Europeans' Strategic Research Agenda for Integrated Spatial Planning, Land Use and Soil Management

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Disclaimer

Contents

“This Strategic Research Agenda (SRA) is based on research and innovation needs identified by over 500 stakeholders from across Europe in a unique bottom-up approach.”

Foreword

The Europeans’ Strategic Research Agenda for Integrated Spatial Planning, Land Use and Soil-Sediment-Water Management

Soil provides us with essential services. We grow our food in it, it filters rainwater before it reaches aquifers, it supports our buildings, it hosts diverse life forms. Europeans need multi-functional and healthy soils locally and globally to maintain this natural capital while satisfying the needs of a prosperous society. Soil must be safeguarded by urban and rural spatial planning and sustaining soil and land management based on applying the best available knowledge.

This Strategic Research Agenda (SRA) is based on research and innovation needs identified by over 500 stakeholders from across Europe in a unique bottom-up approach. These needs reflect genuine demand from end users. It is designed to encourage collaborative funding by public and private parties. It will also ensure that knowledge is widely applied by public sector bodies, SMEs and large enterprises wishing to innovate and contribute to a greener, more socially cohesive, smarter and more competitive Europe.

Collaborative funding becomes necessary in times of limited budgets. It is important to create synergies when an organisation does not have the resources to fund a research activity in its entirety. Collaborating with other funders ensures the research activity takes place. Moreover, collaboration allows complementarity between countries’ expertise, facilitates involvement of highly competent and skilled researchers and committed stakeholders from across Europe.

This SRA – based on land and soil user needs – offers the guidance on the specific research required by stakeholders to close their knowledge demands, at all levels from the European to the local. We therefore present, how key stakeholder groups – namely end-users, researchers and citizens – benefit from the implementation of research specifically addressed in the SRA.

What follows is a guide on how to use this document and how to access information online.

A reader's guide

This document is written for someone using it, browsing through it or even just glancing at it. It is written for the funder, the end user, the researcher and the citizen. Colour coding indicates text intended specifically for **funders (blue)**, end **users (red)**, **researchers (green)** and **citizens (purple).**

This knowledge creation, transfer and implementation agenda for Integrated Spatial Planning, Land Use and Soil Management in the light of current and future societal challenges emerged from a funder and end-user demand-driven bottom up approach. Several existing funding models that could facilitate the execution of strategic research projects are introduced.

Why should research funders continue reading?

Funders will find summaries, including the anticipated impact, of each research need. They can see which topics fit with their own funding schemes and decide upon priorities. This will help funders decide to what extent they wish and may be able to contribute to investing in a specific topic. As all topics were identified as common trans-national of interest, they all have a potential of international co-funding.

Why should end users continue reading?

End users bridge between (pure) knowledge and its application to tackle societal challenges. End users will find summaries of the anticipated benefits to different types of end use (industry, spatial planners, regulators, policy makers). They can decide which research needs are most likely to benefit their organisation. This will help end users identify and decide which research needs to promote, to support, to get involved with or even support by their own funding schemes.

Why should researchers continue reading?

Researchers can see what difference their work would make if they committed intellectual capital and energy to satisfying individual research needs. Understanding the kind of activities needed – knowledge creation, knowledge transfer, demonstration - will help researchers prioritise proposal writing efforts.

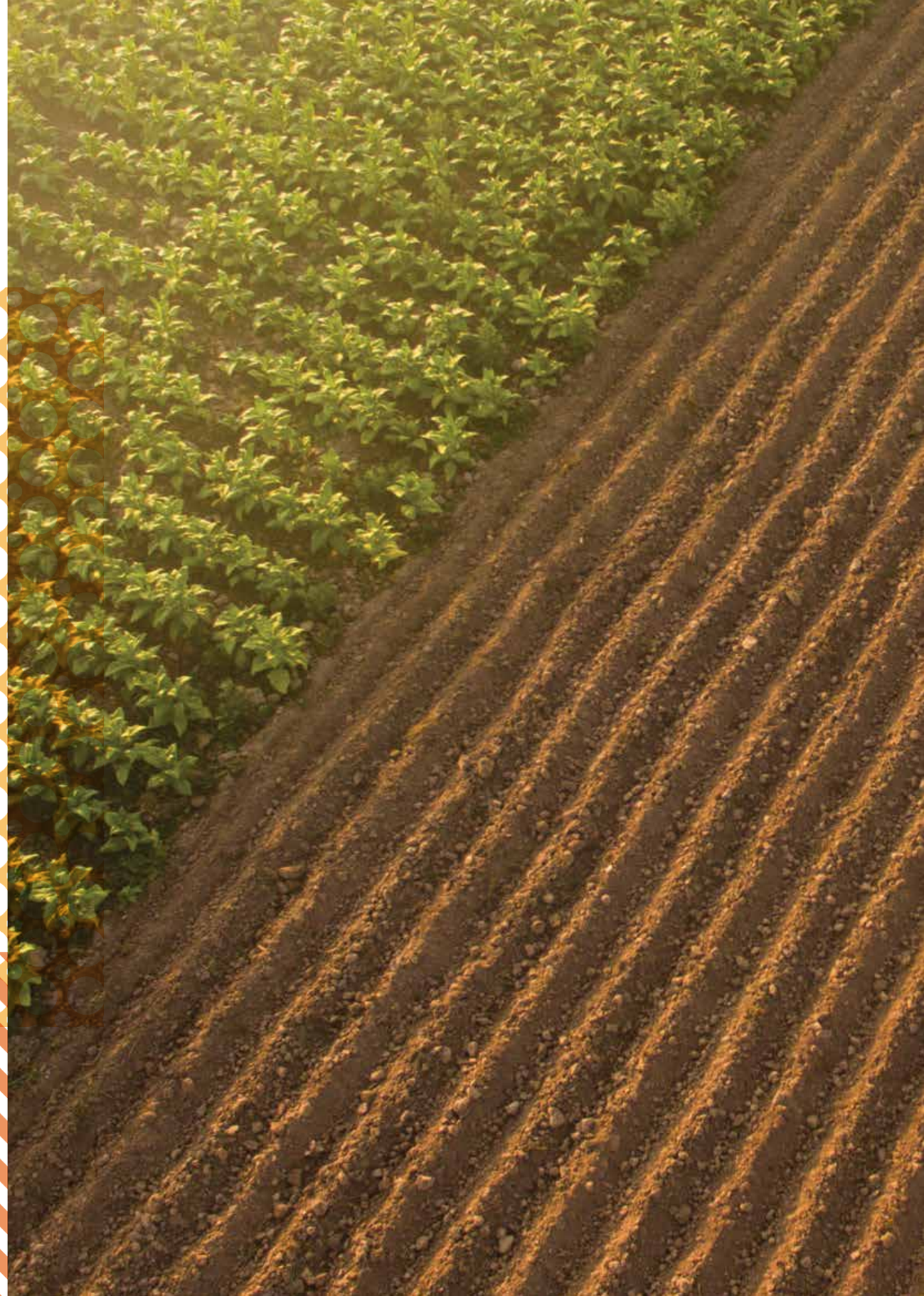
Why should Europe's citizens continue reading?

Quality of life depends to a large extent on how we look after our soil as well as plan and use land for recreation, building, transport, agriculture, mining etc., in both the medium and long term. Europe's Citizens will ultimately benefit from the outcomes of the research needs identified. As such, citizens will be able to read what difference each research need will make in terms of health, safety, prosperity and well-being thus identifying the added value of investing their taxes on this research.

Executive Summary

Europeans' Strategic Research Agenda for Integrated Spatial Planning, Land Use and Soil Management

Land and soil provide us with food, drinking water, energy, materials for shelter, support for infrastructure. They help us overcome the challenges of climate change, non-renewable natural resources and environmental (in)justice. Land and soil, including water and sediment, are finite resources facing growing pressures and with conflicts over their use that contribute to over-consumption of natural capital. "Business as usual" is not an option for Europe and a degree of urgency involving wise land use and soil management is needed to balance the supply of natural capital and ecosystem services with society's demands.



INSPIRATION recognised that the imbalance between the supply of, and societal demands on, natural capital is in part created by land-use management practices whose net impact is insufficiently understood. This helped identify specific research needs on supply of and demand for natural capital, land-use management and net impact evaluation.

The INSPIRATION Strategic Research Agenda (SRA) comprises 17 integrated and 22 thematic research and innovation topics. These are based on needs identified by more than 500 European funders, scientists, policy makers, public administrators and consultants.

The SRA considers soil and land use management challenges, including the links between the soil-sediment-water (SSW) system and topics such as health, energy, climate change, resilient, water supply. It recognizes the need for new knowledge and, particularly, for new applications of knowledge to plan, manage and use land and the SSW system.

The SRA is designed to help public and private research funders identify research they should invest in to innovate and contribute to a greener, more socially cohesive, smarter, more competitive and ultimately more sustainable Europe.

The European Commission and several European countries seek to put the 17 United Nations Sustainable Development Goals [1]published in 2015 at the heart of their policy frameworks, priorities and budgets. Notably, the Commission "commits to mainstreaming the SDGs into EU policies and initiatives … and into the Commission's everyday work". The stakeholder-driven research needs presented in this SRA map on to the SDGs and will enable the Commission and individual countries achieve these goals.

Transnational co-funding is key to creating synergies for organisations wishing to invest in research activities. Support for interested funders will be available until August 2019. National Contact Persons will be available for providing support and for making cross country contacts regarding specific research demands for co-funding.

The complete INSPIRATION Strategic Research Agenda, the background on its development and information on how to contact your National Contact Person is available online at www.inspiration-agenda.eu.

1 https://unstats.un.org/unsd/statcom/47th-session/documents/2016-2-IAEG-SDGs-Rev1-E.pdf

Bottom-up Demand-Driven Research Needs

A set of 17 integrated and 22 thematic research needs have been identified. Thematic needs have been identified for Natural Capital and Ecosystem Services Supply (NC), Demand for Natural Capital and Ecosystem Services (D), Land Use Management (LM) and Net Impact (NI). The integrated needs (IRT) cut across these themes.

Integrated Research Needs

IRT-1: Integrated Environmental Assessment and Soil Monitoring for Europe
IRT-2: Recognising the value of ecosystem services in land use decisions
IRT-3: From indicators to implementation: Integrated tools for a holistic assessment of agricultural and forest land use
IRT-4: Bio-Economy – unleashing potential while sustaining soils
IRT-5: Integrated scenarios for the Land-Soil-Water-Food system under societal pressures and challenges
IRT-6: Indicators for assessing the efficiency of the Soil-Sediment-Water-Energy system
IRT-7: Farming systems to maintain soil fertility and yields
IRT-8: Circular land management
IRT-9: Policies to effectively reduce land consumption for settlement development
IRT-10: Stakeholder participation to facilitate the development of liveable cities
IRT-11: Integrated management of urban soils
IRT-12: Environmentally friendly and socially sensitive urban development
IRT-13: Urban Metabolism – Enhance efficient use of soil-sediment-water resources through a closing of urban material loops
IRT-14: Emerging contaminants' in soil and groundwater – ensuring long-term provision of drinking water as well as soil and freshwater ecosystem services
IRT-15: Sustainable management to restore ecological and socio-economic values of degraded land
IRT-16: Innovative technologies and eco-engineering 4.0: Challenges for sustainable use of agricultural, forest and urban landscapes and the SSW system
IRT-17: Improving preparedness and response for climate change and related hazards

Natural Capital and Ecosystem Services Supply

NC1: Quantity, quality and health of soils, soil carbon, greenhouse gases
NC2: Biodiversity, organismic and genetic resources
NC3: Water, water cycle
NC4: Pollutant degradation, filtering and immobilization capacity
NC5: Prevention of erosion and mudslides
NC6: Geological resources
NC7: Intrinsic values of soils and landscapes

Demand for Natural Capital and Ecosystem Services

D1: The 4 F´s: Food, feed, fibre, (bio)fuel
D2: Regulating Ecosystem Services
D3: Urban / infrastructure land
D4: Water
D5: Geological (and fossil) subsurface resources
D6: Natural hazard prevention and resilience
D7: Health and quality of life (living environment)

Land Use Management

LM 1: Governance, management mechanisms, instruments and policy
LM 2: Climate change challenges for land management
LM 3: Land as a resource in urban areas (Sustainable urban land management)
LM 4: Land as a resource in rural areas (Multifunctionality of rural areas)

Net Impact

NI 1: Developing impact assessment methodology
NI 2: Understanding and assessing impacts of drivers and management
NI 3: Trade-off analysis & decision support
NI 4: Science-Policy-Society Interface

What's in it for you?

This agenda reflects research and innovation demand from a range of perspectives and organisations. It is based on evidence from over 500 stakeholders from across Europe of how Integrated Spatial Planning, Land Use and Soil Management can be improved and what benefits are anticipated from such improvements.

Funders

This bottom-up, demand-driven research agenda is intended to increase coordination and targeting of investment in research. There are many shared needs from more than 17 countries. Individual funders looking to invest their funds in more efficient ways may wish to co-fund specific research activities, including knowledge transfer, with other partners across Europe.

Please contact us with details of which research needs you may wish to co-fund, indicating what budget you may be able to devote, timings for key decisions and any other information that INSPIRATION will help to bring together funders from across Europe to work together.

End users

End users include enterprises using or affecting land; drinking water and energy producers, distributors and suppliers; spatial planners, consultants, brownfield developers and remediation contractors; farmers, foresters and food companies; financiers; policy makers and regulators. End-users will use the knowledge created by research activity.

End users have much to gain from being partners in research projects: helping to formulate projects, sharing existing knowledge, helping validate the outcomes and of course ensuring findings are put into practice.

Researcher / knowledge translators

Research creates knowledge that needs to be translated into policy, practice and across areas of application if it is to have an impact. The SRA presents researchers with the possibility of working on demand-driven research defined by an unique bottom-up approach that might help in getting research projects funded.

Researchers and knowledge translators are provided with information on how working on the identified research needs will have an impact on addressing specific societal challenges should funding become available.

Citizens

Europe's citizens are the ultimate beneficiaries of resolving societal challenges. Their daily lives will be enhanced by the outcomes of the research activities in this agenda.

Projects related to societal challenges benefit from citizens being involved in planning, execution and reporting. This agenda has benefited from local and detailed perspectives and non-technical contributions from citizen group representatives.

Integrating Research Needs

Integrated Research need	Likely impact
IRT-1: Integrated Environmental Assessment and Soil Monitoring for Europe	Long term monitoring to show changes in soil quality to levels impacting soil function, food security and human health and to measure progress on land degradation neutrality.
IRT-2: Recognising the values of ecosystem services in land use decisions	Assessing magnitude and societal distribution of costs and benefits of land use options (e.g. through cost-effectiveness analysis) can help mainstream the value of ecosystem services into decision-making.
IRT-3: From indicators to implementation: Integrated tools for holistic assessment of agricultural and forest land use	A move away from segregated decision making, towards integration by location and across disciplines to assess the role of agricultural and forest land use in different climatic regions and local socio-cultural backgrounds (e.g. Nordic, Mediterranean) in meeting societal demands. Research will develop (regional or land use type specific) methodologies for integrated assessment.
IRT-4: Bio-Economy – unleashing potential while sustaining soils	Unleash the potential of soil to sustain a bio-economy in Europe by better understanding soil and economic systems in order to support land management for biomass production and consumption. Alternatives to non-renewable resources are needed. Soils can provide bio-based resources, but overuse must be prevented to sustain soil system functions.
IRT-5: Integrated scenarios for the Land-Soil-Water-Food system under societal pressures and challenges	Identification of land use scenarios that deliver benefits to society AND to the environment and lead to changes in soil management and spatial planning. Growing populations increase soil and land degradation, rendering remaining scarce fertile soils vulnerable to overuse and further degradation. Scenario modelling will help assess major impacts and decrease further degradation, secure food and identify ways of achieving land degradation neutrality. Changes in the economy and the society should estimate like growing / shrinking areas and their impact on the land-soil-sediment-water system.
IRT-6: Assessing the efficiency of the Soil-Sediment-Water-Energy system of resources	National, regional, local authorities would benefit from a more global and informed vision of the utility (private and public) of their decisions if they were supplied with indicators helping to measure the consequences of their decisions on natural resources. Such "footprint" indicators used in a statistical scoreboard can help analyse environmental impacts through the whole global economic cycle and thus better balance societal benefits and ecological effects of different resource-use options.
IRT-7: Farming systems to maintain soil fertility while meeting demand for agricultural products	Improving understanding of how different food production systems can help maintain soil fertility or reduce negative environmental impacts associated with intensive conventional farming. Increased knowledge about economic and technical aspects of organic food production systems will improve their competitiveness and help mainstream sustainable agricultural practices.

Integrated Research need	Likely impact
IRT-8: Circular land management	Research is required to evaluate patterns of behaviour and interdependencies of actors, especially land owners, in land-related policy areas. Circular land management is a component of sustainable land management. Applied research and pilot case studies can identify modular "tool boxes".
IRT-9: Policies to effectively reduce land consumption for settlement development	Knowledge on how to design effective policies given the institutional constraints of their implementation and enforcement will be necessary to realize reduced land consumption in rural and urban areas.
IRT-10: Stakeholder participation to facilitate the development of liveable cities	Understanding the potential of stakeholder participation will help to ensure the liveability of urban development and enhance transparency and legitimacy of decision-making.
IRT-11: Integrated management of soils in urban areas	Better understanding the role of urban soils in improving quality of urban space and consequently on health and living quality.
IRT-12: Environmentally friendly and socially sensitive urban development	Solutions that bridge the goals of urban environmental protection and social concerns of urban development are crucial to realize sustainable cities. Knowledge on environmental issues and social concerns in urban planning is only partly available but has to be deeper, up to date and better integrated.
IRT-13: Urban Metabolism – Enhance efficient use of soil-sediment-water resources by closing of urban material loops	Further development of the methodological concept of urban metabolism is needed to identify comprehensive measures to enhance urban resource efficiency, consistency and sufficiency. Urban metabolism instruments and tools are needed at different scales (local, regional, national and supranational) to address indirect impacts, such as rebound effects or indirect land consumption. Such new instruments and tools will help manage our common resource basis, minimize negative ecological effects, foster a local circular urban economy and support a long term, high level quality of urban life.
IRT-14: Emerging contaminants' in soil and groundwater – ensuring long-term protection of drinking water, soil and freshwater ecosystem services	Greater knowledge about the properties of 'emerging' contaminants, and mixtures, their distribution in groundwater and soil, their toxicity to humans as well as soil and freshwater ecosystem services is needed to ensure public health and long-term provision of ecosystem services. Methods of analysing emerging contaminants are needed.
IRT-15: Sustainable management to restore the ecological and socio-economic values of degraded land	Dedicated research will elaborate degradation-type and region-specific restoration and rehabilitation approaches for valorisation of degraded areas.
IRT-16: Innovative technologies and eco-engineering 4.0: sustainable use of agricultural, forest and urban landscapes and the SSW system	Improved rural and urban land use through appropriate sustainable technologies, exploitation of comprehensive data collected by high-quality on- and off-site sensors, and purposeful communication. Eco-engineering for the design, monitoring and management of rural and urban ecosystems can integrate human society with the natural and man-made environment. Identifying what is a sustainable intensification via industrial or organic agriculture and forestry will help planning and permitting.
IRT-17: Climate change challenges - improving preparedness and response for climate conditions and related hazards	Spatial planning could be an instrument for coping with effects of climate change, but only if we have a better understanding of climate change mitigation, adaptation and counteracting negative climate phenomena. Integrated strategies on soil protection and land management should help reduce direct and indirect impacts from climate change. New technical and operational solutions can be developed using low cost, widely available data science.

Natural Capital and Ecosystem Services Supply

Integrated Research need	Likely impact
NC1: Quantity and quality of soils, health of soils, soil carbon, greenhouse gases	Land use conflicts may be solved by sustainable land use management concepts based on natural capital and the multiple ecosystem services provided by the soil-sediment-water system.
NC2: Biodiversity, organismic and genetic resources	Biodiversity loss will be halted when the societal benefits of biodiversity and ecosystems is quantified for different areas.
NC3: Water, water cycle	The delivery of the water demanded by society will become more stable and resilient to environmental and societal change, which will contribute to more safe, sustainable and healthy societies.
NC4: Pollutant degradation, filtering and immobilisation capacity	We will be able to manage the legacy of soil contamination from the past more cost-effectively and sustainably, with knowledge on the natural capacity of the SSW-system to detoxify contaminants.
NC5: Prevention of erosion and mudslides, natural hazards	This research will reduce the occurrence, duration and severity of natural hazards, by developing alternative land use management strategies that will increase the natural resilience to floods, fires, land subsidence, erosion and landslides.
NC6: Geological resources	This research will decrease the environmental and societal impact of resource recovery, and protect natural capital by promoting recycling and use of alternatives. It will contribute to the transition towards a circular economy.
NC7: Intrinsic values of soils and landscapes	Aesthetic, cultural and social values of landscapes will be preserved better.

Land Use Management

Integrated Research need	Likely impact
LM 1: Governance, management mechanisms, instruments and policy	Improved policies, governance structures and institutions to promote sustainable land management throughout Europe.
LM 2: Climate changes challenges for land management	This will enable the design of effective and suitable spatial planning and land use management systems, to deal with extreme weather events, flooding, droughts and environmental stresses.
LM 3: Land as a resources in urban areas (Sustainable urban land management)	This research will contribute to the development of a healthy urban environment and sustainable and safe cities.
LM 4: Land as a resources in rural areas (Multi-functionality of rural areas)	This research will contribute to maintaining and improving soil fertility, and improved nutrient and pesticide management. It will also stimulate nature conservation and will provide options to deal with urban sprawl and rural depopulation, as well as to avoid land speculation.

Demand for Natural Capital and Ecosystem Services

Integrated Research need	Likely impact
D1: The 4 F´s: Food, feed, fibre, (bio)fuel	This research will strengthen the transition towards a circular and biologically based economy, by quantifying the societal demand of this transition for soil functions.
D2: Regulating Ecosystem Services	Assessment and mapping of soil ecosystem services are prerequisites for sustainable management of natural resources, to optimize soil functions and services.
D3: Urban / infrastructure land	This research will contribute to land use conflict management, the liveability of shrinking regions and villages, and increased brownfield remediation and re-use of land, which will safeguard soils for other purposes.
D4: Water	Current and future water demand scenarios will enable more futureproof land use decision making to ensure the delivery of sufficient and clean water for future generations.
D5: Geological (and fossil) subsurface resources	This research will help decrease the environmental and societal impact of resource recovery, decrease demand by promoting recycling and use of alternatives and contribute to the transition towards a circular economy.
D6: Natural hazard prevention and resilience	This research will reduce the occurrence, duration and severity of anthropogenically triggered natural hazards; reduce vulnerability by developing alternative land use management strategies, and; increase resilience to a range of hazards including floods, fires, earthquakes, volcanic eruptions, land subsidence, erosion and landslides.
D7: Health and quality of life (living environment)	Research on the contribution of nature to health and well-being will allow for better spatial design to optimize these health benefits, especially with respect to vulnerable groups in deprived areas.

Net Impact

Integrated Research need	Likely impact
NI 1: Developing impact assessment methodology	Developing monitoring and impact assessment methodologies will enable us to detect and assess emerging threats from global change (such as climate change), land management and pollution to human health and well-being, biodiversity and ecosystem service provision as well as the prosperity of our economies.
NI 2: Understanding and assessing impacts of drivers and management	This research will provide us with an understanding of the magnitude of the ecological, economic and social impacts of land management decisions, emerging and/or mixed pollutants, socio-economic drivers of land management and land use change, and policies, planning and regulation.
NI 3: Trade-off analysis & decision support	Research on comparative assessment of land management options will support realizing synergies and trading off conflicts between different societal demands with regard to land use and land management.
NI 4: Science-Policy-Society Interface	Strengthening the science-policy-society interface will facilitate knowledge-based development and implementation of land use policies by awareness raising, stakeholder involvement and policy integration.

Wise management of land and soil has a great potential for balancing society's demands on and supply of natural capital in the form of resources and ecosystem services.

Addressing Land and Soil Related Societal Challenges

Land and soil are vital if society is to meet its needs for food, drinking water, energy, shelter and infrastructure. Many of society's biggest environmental challenges, such as climate change, depletion of natural resources and loss of biodiversity, are related to the use of land and soil. Land and soil are finite resources facing growing pressures and conflicts over their use that contribute to over-consumption of natural capital. Wise management of land and soil has a great potential for balancing society's demands on and supply of natural capital in the form of resources and ecosystem services. The full range of societal costs and benefits of alternative land management practices should be understood in order to make decisions that lead to balanced and sustainable land use.

Sustainable land management requires the creation of new knowledge and the innovative application of new and existing knowledge in the way we plan, manage and use land and soil. This Strategic Research Agenda identifies what is needed according to over 500 Europeans funders, scientists, policy makers, public administrators, consultants, etc.
In 2015, the United Nations adopted 17 Sustainable Development Goals (Figure 1) as means of addressing and overcoming major societal challenges around the world. The EU is now seeking to put SDGs at the heart of its policy framework, priorities and budget (Box 1).

Figure 1 The United Nations' 17 Sustainable Development Goals
To contribute to sustainability, land-use management also needs to be environmentally friendly, socially acceptable and economically affordable, e.g. by means of minimizing the consumption of natural resources such as uncontrolled land take for settlement and traffic purposes. The research needs covered in this strategic research agenda were mapped on to the 17 SDGs and will enable the European Commission to achieve its policy and prioritisation transition (Box 1).This research agenda considers soil and land use management challenges including the land related links between the soil-water-sediment (SSW) system, food, energy (Figure 2).

Over the next two decades, 260 indicators will be used to evaluate progress towards the 169 specific targets that need to be reached to achieve the 17 SDGs. Soil, sediment, water and indeed the entire system have a role to play in achieving many of the SDGs. The research needs presented in this SRA have a direct, sometimes strong, potential role to play in achieving some of the SDGs (Table 1). The SSW system has a particularly strong contribution to make to SDG 6: Clean Water & Sanitation; SDG 11: Sustainable cities and communities; SDG 13: Climate action; SDG 14: Life under water and SDG 15: Life on land.

Box 1
EU's implementation of the Sustainable Development Goals (SDGs)

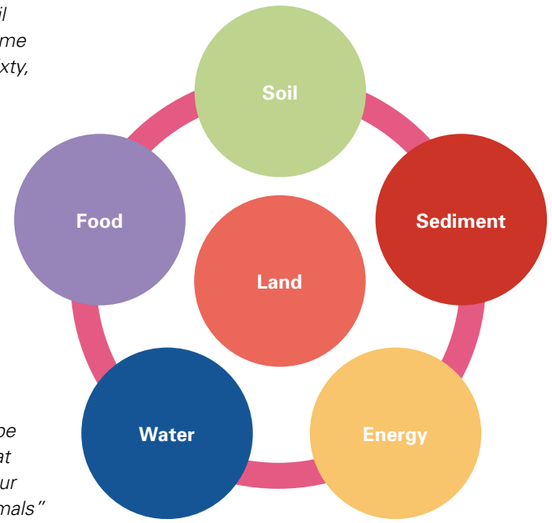
"The first track with the Communication [Next steps for a sustainable European future: European action for sustainability, SWD(2016) 390 final] is to join up the SDGs to the European policy framework and current Commission priorities, assessing where we stand and identifying the most relevant sustainability concerns. With this, the Commission commits to mainstreaming the SDGs into EU policies and initiatives. It will provide regular reporting of the EU's progress as of 2017 (including in the context of the UN High Level Political Forum), and promote sustainable development globally in cooperation with external partners. The Commission will take implementation forward with the Council and the European Parliament. In order to pursue the 2030 Agenda in partnership with all stakeholders, it will launch a multi-stakeholder Platform with a role in the follow-up and exchange of best practices on SDG implementation.

A second track will launch reflection work on developing further our longer term vision and the focus of sectoral policies after 2020, and reorient the EU budget's contributions towards the achievement of the EU's long-term objectives through the new Multiannual Financial Framework beyond 2020. By adopting such a comprehensive approach, the EU seeks to mainstream the SDGs into the Commission's everyday work and to engage all stakeholders, Member States and the European Parliament in its implementation to work towards full implementation of the 2030 Agenda for Sustainable Development".

Figure 2
Soil-sediment-water system links to energy and food (quotes taken from New and Old Testaments)

Soil feeds us ...
"seeds fell on good soil and produced grain, some a hundredfold, some sixty, some thirty"

Water cleans and refreshes us ...
"that streambed shall be filled with water, so that you shall drink, you, your livestock, and your animals"



Sediment fertilises for us...
"Happy and fortunate are you who cast your seed upon all waters when the river overflows its banks; for the seed will sink into the sediment and when the waters subside, the plant will spring up"

Table 1
The role of the soil-sediment-water system in achieving each of the 17 SDGs

Sustainable Development Goal	No poverty	Zero hunger	Good health	Quality Education	Gender equality	Clean water & sanitation	Affordable and clean energy	Decent work and economic growth	Industry innovation and infrastructure	Reduced inequalities	Sustainable cities and communities	Responsible consumption	Climate action	Life below water	Life on land	Peace and justice	Partnership for the goals
SDG	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
Soil	•	•	•	x	x	•	•	•	•	x	••	•	••	x	••	x	x
Sediment	x	x	x	x	x	•	x	x	•	x	•	•	••	••	•	x	x
Water	•	•	•	•	•	••	•	•	•	•	•	•	••	••	•	x	x
SSW System						•			•		•	•	••		•		

x no direct role identified • direct role identified •• strong direct role identified

2 https://unstats.un.org/unsd/statcom/47th-session/documents/2016-2-IAEG-SDGs-Rev1-E.pdf
3 http://ec.europa.eu/environment/sustainable-development/SDGs/implementation/index_en.htm

Stakeholder approach

This strategic research agenda is derived from a multi-stakeholder, multi-national, interdisciplinary approach that covers a range of interested parties (public bodies, businesses, academia and civic society) and the variety of relevant institutions funding research.

If you are interested in how this research agenda was developed then read more on the website www.inspiration-agenda.eu – a brief summary follows.

This research agenda is the outcome of a bottom-up approach involving over 500 stakeholders across more than 17 European countries (Figure 3). This funder and end-user demand-driven approach identified research and innovation needs on land use, land-use changes and soil management in the light of current and anticipated societal challenges. The INSPIRATION conceptual model (Figure 4) recognises the tension between the supply of natural capital and societal demands on such capital that is in part created by land-use management practices whose net impact is insufficiently understood.

In sustainability terms, land management should balance the demand for and supply of resources and ecosystem services. This needs understanding of the supply of natural capital (resources and services), the present and potential demands on that capital, the consequences on supply and demand of different approaches to land management as well as ways to avoid other (unexpected) negative effects within the SSW and finally the ability to evaluate the impacts of those approaches to help maintain a balance and avoid net depletion of natural capital. This thinking has guided the approach to identifying the series of 17 integrating research needs and four sets of research needs focusing on natural capital supply (7 needs), demand (7 needs), land management (4 needs) and net impact (4 needs).

Bottom-Up INSPIRATION

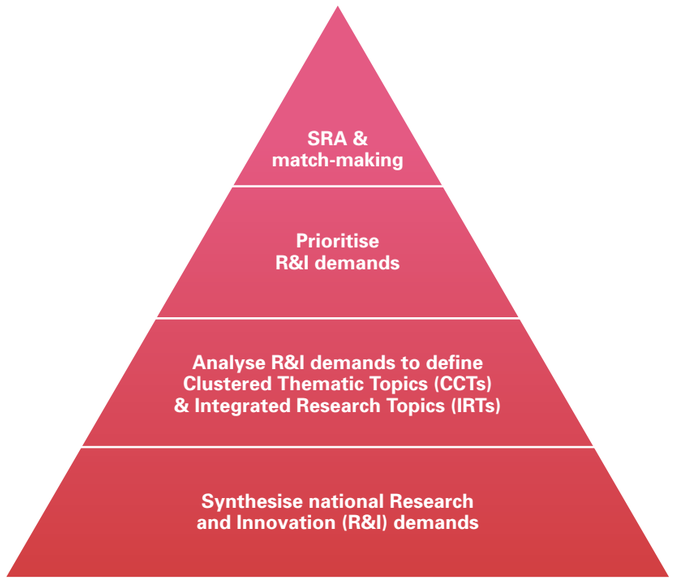


Figure 3
The bottom-up INSPIRATION process showing how the SRA was developed

Driving Forces

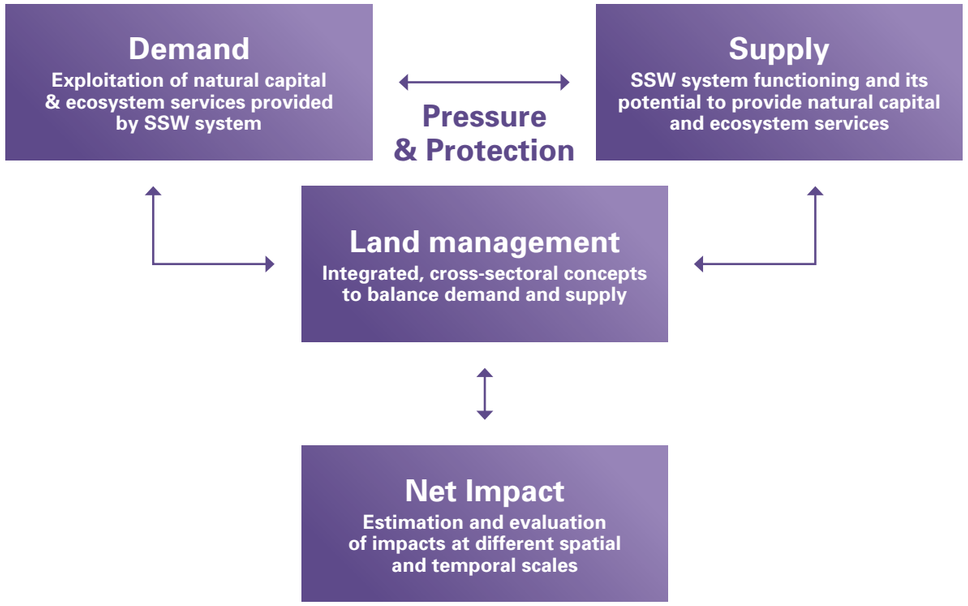


Figure 4
The INSPIRATION Conceptual Model showing the linked themes of natural capital, demand, land use management and net impact assessment

The role of the INSPIRATION Strategic Research Agenda

This strategic research agenda is designed to both attract research funding by public and private parties and ensure that knowledge is widely applied by public sector bodies, SMEs and large enterprises wishing to innovate and contribute to a greener, more socially cohesive, smarter and more competitive Europe. The SRA is particularly intended to be used by research funders to identify needs they would like to collaborate in funding. Collaboration becomes necessary and can create synergies when an organisation does not have the resources to fund a research activity in its entirety yet still sees the need for that activity. It then chooses to collaborate with other funders to ensure the research activity takes place rather than not collaborate and not see the activity happen. Other stakeholders – specifically end-users, researchers and citizens - are also specifically address in parts of the SRA.

Staying informed about the INSPI-SRA

The website www.inspiration-h2020.eu contains further details about the Horizon2020 coordination and support action INSPIRATION. The INSPIRATION SRA and links to National Contacts are available at www.inspiration-agenda.eu. For news of our activities and other relevant information follow our twitter feed @inspiration4eu.

Research needs

This SRA is based on a unique bottom-up approach to identifying priority research needs to address soil and land use related aspects of societal challenges facing Europeans and indeed the world at large. For the needs in this SRA to be met, funders have to be able to see why they should invest in this research, end users need to see how specific activities whose outcomes they value will benefit from their support and researchers need to be attracted to investing their intellectual capital and effort.

Brief summaries of each research need are given below and further details are provided in the Appendices. Appendix A describes the likely difference, or impact, that meeting the research need would make. Appendix B describes the 'likely return on investment' that funders may expect if they were to support a specific research need. Appendix C, D and finally, E describe the likely significance each research need has for end users, researchers and citizens respectively.

Individual research needs demand a range of activities: knowledge creation, knowledge transfer, demonstration, training and education, survey and monitoring, networking, and mapping and assessment.

Further stakeholder specific information is provided in standalone appendices:

- **Funders**
- **End users**
- **Researcher / knowledge translators**
- **Citizens**

The tables that follow present an outline of the 17 integrating research needs, supply of natural capital, demands on natural capital, land-use management and net impact respectively.

Integrating Research Needs

Integrating R&I	Outline
IRT-1: Integrated Environmental Assessment and Soil Monitoring for Europe	A European wide soil monitoring network. Information will assist in meeting the land degradation neutrality target and changes in soils (chemical, biological and physical) that affect soil function. Desirable trends and targets need to be formulated.
IRT-2: Recognising the values of ecosystem services in land use decisions	Ecosystem services underpin human well-being and economic prosperity. The main challenge is to develop integrated ecological indicators that can be used alongside established socio-economic indicators by planning instruments and tools to ensure ecosystem services are given appropriate consideration in land use decision making. • What new metrics are required to assess socio-economic, socio-cultural and environmental impacts and benefits of different land management strategies in response to (new) challenges, e.g. climate change mitigation & adaptation, demand for food, fuel, forest & fibre, housing, tourism & recreation, nature conservation? • How can a new "value" framework, enabling better balance of benefits vs costs could look like? Valuation tools should give more weight to health, environmental and cultural parameters and should take ethical considerations into account. • How to map and assess soil ecosystem services? How to value soil ecosystem services? How can the "bundle" of ecosystem services be gathered and evaluated? All stakeholders (including policymakers) need to take into account the value of the different soil ecosystem services in their processes and projects: how to do that? • How can the accessibility and resolution of data on ecosystem services at relevant levels of decision-making (and in particular at local and regional level) be enhanced? • How do stakeholders value ecosystem services and how can these result in social, economic and environmental development? • What are the impacts of policies, regulations and incentives for resources, ecosystem service provision and society – e.g. for agricultural policies, infrastructure development, housing subsidies?
IRT-3: From indicators to implementation: Integrated tools for a holistic assessment of agricultural and forest land use	Agriculture and forestry affect soil chemistry, water quality, landscape beauty and culture. Commercial and political decisions need to reflect sound science yet be transparent to end-users including farmers, forest managers, conservationists, and planners. Natural systems are subject to diverse disturbances and stressors. Although many indicators are available for ecological and socio-economic evaluation of land-use impacts, most are discipline- and sector-oriented. Integrated, spatial assessment of impacts at the local, medium or regional scale. End-user friendly tools for integrated assessment of the impacts of alternative agricultural and forest land uses are needed.
IRT-4: Bio-Economy – unleashing the potentials while sustaining soils	The bioeconomy comprises those parts of the economy that use renewable biological resources from land and sea – such as crops, forests, fish, animals and micro-organisms – to produce food, materials and energy. There is a need for better understanding of the biomass production and consumption chain, including risks and environmental impacts (e.g. understanding and minimizing negative externalities). The sustainable limits of soil bioeconomy must be established and not exceeded to secure renewable resources.
IRT-5: Integrated scenarios for the Land-Soil-Water-Food system under societal pressures and challenges	Elaborating explorative and target oriented scenarios considering integrated, spatially-explicit models that take into account major trade-offs and synergies between ecosystem functions, land use and societal challenges. External effects of our economy (import of goods, environmental footprint into developing countries) should be taken into account as well.

Integrating R&I	Outline
IRT-6: Indicators for assessing the efficiency of the Soil-Sediment-Water-Energy system of resources	There is a "conceptual gap" how biomass is accounted for in "resource efficiency", as most biomass is produced by humans. The relationship between biomass production and the soil-water-energy system is poorly understood. The goal is to understand the links between consumption and use SSW system services by quantifying and mapping, in time and space, the SSW system and energy resources related to consumption of products and services.
IRT-7: Farming systems to maintain soil fertility while meeting demand for agricultural products	Increasing demand for agricultural products drives intensification of food and non-food production. Intensive conventional farming may have severe negative environmental consequences (loss of fertile soils by erosion, nutrient loss and soil compaction; reduced biodiversity; nutrient leaching to groundwater and rivers; eutrophication of lakes and the sea). Agricultural production techniques are being developed that maintain soil fertility and reduce negative environmental impacts of conventional farming in rural peri-urban and urban contexts. It is still unclear if these techniques could be scaled up to attain food security and meet demand for non-food products. The role of technology (e.g. precision farming) in reducing environmental externalities of intensive farming and encouraging a return to soil-friendly agricultural practices needs to be demonstrated. Incentives are needed alongside knowledge transfer and reformed policies and regulations to encourage sustainable soil management practices at the farm level.
IRT-8: Circular land management	Circular land management in the urban context requires continues urban regeneration and minimizing brownfields. Growing and shrinking cities have different land use dynamics and development objectives. Demographic change requires changing urban structures. Planned continuous renovation of settlement structures and reusing or redeveloping abandoned, derelict and under-used land is used.
IRT-9: Policies to effectively reduce land consumption for settlement development	A better understanding what drives land consumption for settlement development and what constitutes incentives for or obstacles to the enforcement of planning and policies to reduce land consumption will help to create policy interventions in property markets and settlement development more effective. Spatial planning and soil management is hampered more by poor understanding what drives land consumption and how to address these drivers than by a lack of knowledge on the benefits of reduced land consumption for settlement development. Existing legislation and planning controls to steer land development often fails to address these drivers and are characterized by loose implementation and enforcement.
IRT-10: Stakeholder participation to facilitate the development of liveable cities	Understanding how stakeholder participation may facilitate urban development and the creation of livable urban spaces, what pro and cons different participatory approaches entail in a given context and how it might be best embedded in the course of planning and project development. The extent to which such participation can occur without becoming too politicized needs to be established. Demographic variations will need to be reflected in the support and resourcing given to local groups.
IRT-11: Integrated management of soils in urban areas	Urban activities create new man-made soils, but all soils in urban areas are urban soils. Urban soils serve multiple functions. A Typology of urban soils is needed to understand the diversity of urban soil functions and to assess the suitability of soils for different urban land uses. Soil characteristics and quality should be considered by spatial (urban) planning. Urban soils are important part of green infrastructure - specifically the SSW system. Fertile soil should be protected to maintain habitat and support ecosystem services. The agricultural role of urban soil, especially for urban farming and gardening, has an economic and an educational value.

Integrating R&I	Outline
IRT-12: Environmentally friendly and socially sensitive urban development	Better understanding of synergies and trade-offs between environmental and social concerns in urban development is needed. This can be achieved by characterizing conflicting goals and measures then seeking ways to reduce and or resolve such conflicts. Urban development is confronted with heterogeneous and often conflicting needs. Concerns of urban environmental protection and precautions are strongly interconnected with urban development and have to be considered in planning and decision making processes in manifold ways. However, they are just one concern out of many and have to be balanced with other challenges of urban development, not least with societal demands. These include affordable housing as well as securing energy and water supply. On the one hand, social and environmental needs can have synergies and the concept of environmental justice is an upcoming but central interface. On the other hand, conflicting goals of an environmentally friendly and at the same time socially sensitive urban development can be detected, as for example in the field of energy poverty (greener but more expensive renewable energy puts some households at poverty risk). Social diversity adds to the complexity in some cities as different groups will have different interests and priorities.
IRT-13: Urban Metabolism – Enhance efficient use of soil-sediment-water resources through a closing of urban material loops	The concept of urban metabolism tries to integrate all urban material flows, stocks, loops and their internal and external interdependencies in a comprehensive way. Urban metabolism – according to urbanmetabilism.org – is the study of material and energy flows arising from urban socioeconomic activities and regional and global biogeochemical processes. The characterization of these flows and the relationships between anthropogenic urban activities and natural processes and cycles defines the behavior of urban production and consumption. Urban metabolism is therefore a deeply multi-disciplinary research domain focused on providing important insights into the behavior of cities for the purpose of advancing effective proposals for a more humane and ecologically responsible future. A comprehensive understanding of urban material flows, stocks and loops and their environmental impacts strategies, tools and instruments to enhance urban resource efficiency, consistency and sufficiency and to minimize direct and indirect negative environmental impacts that are initiated by urban areas. This needs to be operationalised at individual cities.
IRT-14: Emerging contaminants in soil and groundwater	We need greater understanding of the impacts of 'emerging contaminants' to safeguard freshwater supplies and protect soil related ecosystem services. 'Emerging contaminants' (e.g. firefighting agents, endocrine disrupters, pharmaceuticals & personal care products) may worsen groundwater quality and degrade soil ecosystem services. However, their impacts on different temporal and spatial scales, the effects of mixtures and cost-effective strategies to minimize their discharge or to remediate contamination remains uncertain. Environment specimen banks can provide samples for retrospective analysis (www.umweltprobenbank.de). More samples in multiple media are needed.

Integrating R&I	Outline
IRT-15: Sustainable management to restore the ecological and socio-economic values of degraded land	Land is a vital resource enabling the production of food, the preservation of biodiversity, and facilitating the natural management of water systems and acting as a carbon store. Develop suitable restoration and rehabilitation approaches along the SSW approach to ensure the ecological and socio-economic values of degraded land appropriate to site conditions and type and intensity of degradation. Appropriate management can protect and maximize the services land provides to society. The degradation of land is, however, common in Europe and a consequence of physical, chemical and biological shifts driven by environmental, social and economic pressures. Land degradation is the consequence of multiple processes that both directly and indirectly reduce the utility of land. Due to the high extend of degraded land and areas, reversing degradation into functionally valuable land is indispensable. The concrete goals for restoration or rehabilitation have to be specified according to the type and intensity of degradation on the one hand, and the specific target conditions on the other; just using general ecological value targets used for un-degraded land is inadequate. Thus linking classification of degradation together with future targets for future alternatives (soils, ecosystem functions, water resources, biomass production) are necessary reaching assessment to planning and realization. The application of organic residues with very low contaminant level (e.g. urban composts, residues from food industry, treated grey water) as part of restoration has to be investigated. Here learning from good practices for resetting degraded land into ecological functions (historical experiences) is a prerequisite for future innovative management and spatial planning. The legal framework and private ownership will significantly determine the options and realization for re-grading land; thus considering socio-economic and legal conditions will play a crucial for restoration or rehabilitation.
IRT-16: Innovative technologies and eco-engineering 4.0: Challenges for a sustainable use of agricultural, forest and urban landscapes and the SSW system	Increasing societal demand on land resources and biomass cause land use pressure and endanger ecosystem functions and sustainability of land, water and bio-resources. Classical technologies focus preliminarily on conventional sectors like agricultural mechanization or landscape engineering. Innovative Key Enabling Technologies KET and eco-engineering as basis for integrated solutions may facilitate a greener economy at larger scale for farmers, forest managers and rehabilitation-related SME to support a future development contributing to a sustainable land management. However, the societal acceptance for KET is restricted. Thus understanding and raising awareness for modern sustainable technologies is also a key challenge.
IRT-17: Climate change challenges - improving preparedness and response for climate conditions and related hazards	Climate change affects all European countries. Vulnerabilities and impacts for nature, the economy and society differ across regions, territories and economic sectors in Europe. Challenges of climate change require two types of responses. First is related to climate change mitigation, second is adaptation activities to deal with the unavoidable impacts. Spatial planning and land management practice needs to evolve to consider climate change to ensure administrative, technical and societal preparedness for weather extremes and related hazards. Climate change is a very complex and challenging issue affecting urban and rural management at all scales from global to the local. The EU Strategy on adaptation to climate change (adopted by the European Commission in April 2013) sets out a framework and mechanisms for ensuring EU preparedness for current and future climate impacts. COP21 requires carbon sequestration in soils to ensure their fertility and hence resilience in the face of climate changes. Time frame for all activities related to climate change mitigation and adaptation need to be established (including short, medium and long- term actions).

Supply of Natural Capital and Ecosystem Services

Natural capital refers to those elements of the natural environment which yield services to people by underpinning the provision of clean air, clean water, food, recreation and a plethora of high value and often essential goods and services. Soil, the SSW system and land are important components of natural capital. As such natural capital sustains economic activity and wellbeing. The research and innovation needs to help us understand better the supply of natural capital as it relates to soil and land are presented below.

Natural Capital R&I	Outline
NC1: Quantity and quality of soils, health of soils, soil carbon, greenhouse gases	Land and soil represent natural capital. Land quantity (in m^2) and its (geo)technical, physical, chemical and ecological quality define its value, which may differ between the different users of the land. Scarcity of land in terms of square meters with an adequate quality may trigger land use conflicts. These conflicts may be solved by sustainable land use concepts based on natural capital and the multiple ecosystem services provided by the soil-sediment-water system. This also includes the management of the multiple functions of soil organic carbon. These include soil fertility, water and nutrient management, and carbon sequestration. Knowledge on the dynamics of soil carbon and how this can be managed is crucial to sustainably use land and soil.
NC2: Biodiversity, organismic and genetic resources	Soil is a habitat for flora, fauna and microorganisms. Soils contain the majority of all biomass on earth. Biodiversity is essential for the stability and resilience of ecosystems and their services. Diversity is important with respect to ecosystems (different habitats), organisms, genes, and functions (substitution of functions which enhances stability of the ecosystem).
NC3: Water, water cycle	Depending on climate and landscape conditions, the hydrological cycle that connects soil, surface water, groundwater, seas and oceans, and atmosphere, provides society with water. Disturbance of landscapes, i.e. soil sealing, limited river bank infiltration and soil compaction, may interrupt the water cycle and alter the delivery of water, both in terms of quality and quantity. As a consequence of climate change, parts of Europe may be subject to severe water shortages or surpluses, which will affect agricultural productivity and liveability of cities.
NC4: Pollutant degradation, filtering and immobilization capacity	The potential of soils to degrade and detoxify organic pollutants is an outstanding ecosystem service that requires better evaluation for decision-making on land use and land management.
NC5: Prevention of erosion and mud slides, natural hazards	A healthy soil with an adequate plant and tree cover is an important stability factor with regard to excess soil erosion, landslides and avalanches. These can hardly be equalled by technical means.
NC6: Geological resources	Land contains geological deposits of minerals (e.g. metals) and building materials (e.g. rocks, gravel, sand, clay) as well as energy sources (e.g. wood, peat, coal, gas, oil and geothermal). However, alongside the economic value of these resources are other values, including landscape aesthetics, pollution prevention and biodiversity.
NC7: Intrinsic values of soils and landscapes	Landscapes, soils and ecosystems have intrinsic values such as aesthetic, cultural and social, which are difficult to monetise. Many manmade landscapes have unique cultural, social and historical value that create tensions between public and private demands on land.

Demand for Natural Capital and Ecosystem Services

The research and innovation needs to help understand better the demands society places on natural capital as it relates to soil and land are presented below.

Demand R&I	Outline
D1: The 4 F´s: Food, feed, fibre, (bio)fuel	Soils are the primary geo-resource for production of biomass and a key element in the bio based economy. While demand for the four F's (food, feed, fibre, fuel) is growing, the availability of fertile soils is shrinking, due to land and soil consumption for infrastructure and because of land degradation. While soil assessment traditionally concentrates on biomass production, the provision of environmental services also has to be taken into account and evaluated since they are increasingly demanded by society to contribute to human life and environmental quality.
D2: Regulating Ecosystem services	Soil, sediment and water ecosystem functions include regulating and maintenance services. These are changes and interactions of biochemical cycles, balancing bio-economic pressures with the need to adapt to climate change and protect biodiversity. Assessment and mapping of soil ecosystem services are prerequisites for sustainable management of natural resources, to optimise soil functions and services.
D3: Urban / infrastructure land	The demand of land for settlement is constantly increasing. Land use is in a constant transition according to the changing needs of stakeholders. This high demand leads to conflicting goals with regard to the different urban land uses, such as residential areas, industry, infrastructure, and recreation. On the other hand, shrinking regions require concepts for deconstruction and renaturalisation of land. Brownfield remediation and recycling and reuse will add to saving soils for other purposes.
D4: Water	Water is essential for smart, sustainable and inclusive growth. Demand for sufficient clean water is high in Europe for drinking water, biomass and industrial production and for fresh water ecosystems. Soil and land management highly influence water quality and quantity.
D5: Geological (and fossil) subsurface resources	Geological resources like peat, gravel, sand, clay, lignite and other materials are intensively used for economic development. Depletion of these non-renewable natural resources is an increasing problem. Circular design, promoting recycling and use of alternatives such as biomass may guarantee their availability for a longer period of time and decrease environmental impacts. This will contribute to the transition towards a circular economy. Aquifer thermal energy storage and geothermal energy are relatively new demands on the subsurface of soils that will affect the SSW system.
D6: Areas where Natural hazards are prevented	Due to the construction of infrastructure for the economy, the risk for and vulnerability to natural hazards and disasters have increased. Changes in nature (river straightening, deforestation, agriculture, soil sealing, drainage of peat) cause land and soil instability. This may lead to natural hazards as floods, forest fires, land subsidence, erosion and landslides. Climate change increases the severity of the consequences. What are effective approaches, methods and instruments to reduce the risk for and vulnerability to natural hazards? How can building with nature be of help?
D7: Health and quality of life (living environment)	The natural environment, including soil, provides multiple benefits to health and physical, mental and social well-being, especially unsealed, green areas in urbanised environments. Soil contamination, the absence of green spaces and intensive agricultural land use in densely populated regions may pose a threat to human health. Poor environmental quality affects vulnerable groups and people's health in deprived areas especially.

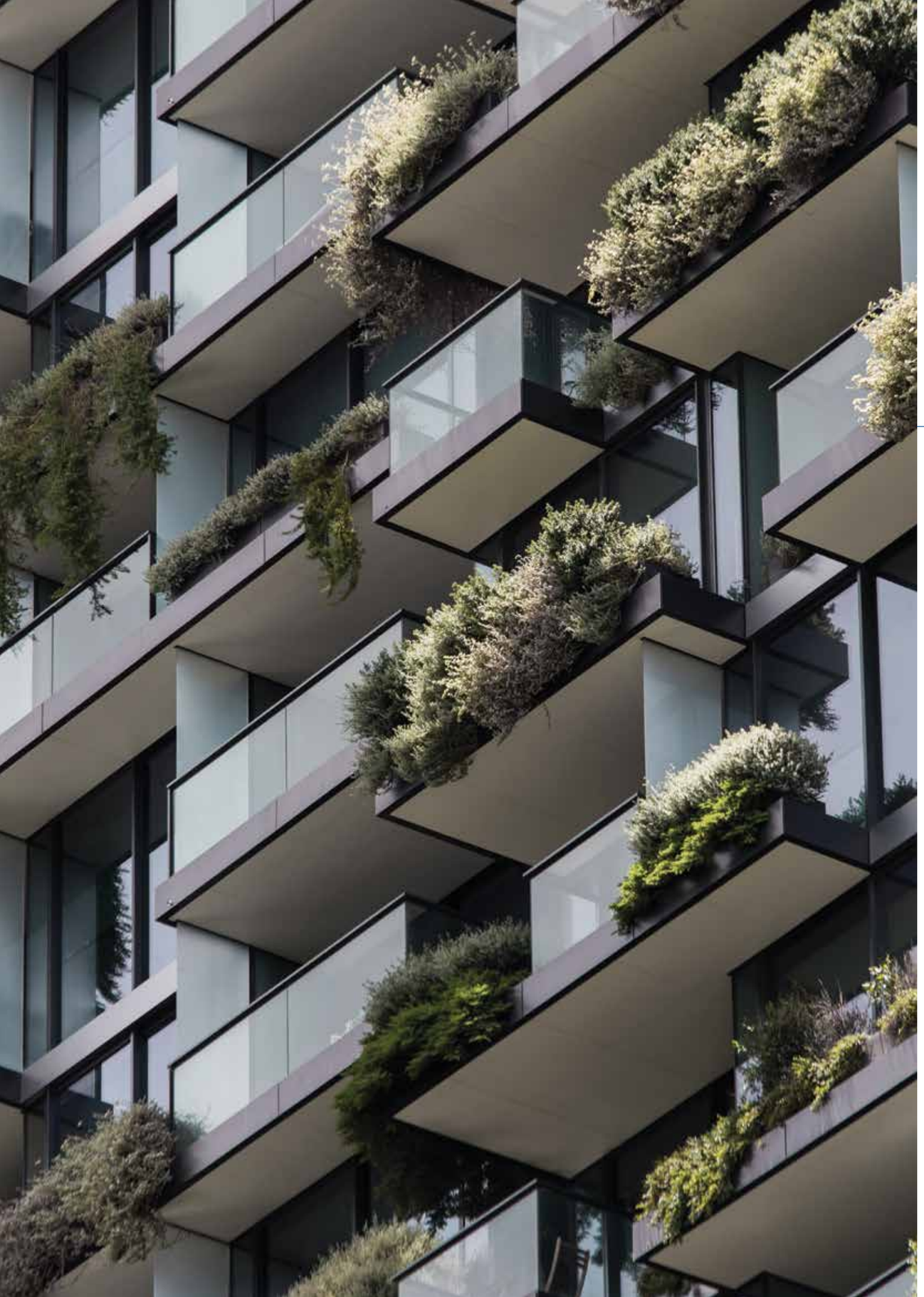
Land-use Management

Land-use management is the process of managing the urban and rural land resources.

Land Management R&I	Outline
LM 1: Governance, management mechanisms, instruments and policy	Governance in the context of land management is defined by the policies (instruments and mechanisms) and the institutional, administrative framework. The main challenge related to land management governance in Europe is to implement sustainable and effective management solutions and to integrate them in the diversity of administrative and planning systems between countries. Future research should focus on best practices evaluation, and introduction of proved mechanisms or instruments into an generic European planning procedure.
LM 2: Climate changes challenges for land management	A comprehensive understanding is needed on how climate change may alter societal demand as well as the provision of natural capital of soil and land. This will enable the design of effective and suitable spatial planning and land use management systems, to deal with extreme weather events, flooding, droughts and environmental stresses.
LM 3: Land as a resources in urban areas (Sustainable urban land management)	Land is a major resource in urban development. Cities are key engines of development. By 2030, almost 80 percent of the European population will live in cities, towns and suburbs. Many growing and shrinking cities are facing challenges related to economic, environmental and social issues that often also relate to land use transitions and soil quality.
LM 4: Land as a resources in rural area (Multiple functionality of rural areas)	Sustainable rural land management refers to SDG 15: "Sustainably manage forests, combat desertification, halt and reverse land degradation, and halt biodiversity loss". Relevant issues are agricultural land management, aiming at maintaining and possibly improving soil fertility, reducing eutrophication of groundwater and surface water through improved nutrient management, and prevention of soil compaction and accumulation of pesticide residues in soils. Nature and biodiversity conservation is another main issue as are rural depopulation and abandonment of the countryside. Next to these traditional rural land uses, also rural-urban partnerships are of relevance, in particular the pressure on high quality soils by new settlements, leading to urban sprawl and soil sealing. This is related also to the role of multifunctional areas within the spatial structure of Europe. Regional differences ask for tailor-made solutions. Multifunctional rural development may contribute to tackling societal challenges.

Net Impact

Net impact R&I	Outline
NI 1: Developing impact assessment methodology	Developing monitoring and impact assessment methodology will increase our understanding of the net economic, societal, administrative and political impact of options for land management on local, regional, global as well as temporal scales. Methodologies include monitoring methods and indicators, data collection and harmonization, risk assessment methods, methodologies to analyse the net impact of governance, policies and planning, integrated valuation that consider economic, ecological and social impacts, and the development of innovative impact metrics that will enable a more holistic impact assessment.
NI 2: Understanding and assessing impacts of drivers and management	This research need concerns the understanding of the socio-economic, ecological and environmental impacts of climate change, land management decisions, emerging and/or mixed pollutants, socioeconomic drivers of land use and land use change, and policies, planning and regulation.
NI 3: Trade-off analysis & decision support	Given the scarcity of resources and the limited availability of natural capital, conflicts and trade-offs between the realization of societal goals that directly depend on sustainable land use and land management will be inevitable, although in some cases also synergies are possible. This calls for research that supports comparative assessment of land management options to balance all demands.
NI 4: Science-Society-Policy Interface	Researching the science-policy-society interface includes developing approaches for awareness-raising among, and behavioural change of policy-makers, land users and society. Also enhancement of participation of stakeholders in planning and decision making is relevant. Mechanisms for effective knowledge transfer to policymakers and land managers are needed as well. Additionally, support tools, infrastructure and governance models need to be developed to facilitate policy integration, which is needed to realize synergies and avoid conflicts in land management.



Stakeholder perspectives

Research Funders

This agenda reflects research and innovation demands from across Europe from a range of perspectives and organisations. The SRA is anchored in an analysis of topical knowledge and implementation needs that are expected to be an effective response to today's societal challenges.

Hence, funders will find here areas where clear societal benefits are anticipated from investments in research, knowledge transfer, demonstration and implementation support actions. Funders should expect returns on these investments! Anticipated returns from each research demand are identified in Appendix B.

Moreover, funders are encouraged to consider co-funding. At a time of budget pressures, investment in research needs to be coordinated and targeted to maximise the impact of its outcomes. The agenda identifies research needs that are shared by stakeholder groups across Europe. Hence, synergies in areas of potential co-funding exist for the mutual benefit of efficient resource allocation of funders in neighbouring countries or across Europe. Such co-funding helps deliver more impact for the same funding and avoids reinventing the wheel several times.

Support for interested funders will be available until August 2019. National Contact Persons are available to provide support and for making cross country contacts regarding specific research demands for co-funding (See Appendix F).

End user needs

Soil, land-use and land management will benefit from new knowledge to provide Europeans with the goods and services they need while protecting European and global environments. Such end users include:

- Enterprises (large, medium and small) using or affecting land and resources
- Drinking water and energy producers, distributors and suppliers
- Spatial planners (at national, regional and local levels)
- Developers and construction companies (builders of houses and infrastructure, dredging companies)
- Farmers
- Food producers; agri-industry and food companies
- Financiers; Bankers; insurers
- Non-governmental organisations (NGOs)
- Policy makers (national; regional; local); Policy implementers
- Landscape stewards; farmers; foresters; nature managers
- Environmental Consultants
- Remediation contractors
- Brownfield developers

End users are anticipated to benefit in specific ways from the implementation of individual research topics. These benefits are outlined in Appendix C.

Researcher / knowledge translators

The SRA presents bottom-up, demand-driven research needs. Researchers might be helped in getting research projects funded that respond to such demand. Research creates knowledge that needs to be translated into policy, practice and across areas of application if it is to have an impact. Further details are provided in Appendix D.

Citizens

Europe's citizens are the ultimate beneficiary of resolving societal challenges. Their daily lives will be enhanced by the outcomes of the research activities in this agenda. (See Appendix E for specific details).

However there is another reason to understand what research is being called for by this agenda. Projects related to societal challenges benefit from citizens being involved in planning, execution and reporting. Indeed the development of the SRA itself has benefited from albeit limited non-technical contributions from citizen groups. The local and detailed perspective that they brought was helpful in identifying research needs that would contribute to dealing with societal challenges.

How to respond

Readers are encouraged to engage with the process of securing support for meeting the research needs presented in this SRA. Such support can be financial or contributions in kind, a willingness to engage with or contribute to specific projects or initiatives.

Funders

Funders are encouraged to inform their National Contacts (NCPs) (Listed in Appendix F) which research topics they are interested in co-funding.

Researchers

Researchers are encouraged to collaborate to carry out research that will make a difference and contribute to resolving societal challenges such as achieving Sustainable Development Goals.

End users

End users are encouraged to support research activities knowing that they will benefit from the outcomes of those activities.

Citizens

Citizens are encouraged to stay informed and to get involved in specific projects of direct relevance to them.

The SRA is also a useful source of ideas for research proposals and of insights into the important research and innovation issues across Europe.

All are invited to:

a. Join their respective national network (by contacting the National Contact Person– see Appendix F and visit www.inspiration-agenda.eu);

b. Visit www.inspiration-h2020.eu

c. Sign up to receive any INSPIRATION Newsletters, currently until the end of February 2018 (email inspiration@brgm.fr to subscribe);

d. Follow us on Twitter @ inspiration4eu

e. Join the INSPIRATION4EU LinkedIn group.

A typology of funding models

Funders adopt, or are set up with, specific approaches to deciding the level for funding to invest in research and on which organisations are eligible for support, and to what extent.

An overview of different funding models is presented below. Each has a specific role to play in delivering the INSPI-SRA.

Models	Summary	Scope
EU Framework	Various models to create knowledge, distribute knowledge, demonstrate applicability and establish the need for new knowledge.	
H2020 JPIs	JPIs aim to pool national research efforts to make better use of public R&D resources and to tackle common European challenges more effectively.	MS agree on a common vision and shared Strategic Research Agenda to address major societal challenges. MS commit to cooperate to implement joint SRAs. Multiple, thematic overlap with JPI Urban Europe, JPI-FACCE and JPI Water, possibly also with JPI Climate, JPI Cultural Heritage and JPI Oceans (through sediments). Potential for a new JPI on Land and Soil?
H2020 JTI/PPP	Joint Technology Initiatives (JTIs) implement the strategic research agendas of a limited number of European Technology Platforms (ETPs).	
H2020 Article 185	Article 185 of the Treaty on the Functioning of the European Union (TFEU) enables the EU to participate in research programmes jointly undertaken by several MS, including in structures created for the execution of national programmes.	The actions supported may cover subjects not directly linked to the themes of the Framework Programme, as long as they are of sufficient EU added value.
H2020 COST	European cooperation in science and technology (COST) is the longest-running European framework supporting trans-national cooperation among researchers, engineers and scholars across the European Union.	COST provides opportunities to jointly develop ideas and new initiatives across fields in science and technology, including social sciences and humanities, through pan-European networking of nationally funded research activities. (http://www.cost.eu/about_cost)
ERC	The European Research Council's (ERC) mission is to encourage the highest quality of research in Europe through competitive funding and to support investigation-driven frontier research on the basis of scientific excellence.	The ERC complements other funding activities in Europe such as those of the national research funding agencies and is a flagship component of Horizon 2020. (erc.europa.eu)
ESF	The European Science Foundation (ESF) helps its member organisations collaborate internationally on the research programmes which it coordinates in almost every scientific domain.	ESF provides services to the science community, including peer review, evaluation and conferences, as well as supportive career tracking. (www.esf.org)

Models	Summary	Scope
ERANets	ERA-NET is designed to support public-public partnerships in their preparation, establishment of networking structures, design, implementation and coordination of joint activities as well as supporting single joint calls and transnational actions.	The focus of ERA-NETs is shifting from the funding of networks to the top-up funding of single joint calls for transnational research and innovation in selected areas with high European added value and relevance for H2020. This aims at substantially increasing the share of funding that MS jointly dedicate to challenge-driven research and innovation agendas. http://ec.europa.eu/research/era/
LIFE	LIFE is the EU's financial instrument supporting environmental, nature conservation and climate action projects throughout the EU.	Since 1992, LIFE has co-financed some 4306 projects. For the 2014-2020 funding period, LIFE will contribute approximately €3.4 billion to the protection of the environment and climate. http://ec.europa.eu/environment/life/
ERDF INTERREG	Interreg Europe helps regional and local governments across Europe to develop and deliver better policy. By creating an environment and opportunities for sharing solutions, we aim to ensure that government investment, innovation and implementation efforts all lead to integrated and sustainable impact for people and place.	European Territorial Cooperation (ETC), better known as Interreg, is one of the main goals of cohesion policy and provides a framework for the implementation of joint actions and policy exchanges between national, regional and local actors from different Member States. The overarching objective of European Territorial Cooperation (ETC) is to promote a harmonious economic, social and territorial development of the Union as a whole. Interreg is built around three strands of cooperation: cross-border (Interreg A), transnational (Interreg B) and interregional (Interreg C). http://ec.europa.eu/regional_policy/de/policy/cooperation/european-territorial/
ESPON	The ESPON 2020 Cooperation Programme aims at promoting and fostering a European territorial dimension in development and cooperation by providing evidence, knowledge transfer and policy learning to public authorities and other policy actors at all levels.	The objective of ESPON 2020 is to support the reinforcement of the effectiveness of EU Cohesion Policy and other sectoral policies and programmes under European Structural Investment (ESI) funds as well as national and regional territorial development policies, through the production, dissemination and promotion of territorial evidence covering the entire territory of the 28 EU Members States, as well as 4 Partner States of Iceland, Liechtenstein, Norway and Switzerland. (www.espon.eu)

Models	Summary	Scope
RDPs	Rural Development Programs (Co-funding for national delivery)	The RDPs are financed by the European Agricultural Fund for Rural Development (EAFRD) and national or regional authorities, to improve quality of life in rural areas and to encourage diversification of rural economies. https://ec.europa.eu/agriculture/rural-development-2014-2020_en
EIP	European Innovation Partnership	The EIPs are a new approach to EU research and innovation. EIPs bring together actors from the entire research and innovation value chain to streamline efforts and accelerate market up-take of innovations addressing key challenges for Europe on themes such as water, raw materials or agricultural sustainability and productivity. ec.europa.eu/research/innovation-union/index_en.cfm?pg=eip
RFCS	The research programme of the Research Fund for Coals and Steel	The RFCS programme contributes to sustainable development, clean and safe production, protection of the environment, conservation of resources, health and safety aspects as well as improvement of working conditions. https://ec.europa.eu/research/participants/portal/desktop/en/opportunities/rfcs/calls/rfcs-2015.html
Bilateral programmes	Various funding programmes to tackle issues of particular interest to participating countries. Can be set up more quickly and administered more cheaply than larger programmes.	Programme specific scope to foster collaboration between participating countries.
Belmont Forum	The Belmont Forum of the world's major and emerging funders of global environmental change research aims to accelerate the delivery of the environmental research needed to remove critical barriers to sustainability by aligning and mobilizing international resources. It pursues the goals set in the Belmont Challenge by adding value to existing national investments and supporting international partnerships in interdisciplinary and transdisciplinary scientific endeavours.	International consortia of researchers, consisting of partners from at least three of the participating countries, may apply for funding. Consortia should bring together natural scientists, social scientists, and research users (policy makers, regulators, NGOs, communities, and industry). Under the Belmont Forum CRA Memorandum of Understanding, each Belmont Forum member funds researchers from their own country. Researchers from countries not participating in the Call may participate in a research project at their own expense. http://www.belmontforum.org/
Lead Agency Procedure	The Lead Agency process supports researchers in Switzerland who wish to conduct cross-border research projects. It simplifies the submission and evaluation of transnational applications.	Swiss cross-border research projects with Austria, Germany, Luxemburg, France and Belgium. An application can be submitted by researchers in Switzerland together with researchers in a country that has signed an agreement with the SNSF. The application is submitted to one of the two national research funding organisations. It is governed by the provisions in force at the relevant organisation. Proposals must have a joint research question and a joint research plan. The project parts carried out in each country must be interdependent and complementary. Costs are calculated on the basis of relevant national guidelines. http://www.snf.ch/en/funding/supplementary-measures/lead-agency/Pages/default.aspx
Crowd funding	Citizens invest small sums that aggregate to enable large projects to take place. Administratively simple and easy to set up.	For technology related crowd funding: https://www.kickstarter.com/

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Appendices

Appendix A

List of Abbreviations

COP21	21st Conference of Parties to the UN Framework Convention on Climate Change
CTT	Clustered Thematic Topics
D	Demand for Natural Capital and Ecosystem Services
IAB	International Advisory Board
INSPIRATION	INtegrated Spatial PlannIng, land use and soil management Research ActTION
INSPI	INSPIRATION
IRT	Integrated Research Need
IRN	Integrated Research Need
KET	Key enabling technology
LM	Land Use Management
NC	Natural Capital and Ecosystem Services Supply
NCs	National Contacts (for INSPIRATION4EU)
NGO	Non-governmental organisation
NI	Net Impact
NKS	National Key Stakeholder
R&I	Research and Innovation
SDG	Sustainable Development Goal
SME	Small and medium sized enterprise
SPI	Science Policy Interface
SRA	Strategic research agenda
SSW	Soil sediment water
UN	United Nations

Appendix A

Glossary of terms

The INSPIRATION website (http://www.inspiration-h2020.eu/page/glossary-0) includes definitions, and sources, of key terms including those below.

Circular economy: economic growth while optimising consumption of natural resources

Ecosystem services: Benefits people derive from ecosystems: provisioning, regulating, cultural and habitat or supporting services.

Land degradation neutral: the area of productive land remains stable.

Natural capital: elements of the natural environment which yield services to people by underpinning provision of clean air, clean water, food, recreation and other valuable, often essential, goods and services.

Natural resources: raw materials such as minerals and biomass; environmental media such as air, water and soil; flow resources such as wind, geothermal, tidal and solar energy; and space (land area).

Non-renewable resources: Resources that cannot be replaced or replenished.

Sediment: Suspended or deposited solid, of mineral or organic nature that has been, or is susceptible to being, transported by water.

Soil: Upper layer of Earth's crust composed of mineral particles, organic matter, water, air and living organisms.

Soil-sediment-water system: Interaction of land-based soil and groundwater with surface water and suspended solids with associated physical, chemical and biological processes.

Spatial planning: Methods to influence the future distribution of activities in space with the aims of creating a more rational territorial organization of land uses and the linkages between them, to balance demands for development with the need to protect the environment and achieve social and economic development objectives.

Stewardship: The responsible use and conservation of natural resources taking full and balanced account of the interests of society, future generations and other species, as well as of private needs, and accepts significant accountability to society.

Sustainable land management: A knowledge-based combination of technologies, policies and practices that integrate land, water, biodiversity, and environmental concerns (including input and output externalities) to meet rising food and fibre demands while sustaining ecosystem services and livelihoods.

Appendix B: Significance for Funders

Integrated Research Need	Significance for Funders
IRT-1: Integrated Environmental Assessment and Soil Monitoring for Europe	Investment in information on trends in soil quality and land use will enable the assessment of links between demand and natural capital (ecosystem services). Long term funding is needed to detect changes in the slowly reacting SSW system that will act as early warning indicators to help prevent harmful changes and to identify tipping points that land use management actions can help avoid.
IRT-2: Recognising the values of ecosystem services in land use decisions	For ecosystem services to be adequately accounted for in decision making, an agreed means is needed for valuing the benefits that nature provides and comparing their worth with other services. Investment in this topic will help advance the appropriate consideration given to ecosystem services in land use management and decision making.
IRT-3: From indicators to implementation: Integrated tools for a holistic assessment of agricultural and forest land use	Investing in the development of non-parametric or monetised tools to help an objective assessment of alternative agricultural or forestry uses will help achieve transparency and widespread agreement with rural land use allocation decisions.
IRT-4: Bio-Economy – unleashing the potentials while sustaining soils	The bioeconomy has an essential role to play in a transition to a post-fossil world. Investing in research to establish the limits of the natural soil system will help ensure the bioeconomy stays within these limits thereby sustaining bioeconomic production and soil functions versus alternative user demands.
IRT-5: Integrated scenarios for the Land-Soil-Water-Food nexus under societal pressures and challenges	Investing in predictive models of alternative scenarios will deliver improved points of reference and baselines as a basis for decision making. It will enable better framing of systemic analyses and modeling. These improvements will contribute to deriving land management recommendations that enable achieving land degradation neutrality.
IRT-6: Indicators for assessing the efficiency of the Soil-Sediment-Water-Energy nexus of resources	Improved accounting of the joint exploitation of the soil-sediment-water system and energy services will contribute to preservation of scarce resources and sustainable production of biomass as a renewable resource.
IRT-7: Farming systems to maintain soil fertility while meeting demand for agricultural products	The business case for agricultural production alternatives to conventional farming systems needs to be made in order to contribute to food security while protecting soil fertility, reducing negative environmental impacts and decreasing externalities to other societal demands such as biodiversity conservation or drinking water supply.

Appendix B: Significance for Funders

Integrated Research Need	Significance for Funders
IRT-8: Circular land management	Land is nonrenewable but non destructible resource. Managing urbanisation, reducing sprawl and intensifying reliance on public services will both protect undeveloped land and reduce environmental impacts from low population densities.
IRT-9: Policies to effectively reduce land consumption for settlement development	Increased understanding of what drives land consumption and how to address these drivers. Creation of effective policy interventions in property markets and settlement development. Reduced land consumption by improved policies on spatial planning and land development.
IRT-10: Stakeholder participation to facilitate the development of liveable cities	Funding more refined understanding of the role of citizens in making decisions is needed to overcome NIMBYism and ensure evidence based decisions.
IRT-11: Integrated management of soils in urban areas	Urban soils are an under-appreciated resource that are able to offer multiple functions. Funding this research will enable more sophisticated management and use of urban soils, including for urban agriculture and gardening with the associated social, health and economic benefits.
IRT-12: Environmentally friendly and socially sensitive urban development	Deeper understanding of alternative changes to urban systems will improve urban planning and neighbourhood planning that help satisfying societal needs without unnecessary environmental impacts as well as tempering societal expectations. Research will help to answer which services are needed and to which extent, to provide citizens with quality of life while protection urban ecology.
IRT-13: Urban Metabolism – Enhance efficient use of soil-sediment-water resources through a closing of urban material loops	This is an innovative philosophical lens through which to consider the complex challenges of urban resources management. Investing in this area promises potentially paradigm shifting approaches towards more systemic urban decision making, which is more economic, limiting ecological impacts while maintaining well-being and health requirements.
IRT-14: Emerging contaminants in soil and groundwater – ensuring long-term provision of drinking water as well as soil and freshwater ecosystem services	Agreed ways of detecting, analysing, monitoring, risk assessing and where necessary remediating emerging contaminants will ensure adequate measures are taken.
IRT-15: Sustainable management to restore the ecological and socio-economic values of degraded land	Ensuring the level of good practice is raised across Europe will contribute to reducing net land consumption and to transitioning to a circular land use economy. Land will not be discarded or be underused as a result of past chemical or physical degradation.
IRT-16: Innovative technologies and eco-engineering 4.0: Challenges for a sustainable use of agricultural, forest and urban landscapes and the SSW system	Exploiting modern data capture, transfer and analysis technologies will improve land management practices and permitting and allow a more nature based approach to industrial and organic methods of farming and forestry.
IRT-17: Climate change challenges - improving preparedness and response for climate conditions and related hazards	Improved understanding of the effectiveness of land management and spatial planning on climate change adaptation and mitigation will improve efficiency and contribute to a circular land use economy. New economic opportunities are afforded by deploying existing information technology to delivering a better understanding of the effects of climate change on land at the local scale.

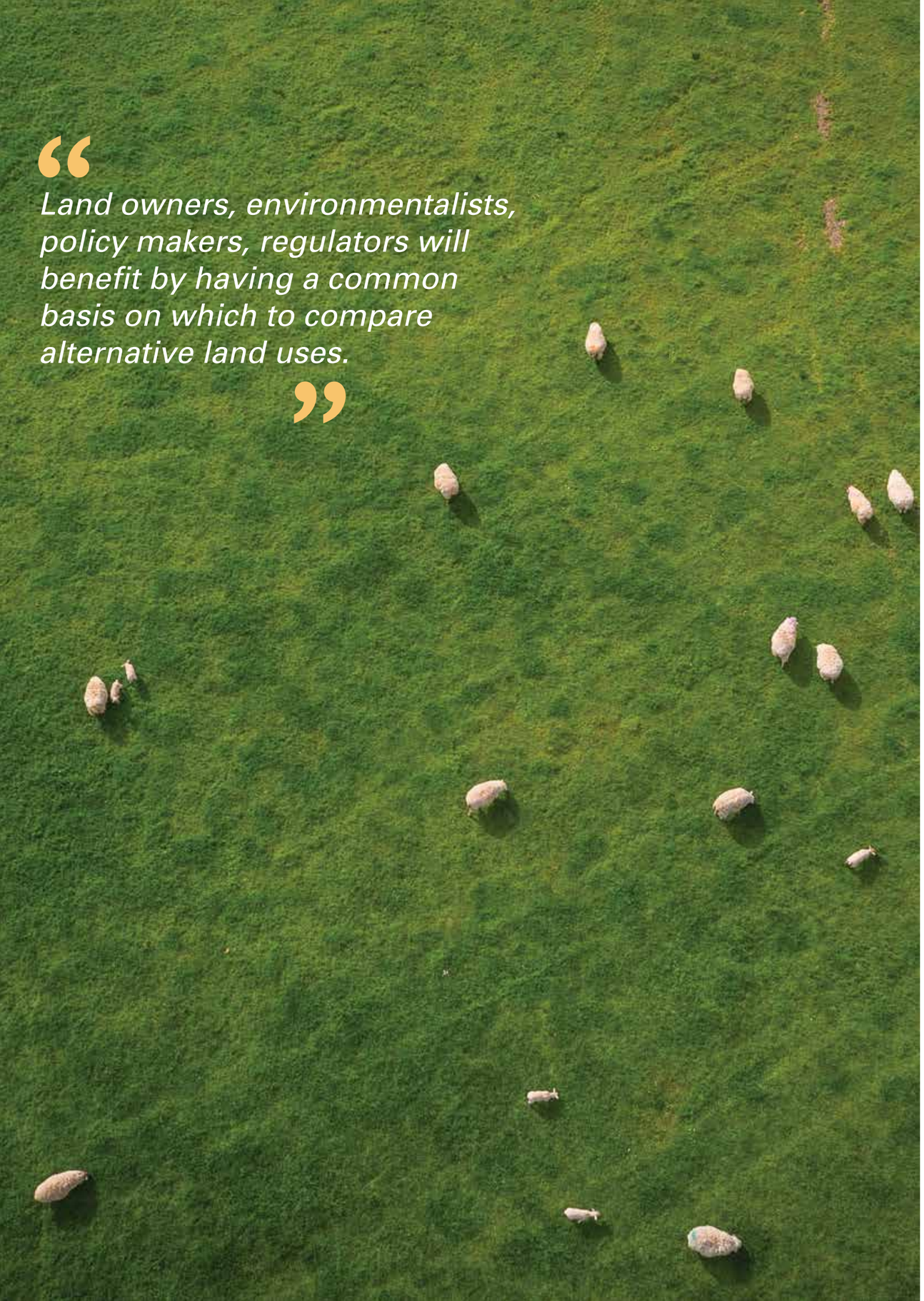
Appendix B: Significance for Funders

Research need Natural Capital	Significance for Funders
NC1: Quantity and quality of soils, health of soils, soil carbon, greenhouse gases	Investing in research on the capacity of soils to deliver multiple ecosystem services to society simultaneously, will open new windows of opportunity towards design and application of sustainable land use and land management concepts. Innovative concepts will address demands from agriculture, forestry, urbanisation and industry in an integrated perspective.
NC2: Biodiversity, organismic and genetic resources	Budget devoted to research on soil biodiversity will contribute to our capacity to maintain stability and resilience of ecosystems, which is essential to maintain life on earth as we know it. This is of particular relevance for climate change resilience, resource depletion, biodiversity loss, agricultural productivity to feed the world, and greening the economy, as captured in the sustainable development goals of the UN.
NC3: Water, water cycle	Funding research on the dynamics of the soil-water-sediment system and how to manage the water cycle as influenced by land use, land use changes and climate, will contribute to securing the delivery of sufficient and clean water to meet societal water demands.
NC4: Pollutant degradation, filtering and immobilization capacity	Dedicating research funding to increase our knowledge on the capacity of the soil-water-sediment system to degrade, filter and immobilize pollutants, will allow society to profit more from this outstanding ecosystem service to improve quality of life.
NC5: Prevention of erosion and mud slides, natural hazards	Funders of research on how healthy soils with an adequate plant and tree cover contribute to stability to prevent erosion, landslides and avalanches, will experience return on investment in cost-effective, and more sustainable protection to these natural hazards.
NC6: Geological resources	Funding research on the natural capital that geological resources represent, will illustrate their societal value beyond the current economic valuation and will contribute to a more sustainable excavation, reduction of use of primary resources and an increased use of secondary resources, leading to preservation of landscapes and resources for the benefit of future generations.
NC7: Intrinsic values of soils and landscapes	Investing in valuing intrinsic soil and landscape valuation, will increase landscape preservation and restauration, tourism and recreation revenues, and stimulates innovative business models to finance urban and rural development.

Demand	Significance for Funders
D1: The 4 F´s: Food, feed, fibre, (bio)fuel	Funding research on this topic will contribute to the transition towards a bio based and circular economy. This may include new business opportunities and technological challenges, reduction of society's dependency on fossil resources from politically unstable countries, climate change mitigation and adaptation, and multiple public benefits such as the reduction of poverty and hunger.
D2: Regulating Ecosystem services	Funding mapping and assessment of ecosystem services will add to the balancing of demand and supply of soil functions and services associated with urban, industrial, natural and agroproduction ecosystems.
D3: Urban / infrastructure land	This research topic addresses the challenges of cities to create a healthy and prosperous living environment for their citizens, balancing the needs of all stakeholders. By funding this research, the social, economic and environmental quality of cities will increase.
D4: Water	Funding research on the dynamics of the soil-water-sediment system and how to manage this as influenced by land use, land use changes and climate, will contribute to securing the delivery of sufficient and clean water to meet societal water demands.
D5: Geological (and fossil) subsurface resources	Funding research on the current and future demand for geological resources and the consequences of their extraction to ecosystem services of land and soil, will provide new insights and opportunities for the transition towards a circular economy, aiming at reduction, reuse and recycling of materials.
D6: Areas where Natural hazards are prevented	Investing in research on land demands to prevent natural hazards will contribute to risk reduction and increased safety to natural hazards such as floods, forest disasters, forest fires, geodynamic hazards and erosion.
D7: Health and quality of life (living environment)	Dedicating resources to research on the societal demand for health benefits provided by nature and nature-based solutions, will reveal novel insights in the need and desire of people to live close to green spaces to increase their wellbeing. It will create knowledge on innovative land use planning from a health perspective.

Appendix B: Significance for Funders

Land and Land use Management	Significance for Funders
LM 1: Governance, management mechanisms, instruments and policy	Funding research on governance will generate improved understanding of effective governance structures that address the challenges of sustainable land management. Research on innovative financing instruments (incentives, co-financing, combinations or modifications of existing instruments) will enable better spatial planning and land management. Open labs enable demonstrations of innovative solutions.
LM 2: Climate changes challenges for land management	Investing in research on land management to generate solutions to climate change challenges will contribute to improved climate resilience in natural, semi-natural, rural, and urban areas. Nature-based solutions will provide innovation and market opportunities.
LM 3: Land as a resources in urban areas (Sustainable urban land management)	Investing in research sustainable urban land management will contribute to the success of innovative urban policies such as compact cities, smart cities, healthy urban living, as promoted by the EU Urban Agenda and many other national and regional initiatives.
LM 4: Land as a resources in rural areas (multifunctionality of rural areas)	Funding research on sustainable rural land management will contribute to the further development of sustainable agriculture, preservation of nature and biodiversity, and the creation of attractive villages and cultural landscapes.
Net Impact	**Significance for Funders**
NI 1: Developing impact assessment methodology	Funding research on developing impact assessment methodology will enhance society's ability to identify, measure and assess risks from global environmental change, emerging contaminants and land use management, including the role of existing policies and regulations. It will also support better utilization of existing data by research on procedures for data management and exchange. Ultimately, as potential risks become more visible and understood, research in this theme will increase transparency of decision making with regard to regulating land use and management.
NI 2: Understanding and assessing impacts of drivers and management	Investments in research on assessing the impacts of drivers of environmental change will generate a better understanding of the magnitude of ecologic, economic and social impacts of climate change, land use and land management at different spatial as well as temporal scales. This will provide critical input for establishing novel and innovative alternatives for land use and land management that better balance the interests of all stakeholders.
NI 3: Trade-off analysis & decision support	Funding research on trade-offs and synergies between societal goals will enable decision-makers to develop land use options that deliver progress on multiple goals simultaneously, in an integrated and coordinated way, thus recognising that these goals are intertwined and cannot be addressed separately without adverse effects on other equally relevant goals. Such research will help creating windows of opportunity for sustainable economic and social development.
NI 4: Science-Society-Policy Interface	Investing in research of the science-society-policy interface will contribute to improved land use policies and decision making processes by awareness raising, citizen empowerment, stakeholder involvement and knowledge-based policy integration. By enhancing transparency and inclusiveness of the decision-making process it ultimately contribute to better acceptance of policy measures and will ease their implementation and enforcement.



Appendix C: Significance for End users

Integrated Research Need	Significance for End users
IRT-1: Integrated Environmental Assessment and Soil Monitoring for Europe	Soil quality and quantity is essential for delivering food, clean water, climate regulation, health benefits and many other ecosystem services. Data and monitoring are the basis for raining awareness on the societal relevance of good soil quality and land quantity. Monitoring identifies changes and will help avoid soil degradation, which is a root cause of land abandonment, states suffering war and land use conflicts, refugees and depopulation of rural areas.
IRT-2: Recognising the values of ecosystem services in land use decisions	Research in this area will facilitate an improved recognition of the values people hold for nature and its services in decision-making at different levels. This will strengthen often overlooked long-term public benefits of land use. It will also help reducing impacts of business activities, setting the scene for new markets and the design of public incentives and regulation.
IRT-3: From indicators to implementation: Integrated tools for a holistic assessment of agricultural and forest land use	Land owners, environmentalists, policy makers, regulators will benefit by having a common basis on which to compare alternative land uses.
IRT-4: Bio-Economy – unleashing the potentials while sustaining soils	Operators and regulators of bioeconomic production will be able to understand and ensure natural limits are observed. They will be aware of the capacity of the soil to deliver output, to a level that safeguards the provision of other ecosystem services. Research on this topic will deliver investment strategies, governance and business models, and approaches for their systemic integration in land use planning.
IRT-5: Integrated scenarios for the Land-Soil-Water-Food nexus under societal pressures and challenges	Land owners will be able to evaluate the impact of alternative courses of action on achieving land degradation neutrality, preserving the value of their land assets. Regulators will be better placed to ensure land degradation neutrality is being achieved and maintained. Scenarios may result in improved spatial planning and soil management.
IRT-6: Indicators for assessing the efficiency of the Soil-Sediment-Water-Energy nexus of resources	Improved understanding of the value of the SSW nexus and energy in the global economy to drive investment and regulatory decisions.
IRT-7: Farming systems to maintain soil fertility while meeting demand for agricultural products	Agri-industry will benefit in the long term by ways of contributing to food security while protecting soil fertility and avoiding environmental externalities of intensive agriculture. This will improve its environmental performance, profitability and the extent of its social license to operate.
IRT-8: Circular land management	Pragmatic regulation that encourages circular land use involving continuous renovation of settlement structures and reusing or redeveloping abandoned, derelict and under-used land and that prohibits consumption of fertile soil and valuable landscape.
IRT-9: Policies to effectively reduce land consumption for settlement development	End users will benefit from more consistent implementation of fit for purpose land use policies.

Appendix C: Significance for End users

Integrated Research Need	Significance for End users
IRT-10: Stakeholder participation to facilitate the development of liveable cities	Developers and businesses as well as governments and administrations will appreciate informed and objective involvement of citizens to enhance transparency and legitimacy of decision-making and urban development.
IRT-11: Integrated management of soils in urban areas	Land owners and local government will have a better understanding of the potential of urban soils that they can make use of.
IRT-12: Environmentally friendly and socially sensitive urban development	Developers and land owners, regulators and planners will be able to make more informed decisions that will help achieve their individual objectives without unforeseen or externalised environmental damage. These end users will be provided with hands-on tools that answer which services are needed to which extent in order to provide citizens with quality of life while protecting urban ecological conditions. Costs for health care and environmental justice will decrease.
IRT-13: Urban Metabolism – Enhance efficient use of soil-sediment-water resources through a closing of urban material loops	Land owners, developers and regulators will have a more sophisticated basis on how to make plans and decisions on optimal urban land use. Practical strategies, tools and instruments will be developed to enhance urban resource efficiency, consistency and sufficiency that will minimize direct and indirect negative environmental impacts of urban development. New local green jobs will be created.
IRT-14: Emerging contaminants' in soil and groundwater – ensuring long-term provision of drinking water as well as soil and freshwater ecosystem services	Land owners and developers will benefit from being able to demonstrate their land is safe for use. Users of emerging contaminants will have a consistent basis for managing their liabilities. Regulators will have a consistent basis from which to implement environmental and human health protection legislation.
IRT-15: Sustainable management to restore the ecological and socio-economic values of degraded land	A targeted array of ways to improve degraded land will restore the value of land and reduce pressure to develop on agricultural land.
IRT-16: Innovative technologies and eco-engineering 4.0: Challenges for a sustainable use of agricultural, forest and urban landscapes and the SSW system	Using modern information technology will deliver a more consistent approach to land management practice and regulation reducing unnecessary costs and avoiding land degradation that compromises ecosystem services. It will also involve an increase in new local green jobs.
IRT-17: Climate change challenges - improving preparedness and response for climate conditions and related hazards	The value of land that is managed to be resilient to climate change will last or even increase. Insurance costs will decrease.

Appendix C: Significance for End users

Natural Capital	Significance for End users
NC1: Quantity and quality of soils, health of soils, soil carbon, greenhouse gases	Knowledge on soil quantity, soil quality and soil health will improve land use decisions to the benefit of all stakeholders. It will reduce land use conflicts, and will promote sustainable soil and land use.
NC2: Biodiversity, organismic and genetic resources	Knowledge on soil biodiversity will contribute to sustaining different natural habitats as well as man-made landscapes (diversity of ecosystems), future plant breeding (diversity of genes), may reveal new antibiotics (diversity of organisms), and enhance ecosystem stability (diversity of functions).
NC3: Water, water cycle	End users of water will benefit from research on the consequences of land management on the delivery of water to meet societal demands, since it will contribute to a stable and continuous delivery of sufficient and clean water to all stakeholders in society.
NC4: Pollutant degradation, filtering and immobilization capacity	End users will profit from research on the detoxification potential of nature, since it will allow stakeholders to assess actual risks of environmental pollution, to improve remediation strategies and risk reduction.
NC5: Prevention of erosion and mud slides, natural hazards	Increased resilience to geo-hazards through nature-based solutions is of major benefit to end users, since it will create a safer living environment at lower overall costs with increased resilience to climate change while providing multiple co-benefits with respect to health, social cohesion and liveability.
NC6: Geological resources	Knowledge on the natural capital that natural resources represent beyond the traditional economic value will benefit end users as primary recipients of these co-benefits. This will include social, ecological and environmental values of natural resources.
NC7: Intrinsic values of soils and landscapes	Research that aims at valuing intrinsic, cultural, aesthetic and social values of landscapes, soils and ecosystems, will benefit end users of these values and will provide them with arguments during decision-making.

Appendix C: Significance for End users

Demand	Significance for End users
D1: The 4 F´s: Food, feed, fibre, (bio)fuel	The outcomes of this research will enable biologically balanced food, feed, fibre and (bio)fuel production, that is sustainable and reduce losses in production chains and ensures healthy and profitable products with equal opportunities for all.
D2: Regulating Ecosystem services	Society depends on long term access to ecosystem services and research in understanding the spatial distribution of these services will help in the formulation of local, regional and national (and transnational) policies and regulation to protect those services without compromising the provision of industrial services that society needs.
D3: Urban / infrastructure land	All stakeholders of urban development will benefit from research on the societal demand on land and how seemingly conflicting land use goals may be integrated in a stakeholder driven land use planning system.
D4: Water	All stakeholders need sufficient and clean water, to maintain life, to produce goods and services, to use as tap water, etc., and will benefit from this research.
D5: Geological (and fossil) subsurface resources	Research on the demand of geo-resources, especially incentives for circular design, reuse and recycling of materials will open a whole new window of opportunity for entrepreneurs and will create new business opportunities. End users may benefit from restored or unspoiled landscapes and natural areas will be preserved.
D6: Areas where natural hazards are prevented	End users will benefit from research on land demand to prevent the occurrence of natural hazards as this will provide options and alternative approaches to lower and eventually eliminate natural hazards and associated risks.
D7: Health and quality of life (living environment)	End users will benefit from research on the societal demand for health benefits, since this will give them the opportunity to highlight the health perspective in land use and land use decision-making. Health costs will decrease and citizens will live longer in better health.

Appendix C: Significance for End users

Land-use Management	Significance for End users
LM 1: Governance, management mechanisms, instruments and policy	Improved understanding of the governance of land management will enable local, regional, national and European administrations to design an effective institutional framework to support sustainable land management to the benefit of all stakeholders. To avoid land speculation, legal and economic monitoring needs to be enhanced.
LM 2: Climate changes challenges for land management	The development of nature-based solutions and implementation of green infrastructure will enhance the delivery of ecosystem services to strengthen resilience to the expected increase in extreme weather events. It will reduce the dangers of droughts, floods, landslides and other hazards, improving both quality of life and business development opportunities.
LM 3: Land as a resources in urban areas (Sustainable urban land management)	Research on sustainable urban land management will benefit all stakeholders in cities, since it will contribute to balancing the needs and pressures of urban growth with the opportunities and constraints of the environment. Innovative urban land use, for instance urban farming, unsealing of soil and remediation of contaminated sites will improve the quality of the urban living environment.
LM 4: Land as a resources in rural areas (Multifunctionality of rural areas)	Farmers will benefit from research on sustainable rural land management, since it will provide them with new land and soil management options, which they can realise a profitable and sustainable business, ready for the future. Retailers and other intermediates will benefit through high quality produce. It offers them an opportunity to become market leader in sustainable trade. Citizens will benefit from this research since it will improve the quality of the rural landscape, creating a more attractive and healthier landscape for recreation and housing, protection of nature and biodiversity, and a healthy and sustainable food production system.

Net Impact	Significance for End users
NI 1: Developing impact assessment methodology	Society as a whole will benefit from research on impact assessment methodologies, since they will help observe trends, detect as yet unknown threats, and better assess risks to human health, the environment and our economic prosperity while making best use of available data.
NI 2: Understanding and assessing impacts of drivers and management	End-users will benefit from research that contributes to understanding the net-impact of land management strategies and the effect of policies and regulations affecting land use, since it will provide them with knowledge and arguments to defend their interests in decision-making and to pro-actively adapt to emerging challenges.
NI 3: Trade-off analysis & decision support	Researching trade-offs and synergies between societal goals will enable balanced land management decisions to the benefit of all stakeholders.
NI 4: Science-Society-Policy Interface	Research that aims at increased awareness raising, stakeholder participation, effective knowledge transfer and policy integration with respect to land management decisions, will benefit all stakeholders in that their interests will be explicitly and transparently weighted against all other interests.

Integrated Research Need	Significance for Researchers
IRT-1: Integrated Environmental Assessment and Soil Monitoring for Europe	Monitoring and data analysis is needed to assess changes in space and time in soil and land properties and soil functioning. The challenge is to develop harmonized, efficient, comprehensive metrics and indicators of soil quality and change, using ground measurements, remote sensing and citizen science. Develop relevant and robust statistical tools to predict approaching tipping points. Applicability needs to span the rural and the urban.
IRT-2: Recognising the values of ecosystem services in land use decisions	Identification, assessing and integrating the values of nature, in particular the non-marketable ecosystem services affected by changes in land use and land use intensity. This requires a transdisciplinary approach to achieve convergence of behavioural economy, sociology, psychology and ecological sciences.
IRT-3: From indicators to implementation: Integrated tools for a holistic assessment of agricultural and forest land use	Researchers need to collaborate to identify appropriate means of combining metrics of relevant indicators in meaningful and acceptable ways. End-user friendly tools for integrated agricultural and forest land use selection will help arrive at - and deliver acceptance of - optimal rural land uses.
IRT-4: Bio-Economy – unleashing the potentials while sustaining soils	To help sustain the bioeconomy, scientists will need to develop transdisciplinary understanding of the spatial and temporal constraints on bio economic production by developing calibrated predictive models of soil functioning and economic, environmental and social consequences. Together with stakeholders, the most effective means need to be identified to steer land management accordingly, trading-off economic, social and environmental needs.
IRT-5: Integrated scenarios for the Land-Soil-Water-Food nexus under societal pressures and challenges	Elaborating explorative and target oriented scenarios considering integrated, spatially-explicit models that account for trade-offs and synergies between ecosystem functions, land use and societal challenges to provide reasoned input into operation decision making. External effects of our economy (import of goods, ecological footprint) should be taken into account as well.
IRT-6: Indicators for assessing the efficiency of the Soil-Sediment-Water-Energy nexus of resources	Improved characterisation of the inter relationships between the SSW nexus, including energy, and bio economic production is achievable with current big data and machine learning coupled with improved monitoring and modelling techniques.
IRT-7: Farming systems to maintain soil fertility while meeting demand for agricultural products	Large scale, long term studies coupled with real time technology driven data collection and agricultural interventions will allow new insights into the way to produce food and non-food products without harming soil fertility or the broader environment.
IRT-8: Circular land management	Creative design, construction, decommissioning, rerolling and replacement of urban infrastructure to avoid the need for sprawl and increase the viability of public and shared services involves multi-disciplinarity and exploitation of big data to constrain activities.
IRT-9: Policies to effectively reduce land consumption for settlement development	New data and agile modelling techniques provide researchers with novel ways of understanding the long term effects of socioeconomic drivers of land consumption and alternative land use policies.
IRT-10: Stakeholder participation to facilitate the development of liveable cities	The means of enabling citizens to be actively involved in decision making requires an informed citizenry and a refined understanding of the legitimacy of the process of deciding who ought to be involved, how and when, in the decision making.

Appendix D: Significance for Researchers

Integrated Research Need	Significance for Researchers
IRT-11: Integrated management of soils in urban areas	Characterising urban soils requires integrating diverse sources of information and handling inherent spatial variability with poor access. Evaluating the potential multiple functions is only possible if such characterisation can be carried out reliably and at a reasonable cost.
IRT-12: Environmentally friendly and socially sensitive urban development	In order to trade off the satisfaction of urban demands with the limits of natural capital, appropriate information, indicators and tools are needed that comprehensive yet applicable in practice. Research should aim at understanding and addressing the complexity of the many interests of societal groups and specific ecological conditions in a large geographic diversity in Europe.
IRT-13: Urban Metabolism – Enhance efficient use of soil-sediment-water resources through a closing of urban material loops	A new body of knowledge with an immediate field of application likely to result in short term impact with long term benefits makes this an interesting, and challenging, area to research. Interdisciplinary research is needed to develop strategic tools and instruments based on the concept of urban metabolism that are able to identify the critical stocks and flows of materials, energy and resources. In a comprehensive assessment, they also address externalities and negative ecological, social and economic impacts that occur indirectly.
IRT-14: Emerging contaminants in soil and groundwater – ensuring long-term provision of drinking water as well as soil and freshwater ecosystem services	There are several challenges in understanding and then managing the behaviour of emerging contaminants. Designed to be recalcitrant (e.g. firefighting agents), to interact with human or animal biochemistry (e.g. pharmaceuticals) and often occurring in mixtures at low concentrations in the environment they pose challenges of measurement, assessment and control.
IRT-15: Sustainable management to restore the ecological and socio-economic values of degraded land	Dedicated research is needed to elaborate region specific restoration and rehabilitation approaches for valorisation of degraded land. It requires a challenging collaboration between disciplines and sectors, crossing borders and the development of new and innovative approaches.
IRT-16: Innovative technologies and eco-engineering for sustainable use of agricultural, forest and urban landscapes and the SSW system	The ability to gather large, real time datasets on land quality brings with it challenges of interpretation and handling uncertainty in ways that are meaningful to land managers.
IRT-17: Improving preparedness for and response to climate change and related hazards	New agile data modelling techniques will be needed to confidently predict which land management actions are likely to result in resilient soils.

Natural Capital	Significance for Researchers
NC1: Quantity and quality of soils, health of soils, soil carbon, greenhouse gases	Research on land and soil from the perspective of natural capital aims at quantifying the benefits of the SSW-system to all stakeholders in society. This research will require an integrated and interdisciplinary perspective, to be able to simultaneously address the multiple ecosystem services that the soil-sediment-water system provides, thus allowing for a balanced decision-making process.
NC2: Biodiversity, organismic and genetic resources	Nature conservation and the halt of biodiversity loss in the context of natural capital are not goals in themselves but means to achieve sustainability.
NC3: Water, water cycle	Researching water issues from a natural capital perspective will contribute to innovations in water extraction, treatment, distribution and consumption, to reduce its environmental impacts and improve its sustainability. The expense and scale of traditional engineering infrastructure approaches in the water sector may be reduced by addressing the root causes of threats through natural capital solutions (such as ecosystem restoration). Incorporation of natural capital will innovate decision-making and risk management approaches.
NC4: Pollutant degradation, filtering and immobilisation capacity	Research on the pollutant degradation, filtering and immobilisation capacity of the soil-sediment-water system will build on the massive work done on this in the last decades, with specific emphasis on its contribution to reducing long-term, low-level chronic exposure to soil contaminants, environmental and human risk reduction of mixtures of toxicants, effects of changing environmental conditions (e.g. induced by climate change) on the filter, degradation and immobilization capacity of the soil-sediment-water system, and the further development of bioremediation techniques.
NC5: Prevention of erosion and mud slides, natural hazards	Researching resilience to geo-hazards will need an integrated analysis of human-induced as well as natural occurrences of geo-hazards. Through improved understanding of geohazards, their occurrence, preconditions, causes and implications, adequate mitigation and prevention mechanisms can be established, to protect citizens and society.
NC6: Geological resources	Investigating the value of natural resources beyond the current economic valuation challenges researchers to work more inter- and transdisciplinary to explore the societal benefits of natural resources in an innovative manner to create new markets and contribute to a more sustainable and circular economy.
NC7: Intrinsic values of soils and landscapes	Researching the intrinsic, cultural, social and aesthetic values of natural and man-made landscapes will challenge researchers to develop innovative valuation metrics and indicators, that will convince at the negotiation table where decisions are prepared on land use and land management.

Appendix D: Significance for Researchers

Demand	Significance for Researchers
D1: The 4 F´s: Food, feed, fibre, (bio)fuel	These research questions combine societal relevance with scientific challenges that require excellence. This research is about the search of innovative solutions to biomass scarcity. It will require field experiments, modeling, and laboratory experiments.
D2: Regulating Ecosystem services	Mapping of ecosystems services presents researchers with methodological challenges and issues of how to aggregate local observations or measurements to regional or continental scale audits of the delivery - and changes in deliver over time - of ecosystem services.
D3: Urban / infrastructure land	Researchers are challenged since this research requires transdisciplinary approach, combining social, economic and environmental sciences, as well as bridging the gap between science and urban practice in land use planning.
D4: Water	Researching the societal demand for sufficient and clean water, by agriculture, industry, homes and nature, requires current as well as future demand analyses and their spatial and temporal /seasonal fluctuations, using scenario studies. Researching demand for water also entails identifying challenges to realise an improved resource and energy efficiency while safeguarding environmental quality, with a specific focus on the consequences for land use and land management.
D5: Geological (and fossil) subsurface resources	Researching the demand for geo-resources extends beyond the traditional economic demand for resources, towards a more holistic approach of the production and consumption patterns, to minimise impacts on natural capital and ecosystem services.
D6: Areas where Natural hazards are prevented	Researchers will be challenged to develop approaches, methods and instruments that aim at preventing natural hazards through land management and land use planning.
D7: Health and quality of life (living environment)	The importance of nature, biodiversity and green spaces for human health is an innovative and still growing field of expertise. The interactions between the environment and human wellbeing are still poorly understood and what is much needed is the development of concepts and approaches towards healthy urban living.

Land-use Management	Significance for Researchers
LM 1: Governance, management mechanisms, instruments and policy	Researchers are challenged to work inter- and transdisciplinary on innovative policy and institutional aspects of land management, integrating social and environmental needs. This will include land use conflict management and options for circular land use. Also financing and control mechanisms need to be included, as well as best practices evaluation.
LM 2: Climate changes challenges for land management	Researchers will be challenged to bridge the global scale of climate change to local land management decisions and its relevance to stakeholders, e.g. in conflicts of urban densification versus green infrastructure benefits. Synergies of research and activities at different levels of urban policy may lead to explicit benefits and may enable cohesive solutions for environmental, social and economic challenges related to climate change.
LM 3: Land as a resources in urban areas (Sustainable urban land management)	Fields of research are impacts of demographic change, economic effects of urban sprawl, and nature protection in urban areas. More specifically, the benefits of urban green infrastructure and nature-based solutions needs further detailing. Additionally, research on brownfield revitalisation, improvement of the quality and efficiency of urban infrastructure, multifunctional use and flexibility of buildings and infrastructure, and urban governance is needed. Related research needs focus on the potentials of innovative urban land and soil management to contribute to improving the quality of the urban environment, for instance by urban farming or other forms of food production in cities,
LM 4: Land as a resources in rural areas (Multifunctionality of rural areas)	Research is needed on land management and steering mechanisms, the development of the land/real estate market and environmental compensation measures linked to ecosystem services. Also innovative management of agricultural land, respecting their multi-functionality, pressure on high-quality soils by settlements and species conservation, public awareness on the economic, ecological and societal value of landscapes, biodiversity versus fertility of soils, the role of the soil-water-sediment system in planning, and food security.

Appendix D: Significance for Researchers

Net Impact	Significance for Researchers
NI 1: Developing impact assessment methodology	Understanding economic, ecological and social impacts of land management decisions in the context of governance structures is inevitably inter- and transdisciplinary. Therefore, developing impact assessment methodologies should combine multiple disciplines and include all affected environmental compartments as well as societal actors' perspectives.
NI 2: Understanding and assessing impacts of drivers and management	Researchers are challenged to develop a thorough understanding of the environmental, socio-economic and ecological impact of land management decisions at and for different spatial and temporal scales.
NI 3: Trade-off analysis & decision support	Researchers are challenged to provide all information necessary to design cost-effective solutions in land management, i.e. on selecting land management approaches with the most favourable impacts. This also includes spatially optimized land use planning: what is the best use of land given its capacities to deliver ecosystem services.
NI 4: Science-Society-Policy Interface	Researchers are challenged to work together with policymakers, land managers, companies and citizens, as well as cross-sectoral and interdisciplinary, connecting the natural and social sciences. This topic is about understanding public and private decision-makers needs and enhancing uptake of scientific knowledge with respect to land use management and land use planning.

Appendix E: Significance for Citizens

Integrated Research Need	Significance for Citizens
IRT-1: Integrated Environmental Assessment and Soil Monitoring for Europe	Health and well-being are linked to adequate soil quality. Monitoring changes in soil and land quality will help prevent reaching conditions harmful to those soil functions delivering food security, pollution mitigation and adaptation to climate change, thereby protecting Europe's citizens consistently and efficiently.
IRT-2: Recognising the values of ecosystem services in land use decisions	Only by acknowledging and assessing the many benefits of clean air, fresh water, healthy soil, green spaces and beautiful landscapes can such "ecosystem services" be properly valued and taken into account when making decisions about land use and soil management.
IRT-3: From indicators to implementation: Integrated tools for a holistic assessment of agricultural and forest land use	Rural land has several roles to play in allowing citizens to live healthy, increasingly urban, lives. Understandable means of comparing alternative land uses will help citizen gain an objective appreciation of the conflicts and compromises involved.
IRT-4: Bio-Economy – unleashing the potentials while sustaining soils	Citizens will benefit from the contribution of the bioeconomy to a post-hydrocarbon society. It will provide independence from the uncertain and finite supply of non-renewable fossil resources and will provide them with new jobs and production means to create bio based products.
IRT-5: Integrated scenarios for the Land-Soil-Water-Food nexus under societal pressures and challenges	Citizens in Europe and beyond will benefit from integrated scenarios, because these will help decision makers to improve land use management. It will contribute to the realization of land degradation neutrality and will secure food provision.
IRT-6: Indicators for assessing the efficiency of the Soil-Sediment-Water-Energy nexus of resources	A more secure transition to a post-hydrocarbon economy is likely if the role of the Soil-Sediment-Water-Energy nexus of natural resources is quantified and accounted for in assessments of bio economic production.
IRT-7: Farming systems to maintain soil fertility while meeting demand for agricultural products	Citizens will have a secure food supply confident that this is not at the expense of long term soil fertility or damage to the environment or subsidies from other parts of the economy.
IRT-8: Circular land management	Technological advances, demographic change and improvements in meeting societal demands drive urbanisation but sprawl reduces air quality and harms health. Healthy, functioning urban areas need renewal and redevelopment.
IRT-9: Policies to effectively reduce land consumption for settlement development	Citizens will have their need for healthy settlements met but without unnecessary consumption of land, thus maintaining open space at urban fringes, decreasing commuting distances, and relieving public budgets by reducing costs for infrastructure development and maintenance.
IRT-10: Stakeholder participation to facilitate the development of liveable cities	Citizens will be empowered to have a larger say in how their living spaces develop. Research results will not only facilitate participation in urban development, but will also enhance transparency and inclusiveness of other decision-making processes.
IRT-11: Integrated management of soils in urban areas	Citizens will benefit from a deeper understanding of what their urban soils can - and cannot - deliver for them.

Appendix E: Significance for Citizens

Integrated Research Need	Significance for Citizens
IRT-12: Environmentally friendly and socially sensitive urban development	Citizens will be more likely to have their needs met without undue harm to the environment and will be better placed to avoid demands that would have unjustifiable levels of environmental impact. Integrated planning will prevent unhealthy living conditions due to a poor standard of environmental protection which may endanger social cohesion.
IRT-13: Urban Metabolism – Enhance efficient use of soil-sediment-water resources through a closing of urban material loops	A dynamic and systemic understanding of how land and soil resources are used by cities will provide to citizens a more sophisticated basis for making decisions about what to allow - and what to prevent - in urban areas, resulting in long term improvements in urban quality of life and in safeguarding scarce resources from overexploitation.
IRT-14: Emerging contaminants' in soil and groundwater – ensuring long-term provision of drinking water as well as soil and freshwater ecosystem services	Citizens have benefited from, and in many cases still use, products containing or comprising less known contaminants. A better understanding of the properties and impacts of such emerging contaminants and the combined effects of mixtures of pollutants will ensure public health is protected and the soil and water environments are not harmed or are restored.
IRT-15: Sustainable management to restore the ecological and socio-economic values of degraded land	Access to the full range of available restoration techniques will reduce the need for further land consumption and contribute to more effective ways of urban development.
IRT-16: Innovative technologies and eco-engineering 4.0: Challenges for a sustainable use of agricultural, forest and urban landscapes and the SSW system	Introducing modern data science eco-based technologies and eco-engineering into land management will ensure efficient means of meeting societal demands for resources sustainably.
IRT-17: Climate change challenges - improving preparedness and response for climate conditions and related hazards	Through greater access to information about the effect of climate change on land and hence quality of life, improved social responsibility and awareness on climate change issues will help bring about voluntary behavioural changes and help to prepare local actions which involve citizens in projects supporting climate change resilience.

Appendix E: Significance for Citizens

Natural Capital	Significance for Citizens
NC1: Quantity and quality of soils, health of soils, soil carbon, greenhouse gases	Citizens will benefit from research on the multiple benefits that land and soil are able to provide, since this research will provide them with arguments and knowledge as stakeholders of land use. Citizens are often overlooked beneficiaries of many of the services provided by the soil-water-sediment system. This research will express and value these benefits for citizens, to generate the relevant input in land use planning processes.
NC2: Biodiversity, organismic and genetic resources	Citizens will benefit from research on biodiversity, since it will provide insights into the relevance of conservation and sustainable use of biodiversity for human well-being and sustainable development.
NC3: Water, water cycle	Research on the natural capital of water will contribute to SDG 6: Ensure availability and sustainable management of water and sanitation for all.
NC4: Pollutant degradation, filtering and immobilization capacity	Increased knowledge on natural detoxification of contaminants in soils, aquifers and waters and how to stimulate this, will benefit the health and well-being of citizens. It also has the potential of reducing the costs for remediation, in terms of money, landscape destruction and further loss of ecosystem services.
NC5: Prevention of erosion and mud slides, natural hazards	Citizens will benefit from research aiming at increasing resilience to geo-hazards, since it will provide solutions that reduce the risks for citizens associated with geo-hazards, related to security, health and infrastructure.
NC6: Geological resources	Citizens are exposed to negative impacts of resource excavation, such as landscape deterioration, land degradation, and environmental contamination. Research on the natural capital of natural resources will provide knowledge on the multiple societal values for decision-making that benefits citizens as well.
NC7: Intrinsic values of soils and landscapes	Citizens are the primary beneficiaries of intrinsic, cultural, aesthetic and social benefits of landscapes, soils and ecosystems. Hence, citizens will benefit directly from increased knowledge on these values.

Appendix E: Significance for Citizens

Demand	Significance for Citizens
D1: The 4 F´s: Food, feed, fibre, (bio)fuel	Research on this topic will contribute to multiple SDGs, such as End poverty (1) and hunger (2), ensure access to energy for all (7), promote economic growth (8), ensure sustainable consumption and production patterns (12), take action to combat climate change (13), and promote sustainable use of terrestrial ecosystems (15).
D2: Regulating Ecosystem services	Citizens depend on long term access to ecosystem services and research in understanding the spatial distribution of where those services are delivered is an important step on the way to ensuring they keep such long term access.
D3: Urban / infrastructure land	Citizens of cities will directly benefit from healthy, sustainable and more climate resilient cities.
D4: Water	Research into the societal water demand and what this means for spatial planning and land use will contribute to SDG 6: Ensure availability and sustainable management of water and sanitation for all.
D5: Geological (and fossil) subsurface resources	Research on the demand for geo-resources and the potential to reduce this, will contribute to sustainable development and reduce the ecological footprint of citizens.
D6: Areas where Natural hazards are prevented	Citizens will benefit from research on land demand to prevent natural hazards to occur, since this will increase their safety and will reduce the risks and impact of natural hazards.
D7: Health and quality of life (living environment)	Citizens will benefit from research on the societal demand for health benefits, since this will highlight the health perspective in land use and land use decision-making, with ultimately the development of more healthy living environments.

Appendix E: Significance for Citizens

Land-use Management	Significance for Citizens
LM 1: Governance, management mechanisms, instruments and policy	Spatial management beyond traditional land use planning relates societal needs, economic activities and natural capital stewardship to mobilise citizen engagement, reach consensus on the use of land, balancing private and public interests.
LM 2: Climate changes challenges for land management	Citizens will benefit from research that explores the relevance of land management for climate change challenges, since this will increase the options to successfully act towards these challenges, thus improving living conditions in rural and urban areas.
LM 3: Land as a resources in urban areas (Sustainable urban land management)	Sustainable urban land management refers to SDG 11: Make cities inclusive, safe, resilient and sustainable. This also includes urban - peri-urban partnerships to connect cities to their surrounding environment.
LM 4: Land as a resources in rural areas (Multifunctionality of rural areas)	Sustainable rural land management refers to SDG 15: Sustainably manage forests, combat desertification, halt and reverse land degradation, and halt biodiversity loss. Moreover, it is also linked with other societal challenges, related to e.g. the ageing population, and migration.
Net Impact	**Significance for Citizens**
NI 1: Developing impact assessment methodology	The ability to identify and assess the pro and cons of different land management options as well as the consequences of threats such as climate change or emerging sources of pollution is indispensable for providing guidance for policy making and land management decisions that best contribute to a more sustainable, healthy, prosperous and inclusive society for all people. By calculating and showing the hidden societal costs and benefits will raise awareness of the consequences of unsustainable land use management practices.
NI 2: Understanding and assessing impacts of drivers and management	Research on understanding net impact will empower citizens as responsible consumers but also as stakeholders in the land use planning decision-making process. It will enable them to put alternatives on the negotiation table that will reduce the possible adverse impacts of land use that they experience and to create benefits from a sustainable use of natural capital.
NI 3: Trade-off analysis & decision support	Research on trade-offs and synergies between societal goals in land use planning and land management decisions, will highlight often overlooked public interests of land use, e.g. the protection of landscapes or environmental friendly production of food, materials and energy, and hence will facilitate their consideration in the decision making process.
NI 4: Science-Society-Policy Interface	Every citizen drinks, eats, lives, works, recreates and is mobile, hence is a land user. Quite often, citizens are also landowners, and hence land managers. Increased awareness of the role that citizens are capable to play in sustainable land use planning and land management, based on knowledge of the functions and potential benefits of the soil-water-sediment system, will enable citizens to participate meaningfully and with authority in discussions at different scales, within their own neighbourhoods, in national or international movements, and individually in their own consumption pattern. This will contribute to ownership and willingness to care for their neighbourhood and community, which will add to social cohesion and liveability.

Appendix F: The National Contacts

We are keen to maintain and widen the network developed by INSPIRATION. We have therefore initiated an 18 month follow-up phase, called INSPIRATION4EU, resourced by INSPIRATION partners and others who want to be involved in helping implement the SRA.

INSPIRATION4EU National Contacts have been identified for each country participating in INSPIRATION and for the European level. They are listed at www.inspiration-agenda.eu and in the following.

Requests and potential National Contact from other EU countries are welcome to contact us at contact@inspiration-agenda.eu.

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