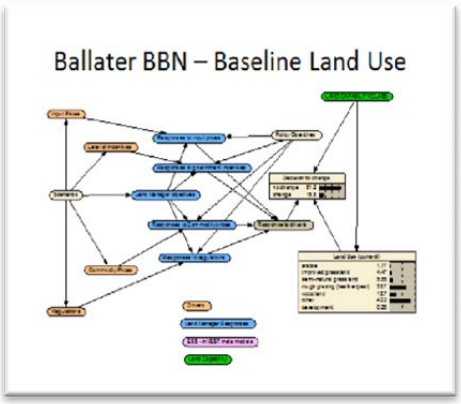
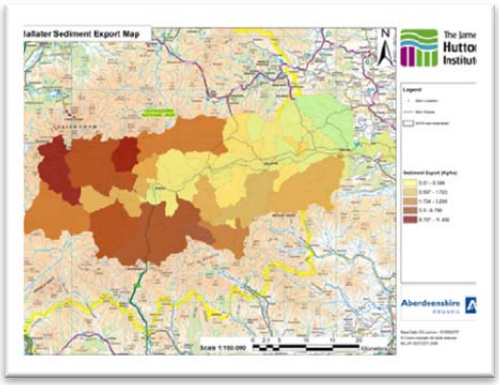
Land Use Scenarios Workshop Report

Workshop held at the Glen Lui Hotel, Ballater

17th November 2014





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Acknowledgments

Thanks to the participants for their insightful and useful comments and good humoured energy during the activities. The James Hutton Institute's research and staff time, which allowed us to attend the workshop, was supported through the Scottish Government's Research Rural and Environmental Science and Analytical Services Division 2011-2016 (RESAS). The report reflects the views of the authors and not necessarily those of Aberdeenshire Council or the James Hutton Institute. A draft was sent to participants and feedback has been incorporated to this final version.

Executive Summary

The third and final workshop to support Aberdeenshire's Regional Land Use Pilot was held in Ballater on 17th November 2014, attended by nine participants representing a range of perspectives on local land use issues.

The workshop focussed on discussing three scenarios representing possible futures for the Ballater area. The scenarios were based on three developed as part of the National Ecosystem Assessment process for the UK and consider global and national drivers of change, providing three contrasts – a world following our current trajectory 'Go with the Flow'; a world where Scottish Government has promoted protection of ecosystem services 'Nature@Work' and a world where Scotland is much more exposed to market forces 'World Markets'.

The participants used a Multi-Criteria Decision Aid (MCDA) process to compare the effects of these scenarios on 21 criteria covering economic, environmental and social issues (e.g. availability of labour and skills; ecosystem resilience; cost of living for local residents). Overall, Nature@Work received the highest average score based on the degree to which participants thought it met the 21 criteria and how important these criteria were to each individual. However, the MCDA process was interesting in illustrating which criteria were important to everyone; and where there were divergent opinions about the importance of criteria, or how they might be affected by the scenarios. Despite the differences in scenarios, the discussions illustrated some common themes around how the Ballater area might respond to changes such as how to reconcile competition for land between arable expansion, housing and flood protection.

The participants were then shown the results of a Bayesian Belief Network (BBN) model, which calculates potential changes in variables if another variable in the 'network' were to alter. Using the same three scenarios, the BBN suggested whether land managers might change their land use in response to drivers; how land use might change; and what effects these changes might have on ecosystem services. Overall, the BBN suggested there would be little land use change in the area, with the most occurring under a World Market scenario, but even then only 1 in 4 land managers might change. Land use changes would generally see increases in arable and improved grassland at the expense of semi-natural and rough grazing land uses, with woodland neither contracting nor expanding by much in any scenario. Increases in arable and improved grassland would lead to increased food production. These results were then used to generate results regarding 'regulating' ecosystem services. In all three scenarios, the model suggests that carbon, nutrient and sediment emissions will increase, albeit Nature@Work shows the lowest increase. In particular, the model suggests that World Markets could see a considerable increase in carbon emissions.

Participants provided many useful comments on the model results and suggestions for future refinements. The results were not intended to be accurate predictions but to provide material for debate. Overall, the combination of participants' knowledge and their responses to the scenarios and modelled results did stimulate new ways of thinking about the complexities of land use change and the trade-offs that are involved. The results from the evaluation of the workshop suggest that the three workshops had increased people's ability to think about multiple issues associated with land use and that the material could be used as part of a wider process to consider how perceptions of land use benefits could inform policy making and grant appraisal processes.

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Introduction

This report reflects the results of a workshop held in the Glen Lui Hotel, Ballater, on the 17th November 2014. The workshop was part of the Aberdeenshire Regional Land Use Pilot. Aberdeenshire is one of two areas in Scotland piloting the Scottish Land Use Strategy (the other area being the Scottish Borders).

The Scottish Land Use Strategy aims to promote the inclusion of multiple benefits from the land into land use decision making based on an 'Ecosystem Approach', which has been defined in the following way:

> "A strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way, and which recognises that people with their cultural and varied social needs are an integral part of ecosystems." (Scottish Government, 2011)

The workshop was organised and implemented by researchers from the James Hutton Institute, and was the last in a series of three workshops carried out in two local areas in Aberdeenshire, Ballater and Huntly.

The overall aim of the workshops was to elicit local input and feedback to the Aberdeenshire Regional Land Use Pilot and to get a local perspective of issues surrounding land use, land use decisions, benefits and services provided by the land and how these are influenced by policies and other factors.

The first workshop had focused on i) the benefits and services provided by the local area, and ii) the factors influencing land managers' decisions about land use. In the second workshop the focus was on i) a conceptual model illustrating the links between decision making and benefits and services from the land, and ii) the goals of the land use strategy and how particular policies might help reach these goals and what impacts they might have at the local level. The third and final workshop focussed on possible future scenarios and the implications these might have on land use and benefits, and also revisited the model of decision making and land use. The aim was to encourage participants to evaluate potential future scenarios in a systematic way, and to present and gather feedback on the predictions the decision making and land use model made for these future scenarios. The structure and results of this last workshop are presented in more detail below.

Participants

Table 1 below highlights the types of stakeholders who attended the workshop. A full list of the participants can be found in Annex 1.

Table 1. Types and numbers of workshop participants

	Numbers attending the workshops
Land managers	1
Community groups	2
National agencies/ NGOs	2
Local agencies/ NGOs	2
James Hutton Institute	1 (+3 facilitators)

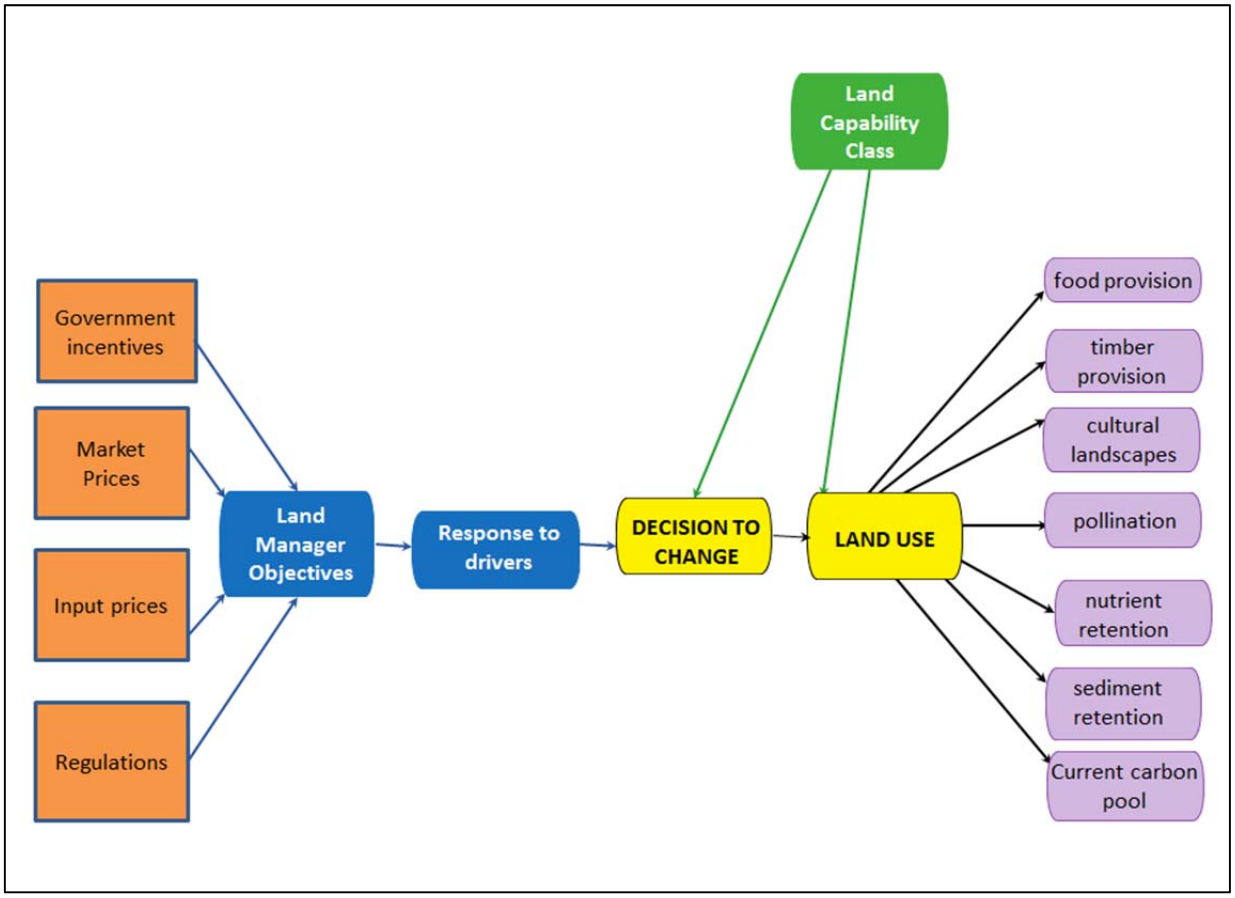
Part 1: Presentation and feedback on the baseline model

In the first part of the workshop participants were presented with the refined version of the decision making and land use model. The structure of the model had been changed (Fig. 1) to take account of some of the suggestions from the second workshop. However, it had not been possible to incorporate all the suggestions and feedback from the second workshop as this would have made the model too complex and models such as this are limited both with regard to the number of factors and to the types of connections between individual elements that they can handle.

The model thus constitutes a hugely simplified representation of land use in the Ballater area. However some of the suggestions and feedback on the model structure received during the second workshop were instead used in the construction of the future scenarios or as evaluation criteria for the scenarios (see Part 2 of this report, below) and were therefore still incorporated in the workshop activities. Other suggestions will be used to inform further developments of the model and research in this area over the next few years.

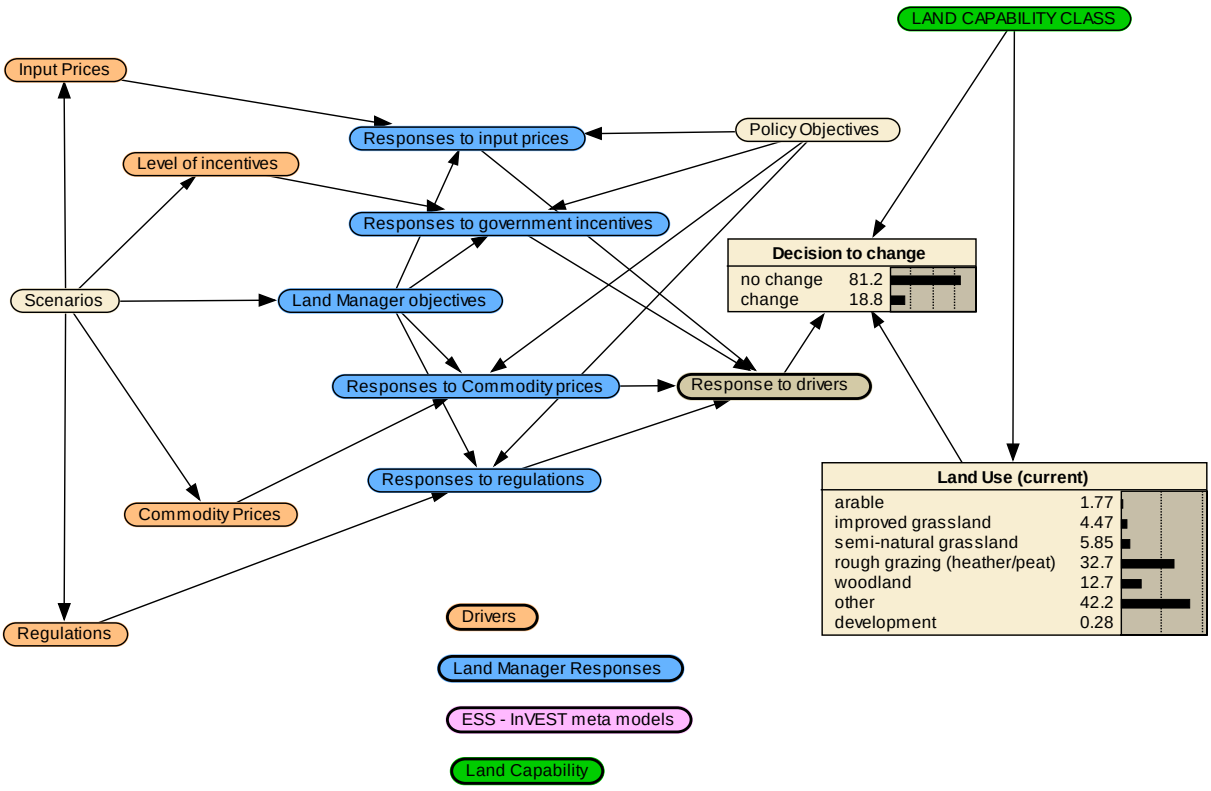
Appendix 2 lists the modifications to the model that participants suggested at the second workshop and how this information had been used.

Figure 1: Structure of the model of land use decisions, land use and benefits & services from the land. The arrows in the diagram show the direction of influence which are captured in the model.



The model was converted into a 'Bayesian Belief Network' (BBN) (Fig. 2). This type of model attempts to show how different influences (factors) affect the likelihood of something happening or changing. It does not make absolute predictions about what will happen, but predicts the probability of different outcomes as the result of a change in one factor. Each 'box' represents a 'variable' in the model and the connecting arrows represent the relationships between these variables. The model result can be modified by changing the values in one of the boxes. This will update the probability for the remaining variables in the model. For example, if changes are made in the regulation box, the model takes account of the fact that different land managers will respond in different ways to this change. In turn, the land use box will take account of the likely different responses by land managers to changes in regulations and will show the likelihood of change in the proportions of land used for different purposes.

Figure 2. The baseline structure of the Bayesian Belief Network for the Ballater area showing the probabilities of different types of land use currently occurring in the area and the probabilities for the land to provide food and timber, respectively.



Following the presentation of the model participants asked clarifying questions and raised some important points in relation to the model and to land use in general. Participants pointed out that in the Ballater area there is only a small proportion of arable and improved grassland and a high proportion (42%) of land classified as 'other' which includes montane, rock and water bodies.

One participant asked if shooting was included as food provision. The model does recognise that rough grazing also provided food albeit not very much, but shooting is also important in relation to cultural aspects and tourism, which are currently not included. It was also noted that small scale details (e.g. soil micronutrients) could not be considered within the scale of the model

Another participant wondered what was covered by the 'woodland' category as this determines what areas are seen as feasible for woodland expansion. For example, many heather areas could be planted with trees, not necessarily on a commercially viable scale, but perhaps other purposes such as biodiversity. The model includes non-commercial and broadleaf woodland. These trees could also provide timber for alternative types of industry e.g. furniture making.

There was a concern that the more intangible drivers of land use been lost completely from the model, but participants were assured that these are partly included in the land managers' objectives/typology, which has been based on the input from the workshops, a survey on CAP adaptation and expert estimates. Some participants felt that land use decisions in the Ballater area were often motivated by personal preferences and different types of manager would assess alternatives according to these preferences. The model partly includes this variability in the decision making box as it takes into account what different land managers are likely to change their land use to. However, the model is not able to spatially associate particular types of land managers with particular land use/land parcels.

Part 2: Evaluating potential scenarios for the future

In the second part of the workshop participants were presented with three potential scenarios for the future. These scenarios were not predictions about the future, but 'what if' thought experiments. Using these kinds of scenarios can help participants to think about the potential impacts of different development paths. The three scenarios presented in the workshop were modified versions of scenarios developed by the UK National Ecosystem Assessment Follow-on work (UK NEAFO 2014). All three scenarios were for the year 2050. All of them included the same projected changes in climate (based on predictions by the Intergovernmental Panel on Climate Change) and in summary involved milder, wetter winters and dryer summers, with more frequent extreme rainfall events.

Scenario 1: Go with the Flow

This describes a scenario in 2050 in which the current policy and economic drivers continue as they are in now in 2014. It is not a 'do nothing' storyline, but a projection to a future resulting from current trends in these policies and drivers. The tension between the need to maintain livelihoods based on productive use of the land (for agriculture and timber) and environmental improvement continues. In Aberdeenshire the following trends continue

Population is similar to current levels with a similar proportion living in urban and rural situations. Land ownership patterns remain similar to today with tenant farmers, owner occupiers, absentee land investors and sporting estates. Rural businesses diversify where possible to capture tourism demand for 'engaging with nature.'

Policies try to promote progress towards a low-carbon economy and better environmental standards, but progress is slow and bumpy. The government maintains woodland expansion targets but it proves difficult to ensure that they support other incentives such as biodiversity conservation. Commercial forest for timber is encouraged alongside multifunctional woodland.

Energy costs are partially offset by support for renewables such as small scale farm based turbines but turbine expansion is limited to protect viewpoints.

Climate change increases the area of prime land: some areas of improved grazing become suitable for arable crops. This new prime land is safeguarded from conversion to woodland except where there is a good case made for planting trees to reduce flood risk in downstream settlements. Commercial forests are limited in areas with acidified catchments.

The prices for commodities such as grain, meat and timber are increasingly related to world market prices as subsidies for production are slowly replaced by incentives related to environmental outcomes.

Subsidies are increasingly targeted towards multiple benefits and encourage landscape scale collaboration but single farm payments continue to underpin more marginal producers.

Input costs for fertiliser, fuel and agrochemicals continue to rise. Efficient use of inputs is aided by advances in drought tolerant and pest resistant cultivars but policies prevent the use of GM.

Regulations remain in relation to water quality, however, outside protected areas, other biodiversity and ecosystem service targets rely on the uptake of incentives and subsidies.

Community engagement in local decisions is encouraged for landscape scale planning. Communities gain access to small areas of community owned and managed land such for community gardens and community run farms that provide some income for local projects.

Scenario 2: Nature@work

This is a scenario in 2050 where Scottish society has decided to increase regulation and incentives in order to maintain and enhance the output of the ecosystem services and benefits that are regarded as important.

Population of Aberdeenshire remains similar but there has been a shift to more people living and working in rural areas. There is an increase in small holdings and community owned land although large long-term landowning patterns remain on productive land and marginal areas. Domestic tourism is more important than international with rural livelihoods marketing opportunities to engage with land management as a recreational activity.

Low-carbon economy is a priority with incentives to convert land of low agricultural capability to woodland (building on the expansion achieved up to 2020). Higher subsidies are attracted if the planting also benefits other ecosystem services such as habitat connectivity, flood risk and water quality. Multifunctional native woodlands are encouraged (provide timber, energy biomass, biodiversity and recreation). No incentives exist for forests solely managed for commercial timber production.

Increases in costs for inputs such as fertiliser and agrochemicals drive technological advances in arable farming on prime land. These include precision farming (placement of seed and fertiliser) as well as improved plant breeding and cultivars that are more drought resistant and more efficient in the uptake of nutrients and resistant to plant pests and pathogens.

Prime land is protected from land use change to safeguard food production and protection is only relaxed to reduce the risk of downstream flooding, reduce nitrogen run-off and improve habitat connectivity. Incentives for this are based on payments for yield but also on associated water quality, flood mitigation, carbon storage, biodiversity and habitat condition in these catchments as well as maintaining landscape character for recreation. There is support to help land owners collaborate across landscapes to deliver regional planning targets.

The prices for commodities such as grain, meat and timber increase as the products are marketed to global customers willing to pay for positive environmental standards.

Land reform effectively imposes responsibilities on land owners to maintain the multiple benefits their land provides as identified in regional planning. Whilst these strategies are influenced by the needs of the urban majority, actions and priorities within a particular landscape or sub-catchment are set in collaboration with local stakeholder (land managers and others in the community) knowledge.

Regulations are tightened to reduce the negative impacts from intensive management. This is based on the "polluter pays" principle and builds on the powers organisations like SEPA have over water quality so that other

statutory bodies can also fine land managers where ecosystem service delivery falls below levels agreed in regional plans.

Upland areas will be incentivised to manage for venison and lamb production at stocking rates that ensure the upland habitats are in good condition (reduce trampling damage on blanket bog, improve the condition of heather, allow tree regeneration in designated sites).

Communities have access to funding to increase engagement with the environment for health benefits with money available to increase core paths and funding to set up community based businesses based around food and food related products. These are funded by feed-in tariffs from initiatives such as community owned renewable operations (large scale wind farms are prevented to reduce impacts on viewpoints).

Scenario 3: World Markets

This scenario for 2050 results from the push for economic growth based on free world markets. International trade barriers have dissolved and subsidies have disappeared. Policies do not take into account the effect on other services and benefits but rely on the assumption that successful management will be the most efficient.

Most of the population lives in urban areas because the costs of commuting are high. Planning restrictions are relaxed allowing development on green belts and flood plains to feed the demand for urban housing. Private land owners enjoy strong property rights. Land holdings used mainly for agriculture have become bigger in size in response to economies of scale and have been industrialised with only the most productive land cultivated. The domestic market for tourism is limited and relies on international visitors.

Progress towards a low carbon economy is no longer a societal objective although energy sources are driven by costs so that the increase in the price of oil has promoted the use of cheap gas from fracking. Incentives for renewable energy have been cut and power is increasingly supplied from centralised nuclear power stations. Incentives for woodland expansion have disappeared.

Input costs (fertilisers and agrochemicals) have decreased due to technological development (often funded by business rather than government) and intensification. High yields are needed if production is to be competitive on the world market. GM cultivars that reduce input costs are broadly accepted.

Food is cheap and plentiful, but mostly of low quality and mostly imported to supply the bulk of the population however, there is a market for high quality locally produced food which is maintained by the wealthy in society. Therefore, generally market prices for commodities have decreased.

Land holdings on non-productive land also remain in private hands. The uplands continue to be managed for recreational field sports with limited venison production but land abandonment has increased with much of the grazing land (land capability 3.2 or poorer) reverting to scrub.

Most meat is imported but niche markets for home reared grass fed beef and lamb maintain some areas of the grassland. Timber is imported from cheap sources on the world market. Commercial woodland only remains viable on abandoned areas of relatively fertile grassland that are close to transport links (risking disease outbreaks and acidification of water bodies).

Regulations on water quality are weakened in order to reduce public spending. The small rural population increasingly depends on private supplies. Urban communities that can afford it pay for clean water through Payment for Ecosystem Services schemes. Poorer communities rely on buying bottled drinking water as the public water supply is only good for washing (‘grey water’). Businesses that depend on clean water (e.g. the Whisky industry) enter into local ‘payment for ecosystem services’ (PES) schemes with land owners. Downstream urban communities also use rely on PES schemes to protect their livelihoods from flooding.

Consequently there is very little community involvement in land use decision making except where communities can buy into it through PES schemes. Rural communities decline - although there are limited jobs in recreational field sports.

Evaluation of the scenarios

In order to evaluate the potential consequences of the three scenarios, the workshop participants were asked to employ a method known as 'Multi-Criteria Decision Making Analysis' (MCDA). MCDA is a technique that can be used to guide complex decision making. It sets out to evaluate how well alternative options fulfil a range of criteria that reflect the values and objectives of different people. The process helps to define the issues and determine their relative priorities among different stakeholders in a transparent manner. MCDA is therefore a structured and transparent method of breaking down complex problems and prompting discussion among relevant people with differing interests and experiences.

MCDA may help us to account for a broad range of objectives in land use decision making. These include both private objectives relating to livelihoods and lifestyles as well as policy objectives relating to the public goods the environment provides such as reducing carbon emissions, reducing flood risk, and providing recreation opportunities.

The first step in a MCDA is to identify which criteria should be used to judge the future scenarios. Prior to the workshop, the James Hutton team had gone through the information from the first two workshops to compile a list of criteria that workshop participants had raised as being important in the two local areas. These had been divided into economic, social and environmental criteria and five of each had been chosen as criteria that could be used to judge the impacts of the future scenarios (Table 2).

Table 2. Criteria for the evaluation of future scenarios

Economic criteria	**Social criteria**	**Environmental criteria**
Infrastructure provision	Health & well-being	Carbon capture
Availability of labour and skills	Landscape beauty	Sediment retention on land (prevent export into water courses)
Income generation (land or tourism based)	Access to recreational opportunities	Nutrient retention on land
Control of pests & diseases	Environmental awareness	Protected species conservation
Local energy security	Local community cohesion	Protected habitat conservation

In addition to these criteria, participants were asked to suggest additional criteria which they thought should be used to evaluate the scenarios. Participants came up with the following additional criteria:

- Natural flood management – and water quality
- Emotional and instinctive relationships of both family and place
- Education e-communications – this is partly social but also economic due to business reliance on broadband
- Political acceptance
- Local food networks (part of health and wellbeing and community cohesion)
- Tourism market (external factors such as currency exchange influencing numbers visiting Scotland)

- Local housing supply and availability
- Local economic circularity
- Quality of life (current residents or new residents who chose to stay/live due to nature of the environment)
- Adaptation to climate change
- More robust ecosystems (better connected, more natural)
- Mitigation for flood events – more natural flooding regime, ability to manage water supplies
- Links to Scottish Biodiversity Strategy outcomes
- Conservation of unprotected species too! Habitat connectivity in the wider countryside, less fragmentation
- Food security
- Something about water (quality, provision, availability , impacts of increased rainfall events etc)
- Enhanced and improved habitat/species conservation
- Improving and maintaining habitat linkages (particularly outside of designated sites)
- Resilience of ecosystems

These additional criteria were discussed amongst the participants and some were slightly revised. In order to keep the task of evaluating the scenarios manageable only six of the suggested criteria were added to the existing list:

- Additional economic criteria: Food security; Affordability for local residents
- Additional social criteria: Access to educational resources; Community empowerment
- Additional environmental criteria: ability to manage water supply and resilience of ecosystems

As the next step in the MCDA, participants were asked to think about the importance of each of these criteria to them personally or to their organisation, and to assign a weight (from 1 to 100) to each criterion reflecting its importance with 100 indicating the most important criterion. The same score could be assigned to several criteria. In addition, participants were asked to indicate whether they thought the achievement of each criterion was a negative or a positive thing. For example, someone may consider infrastructure provision as something positive (e.g. enabling businesses and vibrant communities) or as something negative (leading to more traffic, more urban sprawl, more new-comers in the community, etc.). In either case it may be of high, low or medium importance to a person.

Finally, participants were asked to look at the three scenarios and evaluate to what degree each scenario would deliver the evaluation criteria (regardless of how important they thought the criteria were). To make it easier, the main contents of each scenario had been summarised in tables which were handed out to participants to aid them in the evaluation of the scenarios. These tables and the sheet used for the evaluation of the criteria can be found in Appendix 3 and Appendix 4, respectively.

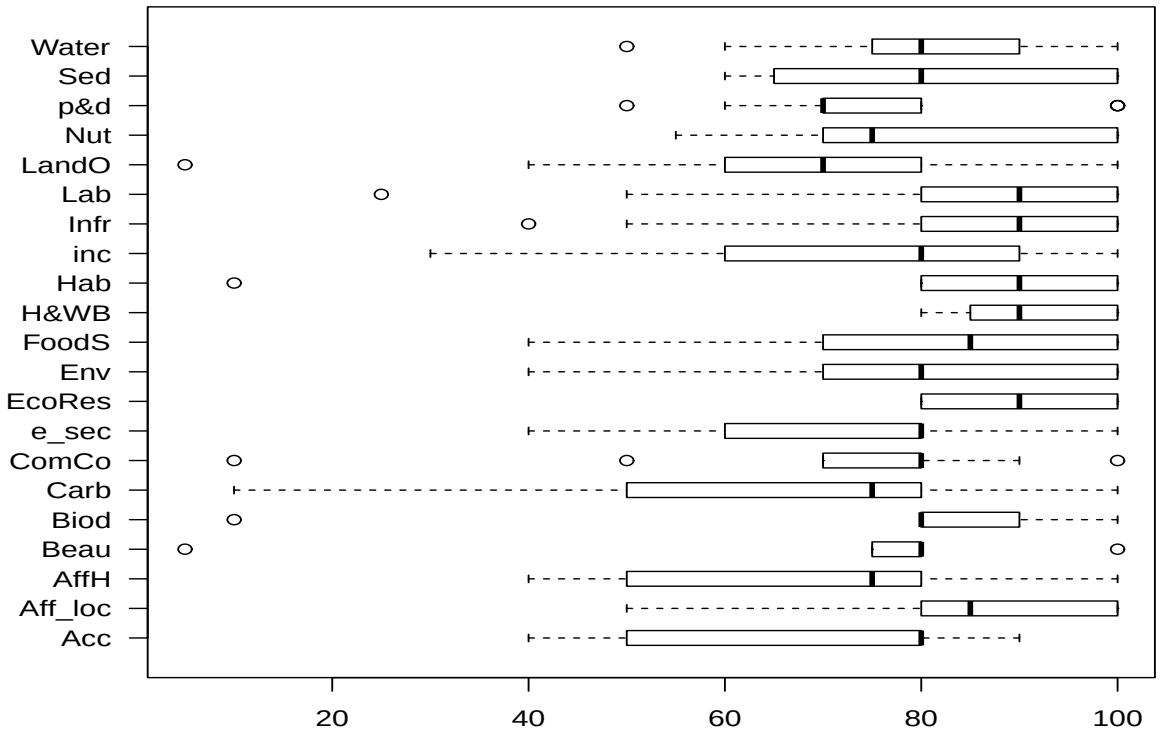
During and after the evaluation of the criteria and scenarios, participants discussed the process as well as the particular criteria and scenarios. These discussions brought up a number of interesting and important points. The evaluation criteria as well as the scenarios were open to different interpretations and this influenced how people evaluated them. Such differences in interpretation could have been reduced by making the criteria and scenarios more specific or narrow. However, this would have meant that they captured less of what had been raised as being important in the area. Another way to avoid ambiguities or differing interpretations could have been to have a more in-depth discussion in the group on the meaning of each of the criteria and scenarios before the actual scoring. Due to the limited time available, there was some discussion but we did not go through all 21 systematically. Participants also raised the point that evaluations could differ depending on whether they did the exercise from their own point of view or from the point of view of an organisation or business they were part of (although they were asked to evaluate the criteria and scenarios from the point of view of the organisations or

sector they were representing). Linked to this was that it is important to clarify who benefits from particular criteria or developments and that this may differ amongst different people.

Results from the evaluation of the criteria and scenarios

From the 21 evaluation criteria, 'availability of labour and skills', 'infrastructure provision', 'protected habitat conservation', 'health and well-being' and 'resilience of ecosystems' were on average ranked as the most important ones (90 on a scale from 0 to 100). These also had very little variability in scoring, suggesting they were important to everyone. 'Pest and diseases control' and 'access to educational resources' were on average ranked lowest though still above 60 on a scale from 0 to 100. However, in most cases these average values cover a wide range and 'carbon capture' showed the biggest variation with regard to how important the participants felt this was with some participants feeling it was very important and others thinking that it was not so important.

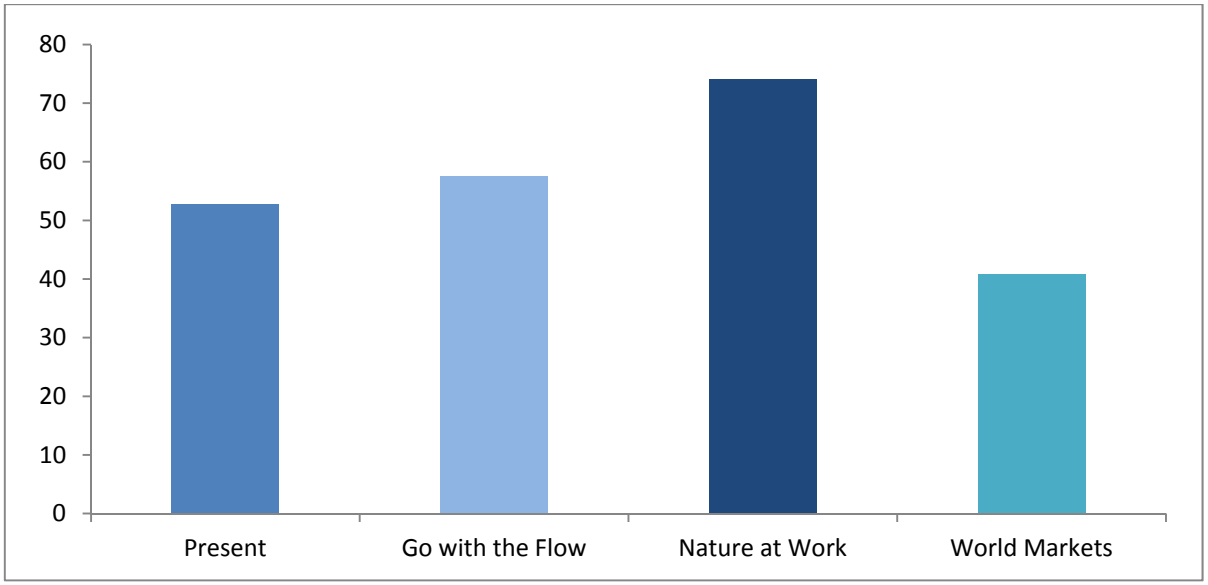
Figure 3: Weightings for the criteria from Ballater workshop participants. The black lines illustrate the median score; whilst the boxes illustrate the scores for the majority and the 'whiskers' indicate the more extreme scores.



Legend: Water: ability to manage water supply; **Sed:** sediment retention; **P&d:** pest & disease control; **Nut:** nutrient retention; **LandO**: Access to educational resources; **Lab**: Availability of labour & skills; **Infr:** infrastructure provision; **Inc:** Income generation; **Hab:** protected habitat conservation; **H &WB:** Health & well-being; **FoodS:** Food security; **Env:** Environmental awareness; **EcoRes**: resilience of ecosystems **e_sec:** local energy security; **ComCo:** Local community cohesion; **Carb:** carbon capture; **Biod**: protected species conservation; **Beau:** landscape beauty; **affH:** community empowerment; Aff_loc: affordability for local residence; **Acc:** access to recreational opportunities

Out of the three scenarios, 'Nature@Work' received the highest average score based on the degree to which participants thought it would be able to meet the 21 criteria and how important these were to each individual (Figure 4). 'Go with the Flow' was evaluated as being very similar to the present, while 'World markets' was evaluated at doing worse than the present in relation to the 21 criteria.

Figure 4. The average scores of the three scenarios and the present based on how well participants thought they did in meeting each of the 21 evaluation criteria and how important these criteria were for each person.



The discussion around the scenarios and the scoring exercise focussed initially on the methodology. Some participants found it hard to make judgements using numbers and would have preferred just to discuss the scenarios without scoring them. However, others felt that the scoring process forced them to think more carefully about the possible issues associated with different futures, such that seemingly positive effects became more ambivalent. There was also some discussion about the fact that the scenarios appeared quite similar when it came down to considering how they might affect their organisations or businesses in the Ballater area. Some participants pointed out that their scores also depended on whether they were thinking about local or global issues and whether they were being altruistic, for the good of Scotland, or focussed on what might be good for their own businesses.

No one was surprised that the World Markets was scored less positively than Nature at Work, as the land management patterns in the area meant that it would be difficult for land based industries to exploit the potential market advantages offered by this scenario. There was some discussion about the social effects of these scenarios; and the fact that the Nature at Work scenario seemed to offer a more egalitarian distribution of opportunities in the area, which seemed to be important to the participants. However, participants felt that they represented a fairly homogeneous view of land use issues, and it would be interesting to run the process again with more market-orientated land managers (e.g. from Eastern Aberdeenshire) or with urban residents who may have a very different view on what they want to see from future land use issues.

Part 3: Model predictions for future scenarios

After participants had evaluated the three future scenarios they were presented with the predictions that the BBN model made for each of the three scenarios. For all three scenarios, the model predicts that most of the land managers will not change their land use. The highest probability of land use change was predicted for the 'World Market' scenario (25.3% of land managers predicted to change land use) while the lowest probability of land use change was predicted for the 'Nature@Work' scenario (14% of land managers predicted to change land use) with the 'Go with the Flow' being intermediate (17.3% of land managers predicted to change land use). The low numbers partly reflect the constraints on land use change in the area, given that much of the land is not suitable for arable or improved grassland uses; but the participants felt this also reflects the land manager objectives in the area, with much of the land being owned by wealthy estates.

The prediction for the way these changes would pan out also differed for the three scenarios. For 'World Markets' the predicted change was mainly an increase in arable land (doubling the current area, but this would still be a very small overall amount), an increase in improved grassland, but a decline in woodland, semi-natural grassland and rough grazing. In contrast, for 'Nature@Work' the model predicted a small decline in semi-natural grassland and rough grazing, and a small increase in woodland, arable and improved grassland. For 'Go with the Flow' the model predicted a small increase in arable, improved grazing with woodland staying stable and semi-natural grassland and rough grazing predicted to decrease.

In turn, the model predicted nutrient and sediment export and carbon emissions would increase for the three scenarios, even though Nature@Work is driven by a concern to increase ecosystem service provision and their benefits. In all cases, Nature@Work would show the smallest increases; Go with the Flow would show slightly larger increases and World Markets would show the largest increases in emissions. However, both sediment and nutrient increases were relatively modest compared to the carbon emissions, where the model suggested that under the World Market scenario carbon emissions could increase by over 400%. This illustrates the trade-off between increasing food provision and the carbon consequences of land use change.

Following the presentation of the model predictions participants raised several points. Firstly, that there probably would be more urban expansion than the model suggested, and whilst the footprint would be small, the specific location is important as urban expansion would compete with land for arable expansion and also flood alleviation schemes. There were questions about the fact that there was no land use into semi-natural grassland under Nature@Work scenario. This is an artefact of the assumption in the BBN, but participants discussed the difficulty of incentivising habitat restoration when incentives can only cover costs incurred and not the opportunity costs of income forgone. The lack of effect of incentives and regulations depended on how radical the government wanted to be – for example if grouse shooting was banned, the results could look rather different. The potential for community ownership might also change the objectives for the land and therefore the land use available.

Some of the predictions in the model were not regarded as very realistic. For example, a participant questioned the carbon emissions, given the potential for peatland restoration to occur in the Nature@Work scenario. The restoration should off-set emissions from converting land into improved grassland or arable. Currently the model looks at averages from land use change, and doesn't account for changes in the quality of the land. Furthermore, there are many other aspects that might affect how land is managed and for what purpose, making it very difficult to provide a single answer for how the scenarios might impact on land use and ecosystem services. All in all, participants hence suggested that the likely impact of any scenario was going to be more messy and complex than the model suggested.

After presenting and discussing the model predictions for the three scenarios, the workshop participants were given the opportunity to change the initial scores they had assigned to the three scenarios in the MCDA process taking the model's predictions into account. None of the participants wished to make any changes to their initial evaluation of the scenarios. Reasons given included that the model did not provide any further information to

change their views, that the information provided was not directly relevant to many of the criteria and that their existing scoring was already quite 'vague' and they did not feel that rescoring would provide useful or accurate information.

Next Steps

The workshop held on the 17th November was the last workshop in a series of three. Hence, there are currently no plans for further workshops as part of this work. The information from this and the previous two workshops will be analysed by researchers from the James Hutton Institute and results will be passed on to the Aberdeenshire Council and to Scottish Government. The workshops have formed part of the Aberdeenshire Regional Land Use Pilot which is ending in spring 2015. The results from the Regional Land Use Pilots (Aberdeenshire and Scottish Borders) will feed into the revision of the Scottish Land Use Strategy due to be completed by March 2016.

Results from the workshops will also be written up in the form of academic papers and will thereby become available to other researchers and policy makers in the rest of the UK as well as internationally. In addition, the results will be used by the researchers from the James Hutton Institute to inform further research questions and projects.

Participants' views on the workshop and what they have learnt from the series of workshops can be found in Appendix Five. Overall, the workshops have been relatively useful to participants and were extremely valuable to the researchers in helping identify the main messages from those living and working in the Local Focus Areas.

Appendix 1: List of workshop participants

Aberdeenshire Council	**Irina Birnie**
Royal Society for the Protection of Birds	**Stuart Jennings**
National Farmers Union Scotland	**David Winton**
Cairngorm National Park Authority	**Andy Ford**
Aberdeenshire Council	**Linda Mathieson**
East Cairngorms Development Partnership	**Nick Mardell**
Ballater and Crathie Community Council	**Jane Angus**
Scottish National Heritage	**Fiona Cruickshank**
James Hutton Institute	**Gary Polhill**
James Hutton Institute	**Kirsty Blackstock (facilitator)**
James Hutton Institute	**Anja Byg (facilitator)**
James Hutton Institute	**Justin Irvine (facilitator)**

Appendix 2: Suggested modifications to the model from workshop 2 and how this information has been used.

Suggestion	What we have done
Expertise and interests of land managers	Part of Land Management Objectives (LMO) typology
Distinction between land manager overall values and philosophy and shorter term business objectives	Final objectives for land management reflect a combination of the land manager's values and philosophy and the needs of the business/Non-Govn Organisation/owner1
Influence of land capability on Land Manager Objectives (LMO); Land capability influenced by/influences drivers	Indirectly represented but direct link became too complex, something to think about in future
Flexibility/reversibility important factor in decision making	Implicit within LMO intersection with policy objectives – woodland harder to 'reverse' than arable or grassland
Business characteristics feed directly into decision to change box not via LMO	We have kept business characteristics as part of the LMO typology (tenancy, profitability etc) but something to think about in the future
Who sets business objectives? And are they principle led or just maintaining tradition?	Covered to some extent in the LMO which includes motivations and attitude to tradition
Issues to include in business or actor characteristics: Age; Attitude to diversification; Short term (ST) or long term (LT) thinking; Attitude/use of technology; Succession; Identity; Response to peer pressure	Diversification, identity and short term (ST) or long term (LT)T thinking are included in the LMO but we were unable to include the rest at this stage. They are things we should try to address in future.
Disease is an important influence on decision making	Pests and diseases are part of the criteria we will look at in the upcoming workshop
Housing affects availability of labour	Labour and skills are part of the criteria we will look at in the upcoming workshop
Current profitability affects labour/skills and whether can access information/advice	Income generation is part of the criteria we will look at in the upcoming workshop; so are labour and skills (but not their inter-relationship); information and advice is not currently included and is something we should address in future.
Price of land and impacts on new entrants	This is not currently included and is something we should address in future.
Input prices would include the price of energy and fertilisers; regulations should include the tax regime and the additional	Included in these drivers

[1] Not all land is managed as a 'business'

bureaucracy	
Consumer demand is linked to population growth (global) and wish for home grown food	We removed consumer demand from BBN as we focussed on 4 drivers, but it is part of the scenarios we will look at in the upcoming workshop
Perceptions of climate change are important driver; affects ability/willingness to diversify	This is not currently included and is something we should address in future.
Public opinions – what do people want/expect from LU; also public opinion about Ecosystem Services impacts on policy; citizen or consumer wants/needs	Included in the scenarios we will look at in the upcoming workshop
Housing/infrastructure/buildings should be included	Now part of the Land Use categories (development)
Confusion over what cultural landscapes means – should include archaeology	Cultural landscapes are represented on the BBN but work is ongoing to refine how to define and measure these.
Designations should be part of land capability	This is not currently included and is something we should address in future.
Should include water quality	Represented by sediment and nutrient ecosystem services
Nature conservation is wider than habitat connectivity	Protected habitats and species are now part of the criteria we will look at in the upcoming workshop
Separate field sportsand fishing from food provision – it is both recreation and economic activity	Field sports and fishing is not named as such. Food provision is within the BBN and access to recreational opportunities is part of the criteria we will look at in the upcoming workshop .
Tourism is business as well as recreation - business is needed; overall economic development impacts on provision of labour and skills	Income generation business opportunities and labour/skills are part of the criteria we will look at in the upcoming workshop
Health (physical and mental)	Health and wellbeing are part of the criteria we will look at in the upcoming workshop
Genetic diversity	This is not currently included and is something we should address in future.
Flood alleviation	This is not currently included and is something we should address in future.
Housing and shelter provided by landscape/topography	Development is a category of land use in the BBN
Connection to the land	Environmental awareness is part of the criteria we will look at in the upcoming workshop
Environmental education	Environmental awareness is part of the criteria we will look at in the upcoming workshop
Reintroduction of lost species	This is not currently included and is something we should address in future.

Protecting/restoring soil quality	This is not currently included and is something we should address in future.
Impacts on designated sites	Part of the criteria we will look at in the upcoming workshop
Pollination is an intermediate service leading to the final benefit of food provision	We have both in the BBN at present.
Links between ecosystem services	This is not currently included and is something we should address in future.
Links between ecosystem services and drivers	This is not currently included and is something we should address in future.
Time lags in changes in benefits; and in changing behaviours	This is not currently included and is something we should address in future.
Feedback loops from land managers to drivers; and the role of trusted intermediaries to make these links	This is not currently included and is something we should address in future.
Accessing/influencing those without grants or who are 'hard to reach'	Partly addressed in the within LMO intersection with policy objectives – Community stewards, ecological stewards and Other include those who do not access grants and/or don't participate in land management networks

Appendix 3. Summaries of the three future scenarios

Aspects	**Go With The Flow**
Policy Direction	Sustainable intensification – balancing increasingly productive land use with environmental minimum standards for water and protected areas, slow transition to low carbon economy
Incentives	Slowly moving away from production subsidies to incentivising environmental outcomes but still large proportion on sustaining viable working farms
Regulations	Maintain environmental, food health and biosecurity standards in line with European Directives
Input Prices	As now – fluctuating – with increased fuel costs slightly offset by renewables
Commodity Prices	Low prices paid to land manager but value added in the supply chain off-farm, low prices off-set by SFP (see incentives above)
Population (remains stable)	Slightly decreased from peak in 2020's as per strategic development plan with similar distribution across the shire
Local employment	Although the number of jobs in land based industries remains low, there is also a shortage of skilled labour for this sector because the majority are employed in urban centres. Oil and gas remain important, despite declining yields in North Sea, due to decommissioning investment
Urban population (influence of)	Political influence reflects balance between land owners and their rights and pressure from urban population where majority of voters live
Community engagement	Where active and charismatic individuals coincide with a tradition of community engagement, there are valuable inputs into regional and national planning processes
Land ownership patterns	Varied pattern continues and includes large long-term land owners; some estates being acquired by corporations for investment; large owner occupier farms , tenant farming and small scale community run small holdings
Technological advances	Ongoing development and up-take of precision farming methods; incremental improvements in renewable technologies; limited to no GM allowed
Food security	Majority of everyday food is imported from Europe but important niche areas of locally produced vegetables, fruit, meat and dairy products
Tourism demand	Domestic (UK) and European tourism remains stable.

Aspects	Nature@Work
Policy Direction(s)	Strong push to maximise delivery of multiple benefits whilst protecting natural capital; and a strong commitment to a low carbon economy
Incentives	Focussed on supporting bundles of services and benefits - sustaining food production only where it also produces other benefits – overall environmental incentives increase
Regulations	Extended. Fines for land managers if other services, e.g. carbon sequestration, habitat condition, fall below targets
Input Prices	Those based on oil increase markedly due to low carbon economy measures (e.g. diesel, fertiliser)
Commodity Prices	Premium prices are paid for locally produced food, timber and energy with a provenance that illustrates how it has sustained wider benefits for society
Population (remains stable)	Outward migration from cities and towns into villages and small-holdings
Local employment	A much higher proportion of paid work is associated with land/water/nature based industries with local skilled labour living close to their workplaces
Urban population (influence of)	Distributed population with much closer links to, and interest in, rural and environmental issues, with strong Green lobby.
Community engagement	Strong community engagement with delivery of multiple benefits from the land, with volunteering becoming normal as part of daily routine
Land ownership patterns	An increase in community owned assets and also an increase in non-productive small holdings as people move out of urban centres. Family farms and estates continue. Investment firms target areas with high incentive payments
Technological advances	Substantial improvements in renewables technology; and investment in other technologies to assist with delivering multiple benefits e.g. low impact timber harvesting; low input/nature friendly farming techniques etc
Food security	Imports continue, but much higher proportion grown in Scotland. Home-grown and wild food common
Tourism demand	Domestic (Scotland) and recreational demand is strong; but international tourism is no longer seen as desirable due to negative environmental impacts of travel

Aspects	World Markets
Policy Direction(s)	Belief in global market forces - policies focus on removing market failures and policing fraud and presumption that the most efficient practices will persist etc
Incentives	Removal of all environmental or production incentives – the market rewards high value commodities; local payment for ecosystem services schemes start up to ensure clean water, flood protection etc
Regulations	Removal of all environmental , food and biosecurity regulations – the market rewards 'clean' producers
Input Prices	Overall lowering of input prices due to fierce competition and cheap biofuels replacing oil
Commodity Prices	Bifurcated market – large units producing quantities of low value products for major retailers; premium products associated with Scottish brands e.g. single malts, organic aged beef, organic cheese, virgin oils etc
Population (remains stable)	Most people live and work in large cities/towns with low population density in the rest of the shire
Local employment	Very low land-based employment (most producers are large-scale and mechanised with imported labour living onsite); service sector employs most people in Aberdeen & major towns
Urban population (influence of)	The majority urban population are more interested in urban jobs and keeping the cost of living as low as possible.
Community engagement	Very limited community engagement, partly as there is no planning or policy cycle to engage in, and partly as people protest or engage through their consumption choices
Land ownership patterns	Economies of scale leading to fewer land managers running large production units; with marginal land abandoned, or only used for field sports or nature tourism for the wealthy minority.
Technological advances	Investment in fuel and input efficiencies for large scale commercial food & timber production; GM is widely accepted
Food security	Most food is imported, and the locally grown food is grown for export as a world commodity (e.g. Scotch Beef, Scotch Whisky) so little available for home consumption except for the elite
Tourism demand	Increased demand from international visitors from emerging nations (e.g. China, Africa, Middle East) to visit honey-pot areas, little local recreational opportunities – local/UK visitors prefer city breaks

Appendix 4. Evaluation sheet for the Multi-criteria Decision Making Analysis (MCDA)

Name:				**Present day**	**Scenario 1: Go With the Flow**	**Scenario 2: Nature at Work**	**Scenario 3: World Markets**
	Criteria	Importance of criteria (0-100)	Are criteria positive? (Y/N)	Impact on criteria (0-100)	Impact on criteria (0-100)	Impact on criteria (0-100)	Impact on criteria (0-100)
Economic criteria	Infrastructure provision						
	Availability of labour and skills						
	Income generation (land based or tourism based)						
	Control of pests & diseases						
	Local energy security						
	NE niche products;						
	Provision of apprenticeship & training						
Social criteria	Health & well-being						
	Landscape beauty						
	Access to recreational opportunities						
	Environmental awareness						
	Local community cohesion						
	Affordability of rural life/housing						
	Land ownership						
Environmental criteria	Carbon capture						
	Sediment retention on land (prevent export into water courses)						
	Nutrient retention on land						
	Protected species conservation						
	Protected habitat conservation						
	Natural balance						
	Biodiversity richness						

Appendix 5: Ballater 17th November 2014 evaluation forms:

The majority of people returned the evaluation forms giving an 89% response rate. Not everyone answered every question.

Nearly everyone found the workshop useful (mean score 3.1, between useful and very useful). From the general comments, the reasons for it being useful included having good discussions about the balance of land use in the future and putting the Scottish Land Use Strategy into practice. This is borne out by the fact that participants scored the quality of interaction on the day as between good and very good (mean score 3.3), however the need for more input from people working on the land in the local area was noted.

Participants agreed most strongly with the statements relating to the increase in their ability to think about multiple issues associated with land use (mean of 3.1, between agree and strongly agree) and whether their inputs had been incorporated (mean 2.9). Most agreed that they had new knowledge about future land use change (mean 2.6, between agree and disagree) but there was a lower score (mean 2.5) regarding whether they had new knowledge about how future land use change might affect ecosystem services.

There was a mixed response in terms of evaluating which 'tools' were most useful in increasing their knowledge and understanding. The scenario and MCDA process; systems diagram and BBN were the most popular in terms of frequency of being picked (picked by six respondents each) but no one selected MCDA as the **most** useful. Furthermore, one respondent felt the scoring matrix was not a useful exercise. The next most popular tools were the policy goal discussions and the participatory/decision making mapping exercises. The following were selected as **most useful**: decision making maps; systems diagram and BBN - in other words participants varied greatly in how they related to, and valued, these tools. One respondent felt that despite these tools, there is still a lack of facts involved in land use decision making. It should be remembered that some participants had not attended earlier workshops or could not really remember them, so the scores must be interpreted with caution.

Additional feedback related to interest in how the results would be used and developed in future including how local perceptions of benefits from land could be used in policy making and grant appraisals and the degree to which the local area will be influenced by external forces, including political short-termism.

Participants were complimentary about the workshop facilitation (mean score 3.4, or between good and very good) and the materials provided (mean score 3.4).