The Strategic Research Agenda for Integrated Spatial Planning, Land Use and Land Management in Europe

Thomas Panagopoulos[1] and Dulce Antunes
[1]Faculty of Science and Technology, University of Algarve, Gambelas Campus, 8005 Faro, PORTUGAL
Email: tpanago@ualg.pt; mantunes@ualg.pt

Abstract: The soil-water nexus has a key role to play as Europe transitions to a low carbon, resource efficient economy. But water resources are under pressure, soil is being lost, while new energy nexus supports clean, smart opportunities worldwide. For us to benefit from the nexus for generations to come, knowledge needs to be created, transferred and put into practice. The way we steward soil resources, manage our land and plan our land use activities is central to ensuring Europe's transition to a sustainable future for its citizens and its global partners. Research and knowledge dissemination are fundamental to securing soils and land for next generations, for competitive economies and healthy landscapes. Clever use of the services provided by the soil-water system provides solutions for meeting societal needs and for overcoming societal challenges. In order to create a new strategic research agenda (SRA) on soil, land-use and land management in Europe, it was collected relevant information on research demands, based on a bottom up approach in 17 European countries collecting information from more than 500 European stakeholders. This investigation revealed the research needs that should be included in the European SRA. According to key stakeholders the societal challenges facing Europe increasingly require research and innovation which integrates different approaches from across research disciplines. These often increase the impact and usefulness of the research for businesses and society. It was highlighted the need to improve the dissemination procedure and was suggested enlarged stakeholder's involvement in research projects. The dissemination of projects should include indicators to access the social impacts, policy implications and applicability demonstrations. Strategic partnerships between universities and enterprises were recommend. Clear and accessible cost-benefits analysis, to increase the added value of research was emphasized. Recommendations for funders, researchers, end-users and citizens are included in the last chapter of this paper reporting about the EU project INSPIRATION executed as a Coordination and Support Action (CSA).

Key-Words: Strategic research agenda; stakeholders; soil; land; land management; land use; global change.

1 Introduction

Soil provides us with food, fuel, materials, filtration, and support for nature and our engineered structures and aggregate for those structures. Sediment is an essential component of river basins, estuaries and seas. Water is drunk, used for irrigation, needed by industry, supports transport and enjoyed for leisure. The new energy nexus supports clean, smart, and sustainable energy startups worldwide. The dynamics of the soil-water nexus at different scales contribute to natural capital and provide multiple ecosystem services.

The importance of the soil-water system is becoming increasingly understood but its behavior, resilience to climate change and anthropogenic influences and our ability to protect or restore it while using it sustainably are much less implicit. Land is a limited resource and sustainable land management seeks to balance the demand and supply of natural capital, handle with the effects of the driving forces putting pressure on the system and decrease the global footprint of human activities. To design sustainable strategies of land management and to decide from alternative uses of land it is indispensable to determine the biophysical and socio-economic indicators and causes of resource degradation, both through scientific knowledge and from the perception of local populations [1]. Research is necessary in order to facilitate sustainable land management and support evidence based policy making to a more sustainable future for Europe's citizens and its global partners. One of the reasons for inadequate implementation and adoption of sustainable land management is the lack of adequate mechanisms and channels for scientific knowledge transmission, and dialogue between science and police-makers [2,3]. Interdisciplinary research and cross-sector approaches may provide a deeper insight into the socio-economic and policy aspects of land degradation and sustainable development [4]. To ensure such interdisciplinary, the research methods must extend over the academic boundaries, enabling

non-academic stakeholder engagement and the inclusion of practical questions [5].

Many studies have advocated and demonstrated the importance of the stakeholder participation (as land-users, decision makers or experts) as an integral component over the development of some sustainable management initiatives and strategies [6, 7]. The iterative process, that includes knowledge exchange between scientists and potential users, it is fundamental to facilitate the application of knowledge on practice and to inform scientists about research needs [8]. Such information would be beneficial to consolidate research agendas and programs, addressing challenging and multi-faceted problems [9]. The involvement of stakeholders helps to take into account local realities and reduce the level of conflict among participants, creating a sense of ownership over the outcomes, and increase their durability application in practice [7, 8].

In that context arises the Coordination and Support Action INSPIRATION (Integrated Spatial PlannIng, land-use and soil management Research Action), financed from European Union under the Horizon 2020 program. INSPIRATION has taken an unique approach to identifying the knowledge needed to understand the soil-water nexus and to help us make better decisions so we can continue to enjoy its benefits in the long term. The INSPIRATION Strategic Research Agenda (SRA) has been developed from an evidence base collected across more than 17 EU member states by 'National Focal Points' [10].

The project aims to establish and promote the adoption of a strategic research agenda (SRA) for soil, land-use and the related, impacted soil-water system in order to meet current and future societal challenges and needs facing Europe. This paper presents the point of view of the Portuguese National Focal Points.

2 Materials and methods

2.1. The method of INSPIRATION

INSPIRATION was based in a bottom-up approach towards developing, delivering, match-making and promoting of a Strategic Research Agenda for land and the soil-water system, land-use changes and soil management addressing the societal challenges in Europe. The specific research and innovation needs of more than 500 European stakeholders, working as funders, scientists, policy makers, public administrators, consultants, have been collected to identify pressing research demands in Europe from their perspective [11, 12].

Workshops and interviews identified research topics on the soil-water nexus. These were synthesized into clusters of research topics as well as a series of cross cutting integrated research topics. The multi-national methodology was built on a multi-stakeholder and interdisciplinary approach, applied by National Focal Points (NFPs) working as knowledge exchange facilitators. Before the procedures to collect information, as for the other countries, in Portugal, a group of National Key Stakeholders (NKSs) was defined in order to include a variety of stakeholders from public bodies, business, scientific community, society, and relevant funders, across the various soil and land management disciplines [12].

Different approaches have been used to review research themes, identify knowledge gaps, questions and indicators and develop research agendas for environmental management [11]. On this project, it was applied personal questionnaires by interview, performed a desk study and organized a workshop discussion [12]. The outcomes of the collation of demands for research are taken up and reviewed following a conceptual model described in the next section.

2.2. Conceptual Model

INSPIRATION has been built around a simple conceptual model: Land use management seeks to meet societal demand for natural resources from the stock and services provided by nature (natural capital and ecosystem services). Effort is needed to understand and then minimize the net impact of such land use. The main EU-societal-challenges which are expressed in the Horizon 2020 work programs must be tackled to benefit from the land and the soil-water system and still to protect the natural capital and resources. Consequently, such challenges should be met on the SRA development process. Therefore, in order to identify cross-country and cross-sectoral knowledge gaps, research questions were structured along four overarching perspectives within the conceptual model of Figure 1.

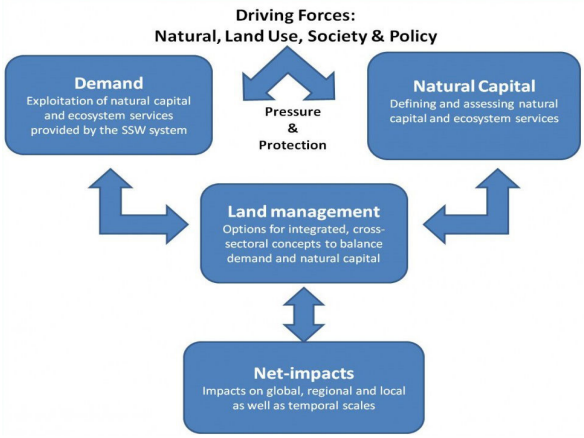

Figure 1: Conceptual framework of the project Inspiration [13].

This conceptual model assumes the importance of land and the soil-water systems as goods and natural capital stocks. However, there are multiple natural, land-use, society and policy drivers which affect these natural resources, their potentials and as well as their use, contributing to ecosystem degradation. An imminent question is the conflicting interests regarding land-use among the relevant stakeholders in a society (farmers, land planners, citizens, etc.), that leads to the paradigm of 'Either-Or': expectations of land-users towards maximizing economic benefits of natural resources stocks and goods on the one hand, and maximum requirements from societal groups towards different protective regulations on the other. Therefore, the sustainable management of land resources (agricultural, forest and urban) has to follow integrated, cross-sectoral concepts concerning the different demands of stakeholders. And lastly, on this process of natural capital management, the economic, societal, administrative and political impacts have to be assessed. Thus the net-impacts on local, regional, global as well as temporal scale are significant back-coupling effects and determinants of crucial importance [14].

The proposed conceptual model links four themes with aim to group research gaps concerning sustainable land management stewardship along four questions [14]:

Demand: What does society demand from natural capital and ecosystem services including the SSW-system?

Natural capital: What has nature, including the SSW-system to offer and which determinants sustain the system?

Land management: What are options for an integrated, cross-sectoral land management to balance societal demands and natural capital?

Net impacts: What are the impacts of different options of managing natural capital, including the SSW-system on global, regional and local as well as temporal scales?

2.3. Desk exercise

The societal challenges facing Europe increasingly require research and innovation which integrates different approaches from across research disciplines. These often increase the impact and utility of the research for businesses and other users. Towards the elaboration of European SRA on land and soil-water management, specific information was collected and analyzed. A clear vision of research state-of-the-art, needs/priorities, difficulties between science and practice/policy and funding prospects were obtained. The desk-exercise was done complementary to the bottom up methods mentioned, and the obtained information can be seen as supportive/underpinning to the information provided by the NKSs as described in the next chapter. Via a desk-exercise NFPs investigated, organized, and summarized information obtained through interviews publications, reports, etc. This step was particularly important to identify/verify relevant documents, programs or agendas already exist in each county.

Figure 2. Desk exercise to identify relevant documents, programs or case studies related to soil, land management and planning.

2.4. NKSs interviews

The personal questionnaires and interviews are common methods and aim to point stakeholders own perspectives. A questionnaire template for interviews of the NKSs by the NFPs was prepared [11]. The template is meant as a guide with sample

questions and points of attention for the discussion with the NKSs. The questionnaire aimed to obtain the information needed to give a foundation to the SRA at national levels regarding three mainly domains: research & innovation needs; connecting science - policy/practice; national and international funding organizations and schemes. In Portugal, 20 NKSs were interviewed and selected to represent different disciplines and institutional backgrounds including: land-use planners; managers; soil, sediment and water experts; researchers, funders and regulators/policy makers. In total 500 NKSs were interviewed in 17 European countries.

2.5. National Key Stakeholders Workshops

In each of the 17 EU countries national Workshops were used as "learning space" of sharing of experiences that can foster learning for participants and lead to new, creative ways of thinking [11]. It was organized at national level 2-day workshops in 2015 (Figure 2) where the collated information (NKSs interviews and desk-exercise) was reviewed, synthesized and prioritized by the NKSs, under NFPs facilitation.

Figure 3: Workshop sessions in Portugal with invited stakeholders.

In each workshop participated 20 to 50 experts from public and private funding institutions, research organizations, industry, NGO and regulation, including the interview applicants. After receiving the NKSs, NFPs made an informative presentation about the INSPIRATION project, and review and synthetize information already collected by interview and desk-exercise. Afterwards, NFPs facilitated three parallel sessions for discussion according the key domains (strategic research agenda topics, science-policy interface and possibilities for funding). Finally, conclusions were drawn up in a plenary session where the results of the three parallel theme groups were presented and integrated [15].

3 Results and Discussion

3.1. Societal challenges for Europe

Land and soil services help society meet its needs (food, drinking water, energy production, shelter, infrastructure) and overcome challenges (mitigating, and adapting to, climate change; increasing demands on non-renewable natural resources; environmental justice). Wise soil and land use management needs to balance the availability of natural capital and resources with society's demands. The value of nature and the ecosystem services it provides need to become part of the decision-making process on spatial planning, land use and soil management.

In 2015, the United Nations adopted 17 Sustainable Development Goals (Fig. 4), which the European Union seeks to put at the heart of its policy framework, priorities and budget. The 17 Sustainable Development Goals (SDGs) have 169 targets and progress will be monitored through 260 indicators. To contribute to sustainability, land-use management also needs to be environmentally friendly, socially acceptable and economically affordable. 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 prioritization transition. This research agenda considers soil and land use management challenges including the links between the soil-water system and health, energy, climate change, water resilience.

Figure 4: The United Nations' Sustainable Development Goals (https://sustainabledevelopment.un.org).

3.2. Research needs/topics for the SRA

During an international conference (Fig. 5), a synthesis of specific topics to include the SRA, indicated by the NKSs was done. It was reported many research questions aggregated in main topics. Then the research needs have been grouped into four themes:

a. Natural Capital and Ecosystem Services Supply (NC),
b. Demand for Natural Capital and Ecosystem Services (D),
c. Land Use Management (LM) &
d. Net Impact (NI).

Figure5. European conference of INSPIRATON at the University of Algarve, Portugal.

For each pf the four themes it was dedicated specific sessions during the international conference (Fig. 6), while each country synthesis of the national output was presented in poster exposition (Fig. 7).

In addition 17 cross cutting Integrating Research Themes have been identified (Table 1). A digest of the research needs in each Clustered Thematic Topic and Integrated Research Topic highlighting the likely benefits implementing them would deliver; the specific policy domains that would be addressed and the types of activity involved.

Table1: Integrating research needs in cross cutting themes (adapted from [10].

Research topic	Likely Impact
Integrated environmental assessment and soil monitoring	A European wide soil monitoring network
Recognizing the value of ecosystem services in land use decisions	Ecosystem services underpin human well-being and economic prosperity
Integrated tools for a holistic assessment of agricultural and forest land use	Agriculture and forestry affect soil chemistry, water quality, landscape beauty and culture
Bio-Economy: unleashing the potentials while sustaining soils	The bio.economy comprises those parts of the economy that use renewable biological resources
Integrated scenarios for Land-Soil-Water-Food nexus under societal pressures and challenges	Explorative and target oriented scenarios considering integrated, spatially-explicit models
Indicators for assessing the efficiency of the Soil-Water-Energy nexus	Informed vision of the links between consumption and use of SW system services by quantifying and mapping in time and space
Farming systems to maintain soil fertility while meeting demand for agricultural products	Precision agriculture, sustainable agriculture, regenerative agriculture
Circular land management	Continuous renovation of settlements reusing and redeveloping abandoned, derelict, underused land.
Policies to effectively reduce land consumption for settlement development	Incentives for or obstacles to the enforcement of planning instruments and policies
Public participation to aid the development of livable cities	Democracy in practice. Ownership of the solutions
Integrated management of soils in urban areas	Urban soils serve multiple functions: agricultural, gardening, economic and educational.
Environmentally friendly and socially sensitive urban development	Synergies and trade-offs between environmental and societal concerns in urban development
Urban Metabolism – Enhance efficiency of using soil-water resources through closing of urban material loops	Sustainable development needs a systemic understanding of provision, use and consumption of resources in cities
Emerging contaminants' in soil and groundwater	Ensuring long-term provision of drinking water and other ecosystem services
Sustainable management to restore the ecological and socio-economic values of degraded land	Land restoration, Regenerative economy

Innovative technologies and eco-engineering	Greener economy and urban re-naturalization.
Climate change challenges	Improving preparedness and response for climate conditions and related hazards

The research topics were summarized according to the four themes and about why it is relevant and for whom, who will be affected and responsible. The specific topics were arranged according the conceptual model through desk exercise and detailed description can be found in [10,14].

This agenda reflects research and innovation demands from across Europe from a range of perspectives and organizations. Far from being curiosity driven, it is anchored in an analysis of topical knowledge and implementation needs that are preventing an effective response to actual societal challenges – hindering the progress to achieving our sustainable development goals [10].

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. The agenda points out demands on several topics that are shared by stakeholder groups across Europe. Hence, synergies in areas of potential cofounding exist for the mutual benefit of efficient resource allocation of funders in neighboring 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 [13]. National Contact Persons are available to provide support and for making cross country contacts regarding specific research demands for co-funding.

End user needs: The ultimate beneficiaries of the knowledge created by implementing the SRA are Europe's citizens. Those benefits will accrue through this knowledge being used to provide Europeans with the goods and services they need and to protect the environment.

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. 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 benefitted from non-technical contributions from citizen groups. The local and detailed perspective that they brought was invaluable in identifying research needs that would contribute to dealing with societal challenges.

Figure 6. Parallel sessions of NKS for each of the four themes of the INSPIRATION SRA.

Figure 7. Poster session with the SRA output of each country at the University of Algarve, Portugal.

3.3. Funding schemes

Several regional, national, European and international funding schemes could offer opportunities for research on soil, land-use and land management. The practice component in the funding programs should be an indispensable the requirement. Demonstration and marketing of the results is considered fundamental. Open access dissemination platforms at EU level should provide scientific results from ongoing and finished projects to avoid the funding on already studied aspects. Higher connection between research institutions and enterprises is fundamental. There is general consensus that public-private partnerships can be a solution [15].

Research activities require long term and substantial funds to cover infrastructure and attract creative and innovative researchers. EU and national funds are

insufficient to fund all the research identified in the INSPIRATION-SRA. Other funding models have a key role to play. Bilateral programs can allow participating countries to support research of common interest. Public-private sector co-funding can accelerate the progression from pure science through proof of concept and prototype to full production and uptake. Crowd funding is widely used to deliver technology related projects. It has also had notable success in environmental research [10].

5 Conclusion

The INSPIRATION SRA contains research topics focusing on four themes: supply of natural capital & ecosystem services, demand for natural resources, land management and impact assessment. The 'Clustered Thematic Topics' (CTT) are accompanied by Integrated Research Topics (IRTs) that cut across these four themes. Each of the INSPIRATION-SRA 22 CTTs and 17 IRTs delivers substantial benefits – substantial return on funder investment. The impact of all topics being funded will be much more than the sum of the individual CTTs and IRTs [10].

Funders of research, knowledge transfer and implementation rightly expect a return on their investment in the form of traditional excellence but also the uptake of findings leading to societal change. Pressures on research budgets means funders will benefit from co-funding partnerships to help deliver their objectives. Funders will benefit from trans-national co-funding partnerships to help deliver their objectives, to realize more output with a limited budget, and to benefit from knowledge and experiences elsewhere. The INSPIRATION SRA makes it easy for funders to identify topics that meet their objectives and to work with National INSPIRATION points to identify partner funders to deliver the research and achieve impact. The INSPIRATION SRA identifies knowledge needs to overcome obstacles to better management of the soil-water nexus. It will help end users decide which research projects to support (financially, in kind or with staff time).

Citizens of Europe and beyond depend on the soil-water nexus. The INSPIRATION-SRA will help us manage the nexus so that it continues to serve us for generations to come.

Researchers are increasingly expected to collaborate in carrying out world class and world changing research: excellence with impact. The INSPIRATION-SRA offers the opportunity for both.

End users are the bridge between (pure) knowledge and its application to tackle societal challenges. End users will find summaries of the anticipated benefit to different types of end use (industry, regulators, policy makers). They can decide which research topics are most likely to benefit their organization. This will help end users decide which research topics to support, to get involved with and to provide letters of support or even support in kind or money.

Concluding the activities of INSPIRATION project, it can be perceived that Europeans are conscious about land degradation pressures and its effects, and on the need of innovative and sustainable ways of land management with respect to environmental quality and human well-being [16]. Besides, aware of some difficulties and gaps on science-practice interface and funding processes, it was consolidated recommendations on the future research projects on soil, land-use and management, which should promote interdisciplinary teams, integrate economic, social and environmental aspects regarding priorities and topics mentioned, ensure linkage between research institutes and companies facilitating funding establishments, and guaranty social acceptance and findings applicability. More information about the INSPRIRATION SRA can be seen at the website of the project [13].

Acknowledgements

The authors acknowledge the financial support given by EU under Project INSPIRATION, H2020-SC5-2014-642372: Integrated Spatial PlannIng, land use and soil management Research Action.

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