

# INSPIRATION for Sustainable Soil and Land Use Management in Austria

## INSPIRATION für nachhaltiges Boden- und Flächenmanagement in Österreich

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### Summary

In times of climate change and increasing societal needs, the pressure on land is unprecedented. Sustainable soil and land use management is only achievable if stakeholders from sectors concerned work together. The aim of the project INSPIRATION (Integrated spatial planning, land use, and soil management research action) was the integration of science and interdisciplinary research fields to develop a strategic research agenda (SRA) for sustainable land use and soil management in Europe. This article presents the Austrian perspective and contribution to the SRA, highlights the findings of the project, and identifies the most urgent research needs addressing key societal challenges. The project followed a bottom-up, multi-stakeholder approach to enable an evidence-based collation process of interdisciplinary research needs. Through expert interviews, reviews of state-of-the-art documents, and public involvement, six key research topics of the most pressing research needs in Austria were identified. This Austrian contribution to the SRA is characterized by the need for a communication frame and knowledge transfer among research, policy, and society. A compatible knowledge transfer is pivotal to establish an understanding of shared responsibilities among all stakeholders.

**Keywords:** sustainable land management, land use, strategic research agenda, soil protection, knowledge transfer

### Zusammenfassung

In Zeiten des Klimawandels und steigender gesellschaftlicher Bedürfnisse ist der Druck auf Boden und Land so hoch wie noch nie. Nachhaltige Boden- und Flächennutzung ist nur möglich, wenn Stakeholder aus verschiedenen Sektoren zusammenarbeiten. Das Ziel des Projekts INSPIRATION (Integrated spatial planning, land use and soil management Research Action) war die Zusammenführung von interdisziplinären Forschungsfeldern, um eine strategische Forschungsagenda (Strategic Research Agenda, SRA) für eine nachhaltige Landnutzung und Bodenbewirtschaftung in Europa zu entwickeln. In diesem Artikel wird der österreichische Beitrag zur SRA präsentiert und der Forschungsbedarf identifiziert, welcher sich mit den wichtigsten bodenrelevanten gesellschaftlichen Herausforderungen befasst. Das Projekt verfolgte einen Bottom-up-Ansatz mit multiplen Stakeholdern, um einen evidenzbasierten Prozess zum Zusammentragen interdisziplinärer Forschungsbedürfnisse zu ermöglichen. Für Österreich wurden durch ExpertInneninterviews, Analyse von Stand-der-Technik-Dokumenten und Einbeziehung der Öffentlichkeit sechs zentrale Forschungsthemen mit dem dringenden Forschungsbedarf identifiziert. Dieser österreichische Beitrag zur SRA wird von der Notwendigkeit der Kommunikation und des Wissenstransfers zwischen Forschung, Politik und Gesellschaft umrahmt. Ein kompatibler Wissenstransfer ist von entscheidender Bedeutung, um ein Verständnis der geteilten Verantwortlichkeiten aller Beteiligten zu schaffen.

**Schlagworte:** nachhaltiges Flächenmanagement, Landnutzung, Strategische Forschungsagenda, Bodenschutz, Wissenstransfer

## 1. Introduction

Sustainable land use is gaining importance because the consumption of soil and land is progressing without noticeable restrictions. As soil is a major crosscutting issue, it is challenging to manage this finite resource. The limited area has to fulfill a high variety of needs, further complicating a fair allocation.

Sustainable land management implies the qualitative and quantitative preservation and restoration of both soil and land to assure the delivery of its services (i.e., European Environment Agency, 2015). Owing to increasing societal needs, the pressure on land is unprecedented in times of demographic changes with an accelerating aging of the population and altered dietary patterns, increased urbanization, climate change, and advanced technology adaptations, which are both global and national issues. At the end of 2017, the total area of sealed soil in Austria was 230,000 ha (Environment Agency Austria, 2018c). Although the daily land consumption decreased by 12% during the period 2015–2017 compared to the period 2014–2016, the overall degree of soil sealing increased by almost 25% since 2001 (Environment Agency Austria, 2018c). This is a clear indication that the current approaches and policies need to be adapted as soon as possible. However, the general public and most policymakers are unaware of the manifold functions that soil can fulfill when kept unspoiled. The challenge is to link the two-dimensional view people have of land with the three-dimensional benefits lying below the surface in the ground (Von Weizsäcker and Wijkman, 2018).

In the past years, research on the complex soil-sediment-water nexus helped to gain new knowledge on the complex interconnections. However, standalone disciplinary approaches will not meet the needs to integrate the generated research findings with the environment or the society. As unsustainable land use management will affect all groups of society, the only seminal solution is to merge the various approaches of different stakeholders as widely as possible. The overarching question, according to Grimski et al. (2018), is how to focus the necessary research to support a resource efficient society.

In 2015, the International Year of Soils, the UN Sustainable Development Goals (SDGs) were adopted. It has become clear that at least six key issues for soil science are vital to society for achieving the SDGs: food security, human health, water security, climate change, biodiversity preservation, and land management (Keestra et al., 2016). The idea is to foster integrated science of interdisciplinary

research fields, ranging from soil science to spatial planning and policy implementation.

The European Union supported efforts in soil- and land-related stakeholder integration with the Coordination and Support Action “Integrated spatial planning, land use and soil management research action – INSPIRATION” to develop a strategic research agenda (SRA) for sustainable land use and soil management in Europe (Grimski et al., 2018). The aim of the project was to identify transnational and interdisciplinary research needs to establish this SRA for Europe and to improve the use of knowledge referring to the soil–water system. The project applied a coordinated and structured cross-national stakeholder process to prepare a transnational network of funders to implement the SRA (Bartke, Boekhold, et al., 2018). This article presents the Austrian perspective and contribution to the SRA, highlights the findings of the project, and identifies the most urgent Austrian-specific research needs addressing key societal challenges.

## 2. The information collation process

INSPIRATION was designed as a bottom-up, multi-stakeholder approach to enable an evidence-based collation process of interdisciplinary research needs concerning key societal challenges.

In order to collect the research needs, 17 European countries collaborated and followed a national three-step process (Figure 1), which will be explained in the following sections. The INSPIRATION project aimed to synthesize and collate the research needs into one international SRA in the fourth phase. National Focal Points (NFP) were mobilized to facilitate the collation process and knowledge exchange. In total, more than 500 international stakeholders from various fields contributed to the SRA, enabling an interdisciplinary foundation for future research projects (Bartke et al., 2018).

### 2.1 Phase 1: National expert interviews

The initial phase comprised interviews with selected national key stakeholders (NKSs) to determine essential research needs. Representatives from the end users’ perspective as well as science, funding, and policy institutions were invited to contribute their expert views. Of more than 20 NKS from a variety of relevant disciplines, 11 experts were interviewed in individual and semi-structured inter-

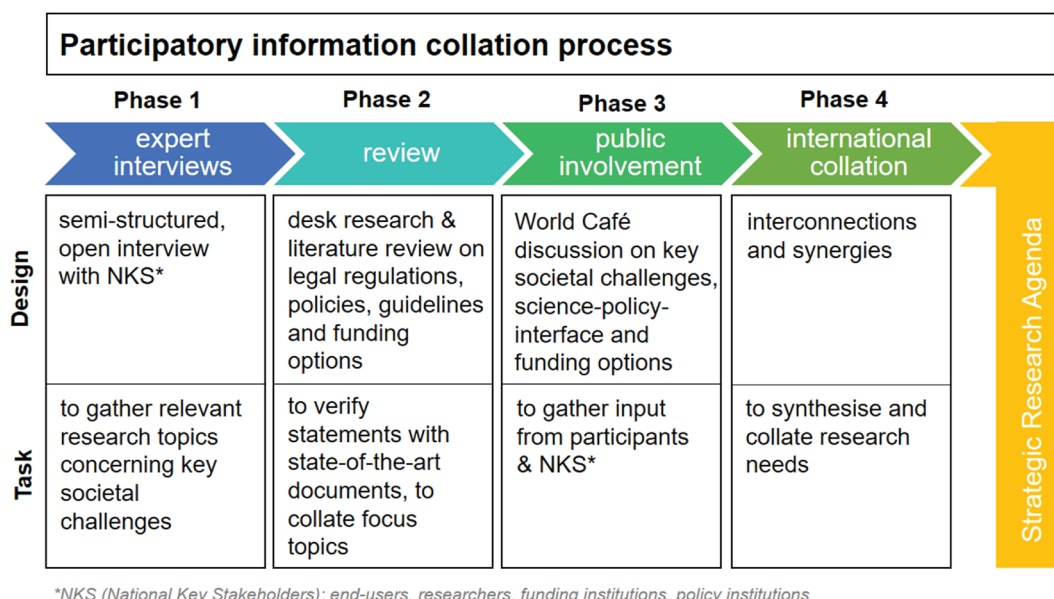


Figure 1. National stakeholder participation: information collation process in Austria for research needs based on the INSPIRATION participatory approach according to Bartke et al. (2018)

Abbildung 1. Nationale Stakeholder Partizipation: Prozess zur Sammlung der Informationen zur Erfassung des Forschungsbedarfs basierend auf dem partizipativen Ansatz des INSPIRATION Projekts nach Bartke et al. (2018)

views. The open interview questions enabled them to discuss openly and to offer new perspectives. NFP collated the provided information and reviewed it without prioritization of individual research topics.

## 2.2 Phase 2: literature review

In a second phase, NFP reviewed and verified the statements and state-of-the-art documents mentioned throughout the interviews. An extended literature review to collect relevant policy papers, legal documents and, research findings was conducted. The results set the legal and structural scope for new research needs. Subsequently, the most common themes were then classified into eight focus topics (Figure 2).

## 2.3 Phase 3: public involvement on national level

In the third phase, NFP assembled the NKS and the interested public in a two-day workshop to confirm and consolidate urgent research needs on specific focus topics. More than 100 participants shared their insights during the sessions.

The workshop days were designed after the seven key principles of a World Café according to Brown and Isaacs (2007). The traditional design was slightly adapted to

ensure that the participants from various backgrounds could gather information on the different aspects of sustainable land use management. One adaptation was that the first day started with presentations from key speakers on sustainable soil and land use as well as a short introduction to the INSPIRATION project. Furthermore, participants were invited to choose two World Café table discussions out of eight focus topics. At last, the participants presented and discussed the key findings for each topic in the plenum.

On the second day, the NKS synthesized the obtained perspectives. Guided by the NFP, the identified strategic research needs were put in context with the science–policy interface and potential funding options. The NKS received the results of these workshops for a verification review. The feedback loop was open throughout all phases of the information collation process to ensure continuous adaptation of the research needs into the international collation phase.

## 2.4 Phase 4: International collation process

After the individual countries had identified their most pressing national research needs, they were transnationally collected and synthesized into “Clustered and Integrating Research Topics (CRT, IRT)” (Bartke et al., 2018). The impact of the implementation of these topics (outlined in

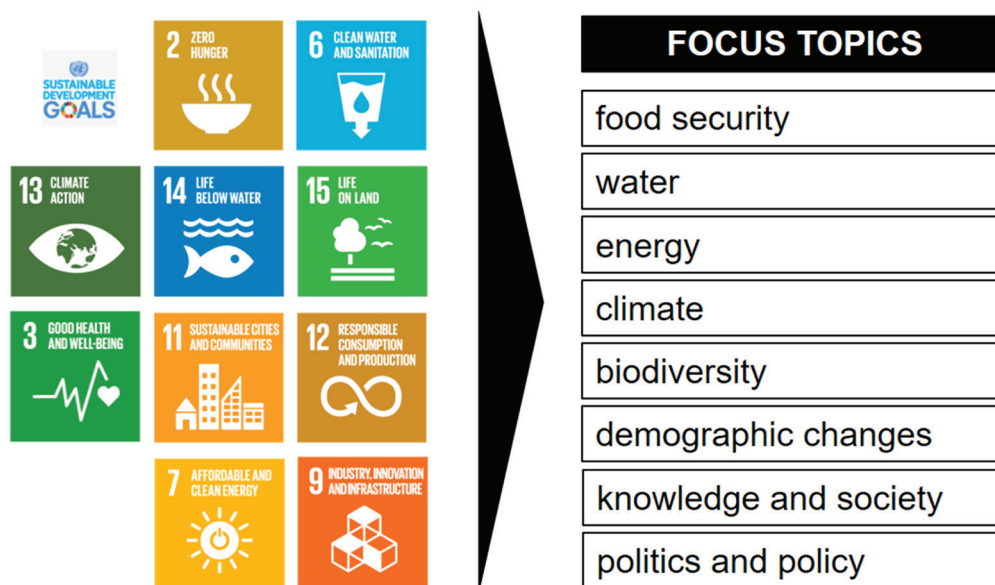


Figure 2. Relevant SDGs and the corresponding focus topics identified in the Austrian expert interviews  
Abbildung 2. relevante SDGs und durch die ExpertInneninterviews identifizierte Fokusthemen

the *Europeans' Strategic Research Agenda for Integrated Spatial Planning, Land Use and Soil Management*) is considered to go beyond the mere sum of the funding for the individual topic (Nathanail et al., 2018) but to achieve a general change in the management approach. For further details on the research topics, a web version of the SRA is open for contribution and funding possibilities (INSPIRATION, 2018).

### 3. National Results

#### 3.1 Legal basis to build a sustainable land use management

As soil and land issues in Austria are spread across a wide array of legal regulations, a profound understanding of the legal basis of soil and land management is crucial and is addressed in the following sections.

##### 3.1.1 (Current) Landscape of EU policies and regulations

The EU legislation concerning spatial planning is rather scarce. However, a few policies tackle land consumption and soil sealing. Foremost, the *Roadmap to Resource Efficient Europe* (COM(2011) 571), the *7<sup>th</sup> Environment Action Programme*, and the *EU Cohesion Policy* lay out the overall

direction for sustainable land use management in Europe (European Commission, 2012b; Batista e Silva, Lavallo, et al., 2013). The programs aim to achieve “zero net land take by 2050” (European Environment Agency, 2015). The EU policy agenda encourages local land allocation and management to use inherent conditions and features, including community knowledge (European Environment Agency, 2015). According to the European Regional Development Fund, one of the investment priorities should be the protection and restoration of biodiversity and soil (European Union, 2013). Various EU projects (e.g., Urban Soil Management Strategy, VOLANTE, and INSPIRATION) show that research on sustainable land and soil management is still a high priority, and guidelines and reports on soil sealing and soil resource efficiency (European Commission, 2012a; European Environmental Agency, 2016) have been published. However, the legislation does not follow suit. The *Proposed Soil Framework COM(2006) 232* (European Commission, 2006) did not pass the legislation in 2006. As a result, the soil agenda is still split up among more than 30 pieces of legislation (Paleari, 2017). Despite the urgency of the matter, the controversial debate on the specifics of the framework (Lee and Bückmann, 2008) again led to the withdrawal of the proposal in 2014 (European Commission, 2016). At present, very few European countries, for example, Germany and The Netherlands, have applicable laws on soil protec-



tion. Although the topic has gained urgency in the last couple of years and was posed to public debate during the International Year of Soils, national legal adaptation has not been initiated in Austria yet and will most likely be subject to a long and tedious process.

### 3.1.2 National policies and regulations

In Austria, legal regulations for soil and land use management are fragmented, attributed to strong legal rights and positions of the nine federal states. Instead of overarching legal guidelines, such as in Germany (Federal Soil Protection Act, 1998), each federal state can decide on its own directives. Land use issues are spread across national law and addressed in manifold regulations, such as forestry law, spatial planning laws, building codes, the Water Act, the Waste Management Act, the Nature Conservation Act, or the ratification of the Alpine Convention Protocol.

Responsibilities of zoning and spatial planning are not the same as for soil management. National spatial development issues are coordinated by the Austrian Conference on Spatial Planning (ÖROK, 2015). Soil quality is regulated for each state individually by the Soil Sewage Regulation, the Compost Ordinance, the Fertiliser Ordinance, the Plant Protection Products Regulation, or regulations on air or water pollution (Environment Agency Austria, 2018a). Only two states, namely, Salzburg and Vorarlberg, passed a comprehensive legal regulation on soil quality and quantity (Salzburg Soil Protection Act, Regional Law Gazette No. 80/2001 and Vorarlberg Regional Law Gazette No. 26/2018). Some counties have not passed a law on soil management at all (Carinthia, Tyrol, and Vienna), whereas the other federal state laws focus only on agricultural land (Burgenland Soil Protection Act, Regional Law Gazette No. 87/1990; Lower Austrian Soil Protection Act, Regional Law Gazette No. 6160-0; Styrian Soil Protection Act, Regional Law Gazette No. 66/1987; Upper Austrian Soil Protection Act, Regional Law Gazette No. 63/1997).

## 3.2 Knowledge gaps and research needs

Scientific assessment of soil differs significantly between soil sciences and spatial planning sciences. To this day, soil science considers primarily qualitative aspects and ecological benefits of soils, whereas spatial planning focuses mainly on the utilization of the land surface. Although open source data on the state of the Austrian soil, collected from agricultural and forest soil inventories, is available online (Soil Information System BORIS) and can

be updated if required (Jandl et al., 2018), soil quality is not a key factor for spatial planning decisions (Zech et al., 2010). Substantiate policy decisions for sustainable management of soil and land resources can only be achieved with the establishment of an extensive scientific basis.

In Europe, land degradation is a direct result of the overconsumption of soil and land. The situation is becoming critical because it is followed by agricultural intensification and fragmentation (European Environment Agency, 2015). In Austria, the biggest challenge is the high land consumption for settlements and accompanying infrastructure. The daily rate of land consumption is still 12.9 ha per day according to the latest registered period (Environment Agency Austria, 2018b), with a retail space of 1.75 m<sup>2</sup> per capita, being among the highest in international comparison (RegioData Research, 2017). The living space per capita is increasing, whereas the density per housing unit is decreasing (Tötzer et al., 2009). Land consumption is, therefore, a pressing issue in Austria and needs to be addressed and debated on the public, business, and political levels.

The INSPIRATION project aimed to collect knowledge gaps and research needs from a national bottom-up level. Here, the participatory approach applied helped to identify various aspects to tackle the key societal challenges in Austria. First, focus topics were based on the input given by the NKS during the interviews (Phase 1) and related to the SDGs (Figure 2).

Following the first two phases, six key topics were elaborated based on a broad consensus during the national workshop in Austria (Phase 3), covering various research areas ranging from food production to ecosystem services (Figure 3). The stakeholder process revealed that the most important issue is to balance the transfer among societal needs, scientific information, and policy institutions and actions. Communication and exchange processes were consensually identified to set the most essential frame around the key topics in order to link and balance needs, science, and legal regulations for a sustainable management approach. Short characteristics on the key topics are given in the subsequent sections.

### 3.2.1 Key Research Topic 1: Agriculture and food security

Land consumption has a direct impact on agriculture and food production. Arable land competes for fodder, raw material, energy production, as well as mobility, transport, infrastructure or construction of buildings, and settle-

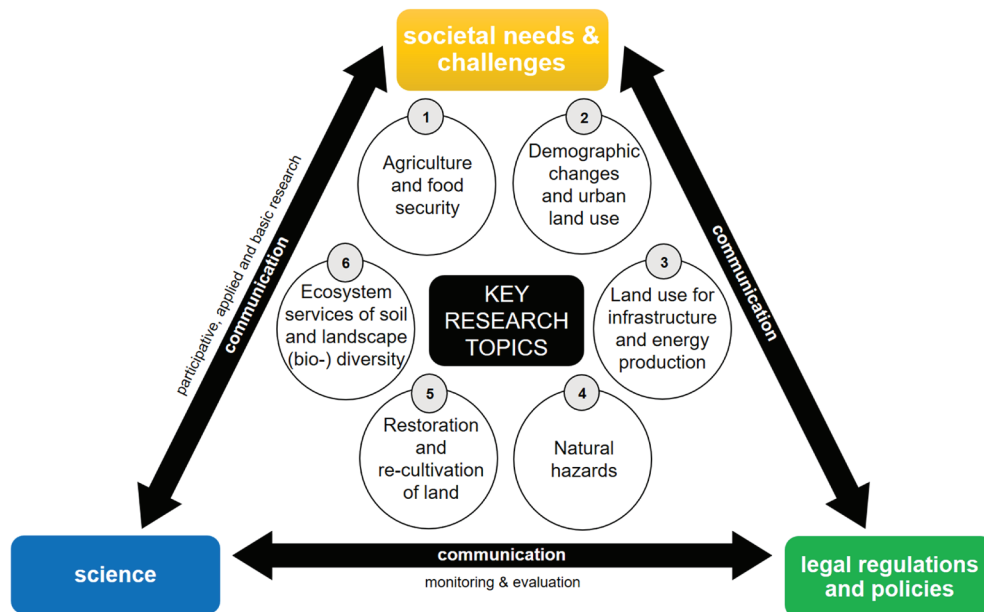


Figure 3. Identified key research topics and the strongly needed communication frame among society, science, and politics/policies for sustainable land use management derived in the Austrian stakeholder process

Abbildung 3. Identifizierte Schlüsselthemen für die Forschung und das erforderliche Kommunikationsgerüst zwischen Gesellschaft, Wissenschaft und Politik für ein nachhaltiges Flächenmanagement (erarbeitet im österreichischen Stakeholderprozess)

ments. In the past 50 years, the world population doubled, whereas the available agricultural land decreased from 0.5 to 0.25 ha for each person worldwide (Straßburger, 2014). In times of increasing world population and exaggerating consumption, food security will continue to be a pressing issue (Food and Agriculture Organization, 2017).

Austria does not have enough farmland to produce enough food for all citizens if dietary habits will stay the same (Zessner et al., 2011). However, technological advances and dietary changes can help to use the existing farmland and pastureland more efficiently and to account for organic and nature-based production methods. In light of spatial heterogeneity, the cultivation methods for agricultural production need to be adapted to regional and local circumstances because they have a considerable impact on soil quality. New approaches for food as well as biomass production would enable the local and global populations to fulfill their dietary and energy needs, while making sure the water resources are not contaminated (Blum, 2016). Many possibilities to improve agricultural engineering techniques and adaptation to changing climatic conditions are opened up by the ongoing digitalization, ranging from precision farming considering spatial and temporal restrictions to smart grids with advanced communication settings.

Socio-economic drivers need to be considered in this context to secure the livelihoods of those who cultivate the soil.

As the pressure on expenses and time increases, more and more small-scale and part-time farmers quit their agricultural businesses. An open question is the implementation of an effective support mechanism, so they can maintain their farms in the future. According to the workshop participants, knowledge transfer has to be improved to approach farmers and other land users with useful information and incentives to avoid selling prime agricultural land for building purposes. However, standalone knowledge support for farmland owners seems to fall short. Private land sale is attractive, sometimes even a necessity in times of economic shortage. Key is to restrict the excessive rededication of agricultural land into building land on a regulation level and to establish attractive agricultural business alternatives.

### 3.2.2 Key Research Topic 2: Demographic changes and urban land use

Soil and land are getting scarcer as global population and land consumption increase. More people are moving toward cities, resulting in different challenges for urban and rural areas. Municipalities in rural areas are expected to shrink because of migration to cities (Statistics Austria, 2018). Along the way, decentralization is expected to demand more land as necessary infrastructure will emerge along transportation routes. In addition, more farmland gets abandoned, whereas more properties are used as second homes. The

workshop participants suggested focusing on the declaration of building and transport zones in strong structural areas instead of less-developed zones in the countryside. Unused industrial sites, brownfields, and abandoned infrastructures can find a new purpose with appropriate land recycling. This will further reduce and help to restrict the use of undeveloped land (Hepperle, 2014).

In terms of sustainable urban land use, the most urgent matter to the participants seems to be the application of spatial planning tools to foster inner urban development with a mix of different usages. Dense construction developments generally correlate with lack of green areas. A coefficient between green area and population density, especially for its benefits on air quality, urban heat island effect, or stormwater management is not yet scientifically established (Morawetz et al., 2016). Novel management tools to deliver ecosystem services need to be developed and may include proactive land recycling, focused inner-city development, balanced individual approaches, and beneficial green infrastructure (European Commission, 2013; European Environment Agency, 2015).

In general, participants announced that the motivation for land use change is a key to develop effective strategies in favor of sustainable land use management. In this context, the effectivity assessment of various financial incentives to increase the attractiveness of re-purposing urban land should be investigated.

### 3.2.3 Key Research Topic 3: Land use for infrastructure and energy production

Of all the uses that land can fulfill, infrastructure and energy production might consume the most area in terms of square meters. Large infrastructure measures, such as power plants or transport routes, are often irreversible. Therefore, soil sealing should be considered carefully and simultaneous multiple usages should be aspired (e.g., for energy supply; Erker et al., 2017).

The consideration of soil quality for infrastructure projects is perceived to be one of the most pressing issues. According to Seher<sup>(2014)</sup>, spatial planning should promote quantitative soil protection to save soil from building development and sealing. An adequate tool for the assessment of soil quality in spatial planning is considered of uttermost importance by the participants to secure soil functions while maintaining favorable spatial development. A set of indicators at hand would be helpful to assess the value of undeveloped land in comparison to different developed land types, for example, vacated infrastructure sites or brownfields. This

set of indicators could include the area ratio of sealed land compared to open land (per capita), biochemical parameters, nutrient values of the soil, or parameters to gather information on the biodiversity on site and the contribution to the ecosystem services.

### 3.2.4 Key Research Topic 4: Natural hazards

In Austria, only 37% of the total land area is not in danger of natural hazards (Prokop et al., 2011). This is not much given that Austria has already scarce resources of inhabitable land area because of the topography and mountainous regions. As one of many demands that land can potentially fulfill, it is important to include the area demand for the protection against natural hazards. Depending on the geographical location and local conditions, a variety of natural hazards repeatedly causes significant damage. In view of climate change, Austria will need further flood protection measures as well as applications to combat droughts. The participants assessed the importance of buffer zones for extreme events and the availability of fertile land as increasingly important. Effective ways on how to address the re-zoning efforts of municipalities are regarded essential and inter-municipal financial compensations should be evaluated. A decentralized approach was recommended in the workshops. Therefore, legal regulations seem quite challenging as they need to be adapted to at least federal state level.

Open space could be used to tackle potential conflict of interests for nature conservation, silviculture, and areas for hazard prevention. Multi-purpose usage models can offer non-permanent alternative services for certain retention areas or agricultural land, such as flood protection areas or (water) transportation ways. However, yield impact and biophysical soil functions need to be assessed in case the areas were flooded and contaminated.

### 3.2.5 Key Research Topic 5: Restoration and re-cultivation of land

Within our lifetime, soil has to be regarded as a nonrenewable resource. This makes the restoration and recultivation of unused or polluted land essential. Fertile soil and unsealed land can only be maintained if the benefits of repurposing abandoned areas receive broader acceptance. The participants suggested creating simplified illustrations and explanations of the available and potential methods for recultivation and interim use. Visualizations tailored to make it easier for the various stakeholders to grasp the complex issue could help to alert people over all ages and professions to the urgency of the matter. This should fur-

ther on encourage the application of the various restoration and recultivation options and make the benefits for sustainable land use management more apparent.

In case of restoration, soil quality is a major issue. Although only a small proportion of known brownfields is polluted, a consistent assessment should show the restoration extent, any long-term impact, or pollution source, such as heavy metals or pesticides, as well as liability claims.

The overall opinion was that uniform guidelines for soil quality assessment in spatial planning and soil management could enhance the prevalence of restoration and recultivation of land. However, collating these assessments and guidelines applicable to large construction sites as well as small properties seem quite complex.

### 3.2.6 Key Research Topic 6: Ecosystem services of soil and landscape (bio-) diversity

Soil and landscape (bio-) diversity is an essential part of valuable ecosystem services. From the high and unexplored gene pool in the soil to the species richness of individual areas, the preservation of soil and landscape is considered to be important for medicine, pest control, and tourism alike. Given that a handful of soil contains more living organisms than there are people on the planet, any loss is devastating. A clearly structured set of indicators and scales could unify the assessment of biodiversity. Ecosystem services are not easily monetized and, therefore, often neglected in debates about spatial planning. This leaves the question if a monetization is necessary to achieve cost transparency and global equality. In the context of bio-economy soil is a major factor as many renewable biological resources need soil to grow (Juerge and Hansjürgens, 2018).

Austria's cultural landscape is very diverse and small structured. The regional identity and local economy depend on the preservation and cultivation of historically adapted landscapes, ecosystems, and cultural heritage. The participants identified the most difficult question as how to keep and cultivate these heterogenic landscapes to secure biodiversity, while allowing for economic growth and development.

## 4. Discussion

The stakeholder and information collation process in Austria revealed the interlinkages among the various regulations, societal needs, and research needs. The six identified key research topics for Austria are framed by the need for transfer and communication among society (societal chal-

lenges and needs), politics (legal regulations and policies), and science (research).

### 4.1. Communication and cross-sectoral exchange

The Austrian stakeholder process revealed a gap among science, policy, and society, which is currently hampering goal-oriented discussions to find solutions for the pressing issues of land consumption and land use change. Thoughtful solutions will depend heavily on the broad cooperation of stakeholders and the assigned importance of the various challenges for each region. The stakeholder debate demonstrated that sustainable land use management can only be achieved if all stakeholders are aware of a common long-term understanding of sustainable land use management and are able to communicate their needs to each other. The decisive key to sustainable land use management has been consensually identified as appropriate communication over all levels. The biggest challenge for sustainable land use management is the cross-sectoral connection between stakeholders to ensure committed involvement. However, continuous exchange and debate are also important within institutions or regions and in between departments or regional governments. Effective communication tools need to be developed, implemented, and evaluated to overcome the gaps. It is considered beneficial to develop and implement easy and accessible communication tools for the public to raise their concerns and problems (e.g., interactive panels to connect scientists and people interested in science). Communication was identified as the baseline connection among science, policy, and research, setting a triangle frame for sustainable land use. Hence, communication must be addressed equally on the research and the policy levels to trigger societal communication of the needs accordingly.

### 4.2. Societal needs and challenges

The societal needs and challenges can be addressed sustainably if they are understood by individuals and tackled collectively by the national community on regional and local levels. The unanimous stakeholders' opinion was an evident unawareness of the general public concerning the addressed issues. To accordingly respond to societal needs, policymakers and the public must be aware of the many benefits and functions soil can provide. Reversely, novel participative and responsible research approaches, as well as citizen science, have the potential to bring pressing societal problems to scientists.



### 4.3 Science and research

The workshop participants strongly emphasized a distinct gap between the understanding of basic and applied research results within the scientific community and the public. The workshop participants have requested that research projects have to include considerations on awareness raising and the demonstration of consequential costs of land use changes. Another approach to overcome the lack of knowledge is the application of participative research because it can help to increase public awareness (Bonney et al., 2016). Increased participation on all levels within research projects can foster change.

Policymakers need to take the scientific facts and distribute them among their constituents. Adequate monitoring and evaluation can show the benefits and disadvantages of implemented measures. Researchers have to create understandable data and imagery for media and awareness campaigns to be able to promote less area intense lifestyles. The creation of maps visualizing the current soil functions in comparison to its potential usages can illustrate potential losses and gains.

### 4.4 Legal regulations and policies

As pointed out earlier, Austria's policies and legal regulations are very fragmented when it comes to sustainable land use management. It is of utmost importance to coordinate or unify the fractured responsibilities of the state, the federal states, and the municipalities. The Environment Agency Austria advocates for a strategic land management and the inclusion of the soil functions in the relevant laws (Environment Agency Austria, 2018a).

Deterioration, restoration, and sustainable zoning are not seen as main drivers to gain political weight in municipalities and, hence, politically not sustained. According to the participants, financial incentives and sanctions could provide motivation to drive sustainable land use. Policymakers can also encourage research topics if they find them in the interest of their own political conviction.

## 5. Conclusion

The participatory information collation process of the INSPIRATION project revealed the six key research topics of the most pressing research needs in Austria that are framed by the need of communication and knowledge

transfer among the cornerstones: research, policy, and society. The participation in the SRA will generate the most sustainable impact to fulfill the societal needs. The striking benefit of the SRA is the shared funding of joint research needs for sustainable land use and soil management in Europe.

In addition, the stakeholder contributions demonstrated that soil and land are challenging topics to grasp for different scientific communities, let alone the general public. As soil sciences and spatial planning have a different understanding of the resource soil, it is of uttermost importance to communicate the overall benefits of unsealed soil in a tailored way. A compatible knowledge transfer is a pivotal pillar to political decision makers. The results of continuous monitoring, evaluation, and implementation of state-of-the-art research have to be shared with all stakeholders to establish an understanding of shared responsibilities.

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