



Developing a Strategic Framework for the Climate challenge

Workshop Report

18th May 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 Climate Challenge is one.

- **Climate Challenge:** To understand the risks of climate change and assess options for avoiding or managing such risks
- **Ecosystems Challenge:** To ensure that decision-making takes full account of impacts on the natural environment and their consequences for ecosystem sustainability, human well-being, and economic prosperity.
- **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 LWEC’s Envirobase, a database of research and observations funded by partners and others). These frameworks will be implemented through the establishment of Challenge Steering Groups which include partners, business and representation from other stakeholders. The process for developing the climate challenge strategic framework was initiated by a roadmapping workshop held on 18th May 2011. This document is a record of the discussion at the workshop but is not meant to be a fixed set of outcomes.

1.2. Objective for the day

The objective for the day was *to understand the risks of climate change and assess options for avoiding or managing such risks*

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 these
- Resources

1.3. The LWEC Climate Challenge

Strapline: to understand the risks of climate change and assess options for avoiding or managing such risks

Challenge statement: The climate challenge aims to provide decision makers with the evidence they need to achieve effective mitigation of and adaptation and resilience to climate change, including preparedness for changes to the intensity and frequency of extreme events so that human health, wellbeing and a healthy natural environment are ensured through the use of sustainable and socially acceptable environmental management approaches and technologies.

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. The mix of participants, who attended the climate challenge workshop, was not as balanced as we would have liked, in that, for example, the Met. Office was not represented. We believe that this will have affected the outcomes of the workshop including the climate challenge priorities that emerged and we shall take this into account when developing the strategic framework for the climate challenge.

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 Climate challenges that a changing environment will bring.

Challenges: in response to these most important drivers, which Climate 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 Climate challenge the workshop participants identified the top ten key drivers listed below and the degree to which they were identified as being relevant to the priority challenges selected. See annexes A and B for more detail.

1. Physical and social impacts of climate change
2. Climate change/extreme events and sea level rise
3. Water and food security
4. Competing pressures on land use
5. Social division and civil unrest in UK/other parts of the world
6. Behavioural change
7. Carbon budgets and policy for decarbonisation
8. Increase public and government awareness of environmental change
9. Joined-up thinking including at a European/global level
10. Conflict amongst users of ecosystems

These drivers will lead to a number of specific climate challenges in the future. Eleven Climate Challenges were prioritised (see Annex B) and considered in some detail (Annex C):

1. **Ocean warming & acidification:** To monitor the change in the marine environment and understand/model spatial and temporal variation. Work in the terrestrial environment is further advanced.
2. **Understanding at higher/multispatial/temporal scale resolution:** Develop reliable authoritative predictive capability at smaller spatial / temporal scales in sustained / real time.
3. **Provision of food in a changing climate (also Resources challenge):** To forecast changing climate and responses of resources underpinning sustainable food production (including nutritional qualities) and to understand future supply and demand at UK and global level (including energy). To influence perception on and behaviour responses (including trade-offs between ecosystem services, food choice, GM) while minimising environmental impact. In order to achieve this, we must have an end-to-end climate impacts approach ie must link to 2 above (understanding at higher multispatial/temporal scale resolution). *Achieving food/water security in an environmentally sustainable way.
4. **Interactions between the carbon and nitrogen (and phosphorus?) cycles in a changing climate (see Resources challenge):** To understand the interactions between the carbon and nitrogen (and phosphorus?) cycles in a changing climate.

5. **(Predicting) Impact of mitigation & adaptation responses to climate change (including CCS):** Quantify the impact of mitigation and adaptation responses on CO₂; quantify the impact of these responses on non-CO₂ drivers; balance GHG reduction against wider costs and impacts; quantify (monetise) costs and benefits; identify winners and losers; quantify (monetise) the cost and effectiveness of adaptation.
6. **Role of natural carbon sinks (eg. forests/biota) in mitigating climate change:** To understand the role of natural carbon sinks (vegetation and soil) in mitigating climate change; and to develop the tools, policies and instruments to maintain and enhance them.
7. **Societal tipping points (and influence of climate change on population):** To understand, predict and (possibly) engineer abrupt changes in societal attitudes or behaviour related to the environment / resource use eg. recycling behaviour, fuel protests. Include events due to internal dynamics or external factors eg. technological developments, nuclear disaster, economic pressures, political change.
8. **Influence public policy, communication & behaviour:** To influence public policy, communication and behaviour by promoting public understanding of climate change and issues.
9. **Understand (and deal with) abrupt, rapid or flickering climate change tipping points:** Identify /quantify climate change of a magnitude and rapidity beyond the response capacity of key system components; quantify the system response; and model, at high-resolution, the holistic environment sensitivity to climate change.
10. **Business opportunities & predict how business will react to climate change regulation:** How do we get effective regulation to enable business to respond to the opportunities afforded by climate change? (Informed by the research base).
11. **Better climate risk assessment (methodologies, uncertainty& integration):** Understand vulnerability: Scale issues - robustness and risk of understanding. Understand linkages between climate and other drivers and critical impacts. * Need to shift focus onto consequences, knock-on effects and on what people value.

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

1. Improved modelling and forecasting
2. Earth Systems modelling
3. Decision support tools
4. Impacts of feedbacks on climate change
5. Links between local & global environmental change
6. Predicting effectiveness of technology responses to the environment
7. Improved weather, climate & seasonal forecasting approaches
8. Adaptation strategies to mitigate the risks and impacts
9. Ecosystem based management
10. Improved monitoring & observations.

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's remit and such delivery will involve collaboration with other initiatives such as RCUK Priority Themes or work by the UK Collaborative on Development Sciences. 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 Autumn 2011, implementation plans will be developed for the frameworks, although work on implementation will begin in priority areas before this.

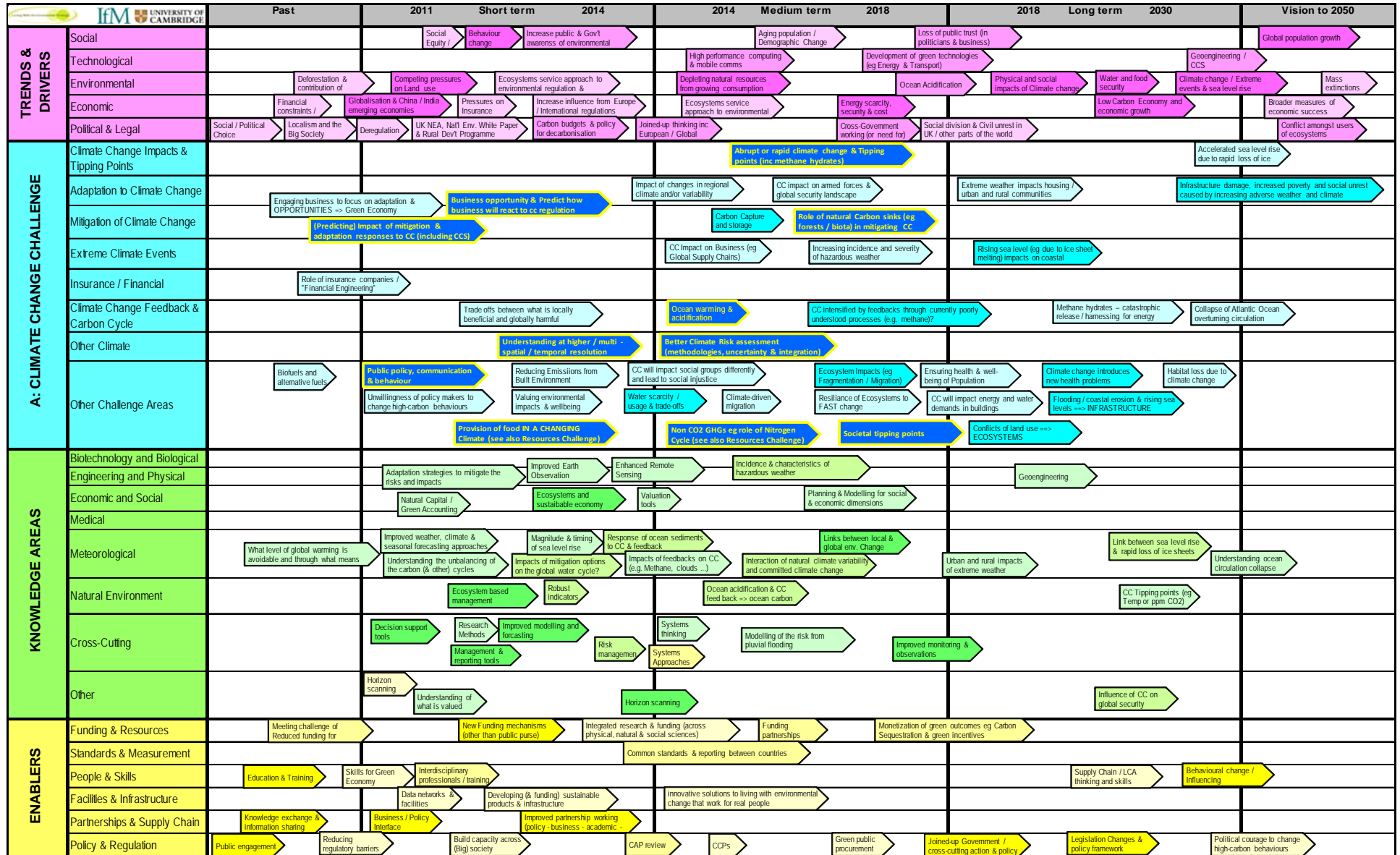
ANNEX A: Landscape Summary

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

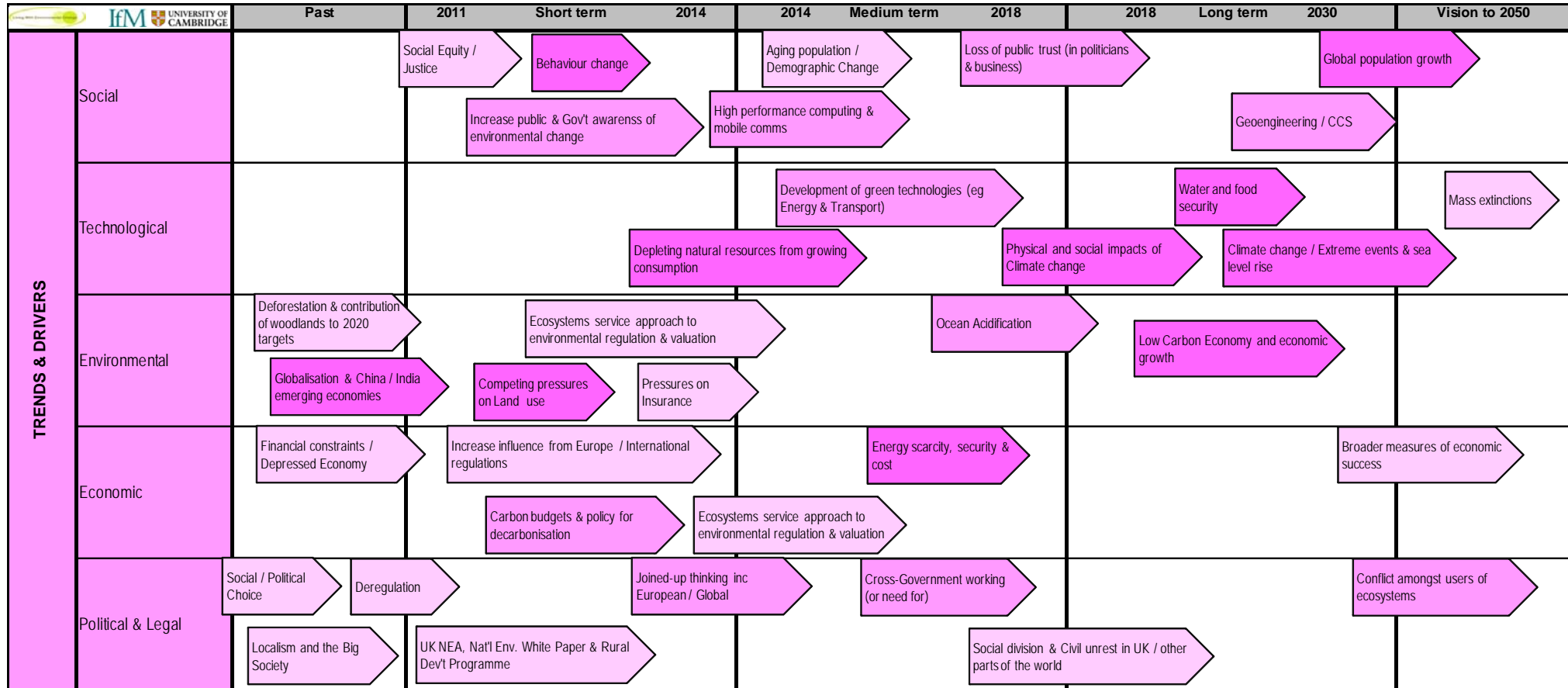
- Trends & Drivers
- Challenges
- Knowledge, Tools & Foresight; and
- Enablers.

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.

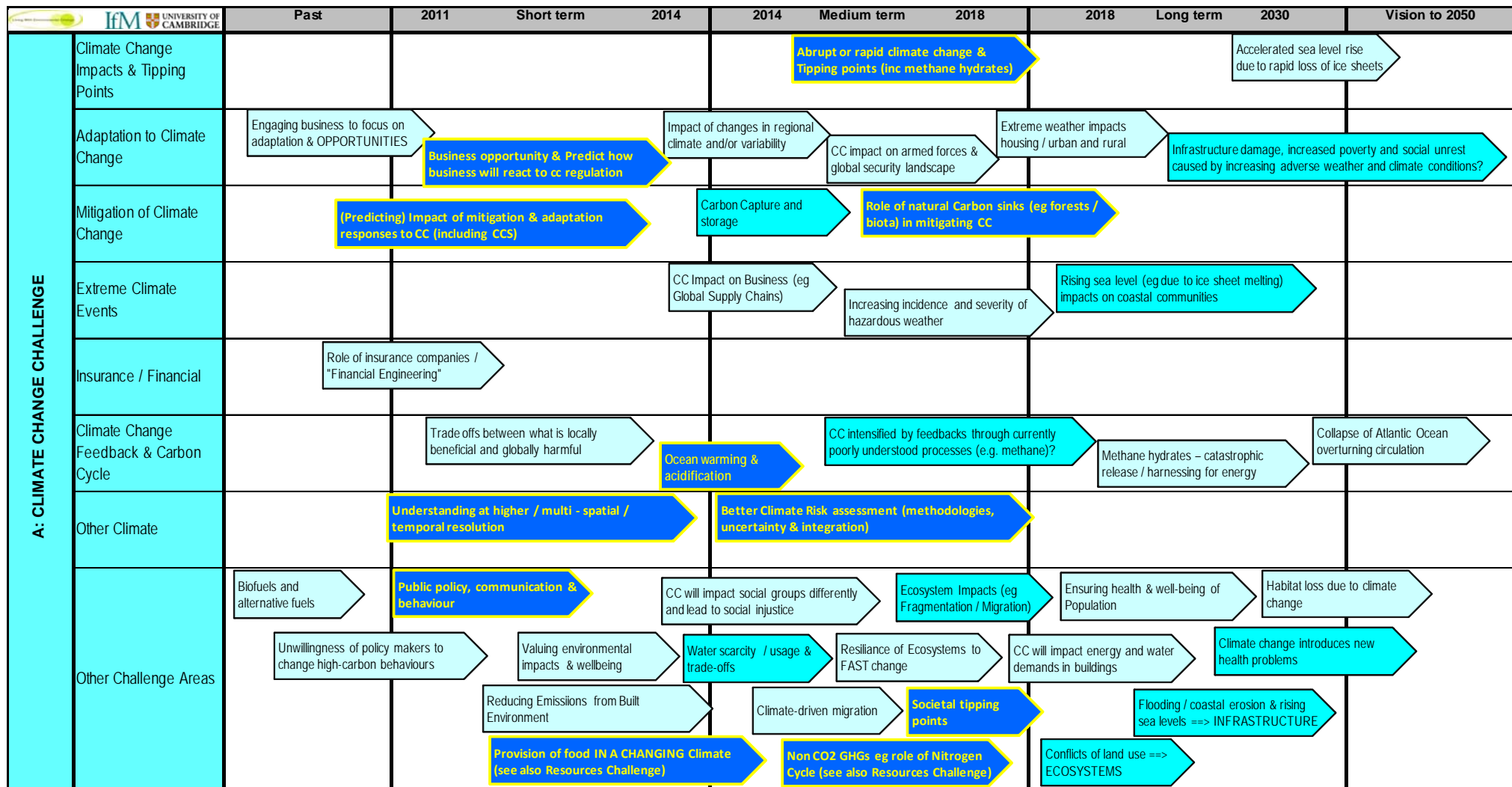
Key: Darker / Deeper Colours represent higher priority issues:	
	 Trends & Drivers
	 Challenges
	 Knowledge, Tools & Foresight
	 Enablers



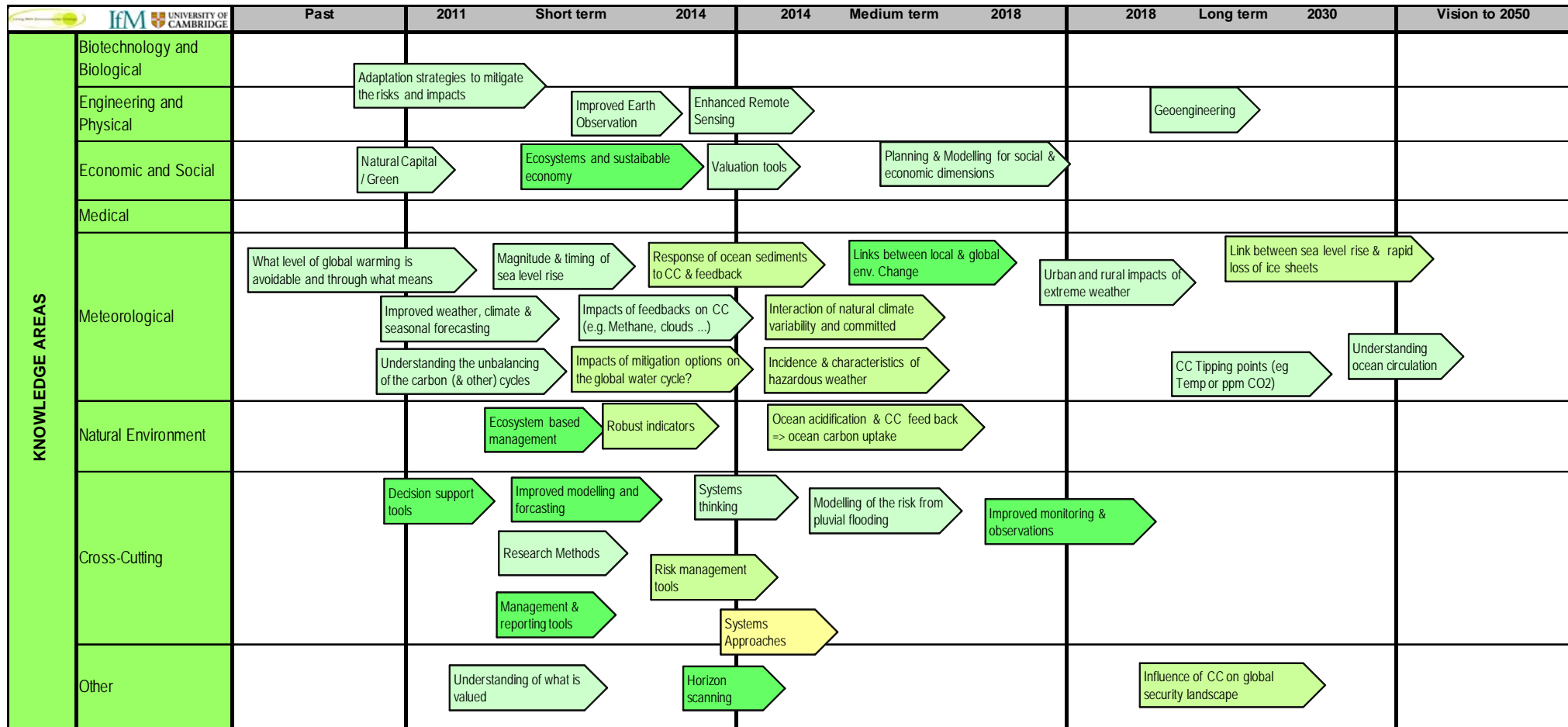
Trends and Drivers (larger version)



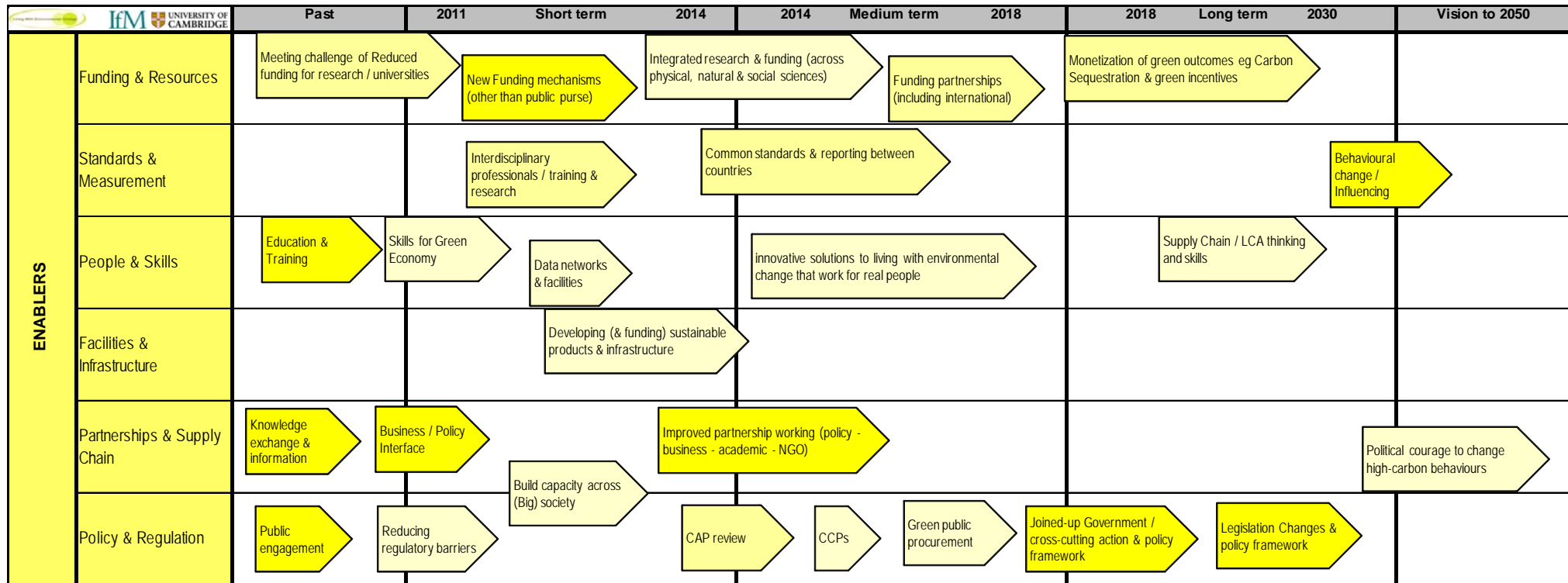
Climate Change Challenge (larger version)



Knowledge Areas (larger version)



Enablers (larger version)



ANNEX C: Mini-business cases and elevator speeches

Challenge: (a) To influence public policy, communication and behaviour.			Team		DF CW	DO DW
Challenge Description: - To influence public policy, communication and behaviour by promoting public understanding of climate change and issues.			There is a priority Climate challenge: Policy makers and scientists must work together - need to understand the interaction between them. There needs to be enough transparency, recognition of other values and other expertise. MAKE IT FUN? *Who owns these issues, who will cause transformation to improvement?			
Key Responses & Decisions:			Knowledge, tools and foresight will enable us to: Academic, professional, informal training - more relevance. Better communication skills			
Outcome	Mitigate -Science to open the solution space. New technologies, new approaches	Adapt to -Science to open the solution space. New technologies, new approaches	Benefit from Open-ness in policy goes with grain.			
	Need for knowledge, Tools & Foresight Human science research area to understand how policy and knowledge affects behaviour. Behaviour covers all actors and is wider than just physical science.		Apply	Adapt	Create	
Enablers Media, experts? People themselves, industry, returns on capital. *Alternatives - choices - possibility to change behaviour.		Barriers "WE know what we like!" Fear of losses, Sycicism, distrust of science. Tabloid newspapers. Scientific hub is too much bad news.				
			Open questions and input required from group: * The environmental sustainability knowledge transfer network can help link stakeholders and actors and translate. *Develop partnership with advertising industry or academic version in order to learn how we as scientists can better sell our ideas. *Science is necessary but not sufficient. *Measurement of policy impact is still not a central principal of the policy cycle due to lack of expertise and resources. *Why is post implementation policy review so rare? *Ex ante evaluation doesn't happen because we are too busy on the next task or we might discover the minister was wrong and the signal was too weak. *Not sure about celebrity scientists - they always become the "go to" people for comments not necessarily presenting a range of views. *Rather traditional picture - is it realistic to think that scientists can become advocates? Is that what we want? Better to use professionals, including media, better. Continue exchange schemes. More focus on education system etc. Develop knowledge and understanding in others.			

Challenge:
(b) Understanding at multispatial/temporal scales

Team	BG	RH
	JP	SR

Challenge Description:
Developing reliable authoritative predictive capability at smaller spatial / temporal scales in sustained / real time.

There is a priority Climate challenge:
Developing reliable authoritative predictive capability at smaller spatial / temporal scales in sustained / real time.

Key Responses & Decisions:

Knowledge, tools and foresight will enable us to:
See priority challenge.

Outcome	Mitigate Targeted Responses / cost effective	Adapt to Targeted Responses / cost effective	Benefit from		

<p>Need for knowledge, Tools & Foresight -Process level understanding at different scales.</p> <p>*Beware of the trade-off between spatial science and uncertainty. -High quality data from sustained integrated monitoring systems. - Drivers eg. GHG scenarios</p> <p>*Need user engagement to define what spatial temporal scales are relevant to them. This should be sustained user engagement to get info to users.</p> <p>*Scaling tools and methodologies eg. Scale space transforms, geo-statistical change of support, down scaling techniques.</p>	Apply	Adapt	Create
	YY	YY	YY

Open questions and input required from group:
* How does uncertainty scale in space and time integrating effects of slow cycling processes and rates of transformation at different scales.
*Can't monitor everything - what should be the key things?

<p>Enablers Research and community HPC data ESKTN. *Integration of event attribution with process understanding. The knowledge transfer network can help with the communication between stakeholders.</p>	<p>Barriers HPC? Key data acquisition and networks, science - action barrier for multiple end users. MONEY / Infrastructure. *Which barrier is a show stopper? Observations?</p>
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Challenge:
(c) Provision of food in a changing climate

Team	NG	RW
	EB	

Challenge Description:
To forecast changing climate and responses of resources underpinning sustainable food production (including nutritional qualities) and to understand future supply and demand at UK and global level (including energy). To influence perception on and behaviour responses (including trade-offs between ecosystem services, food choice, GM) while minimising environmental impact.
*Link to group b - we can't do this without an end-to-end climate impacts approach.
*Achieving food/water security in an environmentally sustainable way.

There is a priority Climate challenge:
Develop trustworthy forecasts for the key variables that affect food production. Impacts on global food production, trade and costs.

*Supply and demand including social, political, economic and UK and international.

Key Responses & Decisions:

Outcome	Mitigate Better soil and water management. Food waste prevention, reduction technologies.	Adapt to * Adaptation change in diet. * Adaptation regional crop selection. *Local supply very important.	Benefit from *Greater consumer awareness. *Novel food

Knowledge, tools and foresight will enable us to:
-Increase production to feed a growing global population

<p>Need for knowledge, Tools & Foresight *Changing climate new disease - threat if reduce UK food production. *How will rainfall patterns change? How will soils change in a changing climate? *Prediction of national / international production maps - distribution of resources. *Better seasonal forecast to inform farmers planting decisions. *Understanding UK dependencies on global supply and demand and energy costs. *Sometimes food crop choices have bearing on ecology eg. Bees, nutrition suffer in mono-crop situation. *Better understanding of disease spread. *Nutritional quality *Trade-off - what is the environmental footprint of food choices. *Distribution and supply chains. *How do we reduce waste and over consumption? *Do we need to eat less resource intensive food?</p>	Apply	Adapt	Create

Open questions and input required from group:
Are better forecasts achievable?
*Does increasing food supply push humanity even harder into a dead end?
*Better regional forecasts
*We don't know what we don't know.

*Responses including behavioural.
 *Trade-offs between food production and other ecosystem services versus mitigation / land use and priorities.

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Enablers
 *Waste disincentives eg. No BOGOF
 *Green labelling (carbon, water etc footprint).
 *More resilient food crops and low input crops.
 *New crop varieties in response to wetter & hotter climate.
 *What are the risks and opportunities
 *International trading

Barriers
 *International trading
 *Economic, global political change, population growth.
 *International equity and poverty alleviation.
 *Changing energy costs and fertilisers.
 *Transgenic / GM crops - public perception.
 *Inherent uncertainty. Land use competition for food, fuel and biodiversity?

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Challenge:
 (d) Understanding (and dealing with) abrupt rapid or flickering climate change tipping points.

Team	ME	PN
	CR	

Challenge Description:
 *Identify/quantify climate change of a magnitude and rapidity beyond response capacity of key system components.
 *Quantify system response.
 *Ability to model, at high-resolution, the holistic environment sensitivity to climate change.

There is a priority Climate challenge:
 *Is it possible to detect signals of approach to tipping point?
 *Have a disaster management plan.

Key Responses & Decisions:

Outcome	Mitigate *Motivate global GMG reduction.	Adapt to *Choice over change, mitigate, adapt, degrade or destroy	Benefit from

Knowledge, tools and foresight will enable us to:
 *Will help us to prioritise adaptive responses and choices in saving or abandoning systems .
 *Gain better understanding of potential non-linear responses to slow/rapid changes in forcing.

Need for knowledge, Tools & Foresight *Lack of observation eg. methane release in frozen land for example or global energy balance. *Distinguishing slow or fast or catastrophic changes. *Process coupling re-environmental processes eg. Landslides, water routing, sediment flux etc.	Apply	Adapt	Create

Open questions and input required from group:
 *But must not conflate the actual risks of climate tipping point with the "perception of those risks" The latter determines behaviour change.
 *How do you avoid perception of research pre-supposing outcome?

Enablers *Belmont forum - action to bind UK effort effectively into international effort on this topic.	Barriers * The inherent inability to predict timing and magnitude of some forms of abrupt climate change. *Need science including social disciplines that typically don't know how to talk to each other. *Complexity of positive and negative feedbacks in earth systems. *RCUK rules on funding, international co-operative research (G20 problems) (RCUK include BIS and many other forums funding research)
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Challenge:
(e) Better climate risk assessment (Methodologies, uncertainty and integration)

Team	RS	AC
	CJ	

Challenge Description:
 -Understanding vulnerability
 1. Scale issues. Robustness and risk of understanding.
 2. Understanding linkages between climate and other drivers and critical impacts.
 * Need to shift focus onto consequences, knock-on effects and on what people value.

There is a priority Climate challenge:
 -Develop a co-designed strategic approach to improving climate risk assessments.

Key Responses & Decisions:

Knowledge, tools and foresight will enable us to:
 -Lower cost and adapt in a timely fashion
 - Have fewer (nasty) surprises
 - Have business opportunities
 - Realise full value of science and technology.

Outcome	Mitigate	Adapt to	Benefit from		
			-Lower cost and timely adaptation - Have fewer (nasty) surprises - Have business opportunities.		

Need for knowledge, Tools & Foresight -End to end process understanding (across scales) and disciplines. - longer-term vision = recognition of grand challenge dimensions (model response of certainty).	Apply	Adapt	Create

Open questions and input required from group:
 -How can LWEC address the priority challenge.
 *Need to drive risk-based decision-making with government and businesses
 - this will provide the requirement / impetus used for risk-based assessment.
 *At what scale can LWEC most usefully contribute to better climate risk assessment (national / regional / local)

Enablers -Internationally co-ordinated infrastructure for observations. Earth system modelling (including evaluation), attribution and prediction. *Greater open-ness, use of new media and citizen science.	Barriers -Politics! - Organisational and cultural inertia - Incentive systems. *Whose politics is a barrier? Be specific and point fingers then we can remove barriers. *Need a tiered approach - mustn't let pursuit of the best stop us from taking decisions now.
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Challenge:
 (f) (Predicting) Impact of mitigation and adaptation responses to climate change.

Team	DL	MA
	CS	

Challenge Description:

- Quantify impact of responses on cumulative CO₂ and on emission rates of CO₂.
- Quantify responses on non-CO₂ drivers.
- Balance GHG reduction against wider costs and impacts.
- Quantify (monetise) costs and benefits.
- Identify winners and losers.
- Quantify (monetise) cost and effectiveness of adaptation.

There is a priority Climate challenge:

- *Prioritise the trade offs - maximise the winners and minimise the losers.
- *Promote objective debate on the trade-offs replacing pseudo-debate on science.
- *Role of time scale trade-offs.
- *Permanent reductions in fluxes of short lived GHG's eg. methane lead to permanent reduction in concentrations.

Key Responses & Decisions:

Outcome	<p>Mitigate</p> <ul style="list-style-type: none"> *Determine short-term and long-term mitigation objectives. *Integrating UK mitigation into global mitigation needs. *Optimise actions to maximise co-benefits and minimise trade-offs. 	<p>Adapt to</p> <ul style="list-style-type: none"> *Public agreement on trade-offs. *Greater clarity on time scales on public debate. 	<p>Benefit from</p> <ul style="list-style-type: none"> *Setting research and technology agendas. *Galvanise the winners
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Knowledge, tools and foresight will enable us to:

- *Cost-benefit assessment
- *Better integrated understanding of the impacts of mitigation and adaptation.
- *Econometrics never taught us anything useful.
- *What about Solar Radiation Management (SRM) geoengineering as climate mitigation.

<p>Need for knowledge, Tools & Foresight</p> <ul style="list-style-type: none"> *Land-based renewable project. *Build on the 2020 focus on the land based renewable project to look out to 2050. *Avoiding dangerous climate change. *DECC 2050 pathways model. *Variety of research on impact of specific technologies. *UK Community Integrated Assessment Model (IAM) genuinely integrated with climate, impacts and economics research. *Plugging gaps in cumulative impacts of specific technologies. *Prioritising trade-offs between impacts of each technology. *Joint Weather & Climate Research Programme (JWCRP) and build links. *Coherent climate impact and economics model, IAM's etc. 	Apply	Adapt	Create

Open questions and input required from group:

- *"Where does climate change fit?" On it's own?

Environmental, sustainable development, economic elsewhere?

*Develop ESM modelling capability for assessment.
*DEFRA pathways to adaptation model

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Enablers

*Initiatives which bring together and target different research bodies and funders.
*Need for inventor confidence in policy and pathway.

Barriers

*Lack of understanding of public perception and decision making.
*Lack of economic and social science engagement.
*And need to integrate with governmental in-house economists who are not always joined up with other evidence actors.
*Economists work alone where as scientists work in larger teams. This is a barrier.

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Challenge:
(g) Interactions between carbon & nitrogen (& phosphorus?) cycles

Team	AW	LS
	PS	

Challenge Description:
To understand the interactions between the carbon and nitrogen (and phosphorus?) cycles and in a changing climate
*We focused on the C & N cycles with non-C GHGs.

There is a priority Climate challenge:
Integrate process knowledge and interactions between the C&N cycles into current biogeochemical cycling models. And inventories ie. Bringing agriculture and Land-Use, Land-Use Change & Forestry (LULUCF) together as per IPCC 2006 guidance.

Key Responses & Decisions:

Knowledge, tools and foresight will enable us to:
*Input into CAP process either at EU level or nationally. Are CAP payments linked to CN cycle government practice?
*Manage level to maximum GHG impacts

Outcome	Mitigate -Understand and reduce emissions including methane oxidation.	Adapt to Manage land and fertiliser differently See a direction of travel ie. Can predict future needs and issues	Benefit from Reduce N, store some C, avoid mal-adaptation.

Need for knowledge, Tools & Foresight -Tyndall centre, macronutrients cycle (NERC), agricultural GHG R&D platform. Nitro-Europe (complete), Scottish government research programmes, RCUK, and other DA's *Integrate outputs from above - Apply a gap analysis and synthesis tools. Create – a. A targeted research process interactions b. Integration of knowledge on feedbacks into biogeochemical models c. Knowledge transfer to policy.	Apply	Adapt	Create

Open questions and input required from group:
-What are the potential extreme events and interactions?
*What else can we do with this knowledge. Is it useful to industry?
*Non-CO₂ GHG's are more than CN interaction.
*And include Phosphorus?
*What fraction of GHG emissions are under human control? How will that fraction change in the future?
*What are the impacts of nitrogen deposition on the rates of C-cycling and storage in soils?

Enablers *Targeted research programmes *IPCC2006 inventory guidance, agriculture and Land-Use, Land-Use Change & Forestry (LULUCF), Agriculture, Forestry & Other Land Use (AFOLU)	Barriers *Effective knowledge transfer to policy. *Vested interest *Lack of continuity of funding and personnel.
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Challenge:
(h) Role of natural carbon sinks in mitigating climate change.

Team	VW	HC
	AM	

Challenge Description:

- To understand the role of natural carbon sinks (vegetation and soil) in mitigating climate change; and
- To develop the tools, policies and instruments to maintain and enhance them.

There is a priority Climate challenge:

Key Responses & Decisions:

Knowledge, tools and foresight will enable us to:

Outcome	Mitigate -To enhance the capacity for C storage in soils, trees and other vegetation.	Adapt to How to build resilience to gradual climate change and extreme events and other policy drivers and societal pressure.	Benefit from -Payments for ecosystem services (C and other). - Improved biodiversity. - Water management. - Societal (recreation, "wild places", landscape)

<p>Need for knowledge, Tools & Foresight</p> <ul style="list-style-type: none"> -GHG flux - better understanding / monitor (A, C) - C Capture under different silvi-cultural systems and agricultural systems (A, C). *Including P systems - The role of bio-char in the UK (C). - Landscape - scale - right land use, right place (A). -Permanence of C storage (C). -Better understanding of the carbon cycle over landscape (C). -Better models of GHG flux to aid decisions (A, C). -Life Cycle Analysis/Assessment (LCA) wood products and product substitution (Energy, construction)(C). *Forestry - species choice rotation length and management type. *Agriculture - crop type, tillage, pasture management and waste re-cycling. *Carbon capture/loss under different silvi-cultural systems. *What is business case for carbon storage? How should we value carbon storage? 	Apply	Adapt	Create

Open questions and input required from group:

- What about marine C sinks (Kelp, eel grass)
- *How do we address indirect land use change? By protecting some land you just displace emissions to less protected land elsewhere in the world.
- *The environmental sustainability KTN is running a workshop on biogenic and geological sequestration

Enablers -Joined up research	Barriers -CAP?
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<ul style="list-style-type: none">- Reform CAP?-Agri-environmental schemes-Woodland Carbon Code-Implementation of the National Ecosystem Assessment framework.-National adaptation plan.-EU Emissions Trading Scheme (ETS)-Committee on Climate Change -Carbon budgets.*LWEC, Defra, DECC, FC, Natural England etc, Research Councils, private sector!Joined up research communities.	<ul style="list-style-type: none">-Importance of food-Fragmented approach-Funding for big ideas, not smaller stuff.
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Challenge:
(i) Ocean warming and acidification.

Team	PB	CM
	AW	

Challenge Description:
To monitor the change in the marine environment and understand / model spatial and temporal variation. Some catching up to do compared to terrestrial environment.

There is a priority Climate challenge:
-Monitor and understand change in the marine environment.
-Need projections on nearer "industry relevant" timescales (not just the end of the century) and plausible "range" of futures.

Key Responses & Decisions:

Outcome	Mitigate GHG mitigation essential but will have little immediate impact. - Changing circulation - Tipping points. - Increased warming - then methane hydrates	Adapt to - Fisheries/tourism. - Don't know how marine ecosystems will respond to change. We need flexibility in marine conservation / policy e.g. MPA designations.	Benefit from -Exploiting warm water species Eg. seabass -Increased coastal tourism

Knowledge, tools and foresight will enable us to:
-Improve monitoring, modelling, atmosphere/marine exchange, understanding of impacts, response options.

Need for knowledge, Tools & Foresight -Improved and long term commitment to bio / physical monitoring (A C). -Modelling at improved temporal / spatial scales (A, D, C). -Response options eg fisheries (A, D).	Apply	Adapt	Create

Open questions and input required from group:
-How to get marine issues more visible in these types of workshop. Typically only 1 (max. 2 marine people at workshops for 50 people). Is the perception of 'marine' as an afterthought" fair?
*Has enough benefit been derived from existing /prior research? For example, what happened to knowledge from the International Polar Year? -Probably for the research community. Not sure how IPY is hitting policy/stakeholder communities.
- Wider issue - not just a direct UK issue, seas as a shared resource across notional political boundaries.

Enablers -Marine community well co-ordinated. -Good dialogue between research and policy community. -Co-ordinated [international monitoring of physical environment that requires commitment.	Barriers -Often a lack of visibility of marine issues in groups like this. -Need for co-ordination. -Expensive. [Note: The EQUIP Consortium has a working party on marine environments see www.EQUIP.leeds.ac.uk of use to this]
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Challenge:
(j) Business opportunities and predict how business will react to climate change regulation.

Team	BA	RH
	CR	

Challenge Description:
How do we get effective regulation to enable business to respond to the opportunities afforded by climate change? (Informed by research base)
*Communication lines
*Business opportunity. Wider environment.
*Regulation government.
*Fiscal instruments (government, incentives).
*Reciprocity for business but feedback, not just information.
*Business responds.

There is a priority Climate challenge:
-Regulation / CRC lead to Business opportunity in energy management services and products, resulting in significant CO2 reduction. Exemplars and demonstrations are needed.
*Feedback / publish success.
*Widen CRC to smaller organisations incorporate transport

Key Responses & Decisions:

Outcome	Mitigate -Reducing carbon -Taxes -Fiscal instruments affords opportunities. -Standards. -Better information on up-coming envir? -Legislation on building management systems.	Adapt to	Benefit from -Rapid innovation.

Knowledge, tools and foresight will enable us to:
-Innovate more rapidly.
-See what is ahead more easily (especially SME's).

<p>Need for knowledge, Tools & Foresight -Information on upcoming environmental challenges / risks / opportunities (to businesses). -Closer collaboration between governments, business and research. -consistent / transparent reporting. -Future climate predictions. *This assumes everyone has the same appetite for risk - not so! -Uniform for all businesses. (Air flow - wind around buildings). -Ask business what's important, what drives them, what knowledge etc. they want. *Consistent reporting tools. *Consistent carbon conversion factors. *Research on the extent to which regulation drives</p>	Apply	Adapt	Create

Open questions and input required from group:
-Examples of where it has worked.
-Mandatory reporting.
-How do we involve business at all levels at LWEC?
*Is it an advantage or a problem to have a single source of projections?

environmental improvements.
 *Natural solutions? Trees 4 shading / temperature / humidity control around building.
 *Key link between this challenge and challenge F on the impact of mitigation measure
 - if we can get greater acceptance and certainty about the pathway to 2050 then less risk of policy regulatory change.

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Enablers
 -Consistent regulation EU compliant (trade) regulation.
 -Skills for workforce (blue collar) to drive carbon reduction.
 -Technological innovation.
 -Strong communication between research, policy and business.

Barriers
 -Government policy, Business, research agencies & LWEC need to stop working in isolation and need to work together. Lack of consistency.
 *Carbon priced stability.
 *Consistent carbon prices.

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Challenge:
 (k) Societal tipping points (and influence of climate change on population).

Challenge Description:
 To understand, predict and (possibly) engineer abrupt changes in societal attitudes or behaviour related to the environment / resource use eg. recycling behaviour, fuel protests. Include events due to internal dynamics or external factors (eg. Technological developments, nuclear disaster, economic pressures, political change).
 *We can't do this even for major immediate events like wars. Should we even try to do this for slow defuse change like climate?

Key Responses & Decisions:

Outcome	Mitigate -Environmental policy. *Risk versus risk perception	Adapt to *Risk versus risk perception	Benefit from

Need for knowledge, Tools & Foresight -Multi-disciplinary approach needed: 1. Identifying societal tipping points. 2. Monitor data indicative of tipping points. 3. Analysis of time-series data to predict tipping points. 4. Technological / scientific assessment of possible triggers. Eg. Is your nuclear station going to get flooded? *Segmentation.	Apply	Adapt	Create

Enablers -LWEC societal challenge. *Sandpit	Barriers -Inability for different disciplines to communicate effectively. -Potential divergence between "scientific rationality" and "societal rationality".
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Team	KO	PC
	NH	JR

There is a priority Climate challenge:
 See challenge description
 - Food, energy and water.
 -Pilot cross-disciplinary initiative?
 -ESRC / EPSRC / NERC policy

Knowledge, tools and foresight will enable us to:
 -Design policies to prompt positive tipping points or avoid negative ones.
 -Base collective and individual culture around behaviour which is around attitudes which is around value.

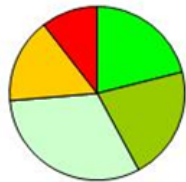
Open questions and input required from group:
 -What would we monitor?
 -Where are the social researchers?
 *Activism is seen as a good thing by many social scientists (contrary to the values of science).
 *Much of the social science is not very relevant to the questions policy makers have.

ANNEX D: Workshop Participants

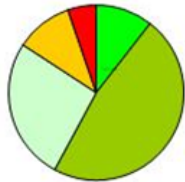
Myles	Allen	allen@atm.ox.ac.uk	University of Oxford
Bekir	Andrews	Bekir.Andrews@romec.co.uk	Romec
Elizabeth	Baggs	e.baggs@abdn.ac.uk	University of Aberdeen
Paul	Buckley	Paul.Buckley@cefasc.co.uk	Cefas (Marine Climate Change Impact Partnership)
Andy	Challinor	a.j.challinor@leeds.ac.uk	University of Leeds
Chris	Collier	C.G.Collier@leeds.ac.uk	University of Leeds
Peter	Cox	P.M.Cox@exeter.ac.uk	University of Exeter
Humphrey	Crick	Humphrey.Crick@naturalengland.org.uk	Natural England
Michael	Ellis	mich3@bgs.ac.uk	British Geological Survey
Ned	Garnett	nedg@nerc.ac.uk	Natural Environment Research Council
Beth	Greenaway	beth.greenaway@ukeof.org.uk	UK Environmental Observation Framework
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Neil Harris	Harris	Neil.Harris@ozone-sec.ch.cam.ac.uk	European Ozone Research Coordinating Unit, University of Cambridge
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Charlie	McLaren	C.McLaren@ukcds.org.uk	UK Collaborative on Development Sciences
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Sam	Austin	Sam.Austin@LWEC.org.uk	Living With Environmental Change
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Mary	Barkham	Mary.Barkham@LWEC.org.uk	Living With Environmental Change
Dominic	Oughton	do251@cam.ac.uk	Institute for Manufacturing, University of Cambridge

ANNEX E: Participant questionnaire results

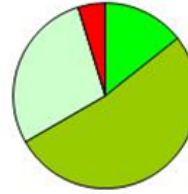
Joining instructions and pre-workshop information



Opening remarks and introduction to the workshop



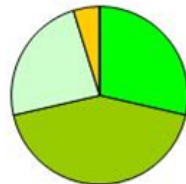
Facilitation of the workshop



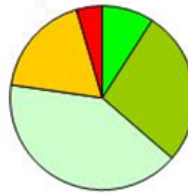
Structure / process of the workshop



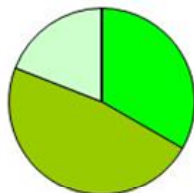
Opportunity to participate and contribute



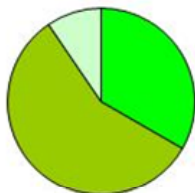
Make-up of workshop participants



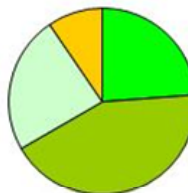
Time keeping



Catering

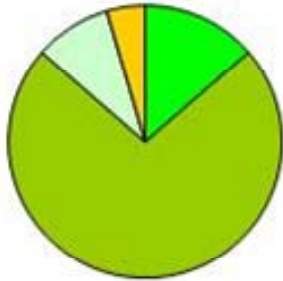


Venue

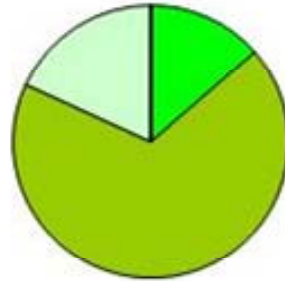


88% Excellent,
Very Good or Good

I found the workshop stimulating



I enjoyed the workshop



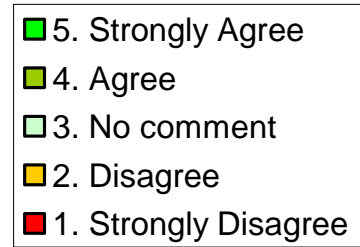
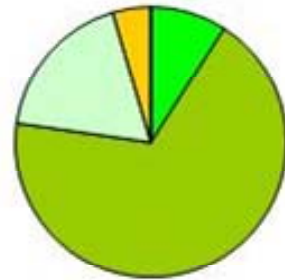
I found my participation worthwhile



I feel I have contributed to the workshop



The workshop provides useful insights



84% 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:

