climate change

Scotland's centre of expertise connecting climate change research and policy

Land estates in Scotland: Perceptions of climate change and climate policy Implications for future policy support

Andy J Moffat on behalf of Heriot-Watt University

1. Introduction

ClimateXChange[1] (CXC) is funded to provide robust, independent analysis and evidence to support the process of Scottish Government policy-making and implementation. One strand of CXCs planned work programme has involved analysing the implementation of climate adaptation actions "on the ground" in Scotland. This paper has not been specifically requested by a Scottish Government policy team, but presents policy-relevant interim findings from CXC's ongoing work programme. This paper provides feedback from interviews with land estate managers and their responsiveness to the need for climate change adaptation; and offers reflections on how policy support for these estates can be more effective in future.

2. Key Points

- Rural land ownership in Scotland is 83% private sector, of which 50% is owned by only 432 individuals/companies
- In a small sample of Scottish estates, climate change impacts are acknowledged by estate staff via personal experience, notably of weather extremes. In contrast, government communications of future projections (e.g. UKCP09) are reported as confusing and appear to have little or no influence on business planning processes
- Climate change is not rated as a high priority business risk (as compared to policy and commercial drivers). Nor is it seen as a driver in its own right, but integrated into other management practices
- There is some confusion between climate change adaptation and mitigation; and business adaptation to take up opportunities for renewable energy generation. The latter contributes towards mitigation, but is largely taken up for financial reasons
- Actions and interventions that improve climate resilience are often made in response to drivers and imperatives other than adaptation to climate change. Such actions should be viewed as 'autonomous climate adaptation' (even if they are not recognised as such by their creators)
- Much autonomous adaptation and mitigation may remain 'under the radar' – i.e. undetected - if the language used and the management imperatives experienced by estate and land managers are not recognised by academics and policy makers

Some autonomous adaptation is already in evidence – namely:

- Widened drains
- Winter housing of livestock
- Move away from monocultures in agriculture and forestry
- Improved building performance through insulation and heating
- Provision of buildings and reservoirs to increase operational flexibility
- Improved monitoring and maintenance

Some adaptation for sporting activities already in evidence – namely:

- Catch and Release for wild salmon fishing

[1] climatexchange.org.uk

- Riparian tree planting to increase shade and reduce water heating for fish
- Heather cutting / swiping in regions where high rainfall hinders burning

Policy, research and communications feedback includes:

- Some dissatisfaction with national climate change policy, and the lack of inclusion of land estates in policy development
- Forestry policy and grants in particular singled out as unsatisfactory for estate business
- Feeling government communication about the implications of climate change policy is inadequate
- Research focus and researchers' communications are not seen as useful for the estate sector
- Face to face contact with individuals with understanding of estate business issues is the preferred route – web information not highly rated

Issues arising for Policy and Decision Makers:

- Recognise the preference for 'face to face' communication, and accommodate as far as possible. This bodes well for the proposed 'single hub' advice service
- Explore value in establishing a 'Risk Audit Service'
- Use Scottish Enterprise to support business opportunities associated with climate change
- Recognise the impact of grant structures on land management (e.g. SRDP) and ensure these schemes support resilience and adaptation in a joined-up fashion
- Make effort to communicate more about incremental vs. extreme weather due to climate change

---

3. Climate adaptation and rural land use

To date, adaptation to climate change has largely been studied within single land-uses and scientific disciplines, e.g. agriculture, forestry, built environment, etc. Indeed, CXC has largely structured its adaptation research in this way. Yet, single land-use studies, whilst relevant, are inevitably incomplete and do not indicate the challenges and opportunities of adaptation which are faced at the scale of the (really) dominant economic and managerial rural land-use unit in Scotland, i.e. the estate. Rural landownership in Scotland is such that only forty nine owners accounted for 20% of the privately owned rural land area in 2012 and just 432 owned 50% (Wightman, 2013). Private estates can be very large in size, ranging from over 97,000 hectares (largest) to nearly 8,500 hectares (100th largest). Together, the private sector owns over 83% of the rural land in Scotland (Wightman, 2013), a much greater proportion than the more intensively studied public sector (12.1%).

Estate managers operate across a range of land-uses and deliver a wide range of ecosystem goods and services. This is likely to give them a variety of opportunities and perhaps more flexibility in adaptation, and these cross-sectoral issues should be understood more clearly so that policy makers can develop appropriate instruments. It is also important to learn more about how land managers are seeking to integrate adaptation and mitigation via changes in land-use (e.g. towards forestry) or changes in business and income generation, and the extent to which current government policies are supporting or hindering this. In addition, a case study approach which seeks to showcase good examples of adaptive management at estate level can be used to communicate the needs for, and opportunities of, adaptation to the land-based sector, a methodology recognised in the draft Scottish Climate Change Adaptation Programme published in June 2013 (Scottish Government, 2013).

Social research into land manager attitudes to climate change adaptation is already underway. Probably the largest recent input has come from researchers in Scotland's Rural College (SRUC, formerly SAC). Farmers'

attitudes to and perceptions of climate change have been studied (Barnes and Toma, 2012; Islam et al., 2013; Barnes et al., 2013a, 2013b). In forestry, a small study of forest managers in Wales has been performed (Lawrence and Marzano, 2013) and a broader study of owner motivations for forest management in the UK (Lawrence and Danby, 2014). Further research in Scotland is planned by members of Forest Research, but this will again focus on the forestry sector *per se* (Anna Lawrence, pers. comm.).

This small study, perhaps for the first time, has examined attitudes *across* traditional sectors and policy boundaries at the scale of the Scottish Estate, an area which other commentators have suggested is in need of research (Sutherland et al., 2011). Research into the interconnectivity of the component subsystems allows issues such as market responses and the very perception of risk (which do not necessarily have a clear process based dependency on climate drivers) to be observed and recorded. Given the long length of time that many of the estates have been in the same ownership, another value of study at the estate level is that it facilitated understanding of the degree of "autonomous adaptation" that is taking place irrespective of climate change policy drivers.

4. Climate change impacts

The first Climate Change Risk Assessment for Scotland scoped the main climate change impacts (HR Wallingford, 2012). The following summary is taken from the Scottish Government's Adaptation Programme webpage[2]

> With a future of generally warmer weather, drier summers and wetter winters, Scottish agriculture may experience positive change in some areas and negative change in others, including an increased risk of extreme weather event damage such as droughts or floods.
>
> Scottish agriculture may experience positive change in some cases such as increased productivity in agriculture and forestry, with central, eastern and southern parts of Scotland likely to benefit the most where other conditions are not limiting. Primary producers in Scotland may also benefit from both improved growing conditions and higher global food prices. However, these positive impacts could be largely or entirely offset as there may also be negative consequences that would likely result in a decline in agricultural and forest productivity. An increased prevalence of pests and diseases, affecting either livestock or crops, and of drought conditions would reduce yields and any reduction in soil function. Flooding may result in crop damage, increase soil erosion and inflict longer term damage to high quality agricultural land.
>
> Land based businesses are also well placed to help wider society adapt to climate change, most notably through managing flood risk and enhancing biodiversity.
>
> A more detailed recent review is provided by Werritty and Sugden (2012).

5. Policy environment

Scottish policy on climate change and rural land-use has evolved significantly since the Scottish Parliament was established in 1999. There is a strong influence from the European Union in the form of the Common Agricultural Policy (CAP) and the (Scottish) Rural Development Programme (SRDP), both of which administer significant grants to landowners and managers. As well as supporting rural businesses, there is a strong component of environmental management in these instruments, and one of the "key outcomes" of the SRDP

[2] http://www.scotland.gov.uk/Publications/2013/06/2469/4

is 'adaptations to mitigate climate change' (Thomson, 2010). Forestry policy, too, is based on principles of 'sustainable development' (Forestry Commission, 2011), and the importance of mitigating and adapting to climate change is now fully embedded. Policy for semi-natural habitats has also been 'climate-change proofed' (SNH, 2012). A range of government-sponsored agencies and initiatives have been created or developed to support climate change adaptation. These include:

- Adaptation Scotland
- ClimateXChange (CXC)
- Scotland's Environment and Rural Services (SEARS)
- SRUC's 'Farming for a better climate'

As well as working through the individual land-use sectors, the Scottish Government published Scotland's Climate Change Adaptation Framework in 2009. From it, a series of sector Action Plans have been produced to identify specific actions required from government. The draft Scottish Climate Change Adaptation Programme was published in June 2013[3] and includes a range of policies to be delivered, again identifying government departments or agencies as the main agents to do so.

Rural businesses can benefit from involvement and partnership with Scottish Enterprise, designed to support business growth. Renewable energy and low carbon technologies are two of the stated strategic priorities for this organisation[4].

6. Study methodology

This study explores adaptation on three estates of contrasting size. The sample estates were chosen to cover a wide range of enterprises. The existence of any published environmental or sustainability statements which identify an understanding of climate change issues was also taken into account in selecting the case study estates. The final choice was taken in conjunction with staff in Forest Research in order to prevent study overlap and the potential for interview fatigue during more detailed research (see p.3). At the chosen estates, appropriate members of staff (Table 1) were interviewed using a structured approach. A fourth estate provided written responses to the questions posed to the others. The following issues were explored:

- Adaptation philosophy - how does it play to formal/informal analysis of risk within the Estate business(es)
- Adaptation leadership and management for the Estate; at what level(s) is it deployed? How is it integrated with other business functions and corporate affairs?
- Adaptation across land-use and between land-use: constraints and opportunities? Trade-offs and/or synergies; the degree of autonomous adaptation
- The relation between drivers for climate change mitigation and adaptation; principal drivers/motivations for each
- The relationship between climate change and other, related, drivers for building resilience, notably flooding, storm damage and risk of pests and pathogens

[3] http://www.scotland.gov.uk/Publications/2013/06/2469/downloads
[4] http://www.scottish-enterprise.com/about-us/what-we-do/strategic-priorities

Table 1. Diary of interviews/response received

	Date	Interviewees	Estate/Company	Area (ha)
1.	26th February 2014	Henry Birch (Factor), Ian Fleming (Estate Manager), Sally Watts	Douglas and Angus Estates	18,750
2.	26th February 2014	Michael Bruce (Owner)	Glen Tanar Estate	11,825
3.	28th February 2014	Anne Gray (Policy Officer)	Scottish Land & Estates	n/a
4.	4th March 2014	Andrew Bruce Wootton (General Manager)	Atholl Estates	50,250
5	14th March 2014	Robert Balfour (Owner and Managing Partner)	Balbirnie Estate	2,800

- Costs of adaptation - and perceptions of costs as investment? How does this affect wealth creation?
- Relative timescales for adaptation - any influence on policy and practice (e.g. between forestry and agriculture)
- Benefits of considering adaptation across other estate business interests (e.g. sport, leisure)? Any examples to date?
- Attitude to 'learning by doing' - any good examples?
- Dependency (or otherwise) on government/non- government science/research/expertise? Role of consultants and other specialists or advisors (e.g. agronomists)
- Interest in participating in an adaptation network (?)
- Are messages and Scottish Government policies supportive or counteracting? Suggestions for more effective support
- Suggestions for further research, and prioritisation

The interviews were devised to gain an understanding of estates' responsiveness to the need for climate change adaptation, to identify messages for policy makers in order that more effective policy instruments may be devised, and to produce a case study of adaptation response, as an example to the estates sector as a whole of how adaptation can be beneficially embraced. There was particular focus on estate activities and attitudes in relation to:

- Scottish Government (SG) land-use and climate change policies;
- current SG (and EU) agricultural, forestry, energy and land-use subsidies and other support mechanisms;
- current SG (and EU) agricultural and other land-use Laws and Regulations.

Interviews were variable in length (20 minutes to almost two hours) depending on the available time that interviewees could give. Interviews were recorded and transcribed, and then analysed for relevance to the project research questions. In addition to the interviewees identified in Table 1, a further interview was carried out with an environmental consultant who has an active role in advising estates on matters related to climate change. This interviewee requested anonymity.

7. Results

Interviewees were enthusiastic about the opportunity to communicate their experiences and thoughts on estate adaptation in the face of climate change, and conversations ranged widely, covering mitigation projects (e.g. renewable energy, carbon offsetting, energy efficiency) as much if not more than adaptation and resilience building per se. There was much concurrent thinking between estates, though with obvious differences depending on size, location and types of businesses[5]. Important points are grouped under the following main headings below:

- Perceptions and understanding of climate change
- Effect of climate change on estate business(es)
- Impact and relevance of Scottish Government climate change policies

7.1 Perceptions and understanding of climate change

All interviewees were aware of climate change and confirmed that some changes in climatic phenomena (notably winter rainfall) had already been experienced. All appeared to accept that, in part at least, climate change was anthropogenic in origin, and that individual actions could be taken to exacerbate it - or, to some degree, to mitigate it.

Nevertheless, there was much less appreciation of the clarity of the climate change 'signal' - and some understandable confusion about how to adapt to a climate which has been extremely variable over recent years. Extreme weather conditions appeared to have a much greater effect on estate consciousness over climate change than official predictions made by UKCIP and published through government auspices. In fact, the latter seemed to have little or no influence on business planning processes, and this is probably as much due to the lack of message reception than the nature of the message itself.

In the context of business risk, climate change was perceived as far less important than key influences such as political direction and the nature and level of financial support through CAP, SRDP etc. Nevertheless, estates were conscious of the opportunities afforded by government priority for renewable energy, itself partly driven by climate change mitigation obligations. Adaptation was interpreted as meaning adapting the estate business model to encompass renewable energy and energy efficiency projects rather than building estate resilience against the likely effects of future climate change (see below). Such confusion may be partly driven by language used in government publications and websites, where the principal focus is on taking mitigating action to reduce carbon dioxide emissions and increase energy efficiency – such actions can be interpreted as ‘adaptation’ in the context of business development. It was noticeable that during interviews with the three estates, the terms ‘adaptation’ and ‘mitigation’ were rarely volunteered, and discussion centred primarily on ‘climate change’.

7.2 Effect of climate change on estate business(es)

This study detected a feeling amongst the seven interviewees that estates were ‘in control of their destiny’ with respect to climate change, and working at an appropriate pace and scale. They exhibited a working, if not fully effective, understanding of climate change and optimism that they could adapt satisfactorily and successfully. In other words, no fears were expressed of the impossibility of maintaining business models or that extremes of climate change might seriously disrupt ‘business as usual’ principles. ‘Corporate’ or ‘organisational’ memory, derived from long-term ownership and management of the estates was put forward

[5] Though the very small sample size needs to be borne in mind when drawing comparisons.

as one reason why estates were able to assess the implications of a changing climate. Another was the ability and skills of the estate workforce to observe and interpret climatic phenomena.

The most significant changes in estate business related to climate change policies are those related to mitigation. The estates surveyed have seemingly embraced opportunities to diversify into renewable energy, and depending on geographical location and resources available (e.g. favourable wind resource and supportive planning regime, river gradients or forestry for biomass), each has at least one renewable project. Uptake has been encouraged by financial incentives and where opportunities fit in well with existing infrastructure and/or future business need(s).

In contrast, adaptation to build resilience shows small incremental steps. Nevertheless, several examples of adaptation behaviour are taking place on the estates sampled. These include:

- widening of drains and/or converting to open ditches for removal of excess rainfall;
- increased winter housing of farm stock, principally cattle and sheep, due to increased winter rainfall;
- conversion of monocultures in agriculture and forestry to more diverse systems;
- reducing the weight of machinery used in soil operations; changes to soil cultivation techniques;
- heating of buildings to contend with adverse weather conditions, and improvements in insulation;
- investment in general purpose sheds, enabling more 'forward selling' of crops;
- investment in reservoirs to store water for use in summer months (e.g. irrigation of potatoes);
- greater attention to monitoring and maintenance across the estate.

Such adaptations are based primarily on 'in house' observation and interpretation rather than recourse to expertise or authority.

Although there was evidence of adaptation in several parts of estate businesses, there was also a form of a fatalistic approach in places, with a reluctant acceptance that climate change was likely to be contributing to a reduction in business efficiency or profitability. In some cases, notably in respect of shooting and fishing interests, estates appeared to take a tolerant view, accepting that failing parts of the business would be supported by other parts that were in profit if adaptation was only partially successful.

There exists a strong desire to maintain traditional estate business elements such as shooting and fishing, even though these are increasingly affected by adverse climate phenomena such as heavier rainfall in autumn and winter. However, there is some good evidence of adaptation responses to support sporting interests, three of which are noted here. Firstly, there has been the voluntary implementation of a 'catch and release' system for those fishing important salmon rivers. This recognises that in the face of changing climate, salmon populations can be maintained if anglers agree to return fish to the water in good condition once caught. Secondly, riparian tree planting is taking place in some catchments, partly to help reduce river water temperature in summer months and thus preserve suitable fluvial environments for fish to survive and spawn. Other responses include the trialling of heather cutting or swiping instead of muirburn which is increasingly difficult in areas experiencing increased rainfall.

To a significant degree, resilience building is seen as a response to other policies than climate change, particularly nature conservation, good farming practice, and improving business efficiency. For example, changing from monocultures to more diverse husbandry in both agriculture and forestry was seen as a good thing in its own right, improving the landscape and supporting communities, rather than as an appropriate response to the impacts of climate change.

Climatic variability (rather than climate change per se) is inevitably already experienced, understood and encapsulated in estate businesses and in management operations (e.g. at farm level). Although there was a sense that extremes of weather are getting larger, probably driven by climate change, there remained a strong optimism that these could largely be managed through existing systems but with increased vigilance and greater attention to maintenance and renewal (especially of properties). These sentiments could be interpreted by some as being complacent but they actually underline an important message: ***that estates do not look upon climate change adaptation as a separate driver for change, but one that is implicitly and intuitively built into current management processes and business models***. Another factor which plays to this approach is that of the timescales for estate planning which are traditionally long. Thus, the need to implement significant and widespread changes to current practices was generally rejected in favour of a 'softly softly' approach, allowing smaller changes to be explored and evaluated before wider and larger scale application.

Opportunities to effect changes in management, for example driven by an appreciation of the need for resilience building, can be complicated by the need to respect farm tenancies and farm tenancy agreements. Tenants were regarded as working to a much shorter time-frame than the families or businesses owning the estates, and with a focus on annual financial accounting rather than taking a long term view that family ownership can give. Therefore, significant changes in land-use practices needed to be explored between landlord and tenant and negotiated to a 'win win' position before implementation could be expected. This took significant time and energy, and could also involve community consultation too.

Estate response to climate change is facilitated (in the study sample) by integration of the various business elements and therefore the ability to effect changes across land-use 'boundaries'. In all cases, senior management had a wide and all-embracing view of the business model for the estate and seemed able to act in a synergistic way when changes in management practice or infrastructure investment (linked to climate change) were foreseen.

The intricacy of estate businesses means that it is perhaps more difficult to rigidly define and separate mitigation from adaptation activities than when dealing with simple business built upon one land use (e.g. horticulture, forestry). So for example, the building of a biomass energy plant to heat estate buildings can be viewed as contributing to Scotland's target for renewable heat generation. But it is also responding to changing climate and significantly higher rainfall, through the use of the generated heat to dry grain or wood chip on the estate. Another example of a synergy between mitigation and adaptation is the planting of woodland suitable for black grouse habitat in order to offset losses of forest area involved with wind turbine installation. Despite a relative lack of focus on climate change adaptation, as discussed above, **the consequence of an effective renewable energy driver has been to facilitate some valuable adaptation actions on the estates sampled**.

There was some evidence of a willingness to significantly modify existing land-use (e.g. by tree planting), but this is very limited at present. Afforested land was variously perceived as supporting vermin, causing run-off and being an unwelcome change to the estate landscape.

7.3 Impact and relevance of Scottish Government climate change policies

The study identified that the main reasons for changing estate business models to account for climate change are ***commercial***; estates are respectful of the natural and semi-natural environment upon which their businesses are largely built, but as businesses, decisions around adaptation have to be financially sound – this criterion is inevitably tested over the short rather than the longer term.

The climate change policies with most recent relevance to estates are those related to energy generation and energy efficiency, mainly because of the financial incentives associated with them. Carbon is another issue

which some estates are beginning to take an interest in, e.g. carbon certification for woodland or peatland resources. Other existing policies, most notably for wildlife habitat, impinge, generally synergistically, on managing estate land for resilience, though these do not generally conspicuously carry with them a climate change adaptation benefit.

Forestry policy, exercised through financial incentives to plant and manage woodland was rejected by all respondents as totally inadequate or associated with an unacceptable form of control. One respondent suggested that generally only forestry consultants and contractors profit from forestry unless sufficiently large scale planting for quality timber can be achieved. This is a challenging and undesirable step to take for the estates visited in this study. Thus there was reluctance or refusal to engage with Forestry Commission Scotland, and thus an opportunity lost for forestry policy related to climate change to be shared, negotiated and implemented. The future of forestry in Scotland is under debate at present[6] and there is little doubt that the issues raised in this study will be discussed in depth in the future. More broadly, Scottish government policies for a national response to climate change were largely seen as the responsibility of government to execute – there was a view that these were largely remote from the front line responsibilities and concerns of estate managers.

There appeared a heart-felt view that the concerns of and priorities for estates were not listened to and understood at governmental level, or reflected in policy. In addition, there were examples of conflicting or disjointed policies or policy instruments reflecting the view that climate change was such a broad issue that it wasn't being executed effectively through the 'narrow focus' of sector policy leads. For example, mention was made of 'rewilding' and natural regeneration policies conflicting with those which seek to build protection from wildfire. The short term nature of many government grants and other financial incentives was also raised as an impediment to investment in adaptation (and mitigation) measures.

In common with information exchange in broader aspects of Scottish land-use policy (Sutherland et al., 2011), communication of climate change policy was seriously criticised. Publication of key elements of policy on government websites was considered as ineffective and remote from the 'day job'. Instead, there was general support for opportunity to have detailed dialogue with expert advisers, though some negative experience with those regarded as inexpert or 'going through the motions'. Researchers were largely regarded as poor communicators and out of touch with the practical problems faced by estates and their managers. Little attempt was made to use them for advice on climate change or its consequences; this was drawn from consultants as required.

8. Discussion

This study, though limited in the number of estates sampled, has shown a degree of unanimity in their regard to current policy and the way it is deployed. Interviewees pointed to the complexity of the policy landscape, especially in the context of gaining grants, and gave examples of conflicting or overlapping policy directions. These included the lack of adequate grant to support woodland planting, or market for carbon storage. Interviewees felt that policy making was remote from those affected by it. The need for better policy integration has been remarked upon by other commentators (Milne et al., 2010; Thomson, 2010). These authors pointed to the potential of the Scottish Land Use Strategy to improve integration, whilst others have emphasised the value of taking an ecosystems approach (e.g. Reed et al., 2009). Nevertheless, the trade-off between increasing integration whilst introducing undesirable complexity in policy delivery (e.g. through advisory services or in devising and administering financial instruments) should also be recognised and mitigated against as far as is appropriate.

[6] For example, http://www.scotsmanconferences.com/viewconference.aspx?id=43

Although more is needed to communicate the importance of adaptation and incentivise its take up, adaptation is occurring on many estates. However, it appears to be driven mainly by motives other than preparing for climate change *sensu stricto*. Autonomous adaptation is thus taking place, the result of an intimate knowledge of estate business. Such adaptation may be comparatively invisible to adaptation auditing processes, and further work is warranted to examine how best to continue to monitor adaptation take-up at national level.

Nevertheless, estates remain exposed to climate change risk inasmuch as they do not appear to formally analyse their level of exposure and vulnerability and appear to only address those risks where there is already evidence of change. Preparedness for extreme events is 'patchy'. Adaptation Scotland's (AS) 'Climate Risk Management Plan' template for businesses was not known by interviewees, though this may be due to its relatively recent arrival, and AS might seek to use Scottish Land & Estates to publicise it. A 'risk audit service' involving expert advisors may be a possibly better way to make progress, as it would involve face to face interaction rather than simple reliance on web-based browsing.

Some recent research (e.g. Evans et al., 2013) has suggested that focusing on financial incentives to encourage change may be partly ineffective or counter-productive. This study has identified that whilst some forms of adaptation have been adopted because they fit into the overall management model for the estate, most have occurred because they have been regarded as financially sound, and many have been catalysed by grants of various kinds. Some estates wish to be regarded favourably from an environmental standpoint, as is evidenced by the environmental or sustainability statements on some estate websites. But this was by no means a common phenomenon, suggesting that adaptation campaigns which rely on the importance of 'prestige value' are likely to be relatively unsuccessful.

More work is required to articulate adaptation for building resilience in contrast to adaptation of estate business to support mitigation (see p. 6). It would be useful to map opportunities for building resilience using existing financial instruments such as CAP, SRDP etc., which already provide measures for business 'restructuring', 'upgrading of infrastructure' and 'diversification', concepts closely aligned to adaptation. Such an approach could help roll out adaptation responsibilities beyond government, which is currently regarded by some estates as the main 'player' for climate. An approach using existing web and other communication portals well known to the agriculture and forestry land-use sectors seems more likely to succeed than continuing to regard climate change separately and to expect the land-use community to make appropriate connections themselves.

There is a further need to clarify and better explain the dual impact of 'incremental' and extreme effects of climate change, and particularly how to communicate the importance of the latter risk in estate future planning. One approach to explore might be whether risk management systems used in the context of national emergency (e.g. ISO 31000:2009[7]) might have some value, notably their principles of risk 'Reduction', 'Readiness', 'Response' and 'Recovery'. Certainly, these concepts are already well known by some Scottish land managers in the context of managing wildfire risk[8].

Another approach, not mutually exclusive to that above, is to rebrand climate change in the context of business opportunity, and consider strengthening the linkage with Scottish Enterprise (SE) to sell the concept more effectively, including adaptation for resilience as appropriate. The current uptake of support from Scottish Enterprise by Scottish estates has not been investigated during this study, but it is clear that some larger estates have a business relationship with SE which might be broadened to encapsulate adaptation. This would probably require a cross sectoral review of current financial mechanisms for adaptation support.

[7] http://www.iso.org/iso/iso31000
[8] http://www.scotland.gov.uk/Publications/2013/10/6118

A brief discussion with SE suggested that there is currently little or no formal communication between SE and climate change adaptation policy makers, but also a willingness to engage with them in future.

From the small sample in this study, estates seem to prefer face to face contact for knowledge exchange on matters such as climate change. The proposal to "establish a co-ordinated Advisory Service delivered through a Scottish Government hub with a singular brand identity to build customer recognition and designed to help farmers, forest holders, other land managers improve their economic and environmental performance"[9] is therefore to be welcomed. The new Advisory Service should be examined for its ability to provide 'front-line' information and expert advice on 'adaptation for resilience' too. Opinion collected in this study suggests the advisory staff must be suitably qualified, with the ability to take a cross-sectoral view and to understand estate business motivations, if they are to succeed in effecting changes identified as desirable by policy makers.

Demonstration projects, as endorsed in the draft Scottish Climate Change Adaptation Programme (Scottish Government, 2013) seem to have a part to play in spreading the word about good adaptation practice and they may also involve face to face knowledge exchange. Further work is needed to understand the best ways to involve estates in this endeavour, and how to communicate effectively with appropriate estate personnel. Scottish Land & Estates have stated that they are willing to help deliver this policy objective through their well-established communications network with the estates in their membership. However, the involvement of appropriate SG divisions and agencies is central to S L & E's ability to undertake this role.

The Scottish research community is seemingly regarded as too remote and this issue requires further analysis. From our sample, interviewees asked for researchers to work with land managers to help prioritise research need and to scope suitable research outputs. There may be a role for both ClimateXChange and Scottish Land & Estates to support these processes.

9. Conclusions

This small study has revealed a 'snapshot' of some estate attitudes and responses to climate change adaptation. It shows an interesting degree of autonomous adaptation and other actions for building resilience driven by commercial objectives - and reveals that such actions might go undetected if enquiries were based solely on terms such as 'climate adaptation' and 'climate resilience'. Nature conservation policies have also helped build resilience. Nevertheless, amongst estates sampled, the study points to a perception of a complex, remote, non-integrated, overlapping or conflicting policy environment related to climate change adaptation. The study has also indicated that there is a gap in the communication of government adaptation policy to some Scottish estate managers and owners – in places, this is considerable. The remaining part of the report has explored the potential to modify these positions, primarily by integrating across the policy landscape, developing existing lines of communication and using public and private agencies in closer partnership.

Acknowledgments

I wish to thank all interviewees for the generous time and insightful evidence they gave and Heriot-Watt University, in particular Kate Beckmann, for supporting and providing feedback on the study.

[9] http://www.scotland.gov.uk/Publications/2013/12/7550/291114

References

Barnes, A.P. and Toma, L. (2012). A typology of dairy farmer perceptions towards climate change. *Climatic Change* 112(2), 507-522.

Barnes, A.P., Islam, M. and Toma, L. (2013a). Heterogeneity in climate change risk perception amongst dairy farmers: A Latent Class Clustering Analysis. *Applied Geography* 41, 105-115.

Barnes, A.P., McCalman, H. and Buckingham, S. (2013b). Farmer decision-making and risk perceptions towards outwintering cattle. *Journal of Environmental Management* 129, 9-17.

Evans, L., Maio, G.R., Corner, A., Hodgetts, C.J., Ahmed, S. and Hahn, S. (2013). Self-interest and pro-environmental behaviour. *Nature Climate Change* 3, 122-125.

Forestry Commission (2011). *The UK Forestry Standard*. Forestry Commission, Edinburgh.

HR Wallingford (2012). *A climate change risk assessment for Scotland*. Defra/Scottish Government, London/Edinburgh.

Islam, M., Barnes, A.P. and Toma, L. (2013). Climate Change scepticism among farmers. *Journal of Environmental Psychology* 34, 137-150.

Lawrence, A. and Marzano, M. (2013). Is the private forest sector adapting to climate change? A study of forest managers in north Wales. *Annals of Forest Science* DOI 10.1007/s13595-013-0326-4

Lawrence, A. and Danby, N. (2014). Private landowners' approaches to planting and managing forests in the UK: What's the evidence? *Land Use Policy* 36, 351-360.

Milne, J., MacDonald, J., Dobbie, K.E. and Crothers, D. (2010). Future policy needs: rising to the challenge. In: *Agriculture and the Environment VIII. Climate, Water and Soil: Science, Policy and Practice* (eds K. Crighton and R. Audsley), SAC/SEPA, pp. 165-171.

Reed, M.S., Bonn, A., Slee, W., Beharry-Borg, N., Birch, J., Brown, I., Burt, T.P., Chapman, D., Chapman, P.J., Clay, G.D., Cornell, S.J., Fraser, E.D.G., Glass, J.H., Holden, J., Hodgson, J.A., Hubacek, K., Irvine, B., Jin, N., Kirkby, M.J., Kunin, W.E., Moore, O., Moseley, D., Prell, C., Price, M.F., Quinn, C.H., Redpath, S., Reid, C., Stagl, S., Stringer, L.C., Termansen, M., Thorp, S., Towers, W. and Worrall. F. (2009). The future of the uplands. *Land Use Policy* 26S, S204-S216.

Scottish Government (2013). Climate Ready Scotland: Scottish Climate Change Adaptation Programme. Draft Scottish Climate Change Adaptation Programme Required by Section 53 of Climate Change (Scotland) Act 2009. Scottish Government, Edinburgh.
http://www.scotland.gov.uk/Resource/0042/00426516.pdf

SNH (2012). *Climate change and nature in Scotland*. SNH, Edinburgh.

Sutherland, L-A., Barnes, A., McCrum, G., Blackstock, K. and Toma, L. (2011). Towards a cross-sectoral analysis of land use decision-making in Scotland. *Landscape and Urban Planning* 100, 1-10.

Thomson, K. (2010). Devolution and delivery: recent rural policy-making in Scotland. Proceedings of the 11th Seminar of the European Association of Agricultural Economists, Rural development: governance, policy design and delivery, Ljubljana, Slovenia.

Tompkins, E.L., Adger, W.N., Boyd, E., Nicholson-Cole, S., Weatherhead, K. and Arnell, N. (2010). Observed adaptation to climate change: UK evidence of transition to a well-adapting society. *Global Environmental Change* 20, 627-635.

Werritty, A. and Sugden, D. (2012). Climate change and Scotland: recent trends and impacts. *Earth and Environmental Science Transactions of the Royal Society of Edinburgh* 103, 133-147.

Wightman, A. (2013). *The poor had no lawyers. Who owns Scotland*. Birlinn Ltd, Edinburgh.