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Front Page Word Cloud: based on participant’s responses to the question ‘what would success for the LWEC Resources Challenge look like?’. The size of the words represents the frequency of their occurrence in the compiled responses.

1. Introduction

1.1. Background

The Living With Environmental Change (LWEC) partnership, launched in 2008, brings together the main funders and users of environmental research in the UK (government departments, agencies, research councils and devolved administrations) to accelerate the delivery of research to “ensure government, business and society have the knowledge, foresight and tools needed to be able to mitigate, adapt to and benefit from environmental change”. This vision will be delivered through 6 strategic challenge areas, of which the Resources Challenge is one.

- **Climate Challenge:** To understand the risks of climate change and assess options for avoiding or managing such risks
- **Ecosystems Challenge:** To manage **ecosystem services** for human well-being and to protect the natural environment in a changing world
- **Resources Challenge:** To promote human well-being, alleviate poverty and minimise waste by ensuring a **sustainable supply of food, water and other bio-resources**
- **Health Challenge:** To understand and protect human health in a changing environment
- **Infrastructure Challenge:** To make **infrastructure, the built environment and transport** systems resilient to environmental change, less carbon intensive and more socially acceptable
- **Societal Challenge:** To understand the role of government, business and society in enabling all to live with environmental change

With such a broad scope, diverse range of Partners, and with environmental change touching all aspects of life, the LWEC Partners identified the need for a strategic framework in each of the challenge areas within which to identify and prioritise the issues, needs and challenges for environmental evidence.

The process of developing strategic frameworks will include engagement of all relevant beneficiaries, and will not be restricted to LWEC Partners, to achieve buy-in and deliver insights to maximise the impact and effectiveness of environmental research in UK. The frameworks will build on the existing work of LWEC and the full body of evidence that addresses these challenge areas (e.g. from the Environmental Research Database, ERD). These frameworks will be implemented through the establishment of Challenge Steering Groups which includes partners, business and representation from other stakeholders.

The process for developing the Resources Challenge strategic framework was initiated by a roadmapping workshop held on the 21st of June 2011. This document represents the discussion and outputs of the workshop. These outputs will, alongside other inputs, inform the developing strategic framework process for the Resources Challenge.

1.2. Objective for the day

The objective for the day was *to identify and prioritise issues and needs that will enable the UK to manage ecosystem services for human well-being and to protect the natural environment in a changing world.*

Particular emphasis was placed on

- short, medium and long term needs and issues
- trends and drivers
- specific challenges relating to high level objectives
- the knowledge, tools and foresight needed to deliver this
- resources

1.3. The LWEC Resources Challenge

Strap-line: To promote human well-being, alleviate poverty and minimise waste by ensuring a sustainable supply of food, water and other bio-resources.

Challenge statement: to assess the links and feedbacks between the natural environment, ecosystem services and human well-being; how these might continue to develop within environmental limits in the face of major environmental change; and how decision-making and local and national planning can take account of these links and feedbacks to help in the development of new social, environmental and economic opportunities.

1.4. What is Roadmapping?

Roadmapping uses a graphical approach to visualise an entire strategy on a page. It provides a framework to help organisations tackle fundamental questions applicable in any strategic context and is used extensively at company, sector and national levels to align investment and research with strategic goals. Significant features of roadmapping are its breadth and versatility: roadmaps can encompass a complex scope of issues and long time frames, whilst at the same time focusing down on critical details, leading to decisions and actions.

1.5. Roadmapping and LWEC

The UK needs to have a robust understanding of environmental knowledge needs so that investment can be prioritised effectively. The UK also needs to clarify what the desired outcomes of using existing and deploying new knowledge would be and the smartest route to achieving these. Roadmapping is a first step technique in developing strategic frameworks for LWEC that helps to achieve such clarity. But its success depends on participation from a balanced mix of strategy- focussed business leaders, policy-makers, regulators, research managers, NGOs and others.

2. Workshop Summary

The workshop began with summary overviews from:

- the workshop facilitator, introducing the roadmapping process and format for the day;
- the Resources Challenge secretary, who provided an overview of LWEC and Challenge C progress to date; and
- Catherine Wright, Environment Agency, providing a regulators/end-user perspective on how the LWEC Resource Challenge can help to deliver for partners.

Participants had been requested to complete a roadmap template (example at **Annex A**) prior to the workshop, providing material to examine and refine during the workshop. The workshop facilitator collated themes and produced a ‘master’ template roadmap. On the day of the event, participants prioritised the inputs at each layer of the roadmap, through a voting scheme, as follows:

- **I. Trends and Drivers:** which global trends and drivers will be most important in determining the future priorities of relevance to the LWEC Resources Challenge?
- **II. Challenges:** in response to these key drivers, which Resources challenges are likely to have the biggest impact, in terms of People, Planet & Profit?
- **III. Knowledge, Tools & Foresight:** what will be required to inform decisions and policy to support adaptation, mitigation and benefit from these high impact challenges?

Workshop participants were then asked to prepare ‘mini-roadmaps’ for a subset of the key challenges, as prioritised, to present summarised cases for the knowledge, tools and foresight needs related to each challenge, and enablers and barriers of progress.

I. Trends and Drivers

For the Resources Challenge, the workshop participants prioritised the following 12 key drivers, which included social, technological, environmental, economic, and political and legal drivers:

- a. Behaviour change
- b. GM and other food production efficiencies
- c. Global population growth
- d. Water and food scarcity
- e. Competing pressures on land use
- f. Depleting natural resources from growing consumption
- g. Physical and social impacts of climate change (medium term)
- h. Climate change/extreme event and sea level rise (long term)
- i. Ecosystems services approach environmental regulation and valuation
- j. Increased influence from EU/International regulation
- k. Social/political choice
- l. Carbon budgets and policy for decarbonisation.

Each of these drivers attained a ‘high priority’ rating in the voting system. The full list of drivers identified, including those attributed a lower priority by the delegate voting system, is captured in the ‘Trends and Drivers’ Landscape Diagram, **Annex B**.

II. Challenges

Considering the key drivers listed above, the workshop participants identified the top 10 key challenges for resources, each set into an environmental change context:

- a. Waste as a resource (including waste reduction)
- b. Achieving multi-functional landscapes (plus sea)
- c. Evidence- and model-based policy
- d. Sustainable intensive agriculture/ecosystem services
- e. Protecting our soils
- f. Water scarcity/usage and trade offs/ fair access
- g. Endemic and invasive organisms/species
- h. Achieving public engagement/changed behaviour
- i. Increasing aquaculture (inc. need for understanding marine ecosystems)
- j. Resource conflicts across boundaries (local/regional/national).

Each of these challenges attained a 'high priority' rating in the voting system. Each challenge relates to one or more of the priority drivers, and the linkages identified by the workshop participants between the top 8 challenges and top 20 trends and drivers are detailed in the landscape linkages (**Annex C**). The full list of challenges identified, including those attributed a lower priority by the delegate voting system, is captured in the 'Challenges' Landscape Diagram, **Annex B**.

III. Knowledge, Tools & Foresight

Participants were asked to consider what knowledge, tools and foresight is required to deliver the key challenges, as previously prioritised. In advance of this prioritisation activity, the Resources Challenge Secretary provided a brief summary of relevant LWEC-accredited activities to date, and also programmes of relevance that are currently not captured by the accreditation process, to raise awareness of the range of existing research investments that might already be delivering some of the prioritised needs, in part or full. Participants were requested to take into account these existing research programmes, where relevant. Participants were provided with a list of all accredited activities, with summary details, and highlighting those activities of greatest relevance to the Resources Challenge. Timeline details of the programmes of relevance were also provided. Activity timeline and summary details for LWEC-accredited activities are recorded at **Annex B, ii and iii**, respectively.

In order to deliver the challenges identified above the following knowledge, the following tools and foresight were given highest priority by delegates:

1. Improving crop yields
2. Social and environmental economic research (SEER) into multi-objective land use decision making
3. Water catchment management
4. Ecosystem-based management
5. Agricultural GHG R&D Platform
6. Decision support tools
7. Tools to manage at the field and landscape levels
8. Improved modelling and forecasting
9. More local solutions/supply chain redesign
10. Sustainable farming

The full list of knowledge, tools and foresight identified, including those attributed a lower priority by the delegate voting system, is captured in the 'Challenges' Landscape Diagram, **Annex B**.

Each of the above knowledge, tools or foresight needs relates to one or more of the priority challenges, and the linkages between the top 20 knowledge, tools and foresight issues and the 8 priority challenges identified by the workshop participants are detailed in the landscape linkages (**Annex C**).

Mini Business Cases

Delegates worked in groups of 3 or 4, to prepare a mini business case for one of the 10 challenges ranked as high priority. Of the 10 key challenges identified, mini business cases were prepared for the first 8 as listed (a-h). The challenge 'impacts of land use, interactions and conflicts, as captured on the landscape diagram, morphed into 'Evidence- and model-based policy' for the mini business case.

The mini business cases allowed participants to develop the case for the knowledge, tools and foresight needs for each high priority challenge, to consider whether these needs represented 'apply', 'adapt' or 'create' challenges, to consider enablers and barriers to progress and open questions to other delegates; for example, examining linkages to disciplines and knowledge that might not previously have been engaged.

The transcribed mini business cases are presented at **Annex D**.

3. Next Steps

The outputs from this roadmapping workshop will be used as a first step to developing strategic frameworks that will identify and prioritise issues and needs for each of the LWEC strategic challenges. It is important to recognise that not all priorities will lead to the development of new research; a number of knowledge exchange activities, including reviewing current research and evidence, knowledge exchange fellowship placements, networks or communities of practice, could be suggested as implementation for potential delivery mechanisms. In addition, it is likely that some priorities will be identified that are on the periphery of LWEC remit and such delivery will involve collaboration with other initiatives such as Research Councils UK (RCUK) Priority Themes or UK Collaborative and Development Sciences (UKCDS). Furthermore, some of the issues or needs identified by the strategic frameworks may still be at a sufficiently high level that direct delivery mechanisms cannot be identified. In these instances the implementation plan may recommend that further work will be needed to identify the priorities in these areas.

After all the Challenge roadmapping workshops have been considered there will be a further workshop specifically dedicated to cross-cutting issues. All the workshop outputs will be accompanied by a gap analysis of evidence mapped against needs. This, and information collated from recent reports or reviews (e.g. the recent UK National Ecosystem Assessment) will make up the strategic framework. Workshop participants and others will be given the opportunity to comment on draft framework documents over the summer. During the Autumn 2011 implementation plans will be developed for the frameworks, although work on implementation will begin in priority areas before this.


4. Feedback

A full list of participants is provided at **Annex E**. Participants were asked to complete a feedback questionnaire for the workshop; compiled results are presented at **Annex F**.


ANNEX A: Workshop input materials

- i. Roadmap 'landscape' template, for advanced completion by participants.
- ii. Timeline of LWEC-accredited activities of relevance to the Resources Challenge.
- iii. Summary detail of the LWEC-accredited activities of relevance.

- i. Roadmap 'landscape' template, for advanced completion by participants.

 **Name:** **Organisation:**

What would "success" look like in 2030 having met LWEC's Resources Challenge?										
		2011	Short term	2014	2014	Medium term	2018	2018	Long term	2030
TRENDS & DRIVERS	<ul style="list-style-type: none"> ▪Social ▪Technological ▪Environmental ▪Economic ▪Political & Legal 									
CHALLENGES	<ul style="list-style-type: none"> ▪Energy ▪Water ▪Land & Soil ▪Sustainability ▪Resource Consumption & demand management ▪Food, Agriculture & Forestry ▪Fisheries & Marine ▪Waste reduction, re-use & recycling ▪Plant & Animal Health ▪Other 									
KNOWLEDGE, TOOLS & FORESIGHT	<ul style="list-style-type: none"> ▪Biotechnology and Biological ▪Engineering and Physical ▪Economic and Social ▪Medical ▪Meteorological ▪Natural Environment ▪Cross-Cutting ▪Other 									
RESOURCES	<ul style="list-style-type: none"> ▪Funding & Resources ▪Standards & Measurement ▪People & Skills ▪Facilities & Infrastructure ▪Partnerships & Supply Chain ▪Policy & Regulation 									



ii. Timeline of LWEC-accredited activities of relevance to the Resources Challenge.

TIMELINES FOR LWEC ACCREDITED ACTIVITIES PARTICULARLY RELEVANT TO THE RESOURCES CHALLENGE																
LWEC Ref	LWEC ACCREDITED ACTIVITY	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017			
63	Landscape and Environment Programme													01 September 2005	01 August 2010	
35	The Waste of the World													01 October 2006	30 September 2011	
6	Met Office Hadley Centre Climate Programme													01 April 2007	31 March 2012	
32	Sustainable Marine Bioresources													2007	2012	
36	BGS Groundwater Science													01 April 2007	31 March 2014	
26	Southern Ocean Fisheries and Climate Change													01 April 2007	31 August 2015	
4	The Centre for Climate Change Economics and Policy													01 October 2008	30 September 2013	
31	BioMara (Sustainable Fuels from Marine Biomass)													05/01/2009	31/12/2013	
58	Resilient development in social science ecological systems													01 January 2009	31 December 2011	
9	Icesheets and Sea Level Rise													01 March 2009	31 May 2013	
17	UK Ocean Acidification Research Programme													01 April 2009	21 March 2014	
25	Knowledge-based Sustainable Management for Europe's Seas (KnowSeas)													01 April 2009	31 March 2013	
37	BGS Minerals and Waste theme													01 April 2009	31 March 2014	
16	National Ecosystem Assessment													01 May 2009	01 March 2011	
42	Insect Pollinators Initiative													03 July 2009	01 July 2014	
59	Centre for Business Relationships Accountability, Sustainability and Society (BRASS)													01 October 2009	30 September 2011	
52	Land Based Renewables													01/10/2009	01/10/2013	
34	Changing Water Cycle Programme													01 November 2009	31 March 2014	
33	Ecosystem Services for Poverty Alleviation (ESPA)													01 November 2009	01 March 2017	
20	Demonstration Test Catchments													01 December 2009	30 November 2014	
51	Cross-government Biofuels Executive Research Board													10/12/2009	01/04/2011	
27	Network for Valuing Biodiversity, Ecosystem Services & Natural Resources													01/01/2010	31/12/2012	
30	Algal Bioenergy Special Interest Group													2010	2012	
60	Low Carbon Communities Challenge													08 February 2010	30 March 2012	
62	Sustainable Lifestyles Research Group													01 March 2010	28 August 2013	
54	Social and Environmental Economic Research (SEER) into Multi-Objective Land Use Decision Making													01 April 2010	31 March 2014	
55	Adapting Rural Living and Land Use to Environmental Change (Relu Phase IV)													01 June 2010	30 November 2011	
61	Sustainable Practices Research Group													01 August 2010	31 July 2013	
28	Macronutrients Cycles Programme													01 September 2010	31 August 2015	
11	Agriculture GHG R&D Platform													01/11/2010	30/06/2015	
46	Ecology of Infectious Diseases (EID) – US-UK Collaboration													01 July 2011	30 September 2016	

iii. Summary detail of the LWEC-accredited activities of relevance.

As of June 2011. Leading LWEC Partners indicated in parenthesis. Activities highlighted in yellow are considered of greatest relevance to the Resources Challenge; these are included in the summary table above, and details provided here.

1. **Joint Weather and Climate Research Programme** (Met Office and NERC)
2. **Methods for Quantifying Uncertainty in Predictions of Regional and Local Climate Change and Climate Impacts** (NERC, EA, Met Office)
3. **Avoiding Dangerous Climate Change** (DECC and Defra lead with other partners)
The £1.3M Avoiding Dangerous Climate Change (AVOID) programme is to be delivered by a consortium including the Met Office and research centres. The three main outputs will be policy-relevant evidence and research needed to achieve international agreement on greenhouse gas emission reductions, core research for understanding dangerous climate change and its implications and a framework that will further encourage the integration and communication of scientific and socio-economic research on climate change.
4. **Centre for Climate Change Economics and Policy** (ESRC funds with non-LWEC partners)
The primary focus on the Centre, which is chaired by Lord Stern, is to improve climate-change policy and to increase the capacity of decision makers (both public and private) to respond to one of the most critical challenges facing the world today. £7.3M of the Centre's funding forms the portion of work accredited by LWEC.
5. **Tyndall Centre for Climate Change Research** (NERC, EPSRC, ESRC)
The internationally renowned Tyndall Centre for Climate Change Research that contributed significantly to the IPCC assessments on climate change adaptation and mitigation has been provided with an additional £2.4M of funding. This is to help orientate and engage the UK climate change research community to deliver more effectively on the LWEC environmental change objectives.
6. **Met Office Hadley Centre Climate Programme** (Defra and DECC)
This is a five year programme with just over £72M funding. The aim of the programme is to provide tailored climate change advice to UK government, and supporting DECC and Defra in developing policy to tackle climate change.
7. **Integrated Research Programme to assess the Impacts of Climate Change in the UK and Adaptation Options** (Defra, EA and non-LWEC partners)
8. **The Collaborative Centre of Excellence in Understanding and Managing Natural and Environmental Risks** (EPSRC, ESRC, NERC, Defra)
9. **Icesheets and Sea Level Rise** (NERC (BAS), Met Office & 22 other partners)
10. **Identification and modelling of the processes that govern climate on multi-decadal to centennial time-scales; quantification and reduction of the uncertainty in predictions for the next century** (NERC (NCAS), Met Office & other non-LWEC partners)
11. **Agriculture GHG R&D Platform** (Defra, SG, WAG and NI Executive)
The overarching aim for the £12.6M GHG platform is to track, understand and predict future changes in greenhouse gas emissions from agriculture. This requires significant reduction in the uncertainties in the agricultural GHG inventory and development of country-specific emission factors to be used in combination with national statistics in order to better characterise and allocate GHG emissions from agriculture. The projects will be managed by Defra in collaboration with the above partners and a Research Advisory Group (RAG) will be responsible for providing quality assurance.
12. **Using earth sciences to understand climate changes and to predict their environmental responses** (NERC (BGS), Defra, EA, BBSRC (Rothamsted Institute) and many other UK and International non-LWEC partners)
13. **Developing geoscience technologies for environmental monitoring** (NERC (BGS), Defra, EC Environment DG and EC Space DG)
14. **Storm Risk Mitigation through Improved Prediction & Impact Modelling** (NERC, Met Office, EA)
15. **Next Generation Weather and Climate Prediction Systems** (NERC, Met Office, STFC)

16. **National Ecosystem Assessment** (Defra, SG, WAG, NERC, ESRC)
This world-leading, £1.2M initiative will produce the world's first national assessment of its kind. Following the Millennium Ecosystem Assessment chaired by Professor Robert Watson (Chief Scientific Adviser for Defra) it will provide an assessment of the current state of all of the ecosystems in the UK. The study will provide the evidence foundation of the ecosystems approach to policy that Defra are leading across Whitehall, identifying both threats and opportunities.
17. **UK Ocean Acidification Research Programme** (NERC, Defra, DECC)
The overall aim of this £12.4M Research Programme is to provide a greater understanding of the implications of ocean acidification (as a result of the absorption of anthropogenic carbon dioxide) and its risks to ocean biogeochemistry, biodiversity and the whole Earth System. SG and WAG have also been consulted in the design phase of the programme.
18. **Designing a Programme to Address Evidence Gaps in Greenhouse Gas and Carbon Flux from UK Peatlands** (NE, Defra, DECC, SG, WAG, SEPA)
19. **Pilot Review Scheme – Objective B** (Defra, NERC)
20. **Demonstration Test Catchments** (Defra, EA, WAG)
The Demonstration Test Catchments will develop an evidence-base for wider application to the management of river catchments across England and Wales.
The £8M project will initially set up three instrumented catchments with an integrative data infrastructure to provide a shared-use network as the framework for collaborative analysis. Research and mitigation actions in other catchments will also be drawn in and supported where relevant, to enhance the developing evidence base.
21. **OPAL (Open Air Laboratories)** (Lottery fund to Imperial College London, with additional contributions from Defra & EA)
22. **Marine predators as indicators of the integrity and health of marine ecosystems** (SMRU (NERC), SG, Defra, SNH, Natural England)
23. **The Continuous Plankton Recorder (CPR) survey** (NERC Defra & many non-LWEC UK and International contributors; run by NERC (SAHFOS))
24. **Character and Quality of England's Landscapes (CQuEL)** (NE, Defra and English Heritage)
25. **Knowledge-based Sustainable Management for Europe's Seas (KnowSeas)** (NERC (SAMS), NERC (SAHFOS), Defra (Cefas), and many non-LWEC UK and International partners)
KnowSeas is a large-scale integrating EU FP7 collaborative project with 30 partners from 15 countries, coordinated by the Scottish Association for Marine Science (SAMS), a NERC Collaborative Centre. The total project cost is £6,335,740, with a total EU contribution of £4,923,570. Europe's four regional seas have suffered severe environmental degradation due to human pressure. The Ecosystem Approach to management, a management paradigm that encompasses humans and the supporting ecosystem, offers a means of sustainably managing our seas to optimize both ecological and social well being. However, the science base for this approach needs strengthening and practical tools must be developed and tested for policy implementation. The KnowSeas consortium will strengthen the science base for managing Europe's seas through the practical application of systems thinking.
26. **Southern Ocean Fisheries and Climate Change** (NERC, FCO)
Work on Southern Ocean fisheries and Climate Change is delivered through the ~£5.5M Ecosystem Science into Policy (ESP) programme which focuses on the maintenance of, and potential threats to, Ecosystem Services derived from the Southern Ocean. ESP is specifically targeted at providing policy makers, particularly the Foreign & Commonwealth Office (FCO) that leads on UK policy for Antarctica, with the information they require concerning management of ecosystems in a changing environment. ESP is the NERC/UK contribution to the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR).
27. **Network for Valuing Biodiversity, Ecosystem Services & Natural Resources** (NERC, with possible involvement from ESRC, Defra, SG and NE)
The aim of the proposed £0.6M research network is to create partnerships to promote and develop research capacity in the valuation of biodiversity, natural resources and ecosystem services. Capacity will be created by establishing cross-disciplinary collaborations between the natural and social science communities designed to:
- Articulate the nature of the valuation problem we currently face in relation to understanding the contribution that natural capital makes to human well-being; and,
 - Identify and develop the underpinning natural science knowledge that would enable robust monetary and non-monetary valuation to be achieved.

- 28. Macronutrient Cycles Programme** (NERC, EA, Defra, SG, WAG)
This is a major new £9.5M programme that aims to understand the interactions between Carbon, Nitrogen and Phosphorus Cycles in the environment. The research will assess the fate and distribution of these nutrients and the likely changes due to man-made impacts such as climate change, land use change, population changes and changing pollution gradients across the UK and Europe.
- 29. Marine Renewable Energy** (NERC, Defra)
This £3.7M programme will contribute to the evidence base to predict the environmental implications of future marine renewable energy options at appropriate scales, and to the research capacity to deliver decision support about the biophysical properties of coastal and marine environments to promote offshore and near-coastal renewables development with enhanced environmental benefits.
- 30. Algal Bioenergy Special Interest Group** (NERC, TSB)
The key goal of this £0.77M network is to understand the opportunities and risks to the quality of freshwater and marine environments of using algal biomass as a source of renewable energy. The network will enable early evaluation of the environmental and economic impact of algal bioenergy through development of a 'sustainability framework' using analogues developed for terrestrial bioenergy deployments. The network will also ensure close engagement with technological developments in this area.
- 31. BioMara (Sustainable Fuels from Marine Biomass)** (NERC (SAMS) lead, SG Agency and other non-LWEC partners including EU Framework funding, Universities and Irish and Northern Irish Departments and Institutes)
This €6 million UK and Irish joint project (funded through Interreg IVA, Highlands and Islands Enterprise and the Crown Estates) aims to demonstrate the feasibility and viability of producing third generation biofuels from marine biomass, using both macroalgal (seaweeds) and microalgal (single celled plants) sources as an alternative to agri-fuels production from terrestrial land plants. It focuses on Scotland, Northern Ireland and the border part of Ireland, aiming to provide the region with access to a more economically and environmentally sustainable local renewable fuel source, whilst also helping to service local public transport infrastructure and build on the regions' technology-base.
- 32. Sustainable Marine Bioresources** (NERC, Defra and other non-LWEC partners including SEERAD/FRS and AFBI)
This collaborative 5-year programme is a response to the Prime Minister's Strategy Report on the future for UK fishing (2004), which called for Research Councils, universities and government agencies to pool their scientific expertise to help deliver the knowledge and understanding needed to progress the objectives and practice of ecosystem-based fisheries management. Funding includes £1.4M cash with a further £0.9M in kind contributions.
- 33. Ecosystem Services for Poverty Alleviation - ESPA** (NERC, ESRC, Defra, DFID)
This £40.5M programme will address key environmental vulnerabilities in areas of the world where poverty is worst. The aim is to find ways in which poverty can be reduced by accounting for regional variations in climate, weather patterns and land use without causing or worsening enduring environmental problems.
- 34. Changing Water Cycle Programme** (NERC with other Partner input)
This programme will develop an integrated, quantitative understanding of the changes taking place in the global water cycle, involving all components of the earth system. It will address the urgent needs to understand the changes taking place now; predict changes that will take place over the next few decades; and, through LWEC, work with partners to build resilience, mitigate problems, and develop adaptive solutions. The EA, Met Office and Defra have all been involved in the development stages of the programme. The current funding figure is £10.1M, which is likely to increase once contributions from other stakeholders are confirmed.
- 35. The Waste of the World** (ESRC)
This £3M programme of six linked projects aims to produce a defining social science study of waste, for academics, policy makers and stakeholders. Its overarching aims are to reconceptualise the place of waste and how we think about waste within social science.
The programme has three objectives.
- Provide the first investigation of newly emerging global waste economies, focusing particularly on hazardous waste, its trade, management and disposal.
 - Offer a radical reconceptualisation of waste within productive activities. Rather than locate waste as the end point of production-consumption, we argue that surplus and loss (and therefore waste) is fundamental to all economic activity.
 - Provide the first empirical examination of the disposal rituals surrounding the excess of economies in key parts of the world, within the EU and in India.
- 36. BGS Groundwater Science** (BGS (NERC), Defra, EA, SEPA, DFID & other non-LWEC partners)

The ~£6M Groundwater Science programme focuses on providing an improved understanding and characterisation of the fundamental properties of groundwater systems and on investigating/forecasting the impacts of a changing environment (from both a quality (chemical) and quantitative perspective) on groundwater and on other parts of the aquatic and terrestrial environments directly dependent on groundwater, e.g. rivers and wetlands.

37. **BGS Minerals and Waste theme** (BGS (NERC), DCLG, Defra & other non-LWEC partners)
The drivers for the ~£8M Minerals and Waste theme/programme within the overall BGS Strategy are the need to secure a sustainable supply of minerals and energy, in the face of the twin challenges of population increase and climate change. The research outputs focus on the need to move towards a low carbon economy as set out in the UK Climate Change Act 2008 which sets legally binding emission reduction targets of 34% (by 2020) and 80% (by 2050).
38. **Urban Atmospheric Science Research Programme entitled 'Clean Air for London (ClearLo)'** (NERC, Defra, EA, Met Office)
39. **Environmental and Social Ecology of Human Infectious Diseases Initiative – ESEI** (MRC, NERC, ESRC, BBSRC)
40. **Environmental Exposure and Health Programme** (NERC, MRC, DH, ESRC, Defra)
41. **MRC-HPA Centre for Environment and Health** (MRC, DH/HPA)
42. **Insect Pollinators Initiative – IPI** (BBSRC, Defra, NERC, SG)
This initiative (which also includes a significant contribution from the Wellcome Trust) will invest almost £10M in determining the importance of factors that lie behind the declines in pollinators (such as honeybees and bumblebees). Possible causes include disease, chemicals (such as pesticides), habitat change and a range of management practices. The research will aim to identify solutions that will help reverse the declines in this economically important group of organisms.
43. **Detection and Identification of Infectious Agents Innovation Platform** (TSB, DH)
Infectious diseases are a constant threat to the health and wealth of the nation. The research and development that will be funded by the Innovation Platform will be aimed at producing new rapid diagnostic tests and Point of Care (POC) devices for the detection and identification of infectious agents in both humans and animals. The range of diseases and areas chosen were prioritised by government (DH and Defra). This platform (currently £55M) may also potentially involve ESRC, EPSRC, BBSRC, Defra and MRC contributions.
44. **Scoping of Reducing Uncertainty in Models for Environmental Decision-Making** (NERC, Defra)
45. **Increasing resilience to natural hazards in volcanic and earthquake-prone regions** (NERC, ESRC)
46. **Ecology of Infectious Diseases (EID) – US-UK Collaboration** (ESRC, BBSRC, NSF, NIH)
This international £7.95M collaborative programme supports the development of predictive models and the discovery of principles governing the transmission dynamics of infectious disease agents, with a strong focus on interdisciplinarity. The funders are particularly keen to receive proposals for studies to better understand animal reservoirs as a source of infectious diseases, how animal pathogens spill-over into human populations, and the spread of those pathogens through and between communities in the UK or other parts of the world. The aim is to fund research into pathogens that are considered to be a significant threat to public health now or in the future.
47. **Adaptation and Resilience to a Changing Climate - ARCC** (EPSRC, ESRC and Defra, with potential interest from DCLG and other Partners as the programme develops)
48. **Intelligent Transport Systems and Services Innovation Platform** (TSB, DfT, EPSRC)
49. **Low Carbon Vehicles Innovation Platform** (TSB, DfT, EPSRC)
This £89M platform aims to maximise the benefit to UK-based businesses of the rapidly-developing low carbon vehicles market, and to help accelerate the adoption of low carbon vehicles in the UK. The platform currently supports two key activities: 'The Low Carbon Vehicles Integrated Delivery Programme' and 'The Ultra Low Carbon Vehicle Demonstration Competition', both of which also involve key input from RDAs.
50. **Low Impact Buildings Innovation Platform** (TSB, NERC, ESRC, EPSRC, DCLG)
51. **Cross-government Biofuels Executive Research Board** (DfT, Defra, DECC)
The biofuels executive research board brings together Chief Scientific Advisors from across Government and so provide a forum through which to monitor and manage research into biofuels and facilitate successful engagement with experts outside UK government. The three sponsoring Departments are expected to contribute £2million pa to biofuels research.

- 52. Land Based Renewables** (NERC, NE plus Shell UK)
By 2020, the proposed EU requirement is that the UK meets 15% of its final energy demand from renewable sources, which equates to around 40% for electricity. There is an urgent research need to understand the environmental implications of this requirement, as the recent controversy over biofuels shows. Up to £2.4 million has been invested to date in support of collaborative grants to address this topic, including a financial contribution from Shell UK of £350k. Natural England is contributing support in kind to the research programme which has included expertise helping define the scope.
- 53. Science and Heritage Programme** (AHRC, EPSRC)
- 54. Social and Environmental Economic Research (SEER) into Multi-Objective Land Use Decision Making** (ESRC, Defra)
This deliberately ambitious £1.8M research project examines arguably the most fundamental of all resource problems: the optimal use of land. It seeks to assess this using a novel methodology intended to undertake simultaneous economic assessment of both (a) the primary effects of policy, market or environmental change upon land use and (b) the second round, dynamic consequences of that change which may in turn generate multiple feedback effects upon various other environments.
- 55. Adapting Rural Living and Land Use to Environmental Change (RELU Phase IV)** (ESRC, NERC, BBSRC, Defra, SG)
The RELU Programme is to fund (£1.2M) projects under a fourth call on the above theme, co-designed with LWEC. The projects will tackle two objectives. First: to build networks and capacity for creative knowledge exchange with a view to strengthening adaptive capacities. Second: to explore and promote novel approaches and partnerships for interdisciplinary research and analysis on living with environmental change in rural contexts.
- 56. ESRC Climate Change Leadership Fellowships** (ESRC)
- 57. Flood, vulnerability and urban resilience: a real-time study of local recovery following the floods of June 2007 in Hull** (ESRC, EPSRC, *EA*)
- 58. Resilient development in social science ecological systems** (ESRC)
Research under this £0.25M fellowship will develop a deeper and broader social science understanding of resilience and how the concept is applied to linked social ecological systems. It will do this by drawing on theory across a range of social science disciplines, synthesising recent research findings, and undertaking new empirical investigation of resilience. It will produce a book provisionally titled 'Towards Resilient Development' and a series of scientific papers targeted to social science and interdisciplinary journals.
- 59. Centre for Business Relationships Accountability, Sustainability and Society (BRASS)** (ESRC)
BRASS is a ~£5.2M joint venture between Cardiff University's School of City and Regional Planning, Business School, and Law School. It pursues high quality, interdisciplinary social science research and engagement with research users, to create knowledge and tools that will promote more sustainable stakeholder relationships amongst and within businesses, society and the environment. Environmental change is a common theme across BRASS projects, either as an influence of businesses, communities, organisations and consumers and their behaviour, or as a consequence of the activities of businesses and their stakeholders within our production and consumption systems.
- 60. Low Carbon Communities Challenge** (DECC, Defra, DCLG, WAG)
The £10.9M LCCC is an innovative approach to policy development being taken forward by DECC, working alongside a number of government departments.
Recognising that Government doesn't necessarily know the best means of helping people cut their carbon emissions, the LCCC is a two-year research programme designed to test delivery options through practical delivery on the ground at community level. Through the project, Government is providing up to £500,000 to 22 test communities in England, Wales and Northern Ireland. Its aim is to support both technical innovation and understand the social changes that are needed to help meet carbon reduction targets.
- 61. Sustainable Practices Research Group** (ESRC, Defra, SG)
The essence of this £1.6M programme of work is to enhance the social scientific understanding of habitual behaviour in areas of everyday consumption with consequences for environmental sustainability.

The Sustainable Practices Research Group (SPRG) will put particular emphasis on better understanding consumption - on the grounds that changing personal behaviour of billions of individuals provides the greatest of challenges to the achievement of sustainability. The Programme involves seven work packages which will deliver a multi-level analysis of three environmentally-sensitive practices - eating, water-use and sheltering.
- 62. Sustainable Lifestyles Research Group** (ESRC, Defra, SG)

This £1.76M Group aims to achieve new and relevant understandings of the processes which lead to changes in people's behaviours and practices and to provide advice on realistic strategies to encourage more sustainable lifestyles. It will be coordinated through the University of Surrey under the direction of Professor Tim Jackson. Other key partners included the University of Bath, the University of Sussex and the institute of Fiscal studies.

63. Landscape and Environment Programme (AHRC)

The ~£6.6M Landscape and Environment Programme was created to support research from an arts and humanities perspective on issues related to landscape and environment. The core challenge for this programme was to advance knowledge, critically and creatively, of the cultural forms and processes shaping, and shaped by, landscape and environment.









ANNEX B: Landscape Summary

Annex A Key

Annex A shows the summary of the Roadmap “Landscape” together with detailed views of each ‘layer’:

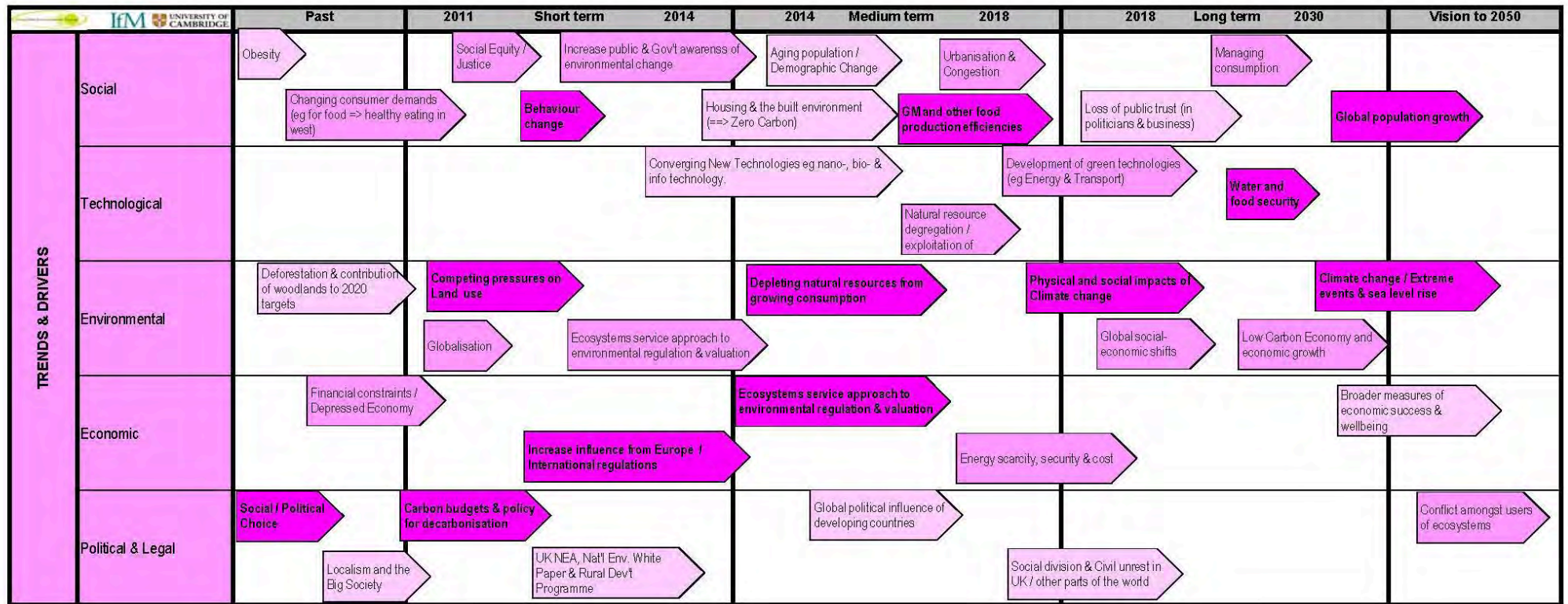
- Trends & Drivers
- Challenges
- Knowledge, Tools & Foresight
- Enablers.

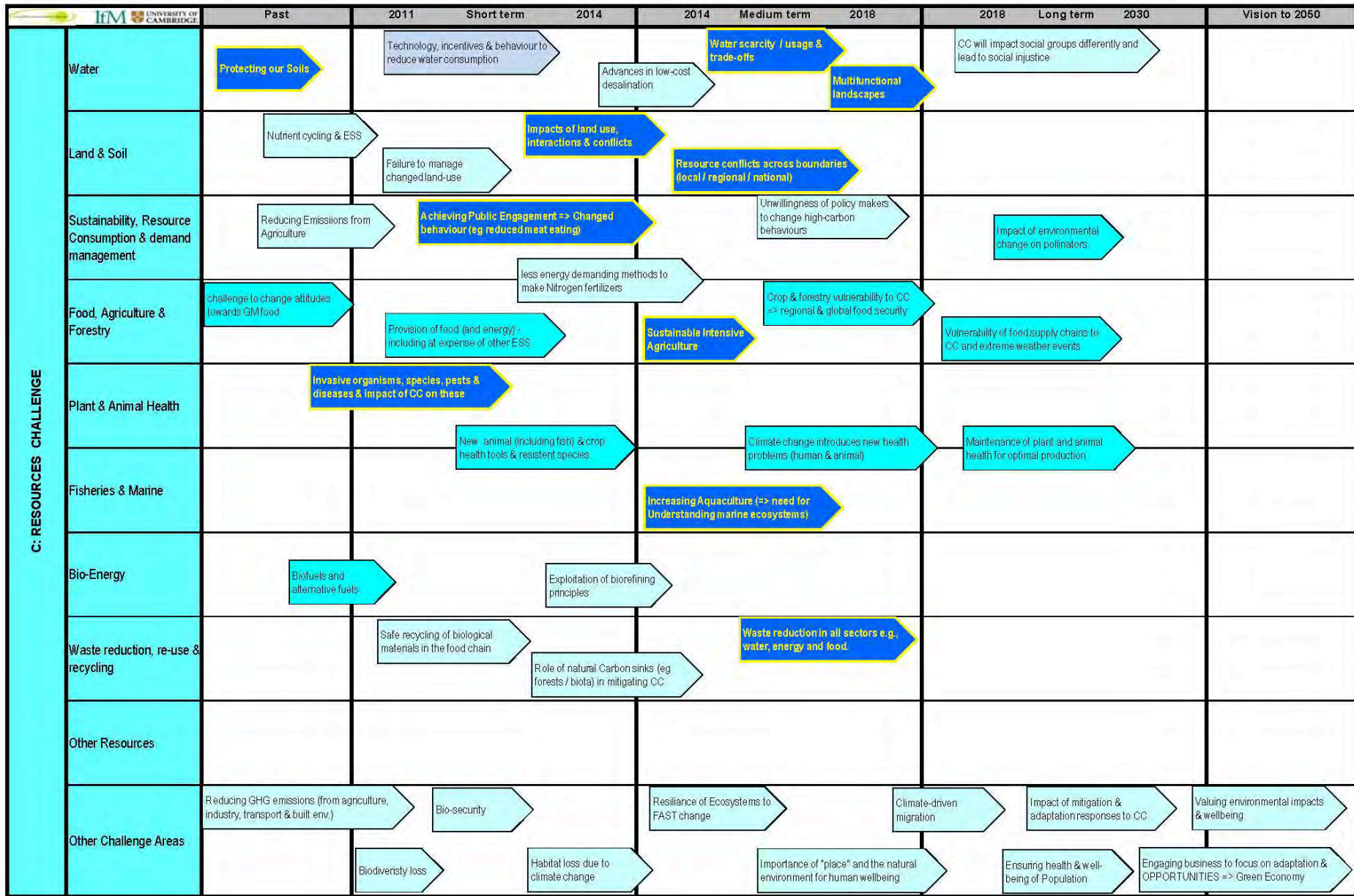
Items in each layer are colour coded based on their importance according to the views of the workshop participants (as expressed in their pre-workshop perspectives and as they relate to the priority issues identified at each stage of the workshop process). Darker / deeper colours indicate higher priority, as follows.

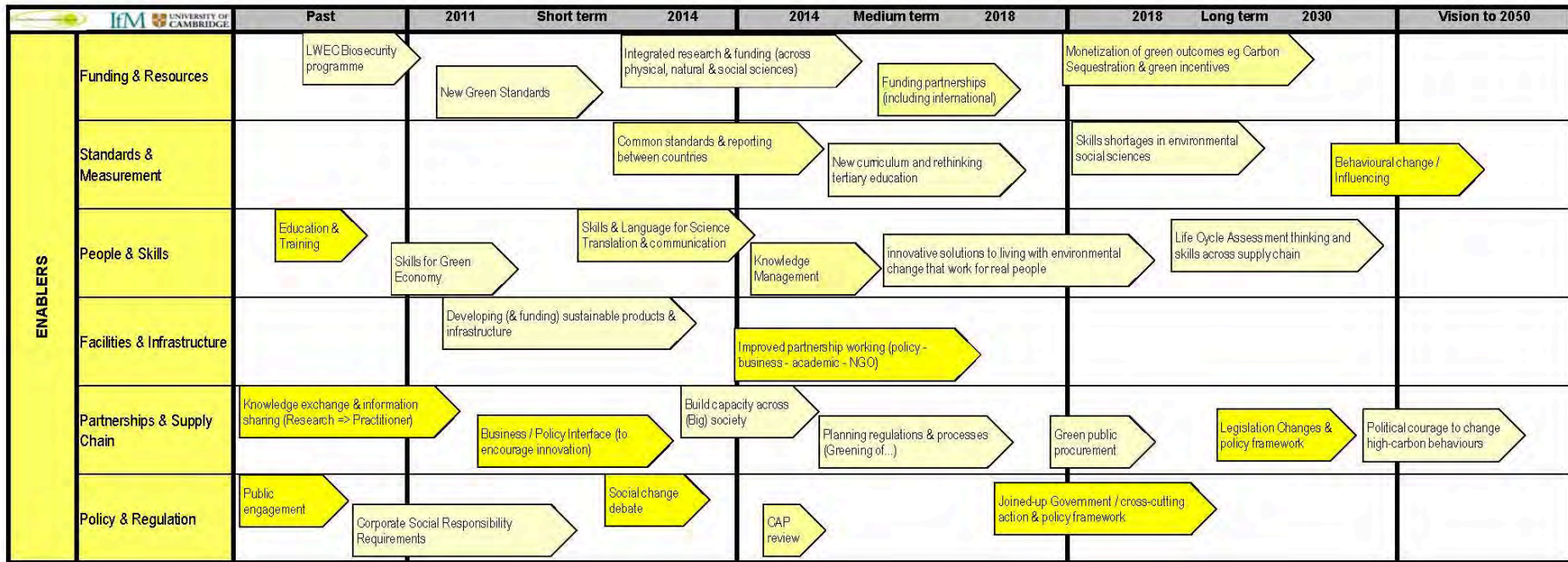
Key: Darker / Deeper Colours represent higher priority issues:	
	 Trends & Drivers
	 Challenges
	 Knowledge, Tools & Foresight
	 Enablers



Landscape Detail







ANNEX C: Landscape linkages

The following table indicates some of the linkages between the different layers in the roadmap. The left hand grid indicates how different Drivers will influence the future Challenges and Opportunities that a changing environment will bring. The right hand grid indicates how various areas of Knowledge, Tools, Foresight and other Enablers and Resources might be brought to bear to address these Challenges and Opportunities. This report indicates those linkages which were initially identified in the workshop – further work will be undertaken by the Steering Group to refine the content and linkages for the whole roadmap.

ANNEX D: Mini business cases

These tables capture the transcribed outputs of participants in creating mini business cases for one of the identified high priority challenges.

Further contributions by participants who were not part of the original group developing the case are denoted by an asterisk (*).

Challenge:
(a) Waste as a resource (including waste reduction)

Team	CW	CW2
	NP	PM

Challenge Description:
 - Example –
 1. Food waste back to animal feed
 2. Sewage sludge to land use
 3. Biorefining.

There is a priority Resources challenge:
 - Preventing waste, optimising the use of resources and, where waste arises, putting it to the best economic and environmental use.
 - Ban putting metals and carbon intensive products to land fill.
 - Focus on bio-degradable waste (CCA).
 - Establish a standard for different grades of refined waste.

Key Responses & Decisions:

Knowledge, tools and foresight will enable us to:
 - Have a more informed approach to waste policy and action.
 - Evidence based strategy for government and industry.
 - Move to a zero-waste economy.

Outcome	Mitigate - Producer responsibility for waste management. - Inform waste policy infrastructure building, behaviour change and end market for waste. *renewable energy for oil decline.	Adapt to - Rising energy costs and rising fuel costs (effects viable solutions). *What about increasing levels of waste, decreasing amount of land to dispose of waste. Changing climate and nature of waste.	Benefit from - Green economy =creating jobs. - Maximising food value of waste. - Economic and environmental benefits of taking action.
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Need for knowledge, Tools & Foresight - Material flow mapping. - Data on waste and resource flows (bioresources, bio-waste). - lifecycle analyses that capture waste; debate involved in different systems. * Need for practical methodologies. - recycling technologies and more bio-refining. - Behaviours and innovation - product lifetime replacement, re-use/repair. - End markets for waste recycling/recovery. - Novel bio-technologies/other technologies for dealing with waste, e.g. bar coding of domestic waste. - Biological efficiency reduces waste. e.g. GHG per unit food produced.	Apply	Adapt	Create

Open questions and input required from group:
 - How big are the economies of scale for waste in primary production and manufacture?
 * Localism or regional scale co-op models. *
 Solutions/approaches appropriate to scale.
 * Could small producers club together?

<ul style="list-style-type: none"> - Design of goods to stop waste arising in the first place, and eco-labelling. - Carbon accounting standards. - Foresight. - Future scenarios & sensitivity. * Waste streams (new waste) infrastructure (local/global), behaviours, economy. * What about reduction in energy costs, carbon emissions, environmental degradation. 				
<p>Enablers</p> <ul style="list-style-type: none"> - Inform policy/stakeholders - Integrated supply chains. - fiscal policy. - Oblige water companies to auction their sewerage plant estate. * Need a uniform set of international policy regulations on waste. - Good regulation 	<p>Barriers</p> <ul style="list-style-type: none"> - Unintended consequences of regulation . - Risk averse regulation. <p>Other barriers:</p> <ul style="list-style-type: none"> - No data. - Risk management. - Localism agenda - Repair/re-use/negative impact on growth. - Behaviour change of retailers and consumers. - End of waste definition process and cost. 			

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Challenge:
(b) /achieving multi-functional landscapes (plus sea)

Team	ID	PK
	TG	

Challenge Description:
 How do we achieve multifunctional landscapes?
 (caveat - context of political decisions on scale of global ecosystem / environmental footprint)

There is a priority Resources challenge:
 Understand how we deliver sustainable/multi-benefits from land and sea so people have sustainable and equitable access to food water, energy and other ecosystem services now and in the future.

Key Responses & Decisions:

Outcome	Mitigate	Adapt to	Benefit from Delivers sustainable food water energy and other ecosystem services now and in the future

Knowledge, tools and foresight will enable us to:

- Some organisations to develop a land use strategy for the UK.
- * Government.
- * Need to determine impact of indirect land change.
- * What is the role of 'big society'/localism?
- Optimise delivery of resources.
- * Has top down ever worked? Don't we need flexible adaptive approaches?
- * Yes it has! In many areas of policy. e.g. CAP aimed to prevent food shortages but needs reform.
- * Need to review and revise more regularly. CAP was a disaster in some ways.

<p>Need for knowledge, Tools & Foresight</p> <ul style="list-style-type: none"> - What units/scale? National/regional? Global? Sub regional? - Better tools for valuing /critical dependence. * What is the social capital & economic value of landscapes and multi-functional land use? - Lack of understanding of the inter-dependencies of the whole socio-ecological system; needs to be unpacked to deliver. - Better prediction of key drivers at the right scales e.g.. climate change, population, demographics. - Integration of models. * Including understanding of inherent uncertainties 	Apply	Adapt	Create
	YYY	YY	YYYYY

Open questions and input required from group:

- Who owns this?
- Role of business verses government's policy. Is the big society agenda a problem?
- * Yes if double standards are used in terms of A=QA and JCOP auditing.
- * We need honesty about examples where it does not work and how it biases research into "fashionable" areas of science.

<p>Enablers</p> <p>Land use managers.</p> <p>* Coherent land use strategy with linked incentives.</p> <p>* Use farm plans / fuelled by field approach. - Reformed?</p> <p>CAP</p> <p>- Better evidence for policy and that evidence used. -PES? Joined up governance.</p>	<p>Barriers</p> <p>Big society?</p> <ul style="list-style-type: none"> - Public buy-in/lack of understanding. - Individual rights (infringed). - Lack of evidence for decision makers - CAP. - Remit boundaries of different actors. <p>* Is multifunctional land use for government to invest in infrastructural change to make it happen?</p>
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Challenge:
(c) Evidence and model based policy

Team	AC	NM
	SG	

Challenge Description:
 How can scientific evidence be better used to inform policy?
 - Bridging the gap between scientific capability and making policy decisions.
 - Bridging the gap between scientific objectivity and policy need.

There is a priority Resources challenge:
 - Identify a do-able area of policy that LWEC can target for proof of concept. E.g. Something like ozone depletion.
 * Policy = framework only, as the local situation decides on outcome.
 * Provide policy makers with easy to use, what if ? tools, which allow rapid comparison of scenarios/options.

Key Responses & Decisions:

Outcome	Mitigate - Reduce Unquestioned assumptions	Adapt to - Need to balance conflicting priorities and views. - More overtly risk based approaches. *Reactive political changes vs. horizon scanning/scenario needs.	Benefit from -Better, more consistent policies - fewer flip/flops.
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Knowledge, tools and foresight will enable us to:
 Answer the original question.

Need for knowledge, Tools & Foresight - Focused multi-disciplinary teams. - Focused by dialogue with policy makers, developing questions. - Models designed for use in decision making (qualified, risk based, transparent) * That take account of efficiency of land use of feeding people. E.g. ruminants eat grass! * Ensure tools develop in scale beyond tiny plots not used for landscape applications. * Quantify models against real life observations. * Multi-model applications (IPCC approach) to identify uncertainty. - Iterative approach to gap analysis.	Apply	Adapt	Create
	YY	YYY	YYY

Open questions and input required from group:
 How to identify the unknown unknowns.

<p>Enablers</p> <ul style="list-style-type: none"> - Investing time in dialogue between scientists, funders and policy makers. * This could be LWEC 'added value' activity and collaboration. * and communicators and media. - Investing in and rewarding problem focused, multi-disciplinary research. 	<p>Barriers</p> <ul style="list-style-type: none"> - Ownership of data/models. * What about the transparency agreement - making public data public? - Difficulties engaging policy makers. * Language difficulties/differences. * Communication and public perception are as important as the facts in determining outcomes. - Policy makers need to understand what researchers can deliver and researchers need to understand what policy makers want. - Academic culture/'single discipline' outlook and desire to protect data. 	

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Challenge:
(d) Sustainable intensive agriculture / ecosystem services (in the context of climate change)

Team	MR	AM
	IS	

Challenge Description:

- **Maximise sustainable yields**, minimise water and air impacts.
- This is a better description than sustainable intensive agriculture.
- Soil degradation and loss of agricultural land.
- Inherently productive land should be used to provide resources: food, energy, materials. - To be sustainable it needs to be done with respect to soil, water and air (ecosystem services).
- Increase food production, reduce environmental impact.
- Ecosystem services are a huge resource to reduce global poverty.
- crops losing range due to climate change.

There is a priority Resources challenge:

- Stop theorising and start applying and learn by experience.
- Research that delivers commercially viable solutions. - - Policy that delivers policy relevant solutions.
- Work towards a true understanding of factors limiting agricultural policy such as climate, location needs to be done by those with expertise and experience.
- Find ways to reward those who provide services.
- Give SIA a chance and have a positive attitude to it's success.

Key Responses & Decisions:

Outcome	<p>Mitigate</p> <ul style="list-style-type: none"> - Moorland carbon capture and storage from re-wetting 2-5 k/ha/year. *Yes but increased methane which off-sets this., - Methane increase is temporary, CO2 capture is ongoing. - ESS payments being developed for Dartmoor. Carbon owner, water farm and run-off /SWW. - Payments for ecosystem services, stewardship of global comms. 	<p>Adapt to</p> <ul style="list-style-type: none"> - Changing environment (climate) - Pressures on crop processes, soil processes, UK and overseas. - Extreme weather events and shifting weather patterns. - Effects on physiological processing in crops. - Pests and disease incidence. *New disease threats. 	<p>Benefit from</p> <ul style="list-style-type: none"> - Farmers paid for flood control by urban communities. - Farmers paid for drought protection by SWW (sewage effluent dilution). - Farmers paid for water quality and quantity provided to SWW. Avoided run-off retains manures so cost saving on artificial fertiliser. - Biodiversity migration corridors and WFD aims met by ESS. - Quality food at reasonable prices. - Livestock kept out of streams saves cost of illness and vets bills. - More water re-use on farms saves money and minimises volume in slurry stores. - Local communities in UK and developing countries would benefit from ecosystem stewardship payments.
	<p>Need for knowledge, Tools & Foresight</p>		

Knowledge, tools and foresight will enable us to:

- Minimise the impact of intensive food production on non-target desirable sectors. SO, air, water ecosystems. - Maximise farm output whilst protecting air and water. Agree!
- Reduce hunger and global poverty whilst preserving global community and sustain the worlds bio-resources. - Make informed decision about policy trade-offs.

Open questions and input required from group:

<p>*Techniques</p> <ul style="list-style-type: none"> - minimise pesticide - wetlands to filter <p>-Whole farms plans. Avoid soil compaction, run off and loss to rivers.</p> <p>*What limits crop yield and how will environmental change effect it. Livestock yields also equally relevant.</p> <p>*Germ plasm collections exist in crops and new crops.</p> <p>*New crop varieties and GM crop.</p> <ul style="list-style-type: none"> - Capture knowledge from existing studies. -Animal welfare concerns (avoid GM fiasco). -Need better knowledge of impact/costs/benefits of mega-units in positive lights. <p>*Animal breeding for resource use/disease resistance.</p>	
<p>Enablers</p> <ul style="list-style-type: none"> - Benefit: cost is 65 to 1 over 30 years from avoided capital projects due to cleaner raw water. - Urban area protection. - economic cost of damage avoided. - 'Upstream thinking' farmers' income up by 3K which is an increase of 25% 	<p>Barriers</p> <ul style="list-style-type: none"> - Lack of voice for community. Poor governance. - Pressure groups - Resistant to change. - NIMBY-ism. - Lack of honesty/understanding about transfer from plot controlled, theoretical based experiments to the real world. - Trade barriers. - Corruption. - Producers resistant to change. - Governmental regulatory policies inhibiting innovation and use of all tools. - Social acceptance of farming conditions (welfare etc).

<ul style="list-style-type: none"> - What extra skills and knowledge can you offer? * What is classed as 'You'? Need to collaborate, including stakeholders, experts, farming industry. *Sorry 'You' = this group

Challenge:
(e) Protecting our soils *and our soil carbon

Team	BE	TK
	JG	

Challenge Description:
 - Context/state of play conservative, range of practices which often not efficient when tested.
 - Intensification multiplied by climate change equals even worse in the future.
 - What goes wrong? Erosion, building on it, soils stop doing what we need them to. Costly.

There is a priority Resources challenge:
 - Protect and value our soil through applying and developing understanding and act now as it's only going to get worse through intensification multiplied by climate change.

Key Responses & Decisions:

Outcome	Mitigate - Developing and insisting on urban developments that let soils work (ambition). - Think of soil as a living ecosystem; don't over feed it, don't squash it, don't drain it and exploit biodiversity.	Adapt to - Vertical farming and hydroponics are the only options if we lose our soil.	Benefit from - Bringing economic benefit for companies if the can demonstrate this. - Efficient use of fertiliser, which benefits farmer and environment.
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Knowledge, tools and foresight will enable us to:
 - Develop economically sustainable, evidence-based, ecologically/farm-relevant and thermodynamically consistent soil protection strategies.

Need for knowledge, Tools & Foresight (Adapt) - Problem of scalability and transfer from experiments. Too many times it does not transfer. (Apply) - Remember sand dunes and costal soils. (Apply) - Law of thermodynamics. We need to recognise trade-offs, e.g. food v. biodiversity. Be honest in our claims for our research/proposed solutions. (Adapt & create) - Need to understand and adapt to threats in climate change. (Adapt & create) - Promoting healthy soils. Plant species richness, big roots? Evidence based, ecologically relevant & scaleable. * Extension services? Do they work? Next generation to develop. * Appropriate tools for local operators which link to other issued. * Understanding the value of microbial stock/action.	Apply	Adapt	Create

Open questions and input required from group:
 - How do we get existing knowledge and tools used joining forces?
 - Use champion farmers and case studies.
 - This is the added value of LWEC, to draw together multi-disciplines collaboratively.

* Create-Thresholds for tipping points - when is point of no return and what is the balance of production vs. biodiversity vs. soil carbon?

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Enablers

- Quick easy wins gets momentum going and builds confidence.
- Education at all levels (extension services & appropriate tools for local operators).
- Translate to simple steps for land managers.
- Link incentives to soil carbon protection.

Barriers

- Tribal practices , lack of infrastructure, conservatism do not want to be told what to do.
- Lack of trust in Defra by farmers.
- Soil is not sexy (but getting sexier).
- Fragmented and bruised soils community but we have lots of people doing science in soils.
- Farmers (some) do not look after their soil and cannot see or appreciate change since their parents' time.
- Look at the work of livestock Northwest Association project 4.

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Challenge:
(f) Water scarcity/usage and trade offs/ fair access

Team	DY	DH
	GL	MG

Challenge Description:
 - Global water scarcity.
 - Equitable management of water.
 - Quantity and quality.
 Challenge: Inequitable distribution and scarcity under changing environmental conditions.

There is a priority Resources challenge:
 Integrated modelling (national level) using natural, social and engineering systems:
 - bringing the right people together;
 - Understanding gaps/threats.
 * How to change social attitudes to wasting water.

Key Responses & Decisions:

Outcome	<p>Mitigate To mitigate this challenge we need to : - Understand threats and current use; - New models (doing things differently); - Infrastructure investment (treatment, leakage, maintenance, rain water harvesting); - Future modelling. * Big difference between consumptive and non-consumptive water useage. Water is special as it is constantly re-cycled through natural systems. - Political awareness & prioritisation.</p>	<p>Adapt to As per Mitigate.</p>	<p>Benefit from - Poverty reduction. - Prosperity. - Political stability. - Good health, environment, ecosystems.</p>
	<p>Need for knowledge, Tools & Foresight - Sector building. 'Stern value for water' * Needs appropriate measurement of water (not all water is</p>		

Knowledge, tools and foresight will enable us to:
 Achieve equitable and efficient distribution (quantity and quality)

	Apply	Adapt	Create
	Y *Apply changing	Y	Y

Open questions and input required from group:

<p>the same).</p> <ul style="list-style-type: none"> * Improve policy awareness for 'embedded' water. * Virtual / embedded water is important but over simplified. Context is very important. Avoiding/reducing consumption doesn't result in automatic re-distribution. <p>- Needs to balance with access / equity (poorest most expensive to reach).</p> <ul style="list-style-type: none"> * Affordability? <p>- Understanding ecological impact of water use on water environment.</p> <p>- Effective knowledge exchange.</p> <ul style="list-style-type: none"> * Need to integrate into other issues to stop SILO management. <p>- Monitoring.</p> <p>- Understanding water scarcity/security.</p> <p>- Application of principles from current investment to long term.</p> <p>- Ground truthing models.</p> <p>- Integrating modelling of natural, social and engineered systems.</p>	<p>water cycle programme, adapt to shorter time scale implications, create new knowledge of other drivers e.g. Population, economics</p>			
<p>Enablers</p> <ul style="list-style-type: none"> -Partnership programmes/multi-disciplinary investment and innovation. * Needs best examples widely circulated. - Governance models, - NGO's * Regulation to require providers to stop supply systems leakage. * Better application of existing evidence in UK/Europe. 	<p>Barriers</p> <ul style="list-style-type: none"> - Language - Communication. - Leadership. - Regional capacity/capability (developing countries). - Sharing of data/security issues 			

Challenge:
(g) Endemic and invasive organisms/species

Team	LG	MW
	RC	

Challenge Description:
 Pest and disease risks / burdens are changing:
 - Changing agricultural practice (host demographics)
 - International trade, local movements.
 - Vector ecology and insect pests.
 * Spectrum of hosts plants and animals/fish.
 * Need to include climate change.

There is a priority Resources challenge:
 - Find out what is out there.
 - Effective surveillance and detection systems.
 - Understand drivers of disease/burdens/risks.

Key Responses & Decisions:

Knowledge, tools and foresight will enable us to:
 Do the above.

Outcome	Mitigate - More regulation (self regulation?). - More resilient farming methods.	Adapt to Change husbandry practices, use resilient animals/plants. *Need to adapt as changes can't be stopped.	Benefit from Local production, rapid detection and response.
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<p>Need for knowledge, Tools & Foresight Find out what is out there. Base line distributions and burdens. * Economic impact of disease burden and link to sustainability. * Herd health approaches to disease security. * Breeding for disease resistance. - Good surveillance systems/new ideas. (e.g. remote sensing). - Diagnostic/identification tools (rapid, easy and cheap). - Forecasting future changes in risk/burdens; understanding drivers. - assess and identify future threats to prepare e.g. Invasive shrimp * Damage costs? * At what point do we go from control to adaptation? * Rapid response capacity - Flexibility in resource is needed. * Utilise existing knowledge. - DEFRA and OPAL run a web site and group to identify and increasing public engagement for invasive species.</p>	Apply	Adapt	Create
	YYYY	YY	YYY

Open questions and input required from group:
 - Agree that plant and animal diseases not covered by other LWEC activities.
 * Three people agree with this!
 - Thoughts on invasive organisms?

<p>Enablers</p> <ul style="list-style-type: none"> - Good records for livestock - Priority given to animal welfare. -Heightened political profile for forest and trees. * short of enablers! * Inter-government cooperation and planning for outbreaks. * Good records for invasive plant species through BRC & CS & DAISIE projects. Animals also covered. Talk to CEH for info. 	<p>Barriers</p> <ul style="list-style-type: none"> - Non-uniform approach to plants and their diseases. - Attitudes to exotic vs. endemic diseases. - Free trade, poor border controls. - Poor records for plant and trees. - Mixed attitudes to bio-security. * Lack of risk and contingency plans with a joined up UK approach. ** This is true for plants, but not livestock. 	

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Challenge:
(h) Achieving public engagement/changed behaviour.

Team	PB	KB
	AV	

Challenge Description:
 Improve the public understanding of the value of natural resources to encourage sustainable resource use.
 * People don't understand the link between production and use or availability of resources.

There is a priority Resources challenge:
 - Improve understanding of true value of natural resource.
 * Promote ecosystem benefits. Relevance will be key.
 * Also waste and agriculture divorced living from resource use.

Key Responses & Decisions:

Outcome	Mitigate - Education schemes schools, community programmes, localism, manufacturing/suppliers innovation (driven by regulation) e.g. move to brown water in homes and give away bottled water. *Suppliers include retailers.	Adapt to - Society adapts to efficient resource use through behaviour change. e.g. shopping, fuel use and diet, etc.	Benefit from - Reduction in waste, more efficient use of natural resources, ecosystem benefits, health benefits; e.g. economic benefits to retailers/suppliers. e.g. using less packaging increases profits.
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Knowledge, tools and foresight will enable us to:
 - Educate on sustainable resource use.
 - Reduce resource waste (food, water, etc) and over-use. - Understanding impact / consequences of continued non-sustainable use of resources.
 - Promote personal responsibility.

Need for knowledge, Tools & Foresight - Knowledge about the cost of production of different resources. Modelling cost of status quo consequences/impact (required base line data). - Translate information for public education. - Transparency of costs and inputs for food production, water supply, food, etc. - Knowledge of behaviour - current and changes in future. * Public engagement exploring different/innovative approaches to public engagement. * Role of social responsibility and consumer confidence as drivers. * What drives different values / behaviours in different segmentations? * Understanding consumer behaviours/insights. What makes	Apply	Adapt	Create
	YYY	YYY	YYY

Open questions and input required from group:

people change?

* Explore choice editing and eco-labels.

* Need to understand socio-cultural barriers to change. Logical, rational evidence are not enough.

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Enablers

- Expert volunteers * Link to expert volunteers in rivers, trusts.
- Industry/government open data sharing.
- Governmental priority/regulation.
- Social peer pressure.
- Cost of goods reflecting resource input.

Barriers

- Data format not appropriate for public education or for modelling. Public don't want to change. Public can't afford to change.
- * Existing vested interests need to know why people engage in current behaviour.
- * Mixed and changing messages.
- * Communication in media based on new studies, not the systematic review approach which would stop the media 'setting hare's running'. E.g. 'Bad science' - See Ben Goldacre's new study on reviewing basis of science articles in one week of news.

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ANNEX E: Workshop Participants

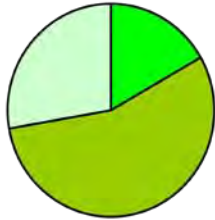
Roobina Baloch	Syngenta
Konrad Bishop	Department of Environment, Food and Rural Affairs
Andy Challinor	University of Leeds
Roger Coppock	Forestry Commission
Iain Donnison	University of Aberystwyth - Institute of Biological, Environmental and Rural Sciences
Bridget Emmett	Centre for Ecology and Hydrology, NERC
Murray Gardner	Natural Environment Research Council
Tom Gill	Promar International
Sarah Gledhill	Scottish Government
Laura Green	University of Warwick
David Harley	Scottish Environmental Protection Agency
Brian Harris	Biotechnology and Biological Sciences Research Council
Peter Jones	Ecolateral Ltd
Trudi Keene	Economic and Social Research Council
Pamela Kempton	Natural Environment Research Council
Graham Leeks	Centre for Ecology and Hydrology, NERC
Peter Maddox	WRAP - Waste and Resources Action Programme
Nigel Mortimer	North Energy
Alessandro Moscuza	Department for International Development
Dan Osborn	Natural Environment Research Council
Nina Prichard	Welsh Assembly Government
Martin Ross	South West Water
Ian Shield	Rothamsted Research
Alan Tollervey	Department for International Development
Amber Vater	UK-Environmental Observation Framework - LWEC
Chris Warkup	Biosciences Knowledge Transfer Network
John Whittall	Technology Strategy Board
Mark Woolhouse	University of Edinburgh
Catherine Wright	Environment Agency
Daniel Yeo	WaterAid

Secretariat

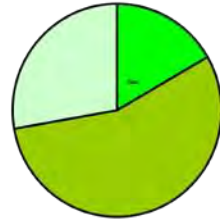
Mary Barkham	Living With Environmental Change
Sam Austin	Living With Environmental Change
Jef Grainger	Biotechnology and Biological Sciences Research Council
Dominic Oughton	Institute for Manufacturing, University of Cambridge

ANNEX F: Participant questionnaire results

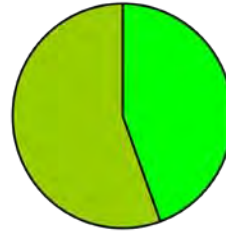
Joining instructions and pre-workshop information



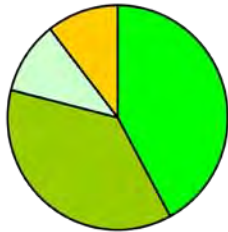
Opening remarks and introduction to the workshop



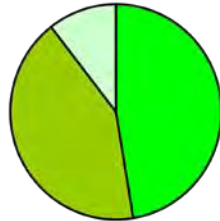
Facilitation of the workshop



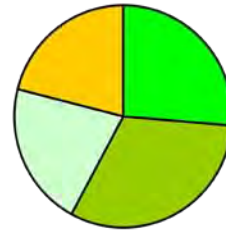
Structure / process of the workshop



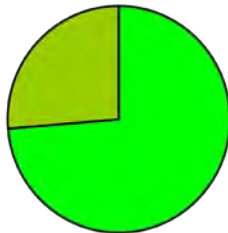
Opportunity to participate and contribute



Make-up of workshop participants



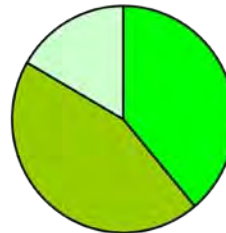
Time keeping



Catering



Venue



96% Excellent, Very Good or Good

I found the workshop stimulating



I enjoyed the workshop



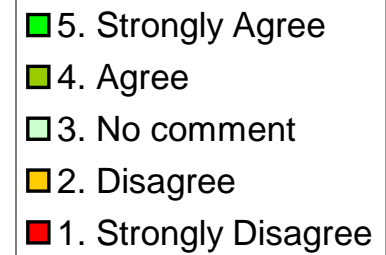
I found my participation worthwhile



I feel I have contributed to the workshop



The workshop provides useful insights



90% Strongly Agree,
Or Agree

About Living with Environmental Change (LWEC)

LWEC is an influential partnership of 22 public sector organisations that invest money for UK taxpayers to reach “solutions” to urgent challenges and realise opportunities that environmental change can bring.

LWEC partners, can pool resources to develop a “whole systems” approach to research. For instance, bringing together different types of expertise to discover how to preserve the health of the insects we need to pollinate our crops, or collaborating to create the best conditions for commercial innovation in for example, low carbon vehicles.

For more information about LWEC please visit: www.lwec.org.uk



In collaboration with:

