Producing recommendations on methods and indicators for assessing the "Greener" Strategic Objective at Data Zone Level

Report from mini-workshops

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Purpose of document, aim and background

This document summarises three mini-workshops which took place in September 2016 as part of the "Web-based mapping for open access – building capacity and exploring user preferences" project. These events took place as part of Work Package 3 of the project, which had an aim to "produce recommendations on methods and indicators for assessing the "Greener" Strategic Objective[1] at Data Zone level".

"Greener" forms one of five Strategic Objectives within Scotland's National Performance Framework, which was established by the Scottish Government in 2007 and forms "A single framework to which all public services in Scotland are aligned" and "A framework based on delivering outcomes that improve the quality of life for people in Scotland". The Strategic Objectives themselves "…describe where we will focus our actions" and "Ensure policies are developed in an integrated way and describe the kind of Scotland we want to live in" (quoted from Scottish Government, 2016). The four other Strategic Objectives – "Wealthier & Fairer", "Smarter", "Healthier", and "Safer & Stronger", have been used as a conceptual framework by researchers at The James Hutton Institute in the assessment of spatial differences in socio-economic performance within rural areas and small towns in Scotland (Thomson et al., 2014; Copus and Hopkins, 2015); in 2015, each Data Zone in rural and small town Scotland received a 1-10 score for these four Strategic Objectives, as well as an overall 'Socio-Economic Performance (SEP) Index' (Copus and Hopkins, 2015). However, a Data Zone level Greener indicator was not developed, as it was more conceptually distinct from socio-economic development than the other Strategic Objectives, and the difficulty of accessing environmental data at the Data Zone scale (described in Copus and Hopkins, 2015: 3; Thomson et al., 2014: 3). This gap in knowledge and information forms the starting point of this project.

Methods

Following 'hold the date' emails sent In July 2016, meeting invitations were sent to 26 staff in the SEGS group and 51 staff who were identified as natural and computer scientists on the 11th and 12th of August. Eight further staff within the SEGS group, who were not attending the mini-workshop for social scientists, and were identified as potentially having contributory expertise, were contacted regarding the computer scientists workshop (8th September). The 51 staff were sent two invitations, one to a mini-workshop aimed at natural scientists (described within an accompanying email as "land use, agriculture and ecosystems research"), and to a second mini-workshop aimed at computer scientists ("staff with expertise in database management, programming and/or GIS"). The email accompanying the invitations requested that participants should only accept one invitation, and that the computer scientists mini workshop "is particularly aimed at those who work directly with data (including spatial data) and have expertise in relevant computer methods".

Staff who had accepted an invitation, or had 'tentative' status as of the 5th September, were sent introductory information in the form of a short slideshow (Appendix 1), and a preparation task which would feed in to the workshop activities. For potential attendees at the social/natural scientist mini workshops, this was as follows:

[1] See http://www.gov.scot/About/Performance/scotPerforms/objectives/greener (Accessed 17th February 2017)

In your view, which policy domains are most important and most relevant to the 'Greener' strategic objective?

The 'Greener' strategic objective is described by the Scottish Government online (http://www.gov.scot/About/Performance/scotPerforms/objectives/greener); this information is reproduced on slide 10 of the slideshow.

A useful definition of "policy domain" is "…a component of the political system that is organized around substantive issues" (Burstein, 1991: 328; who also notes that other authors have used alternative terms including 'policy areas' and 'sectors')

Please bring a list of up to five key policy domains with you to the workshop.

Reference: Burstein, P. (1991) Policy Domains: Organization, Culture, and Policy Outcomes. Annual Review of Sociology, 17: 327-350. doi: 10.1146/annurev.so.17.080191.001551

Identifying the policy sectors perceived to be most relevant to "Greener" was a crucial starting point. The first version of the SEP Index was developed to measure policy success in the context of the National Performance Framework (see Thomson et al., 2014: 2), and the 'extended' SEP Index report published in 2015 acknowledged that the National Performance Framework "…provides… a basis for assessing the impact of the full range of policies within (the Scottish Government's) devolved powers" (Copus and Hopkins, 2015: 2). The Framework monitors policy success relevant to defined "National Outcomes" and the broad "Purpose" of the Scottish Government through a range of "National Indicators" (Scottish Government, 2016): the Community Empowerment (Scotland) Act (2015) compels Scottish Ministers to develop and review these National Outcomes on a regular, ongoing basis (noted in Scottish Government (2016) and Part 1 of the Community Empowerment (Scotland) Act (2015)).

Likely attendees at the computer scientist mini workshop were provided with the following task:

We would like to create an index, or numerical score, to measure government policy success in terms of progress towards the 'Greener' strategic objective, at the scale of small areas (data zones of 500-1,000 people) in rural areas and small towns in Scotland.

Which criteria should we use to decide which indicators are suitable for inclusion in this index? (Note that this is not asking which specific indicators should be chosen, or which 'subject areas' should be covered)

Please produce a list of up to 10 of the most important criteria and bring a list of these to the mini-workshop.

The 'Greener' strategic objective is described by the Scottish Government online (http://www.gov.scot/About/Performance/scotPerforms/objectives/greener); this information is reproduced on slide 10 of the slideshow.

Preparation tasks and information were also forwarded to some staff not initially contacted on the 5th of September.

The main activities used during the mini-workshops are described during the description of results detailed below. Informed consent was collected at the workshop using paper forms (Appendix 2) which had been forwarded for information purposes with invitations and the preparation tasks described above. A document containing a description of the research project, the 'work package' and a summary of data collection at the workshop was also included with invitations and with the preparation tasks.

In total, there were five attendees at the social scientists mini-workshop, and four attendees at both the natural and computer scientist mini-workshops. It should be noted that the social/natural/computer scientist split is obviously artificial, as several staff involved could have contributed to multiple workshops and activities due to their work across disciplines. These descriptions do not imply that these are appropriate 'labels' for staff, or that the staff involved only work in one sector of science. To anonymise the results, participants were asked to provide a research background or role description to be used instead of a name on outputs (Table 1). Attendees were drawn from a range of disciplinary backgrounds.

Mini-workshop	Attendees (research backgrounds/role descriptions)
Social scientists	Social researcher
	Social researcher + project manager
	Environmental psychologist
	Social researcher
	Social scientist
Natural scientists	Geographer
	Ecologist
	(None given)
	Interdisciplinary
Computer scientists	(None given)
	Post-doc researcher in agricultural economics
	GIS specialist
	Soil science, but work with GIS and databases

Table 1 – Mini-workshop attendees

The overall data collection approach within the three mini-workshops was derived from parts of a framework for identifying environmental indicators described by Niemeijer and de Groot in 2008 (Niemeijer and de Groot, 2008a)[2]. This article details a method of selecting indicators based upon an adapted version of the Driving force-Pressure-State-Impact-Response framework (for an introduction to this framework, see Kristensen, 2004), creating a 'causal network' of elements describing components of the environment, society and pressures on the environment which are associated with an issue, then identifying causal links between these, and finally identifying 'key nodes': particularly important parts of the network, and identifying strong indicators which could represent these (see Niemeijer and de Groot, 2008a: 19-23 for a fuller description: this is a very brief and simplified summary of this approach). While the activities which were carried out during the mini-workshops were modified from those planned (Appendix 3), the overall approach can be summarised as follows:

1) Recognising the policy areas which are most pertinent to the "Greener" Strategic Objective.

[2] the "indicator causal network" is also described in Niemeijer and de Groot (2008b).

2) Looking at what policy success might mean for rural areas and small towns: more specifically, identifying features of the environment and society which would change, and the environmental pressures caused by human activities which would change. These 'features' correspond to 'abstract indicators' which form broad, general descriptions of factors or processes (described by Niemeijer and de Groot (2008a: 19-21; 2008b: 101): these authors also noted the need to "Organize indicators in terms of environment related indicators, society related indicators and those at the pressure interface" (Niemeijer and de Groot, 2008a: 20)[3].

3) Prioritising features for representation in a "Greener" index or score, forming 'summary features' and suggesting potential indicators to represent these features. Niemeijer and de Groot describe 'key nodes' in a causal network which are those 'abstract indicators' that are a nexus for several cause-and-effect links (described by Niemeijer and de Groot (2008a: 22; 2008b: 101-104)). Within the social and natural scientist mini-workshops, 'summary features' constituted the outputs of this process, and suggestions were made for the more specific variables which could represent them. This corresponds with the recommendation to select 'concrete indicators' after the broader factors that they stand for have been recognised as important (described by Niemeijer and de Groot, 2008a: 20-21).

4) Based on key criteria and descriptors of indicator strength, identification of the strongest indicators out of those identified earlier by social and natural scientists. This took place within the computer scientist mini-workshop. This process links to the use of "…all the classic indicator selection criteria" after the judgement of the most important broader indicators (Niemeijer and de Groot, 2008a: 23). Several criteria have been used to select environmental indicators (literature review summary: Niemeijer and de Groot (2008a: 16-19); for example, the well-known 'SMART' criteria[4] were described around twenty years ago (Schomaker, 1997). More recent work related to ecosystem service indicator assessment used criteria within the wider categories of "Ability to convey information" and "Data availability" (Layke, 2009); other lists of criteria have been formed and used in evaluating indicators related to ecosystems (van Oudenhoven et al., 2012). In this study, the criteria for indicator selection were sourced from, and discussed by, computer scientist participants.

Results

The first part of this section summarises the results of the social and natural scientist workshops. It is structured into three sections based on the aims of the activities in these two mini-workshops. For clarity, the results of both mini-workshops are described together. The findings from the computer scientists mini workshop are described later in the results section.

The activities carried out at the three mini-workshops were adapted, during the workshops, from those planned beforehand. With regards to the social and natural scientist mini-workshops, this was due to how certain activities were received within the first (social scientist) mini-workshop. Within the natural scientists mini-workshop, the methods and activities used within the first mini-workshop

[3] The definition of "pressures on the environment caused by human activities..." introduced to participants within the mini-workshops was based on that within Kristensen (2004) and Niemeijer and de Groot (2008b: 101-2)

[4] Specific, Measurable, Achievable, Relevant, Time-bound.

were used again, for consistencies. Details of how workshop activities used differed from those planned are included within Appendix 3.

Social and natural scientists: Identifying the most important and relevant policy domains to the 'Greener' strategic objective

Following the introductory presentation, participants wrote the policy domains which they felt were "most important and most relevant to the 'Greener' strategic objective" onto post it notes. All notes were then placed onto a large paper sheet and, where possible, similar policy domains were 'clustered' together, with summary names given to the resulting clusters.

The social scientists group identified links between policy domains and policy domain clusters, and also indicated where some clusters overlapped (Figure 1). The policy domain clusters which were given names by the social scientists were:

- Planning
- Green space
- Transport
- Climate change
- Land management
- Land use

Policy domains related to land reform were also clustered together. An individual policy domain "Tourism" was linked to the Green space cluster. Policy domains of behaviour change, public health and education were not linked to any other policy domains or clusters.

The natural scientists produced five policy domain clusters (although one of these only had one policy domain within it), without any overlaps or links between the clusters (Figure 2):

- Planning and infrastructure
- Natural resource management
- Natural capital
- Climate change
- $

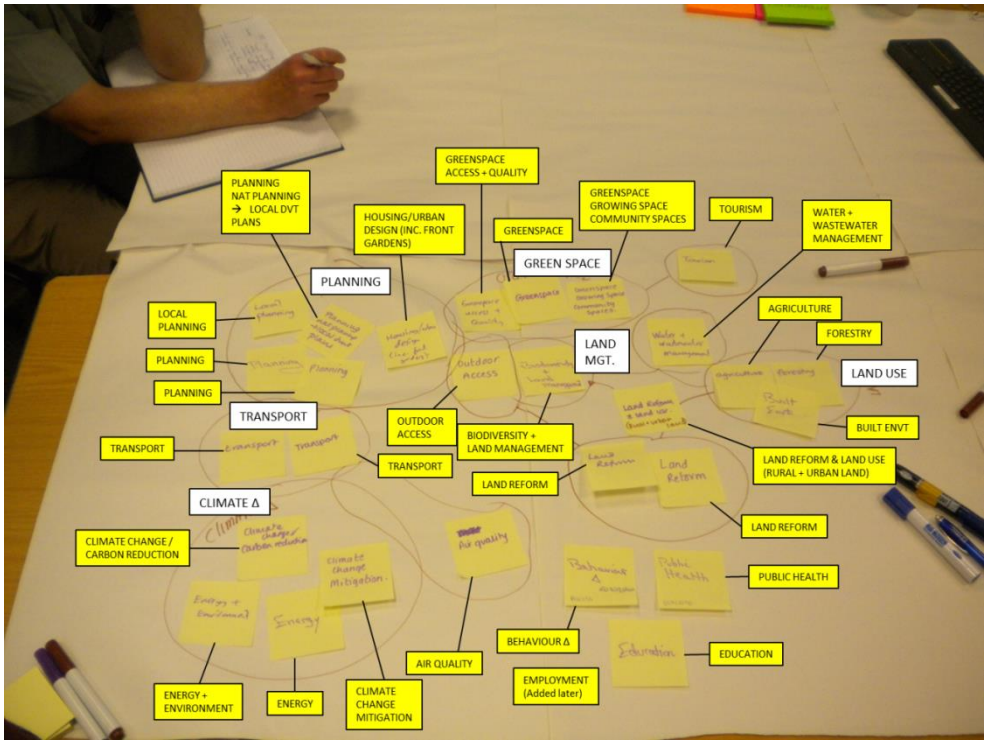

Figure 1 – policy domains and clustering by social scientists. The names of policy domain clusters which were written onto the paper sheet have been highlighted by white labels, yellow labels transcribe the policy domains on post it notes. Note that some small additions were made after this photograph was taken.

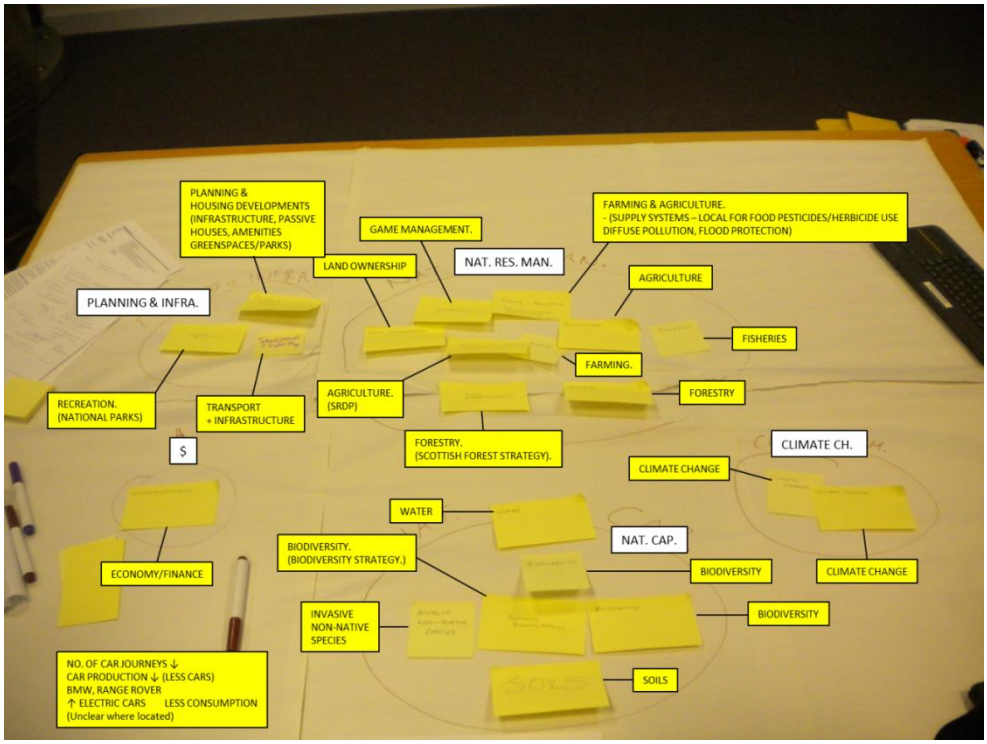

Figure 2 – policy domains and clustering by natural scientists. The names of policy domain clusters which were written onto the paper sheet have been highlighted by white labels, yellow labels transcribe the policy domains on post it notes.

Social and natural scientists: What would government policy success within these domains look like?

The defined policy domain clusters were used as a structure to explore what policy success would change in rural areas and small towns of Scotland. Participants were asked to consider the questions "Within these policy domains, if government policies are successful (in terms of progress towards the 'Greener' strategic objective), which features of a) the environment and b) society in rural areas and small towns would change? Also, which features that represent c) pressures on the environment caused by human activities (e.g. resource use, land use change, emissions) would change?" (Appendix 4). Participants were asked to carry out a brainstorming activity, using coloured post it notes to identify features of the environment (green notes), society (orange) or pressures on the environment (pink) which would change given policy success. In the social scientist workshop (only), participants were asked to note the policy domain clusters which these features were linked to. This activity was carried out as a group. When these features had been identified, participants were given five stickers with the instruction to label features which they felt should be represented in a 'Greener' index or numerical score. During voting participants carried out further clustering of features by moving them around on the table. Features with relatively high numbers of 'votes', and clusters of features with votes, were used by participants to form broad summary features, which were noted on a flip chart. The result of these processes is shown in the photographs below (Figure 3 for social scientists, Figure 4 for natural scientists).

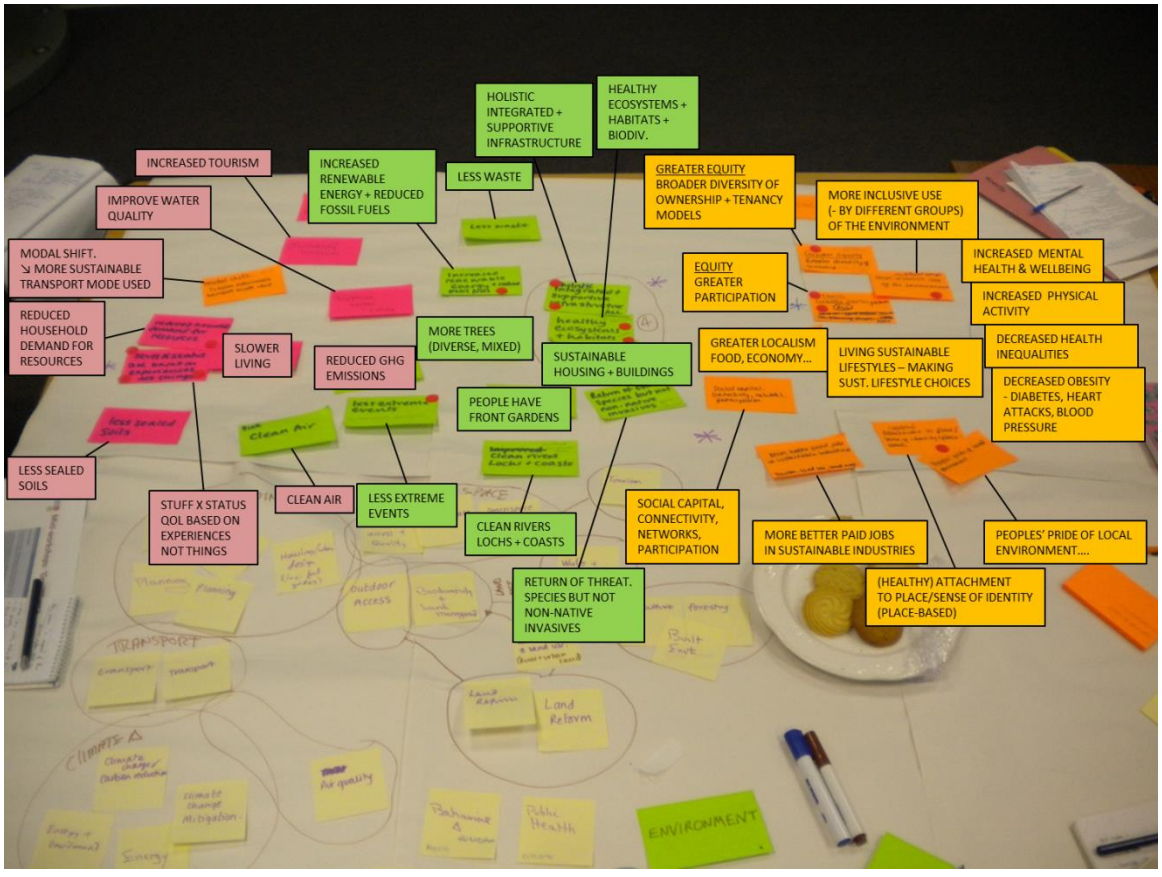

Figure 3 – Results for social scientists. Note that the labels do not include notes by participants on the policy domain clusters which they linked to.

Figure 4 – Results for natural scientists, showing labelled post-it notes (description of colours given above)

Social and natural scientists: Which features should be represented in a 'Greener' index?

Following these exercises, the question "Based on the discussions and voting, can we arrive at a consensus on the features to be represented in a 'Greener' index" was shown on screen, with the proviso "Note: we do not have a specific number of features in mind". Participants used the results of the brainstorming, voting and clustering to derive what might be described as 'summary features' which were transcribed onto a white board. Following the identification of these summary features, participants suggested potential indicators which could represent these features (Figures 5 and 6). Summaries of these in 'neat' form are shown in Tables 2 and 3.

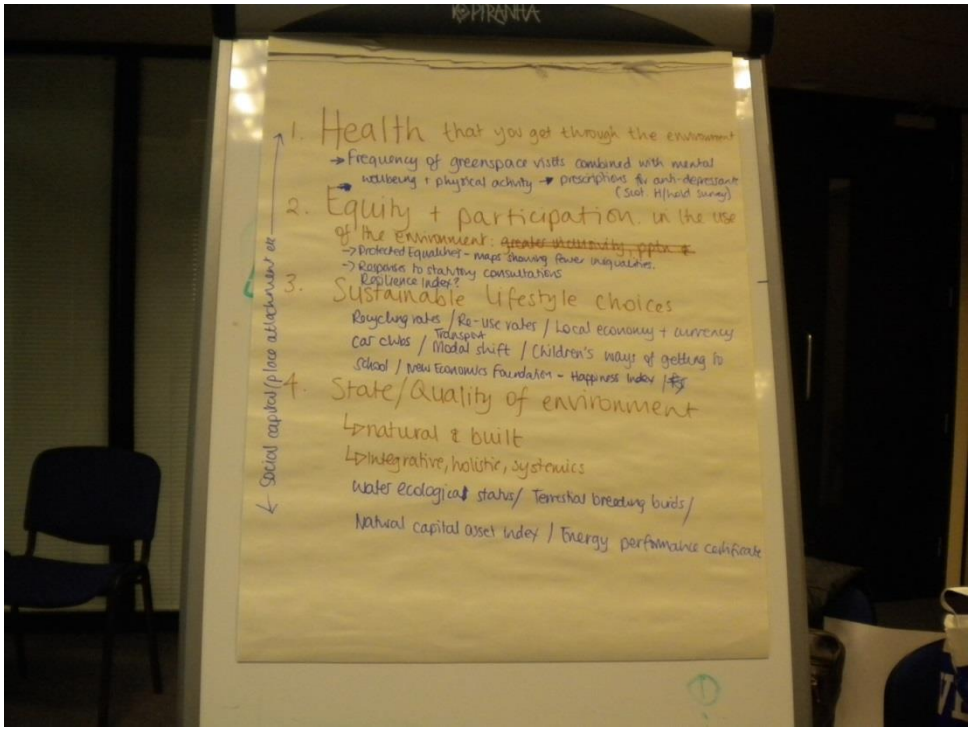

Figure 5 – 'Greener' summary features and potential indicators produced by social scientists. Summary features shown in brown, potential indicators shown in blue.

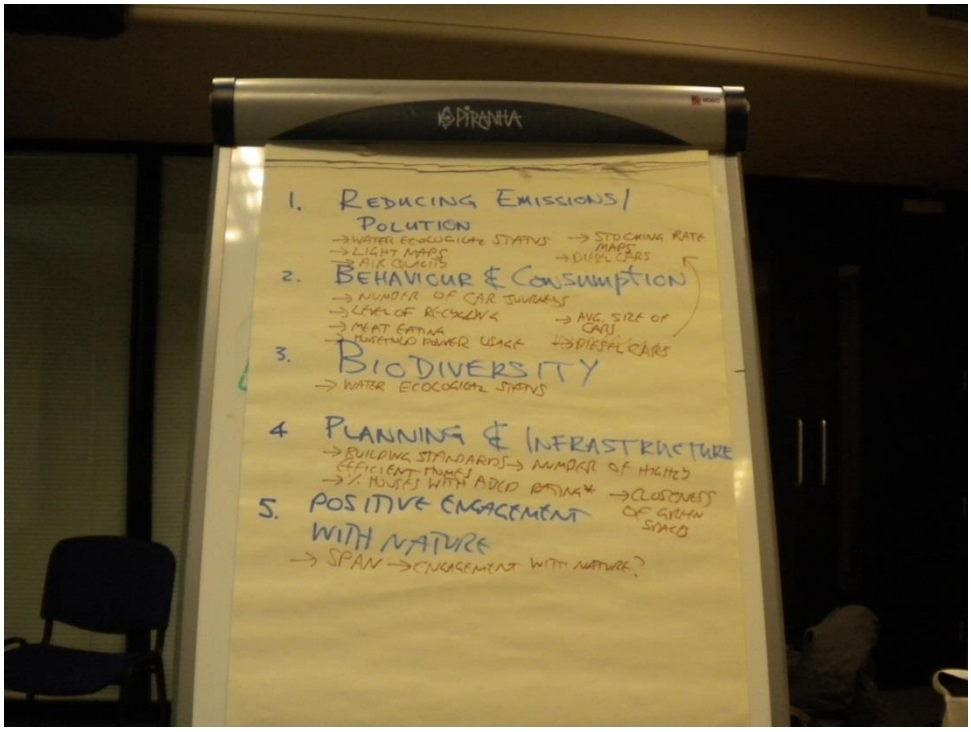

Figure 6 – 'Greener' summary features and potential indicators produced by natural scientists. Summary features shown in blue, potential indicators shown in brown.

Summary feature	Potential indicators
1. Health that you get through the environment	Frequency of greenspace visits combined with mental wellbeing + physical activity → prescriptions for anti-depressants (Scottish household survey)
2. Equity + participation in the use of the environment	Protected Equalities – maps showing fewer inequalities Responses to statutory consultations Resilience index?
3. Sustainable lifestyle choices	Recycling rates / Re-use rates / Local economy + currency Car clubs / Transport Modal shift / Children's ways of getting to school / New Economics Foundation – Happiness Index
4. State/Quality of environment - natural & built - integrative, holistic, systemics (Linked to all summary features)	Water ecological status / Terrestrial breeding birds / Natural capital asset index / Energy performance certificate Social capital / place attachment etc

Table 2 - Summary features and potential indicators produced by social scientists (derived from Figure 5)

Summary feature	Potential indicators
1. Reducing emissions / pol(l)ution	Water ecological status Light maps Air quality Stocking rate maps Diesel cars
2. Behaviour & consumption	Number of car journeys Level of recycling Meat eating Household power usage Average size of cars
3. Biodiversity	Water ecological status
4. Planning & infrastructure	Building standards → number of highly efficient homes % houses with ABCD rating Closeness of green spaces
5. Positive engagement with nature	SPAN → engagement with nature?

Table 3 - Summary features and potential indicators produced by natural scientists (derived from Figure 6).

Computer scientists: Which criteria should we use to decide which indicators are suitable for inclusion?

Following the two mini-workshops described above, the third event for computer scientists was held with distinct aims. The question above can be phrased slightly differently as "What makes a good indicator?". To prepare, participants had been asked to produce up to ten of the most important criteria relevant to producing indicators for a numerical score to measure government policy success (progress towards the 'Greener' objective) for data zones in rural areas and small towns. In the mini-workshop, these criteria were written onto post it notes, with the instruction to cluster together

criteria which were similar. Participants were also encouraged to produce names for these clusters (Figure 7) and the criteria which emerged from these activities are described here.

- The 'resolution' of data – particularly related to its availability at the appropriate spatial scale (Data Zones) was highlighted, and was a central theme to discussions within the mini-workshop. A GIS specialist strongly emphasised, from the start of the workshop, that mapping 'Greener' at the Data Zone scale was highly difficult if not impossible; subsequent discussions confirmed this. This summary name also covers the temporal scale, but the point was emphasised in discussions that several environmental and physical indicators were not available, or were easily calculated, at the Data Zone level.
- Transparency and simplicity were two summary criteria which were 'drawn out' from the criteria identified by participants. These related to the need to avoid indicators which were 'black boxes' where calculation methods were unclear, and the ease of understanding of the indicators (e.g. a suitable level for a range of stakeholders).
- Accessibility was a key criteria, in the context of both the openness of data access, and the cost of collection. The latter was associated with the capacity (in terms of cost and staff skills) to collect and measure different types of data. A commitment to the collection of this data in future was also identified.
- A collection of criteria were summarised as 'Interaction' which related to how well indicators 'fit' with other indicators and the conceptual framework they fit into. Broadly, this relates to indicators working well together to measure the overall 'Greener' concept: the situation where indicators record high values if one element or aspect of 'Greener' is strong, and low values if another aspect of 'Greener' is strong, should be avoided.
- 'Appropriate measurement' (quantitative or qualitative if these data types were suitable for the indicator) was another summary criteria.

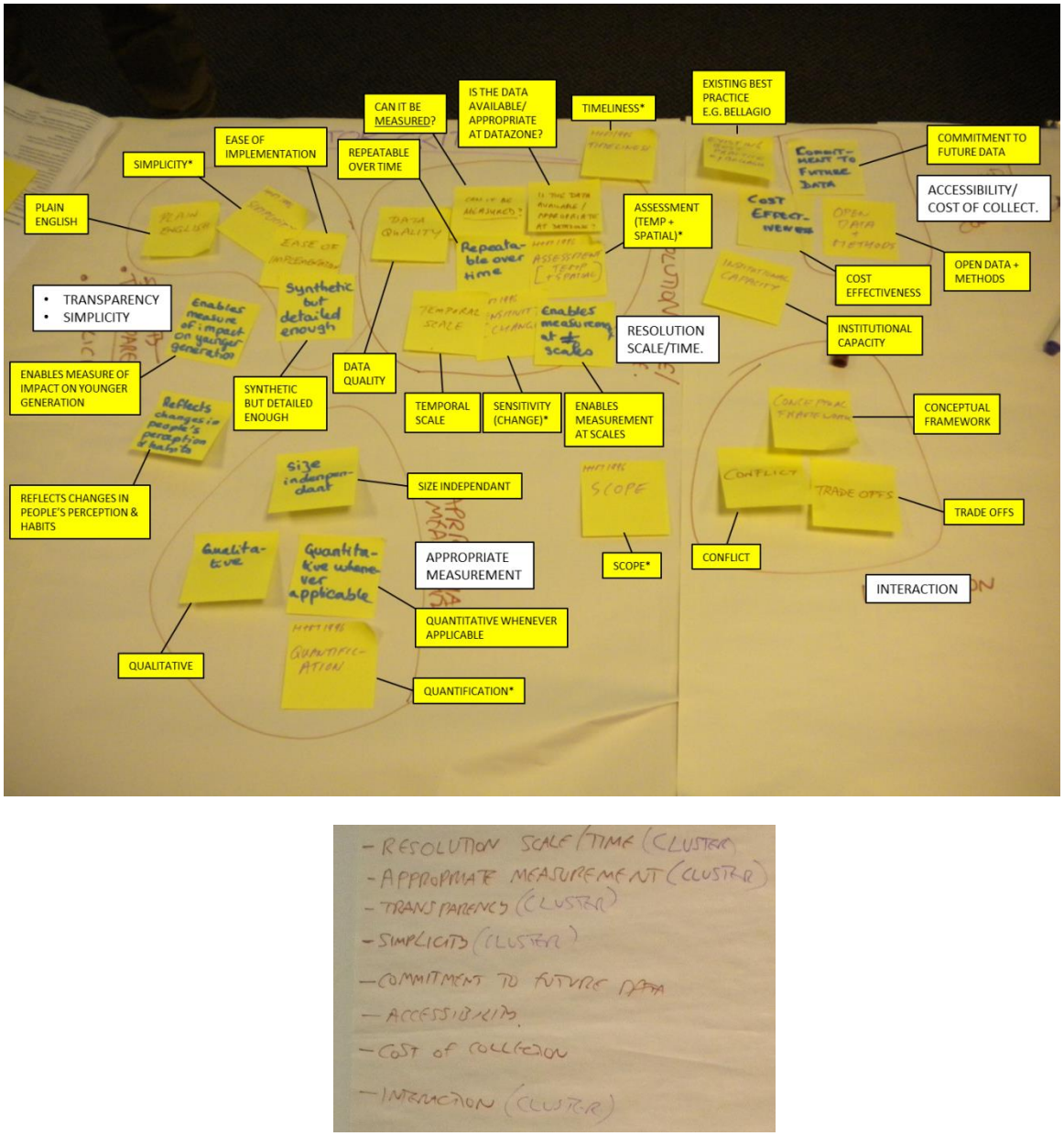

Figure 7 – (top) Identified criteria (yellow labels, which transcribe the post it notes) and cluster names (white labels). Note that post it notes with the note "H+M 1996" are labelled "" on the yellow labels. (bottom) separate summary of criteria clusters and other criteria derived from the clustering.*

Computer scientists: Judgement of the strongest indicators

Following the identification of these criteria, participants studied the potential indicators produced by participants within the mini-workshops for social and natural scientists (Tables 2, 3). A list of these was produced, with definitions added for three indicators for clarification. Following discussion on how a voting exercise should take place, it was decided that each of the potential indicators should be assessed in terms of two criteria:

- Whether the indicator was available at the Data Zone level ("DZ LEVEL" on Table 4). If they wished, participants added a sticker for each indicator to show if the indicator was

unavailable at Data Zone resolution (red), whether it could possibly be derived or calculated for Data Zones (yellow) or whether it was available (green).

- Whether participants felt that the indicator was an appropriate one for 'Greener' ("GOOD INDICATOR FOR GREENER" on Table 4). Good indicators were marked with a green sticker, poor indicators with a red sticker, and a yellow sticker for average indicators.

The full list of summary criteria which were produced within the first part of the workshop were not used in this assessment. Following discussion about how the indicators could be assessed, the two criteria described above were used. Additionally, during 'voting' some additional indicators were added to the table: participants felt that these could be appropriate indicators for 'Greener' which were missing or not fully captured in the list provided. Details of the voting are shown in Table 4.

Following this voting the aim to produce two data zone level indices/scores to measure policy success towards the 'Greener' Strategic objective was introduced, and the key question of arriving at a consensus on the strongest indicators was introduced (for the slide shown, see Appendix 5). Following discussion with participants, the lead investigator 'starred' indicators where voting indicated that this indicator was viewed favourably. These indicators were typically those with multiple green stickers to indicate that participants felt that the indicator was a good one for the 'Greener' Strategic Objective. It was felt that there should be a 'weighting' to voting in this column, rather than data availability at the Data Zone level. The aim to cover a large number of 'summary features' in selecting indicators (Appendix 5) was not emphasised as strongly within this discussion, although one participant (who worked in soil science) noted that the 'starred' indicators did in fact cover several summary features. The indicators which were 'starred', or judged to be strongest, were:

- Recycling rates
- Car clubs
- Children's ways of getting to school
- Water ecological status (note that this appeared in the list of indicators twice)
- Energy performance certificates (note that this appeared in the list of indicators twice, and was also conceptually similar to "number of highly efficient homes", another starred indicator)
- Air quality
- Diesel cars/ number of car journeys (two indicators linked together)
- Household power usage
- Number of highly efficient homes (see note for "Energy performance certificates", above)
- Broadband (this indicator was one of four indicators which were added by participants to the list)

Next two pages:

Table 4 – Voting on indicator quality, showing sticker colour (explained in text above) and sticker placement. Additional indicators added to the table are shown in purple text, "(repeat)" after the potential indicator description shows that it is repeated elsewhere on the table. Appendix 6 shows a photograph of the sheet.

Summary feature	Potential indicators	DZ LEVEL	GOOD INDICATOR FOR GREENER
1. Health that you get through the environment	a) Frequency of greenspace visits	🟡	🟡
	b) mental wellbeing		🔴
	c) physical activity		🔴
	d) prescriptions for anti-depressants (Scottish household survey)		🔴
2. Equity + participation in the use of the environment	e) Protected Equalities – maps showing fewer inequalities (note: differences in the use of the environment between people with different characteristics (age, disability, gender reassignment, marriage and civil partnership, pregnancy and maternity, race, religion or belief, sex, sexual orientation) characteristics: http://www.legislation.gov.uk/ukpga/2010/15/section/4)		
	f) Responses to statutory consultations	🔴	🔴
	g) Resilience index	🟡	
3. Sustainable lifestyle choices	h) Recycling rates	🔴🟡	🟢🟢
	i) Re-use rates	🔴🟡	🟢
	j) Local economy		
	k) currency		
	l) Car clubs	🟡	🟢🟢
	m) Transport Modal shift ("moving away from heavily polluting transport methods towards more environment friendly methods" definition: http://www.case-optimodal.eu/en/centre-atlantique-de-short-seashipping-europeen/modal-shift-and-csr/)	🔴	🟢
	n) Children's ways of getting to school	🔴	🟢🟡🟢
	o) New Economics Foundation – Happiness Index		
4. State/Quality of environment - natural & built - integrative, holistic, systemics	p) Water ecological status **(repeat)**	🟡	🟢🟡
	q) Terrestrial breeding birds	🟡	🟢
	r) Natural capital asset index	🟡	🟢🟡🟡
	s) Energy performance certificate **(repeat)**	🟡	🟢🟢
(Linked to all summary features)	t) Social capital		
	u) place attachment		
1. Reducing emissions / pollution	v) Water ecological status	🟡	🟢🔴🔴
	w) Light maps	🟡	🔴🟢
	x) Air quality	🟡	🟢🟢🟢
	y) Stocking rate maps	🟡	🟡🟡
	z) Diesel cars	🟡	🟢🟢
2. Behaviour & consumption	aa) Number of car journeys		🟢
	ab) Level of recycling		🟢

Summary feature	Potential indicators	DZ LEVEL	GOOD INDICATOR FOR GREENER
2. Behaviour & consumption	ac) Meat eating	🔴	🟡🟡🟡
	ad) Household power usage	🟡	🟢🟢🟢
	ae) Average size of cars		🔴🔴
3. Biodiversity	af) Water ecological status	🟡	🟢🟢
4. Planning & infrastructure	ag) Building standards		
	ah) number of highly efficient homes	🟡	🟢🟢🟢
	ai) % houses with ABCD rating	🟢	🟢
	aj) Closeness of green spaces		🟢
5. Positive engagement with nature	ak) SPAN – engagement with nature (note: this is Scotland's People and Nature Survey, commissioned by SNH, covering participation in outdoor recreation, perceptions of benefits, and evaluations and perceptions of outdoor spaces (see http://www.snh.gov.uk/land-and-sea/managing-recreation-and-access/increasing-participation/measuring-participation/))		
4.	BROADBAND	🟢	🟢🟢
1.	ELECTRIC CARS	🟡	🟢
1.	HEAT MAPS	🟢🔴	🟢
4.	INSECTS / BUTTERFLIES	🟡	🟢

Analysis

The following analysis is based on the description of the results from the three mini-workshops which were described above, notes taken by Andrew Copus at the mini workshops, and the views of both investigators formulated after the mini workshops.

Firstly, it is notable that the natural scientists and social scientists produced similar numbers of 'summary features' (five and four, respectively). While it was made clear that there was no specific number of features in mind, the structure of the SEP Index was shown in the introductory presentation, which has four or six indicators per Strategic Objective. It is possible that this may have influenced perceptions of the appropriate number of features to take forward to a 'Greener' index. One of the participants in the natural scientists mini workshop made a comment of what would be too high a number of features, and referred back to the SEP Index structure. Also, if participants had been given a different number of 'votes' (rather than five), this could have influenced the final features produced.

It can be argued that the summary features identified by the groups are closely associated with some of the Scottish Government's other four Strategic Objectives, as well as 'Greener'. For example, environment-related health (identified by the social scientists) obviously links closely to the 'Healthier' Strategic Objective. Links between some of the indicators and the 'Healthier' objective were also noted by the computer scientists. In the same way, "Equity + participation in the use of the environment" could link closely to the 'Wealthier and Fairer' strategic objective, and

"Sustainable lifestyle choices" and "Behaviour & consumption", with their themes of resilience and sustainability, could also link to the 'Safer and Stronger' Strategic Objective. As a parallel, several of the Scottish Government's National Outcomes[5] are associated with multiple Strategic Objectives. For example, the National Outcome of "We value and enjoy our built and natural environment and protect it and enhance it for future generations" is related to 'Healthier' and 'Wealthier and Fairer' as well as 'Greener'[6], and a further National Outcome "We live in well-designed, sustainable places…" is linked to 'Greener' and also 'Safer and Stronger'[7].

The summary features identified by natural and social scientists were, interestingly, quite similar in some respects. The social scientists produced the summary feature "Sustainable lifestyle choices" which is conceptually similar to "Reducing emissions/pollution" and "Behaviour & consumption" produced by the natural scientists. "Planning & infrastructure", the fourth summary feature identified by natural scientists, correlates with the built environment aspect of the "State/Quality of environment" summary feature and indeed the "Planning" policy domain cluster produced by the social scientists. If the potential indicators associated with these summary features are considered, indicators linked to access to greenspace, recycling, water ecological status, travel and transport, buildings (energy performance certificates) and types of 'engagement' were produced by both groups. However, while the social scientists identified a summary feature related to health, there was no obvious counterpart among the summary features from the natural scientists. Conversely, the "Biodiversity" summary feature produced by the natural scientists is a specific subject which is not represented in the summary features produced by the social scientists.

Discussions within the mini-workshops covered a broad range of subjects. Both social and natural scientists mentioned potential sources of data. The natural scientists noted the importance of a Biodiversity indicator, but noted the lack of data availability at smaller geographical levels. Another issue raised was that the Data Zone geography was inherently designed to work with social and economic data, rather than physical data. The unavailability of potential 'Greener' indicators at the Data Zone level was strongly emphasised within the computer scientist mini-workshop, and the resources which institutions have (related to the cost of data collection and staff capacity) to collect certain types of data for small areas is a key related issue. When computer scientists assessed whether indicators were available at the Data Zone level, it is revealing that only three indicators received a 'vote' that they were available (Table 4): two of these were suggested by the computer scientists themselves.

As an example, air quality was felt to be a good indicator to represent 'Greener', however the current automatic monitoring network of 90 stations for air quality is concentrated in Scotland's urban areas and towns; six Local Authorities (including the geographically large areas of Aberdeenshire, Argyll and Bute, and the Western Isles) have no automatic monitoring[8]. Clearly, interpolating values for Data Zones from this data would be inappropriate. This would also be the case for any indicators which are collected through spatially restricted monitoring networks. However, it can also be observed that while very few potential indicators for a 'Greener' index were

[5] http://www.gov.scot/About/Performance/scotPerforms/outcome (Accessed 17th February 2017)
[6] http://www.gov.scot/About/Performance/scotPerforms/outcome/environment (Accessed 17th February 2017)
[7] http://www.gov.scot/About/Performance/scotPerforms/outcome/susplaces (Accessed 17th February 2017)
[8] See http://www.scottishairquality.co.uk/latest/summary?view=la (Accessed 17th February 2017)

assessed as available at the Data Zone level (Table 4), it is notable that several indicators received 'yellow sticker' votes, indicating a perception that Data Zone-level values could possibly be derived or calculated. Therefore, there may be the potential for calculating Data Zone-level values for indicators which are based on other types of data sources:

- Existing datasets with full coverage of the Scottish population. The best example is Scotland's Census[9], although this has the disadvantage of only being collected at ten year intervals. However it is possible that indicators which represent 'green' behaviour by people are available from the Census for Data Zones, or suitable proxies could be derived from this dataset. For example, Census data tables exist on the themes of transport methods for journeys to work/study. Additionally, there is the potential to derive Data Zone-level estimates of indicators via proxies. For example, household power usage could potentially be estimated from Census data on household size and central heating which is available at the Data Zone level, if a reasonably strong correlation could be found between these variables and power usage. Alternatively, data on electricity and gas consumption is available at the level of intermediate geographies in Scotland from the Department of Energy and Climate Change: there are 1,235 of these areas[10] and an existing lookup table[11] can be used to link this data to Data Zones.
- Geographically widespread monitoring. For instance, data on broadband connections and speeds is available for fixed postcode units, although data for postcodes with small numbers of connections are redacted[12]. Using available lookup tables[13], it should be possible to calculate a variable to represent broadband quality at the Data Zone level: the resultant variable could arguably form a proxy for potential 'green' behaviour. While the poor availability of air quality data was described above, some environmental monitoring data is collected extensively across Scotland, such as data on water quality in relation to the Water Framework Directive. Through GIS methods, there is the potential for producing a measure to describe the monitored water quality within (or nearest to) each Data Zone. This indicator could be similar in form to the indicator on river water quality (the length of rivers at different water quality levels) produced for Scotland by SEPA[14].
- Some land use data which is potentially highly relevant to 'Greener' due to its role in landscape quality, carbon sequestration, and recreation potential - on forest extent – is also available in polygon form across Scotland. While forestry or woodland expansion were not selected as an indicator, it fits clearly with the summary features of "State/Quality of environment" and "Health that you get through the environment", and Data Zone-level woodland extents, or changes in extent, could be calculated. Scotland's Greenspace Map is another potential data source for information on extent and types of greenspace: however,

[9] http://www.scotlandscensus.gov.uk/ (Accessed 17th February 2017)
[10] http://www.gov.scot/Publications/2005/02/20732/53083 (Accessed 17th February 2017)
[11] http://www.gov.scot/Resource/0050/00503549.xlsx (Accessed 17th February 2017)
[12] http://stakeholders.ofcom.org.uk/binaries/research/infrastructure/2014/fixed-postcode.txt (Accessed 17th February 2017)
[13] http://www.gov.scot/Resource/0050/00505244.xlsx (Accessed 17th February 2017)
[14] http://www.gov.scot/seso/SourceDetails.aspx?ID=227 (Accessed 17th February 2017)

this has the limitation of being only available for settlements with a population of at least 3,000[15].

Overall, potential data availability at the Data Zone level appears to be higher for 'Greener' indicators representing Greener behaviour, due to the collection of relevant data (and possible proxies) within the population Census and other data collected from all parts of Scotland (Table 5). Some variables which describe physical resource availability (and, potentially, Greener behaviour in land management decision making): water quality, and relevant land use change, are also calculable for Data Zones. Variables shown in bold text within Table 5 could be calculated from data sources shown, and taken forward to a 'beta' version of a 'Greener' index.

[15] http://greenspacescotland.org.uk/1scotlands-greenspace-map.aspx (Accessed 17th February 2017)

Indicator (associated summary feature)	Data availability for 2011 Data Zones, and **variables which could be calculated from data sources shown and used within a 'Greener' index.**
Number of car journeys (Behaviour & consumption)	2011 Census[16] – Table QS702SC "Method of travel to work or study", Table LC7701SC "Distance travelled to work or place of study by method of travel" **Available** **% of people travelling to work or study using active transport (on foot or by bicycle)** **% of people using cars for relatively short (less than 10 km) journeys to work or study**
Household power usage (Behaviour & consumption)	2011 Census[17] – Table QS406SC "Household size", Table QS415SC "Central heating" **Possibly estimatable by proxy** Department of Energy and Climate Change – Middle layer super output area (MLSOA) and intermediate geography zone (IGZ) electricity and gas data 2007[18] **Available (Intermediate geography level)** **Domestic electricity consumption, as a % of expected consumption (based on numbers of electricity meters and average per meter consumption in Scotland)**
Broadband (Planning and infrastructure)	OFCOM – Fixed Postcode broadband data[19] (covering variables on numbers of connections and speeds) **Could be calculated**
Water ecological status (State/Quality of environment, Reducing emissions / pollution)	Scotland's environment – water quality (High/Good/Moderate/Poor/Bad Status/Potential of rivers, lochs, estuaries, coastal areas)[20] **Could be calculated through interpolation** **% of monitored water (lochs, coast, rivers, estuaries) associated with Data Zone at good or high status**
(State/Quality of environment)	Forestry Commission – National Forest Inventory[21] (variables related to woodland extent, new planting and woodland expansion could be identified) **Could be calculated** **Change in woodland area (% change)**

Table 5 – Examples of indicators which could be used within a 'Greener' index, assessed data availability for 2011 Data Zones, and more specific variables which could be calculated from data sources shown and used within a 'Greener' index. This is an illustrative table, only, rather than an exhaustive list of possibilities. The assessment of data availability for 2011 Data Zones (shown in coloured text) was assessed by the author.

[16] http://www.scotlandscensus.gov.uk/ods-web/download/getDownloadFile.html?downloadFileIds=SNS%20Data%20Zone%202011%20blk (Accessed 17th February 2017)
[17] http://www.scotlandscensus.gov.uk/ods-web/download/getDownloadFile.html?downloadFileIds=SNS%20Data%20Zone%202011%20blk (Accessed 17th February 2017)
[18] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/49413/file50241.xls (Accessed 17th February 2017)
[19] http://www.ofcom.org.uk/static/research/ir/Fixed_postcode.zip (Accessed 17th February 2017)
[20] Data viewable at http://map.environment.scotland.gov.uk/seweb/map.htm?menutype=0&layers=2 (Accessed 17th February 2017)
[21] http://www.forestry.gov.uk/inventory (Accessed 17th February 2017)

Conclusion

Overall, we would argue that there is potential to develop a 'Greener' index, calculated at the Data Zone level, with a conceptual focus on human behaviour. As stated above, data availability (within Census datasets, for instance) is higher for variables which could describe human behaviour, or at least form proxies for it. Secondly, the wording of Scottish Government's 'Greener' strategic objective highlights "…the sustainable use and enjoyment of (Scotland's natural and built environment) and facilitate the transition to a low carbon economy"[22]: which has an implicit emphasis on human action and behaviour. Furthermore, the focus on human behaviour rather than resource availability would ensure that the Greener index would complement, rather than duplicate, ongoing research to develop a natural assets register within the 2016-2021 Scottish Government Strategic Research Programme[23].

Feedback

The following summary is a compilation of the feedback for all three mini-workshops.

More detailed comments were made in response to the question **"What did you think could have been done to improve the workshop?"** One comment noted that the mini-workshop (natural/social scientist structure) had a broad scope, and that more focus could have been helpful ("*The scope was extremely broad – which is good (and necessary!) But – I wonder if it might have helped to put a couple of concrete examples on the table and initially focus discussion around these? Not sure…")* although another comment noted that the subject was complex and so (*"not much"*) could have been done to improve the mini-workshop. Two comments pointed out that the exercise based on identifying features related to the environment, society and 'pressures' needed to be better explained (*"The second exercise – environment, society, pressures – could have been better explained. I didn't understand what we were doing." "I struggled a bit with getting my head around the different things we needed to do for the coloured post-its, so maybe that could be made clearer?"*). An additional comment noted that the facilitator could have controlled discussion at times.

Several comments in response to the question **"What do you think was most enjoyable and/or useful about the workshop?"** were related to enjoying the chance to consider and discuss the issues with work colleagues (*"To step back + think about the issues of index, NPF, Strategic Objectives + 'greener' + to have the chance to discuss with colleagues." "A chance to think and discuss outside my usual daily activities" "It's always interesting to hear about other colleagues' work and future work @ the Institute."*). Another comment noted that the workshop was useful for stimulating thinking for future work.

Participants were asked to respond (on a Likert scale) to a series of contentions about the mini-workshop which they attended. A summary of the responses received is shown in Table 6 below, which suggests positive views of the workshop. The small number of 'disagree' responses for "At the workshop, I worked with staff who I otherwise wouldn't work with" and "At the workshop, I gained contacts which will be useful for work in future" may have resulted from the composition of the

[22] http://www.gov.scot/About/Performance/scotPerforms/objectives/greener (Accessed 17th February 2017)
[23] See http://www.gov.scot/Resource/0050/00504328.pdf (Accessed 17th February 2017)

social scientist mini workshop participants (all participants were from the same science group: comments were received on the feedback forms to this effect). However, majority agreement with other statements related to knowledge and ideas gained from the workshop suggests that these mini-workshops may contribute to research activities and research impact in the future.

Statement	**Strongly disagree**	Disagree	Neither agree nor disagree	Agree	**Strongly agree**
The objectives of the workshop were clear.	**0**	0	0	4	**5**
Material sent to participants before the workshop was useful.	**0**	0	0	3	**6**
The workshop venue was suitable.	**0**	0	0	3	**6**
The workshop was well organised.	**0**	0	0	5	**4**
The workshop facilitator(s) were good communicators.	**0**	0	0	4	**5**
The workshop facilitator(s) were knowledgeable about the topics discussed.	**0**	0	0	3	**6**
The workshop activities were well designed.	**0**	0	1	6	**2**
The workshop activities were enjoyable.	**0**	0	1	4	**4**
The workshop content and activities met my expectations.	**0**	0	3	4	**2**
The workshop was well-paced.	**0**	0	1	5	**3**
At the workshop, I worked with staff who I otherwise wouldn't work with.	**0**	2	2	3	**2**
At the workshop, I gained contacts which will be useful for work in future.	**0**	3	3	2	**1**
From participating in the workshop, I gained knowledge and/or ideas	**0**	0	2	5	**2**
Knowledge and/or ideas gained from the workshop will be useful in my own work	**0**	0	3	4	**2**

Table 6 – Mini-workshop feedback summary. Figures show the number of participants who gave the response (columns) to the statement.

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Scottish Government (2016) An introduction to Scotland's National Performance Framework (NPF) Available at http://www.gov.scot/Resource/0049/00495539.pdf (Accessed 17th February 2017)

Thomson, K., Vellinga, N., Slee, B., Ibeyemi, A. (2014) Mapping Socio-Economic Performance in Rural Scotland. Scottish Geographical Journal, 130(1): 1-21.
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Appendix 1 – Introductory slideshow

Exploring online mapping applications for socio-economic data: their use and impact

Introduction

The James Hutton Institute

Mini-workshops: September 2016

Project funded by the Macaulay Development Trust

MACAULAY DEVELOPMENT TRUST

Summary

- These slides form an introduction to the research project, for staff participating in the three mini-workshops in September 2016.
- They cover:
  - Scotland's National Performance Framework and the Government's Strategic Objectives
  - A background to recent research by staff at the James Hutton Institute on socio-economic performance
  - The research project background, the "Greener" Strategic Objective and mini-workshop aims

Scotland's National Performance Framework (NPF)

- It is "A single framework to which all public services in Scotland are aligned, encouraging more effective partnership working"
- It is "A clear, unified 10-year vision, set out in 2007, of the kind of Scotland we want to see"
- It "…provides a clear vision for Scotland with broad measures of national wellbeing covering a range of economic, health, social and environmental indicators and targets"
- The 'outcomes approach' is now defined in law: the Community Empowerment (Scotland) Act 2015 "…places a duty on the Scottish Ministers to consult on, develop and publish a set of national outcomes for Scotland" and report on them

Information on this slide is derived from Scottish Government (2016) An introduction to Scotland's National Performance Framework (NPF).
Available at http://www.gov.scot/Resource/0049/00495539.pdf (Download: 2nd September 2016).

Scotland's National Performance Framework (NPF)

- The NPF is a framework with five components. The **Strategic Objectives** have been incorporated within the James Hutton Institute's recent work on socio-economic performance.
- The Scottish Government summarises the NPF as follows:

How does the NPF fit together?

Our vision for a successful Scotland is described and measured in five parts which support and reinforce each other.

- **The Scottish Government's Purpose** sets out the direction and ambition for Scotland
- **Purpose Targets** are high level targets that show progress towards the Purpose
- **Strategic Objectives** describe where we will focus our actions
- **National Outcomes** describe what the Scottish Government wants to achieve and the kind of Scotland we want to see
- **National Indicators** enable us to track progress towards the Purpose and National Outcomes

Each part of the framework is directed towards, and contributes to, a single overarching Purpose:

To focus government and public services on creating a more successful country, with opportunities for all of Scotland to flourish, through increasing sustainable economic growth

Information on this slide is derived from Scottish Government (2016) An introduction to Scotland's National Performance Framework (NPF).
Available at http://www.gov.scot/Resource/0049/00495539.pdf (Download: 2nd September 2016).
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National Performance Framework (NPF): Strategic Objectives

- "One of the Government's first actions on taking office in May 2007 was to streamline the resources of government in order to focus on creating a more successful country. We aligned the Scottish Government around five Strategic Objectives that underpin our Purpose and describe the kind of Scotland we want to live in – a Scotland that is Wealthier and Fairer, Smarter, Healthier, Safer and Stronger, and Greener"
- They "…describe where we will focus our actions" and "Ensure policies are developed and implemented in an integrated way"

Information on this slide is derived from Scottish Government (2016) Strategic Objectives. Available at http://www.gov.scot/About/Performance/scotPerforms/objectives (Accessed: 2nd September 2016) and the reference on the preceding slide.

James Hutton Institute work

- Recent work was developed within the Strategic Research Programme (2011-2016) in the Vibrant Rural Communities theme, noting the objective "Map the 'contemporary patchwork' of rural Scotland's socio-economic performance at multiple scales"[1]
- Paper published by Thomson et al. (2014)[2]

- "…the devolved Scottish Government has formulated, within its National Performance Framework, a number of policy goals relating to sustainable growth and distributive justice that have implications for the rural parts of Scotland… To assess the success of these policies, we derive a single index of socio-economic performance" (page 2)
- Index calculated from seven indicators linked to four Strategic Objectives (excluding 'Greener'), for 2001, for data zones (n = 6,505 across all of Scotland)

1 http://www.gov.scot/Resource/Doc/175356/0120147.pdf (Accessed: 2nd September 2016)
2 Thomson, K., Vellinga, N., Slee, B., Iboyomi, A., 2014. Mapping Socio-Economic Performance in Rural Scotland. Scottish Geographical Journal 130(1) 1-21. http://dx.doi.org/10.1080/14702541.2013.858655

James Hutton Institute work

- In 2014-2015, the James Hutton Institute developed and updated the SEP Index to assist in the distribution of rural development funding.
- The report[3] acknowledged that the NPF is "…implemented at the national level" – this work aimed to analyse spatial differences in SEP across rural areas and small towns.
- Index focuses on small town and rural data zones in Scotland (n = 2,014), created for the year 2011. It used the same four of the Strategic Objectives as a framework.
- For each data zone, a 1-10 score was calculated based on performance related to each of the four Strategic Objectives. This was calculated as an average of scores for component indicators, which had been selected to represent the Strategic Objective.

3 Copus, A. and Hopkins, J. (2015) Mapping Rural Socio-Economic Performance (SEP): Report for Rural Communities Team, Food, Drink and Rural Communities Division, The Scottish Government. Available at: [illegible] (Accessed: 1st September 2016)

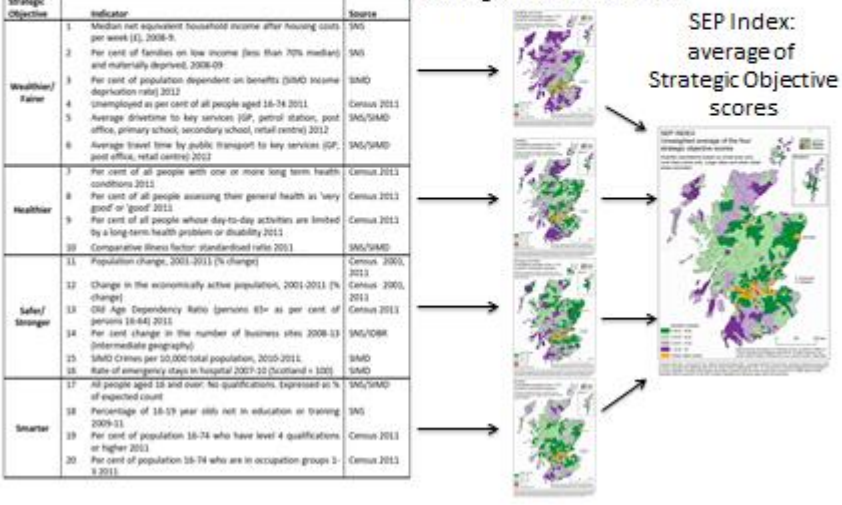
James Hutton Institute work

Indicators rescaled (1-10)

Strategic Objective scores: average of indicator scores

SEP Index: average of Strategic Objective scores

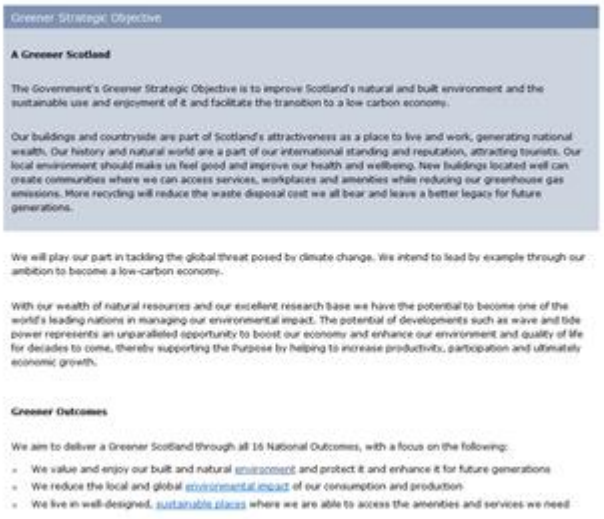
Strategic Objective		Indicator	Source
Wealthier/ Fairer	1	Median net equivalent household income after housing costs per week (£), 2008-9.	SNS
	2	Per cent of families on low income (less than 70% median) and materially deprived, 2008-09	SNS
	3	Per cent of population dependent on benefits (SIMD income deprivation rate) 2012	SIMD
	4	Unemployed as per cent of all people aged 16-74 2011	Census 2011
	5	Average drivetime to key services (GP, petrol station, post office, primary school, secondary school, retail centre) 2012	SNS/SIMD
	6	Average travel time by public transport to key services (GP, post office, retail centre) 2012	SNS/SIMD
Healthier	7	Per cent of all people with one or more long term health conditions 2011	Census 2011
	8	Per cent of all people assessing their general health as 'very good' or 'good' 2011	Census 2011
	9	Per cent of all people whose day-to-day activities are limited by a long-term health problem or disability 2011	Census 2011
	10	Comparative Illness factor: standardised ratio 2011	SNS/SIMD
Safer/ Stronger	11	Population change, 2001-2011 (% change)	Census 2001, 2011
	12	Change in the economically active population, 2001-2011 (% change)	Census 2001, 2011
	13	Old Age Dependency Ratio (persons 65+ as per cent of persons 16-64) 2011	Census 2011
	14	Per cent change in the number of business sites 2008-13 (intermediate geography)	SNS/IDBR
	15	SIMD Crimes per 10,000 total population, 2010-2011.	SIMD
	16	Rate of emergency stays in hospital 2007-10 (Scotland = 100)	SIMD
Smarter	17	All people aged 16 and over: No qualifications. Expressed as % of expected count	SNS/SIMD
	18	Percentage of 16-19 year olds not in education or training 2009-11	SNS
	19	Per cent of population 16-74 who have level 4 qualifications or higher 2011	Census 2011
	20	Per cent of population 16-74 who are in occupation groups 1-3 2011.	Census 2011



Mini-workshops: aim

- None of the James Hutton Institute's work on SEP has assessed the Greener Strategic Objective. This has been partly driven by the focus on socio-economic performance, and also by the data availability for environmental indicators at the scale of small areas.
- During this project, we aim to **"…produce recommendations on methods and indicators for assessing the "Greener" Strategic Objective at Data Zone level"** by consulting the expertise of social, natural and computer scientists.
- A description of the Greener Strategic Objective is shown on the next slide.

Mini-workshops: 'Greener'



Greener Strategic Objective

A Greener Scotland

The Government's Greener Strategic Objective is to improve Scotland's natural and built environment and the sustainable use and enjoyment of it and facilitate the transition to a low carbon economy.

Our buildings and countryside are part of Scotland's attractiveness as a place to live and work, generating national wealth. Our history and natural world are a part of our international standing and reputation, attracting tourists. Our local environment should make us feel good and improve our health and wellbeing. New buildings located well can create communities where we can access services, workplaces and amenities while reducing our greenhouse gas emissions. More recycling will reduce the waste disposal cost we all bear and leave a better legacy for future generations.

We will play our part in tackling the global threat posed by climate change. We intend to lead by example through our ambition to become a low-carbon economy.

With our wealth of natural resources and our excellent research base we have the potential to become one of the world's leading nations in managing our environmental impact. The potential of developments such as wave and tide power represents an unparalleled opportunity to boost our economy and enhance our environment and quality of life for decades to come, thereby supporting the purpose by helping to increase productivity, participation and ultimately economic growth.

Greener Outcomes

We aim to deliver a Greener Scotland through all 16 National Outcomes, with a focus on the following:

- 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 live in well-designed, sustainable places where we are able to access the amenities and services we need

Scottish Government (2016) Greener Strategic Objective. Available at http://www.gov.scot/About/Performance/scotPerforms/objectives/greener (Accessed 2nd September 2016).

Mini-workshops: activities

- **12th September 2016 at 10am – social scientists**
- **12th September 2016 at 2pm – natural scientists**
- Identify the policy domains which are most important and relevant to the 'Greener' Strategic Objective
- Define what policy success would 'look like' across rural areas and small towns in Scotland
- Through assessment of cause-and-effect links, identify the areas where indicators to represent 'Greener' should be drawn from

- **15th September 2016 at 10am – computer scientists**
- Assess how we can judge the quality of indicators which could be included in a score or index to represent the 'Greener' Strategic Objective at the scale of small geographical areas
- Identify potentially relevant indicators and 'score' them on key criteria
- Produce recommendations for calculating a 'Greener' score or index from strong indicators

Funded by

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The James Hutton Institute is supported by the Scottish Government's Rural and Environment Science and Analytical Services Division (RESAS)

Appendix 2 – Consent form

Consent form for participants in mini workshops

Web-based mapping for open access – building capacity and exploring user preferences

This consent form is for individuals who have volunteered to participate in the project above.

By consenting to participate in the mini-workshop, I understand that:

- Data will be collected in this mini-workshop for the purposes of the research project. This data will include notes taken from dialogue and discussions and information taken from workshop activities.
- I have been informed of the purposes of this research, and the main research procedures. I am also aware that I have the opportunity to ask investigators questions at any time.
- I understand that participation in this mini-workshop is voluntary, and participation in all activities is voluntary. I am aware that I have the opportunity to withdraw from the research for any reason.
- I understand that data collected will be treated with full confidentiality and stored anonymously. I am aware that my name will not be linked directly or indirectly with any data or descriptions in outputs.
- I am aware that in outputs from the research (including reports, presentations or articles) any published data or analysis will not be linked to a person's identity, but to a broad description of their research background or role, provided by participants themselves on this form. I am aware that outputs will include the disclaimer that views expressed do not necessarily represent those of employers, institutions, or their funders.

By adding your signature below, you:

- **confirm that you have read and understood information provided about the mini-workshop, research project, data collection and data use**
- **consent to your participation in the research project and the use of data in research outputs**

Name:

Research background or role description, to be used instead of a name on outputs:

Sign:

Date:

Appendix 3 – Reflections on methods used

The activities within the social and natural scientist mini-workshops were adapted from those planned in the following ways:

1. The size of the mini-workshop groups: five social scientists, and four natural scientists, meant that relevant activities and discussions were held as an entire group, and there was no need to split up the groups and feedback separately. Arguably, this helped the efficiency and speed of the activities and discussions.

2. Initially the plan was to link the policy domain clusters to identified features (with string to show links), however this was dropped. Additionally, during the natural scientist mini workshop, participants were not asked to label features with the policy domain clusters which they linked to as a) in the first mini workshop, this wasn't felt to be helpful, and b) the participants in the natural scientist mini workshop positioned the features close to or overlapping with the relevant policy domain clusters.

3. The identification of the most important features from which to draw indicators was to be partly based on a 'causal network' construction (see Niemeijer and de Groot, 2008a,b). This idea was introduced within the social scientists mini workshop; however the feedback for this method seemed mixed. Following suggestions from participants, a voting method was used in the social scientist workshop, and this method was taken forward to the natural scientist workshop.

4. After the broad 'summary features' were derived and noted, some examples of what may be described as 'concrete' indicators were suggested. This was a step further than we initially planned to go. One of the mini-workshop participants transcribed these (and the broad summary features) in the social scientist mini workshop, the investigators did this in the natural scientist mini workshop.

5. Some minor points include the fact that policy domains were added by participants within the social scientists mini workshop which were in addition to those which were added during preparation. Additionally, numbers of policy domains produced did not equal five for some participants during the natural scientists mini workshop.

The activities carried out in the computer scientists mini-workshop were altered quite extensively during the event from those originally planned:

1. In common with the social scientist and natural scientist mini-workshops, the number of attendees favoured activities and discussion as one group.

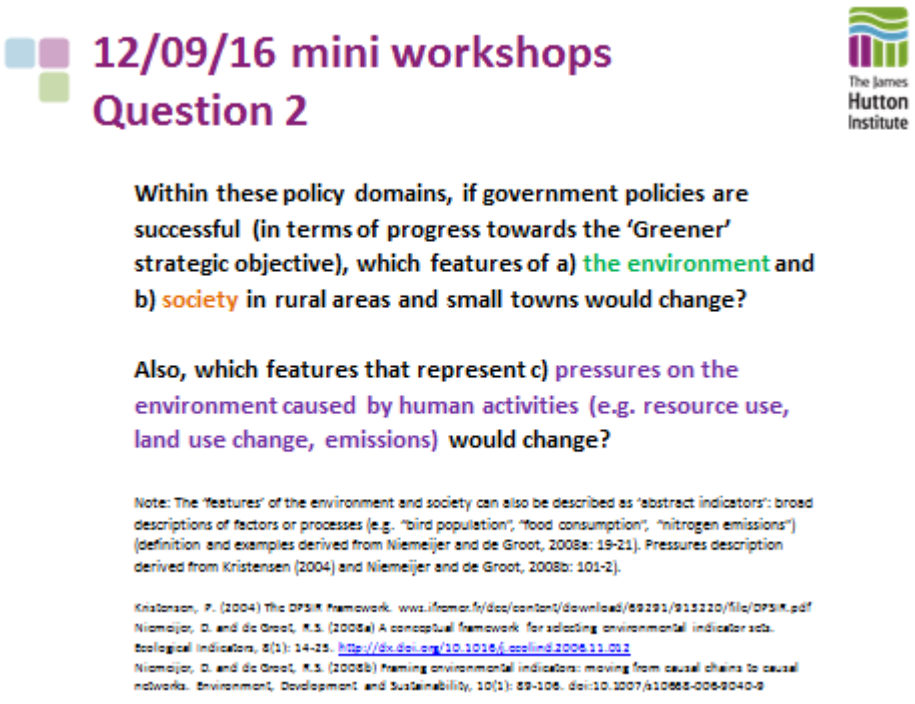
2. The initial plan was to carry out a 'voting' exercise, similar to that which took place in the first two workshops with natural and social scientists, to assess which of the criteria 'clusters' were the most important and relevant. This was not taken forward. A small number of criteria were produced, possibly correlating with the small number of attendees.

3. Before any of the mini-workshops had taken place, the plan was for computer scientists to identify potential indicators from the features identified by social and natural scientists. However, as some potential indicators had already been identified by the latter groups, it was decided that it was more appropriate for computer scientists to judge the strength of these indicators. Therefore, the

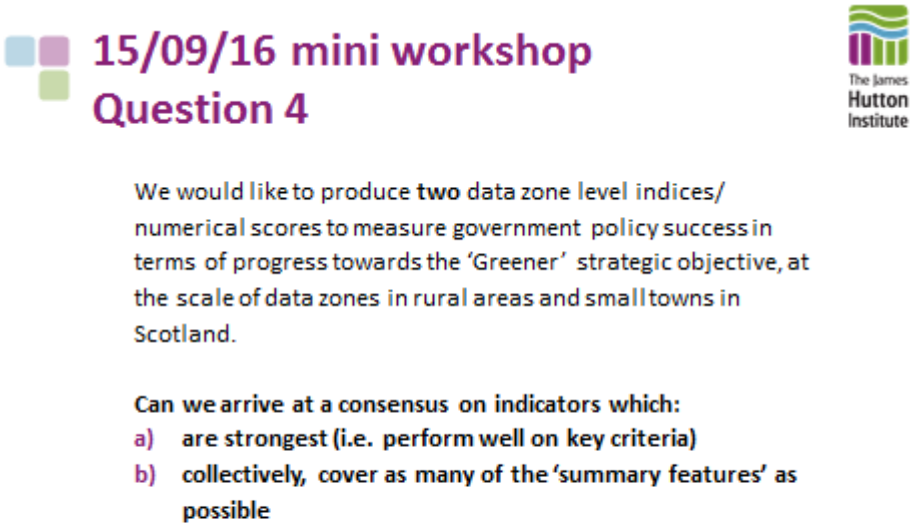
potential indicators and their associated summary features were printed to form one side of a matrix.

4. The indicators were not judged based on all of the criteria which were identified by participants, as was initially planned; additionally, the format of the voting also changed slightly from that intended. Following the voting, the criteria that indicators should, collectively, cover as many of the 'summary features' as possible was de-emphasised. The aspiration to produce two 'Greener' indices, based on the conceptualisations of social and natural scientists, caused some confusion, and this was de-emphasised and not considered by the participants. Additionally, a series of "Final questions for discussion", pertaining to appropriate sources for indicators, methods for producing data for each indicator at the Data Zone level, and methods for calculating 'Greener' were only briefly introduced, as some of these issues had been discussed previously.

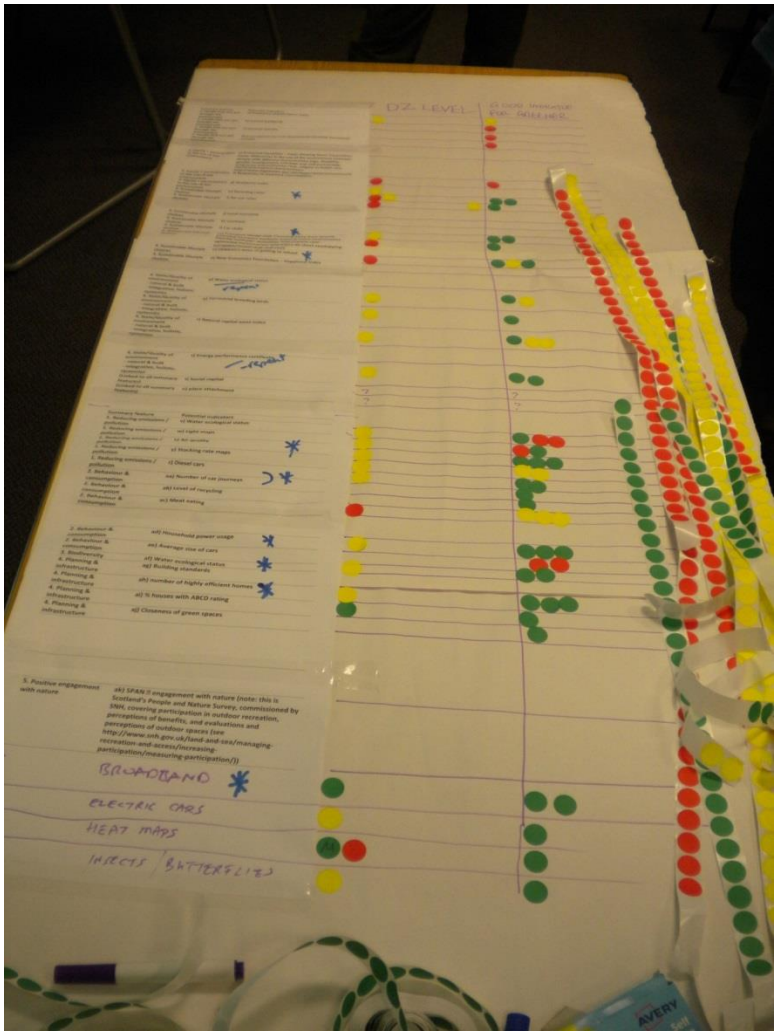
Appendix 4



Appendix 5



Appendix 6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BROADBAND
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HEAT MAPS
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