



# Developing a Strategic Framework for the Ecosystems challenge

## Workshop Report

11<sup>th</sup> March 2011, 10:00 to 16:30hrs

Charles Darwin House Conference Centre, 12 Roger Street, London, WC1N 2JU

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# 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 ecosystems 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 biological 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 ecosystems challenge strategic framework was initiated by a roadmapping workshop held on 11<sup>th</sup> March. This document is an accurate representation of the discussion at the workshop and is by no means a fixed set of outcomes.

## 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 Ecosystems Challenge

**Strapline: to manage ecosystem services for human well-being and to protect the natural environment in a changing world**

**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

At each layer of the roadmap the workshop participants prioritised the most important items through a voting scheme, as follows:

**Drivers:** which drivers will be most important in determining the future challenges for Ecosystems.

**Challenges:** in response to these most important drivers, which Ecosystems challenges are likely to have the biggest impact in terms of People, Planet & Profit.

**Knowledge, Tools & Foresight:** what K, T & F will be required to inform decisions and policy to support adaptation, mitigation and benefit from these high impact challenges.

For the Ecosystems challenge the workshop participants identified the top ten key drivers listed below. See annex A and B for more detail.

1. Global population peaks at ~ 10 billion before 2100
2. Water and food security
3. Extreme events and sea level rise
4. Land and water use
5. Behaviour change
6. Globalisation
7. 2015 peak global oil and gas production and energy scarcity
8. Social / Political choice
9. Societal response to climate change and the unforeseen consequences
10. Emerging new technologies e.g. nano-, bio- and information technology

These drivers will lead to a number of specific challenges for ecosystems in the future. Twelve of these were considered in some detail (Annex C). Each of these challenges relates to one or more of the priority Drivers, and these linkages are indicated in the landscape linkages (Annex B):

1. **Provision of food (and energy) including at the expense of other ecosystem services:** understanding trade-offs between provisioning and other ecosystem services. If provisioning services are prioritised, what are the consequences of focussing exclusively on food and energy? How can we achieve the level of provision we want while mitigating or reducing tradeoffs
2. **Unforeseen consequences (of societal choices):** the outcome from policy, technology implementation as a consequence of putting a boundary of a complex system or thinking in a linear or simplistic way; and the choices that the public make and the consequences of not understanding the impacts that this has.
3. **Ecosystem fragmentation:** carrying capacity through reduced area and isolation of ecosystems due to fragmentation combines to reduce resilience of biodiversity to change.
4. **Land trade-offs and impacts:** assessing and managing trade-offs and impacts at scales from local to global
5. **Resilience of ecosystems to FAST change:** identify vulnerabilities, including, why are some ecosystems more vulnerable? what are the consequences of vulnerability? and should we respond to this, and if so how?
6. **Tipping points/ irreversible changes:** environmental change drives ecosystem changes to novel, irreversible or threshold states e.g. 1) Trophic collapse 2) Greenland ice melt
7. **Biodiversity loss:** halt or reverse biodiversity loss

8. **Extreme events (droughts):** including low flow impacts on ecosystems and soil moisture impacts
9. **Habitat loss and adaptation to climate change:** most UK habitats are susceptible to climate change
10. **Invasive organisms/species and bio-security:** prevent, mitigate and adapt to increases in invasive species in ecosystems under climate change and globalisation
11. **Water scarcity:** availability and equitable access to water that meets needs of society and key ecosystem functions
12. **Ocean warming and acidification:** major changes to marine ecosystems (and the services they provide) on a global basis

In order to deliver these challenges the following knowledge, tools and foresight were identified:

1. Data interoperability and management
2. Decision support tools, management and reporting
3. Ecosystem based management (including species movement & experiments to inform management)
4. Ecosystems and sustainable economy (including valuation)
5. Improved modelling and forecasting (including systems modelling)
6. Improved monitoring and observations
7. Links between local and global environmental change

### 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 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.









# ANNEX A: Landscape Summary

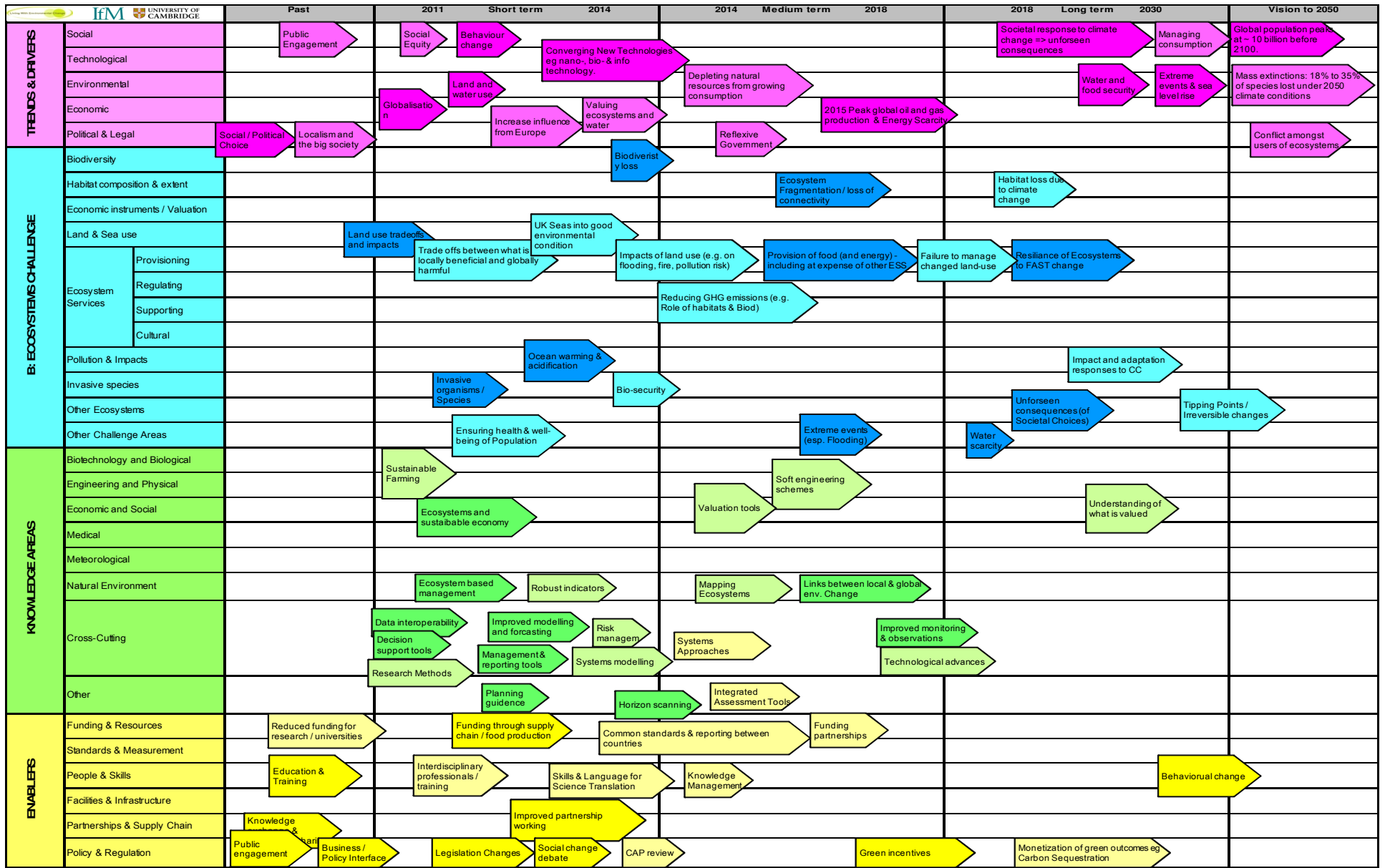
## Annex A Key

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

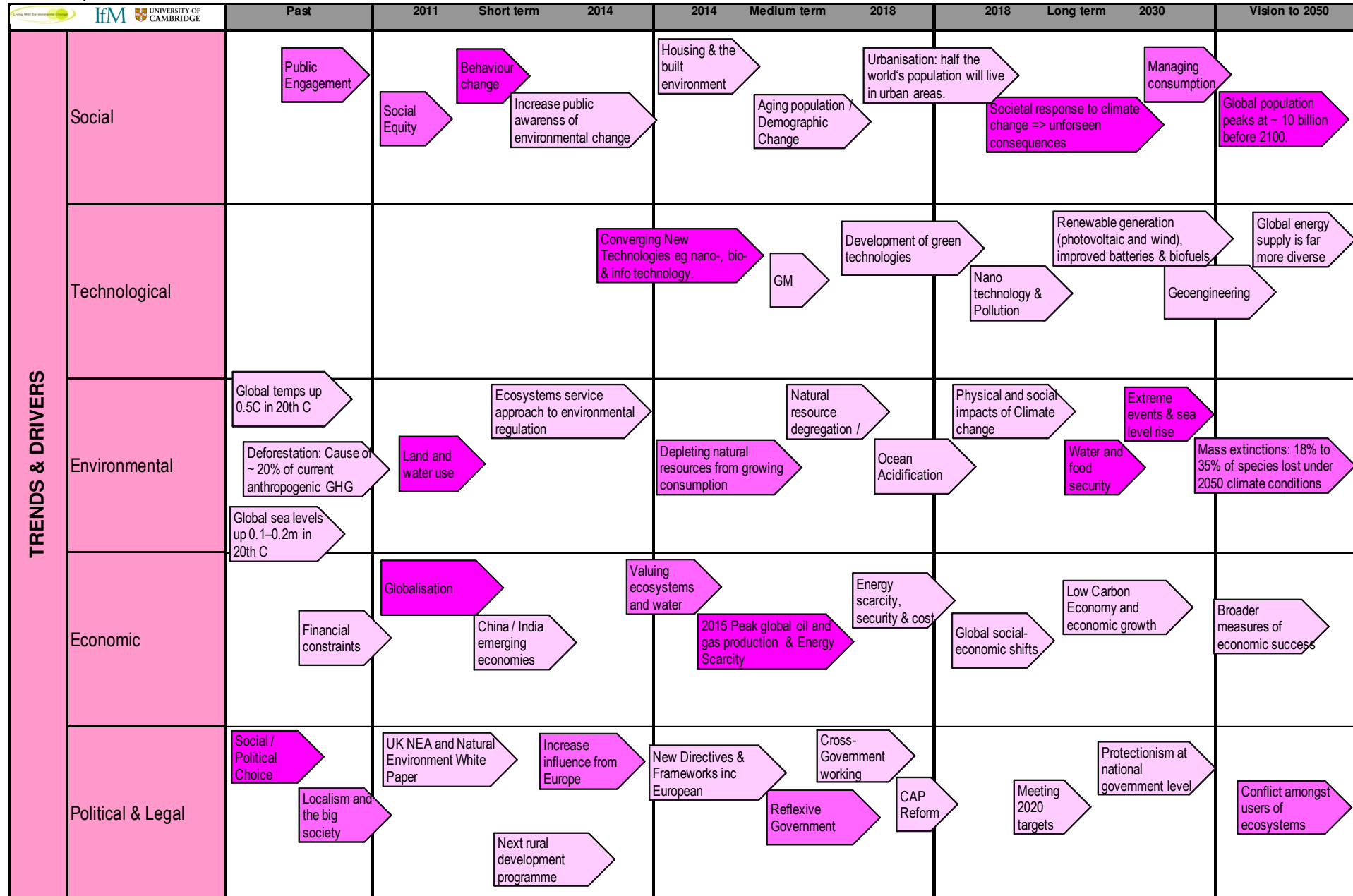
- Trends & Drivers
- Challenges
- Knowledge, Tools & Foresight
- and Enablers.

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.

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




# Landscape Detail



		Past	2011	Short term	2014	2014	Medium term	2018	2018	Long term	2030	Vision to 2050	
<b>B: ECOSYSTEMS CHALLENGE</b>	Biodiversity				Biodiversity loss								
	Habitat composition & extent						Ecosystem Fragmentation / loss of connectivity		Habitat loss due to climate change		Quantifying ecosystem change		
	Economic instruments / Valuation			Resource equity					Systems approach to valuation				
	Land & Sea use		Land use tradeoffs and impacts	UK Seas into good environmental condition	Protecting our Soils			Integrated approach to land management (see "land use trade offs and impacts")					
	Ecosystem Services	Provisioning		Trade offs between what is locally beneficial and globally harmful	Impacts of land use (e.g. on flooding, fire, pollution risk)			Provision of food (and energy) - including at expense of other ESS		Failure to manage changed land-use		Resilience of Ecosystems to FAST change	
		Regulating		Practical use of ecosystems services				Reducing GHG emissions (e.g. Role of habitats & Biod)					tradeoffs in ecosystem services
		Supporting			Nutrient cycling & ESS								
		Cultural					Multifunctional landscapes						
	Pollution & Impacts			Ocean warming & acidification						Impact and adaptation responses to CC			
	Invasive species		Invasive organisms /	Bio-security				New threats					
Other Ecosystems					Risk management			Unforeseen consequences (of Societal Choices)		Tipping Points / Irreversible changes			
Other Challenge Areas		Ensuring health & well-being of Population		Societal outreach and knowledge exchange		Extreme events (esp. Flooding)		Water scarcity					

IfM UNIVERSITY OF CAMBRIDGE		Past	2011	Short term	2014	2014	Medium term	2018	2018	Long term	2030	Vision to 2050
KNOWLEDGE AREAS	Biotechnology and Biological			Sustainable Farming						New remediation techniques		
	Engineering and Physical			Improved Earth Observation	Enhanced Remote Sensing		Soft engineering schemes			Geoengineering		
	Economic and Social			Ecosystems and sustainable economy (inc			Valuation tools		Natural Capital / Green Accounting		Understanding of what is valued	
	Medical				Predicting emerging diseases							
	Meteorological						Improved (seasonal) forecasting approaches					
	Natural Environment			Ecosystem based management (inc spp		Catchment Management		Links between local & global env. Change			Dynamic risk based conservation.	
					Robust indicators		Mapping Ecosystems Services		Modelling tools for predictive ecology			
Cross-Cutting			Data interoperability and management	Improved modelling and forecasting (inc		Risk manageme		Improved monitoring & observations				
			Decision support tools,	Systems modelling		Systems Approaches						
			Research Methods	Systems modelling				Technological advances				
Other				Planning Guidance			Horizon Scanning	Integrated Assessment Tools				

		Past	2011	Short term	2014	2014	Medium term	2018	2018	Long term	2030	Vision to 2050
<b>ENABLERS</b>	Funding & Resources	Reduced funding for research / universities		Funding through supply chain / food production			Funding partnerships					
	Standards & Measurement		(Standards) INSPIRE compliance		Common standards & reporting between countries							
	People & Skills	Education & Training		Interdisciplinary professionals / training	Skills & Language for Science Translation		Knowledge Management	Skills shortages eg Taxonomists, hydrologists, mycologists & environmental economists		LCA thinking and skills		Behavioral change
	Facilities & Infrastructure											
	Partnerships & Supply Chain	Knowledge exchange & information sharing			Improved partnership working							
	Policy & Regulation	Public engagement	Business / Policy Interface	Big Society	Legislation Changes	Social change debate	CAP review	Planning regulations & processes	Green incentives		Monetization of green outcomes eg Carbon Sequestration	

## **ANNEX B: 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 C: Mini-business cases and elevator speeches

Challenges and Opportunities were reviewed for their impact on the basis of a “balanced scorecard” of measure – on “People” (society), “Planet” (environmental) and “Profit” (financial / economic), and also for the likelihood of these impacts coming to pass. The attached score-sheet was used as the basis of this characterisation – though it should be understood that any such assessment is very much indicative rather than quantitative.

	Impact			Likelihood
	People	Planet	Profit	
0	Limited or no Impact	Limited or no Impact	Limited or no Impact	Less than 1%
- 2	Potential impact on quality of life of local populations or groups	Potential impact on localised ecosystems or habitats	Annual costs (in mitigation or recovery) of £millions	1% to 5%
- 4	Potential injuries or health risks or significant impact on quality of life to localised groups	Some impact on regional or local ecosystems, potential threats to health of some species or localised habitats	Annual costs (in mitigation or recovery) of £10s millions	5% to 10%
- 6	Potential fatalities or serious injury or significant impact on quality of life of regional / local populations or groups	Significant impact on regional or local ecosystems, potential threats to viability of some species or localised habitats	Annual costs (in mitigation or recovery) of £100s millions	10% to 20%
- 8	Numerous fatalities or significant impact on quality of life of whole population	Significant impact on national ecosystem, threats to viability of key species or significant loss of key habitats	Annual costs (in mitigation or recovery) of £billions	20% to 50%
- 10	Hundreds of fatalities or major impact on quality of life of whole population	Catastrophic impact on national ecosystem, species extinctions or major loss of key habitats	Annual costs (in mitigation or recovery) of £10s billions	>50%

Note – Whilst the default scoring assumes that Challenges carry a range of adverse / negative impacts, a positive score can be used to indicate a benefit eg +6 for Profit would indicate opportunities to generate revenues of £100m

**Challenge: Water Scarcity**

<b>Team</b>	CS	MB
	OD	

**Challenge Description:** Availability and equitable access to water that meets needs of society and key ecosystem functions

**Likelihood:**  
10 (>50%)

<b>Impact</b>	<b>People</b> -4 (global -10)	<b>Planet</b> -8 (global -10)	<b>Profit</b> -6 (opportunity for re-engineering +4)
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**Key Responses & Decisions:** New Policy Direction Water for All

<b>Outcome</b>	<b>Mitigate</b> √ Reduce consumption	<b>Adapt to</b> √ managing conflict	<b>Benefit from</b> re-engineered water consumption processes
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<b>Need for knowledge, Tools &amp; Foresight</b> - Water dependence of ecosystem functions (& species limits) - How much water does a wetland need? (for minimum sustainability) - Operational planning tool for safeguarding wetland ecosystems from water scarcity (long-term horizons) - Big picture future proofing strategy at landscape/development scale - International framework for cooperative and common standards	<b>Apply</b>	<b>Adapt</b>	<b>Create</b>
	X	√	√
	X	√	√
	√	√	X
	X	√	√
X	√	√	

<b>Enablers</b> - Regulatory tools to drive behavioural change (business and public) - Community buy-in - Clear evidence base	<b>Barriers</b> - Understanding needs (desires) - Extreme events will drive instant, local response - Lack of recognition of cost and value of water
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**There is a priority Environmental challenge:**  
See Challenge description and impact

**Environmental knowledge will enable us to:**  
- Produce the biological, hydrological and social science bases to identify potential environmental and socio-economic stress points  
- Tools development to value and allocate water between potentially competing present and future ecosystem services.

**Validation / next steps**  
Is there an accepted method for identifying and allocating water resource between ecosystem services?

**Challenge:** Unforeseen Consequences (of Societal Choices)

<b>Team</b>	MV	KL
	BH	JW

**Challenge Description:**\* Outcome of policy/ technology implementation  
 - as a consequence of putting a boundary of a complex system  
 - or thinking in a linear or simplistic way

**Likelihood:**  
 10 (pretty much a cert)

<b>Impact</b>	<b>People</b> 0 to -10	<b>Planet</b> 0 to -10	<b>Profit</b> 0 to -10!

**Key Responses & Decisions:** Methods to encourage adaptive management, learning processes, holistic approaches - accepting that uncertainty will always be there

<b>Outcome</b>	<b>Mitigate</b>	<b>Adapt to</b> √	<b>Benefit from</b> √

<b>Need for knowledge, Tools &amp; Foresight</b> - Create space/ opportunity for dialogue, reflection outside of normal silos - More participatory approaches (planning etc). Including 3rd sector etc, end-users throughout - Action research processes - Experiment for learning purpose (taking small steps, testing, learning lessons)	<b>Apply</b>	<b>Adapt</b>	<b>Create</b>
	X	X	√
	X	√	X
	X	√	X
	X	X	√

<b>Enablers</b> - Programmes that specify on real innovative and multidisc working - RCs working with R&D bodies on real-world problems	<b>Barriers</b> - Inertia of funding systems, which are made worse in current climate - Perception of token activity in this area, good to secure a grant, but does not happen in practice
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**There is a priority Environmental challenge:**  
 Outcome of policy/ technology implementation is different to design. E.g. bio fuels- leading land use pressure, water pressures, deforestation etc

**Environmental knowledge will enable us to:**  
 Develop and inform methods to encourage adaptive management, learning processes, accepting that uncertainty will always be there.

**Validation / next steps**  
 - Evidence of the benefits of new ways of working- case studies (perhaps international)  
 - Communication challenge for established, highly specialised professionals e.g. GPs, Engineers, Finance etc

\*This description is was discussed with this definition within this group but this challenge can also include the choices that the public make and the consequences of not understanding the impacts that this has.

**Challenge: Tipping Points/ Irreversible Changes**

<b>Team</b>	TD	GM
	SB	

<b>Challenge Description:</b> Environmental change drives ecosystem changes to novel, irreversible or threshold states e.g. 1) Trophic collapse 2) Greenland ice melt (limits)		<b>Likelihood:</b> 1) High 2) Medium		
<b>Impact</b>	<b>People</b> 1) -6 2) -10	<b>Planet</b> 1) -8 2) -10	<b>Profit</b> 1) -6 2) -10	
	<b>Key Responses &amp; Decisions:</b> 1) Management intervention for resilience ahead of tipping point 2) Emissions reductions or geoengineering			
<b>Outcome</b>	<b>Mitigate</b> 1) √ √ 2) √ √ √	<b>Adapt to</b> 1) √	<b>Benefit from</b> 1) ?	
	<b>Need for knowledge, Tools &amp; Foresight</b> 1) Understand system dynamics and build predictive tools 2) Better social behaviour - carbon-free energy provision - direct and indirect consequences of geoengineering		<b>Apply</b> X	<b>Adapt</b> √
<b>Enablers</b> 1) Control and Jurisdiction 2) National and international policy		<b>Barriers</b> National economic interests		

<b>There is a priority Environmental challenge:</b> Identify tipping points
<b>Environmental knowledge will enable us to:</b> Avoid catastrophic collapse
<b>Validation / next steps</b> - Develop a risk register - Risk management tools

**Challenge:** Resilience of Ecosystems to FAST change

<b>Team</b>	RF	PC
	JGF	

<b>Challenge Description:</b> Identify vulnerabilities: Why are some ecosystems more vulnerable? What are the consequences of vulnerability? Should we respond to this, and if so how?		<b>Likelihood:</b> -10 High e.g. trees and climate change. Moorlands and nitrogen, changing agricultural land use		
<b>Impact</b>	<b>People</b> -4	<b>Planet</b> -9	<b>Profit</b> -6	
	<b>Key Responses &amp; Decisions:</b> - Fund research - Counteract the drivers - Change ecosystems to build their resilience - Adaptive management - Improve connectivity			
<b>Outcome</b>	<b>Mitigate</b> √	<b>Adapt to</b> √ √	<b>Benefit from</b> √ (look for opportunities)	
	<b>Need for knowledge, Tools &amp; Foresight</b> - Refer to challenge description to inform research priorities - Develop adaptive management tools to assist practitioners		<b>Apply</b> √ √ √ √	<b>Adapt</b> √ X
<b>Enablers</b> - Making practitioners aware - Plain English - Being able to detect change locally and over long periods		<b>Barriers</b> - Some causes are intractable and outside control of local actors. By time change is detected its too late. - Ownership issues.		

<b>There is a priority Environmental challenge:</b> We risk losing valuable ecosystems (before we are aware of it) because of rapid* environmental change * rapid+ decadal timescales (which is not perceived as rapid by many people)
<b>Environmental knowledge will enable us to:</b> - Detect change earlier - Suggest what we might do to slow the change or respond - raise public awareness of the cost of changes and the need to respond - Improve techniques of adaptive management
<b>Validation / next steps</b> - Describe existing situations using these resilience concepts, develop the stories. - Identify and map other vulnerabilities and risks - Quantify economic consequences

**Challenge: Ecosystem Fragmentation**

<b>Team</b>	JM	JH
	AC	

**Challenge Description:** Carrying capacity through reduced area and isolation due to fragmentation combine to reduce resilience of biodiversity to change (recovery, defence against invasive, edge effect of climate)

**Likelihood:**  
Dead cert 10

<b>Impact</b>	<b>People</b> (-2) to (-8) depending on area of globe and reliance on ecosystems	<b>Planet</b> -8	<b>Profit</b> ? What are losses associated with low efficiency ecosystem services
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**Key Responses & Decisions:**  
 - Implement Lawton  
 - Improve land management for protection of biodiversity and ecosystem services

<b>Outcome</b>	<b>Mitigate</b> √√	<b>Adapt to</b>	<b>Benefit from</b> √√
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<b>Need for knowledge, Tools &amp; Foresight</b> - Make better use of existing knowledge of species/ area relationships - Understand degree of existing fragmentation - Review evidence of impact of fragmentation on collective knowledge of population trends and dispersal - Research on ecology of edges - Implications of fragmentation on delivery of ecosystem services	<b>Apply</b>	<b>Adapt</b>	<b>Create</b>
	√√	√	X
	√√	√	X
	√	X	√√
	√	X	√√

<b>Enablers</b> - Production of guidance - Legislative change (corridors and site management) - Research funding	<b>Barriers</b> Perception of society of importance of issue, lack of clear story
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**There is a priority Environmental challenge:**  
 - Decrease existing fragmentation  
 - Prevent further fragmentation  
 - Increase connectivity  
 - Identify priority areas for action

**Environmental knowledge will enable us to:**  
 - Demonstrate there is an issue  
 - Improve land management conserve biodiversity at landscape scale  
 - Demonstrate improved delivery of ecosystem services following reduction of fragmentation.

**Validation / next steps**  
 - Economic benefits  
 - Societal benefits  
 - Relationship to other challenges related to land/ water use

**Challenge: Biodiversity Loss**

<b>Team</b>	DM	MB
	RH	MK

<b>Challenge Description:</b> Halt or reverse biodiversity loss		<b>Likelihood:</b> Its happening		
<b>Impact</b>	<b>People</b> -10	<b>Planet</b> -10	<b>Profit</b> -10 (Constanza <i>et al</i> )	
	<b>Key Responses &amp; Decisions:</b> Policy formulation, review, implementation			
<b>Outcome</b>	<b>Mitigate</b> √	<b>Adapt to</b> √	<b>Benefit from</b> √	
	<b>Need for knowledge, Tools &amp; Foresight</b> - Whats there? - Is it changing? - What shall we measure and why, where and how often? - Indicators, proxies, generalisation - Understanding drivers/ pressures - Are existing policies/ instruments fit for purpose?		<b>Apply</b>	<b>Adapt</b>
<b>Enablers</b> Forecasts/ early warning systems, long term data		<b>Barriers</b> - Explaining reason for importance of biodiversity - Language and definition		

<b>There is a priority Environmental challenge:</b> To retain to use the ecosystem services concept to bring more people on board with conservation.
<b>Environmental knowledge will enable us to:</b> To communicate what biodiversity does for us and how to manage it sustainably.
<b>Validation / next steps</b> - Understand links between biodiversity and ecosystem function - Create/ preserve appropriate monitoring systems - Engage everybody

**Challenge:** Provision of food (and energy) including at the expense of other ecosystem services

<b>Team</b>	MR	DH
	GP	PM

<b>Challenge Description:</b> - Understanding trade-offs between provisioning and other ESS if we prioritise provisioning services, what are the consequences of focussing exclusively on food and energy? - How can we achieve the level of provision we want while mitigating or reducing tradeoffs		<b>Likelihood:</b> High - it is happening already		
<b>Impact</b>	<b>People</b> -2 (in the short term, higher in the long term)	<b>Planet</b> -10	<b>Profit</b> 0 (short term) to -10 (long term, especially if ESS are monetised)	
	<b>Key Responses &amp; Decisions:</b> - Inform and build on sustainable food strategies to show how we can provide food and energy without compromising other ESS - Provision of public (and private) finance for non-provisioning ESS			
<b>Outcome</b>	<b>Mitigate</b> - balance between self-sufficiency vs food security - value all ESS and explicitly consider trade-offs in decisions	<b>Adapt to</b> - adapt food systems to multiple future pressures (e.g. climate change, oil prices)	<b>Benefit from</b> - more resilient agro-ecosystems - broader range of ESS delivered over long-term	
	<b>Need for knowledge, Tools &amp; Foresight</b> - ESS values - Altered incentives - ESS modelling and mapping scenarios			<b>Apply</b> √ X √
<b>Enablers</b> - Realign agri-environment schemes or green pillar I of CAP to subsidise provision of ESS and retrain competitiveness - P.E.S / Big Society			<b>Barriers</b> - Decreased competitiveness of UK agriculture - Behavioural Change: persuading shoppers to buy sustainably produced UK food	

<b>There is a priority Environmental challenge:</b> Delivering more food in the future, cost-effectively, without compromising other priority ecosystem services . There is a balance between - national self-sufficiency in food versus global food security that requires difficult ethical decision to be made, e.g. regarding equity - Short-term benefits versus long-term sustainability / resilience
<b>Environmental knowledge will enable us to:</b> - Prioritise management / provision of ESS over space and time - Make trade-offs between ESS in the decision making process: make informed choices about which trade-offs to accept - Target financial incentives to provide priority ESS - Facilitate P.E.S schemes that avoid unintended consequences
<b>Validation / next steps</b> Identify regulatory and policy barriers and ways to overcome these.

**Challenge:** Ocean warming and acidification

<b>Team</b>	PW	AS
	MB	SK

**Challenge Description:** Major changes to marine ecosystems (and the services they provide) on a global basis

**Likelihood:**  
Inevitable - 100%

<b>Impact</b>	<b>People</b> -6 (depends on time scale)	<b>Planet</b> -7	<b>Profit</b> -4 (UK) -8 (global)
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**Key Responses & Decisions:**  
 - Improve knowledge of ecosystems response  
 - Finding alternative to marine resource protein  
 - Maintain and improve marine observations (pH, GHG fluxes, plankton and benthic biodiversity)

<b>Outcome</b>	<b>Mitigate</b> GHG emission reduction (Geo-engineering but not solar radiation management)	<b>Adapt to</b> Improve fishery management	<b>Benefit from</b> Oceans might become more productive (e.g. Arctic)
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<b>Need for knowledge, Tools &amp; Foresight</b> - Multiple pressures (over exploitation as well as env. change) - Scaling up species / communities / ecosystems to ecosystem services - Implications for biodiversity and adaptation - Improved technologies (inc. remote sensing, AUVs, lab on a chip sequencing, image processing) - Integrated effort in long-term monitoring	<b>Apply</b>	<b>Adapt</b>	<b>Create</b>
	√	X	√
	X	X	√
	√	X	√
	√	√	√
√	X	X	

<b>Enablers</b> - UK role at European and global level - High energy costs - Greater public awareness and understanding	<b>Barriers</b> - Funding constraints for long-term monitoring - Behavioural changes in emissions reduction
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**There is a priority Environmental challenge:**  
 We take the services provided by the ocean for granted - but they will never be the same again

**Environmental knowledge will enable us to:**  
 Avoid and minimise the impacts and reduce uncertainties through modelling

**Validation / next steps**  
 Long-term monitoring, national/international coordination of research effort, monitoring and assessment. Global problems need a global approach

**Challenge:** Land trade-offs and impacts

<b>Team</b>	PK	CR
	TB	KN

<b>Challenge Description:</b> Assessing and managing trade-offs and impacts at scales from local to global		<b>Likelihood:</b> 10+		
<b>Impact</b>	<b>People</b> -10	<b>Planet</b> -10	<b>Profit</b> -10	
	<b>Key Responses &amp; Decisions:</b> Optimal land use in the right policy framework			
<b>Outcome</b>	<b>Mitigate</b> Develop green agriculture and alternative technologies for land uses	<b>Adapt to</b> Behavioural change (e.g. smaller footprint)	<b>Benefit from</b>	
	<b>Need for knowledge, Tools &amp; Foresight</b> - Tools to get data (e.g. EO, models) - Knowledge of ecosystem services in relation to land use - Understanding of costs and benefits - Behaviour and policy change - Greater ability to predict local and global demand		<b>Apply</b>	<b>Adapt</b>
<b>Enablers</b> Policy, legislation and public understanding		<b>Barriers</b> CAP, Public lack of understanding, local focus, trade agreements, funding constraints - interdisciplinary silos		

<p><b>There is a priority Environmental challenge:</b> Demand for land will reduce the totality of ecosystem service provision at local to global scales. How do we minimise the total impact (across services - responding in deferent ways) and across scales (local to global)</p>
<p><b>Environmental knowledge will enable us to:</b></p> <ul style="list-style-type: none"> <li>- Minimise trade-offs and negative impacts</li> <li>- Informs policy and potentially reduces inequality</li> <li>- Maximise conservation of ecosystem services</li> </ul>
<p><b>Validation / next steps</b></p> <ul style="list-style-type: none"> <li>- Global governance of food</li> <li>- Predicting demand</li> <li>- Measuring value of semi-natural land (and cost of conversion)</li> </ul>

**Challenge:** Invasive organisms/species and bio-security

<b>Team</b>	ST	PW
	DC	LY

<b>Challenge Description:</b> Prevent, mitigate and adapt to increases in invasive species in ecosystems under climate change and globalisation		<b>Likelihood:</b> 10		
<b>Impact</b>	<b>People</b> -8	<b>Planet</b> -10	<b>Profit</b> -10 (already at -8)	
	<b>Key Responses &amp; Decisions:</b> <ul style="list-style-type: none"> <li>- Risk assessment</li> <li>- Monitoring and surveillance</li> <li>- Eradication/ containment plans</li> <li>- Strategic assessments</li> <li>- Appropriate trade restrictions</li> </ul>			
<b>Outcome</b>	<b>Mitigate</b> √√√	<b>Adapt to</b> Last resort	<b>Benefit from</b> Personal / business, but outweighed by ecosystem damage	
	<b>Need for knowledge, Tools &amp; Foresight</b> <ul style="list-style-type: none"> <li>- Risk assessment</li> <li>- Public engagement</li> <li>- Which ecosystems are more susceptible and why?</li> <li>- Legislation: white list approach to planning and scale</li> <li>- Taxonomy (skill shortage)</li> <li>- Tools for evaluating impact</li> </ul>		<b>Apply</b>	<b>Adapt</b>
<b>Enablers</b> <ul style="list-style-type: none"> <li>- Reverse barriers</li> <li>- Increase public awareness</li> </ul>		<b>Barriers</b> <ul style="list-style-type: none"> <li>- Money and time - vast number of species</li> <li>- Trade</li> <li>- Current legislation not tight enough</li> <li>- Taxonomic skills shortage</li> </ul>		

<b>There is a priority Environmental challenge:</b> Impact of invasive species likely to increase with climate change
<b>Environmental knowledge will enable us to:</b> Prevent, slow and reduce impact and build understanding
<b>Validation / next steps</b> <ul style="list-style-type: none"> <li>- Strengthening legislation</li> <li>- Public engagement and behavioural change</li> <li>- Better labelling</li> </ul>

**Challenge:** Habitat loss and adaptation to climate change

<b>Team</b>	DS	SB
	MT	

<b>Challenge Description:</b> Most UK habitats are susceptible to climate change		<b>Likelihood:</b> >50%			
<b>Impact</b>	<b>People</b> heaths: -2 peat lands: -6 woodlands: -6 coastal: -6	<b>Planet</b> UK peat lands: -8 woodlands: -8 coastal: -8	<b>Profit</b> peat lands: -8 woodlands: -6 coastal: -8		
	<b>Key Responses &amp; Decisions:</b> For example: - peat lands: manage for wetness and restoration - woodlands: move to more diver and resilient woods lands, new "native" species - coastal: managed retreat				
<b>Outcome</b>	<b>Mitigate</b> √	<b>Adapt to</b> √√	<b>Benefit from</b> √ (e.g. increase in agriculture and forestry)		
	<b>Need for knowledge, Tools &amp; Foresight</b> Knowledge: impact of climate change on different habitats (building on COP, JNCC, IUCN initiatives ) - information on land use, land use change and carbon implications - GHG flux in peatlands - Water storage and flood risk management - Attaching value to habitats		<b>Apply</b> √	<b>Adapt</b> √	<b>Create</b> √
<b>Enablers</b> - Money - Education and communication - Peatland projects accounts for in carbon trading		<b>Barriers</b> - Current legislation: out modelled approach to habitat conservation - Conservation and conservatism: resistance to undoing past work			

<b>There is a priority Environmental challenge:</b> Making value judgements about which habitats to focus on
<b>Environmental knowledge will enable us to:</b> - Prioritise and focus adaptation - Develop mitigation measures
<b>Validation / next steps</b> Ground truth existing models and then develop adaptive models and strategies

**Challenge:** Extreme events (droughts)

<b>Team</b>	JW	CR
	AW	

<b>Challenge Description:</b> - Low flow impacts on ecosystems - Soil moisture impacts		<b>Likelihood:</b> >50%			
<b>Impact</b>	<b>People</b> -6 impact on water abstraction and supply. Impact on food	<b>Planet</b> -8 some loss of species; some mitigation	<b>Profit</b> -6 cost to farming, industry, communities and individuals at various scales		
	<b>Key Responses &amp; Decisions:</b> - Plan for better allocation of available water - Plan to regulate wetlands and SUDS - Adaptation in agricultural systems				
<b>Outcome</b>	<b>Mitigate</b>	<b>Adapt to</b> √	<b>Benefit from</b>		
	<b>Need for knowledge, Tools &amp; Foresight</b> - Patterns and characteristics of developing drought spatially and temporally (climate model improvements) - Rainfall run-off models at different scales - Scenarios and futures for ecosystems - Better lines, models and languages of communication with stakeholders			<b>Apply</b>	<b>Adapt</b>
<b>Enablers</b> - Communication to raise public awareness - We have the skills, resources needed for research		<b>Barriers</b> - Lack of high performance computers - Lack of holistic/systems perspective			

<b>There is a priority Environmental challenge:</b> - To understand major changes in ecosystem structure during and after drought - Loss of ecosystem services (water supply, food, recreation etc)
<b>Environmental knowledge will enable us to:</b> - Better protection and planning for developing drought (extreme event examples) - Make more cost-effective judgements on the management of water resources on managed ecosystems
<b>Validation / next steps</b> - Analysis from systems perspective - Community engagement to understand the problem and potential solutions - Identify end users

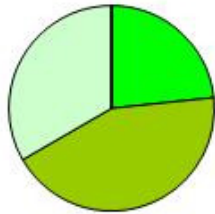
## ANNEX D: Workshop Participants

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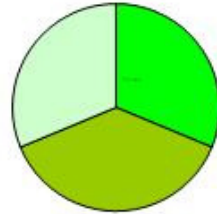
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## ANNEX E: Participant questionnaire results

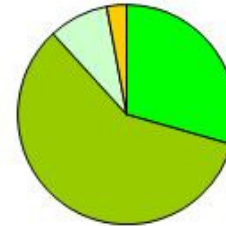
Joining instructions and pre-workshop information



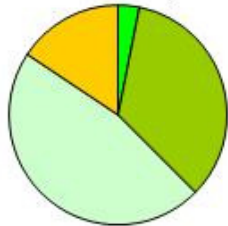
Opening remarks and introduction to the workshop



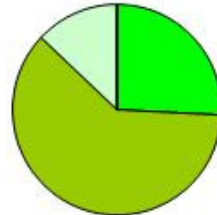
Facilitation of the workshop



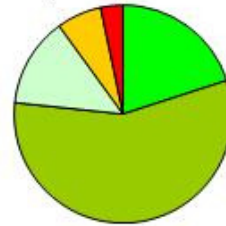
Structure / process of the workshop



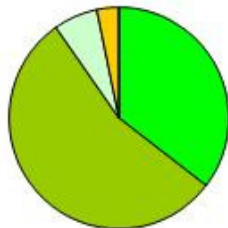
Opportunity to participate and contribute



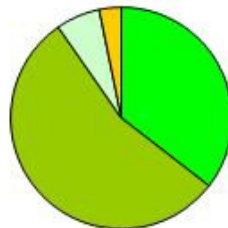
Make-up of workshop participants



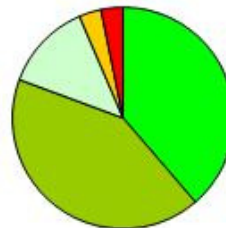
Time keeping



Catering

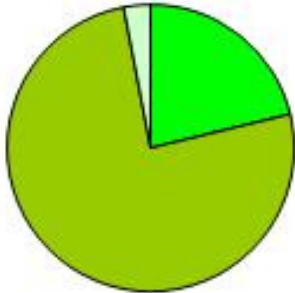


Venue

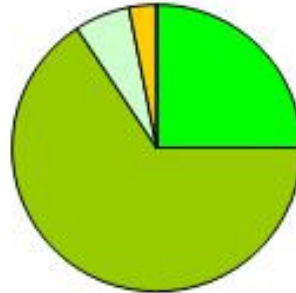


95% Excellent, Very Good or Good

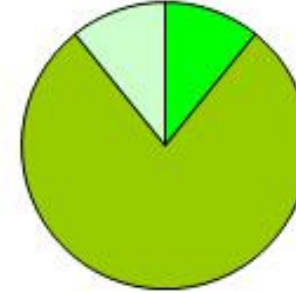
I found the workshop stimulating



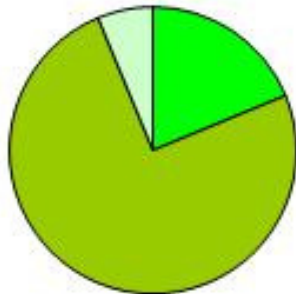
I enjoyed the workshop



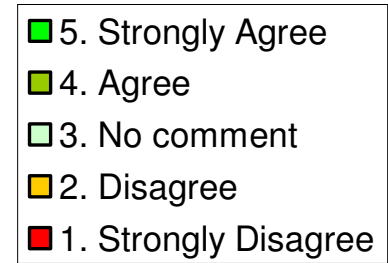
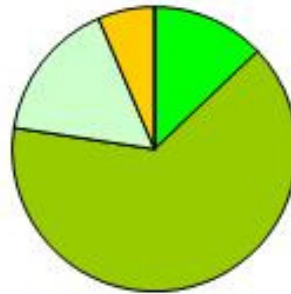
I found my participation worthwhile



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](http://www.lwec.org.uk)



In collaboration with:

