PEER topic ideas regarding Societal Challenge 5

Priorities for research and innovation in the work programme 2018-2020

The PEER topic ideas for the work programme 2018-2020 compile some relevant research demands identified by researchers of the PEER centres and their partners. These ideas are by no means comprehensive. The topics presented below follow the scheduled structure of the WP 2018-2020.

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Call: "Building a low-carbon, climate resilient future: climate action in support of the Paris Agreement"

Topic:

Monitoring and evaluation of experimental initiatives to accelerate the transition to low emission societies

Specific challenge:

The current Intended Nationally Determined Contributions (INDCs) are not able to reach the goals of the Paris agreement. The Paris Agreement therefore requires a proliferation of new solutions for reducing emissions through combinations of innovations in technology and governance.

Experimental approaches at different levels of governance have arisen as a promising route of generating new solutions as well as boosting existing solutions for progressing towards low carbon futures. These initiatives encouraged by various mechanisms and organisations such as the Covenant of Mayors and other city networks, business networks and private sector groups.

The organisations engaged in encouraging mitigation initiatives have developed their own approaches to assess and evaluate the effectiveness of the initiatives, but the standardization and coherence across organisations is not ensured. Current official reporting and monitoring practices such as the monitoring mechanism regulation are also not particularly well geared to identify and evaluate these initiatives and the contribution to low carbon transitions that they may achieve in addition to what is expected to happened through adopted policies and measures.

The lack of comparability in the monitoring, reporting and evaluation of local and business based experimental initiatives means that it is not possible at present to project how much these initiatives can and will contribute to the low carbon transition at the national and European level.

Scope of topic:

The overall scope of the topic is to better understand the experimental climate change mitigation initiatives that local actors and the private sector champion. The topic involves the identification of such initiatives and the development of approaches that improve the evaluation of the initiatives. The proposals should also provide projections of the level of decarbonisation that the initiatives can achieve at national level as a function of the degree of upscaling that can be achieved.

Specific challenge:

The evaluation of local and private sector climate mitigation initiatives is challenging because the assessment and evaluation protocols vary across groups of initiatives. The comparability is therefore often weak, which hampers opportunities for in depth learning, knowledge transfer and effective upscaling and duplication of effective initiatives.

Specific scope: Proposals should focus on developing approaches for the systematic evaluation of local and private sector initiatives, including ways to assess the potential for upscaling of the initiatives. The proposals should emphasise participatory approaches and provide tools that can be applied across scales and contexts. Actors encouraging the initiative should be engaged in the development work to achieve co-creation of the protocols for monitoring, reporting and evaluation (MRE). Proposals should furthermore link the evaluation of the local and private initiatives with the official MRE processes in order to demonstrate how integration could be achieved.

Expected impact:

The proposals are expected to increase understanding of the merit and worth of local and business based mitigation initiatives in fostering transitions towards low carbon societies.

By developing systematic approaches the proposals will provide a base for upscaling and duplication of mitigation initiatives. The proposals will also help to improve the official MRE processes and the general assessments of the low carbon strategies.

The foreseen systematic approach is also expected to encourage public-private dialogues and help also businesses to develop credible low carbon initiatives.

Type of Action: RIA

Topic:
Towards robust inventories of climate mitigation in the LULUCF sector - Support of regional scale high resolution remotely sensed data

Specific challenge:

As part of international agreements, such as the Kyoto protocol, all EU member states are obliged to assess Greenhouse Gas (GHG) emissions related to land use, land use change and forestry (LULUCF). Furthermore, in the wake of the Paris Agreement (PA) and the EU Climate Action, focus on the LULUCF sector is likely to increase.

Individual countries' monitoring schemes of LULUCF however vary substantially in terms of applied data and methods as well as in detail and accuracy. Low accuracies are particularly found in relation to dynamics including forested land and wetlands, which are difficult to monitor on basis of conventional data. To support the implementation of the PA, there is a need to advance monitoring and verification frameworks for the LULUCF sector.

A specific challenge is to develop methodologies for robust and future-proof assessments of emissions and sinks of GHG within the LULUCF sector. The initiative requires a transdisciplinary approach to bring together European expertise in remote sensing and spatial modelling with expertise from emission modelling.

Scope of topic:

Land use and land cover, particularly related to agriculture and forestry, are continually changing. Emissions and sinks of greenhouse gases (GHG) related to LULUCF are therefore major components of GHG balances. Recent years have seen an extensive development within regional scale high resolution airborne remotely sensed information. These include e.g. multispectral satellite images, such as Sentinel2 images from the European Space Agency (ESA) and airborne laser scanning data (ALS). Developing and expanding the application of such regional scale, high resolution airborne remotely sensed data within LULUCF sector will result in unprecedented detail and resolution of crucial information.

Proposals should develop methods to apply high resolution remotely sensed information to support a more robust and future proof inventory of GHG emissions at country and European scale. They should develop and apply methodologies for improved monitoring of land use and land cover changes in the LULUCF sector. Proposals should particularly focus on changes related to monitoring of forest and other woody vegetation and to wetlands, which currently are characterized by rather low accuracies.

Expected impact:

The action will produce relevant scientific knowledge in advance of key PA-related milestones, such as the publication of national mid-century strategies (2020), the 6th assessment cycle of the IPCC (2018-2022) and the first global stock-take in 2023.

The action should lead to guidance for good practice for monitoring of LULUCF at country level and substantially increase the robustness and consistency of GHG emission inventories at European scale. It should particularly provide improved knowledge of and methods for:

- Mapping of dynamics between forest and other land use types
- Assessment of the standing biomass in forest and other woody vegetation
- Monitoring of soil humidity related to change in wetlands

Type of Action: RIA

Topic:

Heat waves and droughts

Specific challenge:

Heat waves and droughts are creeping hydro-meteorological events that could bring societies and natural systems to their limits, inducing large famines, health risks to the population, drinking and irrigation water shortfalls, natural fires, degradation of soil and water quality, and in many cases large socio-economic losses. The heat wave / drought of 2003 had e.g. substantial effects on plant mortality and plant productivity in Central and Western Europe.

According to the IPCC (AR5), it is likely that the frequency and duration of heat waves since 1950 has changed in large parts of Europe, Asia and Australia. In some regions, it is likely that human influence has more than doubled the probability of occurrence of heat waves. Models project near-term increases in the duration, intensity and spatial extent of heat waves and warm spells.

Mutual enhancement between droughts and heat waves in transitional regions between dry and wet climate is common. A drought can make a hot day hotter, while a heat wave can make dry conditions even drier. A characteristic of these hydro-climatic extremes is that they may be the result of an accumulation of weather or climate events that are, individually, not extreme themselves - though their accumulation is extreme.

There is medium confidence that droughts will intensify in the 21st century in southern Europe, the Mediterranean region, and central Europe, due to reduced precipitation and/or increased evapotranspiration. These expected changes would bring unprecedented socio-economic consequences to Europe.

These extreme events leave their legacy on ecosystems and their functions. Due to their singular properties, it is difficult to assess how these events exactly change ecosystem functions and their services (e.g. sustainable provision of food) and much better understanding and prediction is required, including of the economic consequences which can be tremendous (most obvious are e.g. direct losses in agriculture).

Scope of topic:

The understanding of changes in ecosystem functions and services related to heat waves and droughts requires improving skills of numerical weather prediction models (NWP), hydrological models (HM) and monitoring the current vegetation state (productivity/stress), and the linking of their predictive output to changes of ecosystem functions and services (EFS).

This challenge is intrinsically related to four issues: 1) how to get close to reality initial conditions, 2) how to reduce the simulation errors associated with the spatial discretization, 3) how to link the information about potential changes in abiotic factors to potential changes in the ecosystems, and 4) how to assess the consequences for ecosystem functioning and services affected by heat waves and droughts.

The first challenge is ultimately a question on how to get real time observations to be able to assimilate them in the respective models. This implies designing intelligent monitoring networks and mobile devices that can be deployed fast and efficiently where they are mostly needed. This can more easily be done for abiotic conditions. Detecting and recording biotic changes, however, is inherently difficult since it is time-consuming, cannot be done in an automatized way and ideally shall perform a “before-and-after comparison”. The second issue is a problem of computational capability and storage. The third issue addresses the challenge to turn the prediction of changes in abiotic parameters on prediction of changes of ecosystems (e.g. agricultural ecosystems) which is precondition to issue four the assessment.

Expected impact:

Delivering a framework that will enable prediction and analysis of the impacts of heat waves and droughts and their associated societal costs will be essential to mitigate these impacts and hence save a considerably proportion of costs incurring otherwise.

Type of Action: RIA

Topic:

Decision making in a context of climate change: assessing the impacts of natural risks on hydrosystems

Specific challenge:

The water cycle is vulnerable to global dynamics and quite notably to climate change and urbanisation. Climate change induces substantial modifications in hydrosystems and natural hydrological processes. Temperature increase, changes in rainfall patterns, glaciers retreat, ice thawing and extreme weather events triggered by climate change are expected to have an impact on the seasonal distribution of water resources, the state of aquatic ecosystems and hydrological risks (floods, droughts, avalanches, etc.), and consequently on natual and social systems. Measures are needed both to enhance the resilience of hydrosystems to such impacts, and to restore, preserve and manage hydrosystems. **Informed decisions could be taken if impacts were quantified more precisely and if risks were better evaluated. Improvement of policy support tools through modelling, risk assessment and forecasting tools is still manadatory.** In cooperation between engineering, natural and social scientists, nature- and ecosystem-based solutions that preserve ecosystems and that at the same time enable better risk management shall be developed.

Scope of topic:

The challenge here is to underpin policy decisions through the provision of policy-relevant information for adaptation and mitigation to climate change. Integrated approaches of water use and the water cycle, decision support tools, and nature- and ecosystem-based solutions need to be developed to tackle this challenge.

Integrated models should look further at better quantifying the impacts of climate change on seasonal river flows, water catchments, hydrogeological risks (floods, droughts, etc.) and society. To do so, such models need to encompass all compartments of the water cycle (atmosphere, surface soil, non-saturated zones, groundwater) and all possible uses of water resources.

The application of concepts around the determination of non-stationary processes, and their evolution in time, needs to be further explored in order to more effectively model risks caused by climate change. More research actions need to be targeted to the quantification of multi-risks as a basis for land use planning and for a competent emergency management before and during catastrophic events.

Specific objectives are:
- To better assess the impacts of climate change on both natural and social systems through the development of integrated models,
- To forecast the risks of climate change through decision support tools and early warning systems,
- To offer nature- and ecosystem-based solutions to preserve ecosystems and to protect both ecosystems and humans from hydrogeological risks.

Expected impact:

As a result of actions in this area, public authorities and society at large will be better prepared to respond to risks and impacts of climate change (e.g. floods, droughts, poverty, social conflicts due to limited resources). Innovative and integrated tools will offer a more holistic view of climate change processes, and policy makers will be able to take more informed decisions for climate change mitigation and adaptation, and for a more sustainable use of water resources.

The strong focus of this subject on the development of innovative models and policy support tools may make European research a potential game changer in climate change issues, giving Europe the opportunity to become a world leader in the delivery of policy support tools in climate change.

Actions will support the objectives of the EU Adaptation Strategy on adaptation to climate change, COM (2013) 216.

Type of Action: RIA

Call: "Greening the economy in line with the Sustainable Development Goals (SDGs)"

Connecting economic and environmental gains - the circular economy

Topic:

Development of innovative solutions combining ecosystem carbon storage and bioenergy with carbon capture and storage (BECCS) enabling large scale negative greenhouse gas emissions

Specific challenge:

Meeting the ambitious climate targets of the Paris Agreement requires significant cutbacks in greenhouse gas emissions, and in the last half of the 21st century even negative emissions. Most of the current greenhouse gas emissions relate to the use of fossil fuels for energy and energy intensive materials, and a transformation from fossil based systems towards energy and material supply systems based renewable resources is essential. The scale of the challenge is immense. At the end of the 21st century up to ~15 $GtCO_2$ must be removed from the atmosphere annually. A number of options have been identified to provide negative emissions. **Bioenergy with carbon capture and storage (BECCS) is a means of ensuring negative emissions**, through displacement of fossil fuels and moving carbon from the fast domain of the global carbon cycle to the slow domain. Increased carbon storage in ecosystems, e.g. in forests or agricultural soils can be achieved by alternative forest management, forest restoration, reforestation and landscape restoration. Options and instruments can be combined for enhanced efficiency.

To meet the challenge it is imperative to build comprehensive evidence on the opportunities and barriers for negative emissions in the complex interplay between ecosystem management, energy technologies, resource use, circular economy and policy development.

Scope of topic:

Terrestrial ecosystems, particularly forests, have the ability to store significant amounts of carbon for a long time in living biomass, and, at the same time, produce a wide range of products that can displace fossil fuels and energy intensive products like concrete, steel and plastics. The European forest area has continuously increased since 1750. The same applies to the growing stock and growth rates. Wood harvests have generally increased in the same period to support an increasing demand for timber and woody biomass for multiple purposes and products. On local level sustainable intensification can increase production, and additionally, afforestation on degraded lands can increase production of bio-based renewables.

Climate targets call for the development of novel land management strategies and for integration between land management, energy technologies including BECCS and energy system management. A move towards a circular economy is expected to be a major driver for such a development.

A transdisciplinary approach is required to analyse and optimise entire resource and energy systems with BECCS to identify trajectories towards negative emissions and sustainable societies including ecosystem/forest science, environmental science, energy systems science and economic/political science.

Proposals should address:

- economic dynamics between bio resource production, BECCS and CO2 emissions;
- assessment of policy opportunities and barriers to develop and deploy BECCS in Europe;
- development of novel land management strategies that ensure long term productivity and resilience, including protection of biodiversity and ecosystem functions, increased carbon storage potential and increased production potential to displace fossil products for energy and materials; and
- assessment of GHG mitigation potentials.

Expected impact:

Results will contribute to:

- policy recommendations to enable authorities to develop efficient incentives and governance to support the transition towards a net negative emission energy sector;
- a clear understanding of the ecological and technical opportunities to achieve negative GHG emissions from the energy sector through ecosystem carbon storage and BECCS in the view of climate change, sustainable land/forest management and circular economy;
- quantification of the trade-off between carbon storage and fossil carbon displacement to inform implementation strategies, long term planning of energy supply, and optimum siting of BECCS utilities;
- European industries to develop commercial opportunities and technologies;
- major international scientific assessments from e.g. IPCC, IRENA and the global energy assessment (GEA).

Type of Action: RIA

Water for our environment, economy and society

Topic:

Securing the good quality status of aquatic ecosystems under multiple pressures

Specific challenge:

40% of European aquatic ecosystems are subject to multiple pressures ranging from chemical pollution to emerging pollutants, land cover use, exotic species, habitat damage and climate change. Many research efforts have been made in water quality control but there are still knowledge gaps on the long-term effects of multiple pressures on aquatic ecosystems, including living organisms, and hydrological networks. Knowledge is still needed regarding the resilience and adaptation of aquatic ecosystems to long term multiple pressures and new tools are yet to be put forward to better support water management.

Multiple pressures pose a series of complex and non-linear challenges for aquatic ecosystems conservation and restoration. Such complexity is partly due to the combined effects these pressures bring to ecosystems whereby the cumulative damage of multiple pressures may be more than the sum of the individual parts.

As regards chemical pollution (pesticides, heavy metals, pathogens or endocrine disruptors, to cite just a few contaminants), their long-term effect on both ecosystems and human health still needs to be better assessed. This also requires progress in the detection of chemical pollutants, and therefore in the complex analysis of their effects.

Going beyond chemical pollution, there is insufficient knowledge on the effect of multiple pressure factors on biodiversity, the overall status of ecosystems and hydrological networks. There are still uncertainties about the variable impacts of multiple pressures in different levels of organization of living things (from the cell unit to ecological interactions across organisms) and in different transition zones (notably urban-peri urban, transitional waters).

The fundamental importance of water resources, the degradation of ecosystems, including the loss of biodiversity, and the vulnerability of aquatic ecosystems to local and global changes call for more actions aimed at **untangling the effects of multiple pressure factors on aquatic ecosystems and at building long term predictions and management tools**.

Scope of topic:

It is important to a) identify best available measures to better preserve and restore aquatic ecosystems subject to multiple pressures, and b) better inform decision makers on available management practices and policies e.g. in order to improve implementation of the Water Framework Directive.

Activities may include:

- Development of functional indicators and tools for the screening, monitoring, detection and risk assessment of pollutants;
- Better understanding of the long-term effects of multiple pressures on aquatic ecosystems, different levels of organization of living organisms and hydrological networks. For this purpose, observation (long term / large scale from existing databases), experimentation (on target ecosystem functional components) and modelling approaches shall be developed;
- Improved assessment of the resilience and adaptation capacity of aquatic ecosystems exposed to multiple pressures;
- Application of innovative nature-based and ecological engineering practices to restore aquatic ecosystems;
- Development of novel tools for water management.

Expected impact:

Actions in this area will lead to a better characterization of the state of ecosystems, their

vulnerability and tipping points, and especially to a better understanding of the ecological dynamics of aquatic ecosystems subject to multiple pressures. This knowledge is a prerequisite to successful watershed management and safeguarding of an adequate ecological status.

Innovative approaches and practices will be designed and implemented to restore/maintain European aquatic ecosystems, which will allow better complying with the EU Water Framework Directive.

Type of Action: RIA

Topic:

Integrated and adaptive water management: A driver for water security and diplomacy

Specific challenge:

In a context of climate change and growing population, water supply will become a challenge in many areas of the world. Water scarcity is expected to exacerbate in the years to come as a result of more long-term and frequent droughts. Growing population will demand for more water for different uses (human consumption, industry, agriculture, etc.) increasing the risk of water-related conflict.

In response to these challenges there is a renewed interest for decentralised approaches to prevent tensions in water management. The Water Framework Directive (WFD) has succeeded in setting out collaborative management programmes at the catchment level. However, the evaluation of recent River Basin Management Plans (RBMPs) shows that not all goals can be reached e.g. regarding the ecological status of European waters, and that water policies should be better linked with other policies (e.g. Floods Directive).

An overarching challenge is to find the right balance between water supply at appropriate quality levels for different uses (e.g. agriculture, energy, industry, human consumption) and water demand in order to satisfy consumption needs whilst securing the protection of water resources. Efforts should aim at the establishment of long-term adaptive strategies for water management in Europe that take into account users' water needs, learning processes, natural risks to water supply, the resilience and adaptation capacity of water and society (as direct users of the resource), water management assets and governance systems.

Scope of topic:

Breakthroughs are needed in the development of approaches for (i) a better understanding of the natural and anthropogenic processes that govern water quantity and quality; (ii) assessing the state/ vulnerability of hydrosystems and societies; and (iii) the identification of best available adapative water management options. Innovative ideas around decision support tools and governance models are still required. Special attention should be paid to rationalise water management measures as they are conventionally the seeds of conflicts and competition between stakeholders for a limited resource. This requires:

- Better understanding and evaluation of the vulnerability of society and hydrosystems at the scale at which water policies are applied (socio-hydrosystems);
- Monitoring tools to better control the responses of socio-hydrosystems to global changes;
- Development of tools aimed at supporting decision making by providing a better understanding of the effects of natural processes (climate change) and human-driven activities (e.g. agriculture) on water resources, including: participatory-based information systems, water-energy-soil technologies, adoption of policies to support circular economy, integrated models to tackle water-related challenges (see separate topic as well);
- Anticipation and management of social tensions as a result of competitions for a scarce resource;
- Innovative governance models that reflect more accurately social water needs in a context of global change.

Expected impact:

Actions in this field will lead to **water security across sectors**, including a more accurate assessment of water needs and the resilience/ adaptation capacity of hydrosystems to global changes. This will allow making informed decisions and formulating policy at the local, national and even transboundary levels. Information will add legitimacy to the decision-making process whilst promoting public acceptance and the resolution of social conflicts, leading to **credibility of political decisions** on water issues.

Type of Action: RIA

Protecting and leveraging the value of our natural and cultural assets: Earth observation

Topic:

Remote sensing of soil moisture at high spatial and high temporal resolution

Specific challenge:

Soil moisture is a key variable in processes controlling the fluxes of water, carbon and energy between the atmosphere and the land surface. Knowing the soil moisture is essential for predictions how the rainfall that reaches the land is divided between moisture stored in the soil (important for crop growth), run-off (which could cause erosion, and related loss of fertile topsoil), and ground water recharge (reliable groundwater stores are crucial for irrigation and drinking water resources). Local and international businesses would also benefit from soil moisture information. Enhanced or newly developed tools using soil moisture data would help farmers and agribusiness optimize their irrigation water use or manage risk associated to crop failure; water companies manage their water supply; infrastructure managers assess risk of damage by erosion or landslips to road and rail networks; and lending and insurance enterprises improve localized risk assessment models.

Scope of topic:

SMOS and SMAP were built to fit the requirements of the Earth system science community, who are studying global land surface patterns, climate and climate change. Soil moisture measured at spatial and temporal resolutions that are suitable for other users are not yet available, although this would unlock the unrealized societal benefits identified by GEO. There are other relevant missions currently in orbit or planned for launch soon. For example, the UK TechDemoSat-1 mission carries a GNSS Reflectometry instrument which in effect is a low cost L-band forward-scatterometer, and is showing potential for soil moisture sensing. It will be followed at the end of 2016 with the NASA CYGNSS mission which has 8 small satellites carrying the same instrument. The ESA Sentinel-1 constellation has started to deliver global coverage of active SAR (C-band) data and also has the potential to provide frequent soil moisture data. There is scope for improving soil moisture retrieval: nearly all current soil moisture retrieval algorithms based on SAR have used backscatter. Recent studies have demonstrated a clear link between soil moisture and interferometric phase suggesting that the use of both the incoherent (backscatter) and coherent (interferometric phase) image products could be a new and promising approach. Research should be carried out to deliver EO derived soil moisture at high spatial and temporal resolutions that match user requirements (e.g. 100m, daily). The research should consider current missions but also deliver experiments that would help inform future mission designs.

Expected impact:

- New soil moisture models, prediction and forecasting tools
- Enhanced or newly developed tools using soil moisture data relevant to end-users, e.g. farmers, agribusiness, infrastructure, insurance
- Information for the design of future EO missions

Type of action: RIA

Protecting and leveraging the value of our natural and cultural assets: Nature-based solutions, disaster risk reduction and natural capital accounting

Topic: **An integrating nexus of land and water management for a sustainable bioeconomy**
Specific challenge: Policy makers are preparing for a societal transformation towards a bio-based economy, with the overarching aim to create new businesses and job opportunities in the bio-economic sectors. However, the dimensions, directions and consequences of such a green shift are known today only as rough sketches (EC 2015). A bio-economic green shift will change current land use in rural areas, due to increasing demands for fiber, feed, food, fuel and new biomass products. Competition between agriculture and forestry for available space will intensify. More space is also needed to reduce flood risk and degradation of freshwater resources and biodiversity, as required by various EU directives and strategies (Floods Directive, Water Framework Directive and the EU Biodiversity strategy 2020). Drastic land use changes and/or increased biomass outtake may also have far-reaching and long-lasting consequences for environmental and water quality, for river flow patterns, as well as for the living environment and working conditions of rural (human) communities and businesses. However, there is also not quantified innovation potential linked to novel exploitation of the aquatic and terrestrial biodiversity/bioresources. To identify the window of opportunity for a sustainable bio-economic development, there is a need for integrating various climate and land use options with hydrology, biogeochemistry, inland water quality, ecology, ecosystem services, as well as socio-economic costs and.
Scope: Proposals will provide the knowledge base for environmental, land and water resources management considering potential and competing demands for biomass and water. The opportunities and limitations of the green, bio-economic shift for Europe will be assessed. Optimal solutions will be identified to adapt to an intensification of water and material cycles, while maintaining the diverse services of land- and freshwater systems. Interdisciplinary research teams and stakeholders from policy, management and industry across Europe and beyond need to be established to outline various scenarios for a sustainable bioeconomy development. The scenarios should be in line with the IPCC SRES scenarios. Advanced modelling tools, bioeconomy roadmaps and scenario inputs from stakeholders should be applied. The following aspects will be addressed: (i) the present and historical biomass and resource usage in the context of climate change and other drivers/pressures (ii) the stocks/flows/pathways of water, carbon and nutrients and their impacts on water status and biodiversity, and (iii) the value of ecosystem services provided by water and biomass resources and (iv) the innovation potential from exploitation (e.g. bioprospecting) of unused resources, (v). technological innovative solutions, including nature-based measures to reduce flood risk, retain pollution (organic carbon, nutrients, contaminants), re-use and recycling. An accounting framework for ecosystem services and strategies for adaptive management, governance and sustainable use of resources will be developed. Furthermore, the research should consider value-chain and policy perspectives, including possibilities for new markets, regional and rural development and employment including changes in present regulations and governance instruments.
Expected impact: Understanding interactions between primary sectors, bio-based industries, climate, hydrology, ecology and society in an interdisciplinary way will lead to good management and engineering

practices, new innovative technological solutions, as well as development of sustainable pathways for action. An interdisciplinary science-policy-based platform will contribute to increased, but also sustainable biological resource use in the primary sectors and industries, as well as education of students and younger researchers in integrated and holistic 'thinking' and entrepreneurial skills.

Type of Action: RIA

The next two topics present rough ideas requiring further elaboration:

Topic:

Citizen science enabling nature based solutions which build on the biodiversity hypothesis

Specific challenge:

The inflammatory diseases are becoming more common in urbanized societies. Due to intensifying urbanization, there is an increasing need to pay more systematic attention to the role of healthy environments as a base for health and well-being. According to the *biodiversity hypothesis*, the role of biodiversity, including environmental microbiota in natural habitats, is essential in developing human microbiota, which in turn is essential in development of immune tolerance. In biodiversity poor environments the development of immune tolerance is unbalanced, having connection even with increased risk for inflammatory diseases.

Scope of topic:

The *biodiversity hypothesis* encourages exploring how the occurring and emerging green infrastructure can - through its enabling functions – foster health and well-being. In such processes, it is relevant to see the complexity related to environmental health, and in line with the biodiversity hypothesis to explore how the use of and attachment with biodiversity can be increased in various actions, including for example urban farming, mobility and being. The role of citizen science (using innovative applications) is of particular relevance in measuring biodiversity elements in the living environment, actions taken, and finally perceived health. Because stages of urbanization have different challenges and opportunities related to the biodiversity – immune tolerance chain the study should develop empirical settings to compare and lessons learnt across them.

Expected impact:

- developing the conceptual framework
- developing means and practices to measure the biodiversity hypothesis through citizen science
- developing innovative applications to measure living environment and well-being
- lessons learnt about improving qualities of living environments across various stages of urbanization

Type of Action: RIA

Topic:

Procedural justice and Nature Based Solutions

Specific challenge:

There is an increasing need to develop innovative business opportunities related to nature based solutions in cities, in order to find long term solutions to societal challenges encountering from urbanization and to feed for green economy in a sustainable way.

Scope of topic:

To be able to pay attention to the process of developing business opportunities related to nature based solutions, a strong procedural expertise is necessary. Building such expertise requires experimentation and demonstration as well as their critical analysis. Particularly when the aim is to encourage small and medium sized enterprises to find new and innovative roles for themselves in developing markets, more attention should be paid to procedural justice, i.e. to means and practices on how the process of defining and implementing nature based solutions to specific societal challenges occurs, as well as which actors are recognized as the relevant ones to be involved in the process. Moreover, new innovative, alternative platforms should be developed to encourage new types of digital communication and dialogue between actors in order to develop new innovative ways to see and use nature based solutions in cities.

Expected impact:

- developing an innovative conceptual framework
- increased involvement and capacities of small and medium sized enterprises to improve their business on developing markets related to nature based solutions
- new innovative platforms to support such business innovations
- democases to develop, test and disseminate innovatively best practices

Type of action: RIA