SHERPA
Rural Science-Society-Policy Interfaces

D7.4 - SECOND SET

RECOMMENDATIONS FOR FUTURE RESEARCH AGENDAS

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SECOND SET OF RECOMMENDATIONS FOR FUTURE RESEARCH AGENDAS

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Authors	*Miller, D., Schwarz, G., Chartier, O., Salle, E., Zomer, B., Arcuri, S., Bognar, J., Černič Istenič, M., Martino, G., Moodie, J., Vilcu, R., Irvine, K.N., Nijnik, M. and Wang, C.*
Work Package Leader	Ecorys
Project Coordinator	Ecorys

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Acronyms

AFOLU	Agriculture, Forestry and Other Land Use
CAP	Common Agricultural Policy
CBD	Convention on Biological Diversity
CDR	Carbon Dioxide Removal
CLLD	Community-Led Local Development
COP	Convention of the Parties. The 'Parties' are the governments which have signed the UN Framework Convention of Climate Change (UNFCCC)
COVID	Coronavirus 19
CSA	Coordination and Support Action
DESI	Digital Economy and Society Index
DG Agri	Directorate General Agriculture and Rural Development
EEA	European Environment Agency
EEEA	Regulation on European Environmental Economic Accounts
EC	European Commission
EU	European Union
GHG	Greenhouse Gas
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
LAG	Local Action Group
LEADER	Liaison Entre Actions de Développement de l'Économie Rurale
LTVRA	Long-Term Vision for Rural Areas
LULUCF	Land Use Land Use Change and Forestry
MAP	Multi-Actor Platform
NECP	National Energy and Climate Plans
NOAA	National Oceanic and Atmospheric Administration
NUTS	Nomenclature of Territorial Units for Statistics
R & I	Research and Innovation
RBMP	River Basin Management Plan
SCAR-AKIS	Standing Committee on Agricultural Research - Agricultural Knowledge and Innovation Systems
SCAR FS	Standing Committee on Agricultural Research – Food Systems
SEEA	Systems of Environmental Economic Accounting
SHERPA	Sustainable Hub to Engage into Rural Policies with Actors

SRIA	Strategic Research and Innovation Agendas
UK	United Kingdom
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
UN HLEGCC	United Nations High Level Expert Group on Climate Change
VHCN	Very High-Capacity Network
WFD	Water Framework Directive

Executive Summary

The SHERPA process identified gaps in current knowledge and priorities for future research relating to the themes covered in rounds 2, 3 and 4 of the SHERPA project. These gaps reflect the perspectives of the SHERPA Multi-Actor Platforms (MAPs) and the SHERPA Think Tank of weaknesses in the current evidence base in general or as it applies to their areas of responsibility. The SHERPA web crawler enabled the identification of information from EU research projects (principally Horizon 2020) that add evidence to the recommendations in research agendas developed from the SHERPA MAPs.

Six areas of research agendas were developed comprising the topics debated by the MAPs, combining two that related to climate change of Climate Change and Environmental Sustainability, and Climate Change and Land Use, and bringing forward and updating one agenda from the first set of recommendations. The six research agendas are:

- Climate change, environmental sustainability and land use;
- Change in Production and Diversification of the Rural Economy;
- Empowering Rural Areas in Multi-Level Governance Processes;
- Sustainable and Resilient Value Chains;
- Social Dimension of Rural Areas;
- Observation, Measurement and Monitoring.

The research needs identified in the agendas were mapped onto EU priorities reflected in the strategic orientations of Horizon Europe, the proposed or approved European Partnerships, the SCAR-AKIS Foresight Exercise Export Group, and the pillars of the EU's Long-Term Vision for Rural Areas. The output shows that each agenda intersects several of the priorities identified in these strategic documents. The breadth and nature of the content of the agenda under the heading of *Climate Change, Environmental Sustainability and Land Use* matches onto the highest number of strategic priorities (15 of 19 reviewed).

Some knowledge gaps will reflect MAP specific membership or geography of the MAPs, access to information, and perspectives on the types of knowledge (e.g. scientific evidence, practice knowledge) and institutional accessibility of data or tools. In due course, some of the knowledge gaps can be expected to be filled by more recently funded projects and so progress these research agendas.

However, the bottom-up identification of gaps in knowledge and needs for research illustrates the approach of science-society-policy interfaces can contribute to a process of developing research for the public good. That is closely aligned to one aim of the Horizon Europe programme European Partnerships of promoting "societal, ecological and economic transformations by involving, collaborating with and building consensus among citizens and practitioners on research and innovation roadmaps and priorities."

The use of science, society and policy interfaces by SHERPA has enabled actors at local to EU levels to express their views on the needs for research and policy. The co-creation process has in itself contributed to delivering on the EU's Long-Term Vision for Rural Areas through the building block of **Creating a stronger innovation ecosystem** in its pillar of **Stronger rural areas**.

1. Introduction

This Deliverable presents the second set of recommendations for future research agendas. They are based upon the work of SHERPA partners and Multi-Actor Platforms (MAPs) during Phase 2 of the project, presented in the framework of the seven topics reviewed and debated by the MAPs.

The SHERPA approach is in line with that identified in the European Commission Horizon Europe Strategic Plan 2025–2027 (European Commission, 2023a) which states:

> *"Citizen engagement, and the engagement of social partners and civil society actors, are key focuses of the EU's R & I policies because such engagement is critical to reinforce trust in science, and to facilitate and secure the innovation process and its uptake."*

This second set of recommendations for agendas of research augment the first set, reported in Deliverable 7.2 (Chartier *et al.*, 2022). Those were based on a gap analysis between the needs identified by SHERPA and its Multi-Actor Platforms (MAPs) in their contributions to the EU Communication on the Long-term Vision for Rural Areas (LTVRA; European Commission, 2021a; Chartier *et al.*, 2021). They were augmented by a review of H2020 and Horizon Europe projects working in related areas as identified by the SHERPA web crawler and repository.

The first set of future research agendas were:

- Planning coherent, equitable, multi-functional land uses
- Creating conditions and facilitating the generation of wealth by rural communities
- Well-being economies of rural areas
- Relationships between changes in consumer behaviours towards foods and diets and characteristics of rural areas
- Supporting the sustainability of digitalisation
- Systems approaches to Integrated Pest Management with Land Management
- One Health approach to developing strategies for antimicrobial stewardship
- Observation, monitoring and reporting.

Both sets of research agendas are presented in the contexts of policy areas of the strategic orientations of Horizon Europe (European Commission, 2021b), agreed or prospective European partnerships (DG Research and Innovation, 2020), priorities of the Horizon Europe Missions (European Commission, 2021b) and the Long Term Vision for Rural Areas (European Commission, 2021a). This set is also referenced to the Horizon Europe Strategic Plan 2025-2027 (European Commission, 2023a).

2. Methodology

The process of developing the second set of research agendas draws on rounds two to four of the SHERPA process, run between 2021 and 2023 (Arcuri *et al.*, 2022). In phase 2 of the project, the number of MAPs increased to 41, across 20 countries, including one MAP at the EU level. The seven topics tackled in these rounds are summarised in Table 1.

Table 1. Topics debated in the SHEPRA Multi Actor Platforms in rounds 2 to 4 (* number of MAPs discussing topic includes the EU level MAP).

Topic	Number of Multi-Actor Platforms*	Reference to SHERPA Position Paper
Climate Change and Environmental Sustainability	8	Miller *et al.* (2022a)
Change in Production and Diversification of the Rural Economy	9	Martino *et al.* (2023)
Climate Change and Land Use	14	Miller *et al.* (2023a)
Empowering Rural Areas in Multi-Level Governance Processes	41	Moody *et al.* (2023)
Resilient and Sustainable Value Chains	16	Bognar and Schwarz (2023)
Social Dimension of Rural Areas	10	Istenič (2023)
Digitalisation in Rural Areas	5	Arcuri (2023)

For each topic, the SHEPRA process was followed with the development of a Discussion Paper to inform engagement with the MAPs at EU and local levels. This informed debate and co-learning within the MAPs leading to the preparation of their Position Papers, and an overall SHERPA Position Paper on each topic.

In the context of the remit of SHERPA, the research needs and consequent agendas should contribute to the body of knowledge of their topic or theme through a rural lens. The approach to identifying gaps in knowledge and priorities for research within the overall topic of rural areas comprised:

i) Reviewing the SHERPA Discussion and Position Papers, and the outputs from each MAP, produced in rounds 2 to 4 of the SHERPA process;

ii) Identifying the high-level issues for each topic, needs for knowledge and evidence, and recommendations for future research;

iii) The topics and content were reviewed by domain experts within the SHERPA consortium.

iv) Synthesising the recommendations into a set of future agendas of research.

A preliminary subset of these recommendations was submitted to the EU in April 2023 in time to inform discussion of research gaps to be considered in future calls for proposals in Horizon Europe in 2024/25.

3. Contexts for Research Agendas Identified by SHERPA MAPs

The 41 MAPs comprise approximately 630 actors across science (26%), policy (28%) and society (46%) (Arcuri *et al.*, 2020; D6.3), providing insight to the needs to all three sectors of actors. Eleven MAPs operate at a national level (Bulgaria, Czechia, Denmark, Estonia, Finland, Lithuania, Netherlands, Slovenia, and three national level MAPs for Hungary each operating in different domains). Twenty-nine MAPs operate at regional levels (Belgium, Bulgaria, Czechia, France (2), Germany (2), Greece (3), Italy (4), Netherlands (2), Poland (3), Portugal (3), Romania (3), Spain (2), Sweden, and the United Kingdom (2)). The EU level MAP operates at continental level.

In phase 2 round 2 and 3, the national and regional MAPs selected the topics on which they wished to work, leading to an imbalance in the number across topics (e.g. 4 for Digitalisation in Rural Areas, and 15 on Resilient and Sustainable Value Chains). All MAPs discussed the topic of Empowering Rural Areas in Multi-Level Governance Processes. The EU level MAP also debated all of the topics across both phases.

The gaps in knowledge and areas for research follow for each of the topics discussed by the MAPs. The inputs to most topics will reflect the contexts and priorities of some areas of Europe, not all. However, the SHERPA approach provides insights to the issues arising, needs and recommendations for policy and research from the science, society policy interfaces they represent. Findings are not presented as covering all contexts or comprehensive knowledge of existing research and issues on the ground.

4. Recommendations for Research

The intended outcomes of the research and new evidence and insights it should provide, are structured to inform the direction of travel set out in the LTVRA (European Commission, 2021a) of stronger, connected, resilient and prosperous rural areas by 2040. The principal recommendations are summarised below under the headings of the topics upon which the MAPs deliberated. In the summaries of recommendations, the two topics of Climate Change and Environmental Sustainability, and Climate Change and Land Use are combined under the one heading (Section 4.1).

4.1. Climate Change, Environmental Sustainability and Land Use

Tackling climate change and striving for environmental sustainability and appropriate uses of land cross almost all aspects of the lives of citizens, and over multiple generations as individuals take on different responsibilities through their life course (Miller *et al.*, 2022a). This will require informing, motivating and facilitating active participation of citizens in the development of shared visions of approaches to tackling climate change. The significant interventions being planned or implemented such as woodland expansion, peatland restoration, transitions to agro-ecological farming systems, and transitions to renewable energy, all place rural areas at the forefront of achieving aims of carbon neutrality. The IPCC (2023) notes the potential for synergies from such biological Carbon Dioxide Removal (CDR) through "methods like reforestation, improved forest management, soil carbon sequestration, peatland restoration and coastal blue carbon management can enhance biodiversity and ecosystem functions, employment and local livelihoods."

The United Nations Paris Agreement (United Nations, 2015) sets out the aim to limit global warming by 2100 to 1.5ºC above pre-industrial levels. The aim was reiterated by the leaders of most of the world's countries at COP26 and the Glasgow Climate Pact (Glasgow, UK, November 2021) and COP27 (Sharm El-Sheikh, Egypt, November 2022). The Earth's temperature has increased by 0.08° C per decade since 1880, and 0.18° C per decade since 1981 (NOAA, 2022), and for Europe (between 1910 and 2021) the increase has been 0.15ºC per decade. The IPCC (2023), in its AR6 Synthesis Report concludes that "it likely that warming will exceed 1.5°C during the 21st century". To restrict warming to 1.5ºC, global net anthropogenic CO_2 is required to decline by approximately 45% from 2010 levels by 2030, reaching net zero by 2050 (IPCC, 2022), and continue to reduce through the remainder of the century (IPCC, 2018). Updated estimates of GHG emissions by the European Environment Agency (October 2022) are of a reduction by 32% compared to 1990. This is 12% lower than the EU's target for 2020.

Achieving the targets of net zero GHG emissions by 2050, and reversing the loss of biodiversity, requires innovation in delivering the multiple functions from land uses, and changes in land systems. Pörtner *et al.* (2021), in the joint report by the IPCC and IPBES, note that 'measures intended to facilitate adaptation to one aspect of climate change without considering other aspects of sustainability may in practice be maladaptive and result in unforeseen detrimental outcomes.'

In 2019, the Land Use Land Use Change and Forestry (LULUCF) sector at EU level represented a net carbon sink of approximately 249 Mt CO_2e, corresponding to absorption of 7% of total GHG emissions (European Environment Agency, 2021). The IPCC (2022) reports that the "Agriculture, Forestry and Other Land Use (AFOLU)" sector accounted for 13% to 21% of global total anthropogenic GHG emissions between 2010 and 2019, with deforestation responsible for 45% of total AFOLU emissions.

Designing the pathways to climate neutrality by 2050 requires actions at all levels, international, European, national and regional. To achieve this aim, the EU has increased its targets of reducing greenhouse gas emissions to at least 55% below 1990 levels by 2030, as set out in the European Union 2030 Climate Target Plan (European Union, 2021).

Land use change – spatial planning

Land is finite, with constraints on what can be used, by whom and for what. Means should be found to ensure it is used most effectively, whilst recognising the competing demands (e.g. food, biodiversity, energy, recreation, housing), and realities such as current uses and its governance (see also *Governance*).

Its uses are almost always multi-functional even if not planned as such, or if there are predominant uses for any given area (e.g. within field crop production). Significant transformations of land use can only be realised at a landscape scale for which cooperation between communities of place are key. All of the functions of land should be considered together, in the wider contexts of landscapes, water catchments and habitat networks, an aim of which should be for developing integrated land systems rather than land uses, and which are resilient and adaptable to pressures such as climate change. However, in some areas there is low levels of willingness to cooperate between local actors, requiring actions in policy and in scientific evidence and subsequently education. Such holistic perspectives of land systems require sustainable strategies that include land-use zoning, spatial planning, integrated landscape planning, regulations, incentives, and voluntary or persuasive instruments in line with the propositions of the IPCC (2022a).

Those means will be aided by research into principles for guiding spatial planning of land use that supports multiple functions for tackling climate change and reversing the loss of biodiversity, ensuring consistency across geographic levels and jurisdictions, and equitable for all stakeholders. These principles should be accompanied by tools and methods to support decision-making for developing land-use strategies and action plans across sectors (e.g. agriculture, environment, forestry, energy, soil, water, finance and planning) and different levels of governance and the socio-economic contexts within which they are managed. In turn, research is required into governance structures and human capital for enabling citizen led decision-making within the relevant regional and national legal and cultural contexts (see also *Governance*), and how environmental sustainability can be embedded in rural and regional development, taking account of the socio-economic circumstances of those who live, work or visit rural areas.

This research would complement the accompanying action identified in the Rural Action Plan of how "best to incentivise optimal land use planning and zoning to protect and promote sustainable farming and other economic activities and further enhance the networking around LEADER and Smart Villages." (European Commission, 2021b).

Renewable energy …

The development of renewable energy systems is a key part of the transition to climate neutrality. The EC review of CAP National Strategies notes that "planned investments in renewable energy production on farms will add 1,556 MW to the EU's energy production capacity" (European Commission, 2022a). However, some countries have more resources for, and history of, generating such energy (e.g. on and offshore wind, large, mid- and small scale hydro, biofuels, solar).

To achieve the targets set by the EU, and accelerated uptake projected by the International Energy Agency (2022), a greater land area will be required for large scale renewable energy systems, reflecting the magnitude of energy to be generated. That raises questions of how to satisfy the multiple demands on land and access to energy across Europe, and how renewable energy can be generated at a scale sufficient to provide the amount of energy required. Answering such a question also relates to the research requirement above of spatial planning of land uses, and linking with citizens through relevant mechanisms such as LEADER/CLLD and Smart Villages. In turn it raises a question of how motivated citizens may be to participate in developing spatial plans and scope to be 'energy citizens' (H2020 ENCLUDE).

There is likely to be need for more mixes of energy renewable systems with other land uses, and in places where the potential for energy generation is restricted. Key developers of renewable energy systems in rural areas are the owners and managers of land where the wind resource is suitable, and outwith constraints of natural and cultural heritage. As such they have considerable influence on choices of the

types and size of renewable systems in which they might invest or permit to be developed on their land, and scope for electricity transmission. They may also opt not to develop sites for renewable energy. Research is required into drivers and trade-offs made by land managers with respect to renewable energy, and how that varies across Europe and by social-economic and biophysical circumstances (e.g. insufficient financial or human capital, local resistance to infrastructure, more valuable options for uses of land).

Benefits would be gained from systematic evaluations of the development of community energy programmes (economic, social and environmental), to identify elements which have proven to work and those which have shortcomings. This should be accompanied by sharing knowledge across countries of enablers of such initiatives, how different types of cooperation operate, social capital evolve, and how barriers are overcome.

A mix of scales of energy generation will be required to achieve the target of carbon neutrality by 2050. To inform the strategic planning and forecasting of such a mix requires research to develop scenarios of the composition of the portfolio of renewable energy generation required to meet energy demand through time, and how much generation is feasible from community-led initiatives. Such scenarios should be broken down by nation and region across Europe, and take account of differences in legislative, financial and infrastructural frameworks across Europe.

Alongside its functions of sequestering or holding carbon, natural and cultural heritage assets are a resource for passive or active nature tourism which provide valuable new sources of income to rural areas, which needs to co-exist with emerging sources such as energy tourism (tours of wind farms) or engineering tourism (e.g. early hydro-electric power stations). The research need is to identify such opportunities relevant to local contexts and the roles they can play in the evolution of the economy and cultural heritage of rural areas.

Land management and systems ...

Systems and practices of managing land and associated measures are recognised as crucial for mitigating and adapting to climate change. In many areas land used for agriculture has to be managed to ensure the organic carbon remains stored in the soil. Well designed and implemented land management practices can deliver multiple benefits of mitigating climate change, enhancing biodiversity (above and below ground), increasing water retention capacity, and contributing to cultural services such as landscapes. However, there is a need for better understanding of: i) GHG emissions of different farming systems designed around sustainable intensification and agroecology, under different biophysical and social contexts; ii) pathways for how such systems could change through time; and iii) trade-off decisions that should be expected between environmental, economic and social factors.

Increasing the uptake of land management practices which contribute to reducing GHG emissions also requires investment in infrastructure (e.g. changes in farming systems to on-farm manure production; conversion to hydrogen fuelled tractors; internet of things across farms and supply chains), and human capital (e.g. new skills). As digital sensors become available there is greater scope for measuring and reporting of characteristics of land under practices that deliver sustainable land management (e.g. GHG emissions in real time, carbon stocks in soils, predictive model of carbon dynamics). Research should be undertaken to test the capabilities of such tools under different environmental conditions and identify, with developers and land managers, the requirements for mainstreaming their use, and in assessments of the effectiveness of management practices. Methods should align with the expectations of harmonised indicators of soil health and their reporting as per the proposed EU Soil Monitoring Law (European Commission, 2023c). Related, monitoring tools should provide a basis for informing business models that take account of characteristics of soils (e.g. carbon, soil biodiversity, GHG emissions) (see below regarding natural capital accounting).

Changes in farm management or systems in response to climate change or reversing the loss of biodiversity (above and below ground) comes with costs as well as benefits. Evidence is required of the

costs and benefits associated with changing systems of agricultural production, changing land use from agricultural to non-agricultural, the use of water for irrigation, and the role of biotechnology in climate change adaptation. Opportunities are emerging for the use of alternative sources of inputs such as seaweed and legume-based green manure. However, research is needed of the impacts of such sources on nutrient stoichiometry, biological interactions, and pollutants, and how to mitigate any adverse effects.

However, not all land managers are in positions to change systems. Understanding is required of the lock-ins experienced by land managers and communities which may prevent or inhibit realisation of new opportunities such as regulatory restrictions on land use change towards new forms of food production; land management contracts that do not draw on latest knowledge; and commitments to customers which restrict uptake of agro-ecological farming systems.

To increase the effectiveness of agri-environment-climate measures, collective approaches with different levels of co-operation between individual farmers are increasingly considered in Europe (e.g. farmer collectives in the Netherlands, Boerenatuur, 2019; Reichenspurner *et al.*, 2023). However, addressing the challenges of climate change, reversing the loss of biodiversity and improving water quality requires concerted actions and cooperation beyond farmers engaging different actors in rural regions and communities (OECD, 2021). More social innovations involving the young generation are necessary to enhance the capacities of rural communities to cooperate in environmental and climate protection. Further research is needed into piloting collective governance and policy approaches at community and territorial levels (e.g. building on experiences with approaches such as Biodistricts) and on the potential of trust-based networks to transform rural communities into "living labs" for environmental and climate protection innovation (see also *Governance*).

Communities of place can be the first to experience the consequences of climate change first hand, recognise future threats, and identify opportunities offered by the use and management of land. Inappropriate uses of land and its management can intensify hazards including flooding and heat stress, hence intensifying the exposure of communities to such hazards. Romanello *et al.* (2022) report that "extreme heat was associated with 98 million more people reporting moderate to severe food insecurity in 2020 than annually in 1981–2010, in 103 countries". Recent extreme weather events in Europe (e.g. wildfires, flooding) destroyed or damaged food crops, forests, and infrastructure. Rural businesses may be unable, or hesitant to invest to re-establish primary production or to replace infrastructure. Understanding is needed of the perspectives and attitudes of actors (businesses, consumers, policy makers) towards levels of risk, and where and what types of actors may be left behind during transitions in farming and land management systems.

Land systems relating to the concept of natural capital provide considerable opportunities for making progress towards net zero targets. Natural capital can be described and explained at different levels whether functional or geographic, but there is a need to understand how to assess natural capital at multiple levels such as individual land-based business, clusters of collaborating businesses, catchment, landscape, regionally and nationally. A useful step in the process is the plan of the EC to revise the Regulation on European Environmental Economic Accounts (EEEA) (European Commission, 2011) and expand their coverage to include a natural capital accounting to be consistent with the United Nations Systems of Environmental Economic Accounting (SEEA). This will contribute to evolving approaches to quantifying and valuing natural capital, about which there is considerable debate, and which are inhibited by weak understanding of the beneficiaries and what it offers stakeholders (e.g. land managers, citizens). Further support is also required for the provision of environmental data (e.g. soils, land cover, water quality) to support the implementation of natural capital approaches, the effectiveness of which are contingent on the availability of data of relevance, and sufficient accuracy. Addressing these questions is of particular significance to the application of natural capital approaches in the aims and prospective funding associated with emerging initiatives in governance (see also *Governance*).

The types of natural capital in which investments can be made will differ across Europe, such as carbon rich soils, woodlands and agroforestry, and water management. Examples are emerging of how to stimulate natural capital investment markets, and how businesses and communities could benefit, such as through models of social innovation. These open opportunities for areas of research to investigate the roles of such forms of investment and their impacts on a wider valuation of ecosystem services produced by land managers (e.g. farmers, foresters). There are needs for insights to what governance structures are most appropriate for enabling, and protecting, community-led investments in natural capital and use of green finance for achieving policy aims of nature positive economies, as envisaged in the report by Dasgupta (2021). (see also *Governance*).

Related opportunities arise for adding value to the investments in natural capital through new forms of tourism. Research needs include reviewing what alignment is required by policies and measures (e.g. planning, infrastructure) to provide conditions conducive to providing the catering, accommodation, energy, water and transport links to enable an attractive proposition to prospective visitors.

Peatland management and restoration…

Globally, peatlands contain approximately 25% of the carbon locked in soils. Restoring degraded peatlands (IPCC category of eroded peat) is one of the most effective approaches to sequestering carbon over the long term, whilst also providing co-benefits of reversing the loss of biodiversity, reducing flood risk and pollution, enhancing cultural services such as landscape character and sense of place in rural areas. The protection or restoration of peatlands and wetlands is identified in the EU Biodiversity Strategy for 2030 (European Commission, 2020a), National CAP Strategic Plans and other national and regional strategies (e.g. National Peatland Plan, Scotland, UK). The potential for rural development stimulated through peatland restoration importance is reflected in the LTVRA Action Plan flagship of building up carbon sinks in its *Climate action in peatland through carbon farming* (European Union, 2021a).

Restoration is only one step in the overall process over which natural systems will take to recover and achieve restored status, potentially requiring 50 years to restore peat drained to 1m depth. So, there is a need to understand the extent to which intact peatlands will be able to withstand future climate change, including the consequences of patterns of seasonal changes in temperatures and precipitation, and aggregate changes.

Investment in peatland restoration also provides new opportunities for communities through new models of green finance and accounting for the values of natural capital. Acceleration of efforts of peatland restoration, and potentially investment in managing carbon rich soils, would benefit from understanding the perceptions of citizens and land managers who live or work in close proximity to such sites, and those of society more widely of the functions and values of peatlands.

Woodland expansion…

The UN HLEGCC (2022) estimate that deforestation driven by land use change and agriculture contribute c. 11% of annual global GHG emissions, estimating that to reach net zero by 2050 requires ending deforestation by 2025. Woodland protection and expansion are key components of several EU and national strategies in delivering on international commitments, notably the COP26 Declaration on Forests and Land Use, on promoting an inclusive rural transformation, and building resilience, enhancing rural livelihoods and recognising the multiple values of forests, and Forest Biodiversity in the Convention on Biological Diversity. The National Energy and Climate Plans (NECPs), EU Biodiversity 2030 (European Commission, 2020a), and EU LTVRA Action Plan all recognise the multiple roles of forestry to rural development and other environmental benefits (e.g. protecting soils, reducing flood risk, landscape aesthetics).

However, public opinion is not universally supportive of woodland expansion. The emphasis in strategies for woodland expansion is greater on land suitability than social acceptability, or forms of land ownership or tenure, or potential effects of the dynamics within ecosystems such as interactions between plants, animals and water. Capturing public opinions on woodland expansion, combining quantitative information

gathered through Eurobarometers (e.g. European Commission. 2021c) augmented by evidence from qualitative studies would provide insights to community and stakeholder motivations and attitudes towards woodland expansion.

Policies for tackling climate change, reversing the loss of biodiversity and addressing inequalities are symbiotic. Advancing the policy of expanding woodlands would benefit from understanding of the barriers to the realisation of future benefits from assets originally secured through other drivers not directly related to climate change (e.g. land reform, community empowerment).

A relatively new driver is that of green investment using business models that include the concept of biodiversity credits. These models are leading to woodland planting, transfers of ownership of land and forests, offering new possibilities for community-led initiatives. However, they are also perceived as potentially skewing markets for land for use to offset the environmental impacts created by activities elsewhere, and potentially inhibiting scope for ownership by communities and small-holders. Research is required into the magnitude of this driver, its role in relation to mitigating environmental impacts, social consequences in different areas of Europe, and how it should be assessed (e.g. territorial or global impacts).

Investments in woodlands take place in different biophysical and social contexts, often expressed in terms of the prevailing land systems. For example, the integration of trees into agricultural landscapes and land systems is evident in the various agroforestry systems around Europe (H2020 AGROMIX). Although these are well-established in some areas (e.g. Montado, Portugal), it is a newer concept in other areas, or been proposed but faced low uptake by farmers. Understanding is needed of the functions and processes of agroforestry in different biophysical and socio-economic contexts, and effective mechanisms for its uptake in practice.

Adopting agroforestry systems should also be seen in the context of place-based planning. This would benefit from research into the types and magnitude of trade-offs required at relevant geographic levels or units, such as in the vicinity of a village or town, within a landscape unit (i.e. landscape character area), a water catchment or an ownership unit, and from the perspectives of people at each geographic level (e.g. local, regional, national, international).

Water management…

The Water Framework Directive (WFD), adopted in 2000, has the aim of ensuring long-term sustainable water management, but does not explicitly cover climate change. Since 2009, climate-related threats and adaptation planning are required to be incorporated into River Basin Management Plans (RBMPs), and the EU Drinking Water Directive has been revised to consider the impacts of climate change in risk assessments of water supply systems. The importance of ensuring that freshwater is available sustainably is articulated in the EU Strategy on Adaptation to Climate Change, and that the use of water is significantly reduced, water quality preserved. It stresses risks increased frequency and severity of extreme weather events that lead to droughts and floods and consequent economic damage, which are also recognised in the EU Floods Directive (EU Climate Adapt, 2022). In its assessment of the National Energy and Climate Plans (NECPs), the (European Commission, 2020b) argues for integrated approaches which consider the interactions of solutions with environmental domains such as water and soil pollution, resource efficiency and the water-energy nexus, in line with the "do no harm" principle in the European Green Deal (European Union, 2019).

Integrated approaches to water planning and management requires understanding of the multiple uses of water in the context of increasing scarcity, with a particular emphasis on suitable governance arrangements that can facilitate collaboration amongst water users, and how that may vary across Europe (Rowbottom *et al.*, 2022; Zilans *et al.*, 2019). Related, there is a need for knowledge about the motivations and attitudes of stakeholders relevant to the design and implementation of nature-based solutions (e.g. to mitigate risks of flooding). With a view to improving collaboration amongst communities of place, research

could be undertaken into how biomass or 'water mass' can be increased at a landscape scale, increasing evapotranspiration and in turn slowing or reducing global warming.

Education and skills…

Increasing human capital across all sectors of society, policy and science is a key requirement for rural areas to plan and deliver pathways towards climate neutrality, as part of a wider strategy for revitalising rural areas. Such pathways guide the environmental, social and economic contexts for future generations of the managers and residents of rural areas. A strategy for transitions to climate neutrality through the use of land should link education, training, reskilling and communications with the types of changes required in land management (e.g. land manager career changes, implications for families and stakeholders in supply chains). The means of education and learning should enable inputs by young people, reflecting their different cultural and geographic contexts which forms an important element of enabling a just transition to climate neutrality. Research into the process of informing the education curricula and effective means of learning should form part of planning and delivery of skills for young people in rural areas.

There should be a progressive integration of climate related topics in the education curricula of schools in line with their governance in each country and region. This should build on explaining the processes of climate change, its effects across work, life and leisure, and the reasons and mechanisms for its mitigation and adaption, to include contributions of local actions to those at regional and global levels.

There is a need to understand the roles of training and education in innovation in rural areas, and the design and implementation of community-led activities (e.g. social innovations) in adapting to climate change. This should include a review of structures that facilitate the exchange of knowledge within and between countries and regions, and the types of models which might be most impactful in relation to tackling climate change (H2020 SIMRA). Related, to plan approaches to enhancing human capital better understanding is required of the types of career pathways that can be offered to young people in sectors relevant to tackling climate change.

Stakeholder attitudes…

To motivate effective actions to mitigate or adapt to climate change requires public support (Miller *et al.*, 2022, 2023). The Special Eurobarometer on Climate Change reports that, for the first time in its surveys of attitudes of European citizens, climate change ranked first as the most serious problem facing the world as a whole (18%) (European Commission, 2021c). Most respondents expressed positive responses to questions about adaptation to climate change. For example, when asked about attitudes towards adapting to climate change, 62% of respondents either Totally Agree (23%) or Tend to Agree (39%) that "adapting to the adverse impacts of climate change can have positive outcomes for citizens in the EU". Similarly, the majority of respondents (78%) either Totally Agree or Tend to Agree that taking action on climate change will lead to innovation that will make EU companies more competitive. The basis of that relatively high proportion has not been studied in the Eurobarometer. It may reflect perceptions of people of innovation and opportunities which could arise. An in-depth qualitative study is merited to improve understanding of the aspirations and current and future interests of various social actors in relation to tackling climate change, and the potential conflicts between them.

Not all citizens agree with the nature of the changes required, or the actions that may be required of them or their sectors. Views differ across Europe on the roles of different land uses, such as considering agriculture to be part of the cause of climate change and not part of a solution, and concerns about the dominance of land use by coniferous plantation forestry. Research is needed to understand resistance to new regulations or best practices, including public associations of land management practices with cultural heritage (e.g. use of peat and peatlands; expansion of woodlands; water usage).

Findings from the Eurobarometer series also indicate that a relatively small number of respondents considered implications for climate change when purchasing food (16% in 2021). Changes in public

preferences towards diet, and societal approaches to food being affordable and nutritious, are expected to be an important element of transitions to climate neutrality and achieving climate change targets, alongside those of human and environmental health.

The European Commission has launched through Horizon Europe the R&I initiative to develop the Partnership Sustainable Food Systems (P-SFS) for people, planet and climate. Its ambition is to accelerate the transition towards diets that are healthy, safe and sustainably produced and consumed in food systems that have a neutral or positive environmental climate and biodiversity footprint (SCAR Food Systems, 2023). Further research is needed to understand barriers to changes in human diets, and the roles of labelling (e.g. consumers preferences and trade-offs between high animal welfare, organic meat products, local food, low-fat, carbon footprint, and fair-trade). There is also a need to understand the differences in attitudes and actions of rural citizens towards climate change with respect to life courses (e.g. socio-economic status in early-life compared to later life), types of behavioural change taken to date, and barriers to further behavioural change. Related, a key question is what are the key moments when barriers to uptake could have greatest adverse impacts, and when enablers to them being overcome could be most beneficial?

EU level

Recognition is needed of which changes in land systems are required and will take are taking place in rural areas of Europe. The UNFCC notes the need to take measures to facilitate effective and low risk adaptation to climate change, which is particularly important for ensuring that food production is not threatened. Research is needed to understand the trends and nature of future food production across Europe, identifying alternative crops and farming systems that are viable in different territorial contexts, and how to steer the associated transitions. Related, scenarios are required of what crops may be grown in the future, viable alternatives, and the types of supply chains required, and in turn an understanding is needed of potential barriers to the development of supply chains and uptake of crops and associated products.

More broadly, Europe-wide models are required to enable: i) reporting of the environmental, economic and social consequences of land use change on characteristics of climate change over time, and at different rates of change; ii) identification of benefits to communities as instigators or stewards of land use change; and, iii) development of available and transferable models for foresight and forecasting at appropriate levels of governance.

Such models can also inform the targeting of national plans such as the National CAP Strategic Plans and National Energy and Climate Plans. These plans set out approaches proposed by EU Member States to respectively contribute to the EU's environmental and climate ambitions through support mechanisms, and topics such as renewable energy, energy efficiency and greenhouse gas reductions. These are reviewed by the EU, but research is merited as to the internal coherence of such plans, and across levels of governance (regional, national, EU), and how they translate into Nationally Determined Contributions (NDCs) required under the Paris Agreement.

Effective implementation of plans to tackle climate change requires public support, through democratic processes, as customers of businesses, and for individual actions. In this regard, informing policy and practice requires good quality tracking of public attitudes towards climate change, at international, EU and national levels. The Eurobarometer series is one key Europe-wide set from which trends in opinions can be monitored. The series should be extended to enable insights which are valid at a greater levels of spatial granularity (e.g regions, mountains, islands) and demographics beyond gender and age (e.g. abilities), and be complimented by qualitative surveys aiming to reveal what is influencing public attitudes.

Avenues for new research are likely to benefit from building upon existing knowledge, funded programmes and initiatives, and collaboration, such as with the Competence Centre on Behaviour Insights of the Joint Research Centre focusing on the study and analysis of public attitudes towards the governance of land (e.g. barriers and motivation).

Informed by

H2020 CONSOLE, DIVERSIFY, ENCLUDE, Foodshift2030, I-CISK, LIFT, MAGIC, MERLIN, MOVING, SIMRA, UNISECO; Horizon Europe BEATLES, WetHorizons, Erasmus+ Rebound.

4.2. Change in Production and Diversification of the Rural Economy

Issues

Green and digital transitions are required to form part of a much-needed transformational change of European rural areas reflected in changes in the production and diversification of the rural economy (Martino *et al.*, 2022). These transitions will offer new development opportunities within and for rural areas, contributing to improvements in the resilience of rural communities and the post-COVID19 pandemic recovery of rural areas.

They have significant potential for the development of the bioeconomy, the circular economy, the eco-economy. However, the natural benefits of rural areas are often not realised because of the lack of skilled and qualified labour, with professional training not meeting current and evolving needs, whilst at the same time these areas experience high rates of unemployment.

Poor provision of basic services in rural areas, such as housing, education and health, are amongst the factors which reduce the quality of life of their citizens. In turn, this makes rural areas less attractive for people to stay or move into, limiting customers and labour supply for businesses. Improvements in the provision of such services would be a valuable element in an integrated and cross-sectoral strategy, with actions tailored to the needs of particular rural areas (see also SHERPA Position Paper on the LTVRA; Chartier *et al.*, 2021).

Rural areas have smaller markets than cities. To compete with global suppliers in terms of price, quality, and variety of products, additional attention is needed to the integration of approaching markets regionally, nationally and globally. Digitalisation processes and the enhancement of related infrastructure (including broadband) would enable access to new customers and supply chains, and help to overcome the divide between urban and rural areas (see also *Digitalisation*). Online tools, such as apps and online marketplaces, can be an effective means to communicate with consumers about the processes underlying production, authenticity of local goods, and regulation and control (see also *Resilient and Sustainable Value Chains*). Infrastructure needs to include the development of digital knowledge, skills, and competences at administrative, managerial and executive levels.

In some countries agriculture remains amongst the most significant sector in rural areas. Regulatory barriers are inhibiting shifts to more sustainable business models, such as regulations in some countries preventing agricultural buildings from being used for non-agricultural purposes, or disused farms from being bought by firms which are not registered as agricultural enterprises. A lack of mobility and interconnectivity undermines the potential for developing alterative businesses to agriculture, such as tourism-related activities. Changing business models (especially in agricultural businesses) through the adoption of innovation, technological improvements and new business solutions is viewed as a key driver for facilitating change in production and diversification of the rural economy.

The problem of rural economies is not so much in diversification, but in the general level of their economic development compared to other non-rural areas and in the type of economic activities. In some areas there is a lack of confidence or support services to help set-up businesses. There is also lack of an entrepreneurial culture, the presence of which could encourage economic activity and networks that support local and regional vitality. This could also have a positive impact on making rural areas attractive environments for retaining and attracting women and young people.

Needs

An enabling condition for changing production systems in rural areas is to reduce the gap between policy makers, public administrations, researchers, and representatives of the agri-food sector, to ensure evidence-based and proactive participation by all actors (science, society and policy) in the design and implementation of public policies and programmes. Evidence is required for substantiating the strategic plans for vertical integration in the agri-food industry and bioeconomy. Closely linked is that the research process facilitates the exchange of knowledge and its transfer into practice domains (e.g. bio-economy, sustainable management of resources) to ensure its utility, encouraging transdisciplinary research in which knowledge and solutions are co-constructed (e.g. Potters *et al.*, 2022; AgriLink; Schwarz *et al.*, 2022; UNISECO), and communicated to public and society more broadly.

The policy priority of transitioning towards a bioeconomy and the uses of renewable energy offer considerable opportunities to rural areas. However, awareness of local actors of the potential and capabilities for generating renewable energy is sometimes limited, and development dominated by large businesses which can negotiate with landowners and navigate proposals through the regulatory processes, and manage the financial requirements. Yet, in many rural regions, diversification of income streams of farmers, land managers and some communities has been transformational. Greater understanding is required of the barriers to broadening the identification and uptake of opportunities. This should include providing evidence of what can de-risk developments that could make a difference at village and community levels (see also *Climate Change, Environmental Sustainability and Land Use*), and attract or retain women and young people (*Change in Production and Diversification of the Rural Economy*).

The entrepreneurial discovery process needs research into market opportunities and understanding of its dynamics. For example, the localisation of supply chains, such as the procurement and marketing of local food, provides opportunities for rural areas to capitalise on their own particular characteristics (see also *Resilient and Sustainable Value Chains*). However, systems thinking is required in the fields of farm diversification and short food supply chains, by clearly defining and understanding 'food systems', 'local food systems', and 'regional food systems'. Evidence is needed of the economic, social and environmental benefits, the costs involved, and factors upon which local rural areas can build markets for their products and brands (e.g. food security and safety, healthy produce, climate neutral). Such research should include examples of the economic value added for territories with high reputations for food, such as tourism.

A related area of relevant research is the valorisation of environmental services of rural areas (e.g. nature-based solutions) to provide evidence of the cost-benefit generated for a local economy which includes an area of special natural protection, and how they can contribute towards rural development (see also *Climate Change, Environmental Sustainability and Land Use*). Such valorisation is likely to require gaps in the availability of statistical information to be filled at relevant levels of granularity, such as those for use in spatial planning or the evaluation of support measures. In smaller countries (e.g. Lithuania) the types of data sought is often only available at country level (i.e. NUTS 0).

A lack of relevant data was also reflected in consideration of 'smart rurality'. Gaps were identified in understanding of the concept, its spread, and acceptability in various countries, which in turn reflects a lack of data on the topic. Research questions arising include: What is the state of 'smart' rurality across Europe, and are the rural communities of a given region or country 'smart'?

Options for land use change (e.g. due to climate change), and changes in societal priorities (e.g. towards a circular economy) are leading to needs for agri-related innovations. Specific research needs will vary by regional contexts, and the opportunities and pace of prospective change. However, examples of such needs are the application of breeding techniques for livestock, modified feeding to reduce methane emissions, the adoption of new crops with lower environmental impact for human consumption, the use of biochar for carbon sequestration, and new barn technologies. Research into physical and social issues relating to the conversion of industrial and household waste into new products (e.g. business models,

processing chains, collection and processing) would also guide opportunities for new businesses, and social innovations where services are not for profit but for the benefit of the public good (e.g. H2020 SIMRA).

EU Level

Migration into, and across Europe, is changing population levels disproportionately between areas, with increases in some areas and decreases in others. For strategic planning, there is a gap in knowledge of population dynamics with respect to environmental benefits or disbenefits, and attitudes towards production capacity. For example, is a lower human population in some areas associated with lower environmental pressures (e.g. requirements for raw materials of water and energy, and for waste recycling or re-use)? If so, what are the societal implications for such area, and public attitudes of current residents towards planned changes in the provision of capacity? It is noted that findings are expected to come from new projects under the call on Impact of spatial mobility on European demographics, society, welfare system and labour market, due to start in 2023.

Post-pandemic, and with the emergence of new and widely used internet communication tools, there is scope for exploring new, multi-local, living arrangements to help recruit and retain qualified employees and attract new entrants to businesses in a diversified rural economy. Evidence is required of benefits to employers, employees and communities of such arrangements, barriers to uptake in different contexts around Europe, and exemplars of successful multi-local living.

Understanding is also needed into what constitutes success or failure in outcomes of diversification and changes in production in rural areas, and what factors influence or explain those outcomes across different types of rural areas? For example, what are the needs of entrepreneurs in different types of rural areas around Europe, and in particular the needs for stimulating female entrepreneurship?

Informed by

H2020 AURORAL, CAPSELLA, DIVERSIFY, Foodshift2030, LIFT, MAGIC, MATILDE, SIMRA, UNISECO; Erasmus+ Rebound.

4.3. Empowering Rural Areas in Multi-Level Governance Processes

Issues

In a broad sense, governance is about the culture and institutional environment in which citizens and stakeholders interact among themselves and participate in public affairs.' (Moodie *et al.*, 2022; Concept of Governance, 2016). It includes the policies, rules and norms that guide human behaviour; who makes decisions, how decisions are made and carried out; who has the authority to act on those decisions; and who is accountable for actions and outcomes (Miller *et al.*, 2023b).

Rural policy is affected by, and has spillover effects across, other areas of policy. These include water, land use, transport, education and health. These sectors tend to have defined remits that can lead to activities that are siloed, with responsibilities allocated to different public or private bodies that do not always operate collaboratively, with integration and coordination required to ensure coherence in policy and practice. Moreover, the natural resources of rural areas often have multiple functions, and rural residents often have multiple roles (e.g. more than one job, voluntary positions). The multi-functionality which characterises some rural areas emphasises the need for collaboration between different actors and sectors (Vilcu *et al.*, 2023).

Demographic changes present a variety of challenges for the governance of rural areas. In shrinking areas, governance is continually adapting to new contexts. Declining rural populations can mean a reducing pool of citizens from which to appoint or invite volunteers to take responsibilities on governance structures (e.g. fewer young people), and a lack of representation of newly emerging groups within rural areas (e.g. migrants).

Empowering rural areas in multi-level governance policy-making processes across topics and types of territories, and of specific topics and particular places is essential for enhancing synergies between EU, national and regional level policies, and ensuring that these policies are sufficiently informed by local rural knowledge and expertise (Moodie *et al.*, 2022). However, in some areas the combination of structures leads to a complex governance landscape comprising arrangements with different forms of: i) legal standing; ii) functions; iii) modes of operation; iv) resourcing; v) staffing; vi) territorial coverage; vii) ownership; and viii) remit. Such complexity can be a barrier when trying to tackle territorial challenges (see also *Climate change, environmental sustainability and land use*).

One approach to mitigating, or responding to, the complexity of governance structures in rural areas is an increasing shift to community ownership. This tends to involve changes in governance structure(s), with requirements for developing structures which enable new allocation of responsibilities of activities in communities. In some countries or regions, community ownership is a progressive approach to tackling imbalances in land ownership as a component of public policy and legislation. In other areas it can be viewed as an approach to be tried to tackle complex challenges such as adaptation to, and mitigation of, climate change when other approaches have been deemed to fail. Ultimately, understanding and sensitivity to the local realities, aspirations, and perspectives of stakeholders is essential for the development of effective public policies towards governance in and of rural areas.

However, community-led initiatives cannot just be 'switched on'. There is a need for citizens (as individuals or through civil society) who are motivated, willing and able to create and participate in the associated governance structures and discharging of responsibilities. Opportunities for developing such initiatives (e.g. proposals for funding) requires the availability of appropriate human capital at the level of the community and of higher levels of administration and governance. For example, one means of supporting community initiatives is through participatory budgeting. However, the frameworks and capabilities for running participatory budgeting (e.g. transparent processes, auditing, management of finance) require to be in place by the administrative authorities before inviting citizen involvement. As noted by Falanga *et al.* (2021) (H2020 CONEXUS), a comprehensive picture of the achievements of participatory budgeting is required to understand the potential of citizen participation.

Needs

To design effective levers or achieving public policies in rural areas there is a need to understand how and what impacts they can have, and constraints on their effectiveness. Regarding the governance of rural areas, research is required into what benefits accrue from different forms of governance, such as a sense of ownership of decisions or outcomes, and of any unintended negative consequences such as those due to poor structures or mechanisms. An associated question is whether rural stakeholders feel represented in the various forms of governance in their rural area, and the extent to which they feel they are listened to and whether actions are taken if required. Where civil society is taking a leading role in governance (e.g. in relation to agriculture and land management) what impacts does it have on policy outcomes, and what is the nature of their relationship with government and other stakeholders?

It is important to understand local realities, and the aspirations and perspectives of stakeholders in developing successful arrangements for governance in rural areas, and developing effective public policies for their design and support. However, it is also relevant to know why municipalities, local councils and regions should have a more prominent role in rural governance, and why they should, and regions should prioritize citizen engagement, whether in communications or mechanisms for participation, which may be expensive financially, in the face of competing demands for resources.

Moodie *et al.* (2023) note that the LTVRA highlights needs for research into the role of digital tools as a mean to invigorate processes of multi-level governance, removing distance as a barrier to participation and ensuring rural areas are better represented in EU and national level policy discussions. The failure of policy and markets to deliver services can be a trigger for community-led social innovations to emerge as reconfigurations of governance for societal benefit (see also *Social Dimension of Rural Areas*; H2020

SIMRA). However, there is limited experience with the delivery of some forms of digital infrastructure and services in the face of different types of challenge (e.g. means of connectivity, management of shared resources, tailored design of service). Research is needed into alternative means of governance and provision of digital infrastructure in circumstances where it is not financially viable for market-driven structures. For example, what roles are there for cooperation between the public, private and third sectors to support digitalisation and digital infrastructure development in rural areas?

Media, digital and traditional, can be influential in motivating, promoting and reflecting upon the effectiveness of governance structures, and so levels of citizen participation, and the norms of human behaviour in rural areas. Citizens in rural areas include with responsibilities which are very different from urban areas notably landowners and farmers. Most media have a metropolitan focus and control. Research is needed to understand whether or how governance of media impacts upon debates and narratives of issues that disproportionately affect rural areas (e.g. agricultural support, generation of renewable energy, managing environmental resources), and the weight allocated to evidence used in decision-making.

EU level

A fundamental aspect of governance is understanding the geographic area and themes over which the governance structure(s) have a remit. Significant investment has been made in the NUTS system and its use, and work is being done on descriptions of characteristics of areas in the JRC Urban Data Platform and Territorial Dashboard. However, there are considerable differences in the geographic size of area, with some very large areas which are less appropriate to consider as 'functional rural areas' (e.g. in Sweden, Finland). As such, the information available to inform the governance of some areas may be at inappropriate or inconsistent levels of spatial detail. Benefit would be gained from research into how new and emerging forms of data capture and reporting (e.g. of citizen science, scraping social media) and analysis (e.g. of big data) can be most effective in supporting different types of governance, and ensuring consistency of information between different levels of governance.

Synergistic with the availability of data about an area or topic, is data about the processes for its management and outcomes of plans and decisions. A synthesis is required of existing evidence of mechanisms for ensuring accountability, transparency, and information sharing under different forms of governance. Such evidence should take account of organisational structures, cultures, and social and human capital, and how these vary across Europe.

Needs have been identified for research and filling gaps in knowledge in relation to governance models. Structures of governance may be formed of elected or appointed members, employees, volunteers, or combinations thereof. The roles of citizens of rural areas may be under any of those headings but could be subject to constraints (e.g. regulatory requirements, willingness of individuals). There is a need for analysis of governance frameworks at different levels of subsidiarity to identify practices that are more or less conducive to citizen involvement, an intended outcome of which would be to provide examples that could inspire adoption and implementation elsewhere. Related research needs are to understand the most effective means of governance of areas of Europe which have special characteristics and ways of life, such as islands and mountainous regions.

Informed by

H2020 Welcomingspaces, CONEXUS, MERLIN, SIMRA, UNISECO; Erasmus+ Rebound; EU Partnership on agroecology living labs and research infrastructures.

4.4. Sustainable and Resilient Value Chains

Issues

Sustainable and resilient value chains are necessary for sustainable growth in rural areas, for food security, and for the sustainable use of resources (Bognar and Schwarz, 2023). The use of new forms of business models and cooperation can empower producers in rural areas while facilitating social and environmental co-benefits.

The EU's Long-Term Vision for Rural Areas (LTVRA) up to 2040 highlights the 'active' role rural areas will play in transitions towards sustainable value chains and achieving the objectives of the European Green Deal (European Commission, 2019), and its Farm to Fork Strategy (European Commission, 2020c), and Circular Economy Action Plan. Under the LTVRA, the European Commission emphasizes how the preservation of natural resources, the restoration of landscapes, including cultural ones, the greening of farming activities and shortening supply chains will make rural areas more resilient to climate change, natural hazards and economic crises.

Rural areas can build upon sustainable farming, forestry, agri-food economic activities and a diversified range of greener economic activities promoting carbon-farming and local, community-based high-quality production'. However, large-scale and long-term investments will be needed to facilitate the transition towards Sustainable Value Chains, including investments in infrastructure, development of legal frameworks, formal and informal training for rural producers.

Despite efforts, there remain limited opportunities for horizontal and vertical coordination in many rural areas, particularly in the Eastern European MAPs. Improved representation of producers' interests in the agri-food chain is needed as well as in relation with political decision makers. Local contexts need to be accounted for and incorporated into policy designs. In particular, EU level tools are required for implementing strategies need to be adaptable to local levels.

Needs

Examples of value chains with characteristics of sustainability and resilience are presented in Bognar and Schwarz (2022, 2023). Some such value chains can contribute to addressing challenges of climate change, and of fostering climate positive farming, but this could be enhanced by greater awareness and understanding of their roles. However, there is a need to understand how principles and processes of sustainable and resilient value chains can be scaled up to global food systems with the engagement of actors from the food and feed industry. To inform such scaling-up will require improved understanding of the presence, influence and interaction of structural, economic, regulatory, cultural and other factors that hinder or facilitate the emergence of producer empowerment in traditional value chains.

A key driver of sustainable value chains are the consumers and other rural and urban actors and communities. The aim is to strengthen cooperation, responsibility and solidarity in just transitions to sustainable food systems, which would be informed by greater understanding of their behaviours, motivations, values and preferences. A related consideration is expected to be local products to final consumer and to local producers, for which effective mechanisms for their promotion are required, and research into awareness of the challenges, opportunities and benefits of local value chains.

Smart solutions and digital technologies could offer considerable benefits for resource and cost efficient, transparent and equitable food chains. Greater insight is required to their roles and potential at producer, distributor, consumer and institutional levels. Specific research is required into strategies for breeding resistant varieties, biological crop protection and animal health and immune system stimulation.

Rural innovators (e.g. creative personnel, motivators, consultants, mentors) are one element of smart solutions and expected to be important actors in developing sustainable value chains. To inform how they

should be supported there is a need for understanding of their roles and impacts, so as to enhance their participation, planning, and implementation in regional development.

Rural innovators are one type of actor with roles in social innovations which in turn have important roles in agri-food value chains. The fostering of such social innovations over the long-term would be aided by research which enables learning from existing experiences, successes and failures, closely integrating the needs and voices of the local actors. However, COVID-19, natural disasters and conflicts are examples of external events which can create impacts and uncertainty for the development of sustainable and resilient value chains and rural communities. Greater understanding is required about the roles, impacts and associated uncertainties of such crises as barriers and, or, accelerators of development.

EU level

At an EU level, greater evidence is required on the effectiveness and impacts of governance instruments for sustainable value chains beyond the implications within administrative areas (i.e. rural/territorial approaches), with a focus on rural areas. Research should be closely aligned to the development of new capacities and/or technologies for the provision of local food and insights to prospective changes in future, nutritious, human diets. There is an opportunity to link actors at local levels throughout the value chain, such as by connecting Local Action Groups (LAGs) with local value chains.

New knowledge is also needed on consumer preferences and their interactions with global agrifood markets and trends, and in-turn how farmers and other actors in food value chains adapt to emerging trends. Related research should focus on how to ensure that the principle of equitability can apply throughout value chains, including understanding of how costs and returns can be fairly distributed amongst all actors in the value chain.

Further collaborative and transdisciplinary research projects should be sought through fostering the adoption of new technologies, social innovations and approaches to pilot new initiatives in sustainable value chains. Research and innovation partnerships for the creation of innovations, development, and experimentation need to go beyond a single project cycle. Established networks and collaborations should persist and be implemented over longer periods of time to support trust-building processes of collaborative approaches and to create long-lasting impact and benefits.

The Strategic Research and Innovation Agendas (SRIAs) of the forthcoming Horizon Europe Partnerships on Agroecology (SCAR-Agroecology, 2023) and Sustainable Food System (SCAR FS, 2023) recognise the types of research needs identified. These initiatives offer prospects to further improve the understanding of how to strengthen the engagement and cooperation of rural and urban actors and communities in value chains that accelerate transitions to sustainable farming and food systems.

Informed by

H2020 AURORAL, AE4EU, ALL-READY, CIRC4LIFE, Driverfarming, EFFECT, Foodshift2030, Fox, I2CONNECT, InnoForEST, LIFT, MAGIC, NEXTFOOD, NEWBIE, PEGASUS, RUBIZMO, SMARTPROJECT, Strength2Food, SUFISA, SURE-FARM, SKIN, UNISECO; Erasmus+ Rebound.

4.5. Social Dimension of Rural Areas

Issues

The EU LTVRA (European Commission, 2021a) identifies four complementary action areas to create stronger, connected, resilient, and prosperous rural areas by 2040. Strengthening the social dimension of rural areas is a prerequisite for the success of this vision depending as it does on active, committed, and qualified people and especially on the cooperation between them at different levels within the societal

frameworks and relations (e.g. Smart-AKIS, PROVIDE) of areas with different traditions of governance, policy and business. Such a prerequisite faces a number of threats, examples of which are the lack of generational renewal in rural businesses (e.g. farming) and communities, and demographic profiles of rural areas which reflects aging in business and community sectors.

The ambitious vision of the LTVRA should be built upon science-based evidence. An analysis of Horizon 2020 projects (Černič Istenič, 2022) showed that the social dimension has not been explicitly and comprehensively considered in terms of participation and social inclusion, building social capital and social support networks. The social dimension has been a supporting role to other issues of interest (i.e. economic, technological, and environmental goals), with limited work on how instruments should need to be designed and implemented to strengthen the social fabric of rural areas. For example, how should public policies relating to rural areas take account of social issues, especially into the mechanisms of measures of Cohesion policy and the Common Agricultural Policy?

Rural areas in the EU have potential and advantages to become a home for empowered and vibrant local communities (e.g. with creative industries; RURALIZATION). However, in many rural areas, especially the more remote regions and those whose social composition is changing rapidly, social fabric is under pressure as interest in social ties wanes.

The old, 'traditional' forms of community organisation and bonding are in decline, while new forms that could sustain sociability are not yet in place. Barriers to a good quality of life in many rural areas include low levels of public participation in activities, a lack of volunteers and local leaders, low participation of local and public authorities, insufficient capacity of administrative staff, and legislation which make it difficult for rural people to access mechanisms of support and public services. In many rural areas, segments of the population face social exclusion and poor quality of life, manifested in hidden poverty, gender inequality, domestic violence, mental health problems, a lack of information and direct support services, and a culture of shame and stigma.

Tensions and conflicts over the use of rural space and intergenerational relations are also common stresses in the lives of many rural dwellers; The social (non)inclusion of immigrants is also a pressing problem or challenge in some rural areas (e.g. POLIRURAL). Their lack of knowledge of local culture and customs, as well as their low level of engagement with the local population, indicate that they are poorly integrated into rural communities. Some of immigrant groups do not have legal residency status, but only access to jobs with low pay and poor working conditions.

Needs

Process and product as well as technical and social innovations are having different types of impacts in different rural areas. However, research topics relating to rural areas are dominated by issues of agriculture, employment, diversification, and income, with less attention is paid to social infrastructure, which is an important element in people's well-being. Social, economic and environmental issues are closely interlinked, even more so as attention increases on nature positive and well-being economies (e.g. Dasgupta, 2021), but often with social issues neglected compared to the other two (H2020 FARMWELL). For example, research on the mobility of the population for work and access to services (physical or digital, e.g. DESIRA), especially in sparsely populated rural areas, is rare or not up to date. New research is needed on the current mobility needs of the population, and how information can be made available most effectively to different sectors of the population (e.g. migrants, minorities, elderly). Research is also required into how migrants and minorities are represented in different types of governance structures, and how such representation can be enhanced.

One topic of relevance to all rural citizens is their physical and mental health, the latter of which has considerable diversity in approaches and levels of recognition of its characteristics and what constitutes a supportive environment. Amongst sub-groups of rural populations of particular concern is that if farmers, for whom business related pressures are sometimes augmented by negative social perceptions of farming,

whilst working and living in relative isolation (physically and socially). Pressures on the mental health of farmers can be accentuated by a characteristic of farmers themselves of attitudes of minimally seeking help and a lack of knowledge of where to turn for help (H2020 FARMWELL). More understanding is required into the types of interventions which are most effective in tackling and preventing mental health crises, and learning across regions of examples of effective practices and their impacts.

The investment of projects under the Green Deal in citizen science provides emerging opportunities to gain insights to the added value of citizen participation in community-led initiatives, governance structures and businesses in rural areas. Evidence of the value of citizen participation will be enhanced if those values can be quantified (e.g. financially) and thus included in a social cost/benefit analysis to inform deliberations of policy-makers. Triggers for community led initiatives, often referred to as social innovations, is often the failure of markets or public policy (RurInno; SIMRA). So, related research is required to understand to what extent public administrations are remote (actual or perceived) from rural citizens and how such disconnections can be overcome (see also *Governance*).

EU level

Evidence shows the importance of social networks, social capital, and empowering local communities within rural areas. However, there are ongoing needs to understand their functions and how they can be strengthened in different contexts across Europe. This could take the form of a Europe-wide comparative study (learning from ESPON 2013 EDORA; Eurofound 2014) regarding the socio-economic status quo, major demographic, social, and economic changes, and how existing social structures and networks in rural areas are functioning, or not, to the benefit of the entire rural population.

There is also scope for identifying changes in the different levels of regulatory frameworks which would be appropriate for strengthening the social needs of rural areas within prevailing EU, national and regional legislation and policies. Sharing knowledge of best practices in developing regulatory frameworks across Europe would help accelerate processes of such strengthening and should include effective means of supporting cooperation between stakeholders involved in the social economy, businesses, the public sector, and non-governmental organisations in rural areas.

The submission of data from citizen science projects to the EU Rural Observatory should ensure that it becomes an increasingly valuable resource for future research funded by Horizon Europe, enabling access to statistics, indicators and analyses at different levels of territorial granularity. However, the provision of such data often lags behind the requirements of users. In many regions, there are shortcomings in the types of quantitative and qualitative information available for rural areas such as insufficient details on gender perspectives and migration. Those limit the interpretation of the status quo and trends gender equality in rural areas and the impact of the presence or absence of migrant workers on agricultural activity.

Observation, measurement and monitoring from on-the-ground provides a form of validated evidence that can support and encourage the development of the types of tools required to help rural areas address their challenges. As data become available from sources such as the JRC territorial dashboard and new projects in Horizon Europe (e.g. GRANULAR and the Driving Urban Transition (DUT) Partnership), research should be undertaken into similarities and differences of social infrastructure between rural and urban areas, and in rural urban transition areas. That research should also consider situations in different types of areas (e.g. island, mountainous areas) in terms of health, social protection, education, social contacts and connectivity.

Informed by

ESPON 2013 EDORA, H2020 AURORAL, DESIRA, FARMWELL, MATILDE, POLIRURAL, PROVIDE, RurInno, SIMRA, Smart-AKIS, Horizon Europe GRANULAR, Driving Urban Transition (DUT) Partnership.

4.6. Digitalisation in Rural Areas

Issues

The EU places considerable emphasis on digitalisation via the Long-Term Vision for Rural Areas, primarily through the second area of action or Connected rural areas (Arcuri, 2023). In this, digitalisation is inherent to digital infrastructures and their relevance when dealing with the possibilities to use services. One of the flagship initiatives in this area is 'Rural Digital Futures', with actions that include digital connectivity, digital technology, people, and measuring progress (European Commission, 2021a).

The role of digitalisation is confirmed by the Rural Action Plan, and the Digital Compass for the EU's Digital Decade (European Commission, 2021d). This Communication confirms that rural areas have to be active players for achieving the aims of the EU Green Deal, the Farm to Fork Strategy (European Commission, 2020c) and the Biodiversity Strategy 2030. However, a key need is to eliminate the digital divide, which causes the phenomenon that has been indicated as 'digital poverty' (European Commission, 2021d). Slätmo *et al.* (2022) highlight that Finland and Sweden are the European countries with the largest gaps between rural and urban households for access to fast broadband and to next-generation access.

An aim of policy and research should be to prevent digital exclusion, and encourage and facilitate public authorities to take on greater responsibilities of supporting long-term goals of digitalisation. The Digital Economy and Society Index (DESI; European Commission, 2022b) analyses the state of digitalisation in Europe, and provides data on connectivity. The DESI report (2022a) shows that while the internet gap on broadband has decreased in recent years, the gap related to the fixed very high-capacity network (VHCN) has increased. The European Commission (2021d) note that a new digital divide has emerged between well-connected urban areas and rural and remote territories, and between those who can fully benefit from an enriched, accessible and secure digital space with a full range of services, and those who cannot. They also observe that a similar divide has emerged between those businesses already able to leverage the full potential of digital environment and those not yet fully digitalised. From analysis of the DESI, Kwilinski *et al.* (2020) concluded that between 2014 and 2018, countries with higher levels of digitalization had more significant reductions in poverty and social exclusion, but that further positive changes are likely to higher in countries with a lower level of digitalization. Combined, these observations are an indication of the complexity of the digital divide, needing proactive approaches for it to be addressed.

Digitalisation is rapidly addressing some of the gaps in commercial services. For example, e-commerce makes many commodities available in a few days; home banking has already revolutionised the relationship between citizens and their bank; home entertainment (streaming TV, games) provides a partial replacement of traditional entertainment services. It is also offering major opportunities to improve the quality of life and wellbeing of rural citizens via the delivery of essential services (e.g. e-healthcare), and to strengthen the local economy (e.g. e-commerce). Innovation in the provision of services through digital approaches, such as digital school hubs, could serve to attract or maintain young people and families who would otherwise leave rural areas for education, employment and opportunities offered in urban areas. The availability of adequate technological infrastructures can also be an important factor for attracting new rural entrepreneurs (e.g. see H2020 RUBIZMO).

Needs

Insight is required to the drivers of digital uptake in rural areas, with different contexts (cultural, political, economic, physical), and barriers requiring to be overcome by prospective users or beneficiaries (e.g. cost, reliability, quality of access), also a conclusion of DG Agri (2022) with respect to the CAP Strategic Plans. Such knowledge would inform the design of smart systems and future-proof farms and smart rural businesses, envisaged by the European Commission (Wojciechowski, 2022). Policies and programmes to increase the adoption of digital solutions would benefit from research into the characteristics of rural digital

ecosystems, and how they can contribute digital solutions to the sustainable development of rural environments, societies, and economies.

To realise aims of smart rural communities also requires understanding of prospective pathways, and at different levels of governance (Salle *et al.*, 2022; see also *Governance*). Particular insight is required to what and how digitalisation addresses the needs and expectations of younger people through primary to tertiary education, and lifewide opportunities (e.g. access to cultural services), responsibilities (e.g. caring), and their priorities for types of services. However, research is also needed into how to overcome the loss of face-to-face social contacts, particularly between children, if education and services are overly reliant on digital approaches, as evidenced during the COVID-19 pandemic.

Research is needed to assess whether and how smart rural communities enhance the attractiveness of rural areas to current and prospective residents, at different stages of life, and businesses at each of their stages of development (e.g. conception, incubator, maturity). A precursor is understanding the relationship between what constitutes an attractive rural area, such as the services for goods and people (e.g. transport), working and living conditions (e.g. scope, benefits and disbenefits of remote working).

The DESI indicators provide some insight to the trends in relation to digital technologies and infrastructure in the EU, enabling interpretation of digital divides (e.g. between urban and rural areas). As with monitoring systems, such as the Eurobarometer, there needs to be ongoing investment in capturing the DESI indicators, and their interpretation (e.g. regarding differences in digital capital between rural and urban areas). Maintaining the contemporaneous nature of the DESI indicators is essential if they are to provide evidence to support policy and practice in the rapidly evolving deployment of innovative digital technologies (e.g. near real-time measurement and monitoring of attributes of the environment and society; automation of processes), and in recognising what constitutes digital maturity and what that means for further phases of human, social and technological development.

Research should include the topics covered in the four DESI key areas (Human capital, Connectivity, Integration of digital technology, and Digital public services), and what new indicators may be relevant. Related research should be into the means of communicating the indicators for maximising their relevance to users (e.g. spatial granularity), links to specific types of rural areas (e.g. islands, mountainous areas), and linking digital indicators to threats and risks (e.g. to digital infrastructure due to extreme weather events).

Although there is optimism regarding the role of digitalisation as a catalyst for change in rural areas, further work is necessary to ensure that its advantages are widely distributed. That work should include improving coordination and cooperation between different societal groups, policymakers, businesses, and science to evaluate the enabling and impeding factors that influence digitalisation processes in rural areas (i.e. digital rural proofing), and to co-design locally adapted digital strategies. The benefits of digitalisation could be further improved with the provision of technical assistance which is adapted to the particular needs of rural areas. Alongside the expansion of digitalisation, other aspects of infrastructure require to be planned and managed such as the equitable availability of data (e.g. through exploiting open data, which is expanding rapidly; European Commission, 2022c), and means of guarding against cyber attacks and enhancing cyber security as a right (see also Section 4.7 *Observation, measurement and monitoring*).

EU Level

Digital technologies and services are constantly evolving, requiring lifelong and life wide learning and updating of digital skills of rural citizens. It has to be made available in all languages of relevance to reduce the risk of the exclusion of citizens who are not skilled in a few dominant languages (e.g. English). Skills in the use of digital tools will then enable their use in education of all subjects and topics, in line with the Council Recommendation on improving the provision of digital skills in education and training, and the Digital Education Action Plan.

The design and effective delivery of education and training using digital tools would benefit from research into how digitalisation can improve the delivery of education and training in rural areas, considering differences in curricula, stages of learning and requirements for qualifications. Related, designing curricula and means of life-long learning requires understanding of the digital readiness of individuals, households, and across territories, and the links with the uptake of digital technologies.

Evaluations of the impacts of enhancing digital skills should be linked to how they contribute to digital innovation in rural areas. In turn, to inform the provision or approaches to stimulating digital innovation within rural area would benefit from research into its long-term impact on the sustainability and just transitions of rural areas; the role of digitalisation in increasing the attractiveness, well-being, and the functionality of rural areas; how digitalisation influences working and living conditions in rural areas such as forms of remote working; and, opportunities for automation.

More broadly, the effectiveness of digital technologies requires them to be interoperable, relying upon agreed standards for data and databases, software and hardware. The establishment and promotion of such standards should continue to be a topic of EU level research.

EU level research projects also have a role in motivating and enabling the provision of digital capabilities developed with, and not about, local actors (e.g. RURACTIVE, FUTURAL, CODECS). There should be an ongoing programme of research projects which require the involvement of rural actors, extending cascade funding mechanisms and participatory approaches, for the active involvement of rural citizens, young people, rural businesses, municipalities and rural researchers. Evaluations by and of those approaches should study the roles and participation of actors in the new realisations of digital society. Such projects can also form part of the Long-Term Vision for Rural Areas rural revitalisation platform.

Informed by

H2020 AURORAL, DESIRA, RUBIZMO, SIMRA; Horizon Europe RURACTIVE, FUTURAL, CODECS; Erasmus+ Rebound.

4.7. Observation, Measurement and Monitoring

In responding to climate change, citizens, businesses and policy makers need data on greenhouse gas emissions, associated with land use practices, at a granularity to which they can relate, i.e. spatial units of relevance to their authority and responsibilities, or over which they have influence of actions which can be taken (see also *Governance*). Improvements continue to be made at EU and national or regional levels to the provision and maintenance of information on estimates of climate change, GHG emissions and threats. Notable amongst those are the capabilities for observation and measurement, and climate change bulletins (e.g. Copernicus Climate Service), and a range of interactive maps and graphical representations from the European Environment Agency (EEA), such as:

- GHG emissions by sector (e.g. Land Use, Land Use Change and Forestry);
- Forest Fires in Europe;
- Meteorological and hydrological droughts in Europe;
- Renewable Energy dashboard (e.g by country and type).

The digitalisation of agriculture also relies on data and, in this case to enhance access to databases owned by the public administration. In agriculture, some data are generated at the farm level, but a significant amount of data are public (e.g. soil conditions, meteorological data, land parcels information, market prices). However, the arrangements for collecting such data vary by country, and can be quite diverse within country. but unavailable for farm-level decision support applications which do not have the requisite access.

Alongside more data being generated, such as through digital monitoring systems, there are increasing risks associated with of cyber security and cyber-attacks. Topics that may seem of narrow interest in their

early stages of development can take on much greater significance over time. For example, the measurement and monitoring of environmental characteristics (e.g. sensors reporting site level GHG emissions), their access and storage, could become valuable if they are used in relation to future payments schemes (see also *Digitalisation in Rural Areas*, and *Climate Change, Environmental Sustainability and Land Use*).

Needs

Outputs from EU Horizon Programmes are producing new, geographically explicit, tools for use by actors in policy, civil society and science for insights to threats and impacts of climate change, examples of which are the typology of climate risk assessment (H2020 RESIN), and assessments of potential impacts of climate change of European islands (H2020 SOLIMPACT). Enhancements of such assessments, with map-based interfaces and dashboards, can help inform the development of region-specific adaptation plans.

One enabler of community empowerment to take leading roles in developing their resilience in the face of climatic challenges, is increased availability of easily accessed and understood data and information, and capacity to use those data. For example, community initiatives for mitigating and adapting to climate change include monitoring and measuring environmental characteristics, such as GHG emissions from soils, land uses through use of digital sensors and Internet of Things, and public interest in extreme events (e.g. wildfires mapped through the Copernicus Climate Change Service.

As more opportunities arise for funding citizen science or community actions, including through the Horizon Programme (e.g. in Innovation Actions), so there is scope to learn what motivates individuals and communities of interest or place to get involved. Such understanding is necessary for the recruitment and retention of individuals in such efforts, and so broadening the means of capturing environmental observations.

EU Level

To achieve the aim of the EU LTVRA Action Plan flagship of **Increasing environmental, climatic and social resilience** requires a deeper understanding of rural vulnerability to the climate crises, and the identification of potential solutions to enhance the adaptive capacity and transformability of rural communities. There is an associated need for data with a level of granularity suitable for understanding the tangible effects of climate change. Understanding, data and solutions should enable communities build and strengthen their resilience in the short and long term.

Informed by

H2020 DESIRA, RESIN, SIMRA, SOLIMPACT.

5. Alignment with European Research Strategies

As with the first set of research recommendations, the identification of research gaps and agendas are primarily based on the MAPs of the SHERPA project. Their locations, contexts and the topics they covered set boundaries on research needs identified, and not a comprehensive coverage of all the research and evidence required to inform policy and society in rural Europe. The research needs identified by the SHERPA MAPs were independent of EU or national research strategies. However, those needs connect to the strategic orientation of Horizon Europe, approved or prospective European Partnerships, research needs identified in the SCAR-AKIS Foresight exercise and the pillars of the LTVRAs. A description follows of examples of those alignments.

Strategic aims of Horizon Europe

The research topics identified by SHERPA MAPs align with one or more of the four strategic orientations of Horizon Europe (2021-24) (Table 1). All topics have an aspect that contributes to a **Digitally enabled**

economy, such as enhancing digital solutions in rural areas in the monitoring natural capital, empowering citizens, improving smart solutions within value chains and the provision of public services. This is particularly in impact area Climate change mitigation and adaptation onto which research gaps in *Climate change, environmental sustainability and land use* have a close alignment.

Addressing research gaps under climate change, sustainable value chains, governance processes and digitalisation would also contribute to **Open strategic autonomy**, and all four of its impact areas of a competitive and secure data-economy, industrial leadership in key and emerging technologies that work for people, secure and cybersecure digital technology, and high-quality digital services for all. For example, issues of ensuring cyber security were identified under digitalisation and *Observation, measurement and monitoring* in part reflecting the increased provision and uses of data, particular to protect providers such as citizens and civil society groups undertaking citizen science.

The research topic of *Observation, Measurement and Monitoring*, has research gaps that relate to three of the four orientations. That reflects roles identified by the MAPs and related EU projects regarding environmental monitoring (e.g. use of field based sensors) and the provision of information (e.g. through dashboards). These types of tools also contribute to the orientation of **Restoring Europe's ecosystems and biodiversity**, in particular impact areas of Enhancing ecosystems and biodiversity on land and in waters, and Sustainable food systems from farm to fork on land and sea.

Filling gaps in knowledge identified by SHERPA MAPs in five of the topics would contribute to all four impact areas of the orientation of **Resilient, inclusive democratic societies**, namely A resilient EU prepared for emerging threats; A secure, open and democratic EU society; Good health and high-quality accessible healthcare; and Inclusive growth and new job opportunities. These include research on and using *Observation, Measurement and Monitoring* which contribute to community empowerment (e.g. information on extreme events provided through Copernicus Climate Service), and the deployment of tools which enhance community opportunities and responsibilities (e.g. through social innovations investing in natural capital).

European Partnerships

The Horizon Europe programme (European Commission, 2021b) notes that European Partnerships will "promote societal, ecological and economic transformations by involving, collaborating with and building consensus among citizens and practitioners on research and innovation roadmaps and priorities." The SHERPA MAPs and process align with that objective with their science, society and policy forums and development of recommendations for policy and research.

The research needs identified in the first phase of recommendations (Chartier *et al.*, 2022) aligned with 8 of the proposed European Partnerships under Horizon Europe (DG Research and Innovation, 2020). The second set of research needs align with 7 Partnerships (Table 2). This set of research recommendations does not have a direct alignment with the remit of the partnership on One Health and Anti-microbial Resistance although the SHERPA topic of *Sustainable and Resilient Value Chains* topic will have some relevance.

Research recommendations across the topics align with the aim of the Partnerships of overcoming "major climate and sustainability challenges" and delivering on "on the EU's digital ambitions for the next decade" consistent with its goals of the 'twin' green and digital transitions.

All of the topic areas appear to align with the partnership on Accelerating farming systems transition: agroecology living labs, research infrastructures. This reflects the broad nature of the area covered by the partnership, and the cross-cutting nature of some of the recommendations from the SHERPA MAPs (e.g. relating to innovation in digital tools as applied to land uses, food and economic development in rural areas, their roles in community and small businesses, and their governance.

Other recommendations align specifically with topics of partnerships such as that on Rescuing biodiversity to safeguard life on Earth (e.g. *Climate change, environmental sustainability and land use*), and Safe and Sustainable Food Systems (e.g. *Sustainable and resilient value chains*). Recommendations under *Sustainable and resilient value chains*, and *Observation, Measurement and Monitoring* have broad applicability, potentially aligning with five partnerships.

Recommendations regarding the roles of woodland expansion, public attitudes towards that change, natural capital and business models of green investment in woodlands should all have relevance to the proposal in for a new partnership on Forests and Forestry For a Sustainable Future (European Commission, 2023b).

The research in all topics will contribute to the aims of the EU in **Open Science Policy** and the delivery of outputs from all projects to the FAIR principles (Findable, Accessible, Interoperable and Re-usable data; Wilkinson *et al.*, 2016), and increased use of the European Open Science Cloud. They are also consistent with the European Commission priority of "A Europe fit for the Digital Age", with roles for artificial intelligence (e.g. agendas *Supporting the sustainability of digitalisation*; *Observation, measurement and monitoring*); European Data Strategy (European Commission, 2020d)

This second set of research topics are consistent with the expectation of the synergies in the proposed partnerships, bridging business and land management sectors, providing accessible and reliable evidence of what and how land is managed (e.g. soil characteristics). Disseminating and exploiting the outputs from *Observation, measurement and monitoring* can contribute to capacity building of communities of place in rural areas and communities of interest (e.g. emergency response groups), improve processes throughout supply and value chains, and be used in the promotion and marketing of rural areas. An outcome could be to extend the LTVRA flagship initiative envisaged of **Research and innovation for rural communities** to one that is with rural communities.

Table 1. Mapping topics of SHERPA research agenda onto Strategic Aims of Horizon Europe Programme (European Commission, 2021b).

	Research Gaps within SHERPA MAP Topics						
Horizon Europe Strategic Orientation*	Climate Change, Environmental Sustainability and Land Use*	Change in Production and Diversification of the Rural Economy	Empowering Rural Areas in Multi-Level Governance Processes	Sustainable and Resilient Value Chains	Social Dimension of Rural Areas	Digitalisation in Rural Areas	Observation, Measurement and Monitoring
Open strategic autonomy	X		X	X		X	X
Restoring Europe's ecosystems and biodiversity	X	X		X			X
Digitally enabled economy	X	X	X	X	X	X	X
Resilient, inclusive democratic society	X	X	X		X	X	

*Note: Strategic aims of Horizon Europe, in full: i) Promoting an open strategic autonomy by leading the development of key digital, enabling and emerging technologies, sectors and value chains; ii) Restoring Europe's ecosystems and biodiversity, and managing sustainably natural resources; iii) Making Europe the first digitally enabled circular, climate-neutral and sustainable economy; iv) Creating a more resilient, inclusive and democratic European society.

Table 2. Mapping topics of SHERPA research agenda onto prospective European Partnerships (DG Research and Innovation, 2020).

	Research Gaps within SHERPA MAP Topics						
Approved or Prospective European Partnerships*	Climate Change, Environmental Sustainability and Land Use*	Change in Production and Diversification of the Rural Economy	Empowering Rural Areas in Multi-Level Governance Processes	Sustainable and Resilient Value Chains	Social Dimension of Rural Areas	Digitalisation in Rural Areas	Observation, Measurement and Monitoring
Artificial Intelligence, Data and Robotics	X		X			X	X
Accelerating farming systems transitions: agroecology living labs, research infrastructures	X	X	X	X	X	X	X
Agriculture of Data (environmental observations for sustainable EU-agriculture)	X	X		X		X	X
Rescuing biodiversity to safeguard life on Earth	X			X			X
Safe and Sustainable Food System	X	X		X			
Circular bio-based Europe		X		X			
Open Science Cloud Partnership	X	X					X

SCAR-AKIS Foresight Exercise

As with the first set of research recommendations (Chartier *et al.*, 2021), the second set align with the same four cross-cutting research themes identified by the SCAR-AKIS Foresight Group, as presented in Table 3 (Brunori *et al.*, 2020). *Sustainable and Resilient Value Chains* has an intersection with all four Foresight Topics. This reflects the importance of food and well-being to society, transitions in farming systems towards agro-ecology, the roles of digital innovation in the development of the bioeconomy, and how citizens can participate in different ways in value chains including through social innovation.

The research recommendations from the SHERPA MAPs provide additional dimensions to the themes of SCAR -AKIS, expanding aspects notably in the social sphere of the food and agriculture sector of Europe. Examples are interventions for tackling and preventing mental health crises particularly amongst farmers (*Social Dimension of Rural Areas*), and what benefits accrue from different forms of governance such as when civil society takes a leading role in agriculture and land management (*Empowering Rural Areas in Multi-Level Governance Processes*).

Addressing the research gaps identified in the other SHERPA topics will be consistent with the focus of the foresight exercise on knowledge for "improving diet and nutrition, increasing circularity in the food system, and restoring lost biodiversity." They intersect the agri-food remit of the SCAR-AKIS while contributing insight from civil society, science and policy on gaps in scientific and practice knowledge which slow or inhibit the sustainable development of rural areas. Work in these areas, accompanied by action on the recommendations for policy would help achieve the aim FOOD 2030 aims as set out by Brunori *et al.* (2020) of nutrition for sustainable and healthy diets, climate-smart and environmentally sustainable food systems, circular and resource-efficient food systems, and innovation and empowerment of communities.

Long-Term Vision for Rural Areas

Each of the LTVRA pillars is intersected by three or more of the research topics (Table 4). Research needs within the topic of *Change in Production and Diversification of the Rural Economy* deliver to all four pillars of the LTVRAs. This reflects the breadth of the topic, and the significance attached by the MAPs to systems thinking in relation to public goods (e.g. food, environmental services) and new ways of working (e.g. multi-local living) which, in turn, link to several building blocks of LTVRA Pillars.

The **Stronger** pillar is intersected by six of the seven SHERPA topics, with one or more of the research topics delivering to each of its five building blocks, notably four addressing knowledge gaps relating to young people and thus the building block of **Supporting rural youth**. The process of identifying gaps in the provision of education and training, personal development and career pathways of young people more generally is a recommendation of the SHERPA MAPs (Section 4.1).

Similarly, research gaps on the topic of **land use planning** were identified in the topic of *Climate Change, Environmental Sustainability and Land Use* and maps directly onto an LTVRA building block of **Optimising land use planning**. Research requirements include identifying the spatial and temporal granularity of data of most value to users for example in relation to the DESI indicators and specific types of areas such as islands and mountains; *Digitalisation in Rural Areas*; *Empowering Rural Areas in Multi-Level Governance Processes,* and shrinking rural areas (Copus *et al.*, 2020). Such data sets and series would offer further insights to guide policy and planning towards the flagship of **Revitalising rural areas most affected by population loss**.

Also contributing to revitalising rural areas is on the ground actions through research projects. SHERPA MAPs cross-reference research funded through the EU research programmes Horizon 2020 and Horizon Europe, and the programmes of nations or regions. In addition to enabling access to new knowledge, the processes of Innovation Actions and the equivalent elements of Research and Innovation Actions provide means of operationalising innovations on the ground (e.g. H2020 SIMRA; H2020 AgriLink; H2020 RURITAGE). The SHERPA MAPs were part of the project which is a Coordination and Support Action (CSA). This was cited as an example of how science-society-policy interfaces can stimulate multi-actor

engagement across sectors, and at different levels of governance. As such they are an example of how public and private players can act with rural communities to co-create knowledge and recommendations for rural areas to thrive. These types of forums contribute to **Creating a stronger innovation ecosystem** for rural areas (and the flagship of the **Stronger** pillar).

Each of the **Resilient** and **Prosperous** pillars are intersected by four research topics with common research areas in *Climate Change, Environmental Sustainability and Land Use*, *Diversification of the rural economy*, and *Social Dimension of Rural Areas*.

Tackling climate change forms part of a wider approach to rural development. For example, the restoration of peatland is providing new opportunities for rural development, built around new streams of income for entrepreneurial land managers and owners, including public authorities and communities. Entrepreneurial micro-businesses and SMEs are identifying opportunities for gaining new skills for the delivery of public goods such as shaping ditches, monitoring of water levels using digital sensors, and the use of drones to measure and monitor peatland restoration sites. SHERPA MAPs recognised the significance of providing encouraging and enabling environments for such businesses in revitalising rural areas, and that they themselves were the types of forums that form part of the entrepreneurial discovery process outlined by Perianez-Forte and Wilson (2021). Findings from research into the needs of entrepreneurs in different types of rural areas around Europe, and those for stimulating female entrepreneurship (*Change in Production and Diversification of the Rural Economy*) would contribute to the flagship of the **Prosperous** pillar of Supporting entrepreneurship and the social economy in rural areas.

Public policies of expanding woodland tackling crises of climate change and loss of biodiversity are providing a new stimulus for the bioeconomy in rural areas. New initiatives include investments in natural capital, both enhancing environmental quality and opening new income streams for land owners and increasingly for communities. Research needs were identified into what and how policies can align with business and environmental objectives into a package for the building block in the **Prosperous** pillar of **Promoting the development of a sustainable bioeconomy in rural areas** (Section 4.1)

Enhancing skills on the delivery and subject of education and training is identified as of key importance for developing human capital in rural areas (from *Digitalisation in Rural Areas*; *Climate Change, Environmental Sustainability and Land Use*). Particular attention is required for ensuing lifelong and life wide learning and updating of digital skills of rural citizens and answering a research question of the level of digitally readiness of individuals and households, and across territories, and what links there may be with the uptake of digital technologies. Filling such a research gap will contribute to a building block in the **Prosperous** pillar of Encouraging education, training and employment opportunities for young people in rural areas.

Of relevance to the **Resilient** rural areas pillar the SHERPA MAPs identified research needs relating to managing and restoring peatland and carbon rich soils (*Climate Change, Environmental Sustainability and Land Use*) which map directly onto **LTVRA flagship initiatives** of **Addressing climate change in peatland areas through carbon farming**, and **A Soil Deal for Europe** (DG Research and Innovation, 2021). The associated research needs intersect other topics in relation to social innovations, diversifying community income, and governance structures. The significance of delivery to the soil deal is likely to have increased given the proposal in July 2023 for a law on Soil Monitoring and Resilience (Soil Monitoring Law; European Commission, 2023c).

Developing the resilience of rural areas requires supporting and enabling actions by their inhabitants (residents, businesses and employees) which are undergoing changes in demographic profile and in and out migration. Research into multi-local living arrangements (Section 4.2) could help the design of policies that counter brain drain and labour exploitation phenomena and enhance the joint building of human capital across regions and countries, as per the building block of **Analysing spatial mobility and demographically declining areas in Europe**. As a component of change in the composition of rural populations, support is required for both migrants (or 'new citizens') and the wider rural community into

which they move. New knowledge of how they are represented in different governance structures could help build partnerships and the promotion of inclusion and integration of migrants in rural areas, and so building block **Supporting the inclusion of migrants in rural areas**.

Research topics relating to the **Connected** pillar are more specific. Research proposed on what and how digitalisation addresses the needs and expectations of younger people through primary to tertiary education, and lifewide opportunities is one of the recommendations which would aid delivery of the flagship of Rural Digital Futures. Similarly, as noted in Section 4.6, interpreting data from the DESI report (2022a) shows trends of increasing gaps between rural and urban areas with very high capacity networks (opposite to an aim of the flagship), with research needed into addressing that digital divide in terms of quality of access not just availability of connectivity.

Outputs from research into near real-time measurement and monitoring of attributes of the environment (e.g. soils, GHG emissions) could facilitate great precision in targeting land management measures that progress towards climate neutrality or positive farming systems. As such that contributes to the **Connected** building block of further **promoting the digitalisation of the agricultural sector**.

EU Missions

The Horizon Europe programme includes five Missions:

- *Adaptation to Climate Change:* support at least 150 European regions and communities to become climate resilient by 2030;
- *Cancer:* working with Europe's Beating Cancer Plan to improve the lives of more than 3 million people by 2030 through prevention, cure and solutions to live longer and better;
- *Restore our Ocean and Waters by 2030;*
- *100 Climate-Neutral and Smart Cities by 2030;*
- *A Soil Deal for Europe:* 100 living labs and lighthouses to lead the transition towards healthy soils by 2030.

Of these missions, the SHERPA research recommendations align with elements of the two on Adaptation to Climate Change, and A Soil Deal for Europe. Research needs were identified in Section 4.1 that map onto each of the three areas of the Climate Adaption Mission which aims to help regions understand risks now and in the future, develop pathways to be better prepared, and testing innovative solutions on the ground. Examples include planning for multi-functional land uses and landscapes, with a systems perspective.

Similarly, several recommendations relate directly to objectives of the mission of a Soil Deal for Europe, such as conserving soil organic carbon stocks (Section 4.1 Land management and systems, Peatland restoration), and improving soil structure to enhance soil biodiversity (Section 4.1 Land management and systems). Interest has been expressed by some SHERPA MAPs to participate in Soil Health Living Labs envisaged in the Mission, and now represented in calls for research in 2023. This interest is also reflected in the policy recommendations from SHERPA (Martino *et al.*, 2023, D7.5).

Table 3. Mapping topics of SHERPA research agenda onto the cross-cutting research themes identified by the SCAR-AKIS Foresight Exercise Expert Group (Brunori *et al.*, 2020).

	Research Gaps Identified in SHERPA MAP Topics						
SCAR-AKIS Foresight Topics	Climate Change, Environmental Sustainability and Land Use*	Change in Production and Diversification of the Rural Economy	Empowering Rural Areas in Multi-Level Governance Processes	Sustainable and Resilient Value Chains	Social Dimension of Rural Areas	Digitalisation in Rural Areas	Observation, Measurement and Monitoring
Food, well-being and society	X	X	X	X			X
Social innovation	X		X	X	X	X	
Agro-ecology	X	X		X			
Digital transformation of the bioeconomy		X	X	X		X	X

Table 4. Mapping topics of SHERPA research agenda onto the action areas of the EU Long Term Vision for Rural Areas (European Commission, 2021a).

	Research Gaps within SHERPA MAP Topics						
Pillars of the EU LTVRA Rural Action Plan	Climate Change, Environmental Sustainability and Land Use*	Change in Production and Diversification of the Rural Economy	Empowering Rural Areas in Multi-Level Governance Processes	Sustainable and Resilient Value Chains	Social Dimension of Rural Areas	Digitalisation in Rural Areas	Observation, Measurement and Monitoring
Stronger rural areas	X	X	X		X	X	X
Connected rural areas		X		X		X	X
More resilient rural areas that foster well-being	X	X	X		X		X
Prosperous rural areas	X	X		X	X		x

6. Conclusions

The SHERPA process by which the two sets of research recommendations were developed is consistent with the wider co-design approach adopted in work areas of the Horizon Europe Programme (European Commission, 2021b). This is reflected in the European Partnerships which are described as promoting "societal, ecological and economic transformations by involving, collaborating with and building consensus among citizens and practitioners on research and innovation roadmaps and priorities."

The EU level MAP provided insights which included referencing work in other EU funded projects which informed the alignment or wording of recommendations, adding value to findings from the regional and national level MAPs. They were also in a position to synthesise directions of development in policy which may gain from research findings (e.g. scenarios of the mix of sources and sizes of renewable energy development that would achieve energy targets and those of rural development).

Gaps in evidence or knowledge identified from the SHERPA process provides a combination of supply and demand led perspectives (Section 5). The work of the regional and national MAPs has provided a bottom-up perspective on research needs. The needs identified reflect the perspectives of the SHERPA MAPs of weaknesses in the evidence bases, and gaps in evidence relevant to national or regional socio-economic or biophysical circumstances. The expression of those needs will vary according to the predominant composition of the MAP and the nature of the knowledge gaps prioritised (e.g. knowledge available and acted upon in one region does not mean it is universally known or deployed).

Findings of relevance to some of the areas of research identified can be expected to emerge from newly commissioned research in Horizon Europe Work Programmes, and those of other funders (e.g. national funding agencies, philanthropic bodies). Alongside the development of research knowledge, practice knowledge will also evolve adding to the overall evidence base for advancing towards the vision of rural areas of stronger, connected, resilient and prosperous.

Notwithstanding limitations of the approach, the mapping of the SHERPA research agendas onto the Strategic Orientations of Horizon Europe, the Rural Action Plan for the Long-Term Vision for Rural Areas, European Partnerships and Missions all indicated a close alignment and relevance to delivering to European Union priorities. An observation shared across MAPs was the benefits of increasing opportunities of involvement in transdisciplinary research and processes of co-construction of research and policy, at EU and national levels.

As more projects have requirements for interfaces between research, practice and policy so there is greater scope for the approach permeating through nations and the public agencies, business and civil society groups of relevance. Promotion of such approaches from an EU level helps circumvent potential resistance at national or regional levels, and creates or deepens international communities of interest in topics of societal importance. Symbiotically, a community of experience is developed of those participating in and facilitating such approaches.

As a Coordination and Support Action (CSA) has provided SHERPA with a rare opportunity to develop science, society and policy interfaces relevant to rural areas, unrestricted by topic or geographic domains. The approach enabled actors at local to EU levels to express their views on needs for research, and policy. In turn they trusted the SHERPA process to synthesise and elevate their opinions and recommendations to funders and policy-makers at EU level, and to support arguments for use with decision-makers at national and local levels of governance. The co-creation process used in SHERPA has contributed in itself to delivering on the EU Long Term Vision for Rural Areas through the building block of **Creating a stronger innovation ecosystem** in its pillar of **Stronger** rural areas.

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