both terrestrial and marine environments.

Current state of the art

Interest in geodiversity has recently begun to increase due to the realisation that it may be critical in understanding the monetary and cultural value of a given ecosystem. Indeed, geodiversity itself may be

considered a supporting ecosystem service in a similar manner to nutrient cycling and primary production, but its quantification is challenging.

The British Geological Survey (BGS), who are co-supervising this studentship, is the UK geoscience research institute responsible for geological mapping, both onshore and offshore. BGS worked in close partnership with Scottish Natural Heritage (SNH) on the newly formed Geodiversity Charter of Scotland, which recognises the importance of geodiversity, the need to promote its awareness and the requirement for a fully-integrated management scheme within the ecosystem approach. This charter highlighted the uniqueness of Scotland's geodiversity across a relatively small geographical area, making Scotland an ideal location to investigate geodiversity (Figure 2).

Figure 2. Scotland is an ideal for studying geodiversity

However, incorporation of geodiversity into landscape management remains difficult because of a lack of quantitative metrics to describe geodiversity. If geodiversity is to be taken into account – for example when valuing natural capital – these metrics need to be developed and applied. This information is particularly important in areas of proposed land-use change and / or development.

Aim: This project will develop geodiversity indicator metric(s) for application across a suite of environments. This is important for integrating geodiversity into the future management of landscapes.

Methodology

Given Scotland's unique range in geodiversity, the student will initially focus on Scotland-based resources and material. The scholar will have the opportunity to conduct fieldwork during the design and validation phases of the project. Possible field sites include: (1) UK 'geo-sites', as designated by the Geological Society of London, (2) current field sites of the Lyell Centre and BGS (terrestrial and marine) at which extensive background information is available and (3) disused open cast mines in Lanarkshire, which are being developed for geo-tourism and geological research.

Three major research objectives within the PhD will be to:

1. Develop conceptual models for describing and quantifying geodiversity from terrestrial, aquatic and marine environments.
2. Develop suitable indicators for describing and quantifying geodiversity.
3. Test the indicator(s)' robustness in terrestrial and marine environments in the context of existing geology.

Timeline

	Yr 1	Yr 2	Yr 3	Yr3.5
Conceptual models				
Indicator design				
Indicator validation				
Dissemination				

Training & Skills

The student will be actively engaged with BGS throughout the PhD, including a dedicated secondment to maximise access to BGS facilities. This research is also highly topical at the policy / governmental level, thus the student will complete their PhD highly equipped for a career in academia, industry or policy.

This studentship will equip the student with a range of skills including numeracy, proficiency in the translation of science to policy, fieldwork and soil science. Specific research skills will include:

- Terrestrial and marine survey and auditing skills
- Interdisciplinary analysis; combining geology, marine biology and terrestrial ecology
- Sediment analysis
- Marine, coastal, terrestrial and freshwater fieldwork
- Environmental statistics and calculations of uncertainty
- Advanced techniques in GIS

The student will be encouraged to attend relevant NERC short courses (e.g. environmental statistics), and BGS short-courses (e.g. geoscience modelling) depending on need, and will attend appropriate national (e.g. MASTS Annual Science Meeting) and international (e.g. European Geophysical Union) conferences. The project supervisors will also support and encourage the scholar's attendance on transferable skills training such as data management, scientific writing and science communication. These are provided for free by Heriot-Watt University.

Project support: The facilities and instrumentation available within the supervisors' institutions provide a combination of leading laboratory, field and analytical capability and technical support that will be ideal for this proposed research, maximising PhD training and research advances.

Scholar support: The Lyell Centre, Heriot-Watt University has a large research student cohort that will provide peer-support throughout the research program. The scholar will participate in the annual post-graduate research conference within the School of Energy, Geoscience, Infrastructure and Society (EGIS), providing an opportunity to present their research to postgraduates and staff within the School, and to also learn about the research conducted by their fellow postgraduate peers. All project supervisors are highly research-active; the scholar will interact with all members of their research groups, providing an opportunity to learn about other techniques and research areas which may be applicable to their research. Additionally, the supervisors are all based in research-active departments that span a broad range of geoscience, ecological and environmental research, exposing the scholar to a range of other research areas. To facilitate this, the scholar will actively participate in meetings with the 'Benthic Ecology & Biogeochemistry' at the Lyell Centre, providing the opportunity to discuss cutting-edge topics in the field, review recent papers and to present current research plans to academics with a common research interest in an informal and supportive atmosphere.

References & Further Reading

Scottish Geodiversity Charter (2018) https://scottishgeodiversityforum.files.wordpress.com/2011/12/scotlands-geodiversity-charter2018-2023.pdf

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Further Information

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