Project no.217213

Project acronym: SMILE

Project title: Synergies in Multi-scale Inter-Linkages of Eco-social systems

Socioeconomic Sciences and Humanities (SSH)

Collaborative Project

FP7-SSH-2007-1

D30: Policy Implications of growth, trade-offs and synergies

Date of preparation: 31st March 2011

Start date of project: 1st January 2008

Duration: 42 months

Project coordinator name: Jarmo Vehmas

Project coordinator organisation name: Turku School of Economics, Finland Futures Research Centre

Partners: Uniparthenope University of Naples, Autonomous University of Barcelona, Vrije Universiteit Amsterdam, The Macaulay Land Use Research Institute, Institute for Economic Forecasting, Statistics Finland

Prepared by: Keith Matthews, Kirsty Blackstock, Kevin Buchan, Dave Miller.

Non-Technical Summary

This deliverable (D30: Policy Implications of growth, trade-offs and synergies) considers how the DECOIN tools can be used for policy relevant research. The D30 report therefore considers the main results from D28, which considered the relationships between energy, human activity and economic productivity within the Scotland and Cairngorms National Park (CNP) economies; and the D29 analysis of synergies and trade-offs within the Scottish and CNP agricultural sectors. These results are analysed in light of their contribution towards five policies, which were selected as a result of research within WP5 of the SMILE project on interfacing scientific results with societal and policy processes.

The policies are:

- National Park (Scotland) Act 2000 via the Cairngorms National Park Plan (CNPP).
- Scottish Rural Development Programme 2007-13 (incorporating Common Agricultural Policy Reform) (SRDP)
- Scottish Land Use Strategy
- Scottish Government Economic Strategy
- Climate Change (Scotland) Bill

The MUSIASEM and SUMMA tools were able to deliver policy-relevant results, in terms of illustrating trends and patterns at the Scottish, CNP spatial levels with decomposition by geography or paid work sector. In particular, the MuSIASEM tool provides a useful way to compare productivity, efficiency and employment between sectors, between spatial scales and time periods. This contributes to the CNPP, the Economic Strategy and the Climate Change action plan and the SRDP (for the agricultural sector decomposition). The SUMMA tool provides very detailed analyses of the emissions and environmental impacts of the agricultural sector, which contributes to the CNPP, SRDP, Land Use Strategy and Climate Change Delivery Plan.

The tools give a powerful insight into the relationship between economic growth, energy and environmental impacts, which are essential for a focus on strong sustainability. There remain many aspects of these five policies that the applications could not answer. The applications in D28 and D29 do not address ecological, social or cultural aspects of sustainability. However, it is unrealistic to expect even sophisticated tools to be able to cover all aspects of sustainability. The utility of the results and the implications for policy will be addressed in a further stakeholder workshop and the findings presented in two conference papers in Tampere, 9-10th June 2011.

Contents

1 Introduction

The Synergies of Multi-Level Integrated Linkages in Eco-social Systems (SMILE)[1] project seeks to further develop and apply the DECOIN[2] tool kit. This toolkit consists of three models: SUMMA (Sustainability Multi-criteria Multi-scale Assessment); MuSIASEM (Multi-Scale Integrated Analysis Societal Ecosystem Metabolism) and ASA (Advanced Sustainability Analysis). The ambition of the SMILE project is to combine these tools into a system of sustainability accounting that provides useful insights into the dynamics of the sustainability of complex coupled eco-social systems (Giampietro et al. 2009).

This report (D30) is a contribution to WP4: *Synergies and Trade-off Analysis and Scenario Building*. The report builds on the previous work by the MLURI team in the Scottish Case Study (D16) and the Utility of tools to Stakeholders analysis (D23). In D16 a case-study of sustainable development within the Cairngorms National Park Study was developed in partnership with the Cairngorm National Park Authority (CNPA). In D23 the utility of outputs from the SUMMA and MuSIASEM tools[3] were assessed again with the CNPA. Neither analysis was seen a lacking in merit or as being or irrelevant to the CNPA deliberations on sustainability. The MLURI research team, however, recognised that neither approach had overcome the "implementation gap" and neither would feature strongly as an evidence base for decision making in relation to the next Cairngorms National Park Plan (the aspiration at the start of the SMILE research). This partially reflects the inexperience of the MLURI team in using the DECOIN tools and the challenges of using a non-standard statistical region, but also the challenge in resource terms of a single SMILE partner making operational two of the DECOIN tools for a single case-study[4]. The importance of taking the tool kit beyond the academic community and demonstrating its policy relevance, however, was highlighted in the external review of the SMILE project by Redclift in 2010. In the light of these findings and the limited resources remaining to the project team[5] the scope and nature of the analysis for D30 was modified. The objective remains to consider how the tools can be used for policy relevant research, but focus on the implications of findings for the most relevant existing policies, rather than generating scenarios to test the impacts of potential changes in policy. The rationale and objectives for the D28 report are set out below.

In D23 it was possible to identify some high priority issues and modification to the analyses that would greatly increase the salience and credibility of the outputs. These issues were prioritised rather than opening up new avenues of research. Not all of the issues identified in D23,

[1] http://www.smile-fp7.eu/
[2] http://www.decoin.eu
[3] The ASA tool was not implemented in the Scottish case study, as its requirement for specific data to be available as time series were unable to be met for the Cairngorms National Park (CNP).
[4] The MLURI team have also been less able to devote additional resources to SMILE within the SG funded research programme as higher priority policy research has been commissioned.
[5] The analysis has been heavily supported by the MLURI core research funds as well as RTD.

however, have been addressed by the MLURI research team due to limitations on the staff time available. For D30, the analysis draws on the main policies of interest to the case study identified as part of baseline work undertaken for WP5. The D30 report therefore considers the main results from D28, which considered the macro-relationships within the Scotland and CNP economies and the D29 analysis of synergies and trade-offs that uses the outputs from the SUMMA analysis in light of implications for these specific policies.

2 Materials and Methodology

This section briefly outlines the setting for the research, followed by the methods employed to derive the findings. Finally, the policies used in the analysis are summarised.

2.1 Cairngorms National Park

The Cairngorms National Park is the largest national park in the UK and was created as a result of the National Park (Scotland) Act in 2003. It covers approximately 3,800 km2 and is home to approximately 16,000 human residents as well as significant protected habitats and species. As shown in Figure 1 below, the National Park contains a variety of ecosystems from the sub-arctic Cairngorms plateau through managed moorlands, pastures and forestry to intensively farmed land in the river valleys.

The Cairngorms National Park

Figure 1: Topographic map of the Cairngorms National Park

The National Park is protected for both its biodiversity and its geodiversity. The mosaic of habitats present, combine to create a unique and highly valued landscape. In 2006, 39% of the National Park was designated for nature conservation and 25% of the area is designated as being of European or International importance for nature conservation. Furthermore, 25% of species on the UK conservation priority species list are found within the National Park. The geological features are of international importance and account for the Cairngorms' inclusion in the Geological conservation review. The Cairngorms provide one of the best preserved examples of post glaciated landscape in the UK.

The headwaters of Scotland's three largest rivers (Tay, Dee, Spey) all rise within the National Park boundaries. Indeed, the water resources are very important to the tourism, recreation, food and drink industries and as a resource for renewable energy. The Dee and the Spey are also protected under the Habitat's Directive, for drinking water abstraction and to protect the economic salmonoid fishery resource.

The Park contains a number of regionally important settlements that service the rural economy in the National Park. The topography means that these communities have traditionally looked away from one another towards the major settlements on the coast or rivers (Aberdeen, Dundee, Perth or Inverness) as the major transport routes detour around the Cairngorms Massif. Therefore, the topography that gives the Park its special and unique features has traditionally divided, rather than united, the residents within its boundary.

The Cairngorms National Park boundary deliberately includes settlements as the National Park is an example of a living protected landscape that is shaped by ongoing human activities. The population of the Park was 16,252 in 2007, which represents 0.32% of the Scottish population. The population density is 0.04 people per hectare, compared to the Scottish average of 0.65 persons per hectare (based on 2001 census). The age profile indicates that there are fewer children; fewer people of a working age and more retired people (aged 65 years or more) than the overall Scottish average; and this profile has been stable from 2001-2007.

In 2001, there were 6,738 households. Approximately 63% were home owners, close to the Scottish average. The mean house price in 2007 was £178,541. In 1998, the mean house prices were lower than the Scottish average, but in 2007 they were 20% higher than the Scottish average. However, of those households renting their homes, a much higher proportion rent from private landlords and consequently a lower proportion from public or social housing landlords, than the Scottish average (19% private and 17% social compared to 8% and 29% for Scotland).

The population has been growing steadily since 2003. It is important to recognise that the communities within the Park are heterogeneous, consisting of long-term rural residents whose families have lived in the area for generations as well as recent economic or amenity immigrants attracted by the special qualities of the Park. There are differences by gender, age, class, occupation, land tenure as well as important differences in terms of preferences and attitudes to land use, environmental protection and economic development.

The 2001 census data suggests that the residents of the (pre) National Park had fewer professional and managerial grade workers than the Scottish average, but also fewer unskilled and unemployed workers than the average, with a concentration around the C1 (clerical, supervisory/junior management) and C2 (skilled manual worker) grades. The percentage of

total population who are income or employment deprived is half that of the Scottish average. There are also lower than average rates for depression, alcohol misuse and drug abuse reported.

The main industries for the Park area (as of 2001) are shown below, with those higher than the Scottish average highlighted in bold:

Sector	Park % in 2001	Scotland % in 2001
Hotels and Restaurants	**19.4**	13.7
Wholesale and retail	12.6	14.4
Other	**9.8**	5.3
Health and social work	9.7	12.4
Real Estate and Business	9	11.2
Construction	**8.0**	7.5
Manufacturing	7.2	13.2
Education	6.3	7.3
Agriculture, Hunting and Forestry	**5.7**	2.1

There were 21 food and drink processors in the National Park, including seven whisky distillers (whisky being the most valuable Scottish export commodity by volume after oil).

The Park contains, for example, 424 listed buildings and 60 scheduled ancient monuments, as well as many other examples of settlement dating from Neolithic times through to the Victorian hunting lodges and castles. The Park is also the 'playground' for local residents, day visitors from nearby Scottish cities and tourists from the UK, Europe and beyond. The recreational facilities support winter sports, long distance walking, water sports, fishing, mountain and road biking and hunting. There are also over 70 visitor attractions and museums in the Park.

It is important to recognise that the Cairngorms is a **National** not a Natural Park. The national aspect has important implications for its function and challenges facing it. The third aim of the National Park (Scotland) Act requires that Scottish national parks promote themselves to the general public. There is an expectation that National Parks are both an asset for all Scottish citizens, but also are an example used to promote Scotland internationally.

2.2 Methodology

The section below is derived from baseline policy analysis completed as part of WP5: interfacing the scientific results with societal/policy processes, whereby the lead partner asked each case study to prepare a questionnaire response about their case study and the policies related to sustainability and sustainable land use. The Scottish analysis listed 103 policies and plans. The analysis leading to the long list was based on a review of the policy connections

provided as part of the Cairngorms National Park Plan (CNPP); the supporting Strategic Environmental Assessment and a web based search of environmental and sustainability policies applying to Scotland and/or CNP. The short list, the most relevant policies listed in section 2.3 below, was based on the MLURI team's expert judgement, which in turn was strongly influenced by the policies that were being discussed in CNPP delivery team meetings and discussions with the strategic planners in CNPA. A further policy was added after the initial D23 workshop in December 2010, the Scottish Land Use Strategy that was launched in March 2011. The analysis for this deliverable (D30) was again based on expert judgement, whereby the MLURI team compared the findings from D28 and D29 against the objectives, and where possible the indicators, for the policies listed below. Therefore, the analysis remains qualitative and interpretative, as is appropriate when closing the semantic loop (Giampietro et al., 2009 after Rosen, 1978). The robustness will be further increased after 'peer-checking' the analysis during the next CNPA workshop (see section five).

2.3 Policy Analysis

The Scottish case study is focussed on assessing the trends occurring within the Cairngorms National Park and the delivery of the **National Park (Scotland) Act 2000 via the Cairngorms National Park Plan (CNPP)**. The National Parks (Scotland) Act 2000 has the following four objectives:

- To conserve and enhance the natural and cultural heritage of the area;
- To promote sustainable use of natural resources in the area;
- To promote understanding and enjoyment (including enjoyment in the form of recreation) of the special qualities of the area by the public;
- To promote sustainable economic and social development of the area's communities.

As interpreted in the CNPP, the Act aims to deliver better outcomes through coordination; develop solutions for rural Scotland through innovation and disseminating good practice; provide a Park for all backgrounds, interests and abilities and promote 'The Pride of Scotland' – Scotland's most iconic landscapes and heritage that shapes that nation's identity.

The CNPP is a strategic spatial planning document with statutory remit, in that all public (governmentally funded) agencies have to have regard to the plan, but it is not supported by any direct regulation or funding initiatives. It is related to sustainability as it delivers the four aims of the National Park Act. The CNPP has a 25 year vision, five guiding principles and 22 strategic objectives arranged under three themes (conserving and enhancing the Park, living and working in the Park and Enjoying and Understanding the Park). The short term focus has been on 7 'priorities for action' (PfA)as listed below. Each PfA has a delivery team and has been working on projects relating to the aims of the CNPP.

- Conserving and Enhancing Biodiversity and Landscapes
- Integrating Public Support for Land Management
- Supporting Sustainable Deer Management
- Providing High Quality Opportunities for Outdoor Access
- Making Tourism and Business More Sustainable
- Making Housing More Affordable and Sustainable
- Raising Awareness and Understanding of the Park.

As part of the CNPP mid-term review, the CNPP has been linked to 9 Scottish Government National Outcomes (see Economic Strategy below) with a set of performance indicators to allow performance to be monitored.

The **Scottish Rural Development Programme 2007-13** is a £1.6 billion programme of economic, environmental and social measures. The scheme is the main economic incentive mechanism available to land based and community initiatives within the CNP. Unfortunately, the delivery of the SRDP is split into regions, and the CNP falls into three regions (Grampian, Highland and Tayside). The CNPA have employed two support officers to help land managers access the Rural Priorities and land manager contracts that make up rural development contracts.

The **Common Agricultural Policy** is the main form of support to farmers in Europe. Major reforms in 2003, simplified previous subsidy payments into a single scheme, the Single Farm Payment Scheme. The 2003 reforms decoupled payments from production and made them conditional to meeting certain environmental, animal health and welfare and food safety requirements (known as cross-compliance). As part of the ongoing reforms to the CAP, the European Commission has undertaken an initial consultation on the efficiency and effectiveness of current CAP measures and is now proposing new draft legislation. The legislation aims to make the direct aids system more effective and simpler, to make remaining market support measures more relevant to the world we live in and to tackle new challenges such as climate change, bio-fuels, water management and the protection of biodiversity. The CAP is very important to land based industries in Scotland, and approximately half of the land in CNP is registered for CAP payments.

All businesses in Scotland which have an agricultural business holding number (ABN) are entitled access the SRDP, which is the main mechanism by which the CAP is implemented within Scotland. The SRDP is very complex, but in simple terms there are four axes – 3 available to those with ABN's and one available to local community action groups (LEADER). The SRDP is commonly considered to have three tiers – the single farm payment (SFP); land manager options (LMO) and rural priorities. Of interest to the CNP are additional payments such as the Crofting Counties Agricultural Grant Scheme and the Less Favoured Area Support Scheme. All

those with an ABN can claim SFP based on historic production patterns, and the payment in return for maintaining land in good agricultural and environmental condition and compliance with a raft of other environmental and animal welfare policies. LMOs are additional grants available to those with ABN who meet the criteria; and rural priorities are much larger competitive grants for agri-environment; business modernisation or farm diversification projects.

The Scottish **Government Economic Strategy** aims "to focus the Government and public services on creating a more successful country, with opportunities for all of Scotland to flourish, through increasing sustainable economic growth". There are five strategic objectives: WEALTHIER & FAIRER; SMARTER; HEALTHIER; SAFER & STRONGER and GREENER. There are 15 outcomes against which the Scottish Government will seek to measure progress over time. The policy influences all public sector bodies including those active within the National Park. The review indicators are to be achieved by 2011, and 2017.

The **Climate Change (Scotland) Bill** was passed on 24th June 2009. The Bill creates a long-term framework that will: introduce a statutory target to reduce Scotland's greenhouse gas emissions by at least 80 per cent by 2050; establish an interim target of at least 42 per cent emissions reductions by 2020, with a power for this to be varied based on expert advice from the UK Committee on Climate Change; establish a framework of annual targets; and include emissions from international aviation and international shipping. Scotland's Climate Change Delivery Plan sets out how to achieve the statutory emission targets which lie at the heart of the Bill. The Bill will have implications for energy use and activities across Scotland.

The **Scottish Land Use Strategy** was published in March 2011. It is the first of its kind for Scotland and sets out a long term Vision towards 2050 with three clear objectives:

- Land based businesses working with nature to contribute more to Scotland's prosperity
- Responsible stewardship of Scotland's natural resources delivering more benefits to Scotland's people
- Urban and rural communities better connected to the land, with more people enjoying the land and positively influencing land use

The Strategy identifies 10 key Principles for Sustainable Land Use, reflecting Government priorities that influence land use. These cover encouraging multiple benefits; better regulation; valuing primary land use; understanding ecosystem function; managing landscape change; taking account of a changing climate, reusing vacant land, providing recreation opportunities; ensuring people can determine land based decisions and linking land to daily living.

3 Findings:

The implications of D28 and D29 findings for each policy summarised above are set out in order (see section 2.3 above). This section is followed by a short discussion.

3.1 National Park (Scotland) Act 2000/Cairngorms National Park Plan (2007)

As this policy is only relevant to the CNP level of analyses, there will be no commentary on the Scotland level results in section 3.1. The performance of the Park against the 9 national outcomes will be discussed under section 3.4.

The analyses presented in D28 and D29 are most relevant to the 2nd and 4th aims of the National Park Act, namely to promote sustainable use of natural resources in the area; and to promote sustainable economic and social development of the area's communities. However, as the resources did not extend to a household decomposition of the CNP system, our commentary on the social development of the area's communities is limited. The sustainable use of resources is tackled within the commentary on the CNPag sector contribution to public benefits and the commentary on the CNP MUSIASEM results for sustainable growth (see below). The analyses in D28 and D29 are most relevant to the following priorities for action: Integrating Public Support for Land Management and Making tourism and business more sustainable.

Integrating Public Support for Land Management seeks a 'diverse and viable land management sector' that produces high quality products whilst delivering public benefits and contributing to local employment and the economy. The main actions are to focus on the wood fuel action plan; the food and drink action plan and guidance on increasing renewable energy production. The analyses in D29 focussed on the agricultural sector excluding forestry but the SUMMA analyses in particular show that the proportion of renewable energy sources with the CNPag sector has increased from 1991-2007 – a positive outcome. However, the metrics for indirect labour and indirect labour in services have increased in the CNP, suggesting that more employment is being 'out-sourced' beyond the Park boundary, somewhat going against the aim to contribute to local employment. As noted in D29, the analysis was unable to look at local premiums for products, so it is unclear to what extent the CNPag contributes to the food and drink strategy or the CNP brand. In terms of delivering public benefits, the CNPag sector produces less environmental pollutants per hectare than the Scottish average but the model suggests the sector produces more greenhouse gas emissions and other emissions that are negative for humans and other living creatures (e.g. acidification, eutrophication) for every unit of production (dry matter or per Euro of value). Neither the SUMMA nor the MUSIASEM results illustrate other potential positive public benefits of agriculture, e.g. the symbiosis of extensive livestock management and biodiversity or the contribution towards a cultural landscape. We are unable to comment on the proportion of wood fuel energy in the CNP_{AG} sector. The

analyses also contribute to a further aim for this PfA – provision of 'sound information' that can be used in an 'open process involving land managers'. The utility of the analyses of D28 and D29 will be reflected on in the updated D23 report, but initial responses suggested the results would be most suited for discussion within an academic forum rather than involving local land managers.

Making tourism and business more sustainable as an overall aim is supported by D28 and D29 analyses; although the particular outcomes are structured in such a way that it is difficult to connect these analyses with the individual outcomes. For example, the D28 MUSIASEM fund/flow diagrams show that most paid work sectors are producing more income per input of labour or energy over the course of the time series but we are unable to comment whether this contributes to the special qualities of the park; communities' sense of economic self determination or whether it reflects more businesses meeting the Park's environmental criteria. Again, the metrics for indirect labour and indirect labour in services for the CNPag sector have increased, suggesting that more employment is being 'out-sourced' beyond the Park boundary, somewhat going against the aim to increase the use of local suppliers (remember this specific analysis is only for the agricultural sector).

3.2 Scottish Rural Development Programme & Common Agricultural Policy

The SUMMA analyses from D29 are most relevant to the 'decoupling' effect of the CAP reforms, as translated into the current SRDP. The results shown in D29 consistently illustrate that the CNP is an extensive agricultural system, but one that is marginally intensifying. This suggests that some agricultural businesses in the CNP are seeking to increase their efficiencies despite the bio-physical constraints on production, which are represented by the fact that although the extent of SUMMA indicators are often low; and the intensity per ha is lower than Scotland; the other indicators (per Kg of dry matter, Mj of energy, euro of product or emergy indicators) suggest that the sector is less efficient than the Scottish average. It is possible that the decoupling from production and the support provided by the CNPA to help agricultural businesses access the higher tiers of the SRDP may be allowing agricultural businesses in the Park to continue to farm, despite their constraints. The Scotland level results show that overall, the Scottish agricultural sector is extensifying and the metrics for intensity of resource use are improving.

The Scottish SUMMA analyses in D29 are most relevant to axis 2, where there are 14 LMO that aim to improve the agri-environment. In particular, the SUMMA analyses on extent and intensity of environmental impact as measured by Global Warming Potential 100yr - (t CO_2 eq.); Human Toxicity - (t 1.4-dchlorobenzene eq.) ; Photochemical Oxidation - (t ethylene eq.) ; Acidification - (t SO_2 eq.); and Eutrophication - (t PO_4 eq.) could be related to the options of managing cattle and deer grazing and creating or managing woodlands (GHG emissions);

managing headlands, margins and stubbles (diminishing eutrophication) and maintaining organic farming (toxicity and eutrophication).

The Rural priorities are set on a regional basis and for this analysis we have restricted ourselves to the Grampian region using the CNP level analyses for illustration. This region has 32 priorities, but our analyses focus on relevant priorities within the water and soils, adaptations to Mitigate Climate Change and Diversification of Rural Enterprise categories. For example, water and soil priorities GRA16 – 20 all highlight the need to use the existing Dee and Spey catchment management plans and the North East Area Management plan to reduce diffuse pollution, protect drinking water, improve ecological status and habitats, provide flood protection, and reduce acidification of upland waters. The SUMMA analyses demonstrate that although the extent of environmental impacts from the agricultural sector is decreasing, the sector still contributes to eutrophication and acidification. The tools did not analyse how the sector contributes, positively or negatively, to the provision of habitats or flood protection.

Rural priority GRA22 seeks to reduce emissions of greenhouse gases from land based operations, through use of 'green' technologies, appropriate management practices (e.g. organic conversion or organic maintenance, targeted fertiliser applications) and minimising emissions from every stage in the supply chain. SUMMA's analyses of the extent and intensity of emissions are useful here – showing that the CNP system has reduced its extent of GHG emissions from the agricultural sector, and the intensity of emissions, particularly associated with livestock (N2O and CH4). The SUMMA analyses are also relevant to rural priority GR28: The increased local use of renewable energy, e.g. woodfuel, as data shows a consistent increase in the use of local renewable emergy within the agricultural system.

These indicators are also interesting in terms of rural priority GR26c that seeks improvements in environmental performance particularly in resource usage and waste management practices. Here the Emergy Unsustainability Index has increased from 1991 to 2007 i.e. the system is becoming more unsustainable by the SUMMA metrics, even though the 2007 result (0.7) is three and a half times lower than the Scottish average (2.64). The MUSIASEM analysis would be useful for assessing changes in the environmental performance and use of resources, if a flow/fund analysis looking at total energy throughput for the agricultural, forestry and fishery paid work sector was carried out.

3.3 Scottish Land Use Strategy

The analyses in D28 and D29 contribute to the objectives about land based businesses contributing to prosperity and responsible stewardship, although we are unable to comment on to what degree the stewardship delivers benefits to Scotland's people. The MUSIASEM fund/flow analyses in D28 illustrate that the agriculture, forestry and fishery sector employed 5.07% of the paid workers, generated 1.14% of GVA, contributing on average £5.64 per hour

worked for Scotland (all 2009 figures). This can be compared to the CNP agriculture, forestry and fishery sector, which employed 14.4% of the paid workers, generated 10.8% of GVA, contributing on average £22.50 per hour (all 2009 figures). Unsurprisingly, the land based sector in the CNP has a larger part to play in contributing to prosperity than the sector does for Scotland as a whole. However, the differences in productivity as measured by GVA are striking.

In terms of responsible stewardship, the environmental impact as calculated by SUMMA of the agricultural sector has been discussed above, with the agricultural sector contributing GHG and other environmental emissions, although both Scotland and the CNP systems have become more efficient users of energy and environmental inputs over time. As discussed in section 3.1 above, it is difficult to comment on the provision of multiple benefits (principle 1) when the tools tend to focus on negative environmental impacts, rather than contributions to habitat or ecosystem function (principle 4). However, as discussed above, and again in section 3.5 below, the analyses do contribute to principle 6 on the changing climate, particularly the need to reduce Greenhouse gas emissions associated with land use. Section 5.1 discusses how further land based analyses could contribute more results to this section.

3.4 Government Economic Strategy

The Scottish Government's economic strategy sets out five objectives, and is measured by the National Performance Framework which has 15 national outcomes. The analyses in D28 and D29 offer evidence for the WEALTHIER & FAIRER and GREENER objectives. The CNPA have identified 9 of the 15 national outcomes as relevant to their CNPP and within this subset, our analyses can add something to the following outcomes:

- We value and enjoy our built and natural environment and protect it and enhance it for future generations.
- We reduce the local and global environmental impact of our consumption and production.
- We realise our full economic potential with more and better employment opportunities for our people.
- We have tackled the significant inequalities in Scottish society

Unfortunately, the particular indicators selected for each of the above (increase in priority species actions; increase in use of brand; business start-ups; and housing need ratio) are not ones that the tools can contribute towards.

In terms of protecting the natural environment, the MUSIASEM analyses for the EMR/ELP societal average and paid work sectors suggest that both Scotland and the CNP are becoming more efficient at resource use to maintain society and produce economic outputs. However, the SUMMA analyses regarding environmental impacts for the Scottish and CNP agricultural

sector illustrate that economic production comes at a cost. The environmental impacts have reduced 1991- 2007 but the changes are fairly incremental, suggesting that there will continue to be negative impacts until there is radical transition in the sector.

In terms of reducing the environmental impact, the SUMMA analyses provide evidence for the Scottish and Cairngorms agricultural sector. The data show that the emergy unsustainability index is rising for the CNP (0.58 to 0.7 1991-2007) but has decreased to below the 1991 level for Scotland (2.86- 2.64). Therefore this suggests that the local and global impact of Scottish agricultural production is decreasing but is still high; and some extensive systems, e.g. the Cairngorms, is actually increasing. The emergy indicators for the agricultural sector illustrate how embodied energy is imported when one imports goods and services from beyond Scotland; and there is no reason to think that this would be different for other sectors. Thus, switching to a service based economy away from obviously energy intensive industries does not necessarily reduce the global impact, even if the local EMR rates are lowered.

In terms of realizing full economic potential and more employment opportunities, the MUSIASEM analyses illustrate that Scotland and CNP has produced more added value over time, with the average being £25 GVA per hour of paid work for Scotland and £29 for Cairngorms (2009 figures). The proportion of human activity in paid work has reduced over time for Scotland (9.29% 2005 to 8.95% in 2009), compared to static 9.5% of THA for the Cairngorms. However, the tool applications do not allow us to say much about the distribution of this increase in wealth in terms of across demographics such as age or gender. However, the the spatial decomposition of MUSIASEM to NUTS3 regions suggests that there are 'winners' and 'losers' in terms of this labour productivity. As D28 illustrates, Scotland can be divided into three categories – the high performing city regions; the accessible rural economies and the more peripheral rural economies with much lower ELP values (e.g. the Western Isles only generates around £12 GVA per hour worked). Interestingly, the CNP region is positioned within the city regions in terms of its economic performance, despite its rural character – this may be due to its high dependence on the retail and recreation and business and finance sectors.

3.5 Climate Change (Scotland) Bill

The results of both D28 and D29 illustrate that although both Scotland and the CNP systems are reducing their emissions, they are a long way off from achieving the 42% reduction by 2020 or 80% reduction by 2050. In particular, D28 analyses for both Scotland and CNP level show that there have been some reductions in the societal demand for energy and an increase in societal energy efficiency. It is unclear exactly why these reductions from 1991-2007 have occurred, but may be related to increasingly efficient household appliances and more fuel efficient heating and personal transport. However, the decompositions for the paid work sectors illustrate that much of the reduction in energy being utilised is due to the change in the composition of the

paid work sector, moving away from energy intensive industries towards services and retail sectors. However, both the MUSIASEM and SUMMA tools illustrate that these changes do not necessarily reduce the embodied energy used by Scottish and CNP society, but changes where the energy is expended. Thus, the SUMMA indicators for indirect labour, indirect services and emergy are particularly useful in showing that 'dematerialised' economies actually import embodied energy.

The Scottish Climate Change Delivery Plan seeks to reduce energy use through both (1) decreasing demand and increasing the efficiency with which energy is used; (2) Reduce the use of fossil fuels and produce more low carbon energy; (3) Reduce consumption, particularly of products which emit greenhouse gases as part of their manufacture, e.g. cement; production, e.g. meat; or decomposition, e.g. waste; and (4) Sequester carbon geologically and in soils and vegetation, e.g. trees. Our analyses can contribute to analysis for actions 1-3.

The MUSIASEM analyses show that the Exosomatic metabolic rate (EMR - the intensity of energy use per hour of human activity in Mj/hr) for Scotland (societal average i.e. household and paid work sector) has decreased from 2005-2009, suggesting decreased demand; and the EMR/ELP (economic labour productivity) results show there is a pattern of increasing ELP_{SA} with in nearly all cases no increase in $EMR_{SA,}$ suggesting increased efficiency – although it may also reflect changes in the make up of the societal average. However, paid work uses 68% of Scotland and 71% of Cairngorms total energy throughput. The renewable energy targets are discussed under section 3.5 below. In terms of consumption, D28 suggests that some of the positive sustainability trends e.g. the increase in ELP whilst reducing EMR may be due to changing the proportions of the paid work sector.

Those sectors that produce GHG e.g. concrete and meat contribute a relatively small proportion of the overall paid work sector in terms of labour force and GVA. For Scotland, the construction sector is 5.36% and AFF accounts for 5.07% of the paid work labour force contributing 7.8% and 1.14% GVA respectively (2009 figures). For the Cairngorms, the construction sector is 3.85% and AFF accounts for 14.4% of the paid work labour force contributing 6.43% and 10.88% GVA respectively (2009 figures). These figures can be compared with the largest employment sector (public administration and services at 33.74% for Scotland and retail, recreation and transport at 37.43% for the CNP); and the largest contributor to GVA by sector (business services and finances at 28.35% for Scotland and 24.86% for CNP, again all 2009 figures). The sectoral decomposition does not yet allow an analysis of the change in waste products from production or consumption. The emergy indicators for the agricultural sector illustrate how embodied energy is imported when one imports goods and services from beyond Scotland; and there is no reason to think that this would be different for other sectors, even high value service sectors like business and finance.

Thus the analyses can provide some evidence for the 'transformational outcomes' sought as part of the delivery plan, namely a largely de-carbonised electricity generation sector by 2030; a largely de-carbonised heat sector by 2050; a largely de-carbonised road transport sector by 2050 and a comprehensive approach to ensure that carbon (including the cost of carbon) is fully factored into decisions about rural land use (including minimising emissions from agricultural and other land use businesses).

Scotland's commitments on climate change action are set out in the Government Economic Strategy and National Performance Framework: namely generating 80 per cent of Scotland's electricity from renewable sources by 2020 (~8 gigawatts) with an interim target of 31 per cent by 2011(~5 gigawatts), and 20 per cent of Scotland's total energy use to come from renewables by 2020. The SUMMA analyses show that locally renewable emergy inputs have increased in Scotland and CNP (1991-2001) although the units of seJ/yr does not allow us to indicate to what extent this is close to the 8 gigawatt renewables target for Scotland by 2020.

4 Discussion:

This discussion section covers the implications of our findings in light of the literature; the implications for mainstreaming the tool kit and the lessons we have learnt for the next workshop.

Readers may have noticed a certain amount of repetition of policy goals in section three. This is due to the complex and inter-related nature of policies impacting rural Scotland. For example, both the National Park Act and the Land Use Strategy are spatial planning instruments, which try to integrate sectorally-based policies. Furthermore, often their implementation is reliant on other policies e.g. the incentives and regulations associated with the SRDP. The Economic Strategy is another overarching strategy that guides all activities by the public sector; and the Climate change suite of policies seek to put a climate change perspective on existing activities and their policy drivers.

In terms of how well the tools have been able to deliver policy-relevant results, it is obvious that the tools can illustrate trends and patterns that are of relevance to the policies outlined in Sections 2 and 3. In particular, the MUSIASEM tool provides a useful way to compare productivity, efficiency and employment between sectors, between spatial scales and time periods, which contributes to the CNPP, the Economic Strategy and the Climate Change action plan and the SRDP for the agricultural sector decomposition. The SUMMA tool provides very detailed analyses of the emissions and environmental impacts of the agricultural sector, which contributes to the CNPP, SRDP, Land Use Strategy and Climate Change Delivery Plan.

However, 2 of the 4 National Park Act objectives (conserving natural and cultural heritage and promoting recreational enjoyment) and 5 of 7 priorities for action (biodiversity & landscapes; deer management; opportunities for outdoor access; housing and awareness & understanding) were not answered by the analyses in D28 and D29. Likewise, many aspects of the LMO and Rural priorities related to biodiversity, habitats, cultural heritage and recreation are not answered by D28 and D29. The analyses can not help us comment on the 3rd objective for the Land Use Strategy (connecting urban and rural communities to the land) or many of the principles underpinning the strategy (e.g. using derelict land, involving communities in land use decisions). Furthermore, the applications do not offer analyses that contribute to the Scottish Government's SMARTER, HEALTHIER, and SAFER & STRONGER objectives, and can't be used to consider the trends for 11 of the 15 national outcomes. Finally, the tools do not address carbon sequestration for Climate Change Bill. However, although there are many things that the applications could not answer, it is unrealistic to expect even sophisticated tools to be able to answer such a broad range of policy questions.

In particular, we have noted that the applications did not really tackle ecological, social or cultural aspects of sustainability. We recognise that the MUSIASEM tool could provide more

information on social indicators such as income, gender and age distributions if a household decomposition was undertaken. If a land based decomposition was applied to the tourism and recreation sector, it is possible that light could be shed on recreation, a policy issue that arises in the CNPP, SRDP, Scottish LUS and National Performance Outcomes. However, it is unclear how the tools can provide an indication of changes in ecological health of the system; or the perceptions of residents and visitors regarding their wellbeing and cultural heritage. Quantitative data is available for the former, but it is unclear how this would factor in the SUMMA or MUSIASEM co-efficients. Generally, quantitative data is not available for the latter. It is for these reasons that we believe the tools should be used in conjunction with other forms of deliberation to round out the perspective on the system.

Thus, overall, we argue that the analyses provided by MUSIASEM and SUMMA are most appropriate for exploring certain aspects of sustainability, namely the economic and environmental trade-offs that results in either the growth or the change in the composition of a system. With reference to policy, the analyses speak most to the implementation of the CAP via the SRDP; the Economic Strategy and the Climate Change Bill and its action plan. Given that it is the indirect effects of climate change that are most likely to impact on social and economic aspects of Scotland, the focus on climate change has more salience with wider sustainability concerns than might be first apparent. More importantly, the tools capture trends in data, but do not offer causal explanations for why these trends may be occurring. In this way, the interpretation of these tools is still an essential aspect, as the trends alone will not inform policy (cf Bell and Morse, 2008).

The implications for mainstreaming remain less than encouraging if by mainstreaming we mean the potential for policy makers themselves to use the DECOIN tool-kit. Our interpretation of policy makers includes all those who make international, European, UK, Scottish or regional policy (i.e. National Park Authorities or Local Authorities) and administer grants, advice or regulations as means of ensuring policies are implemented. As noted in earlier reports (D16, D23) and repeated in D28 and D29, the tools are data and time intensive and require a considerable investment to become proficient in their use. Time is a commodity that Scottish policy makers do not have and it is likely that the transaction costs associated with these tools are too high to interest policy makers in becoming users themselves. However, transactions costs can be reduced by contracting research out to specialist users, and the Scottish Government and their agencies do let research contracts where they feel they need more information.

Therefore the issue remains whether the results provided by the DECOIN tool kit are salient and credible enough to warrant such expenditure on policy-relevant research. In particular, is the expenditure deemed cost-effective – is it the least cost option for providing the information

policy makers seek? It is possible that the results presented in section 3 will stimulate further interest, but equally, the CNPA stakeholders might judge that the most salient implications were already derivable from existing reports or data sets – something to test (see section 5). Furthermore, this depends on whether the results provide an evidence base that is palatable. Experience with evidence based policy analysis (Solesbury, 2002) suggests that evidence can be screened out as not credible when it contradicts the received wisdom of the policy network. Given the fairly radical ecological economics underpinning the DECOIN tool kit, it is possible that path dependency and autopoesis mean policy makers are likely to continue to collect and marshal evidence that fits with their existing world views than trust a result that challenges the very belief system on which a policy rests (Kirk et al., 2004; 2007). This is an aspect for further development (see section five). Indeed, D23 (p29) highlights that some stakeholders felt that the DECOIN tools were too 'multi-variate' or 'complex' for policy making processes.

Therefore, in terms of the next workshop, section 3 of this report has indicated how the D28 and D29 results can be presented in terms of their policy-relevance, and therefore salience to the CNPA stakeholders. As noted in section five, there are questions arising from this report that can be discussed at the next workshop. These questions include:

- Have the DECOIN toolkit applications provided new insights into the functioning of the Park system?
- Have you gained evidence for policy implementation or evaluation that you did not have already?
- How might you evaluate or implement policy differently in light of these findings?
- Could you have gained this evidence from other sources or methods?
    - Would these alternatives been cheaper, more valid, more useable, more reliable, more interpretable and/or more credible?
- Could you take these analyses out to your stakeholder forums? Would the information be of interest and/or of use to them?
    - The initial response was that the analyses were most appropriate for other academics not agency staff, residents or land owners (see D23).

5 Further developments

The further developments can be divided into research to be undertaken by the end of the SMILE project (30th June, 2011); further research planned by the MLURI team using other resources; and further research to be undertaken should further resources be made available.

5.1 Further research to be undertaken by June 2011

The main task for April – June 2011 is to run a further workshop with CNPA stakeholders, to present the updated results and get further feedback on the utility of the MUSIASEM and SUMMA tools. This workshop will build on the results presented in D28, D29 and D30. The workshop will explore the questions raised in section four above, with the aim to establish whether these results tell stakeholders something new about the system. The key point is whether the results could have been arrived at without the DECOIN Tools, although one needs to avoid the trap of good research being dismissed as 'obvious' as it confirmed what stakeholders suspected but did not know. The workshop will also probe whether the limitations of the DECOIN tool kit were due to problems with data, the way in which they were applied or issues regarding ontology and epistemology (see section 4 above). The workshop outcomes will be used to update the deliverable D23.

Once the land based analysis has been completed, there are further policy implications that may arise. In particular, there will be more to contribute regarding the implications for the Scottish Land Use Strategy objectives and principles, particularly principle five on Landscape change and principle 8 on recreational activities. Additionally, the analyses could be assessed against the indicators for the IUCN category V protected areas and the objectives of the CNPA's Landscape Strategy. Finally, the land analyses will be relevant for objectives with the conserving and enhancing biodiversity (wild land; contribution to landscape) priorities for action. These are likely to be areas that we will discuss in our CNPA workshop.

Finally, two papers based on results from D23, D28, D29 and D30 will be presented at the 'Trends and Future of Sustainable Development' conference, Tampere, 9-10th June 2011. One will focus on the way that the tools help illustrate the trade-offs that result from intensifying or extensifying a system and question the possibility of achieving the Scottish Government's goal of sustainable economic growth. The second will summarise the utility analysis of the tool kit and reflect on the experience of trying to use these tools to support delivery of rural sustainable development in Scotland. Both papers will be further developed after the conference for publication, possibly in Land Use Science or Environmental Modelling and Software journals.

5.2 Further Research to be undertaken post June 2011

Two five year Scottish Government funded Programmes begin on 1st April 2011. The study team will be involved in three themes of relevance to the SMILE approach. These themes cover the

application of the Ecosystem Approach, analysis of a move to a low carbon rural economy and assessing synergies and conflicts between rural and urban areas, with a focus on the CNP. These themes provide an opportunity to take further some of the methodological challenges raised in sections five within D28 and D29. This funding will allow incremental developments in the application such using MUSIASEM for assessing changes in the environmental performance by undertaking a flow/fund analysis looking at total energy throughput for the agricultural, forestry and fishery paid work sector. The themes also allow the implications of the findings in D28 – D30 to be discussed with other stakeholders, such as the Scottish Government for N+1 Scottish scale. However, the funding for use of the DECOIN toolkit is limited to the agricultural sector and does not encompass a full action research approach to mainstream beyond GDP indicators within the policy process.

5.3 Potential Further Research should resources become available

An FP7 proposal named LAUGH has been developed to exploit the DECOIN toolkit as an example of "beyond GDP" (bGDP) research tool, and evaluate the "strengths and weaknesses of these bGDP tool in policy settings. The core concept of the LAUGH proposal is to develop "knowledge brokerage" networks between researchers active in the development of bGDP methods and policy makers. Comparison of the bGDP applications will be undertaken both within partner countries and internationally to assess the degree to which bGDP approaches are likely to have an impact across the EU. The applications will be focussed on the concept of using land as a resource. Evaluation in various forms (utility, process, institutions and outcomes) is an explicit part of all phases, thus is "built-in" from the outset rather than seen as an add-on activity. The research will also take an action research approach, seeking to engender change in the systems and diffuse innovation through active participation by policy –makers. Thus, the project relies on social learning whereby learning collectively leads to changes in cognitive processing, attitudes and finally behaviour. The experience with SMILE illustrates the importance of using tools as boundary objects to open up discussions around sustainability policy objectives, trends and implications for future decision making. Whilst the proposal was not funded in its current form, the consortia are seeking other opportunities to take these ideas forward.

References

Bell S and Morse S. 2008, Sustainability Indicators: Measuring the Immeasurable? Earthscan Books, London (2nd Edition)

Giampietro, M., Serrano, T., & Sorman, A. 2009, Tool Manual, DECOIN: Development and Comparison of Sustainability Indicators, Project No 044428, FP6-2005-SSP-5A, Deliverable D4.4 of WP4.

Kirk, E.A.; Reeves, A.D.; Blackstock, K.L. 2007 Understanding environmental regulation: disciplinary interactions and path dependency. *Environment and Planning C, 25, 250-268*

Kirk, E.A.; Sherlock, K.L.; Reeves, A.D. 2004. SUDS Law: Non-state actors and the haphazard route to the implementation of international obligations. *Journal of Non-State Actors and International Law, 4, 87-109.*

Rosen, R. 1978. Fundamentals of Measurement and representation of Natural Systems. New York :North-Holland

Solesbury W. 2002. The ascendancy of evidence in Planning Theory and Practice, 2002 3(1) pp90-96