



**British Geological Survey**  
NATURAL ENVIRONMENT RESEARCH COUNCIL



## **ENGAGING WITH GEODIVERSITY – WHY IT MATTERS**

**1 DECEMBER, 2010, OUR DYNAMIC EARTH, EDINBURGH**

### **ABSTRACTS OF PRESENTATIONS**

#### **Scotland's geodiversity and why it matters to Scotland's people**

##### **Iain Stewart (University of Plymouth)**

*Iain Stewart is Professor of Geoscience Communication at the University of Plymouth. After presenting several major BBC earth science television series about the planet (Earth: The Power of the Planet, Earth: The Climate Wars, How Earth Made Us), his latest programmes bring him back home to explore the environmental history of his own backyard (Making Scotland's Landscape) and geological history (Men of Rock).*

Scotland's spectacular mountains, wonderful lochs and scattered islands take us back to our nation's historical roots, but take a walk with a geologist and you'll find they also transport us to the very earliest years of our planet. For beneath highland bens and glens or lowland flood plains and rocky shores, Scotland's rocks have revealed to the world not only how our planet works, but also the enormity of time itself. The legacy of our truly prodigious geological inheritance was also the means by which this nation unleashed the industrial revolution and ushered in the modern age of carbon. Today, the global consequences of that remarkable heritage offer Scotland, and its rocks, fresh challenges and new opportunities.

#### **Geodiversity and landscape sensitivity: international and Scottish perspectives**

##### **Michael Thomas (University of Stirling)**

*Mike Thomas is a geomorphologist with wide international experience, whose interests range from rock mass weathering to the impacts of Quaternary climate change on landscape stability and alluvial sedimentation. He is holder of the Centenary Medal of the RSGS and the David Linton Award of the BSG.*

Geodiversity emerged as a concept in the 1990's, a decade after Biodiversity became established in conservation science. Spurred by concern for the conservation of fossil evidence for evolution and by recognition that the properties of the substrate are fundamental to ecosystem functions and to landscape quality, the use of the term has expanded rapidly, but often with too little regard for the scientific issues involved.

Geodiversity is the expression of the varied physical landscapes that are the products of earth history, maintained and continually altered by magmatic and meteoric forces. It straddles the artificial divides between geology, pedology and geomorphology.

This presentation will explore the varied components of geodiversity; their links to biodiversity; and the sensitivity issues involved in understanding landscape changes arising from fluctuations in the operation of earth surface processes over varied timescales.



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## **Valuing geodiversity in an ecosystem services context**

### **Murray Gray (Queen Mary, University of London)**

*Murray Gray is is Emeritus Reader at Queen Mary, University of London and Visiting Professor at the University of Minho, Portugal. Originally a glacial geomorphologist, more recently he has published on geoconservation, including "Geodiversity: valuing and conserving abiotic nature" (John Wiley, 2004). This has led to invitations to lecture at conferences throughout North America, Europe and the Far East.*

Ecosystem services are the commonly undervalued goods and services associated with natural environments. The Millennium Ecosystem Assessment (MEA, 2005) classified these into regulating services (e.g. climate regulation, erosion regulation, pollination), supporting services (e.g. photosynthesis, nutrient cycling), provisioning services (e.g. food, fibre, pharmaceuticals) and cultural services (e.g. aesthetic values, ecotourism, sense of place). However, current descriptions of ecosystem services undervalue the role of the physical environment. This presentation will use a modified MEA classification to examine the goods and services provided by geodiversity that are of value to society. Of particular importance are the supporting services of soil formation and physical habitats as the foundation for biodiversity, the provisioning services of building materials, metallic ores, industrial minerals and gemstones, the cultural services of geotourism, folklore and landscape character and the knowledge services of Earth history and the evolution of life.

## **River Processes, catchment management and ecosystem services in a changing climate**

### **Andrew Black (Wallingford Hydrosolutions/University of Dundee)**

*Andrew Black is a geographer working on the hydrology of Scottish rivers and lochs for 20 years. Based at the University of Dundee since 1995, he is presently on secondment, heading the Scottish office of Wallingford HydroSolutions, a specialist hydrological and environmental consultancy. He is also currently the President of the British Hydrological Society.*

Scotland's rivers are integral to its diverse landscapes, and to the enormous range of physical settings in which human activities occur and ecosystems evolve. These rivers are often seen as living things – they assimilate the effects of geology, topography, climate, soils and various human activities both in their flow behaviour and also in the quality of their waters. Driven by the interaction of rainfall, snowmelt, evaporation, storage and drainage, they exist in a state of continual change. They act as vectors not only for the discharge of water but also for nutrients, sediment and life itself. Through the cycles of erosion, transport and deposition they evolve, reflecting conditions over their entire catchment areas, as well as direct human interventions to manage their form and function. Such continual change over short and long timescales is at least matched by the diversity of habitats which support aquatic ecosystems from the highest headwater spring to any of the estuaries where fresh water meets salt. Spatial and temporal diversity are key to supporting aquatic life. By contrast, human needs are often most readily served by conditions of limited variability, and when extremes occur, they present us with difficult and often costly challenges.

This presentation seeks to illustrate the huge contrasts in types and conditions found in Scotland's rivers, the uses made of them, the roles they play in supporting sustainable communities of all sorts, and considers the frameworks in place for managing rivers in the context of growing development pressures and changing climate.



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## **Coastal processes, management and ecosystem services in a changing climate**

**Jim Hansom\* and Alistair Rennie\*\* (University of Glasgow\* & Scottish Natural Heritage\*\*)**

*Jim Hansom, Reader in Geographical and Earth Sciences, University of Glasgow and adjunct Professor of Geography, University of Canterbury, New Zealand is a coastal geomorphologist with interests in coastal processes and their management.*

*Alistair Rennie is a member of SNH's Earth Science Advisory team and is a coastal geomorphologist engaged with providing advice on coastal issues and their management to Local Authorities and Government.*

So what is changing at the coast? External processes and drivers such as Relative Sea Level, storm wave heights and flood frequencies are all changing and this is forcing landform and habitat response at coastlines and river mouths. In response, our approaches are also changing and the spatial & temporal scale of management is moving from 1-dimensional (*Shoreline Management Plans*) toward 3-dimensional (*Integrated Coastal Zone Management*) approaches. More importantly our appreciation of coastal connections are changing and there is increasing recognition that GeoDiversity underpins coastal ecosystems and thus lies at the heart of ecosystem management. A healthy functioning ecosystem, where GeoDiversity and BioDiversity are equally appreciated is perhaps the only way to secure sustainable management of our landscapes and coastlines. If we are to 'anticipate change and adapt' at the coast then understanding the contribution of coastal GeoDiversity is essential to Natural Heritage management.

## **Geodiversity, biodiversity and landscape in a changing climate**

**Des Thompson, John Gordon & Sally Johnson (Scottish Natural Heritage)**

*Des Thompson is Policy & Advice Manager with SNH. He chairs the JNCC Uplands Lead Co-ordination Network and is an Honorary Professor in Environmental Science at Manchester Metropolitan University.*

*John Gordon is Earth Science Policy and Advice Manager with SNH.*

*Sally Johnson is Policy & Advice Officer with SNH's Uplands and Peatlands Group and Network Officer to JNCC's Uplands Lead Co-ordination Network.*

Scotland's distinctive range of landscapes, habitats, plants and animals is founded on the rocks, landforms and soils, and the influences of climate and land-use. With the advent of the national ecosystem approach we are seeing much clearer expositions on the interplay between biological, human-related and geo-system processes. In this presentation we set out some ideas and examples of how we are trying to develop this approach to guiding the management of Scotland's natural heritage.

We draw on two strands of work. First, we provide examples of indicators which enable us to assess the state of nature. By monitoring these we can provide a timeline on the nature of change, and draw conclusions on land-uses and management practices which are beneficial or inimical. Second, we explore some of the linkages between geo-systems and biodiversity, and provide examples of how knowledge of these can inform conservation and management activities. Finally, we urge the development of a more holistic approach to managing nature, where the functional links between geo-systems and bio-systems are duly acknowledged. In the face of climate changes and economic challenges, it is important that we take a broad and integrated view of how the land and its nature will respond to the pressures ahead.



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## **Soils, geodiversity and ecosystem services - the value of developing a more integrated approach**

**Colin Campbell (Macaulay Land Use Research Institute, UK and Swedish Agricultural Sciences University, Uppsala, Sweden)**

*Colin Campbell leads the Soils group at the Macaulay Institute and the Scottish Government's cross-institute research programme "Protecting the Nation's Soil". He is a Visiting Professor at the Swedish Agricultural Sciences University. He has 23 years experience researching the role of soil biodiversity in the functioning of natural and managed ecosystems.*

Geology, soils, air, water and biodiversity are intimately linked and structured in ways we are starting to understand increasingly better. New evidence of the complexity of our ecosystems and inter-relatedness of geology, soils and biology beg for better ways to frame our understanding and structure integrated approaches to manage them. Biodiversity has done much to bring public understanding of the complexity and inter-relatedness of our ecosystems to a wider audience and geodiversity can and should do the same for linking geology to soils and so to habitats both natural and managed. The 'Ecosystem Approach', which considers all the ecosystem services that nature delivers for humankind, is also gaining popularity as a way of dealing with the complexity and multi-functionality of our ecosystems at the same time as engaging people in the decision making process. Merging of all these concepts is becoming commonplace but what quantifiable links can we demonstrate and how do we communicate the increasing complexity of such messages? I will highlight where we do have new understanding of linkages between geodiversity, biodiversity and ecosystem services and how we can start to consider deploying an ecosystem approach and highlight the need for innovative ways of communicating this.

## **Education and raising public awareness of geodiversity**

**Stuart K Monro (Scientific Director, Our Dynamic Earth)**

*Professor Stuart Monro is Scientific Director at Our Dynamic Earth and a leading practitioner in promoting science to a wide audience. He was Principal Geologist for British Geological Survey, contributing to the application of geology to environmental issues before establishing Our Dynamic Earth, a science centre which tells the story of how the Earth works.*

There is nowhere in the world better placed to illustrate geodiversity and its impact on landscape than Scotland where some of the youngest through to some of the oldest rocks in the world can be found. This rich geodiversity though is illustrative of the global processes that have shaped the planet we live on. It is therefore imperative that an educational system fit for purpose in the 21st century yields citizens who understand a little of how the Earth works.

The talk will look at the old Huttonian maxim 'the present is the key to the past and the past is the key to the future' and explore aspects of the geodiversity of Scotland against a backdrop of modern analogues and in the context of what the future might hold.



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## **‘Geotourism’ – not just rocks and panels**

### **Chris Woodley-Stewart (Director, North Pennines Area of Outstanding Natural Beauty & European Geopark)**

*Chris Woodley-Stewart is the Director of the North Pennines Area of Outstanding Beauty (AONB) Partnership and is also the manager of the area's European and Global Geopark status. As well as being the current Vice-Chair of the National Association for AONBs, Chris is a member of the Advisory Committee of the European Geoparks Network. He has conducted assessments for applications to the Global Geoparks Network on behalf of UNESCO in Europe and the Far East. Chris has a broad professional background encompassing nature conservation, organisational development, nature tourism and environmental education / interpretation. Though not a geologist, he says he knows 'just enough about it to be dangerous'.*

The last ten years in particular have seen a lot of talk about ‘geotourism’, and in this period we’ve also seen the rise of the European and Global Geoparks Networks. But does an approach to tourism that just focuses on ‘geo’ just meaning ‘geology’ instead of meaning ‘earth and nature’ have a market and will it deliver all the things we’d like it to?

There is some very circular debate about the definition of geotourism, and a lot of ‘academic’ work about what geotourism is. This presentation will look at where on the ‘visitor journey’ Protected Area managers, Geopark managers and others in similar situations meet the visitor and at how our product development and ‘post-arrival things to see and do’ – our trails, our events, our training activities, our museums, the landscapes we conserve etc. are part of the tourism industry (and when they are not). We’ll also look at how European Geoparks are faring at attracting, entertaining, sometimes educating, and supporting visitors and encouraging them to come back, and at how they may need to raise their game, and mark themselves out as different from other ‘nature tourism’ destinations, if the concept is going to thrive.

This presentation may raise more questions than answers, but they are questions we should be asking.

## **Geodiversity – the Central Scotland Green Network, health and wellbeing**

### **Simon Rennie (Head of the Central Scotland Green Network Support Unit)**

*Simon Rennie is Head of the Central Scotland Green Network Support Unit and Chief Executive & Director of the Central Scotland Forest Trust. He is a member of the Forestry Commission Scotland (FCS) National Committee, Chair of the FCS Central Scotland Regional Forestry Forum and Chair of the FCS Audit and Risk Committee. He is also a Director of Paths for All.*

The CSGN is one of only fourteen National Developments within the Government’s second National Planning Framework. As such it sits at the apex of the planning system in Scotland and its development is considered to be of national importance to Scotland’s future.

This presentation will describe the CSGN and why the proposed approach to improving the physical environment has particular relevance to Central Scotland. It will set out the vision for the CSGN and detail proposed relevant actions in the light of the health and wellbeing focus of the presentation. The geography of the CSGN will be set out as will correlations between earlier industrial activity, and the legacy of that, and current social circumstances. It will show how what lies beneath our feet, and has been used over time, continues to impact on people’s lives today. The presentation will set out some examples of how intervention, using natural and human made features, can improve the health and wellbeing of local people.



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## **Integrating geodiversity & landscape management within the Cairngorms National Park Matthew Hawkins (Cairngorms National Park Authority)**

*Matthew Hawkins is a chartered Landscape Architect with a background in both private and public sector. He has been with the Cairngorms National Park Authority since 2006 initially as Landscape Adviser and then subsequently, as Senior Heritage Officer, responsible for managing the National Park programme to conserve and enhance the natural and cultural heritage, including geodiversity. His role includes managing the work of the heritage team (ecology, landscape and cultural heritage) and planning case work and policy development.*

At 4,500 square kilometres the Cairngorms National Park is the largest in the UK. It has a number of special qualities that define its physical character and cultural identity. All of these are profoundly affected by its geology. It is best known for its upland plateau, a massive granite pluton, and the conditions here have created habitats and species that are very rare within the UK. Geology is also highly significant in terms of cultural heritage. This is reflected in the land use and built infrastructure. The land ownership of the national park is held predominantly by private estates (75%) with the remainder is owned by Forestry Commission Scotland and Highland and Island Enterprise agency or NGOs such as the RSPB and NTS. None is owned by the park authority.

The integration of land management and geodiversity is therefore largely a private affair and for it to be established effectively the benefits must be clear. These are predominantly indirect benefits and they support a large part of estate income. These focus particularly on visitor experience and their understanding of this wild landscape. Direct benefits are less significant in terms of economy. In future the economic benefits derived from ecosystem services may encourage more active integration.

In all cases effective delivery of the integration of geodiversity with land management at the practical and strategic level is going to be achieved through active partnership between private, public, volunteer and community organisations.

## **Geodiversity and the role of the planning system in Scotland**

### **Mike Browne (Chair, GeoConservationUK)**

*Dr Mike Brown's career with the British Geological Survey spanned 43 years and was spent almost entirely in the Central Belt of Scotland as field survey geologist, project manager and District Geologist; Chair for last 5 years of GeoConservationUK, the national body for voluntary local geoconservation groups in the home nations including Scotland; Chair Lothian and Borders GeoConservation.*

The Nature Conservancy Council Strategy (1990) for Earth Science Conservation in Great Britain had six main areas for action, two of which were maintaining the Special Sites of Scientific Interest (SSSI) series through the Geological Conservation Review (GCR) and expanding the Regionally Important Geological/Geomorphological Sites Network (now known as Local Geodiversity Sites (LGS) in Scotland). In general, protection of SSSI's is well understood, statutory and the planning and development system generally sympathetic (notable exceptions include the Bilston Glen Colliery development about 1950 that destroyed a significant part of the SSSI). For LGS the protection is achieved through local planning policy. However the establishment of a site system and recognition of LGS (and indeed Local Biodiversity Sites) is patchy in Scotland so many local authorities neither have policies nor the system in place to conserve their local geodiversity and give it consideration in planning and development. However, even where LGS have been recognised, damage can happen to them because of lack of consultation during or following emergency incidents. Because there is no current duty on local authorities to care for their local geodiversity, GeoConservationUK has petitioned the Scottish Parliament to establish one so that an integrated approach (ecosystems service) to the environment and its protection is achieved in Scotland.



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## **Towards a geodiversity framework for Scotland**

**John Gordon<sup>1</sup> & Hugh Barron<sup>2</sup> (1<sup>Scottish Natural Heritage & 2<sup>British Geological Survey</sup>)</sup>**

*John Gordon is Earth Science Policy and Advice Manager with SNH and an Honorary Professor in the School of Geography and Geosciences, University of St Andrews. He has over 30 years experience in the field of earth heritage conservation. He also chairs the JNCC Soils Lead Co-ordination Network.*

*Hugh Barron has 24 years experience with BGS and is currently UK Business Development Sector Manager for Scotland and Project Manager for Responsive Surveys Scotland. He has managed many geodiversity projects in BGS including the Greater London Authority geodiversity audit and audits for West Lothian, East Dunbartonshire, Cairngorms and Loch Lomond & The Trossachs National Parks. Hugh is a Chartered Geologist and a Council Member and Director of the Association for Geographic Information Ltd (AGI). He is also Chair of AGI Scotland.*

Geodiversity links people, landscapes and their culture and delivers important ecosystem services through its influence on landscape, habitats and species, sustainable development, historical and cultural heritage and people's health and well-being. It also has a key contribution to make in climate change adaptation and in sustainable management of the land, river catchments and the coast. However, there is scope for improvement in the recognition and integration of geodiversity in the wider policy environment. This could be addressed through a national framework for geodiversity, analogous to the Scottish Soil Framework. The aims, objectives and outcomes of such a framework would need to align with the Scottish Government's purpose of increasing sustainable economic growth and the National Outcome on the built and natural environment. They should support the Government's 5 Strategic Objectives, in particular the *Greener* objective but also contribute to the *Wealthier & Fairer, Healthier, Safer & Stronger* and *Smarter* objectives.



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### **ABSTRACTS OF POSTER PRESENTATIONS**

**(Poster numbers correspond to the numbering system on the display boards)**

#### **1. Adapting Geodiversity Conservation to a Changing Climate**

*Eleanor Brown & Colin Prosser, Natural England.*

Geodiversity is an integral part of the natural environment and underpins ecosystem services on which we depend. Prosser *et al.* (2010) examines the impact of climate change on geodiversity conservation and notes that principles and guidance to facilitate adaptive management is now required. Here we set out key principles, including working with natural processes, assessing site vulnerability, and enhancing delivery of ecosystem services, landscapes and biodiversity through geoconservation. Evidence on how dynamic earth processes respond to climate change along with hindsight from past ecological records can inform adaptive management by helping us understand resilience, scales and rates of change and natural versus human-induced change.

#### **2. Arctic Soils Geodiversity**

*Audrey Wayolle, University of Stirling.*

Arctic soils are sensitive to temperature changes, and have to be integrated to any climate change model. However they are difficult to study and estimates of the carbon stocks they contain are diverse. The quantification of carbon stocks in arctic soils has to be made at several scales to be accurate. The sites of Abisko (Swedish Lapland) and Kevo (Finnish Lapland) are studied to map carbon from the microscopic to the landscape scale.

#### **3. Links Between Geodiversity and Biodiversity on Upland Plateaux in Scotland: the importance of understanding terrain sensitivity in conservation management**

*John Gordon<sup>1, 2</sup>, Stefan Morrocco<sup>2</sup>, Colin Ballantyne<sup>2</sup>, Des Thompson<sup>1</sup> & Vanessa Kirkbride<sup>1</sup>, <sup>1</sup>Scottish Natural Heritage, <sup>2</sup>School of Geography & Geosciences, University of St Andrews.*

There are close links and dependencies between geodiversity and biodiversity in the uplands. Upland habitats are generally of high value for nature conservation but are dynamic and often fragile. They are responsive to climate changes over short and long timescales and vulnerable to disturbance arising from human activities. This dynamism and fragility result in part from the properties of the soils and vegetation, the active geomorphological processes and the extreme climate. It is crucial that management is based on understanding these links and the factors that determine their sensitivity since there is potential for irreversible changes on human timescales if geomorphological and ecological thresholds are crossed. Quantitative assessment of terrain sensitivity based on experimental performance under stress of the soil and vegetation provides a promising means to inform the management of sensitive high plateau areas. Linking geodiversity and biodiversity in this way as part of an integrated geocological approach is consistent with the ecosystem approach in conservation management, which emphasises the functional integrity of ecosystems and maintenance of natural processes.



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#### 4. The Physical Landscape of Britain

*Janet Hooke (On behalf of the British Society for Geomorphology), University of Liverpool.*

The British Society for Geomorphology is proposing a large project in which much of the information on the physical landscape of Britain is brought together in an interactive web site, accessible to professions and the public. A series of integrated national scale thematic maps is to be produced that enable the user to access information on the landforms and processes in shaping the physical landscape at locations within Britain and Northern Ireland. To achieve this bold vision a phased development is proposed, supported by funding that reflects the range of potential beneficiaries of the project.

#### **5/6/7. Anglesey: a landscape carved by ice - introducing a new web-based, interactive landform map for Anglesey, North Wales, from the British Geological Survey. 3 Posters**

*Emrys Phillips, Calum Ritchie, Leslie Oliver & Jez Everest, British Geological Survey.*

A new web-based educational product describing the glacial history of Anglesey has been launched by the British Geological Survey (BGS). The centrepiece of this interactive product is a new landform map of the island which has been draped over a colour shaded NEXTMap™ digital elevation model. Tabbed and dropdown menus, as well as embedded controls allow the user to navigate around this stylish new product, bring up additional information on the bedrock geology and landform assemblage zones, browse through a photo gallery containing images of the glacial landforms and sediments, access informative summaries of how the main glacial features (including drumlins, meltwater channels) were formed. The target audience of the Anglesey *i-map* includes school students, geography and earth science teachers, undergraduates and academic researchers, as well as anyone interested in the landscape around them evolved. The three posters in this presentation are the free-to-download (A0 size, pdf format) map and photo gallery wall posters available as part of this new BGS product. They can be used as a visual teaching aid, the basis of a practical lesson on glacial landforms, or the foundation for a physical geography field course to this part of North Wales.

#### **8/9/10/11/12. Understanding the Links between Geodiversity and Biodiversity Matters in a Changing Climate. 5 posters**

*John Gordon, Vanessa Kirkbride, Alistair Rennie, Patricia Bruneau, Rachel Wignall & Colin MacFadyen, Scottish Natural Heritage.*

Understanding the functional links between geodiversity and biodiversity is particularly important for conservation management in dynamic environments, where natural processes (e.g. floods, erosion and deposition) maintain habitat quality, diversity and ecological functions. This is fundamental at a time when changes in the nature, magnitude and frequency of these processes are likely to have significant implications for most ecosystems. Understanding Earth surface processes can help to mitigate future impacts from climate change and sea-level rise, inform appropriate policies and guidance for adaptive management, and contribute to the restoration of ecosystems already damaged by human activities. Key challenges are to:

- raise awareness of Earth surface processes, particularly in relation to allowing space for natural processes;
- develop better integration of geodiversity within relevant existing policies.



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### **13. Rediscovering a Sense of Wonder: Geoheritage, Geotourism and the Cultural Landscape in Scotland**

*John Gordon, Scottish Natural Heritage*

Geodiversity is closely linked with many aspects of the cultural landscape and the development of tourism in Scotland. These links provide opportunities for raising awareness of Scotland's Earth heritage through literature, poetry, art and the built heritage. The creative influence of geodiversity also allows a broader interdisciplinary exploration of the cultural engagement with geological landscapes and the deep connections between people and the natural world. Rediscovering a sense of wonder through these cultural links can enable people to reconnect with their roots; help develop a wider constituency for geoconservation beyond the geoscience community; and raise awareness of the relevance of geological and geomorphological processes for understanding our dynamic world at a time of potentially far-reaching changes.

### **14. Historical Human Adaption to Geodiversity at Vatnsfjörður, NW Iceland**

*R. Barclay, I. Simpson & E. Tisdall, University of Stirling.*

Geodiversity played a significant role in influencing the Norse settlement of Iceland. Vatnsfjörður, which emerged as one of the wealthiest farms in medieval northwest Iceland, provides a particularly good example, in that its distinctive geodiversity influenced resource availability and land use. Geoarchaeological techniques provide insight into formation, structure and management of the site, with specific focus on inherent soil properties and human adaption to these. In contrast with many early Icelandic farmsteads, the home field of Vatnsfjörður was found to comprise of infertile, shallow soils on which small wet meadows had been created to enhance productivity.

### **15. Click here for your local rock and fossil sites: Using web-based 'mash-ups' to widen access to geodiversity information for non-specialist users**

*Katie Strang & Alistair J. McGowan, University of Glasgow.*

Large amounts of data about geodiversity are now available free-of-charge via web services. While this theoretically makes these data accessible and free to all users, the technical language and knowledge to use text-based searching represents a significant access barrier to many users without specialist earth science knowledge. A more appropriate strategy would be to offer users a map-based interface based on familiar tools such as Google Maps™ and Google Earth™. By using familiar tools, which are also relatively for developers to utilize, a compromise solution can be reached whereby users search based on maps and get some basic information, but can also be linked to the original research-level databases.



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## **16. Linking Geodiversity and Biodiversity: the value of understanding catchment scale processes in conservation management**

*Sue Rees<sup>1,3</sup>, John Gordon<sup>2,3</sup> & Patricia Bruneau<sup>2,3</sup>, 1Natural England, 2Scottish Natural Heritage & 3JNCC.*

Physical processes underpin the structure and function of ecosystems and the services they provide. However, since most physical processes cannot be ‘controlled’ by human management, we have to understand and work with them in a much more effective way than in the past. This is likely to be even more acute in the future as ecosystems respond to climate change and sea-level rise. Using examples from the coast and uplands, this study demonstrates how a better understanding of the functional links between geodiversity and biodiversity can help to inform the future adaptive management of habitats and to deliver favourable conservation status of designated features.

## **17. A Net Environmental Benefit Analysis Framework for Environmental Decision-Making**

*Samantha Deacon (ENVIRON UK Ltd), Joseph Nicolette (ENVIRON International) & Andy Goddard (ENVIRON UK Ltd).*

Geodiversity is an emerging concept in UK policy and planning, requiring ‘intangible’ resources to be valued and compared. A similar focus is being given to ecosystems, where ecosystems are now being recognised for their wider benefit to society. These benefits are known as “ecosystem services” which are becoming a material consideration during the management of our national landscapes. In this poster we describe how new valuation tools, including net environmental benefit analysis (“NEBA”) can be used in the management of land contamination, restoration and development. A case study illustrates how a NEBA is used to value ecosystems and balance economic, ecological, physical and social drivers.

## **18. The Tendring, Essex, Geoaudit**

*Peter Allen*

The geodiversity of Tendring includes volcanoes, earthquakes, a fascinating history of the Thames and Medway in Essex and the quaint industrial heritage of mineral exploitation. The geoaudit provides a detailed resource for planners, developers and others, giving clear maps of the sub-divisions of the region together with explanations of the nature of the geodiversity and archaeological interests and an assessment of their importance. It is also an invaluable resource for local education and for pamphlets and other information sources to convey the richness of the local cultural identity and provide interesting information for visitors.

## **19. Bings and Biodiversity**

*B. A. Harvie, University of Edinburgh*

The West Lothian bings are heaps of industrial spoil; the waste product of an industrial process to extract oil from deep-mined shale. They form a unique habitat that exists only because of the Geological anomaly of strata of oil-bearing shale forming under Lake Cadell during the Westphalian stage of the Carboniferous system. The bing sites are also important havens of diversity, at both a local and a national (UK) level, and provide a refuge for locally rare species, both plant and animal, in an urban/industrial/agricultural landscape making them important to conservation and increased local biodiversity.



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## **20. Developing adaptation and mitigation strategies to minimise the impacts of climate change on the conservation interests of Scotland's standing waters**

*Martin Muir, University of Dundee*

Scotland's lochs contain more than 90% of the total freshwater resource and occupy approximately 3% of the country's land mass. Their iconic status stems from their often spectacular landscape settings and their myriad of forms and sizes providing habitats and environmental services of national and international importance. Given uncertain futures surrounding changing climate (in particular temperature and precipitation regimes) this project aims to investigate the effects these changes will have firstly on standing water hydrology, and consequently on the ecology of loch ecosystems. This research will highlight those systems and locations at particular risk and will develop strategies to minimise potential impacts.

## **21. Tidal Trend Reversals: now showing at a coast near you!**

*Alistair Rennie & Jim Hansom, SNH & University of Glasgow*

A common misconception is that rising land levels since the last glaciation serve to safeguard much of Scotland's coast from the impact of sea-level rise. Recent research comparing long-term and short-term geological and tidal measures show that over the last 15 years all areas of the Scottish coast show rates of sea level rise that now outpace rising land levels, with up to 6.2mm/yr of relative sea level rise (RSLR). Assuming this trend continues, significant coastal change is anticipated within the next two decades and within the next 100 years parts of our coastline may have relocated considerable distances inland. Strategic Development and Flood Risk Management Plans need to incorporate RSLR scenarios to 'future-proof' land-use or make plans which are 'future-smart'.