climate change

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Adaptation Research Issues: Natural Environment

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AIM OF THIS PAPER

The recently published Climate Change Risk Assessment 2017 Evidence Report – Summary for Scotland[1] (CCRA) and the independent assessment of Scotland's Climate Change Adaptation Programme[2] (SCCAP) point to a range of research priorities. This brief focuses on what could be explored under the CXC resource within the next 18 months, focusing on the Natural Environment theme.

Headline priorities

Overall both reports call for increased monitoring of current actions, including reviewing their effectiveness and the need for more integrated research approaches, as well as flexible adaptive policy and methods. The following recommendations for research to inform SCCAP2 policy development are based on a review of CCRA and SCCAP and interviews with topic experts (see annex for interviewees). In the short term, CXC should focus their research efforts on the following key issues to help Scotland better adapt to a changing climate in the long-term:

1. Soil management under a changing climate:
    a. What is the extent of soil compaction and erosion across Scotland and how can the management of soil erosion and compaction impact natural flood management?
    b. How will the land-use capability of marginal lands change under future climate change projections and what are the risks from autonomous adaptation to that capability?

[1] ASC (2016) UK Climate Change Risk Assessment 2017 Evidence Report – Summary for Scotland. Adaptation Sub-Committee of the Committee on Climate Change, London.
[2] Committee on Climate Change (2016). Scottish Climate Change Adaptation Programme: An independent assessment for the Scottish Parliament.

2. Improving Scotland's preparedness for future floods and droughts: How effective are current water management practices in managing water quantity and quality at catchment scales?

3. Adapting Scotland's agricultural and forest lands to climate change:
    a. How will land suitability and capability of current agricultural and forested lands change under future climates and what are the implications for the land use strategy?
    b. What are the cost-benefits of potential new opportunities for novel crop production and threats to current crops?
    c. What are the risks to Scottish crops from pathogens under future climate?

RESEARCH PRIORITIES

Soil management under a changing climate

Soil compaction and erosion can exacerbate flooding impacts, including water quality and quantity. They can also lead to reductions in soil carbon storage, making it difficult for Scotland to meet its carbon sequestration targets. A key priority is to know the extent and severity of soil compaction [and erosion] at the national level. To take this forward we suggest:

1. Completing a synthesis study of soil erosion data for agricultural and peat soils in Scotland, including rates of erosion where possible.
2. Exploring the spatial extent of compacted soils in Scotland and superimpose those on future projections of flood risk areas and marginal land-use areas in Scotland.
3. Assessing what information will help land-users understand the impacts of soil compaction and erosion on forested and agricultural soils; and evaluating what methods/approaches will encourage practical uptake of adaptation friendly measures to soil management, maximising the win-win benefits of soil erosion and compaction prevention.

Prime agricultural areas and future woodland expansion areas could encroach on current marginal lands as the climate warms. Such expansions can impact other ecosystem services currently provided by marginal lands and also potentially in the future (ex. biodiversity, cultural services, water supply, carbon sequestration, etc.). Currently there are no policies regulating **marginal land-use** or guidelines for best practices. Autonomous adaptation by farmers could result in unregulated expansions of agriculture into such areas, potentially having adverse consequences for carbon sequestration and flood prevention under future climates.

Therefore, we recommend:

4. Mapping- out the marginal areas in Scotland that may undergo land-use change in the next 20-80 years, in order to inform monitoring and policy development.
5. Assess the ecosystem services currently provided by marginal lands and identify which maybe infringed upon under future climate scenarios and land-use change.
6. Evaluating the costs and benefits of turning marginal lands to forest versus agriculture use, taking into account a range of ecosystem services provided by these lands.

Improving Scotland's preparedness for future floods and droughts

Increased **risk of flooding and drought** in different parts of the country will require integrated and strategic planning for water management.

We would recommend:

7. Exploring the factors influencing increased water scarcity in vulnerable locations, including re-evaluation of land use options .
8. Using a case-study approach focused on the River Dee, examine the overall effectiveness of Natural Flood Management (NFM) schemes at a catchment scale; and how such schemes may influence the magnitude and severity of more extreme floods (for example, 1-in-50 or 1-in-100 year events).
9. Assessing the potential for NFM approaches to maximise wider benefits for carbon storage, water quality and biodiversity, using cost/benefit analysis for NFM measures to understand critical factors, opportunities and challenges under the future climate.

Adapting Scotland's agricultural and forest lands to climate change

Climate change will impact agricultural and forest land uses. For example, the length of the growing season in Scotland is likely to increase, allowing for the **establishment, intensification and spread of novel crops**, such as corn. It is not clear how intensification or establishment of novel crops could impact local biodiversity, which is important to maintain in the long term to make sure our ecosystems are resilient to future changes. At the same time, increased heat stress and drought could **jeopardize current key cash crops** such as winter wheat and potatoes. Recently, the capacity has been developed to model crops at a high spatial resolution and have undertaken some detailed sensitivity testing to carbon, water, nitrogen and temperature combinations – this knowledge could be used in climate impacts studies to indicate the range and types of adaptation that may be required in agriculture. A warmer and wetter climate could also contribute to the **spread of new invasive pests and diseases**, as well as facilitate the overwintering of those pests and diseases that are already present in Scotland. For example, potato blackleg is the most significant bacterial disease affecting potato production in Scotland, and is a longstanding problem as there are no chemical controls or resistant varieties. In Europe, blackleg is caused by different species that have higher optimal temperatures for disease development, therefore there is a major concern that these species could cause increased disease problems as Scotland's climate warms.

Based on the above, we would recommend:

10. A scoping study focusing on the potential to grow and expand novel crops and species in Scotland, such as corn and broadleaf trees, in the next 20-80 years.
11. Map-out areas that are likely to change significantly in farming and forestry extent or practice (e.x. marginal lands) and overlap those with biodiversity hotspots for key species groups.
12. To identify areas that are currently growing winter wheat, barley and potatoes to see to what extent they may be under climatic stress in the next 20-50 years and also phenological mismatches.
13. Using high spatial resolution modelling of crops, undertake a detailed study of sensitivity to carbon, water, nitrogen and temperature combinations for winter wheat, barley and potatoes to inform the range and types of adaptation that may be required in under future climate scenarios.
14. While decisions on the long-term management of the National Forest Estate are generally taking account of climate change and the threat from pests and diseases, there is a lack of data for private forestry. Therefore, a targeted assessment of current practices with respect to future climate change planning and prevention of pests and diseases should be carried out across the private lands.

15. Likewise, while strict rules and regulations are in place to prevent the spread of pathogens from infected stands within an area (ex. by destruction and quarantine), it is not clear what measures are taken by nurseries to maintain a healthy seedling stock. Therefore, a review of Scotland's tree nursery practices, guidelines and regulations would be valuable to develop any future relevant policies to help stop the spread of pathogens.
16. A climate change risk assessment for potato blackleg as a case study, to guide strategies for agricultural adaptation to climate change in Scotland.

ANNEX:

List of Subject Experts interviewed for this brief

Interviewee	Institute	Subject Area Expertise
Allan Lilly	The James Hutton Institute	Soils
Anna Moss	University of Dundee	Climate adaptation
Dominic Moran	Scotland's Rural College	Costs and benefits of adaptation
Mike Rivington	The James Hutton Institute	Extreme weather events
Pete Smith	University of Aberdeen	GHG, mitigation, bioenergy
Peter Skelsey	The James Hutton Institute	Pests & diseases in agriculture
Rob Brooker	The James Hutton Institute	Ecosystem services
Robin Matthews	The James Hutton Institute	Land use change
Ruth Monfries	Royal Botanical Gardens, Edinburgh	Climate Adaptation
Rebecca Audsley	SAC Consulting	Farmer behaviour
Mark Wilkinson	The James Hutton Institute	Natural Flood management
Maria Nijnik	The James Hutton Institute	Adaptation Policy (Land Use)

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