

The impact of multiple climate stressors on coastal biodiversity and associated ecosystem services

Supervisors: Nicola Beaumont (Plymouth Marine Laboratory), Steve Widdicombe (Plymouth Marine Laboratory), David M. Paterson (University of St Andrews)

In coastal ecosystems the major threats to biodiversity are numerous, with climate stressors being well documented as a significant threat. This project aims to assess the impact of multiple climate stressors on biodiversity and coastal ecosystem service delivery, and in turn how these impacts affect the provision of ecosystem benefits and thus human well-being. The focus of this research will be on two ecosystem services: greenhouse gas sequestration and bioremediation of waste. The overarching approach will be to define and quantify the following relationships: Climate stressors - Ecosystem Processes - Ecosystem Services - Ecosystem Benefits. It is only by understanding the intermediary links that it is possible to project how changes in multiple climate stressors will impact the provision of ecosystem benefits, and therefore human wellbeing. Understanding these linkages also improves our capacity to manage the environment to minimise the negative impacts of climate stressors. It is recognised that the system is not linear, and there will feedback loops between the components, but for simplicity it is considered in this form. Two case study areas will be explored: the Tamar and the Eden estuary. These two case study sites have been chosen for their different attributes, but also for their excellent data availability, and as such it is envisioned that no primary data collection will be required. A key final output of the research will be a robust framework linking climate stressors to ecosystem benefits and human well-being, utilising a detailed understanding of the intermediate ecosystem processes and services, and the mechanisms which link these components.

Cultural and educational services from green space: environmental and social determinants (CASE award)

Supervisors: Karl Evans, (Animal and Plants Sciences, University of Sheffield), Ross Cameron, Carys Swanwick (Department of Landscape, University of Sheffield)

There is an urgent need to understand the constraints and opportunities provided by the current policy focus on ecosystem services, but even basic data concerning the relationship between biodiversity and service provision are scarce. The primary objective of this CASE studentship (with Moors for the Future on behalf of the Dark Peak NIA) is to quantify how biodiversity, other landscape attributes, and socio-economic factors determine cultural and educational ecosystem service provision by green-space. This is achieved by adopting a people focused sampling approach that enables systematic sampling to be conducted across the complete spectrum of socio-economic groups, which is not possible in traditional site based studies. This approach simultaneously enables data to be collected on the visitation rates and the outcomes of these visits across a very large number of sites enabling maps of cultural ecosystem service provision to be constructed across an entire region. The studentship focuses on the Sheffield region, which contains a diversity of landscape types, including substantial amounts of uplands, lowland agriculture, urban areas, woodland and freshwater. This region thus provides an ideal case study as it enables the studentship to cut across BESS's focal terrestrial landscapes, thus providing a novel opportunity for the BESS programme to quantify the relative contribution of each major landscape type to ecosystem service provision, and how this varies with socio-economic factors. Moreover, the studentship exploits opportunities provided by the region's Dark Peak Nature Improvement Area (NIA) to conduct large scale experimental manipulations of biodiversity and determine their consequences for cultural ecosystem service provision. Finally, the student will provide an extremely rare experimental test of the widely stated, but poorly supported, hypothesis that engagement with green-space positively influences biodiversity knowledge and support for conservation. The studentship adopts two approaches to achieve these goals. The first uses systematic sampling of households to obtain data on visits to green-space, their motivations and outcomes, including well-being indices. The second approach exploits activities of the CASE partner and other knowledge exchange partners (see below) to manipulate biodiversity value, green-space visitation rates and participants' knowledge of biodiversity in experimental contexts.

The CASE studentship is a collaboration with Moors for the Future on behalf of the Dark Peak NIA partnership (including RSPB, Sheffield and Rotherham Wildlife Trust, and the National Trust). These stakeholders contribute to the experimental manipulations and provide an ideal platform for wider dissemination of project results through national networks including links with other landscape scale initiatives that have been developed in response to the Natural Environment White Paper, including other NIAs and the Futurescapes programme.

The effects of storminess on coastal ecosystem services and wellbeing

Supervisors: Katherine Selby, Colin Brown (Environment, University of York),
Lorraine Whitmarsh (Psychology, University of Cardiff)

Coastal ecosystems lie at the terrestrial-marine interface and are extremely vulnerable to increased storminess and storm surges as a result of climate change. Two such ecosystems are saltmarshes and sand dunes that offer natural coastal protection against climate induced hazards as well as a range of other services including pollution control, carbon sequestration, recreation and tourism. Despite the range of services offered by these environments, an holistic appraisal of the value and also the vulnerability of these areas across the sciences and social sciences are limited. In particular, the psychological benefits of these environments are often neglected in favour of assessing the economic losses. This research will, therefore, investigate the effects of increased storminess on the ecosystem services provided by saltmarshes and sand dunes through an integrated, innovative and interdisciplinary approach combining two disparate disciplines, environmental science and psychology, and integrate this with stakeholder participation.

To achieve this a multi-method, cross-disciplinary approach will be adopted including: establishing a record of storminess over the last 100 years, through historical records (e.g. maps, photos); establishing the contemporary vegetation and pollen assemblages within the saltmarsh and sand dune environments and in sediment cores; assessing the ecosystem services afforded by saltmarsh and sand dune environments, with a particular focus on the psychological benefits and aesthetic preferences of users; investigating how attitudes of people and their relationships with the coastal landscape vary according to key geographical and socio-psychological characteristics; combining the data using a GIS platform to assess the vulnerability of the ecosystem services to predicted increased storminess.

Field sites will be located within three landscapes, Morecambe Bay, the Essex Marshes and Spurn Point, thus utilising sites already being studied within the CBESS consortium programme as well introducing a new field area in collaboration with the Yorkshire Wildlife Trust. Fieldwork will involve modern vegetation sampling, sediment coring and mapping. Laboratory analysis of the modern samples and sediment cores will involve pollen analysis and ^{210}Pb and ^{137}Cs dating. GIS will be employed to interpret aerial photos, historic maps and LiDAR that will yield information about changes in saltmarsh and sand dune extent. Psychological field research will examine users' motivation for visiting the case study areas, their expected psychological benefits and actual psycho-physical effects. Attention will be given to both individual differences and contextual factors and participants will also be asked about the extent to which they consider the areas at risk from increased storminess. The student will work holistically on all aspects of the project ensuring that points of conflict, as well as areas of mutual concern, between environmental and social perspectives are anticipated. GIS will be the main platform by which data will be combined and statistical analyses will be used to investigate the relationships between the ecological and psychological data.

Matching scales: impact of natural scales on planning, decision and policy environment

Supervisors: Ron Corstanje, Anil Graves (Environmental Science and Technology, Cranfield University)

Introducing biodiversity and in particular, the benefits derived from biodiversity expressed as ecosystem goods and services into a planning, decision and policy making environment requires accurate information on current stocks of biodiversity, a clear understanding of the drivers and processes that determine that biodiversity, and confidence that this biodiversity will deliver the expected ecosystem goods and services, both now and into the future. However, there is a miss-match of scales at which data on biodiversity expressed as ecosystem goods and services relationships are researched and the scale at which they are then processed and used for policy and decision-making over the environment results in data that is inherently uncertain and this uncertainty has to be translated for policy.

This proposed PhD will focus on this (miss)match between the 'natural scales' at both a spatial and temporal scale; i.e. the spatial and temporal scales of natural variation, process and population dynamics with the 'planning scales'; i.e. those spatial and temporal scales at which planner, policy makers and institutions operate and make decisions. Through its links with BESS-Urban and BESS-Wessex, and based on the scale dependent work on biodiversity and Biodiversity ecosystem services relationships in these projects, the research will use a systematic review of literature, a range of deliberative and participatory social research techniques: It will address the following objectives: characterise the miss-match of the production and use of B-ES data and assess the implications for the socio-environmental system; identify the main policy areas where natural scales in B-ES have the potential to impact policy and decision-making; characterise the UK governance, and stakeholder environment, paying particular attention to the importance of spatial and temporal dynamics; determine how research findings on natural scales in B-ES and inherently uncertain data can be effectively used by planning and policy end-users, thereby imparting long term resilience in outcomes; synthesise the above in a novel and easy-to-use framework that is useful to those making policy and decisions over the environment.

The PhD project will develop a coherent framework which can be used to elucidate the effect of scale on the relationships between biodiversity, ecosystem services and to assess the implications for a planning, decision and policy making environment. This will be based on existing ideas in the literature and draw upon current, relevant work on the analysis of spatio-temporal variation and governance, stakeholders, planning and policy tools. A key part of the study will be in tackling how scientific concepts, language, and information can best be adapted for use in planning, policy, and decision-making.

Ecological priorities and real-world governance in the restoration of wetlands in the Humberhead Levels landscape: Do they differ and how can this be overcome?

Supervisors: Helen Moggridge (Geography, University of Sheffield), Liz Sharp (Geographical & Environmental Sciences, University of Bradford), Lorraine Maltby, Phil Warren (Animal and Plant Sciences, University of Sheffield).

The important role that wetlands have in supporting biodiversity and providing ecosystem services is increasingly recognised and this has provided an impetus for a number of landscape-scale wetland restoration initiatives. Whilst the extensive re-creation of entire wetland landscapes is desirable, this is rarely feasible in the UK; rather, new or restored wetlands must be integrated as patches into existing multi-functional landscapes, interspersed with agricultural land and urban areas. The size, quality, location and connectivity of these patches within the landscape are critical to determining species and landscape diversity and the ecosystem services provided. This presents unique challenges to biodiversity conservation and ecosystem service enhancement, at the interface between ecology and societal issues of perception, preference and governance. This project will examine the ecological and societal opportunities and constraints in relation to increasing wetland functionality using the Humberhead Levels (HHL) Nature Improvement Area as a case study.

The key objectives of the study are: to establish a typology for, and assess the form and spatial structure of, wetland patches in the HHL area, and map onto this known information about major biodiversity patterns (key groups, priority species, conservation designation, etc.), indicators of ecosystem service provision (e.g. flood storage, recreational use, etc.), metrics of ecological functionality (habitat size, connectivity, land use, etc.); to use this information to test whether prioritization of locations for wetland restoration developed from these information sources are coincident, and how the restoration sites in the NIA score on these metrics; to identify the actual decision making processes used in the NIA project, focusing especially on the information used to choose the location and form of intended restoration; to compare the two approaches and the extent to which any disparity results from limitations of ecological information/understanding, or from societal issues, such as contrasting value systems, and the implications of these disparities for ecosystem service provision; to assess, through an evaluated intervention in the HHL process, the potential for evidence exchange or dialogue opportunities to help resolve the differences between ecological and societal restoration preferences in HHL and elsewhere.

The project takes a truly interdisciplinary approach to investigate the opportunities and challenges of wetland restoration within a multi-functional landscape. The study will further understanding of the biological outcomes (both for biodiversity and other ecosystem services) of wetland restoration within the HHL, investigate decision-making processes in the HHL and identify opportunities for evidence exchange. This novel research will have strong academic merit, will have tremendous value to the HHL NIA and have an important application to other landscape-scale conservation projects.