Science for the Environment

Future research needs within the climate, environment and resource challenge of Horizon 2020 (societal challenge 5).

Results from joint DCE/PEER conference: Science for the Environment 3-4 October 2013

Fifteen years after the *UN Aarhus Convention* was agreed in Aarhus, we involved the scientific community in a transparent process in order to inspire the European strategic research agenda, in support of a green and prosperous future for Europe and the World. This short paper presents the result of the conference formulated as future research challenges and the expected societal impact of tackling these challenges within the areas *climate action*, *resource efficiency* and *green economy*.

We hosted a scientific conference organized to address the climate, environment and resource challenges as described in H2020. We asked all presenters to conclude their presentation with an identification of core research gaps in their field they would suggest H2020 could address. On the last day the conference turned into workshop mode and compiled and evaluated all the research gaps identified during the conference. This brief paper is a distillate of those discussions.

One of the goals of the EU Framework Programme for Research and Innovation *Horizon2020* is to promote research that tackles major societal challenges. Challenge-driven research needs to be target-oriented and aim at creating societal impact by bringing together resources and knowledge across different fields, technologies and disciplines, including social sciences and humanities.

One of the objectives of H2020 is to achieve a climate resilient and resource efficient society, with a sustainable management of natural resources in order to meet the needs of a growing population on a limited planet. Building a green economy, decoupling economic growth from resource use, is part of the solution which must be achieved.

Aarhus University and the *Partnership for European Environmental Research (PEER)* have brought together researchers across disciplines in order to discuss which research will be needed to significantly contribute to actual societal impact. The main messages are the following:

Main messages Climate Action:

The key challenge is to find ways of truly decoupling economic development from fossil fuels and greenhouse gas emissions and identify sustainable paths of adaptation. There are research gaps in our ability to compare, combine and evaluate climate mitigation and adaptation options, and in our ability to involve industry and business as well as citizens in co-creating new pathways for mitigation and adaptation. These processes can be analyzed, further developed and supported by a variety of scientific methods and tools (e.g. by improved Life-Cycle Assessments (LCA)) that help us to understand how mitigation and adaptation measures affect other processes and ecosystem services. We should gain deeper insights into the drivers of adaptive capacity and the transfer of novel solutions through innovative approaches and focus on sectors which are likely to be affected. We need to raise societal capacities in climate change mitigation and adaptation. Concepts and tools should be fostered for assessing the range of potential response options and for evaluating their impacts, cost and benefits, their legitimacy and synergies with other measures. The gender perspective is an important but also largely neglected research area in climate change. At the level of process and governance we can learn from comparisons of climate policy and environmental policy integration. Finally there is also a need for observational and modeling infrastructures that support Europe's ability to make progress in the fields of climate change mitigation, risk management and adaptation.

Main messages Resource Efficiency:

Improving and maintaining resource efficiency is vital to economy and society. This is especially challenging considering the broad range of resources from raw materials via more abundant essential resources like water or soil to ecosystems and the biodiversity safeguarding ecosystem functions and services. Research under Horizon 2020 needs to provide the scientific basis for sustainable integrated management of natural resources. This includes e.g. efficient and effective implementation of green infrastructure and restoration of ecosystems. Moreover, research needs to identify and assess the maximum potential of ecosystem services and new business opportunities that come from resource efficient use of natural capital and investment in green infrastructure. This also calls for more knowledge on how global supply and demand chains and trade affect natural resources, in order to monitor and govern international resource flows. More generally, research must become more successful in contributing to policy development on all levels (from local to global). There is also a need to develop novel ways to convince consumers to reduce the consumption of natural resources.

Main messages Green Economy:

Economy is ultimately a function of ecosystem services, and wholly dependent upon these. Hence, long term considerations and investments in ecosystem services need to be reflected in the way we construct and conduct our economic and innovation policy. Any transition towards a green economy could be enabled through eco-innovation and a functioning innovation ecosystem. This includes decoupling growth from the use of natural resources, and using alternative options to continue to create opportunities for growth and jobs. There is a need for reconciling sustainability strategies with fundamental socio-economic assumptions, in order to better understand e.g. the motivational issues in consumer behavior and macro-economic rebound effects. There is a need to review current and previous green economy interventions to assess their impacts, effects and influence on the system transition. The efficiency of efforts aimed at whole societies requires further research; this would give a more precise view of efficient resource utilization. Post-occupancy evaluation of existing 'low impact development' would be beneficial in informing future low-impact scenario development.

The specific suggestions for research needs within each challenge can be found in the appendix below.

Appendix: Workshop results:

1) Climate action - mitigating and adapting to climate change

Support for research on climate action under Horizon2020 should:

1) Strengthen the foundation for decoupling of economic development from greenhouse gas emissions without causing non-sustainable use of resources and/or social inequality – e.g. by outsourcing the production and emissions;
2) Engage private businesses and other actors (i.e. citizens) in co-generation of innovative and sustainable solutions for mitigation and adaptation;
3) Deepen understanding of drivers and processes of societal change, and improving societal capacities;
4) Provide opportunities to test and analyse innovative forms of governance aiming for low carbon societies with high adaptive capacity;
5) Further support observational and modeling infrastructures for mitigation and adaptation.

Together these research topics would help Europe to make significant progress in the fields of climate change mitigation, risk management and adaptation.

Challenge: Without successful action, climate change will cause adverse environmental consequences, human suffering, and significant economic costs.
The aim: To develop innovative, efficient and sustainable adaptation and mitigation.

MITIGATION:

Decoupling economic development and greenhouse gas emissions

Specific challenge: How to transform societies by identifying low carbon growth strategies in terms of technology choices, societal acceptance of technological options and new business opportunities for entire sectors? Research should include comparison and evaluation of alternatives.

Expected societal impact: Better growth prospects with sustainable living. It will encourage nations/states to agree in international conventions to commit reducing their annual emission.

Exit strategy/-ies from fossil fuels

Specific challenge: The shut-down of plants operating on fossil fuel has been hasted or a consequence of the increasing use of renewable resources. The large scale use of biomass has turned out to be a problematic solution and there is a need to develop alternatives routes towards a low carbon society.

Expected societal impact: exiting from fossil energies as a key for climate mitigation but without causing sudden societal disruptions.

Bottlenecks and opportunities for technology transfer.

Specific challenge: What factors contribute to the success and obstacles of the transfer of technology and other solutions for mitigating climate change to developing countries?

Expected societal impact: New insights into the difficulties and opportunities in technology transfer and the identification of promising pathways.

LCA of mitigation measures

Specific challenge: Identify true impact over full life cycle for mitigation measures

Expected societal impact: Climate mitigation measures with best possible climate effect & minimal conflicts with other values

Co-benefits of environment, climate and health

Specific challenge: Health effects from climate change have been sparsely studied and addressed; Health effects of adaptation and mitigation strategies and measures have received limited attention although some aspects such as the health effects of burning biomass or the effects of hot or cold spells have been recognized. A comprehensive analysis, including the recognition of health aspects of ecosystem services would provide new insights into the complex interlinkages.

Expected societal impact: Improved knowledge base for mitigation actions, including better recognition of co-benefits and potential adverse side-effects on health.

ADAPTATION:

Adaptive capacity in natural resource management

Specific challenge: Climate change is expected to affect natural resource management (NRM) in many ways, but the knowledge of adaptive capacity and the factors determining it as well as the impact of adaptation on climate change in institutions and organisations for NRM is incomplete.

Expected societal impact: Supporting effective growth of adaptive capacity of NRM institutions and organisations and better realization of specific challenges in NRM adaptation.

Adaptive actions impact on assessed risks

Specific challenge: Development of a risk analysis of adaptive actions that includes indirect effects, including uncertainty

Expected societal impact: Giving confidence on adaptive actions, better knowledge of adaptation,

improved decision-making process for manager/politicians.

INTEGRATED:

Understanding behavior and involving industry and business in mitigation and adaptation

Specific challenge: Developing experimental economic research for new financing instruments for climate action addressing why, when, how companies and other actors develop and engage in mitigation and/or adaptation actions, including joint activities "adaptigation".

Expected societal impact: Elucidation of business models for adaptation and mitigation, leading to more effective <u>real</u> transformations by important change agents in society. Particularly significance for developing countries where climate change creates huge simultaneous challenges for both adaptation and mitigation.

Developing GAMEs for change

Specific challenge: Development of novel game based ways to engage broad ranges of stakeholders (policy makers, researchers, people at large) in addressing local (personal) and global change.

Expected societal impact: Great potential to generate new perspectives on socio-environmental change and to develop action plans with broad societal acceptance.

A gender perspective on climate change response

Specific challenge: Adaptation and mitigation policies suffer from weak gender analysis, both at a practical and normative level.

Expected societal impact: By demonstrating how, from the outset, a gender perspective and gender analysis can be approached and developed within climate change response research, the analysis would improve the quality of climate policy and action.

Assessing and Understanding Climate choices

Specific challenge: Responses to climate change are not only a matter of infrastructural adjustment. Since climate is caused by a variety of social activities from mobility to industrial production, they require a broad range of measures and include fundamental changes in the way of living and planning. They require both, incremental change and profound societal transformation. These include diverse political options from restricted economic growth to accelerating economic growth focused on innovation.

Expected societal impact: demonstrating policies and measures available for mitigating and adapting to climate change and visualizing the wide array of choices that decision-makers and the public have.

Opportunities and limitations of policy integration

Specific challenge: Integration of environmental policy has faced very significant difficulties. Can climate change mitigation and adaptation avoid the pitfalls of environmental policy integration – how and why? We need to assess the benefits and limitations of different approaches to policy integration (for environmental and for climate mitigation and adaptation policies) and understand how integration can most effectively be implemented.

Expected societal impact: Understand better the characteristics of climate mitigation + adaptation and how it can be mainstreamed into policy making.

2) Resource efficiency - sustainably managing natural resources and ecosystems

Natural resources underpin the functioning of the economy and our well-being. These resources include raw materials such as minerals and metals as well as biodiversity and ecosystems, our natural capital, and basic goods like water. Efficient use of natural capital as a resource involves maintaining or enhancing ecosystem services and the biodiversity that underpins them while ensuring sustainable levels of use in combination with appropriate forms of governance. Integrated research under Horizon 2020 needs to:

1) provide the scientific basis for sustainable integrated management of natural resources, including e.g. efficient and effective implementation of green infrastructure and restoration of ecosystems,
2) identify and assess the maximum potential of ecosystem services and new business opportunities that come from resource efficient use of natural capital and investment in green infrastructure,
3) think of novel ways to convince consumers to reduce the consumption of natural resources, and
4) rethink policies which effectively result in sustainable management of social-ecological systems at all scales.

Challenge: establishing a sustainable balance between human needs and the environment
Aim: to identify the knowledge needed for the management of natural resources that achieves a sustainable balance between limited resources and the needs of society and economy.

Maximising the potential of ecosystem services and their trade-off
Specific challenge: Mapping and assessing the potential of ecosystem services to deliver at an optimal level while maintaining sustainable ecosystems.
Expected societal impact: Identifying the sustainability threshold.

Biodiversity and ecosystem services
Specific challenge: Assessing the contribution of biodiversity to ecosystem services (different scales, different systems). Response of ecosystem services (including biodiversity) to land use and management (both in cultural and natural areas).
Expected societal impact: Safe guard ecosystem services required by humans. More efficient provision of ecosystem services. More efficient and (cost) efficient biodiversity conservation.

Developing Europe's Green infrastructure
Green infrastructure, the network which includes urban green areas, green belts, semi-natural areas and nature reserves has the potential to offer nature-based solutions for environmental and societal challenges such as biodiversity loss, climate change and adaptation or land degradation. Reorganising landscapes so that they deliver multiple functions such as agriculture, recreation or wildlife support requires up-scaling restoration efforts to landscape or even regional scales, which necessitates novel scientific research.
Specific challenge: Developing EU knowledge/research hubs to support large-scale restoration of degraded terrestrial, freshwater and marine ecosystems and implementation of green infrastructure.
Expected societal impact: Investment in green infrastructure supports green growth, creates labour intensive jobs and provide new opportunities for business. Up-scaling restoration efforts will save costs. Green infrastructure, if well-planned, increases well-being by providing multiple ecosystem services.

Ecosystem services and business
Investments in green infrastructure and restoration of ecosystems are expected to open new opportunities for businesses in Europe. Examples are firms

which specialize in restoration of land or green development, SME's which typically offer nature based solutions (e.g. constructed wetlands to treat wastewater), opportunities for new types of tourism such as wildlife excursions, or business that profit from the opening of new markets.

Specific challenge: To activate the knowledge base on ecosystem services for new business opportunities.

Expected societal impact: Contribution to smart and green growth.

Coupled Socio-Ecological Systems (SES) and Governing International Resource Flows

Safeguarding biodiversity, restoring ecosystems and maintaining or enhancing services and benefits derived from natural capital requires acknowledging that we live in a social-ecological system which need an adaptive governance approach at all scales. At global scale, it requires better knowledge in how supply and demand chains and trade affect different natural resources. Especially, consumption in industrialised countries is causing overuse of specific resources in developing countries.

Challenge (research gap): Develop methods (models) to work quantitatively with coupled socio-ecological systems at a holistic ecosystem scale. Develop suitable indicators which address synergies and trade-offs caused by a global demand for ecosystem services and natural resources. Develop monitoring and policy instruments.

Expected societal impact: Policy instruments and defendable decisions based on quantified assessment criteria.

Biodiversity and cultural ecosystem services

Challenge (research gap): Different elements of natural systems and their spatial arrangement deliver different ecosystem services in different cultures. We need a better understanding of the cultural values and benefits of biodiversity and ecosystem services in order to improve nature conservation and ecosystem management.

Expected societal impact: Improving integration of cultural benefits to people into land management decisions.

Better informed policies

Challenge (research gap): Research should be policy-relevant and influence decision-making. However, we still need a better understanding and development of processes how research can contribute to decision-making and governance.

Expected societal impact: Better targeted environmental research, relevant to decision-making.

How to influence behaviour? - Sustainable consumers

Achieving resource efficiency is for a large part dependent on decreasing the demand for resources such as water, land, ecosystems, biodiversity, or soil. Regulation and taxation are often used as instruments to change consumer behaviour but also more soft (non regulatory) approaches to influence consumers at large scale justify more research. One such example is changing the default choice for consumers which results in a more sustainable consumption of resources (e.g. vegetarian menu or green energy as default choice). Also the potential role of new media to help change consumer preferences towards sustainable levels of consumption warrants in depth research.

Specific challenge: How to change consumer preferences and behaviour to achieve more sustainable and healthy levels of resource consumption while maintaining human well-being, by developing participatory science.

Expected societal impact: Contribution to resource efficiency targets.

How to influence behaviour? – Improving participatory approaches

Challenge (research gap): The possibility of successfully contributing to policy development can positively steer policy implementation and lead to behaviour change. How can we improve and increase participatory approaches to policy making on the one hand and participative environmental science on the other, leading to actual change in resource use and consumption? Specific regional approaches may be required depending on local and regional conditions (e.g. in Africa).

Expected societal impact: More efficient resource use on voluntary basis instead of regulation.

3) Green economy - enabling the transition

Economy and ecology have the same Greek root, *eco,* yet they currently seem paradoxically somewhat opposite in aim. Economic activity is ultimately a function of ecosystem services, and wholly dependent upon these. Hence, sustainable economy and innovation are dependent upon the protection and sustainable exploitation of the nature, and hence these long term considerations/re-investments in ecosystem services need to be reflected in the way we conduct our economy and innovation – leading to green economy and eco-innovation as the only pass to sustainable development and long-term prosperity. Current economic models need to better incorporate the natural environment-from which all economic activity springs.The solution is development of a green economy which is sustainable leading to eco-innovation and job creation. Horizon 2020 should hence investigate and bring forth the structures needed for this transition.

Challenge: decoupling growth from the use of natural resources, and at the same time creating opportunities for growth and jobs
Aim: to foster eco-innovation and enable a transition to a green economy.

Reconciling sustainability strategies with fundamental socioeconomic assumptions
Specific challenge: The sustainability debate does often not go so deep as to question fundamental assumptions about human needs, welfare etc. and the underlying economic conditions to achieve this. Research on rebound effects is predominantly focused on economical explanations. However, human behaviour is to a large extent motivated by moral or hedonic goals. These motivational issues have to be taken into account when rebound effects want to be understood. How society can be transformed in a way in which eco-efficiency improvements do not rebound offsetting potential environmental benefits?
Expected societal impact: Opposition, accusations of being esoteric, but also critical reflection and possibly willingness to reconceptualise and psychological insights into rebound effect processes are crucial in order to prevent or reduce them. Hence, the societal impact would be solutions, which help to benefit from efficiency technology without suffering from negative side effects. Assuring that we can actually realize potential savings of new promising green technologies.

Review of green economy interventions; assessing their impacts and influence on the system transition.
Specific challenge: Green economy interventions need to be studied systematically; assessing local-regional-global impacts and influence on systems transition.
Expected societal impact: Reduced environmental impacts; improved socioeconomic performance, growth potential for business in domestic and global markets.

Social cost benefit Analysis (SCBA) for Efficient Resource utilization
Specific challenge: Generally, efficiency is defined quite narrowly; specific to a project or a group. In SCBA, efficiency is seen from a view point of whole society.
Expected societal impact: Society's resources can be used optimally and in a sustainable way as SCBA considers the externalities of using the resources.

Post-occupancy evaluation of low impact development
Specific challenge: Little is known about the contribution of designed low carbon/sustainable community low-impact interventions within a green economy.
Expected societal impact: Increasing societal understanding of low-impact type interventions at a community level.