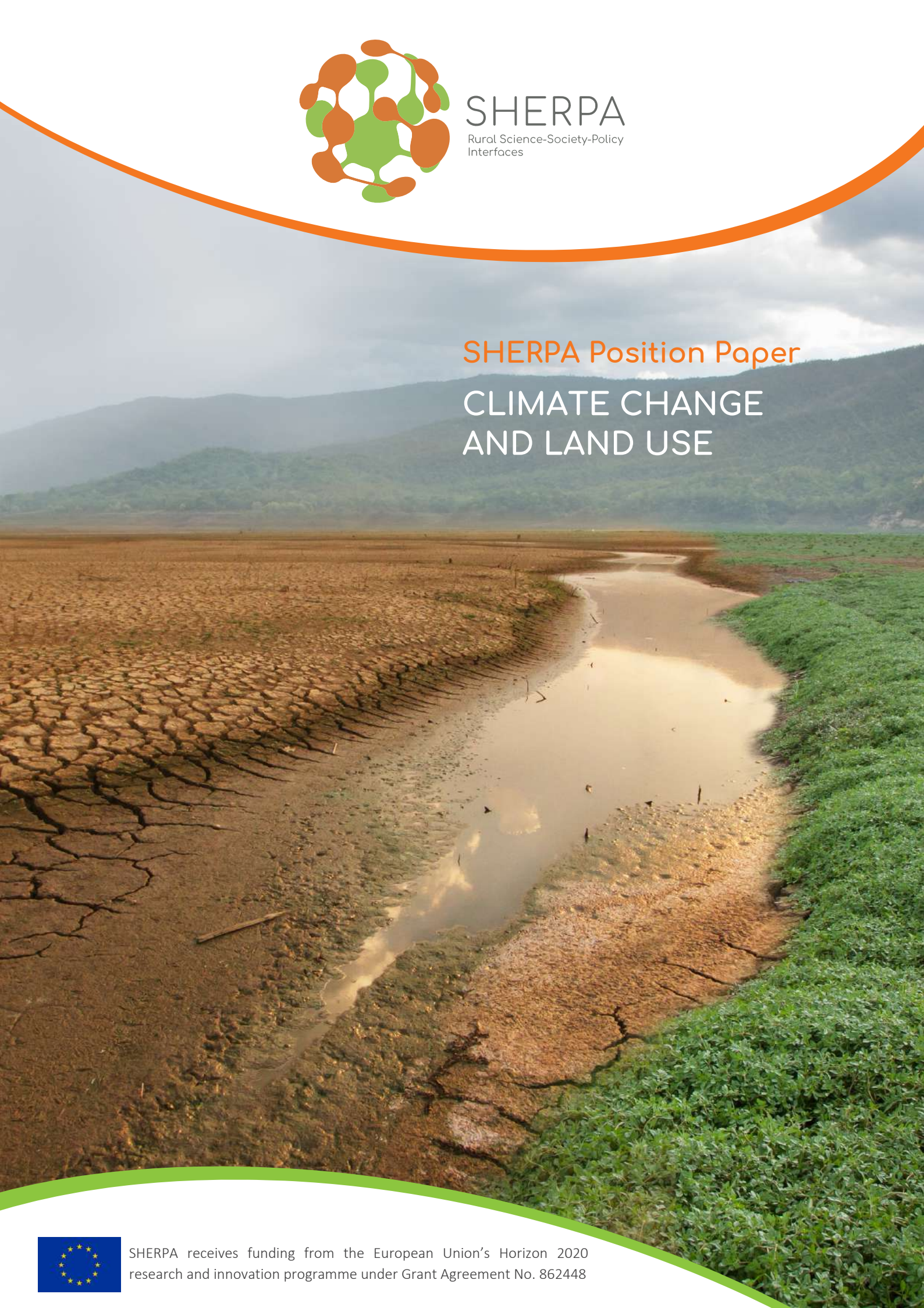
SHERPA
Rural Science-Society-Policy Interfaces



SHERPA Position Paper

CLIMATE CHANGE AND LAND USE

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Sustainable Hub to Engage into Rural Policies with Actors (SHERPA) is a four-year project (2019-2023) with 17 partners funded by the Horizon 2020 programme. It aims to gather knowledge thatcontributes to the formulation of recommendations for future policies relevant to EU ruralareas, by creating a science-society-policy interface which provides a hub for knowledge andpolicy. Find out more on our website:

www.rural-interfaces.eu

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1. Acronyms

AFOLU	Agriculture, Forestry and Other Land Use
AIM for Climate	AIM for Climate Agriculture Innovation Mission for Climate
C3S	Copernicus Climate Change Service
CAP	Common Agricultural Policy
CBD	Convention on Biological Diversity
CCS	Carbon Capture and Storage
CDR	Carbon Dioxide Removal
CLC	Complex Land Consolidation (Czechia)
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
DG Agri	Directorate General Agriculture and Rural Development
EC	European Commission
EEA	European Environment Agency
EIP-Agri	European Innovation Platform Agriculture and Innovation
ERDF	European Regional Development Fund
ESF+	European Social Fund Plus
ESR	Effort Sharing Regulation
ETS	Emissions Trading Scheme
EU	European Union
FCLP	Forest and Climate Leaders' Partnership
GAEC	Good Agricultural and Environmental Condition
GHG	Greenhouse Gas
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

IPCC	Intergovernmental Panel on Climate Change
IPR	Intellectual Property Rights
JTF	(EU) Just Transition Fund
LAG	Local Action Group
LEADER	Liaison Entre Actions de Développement de l'Économie Rurale
LULUCF	Land Use Land Use Change and Forestry
LTVRA	Long Term Vision for Rural Areas
MAP	Multi-Actor Platform
NDC	Nationally Determined Contributions
NECP	National Energy Carbon Plans
NGO	Non-governmental Organisation
NOAA	National Oceanic and Atmospheric Administration
PV	Photovoltaic
RBMP	River Basin Management Plan
RED II	Renewable Energy Directive
SHERPA	Sustainable Hub to Engage into Rural Policies with Actors
SME	Small and Medium-sizes Enterprises
SOC	Soil Organic Carbon
SRADDET	Regional Plan for Planning, Sustainable Development and Territorial Equality
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
WFD	Water Framework Directive

Headline Messages

Over the last 3 years, macro-level challenges of COVID-19, conflict in Ukraine and the cost of living crises can be expected to have taken time of legislatures and public authorities, and research and policy thinking, and reprioritised the allocation of funds and other resources. This reflects the inevitable influences on pathways to net zero greenhouse gas (GHG) emissions which need to be handled and overcome. However, limiting global temperature rise to 1.5°C by reducing GHG emissions to net zero by 2050 must remain the ambition. However, the IPCC (2023) highlights the prospects of an overshoot of the target of 1.5°C above pre-industrial levels, and the need to strengthen policies to avoid global warming reaching 3.2°C by 2100.

Climate change is leading to the transformations in uses of land in Europe, at variable rates and types of change. Policies for mitigating climate change are directing changes in land use towards renewable energy generation, woodland expansion, management of natural capital through restoring peatlands and carbon-rich soils, and changes in agricultural and land systems, collectively contributing to visions for rural areas of a well-being economy. However, spatial planning and suitable governance structures are required to ensure these mitigation actions require to be in places where the greatest impacts on mitigating climate change can be realised (e.g. where energy resource is significant; construction of renewable energy does not release more carbon than it could offset; planting woodland does not release more carbon than it can sequester; agricultural production systems do not increase demand on transporting water). However, such actions must ensure benefits (economic, social, environmental) remain higher than their respective costs.

Rural areas are also at the intersection of many of the frontiers of tackling climate change through marine renewable energy systems along coasts, inshore or offshore (e.g. offshore wind, tidal, wave, hybrid). These sources have the prospect of contributing most to the proportion of renewable energy in Europe. They provide both potential for economic development on islands and in remote rural areas (e.g. test facilities, Orkney, UK; support services), with opportunities for the development of skills. However, as with other marine developments (oil and gas extraction; fishing), consideration of potential impacts on marine habitats and seascapes should be kept under continuous monitoring and regulations contemporaneously (Denmark MAP; UK MAPs).

Climate change effects in rural areas have been direct through creating conditions leading to damage to environmental assets and property (e.g. wildfires, storms), inhibiting production (e.g. restricting crop growth due to droughts), and disrupting communications (e.g. flooding). After periods of disruption in the short term such effects may not lead to changes in land use over the long term (e.g. away from moorland, forestry or arable uses). However, they are leading to innovations in planning and decisions by business and land managers as they adapt land systems (e.g. to agroecology), management practices (e.g. intercropping, on farm manure production), and crop types (e.g. breeding drought resistant varieties), and individuals and communities taking actions in their properties or place.

Product, technological and social innovations have been creating opportunities for rural areas to diversify and accelerate the uses of land to mitigate and adapt to climate change. However, systems thinking is required in the design both of policy and research agendas, reflecting the interdependencies and trade-offs between climate change and land use, and understanding and tackling the main barriers that prevent a change in farming practices (Emilia Romagna Italy MAP). "A systemic approach is necessary because of the interdependence between the sectors" (South Region France MAP). For example, reducing greenhouse gas emissions through changes in food systems requires influencing consumer preferences and purchasing habits to change human diets (e.g. increase plant-based food, reduce red meat production), changing means of food processing, transport and fuel (e.g. hydrogen, biomethane, electricity for fuelling agricultural vehicles), management of land and water, and control of inputs.

In designing and realising opportunities for rural land use to tackle climate change, greater effort should be made to the creation of value locally. The definition of local may be imprecise, but the principle should be one in which an action contributes to creating more successful places, taking account of people, location and resources that combine to address the needs and realising the full potential of communities, and in which resources are directed and used by the people who live in and invest in them.

Barriers to the uptake of transformations in the use of land required to tackle climate change vary across Europe and should be addressed. They include political leadership (e.g. tackling climate change not being a priority at local or regional levels), regulatory issues (e.g. access to land), institutional frameworks (e.g. legal bases for formalising community authority for handling funds, ownership or equity in business ventures), business systems (e.g. locked into unsustainable contracts or practices), attitudes and perceptions of current and new land managers (e.g. on the uptake of new technologies), human capital (e.g. skills, knowledge of how to access information), and social capital (e.g. community organisation).

A challenge for all sectors is having no simple and clear vision of what is meant by success in tackling climate change. The messages are largely ones of reducing the negative impacts (e.g. temperatures lower than they will be; adverse consequences of lack of, or insufficient, action). In 2021/22 the estimated GHG emissions from EU Member States rose slightly, reflecting some of the recovery in economic activities after the tightest COVID-19 restrictions in 2019 and 2020. Perceptible reductions in the rate of GHG emissions will be slow to emerge, and seasonal variations in weather will complicate messaging to all types of audiences.

The lack of a coherent communications strategy across levels of governance is diluting messages and weakening their impacts. Barriers to changing human behaviours can be created by disquiet or frustration over the slow lead time for actions to be undertaken (e.g. the conversion of land uses to woodlands; onshore wind energy), and for actions to translate into clear evidence of success or benefits. The means of monitoring such changes should be enhanced, and their relevance to individuals, places, and regions, to made communicated more clearly for ease of understanding by citizens, businesses and political representatives.

The evolution of new forms of governance (e.g. land use partnerships) provides examples of how priorities can be formed with means of action on the ground. Their nature and rate of emergence of structures and approaches will vary across jurisdictions, but current examples illustrate how to broaden how climate change can be tackled, with greater participation and consultation. A key requirement for empowering such structures is the authority to direct financial resources (e.g. participatory budgeting), source of funding of which could include: the EU Innovation Fund or EU Cohesion Fund in 2028-34 multi-annual funding framework, and levy on infrastructure projects (e.g. largescale renewable energy or Carbon Capture and Storage developments).

In addition to the consequences of climate change on society and the environment, risk is emerging of increasing gaps between and within regions, communities and businesses in their capability to take actions and opportunities. Increases in disparities will test the effectiveness of the mechanisms of the EU and national governments in supporting Just Transitions (e.g. InvestEU Advisory Hub).

Lessons need to be learnt of the strengths and weaknesses of different mechanisms as they are tried within local social, economic and environmental contexts. While recognising that no one approach will be ideal in all circumstances, successes should be scaled out. This will require means of enabling innovation flows across Europe, as per EIP-Agri, an AKIS or national science-society-policy interface, with translation between contexts with appropriate forms of advice and support for implementation for policy, business and civil society.

1. Introduction

The United Nations Paris Agreement (United Nations, 2015) sets out the aim to limit global warming by 2100 to 1.5°C above pre-industrial levels. This threshold is recognised as critical for avoiding many natural systems reaching critical turning points (IPCC, 2022a). This aim has been 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 temperature of the Earth has increased by 0.08° C per decade since 1880, and 0.18° C per decade since 1981 (NOAA, 2022). For Europe, between 1910 and 2021, the increase has been 0.15oC per decade, with the surface temperature anomaly above the 1910 to 2000 average in 31 of the last 33 years since the Brundtland Report (World Commission on Environment and Development: Our Common Future, 1988) was published (Figure 1).

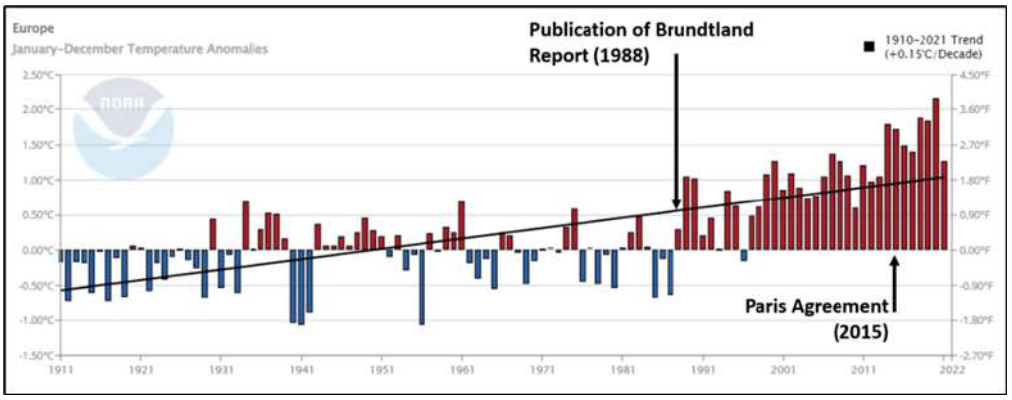


Figure 1. Annual surface temperature anomalies for Europe (annual temperatures are in comparison with the average annual temperatures for the period 1910 to 2000; Source, NOAA).

The pattern of increased temperate globally is reflected in the pattern for Europe. The EU report that 2020 was the warmest year since 1950, c.1.6oC warmer than the average for 1980 to 2010 (Figure 2).

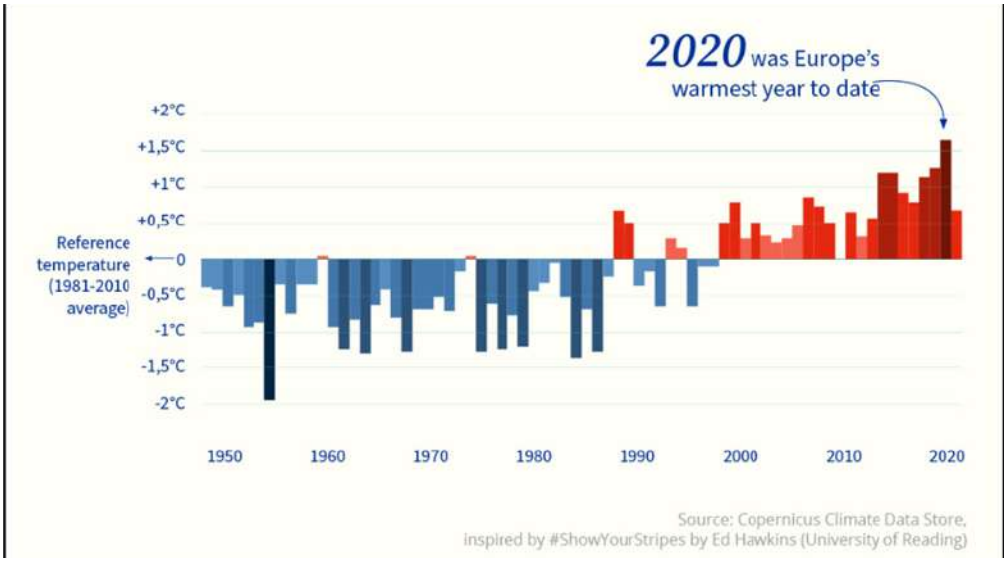


Figure 2. Surface anomaly temperature for Europe compared to 1981 to 2020 average (Source: European Union Climate Change Bulletin, from Copernicus Climate Change Service, C3S).

Temperature is only one of the elements of climate that is changing. However, as an indicator, it is one to which most citizens can relate, albeit the significance of impacts of changes in temperature for different regions varies by season (e.g. impacts on arable cropping, and winter sports).

To restrict warming to 1.5°C, global net anthropogenic CO2 is required to decline by approximately 45% from 2010 levels by 2030, reaching net zero by 2050 (IPCC, 2022a), 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. Figure 3 shows the historic changes in GHG emissions to 2020, a preliminary estimate for 2021, and projections for existing measures and additional measures including the contributions of sequestration by Land Use Change and Forestry (LULUCF) (European Environment Agency, 2022). In 2019, the LULUCF sector at EU level represented a net carbon sink of approximately 249 Mt CO2e, corresponding to the absorption of 7% of total GHG emissions (European Environment Agency, 2021).

The estimated GHG emissions in millions of tonnes of CO2 equivalent for 2021 is a rise of 5% compared to 2020, attributed to economic recovery as COVID-19 restrictions were relaxed, and more uptake of gas from lignite and hard coal which could be further exacerbated in 2022 by alternative sources being sought to supplies of gas from Russia.

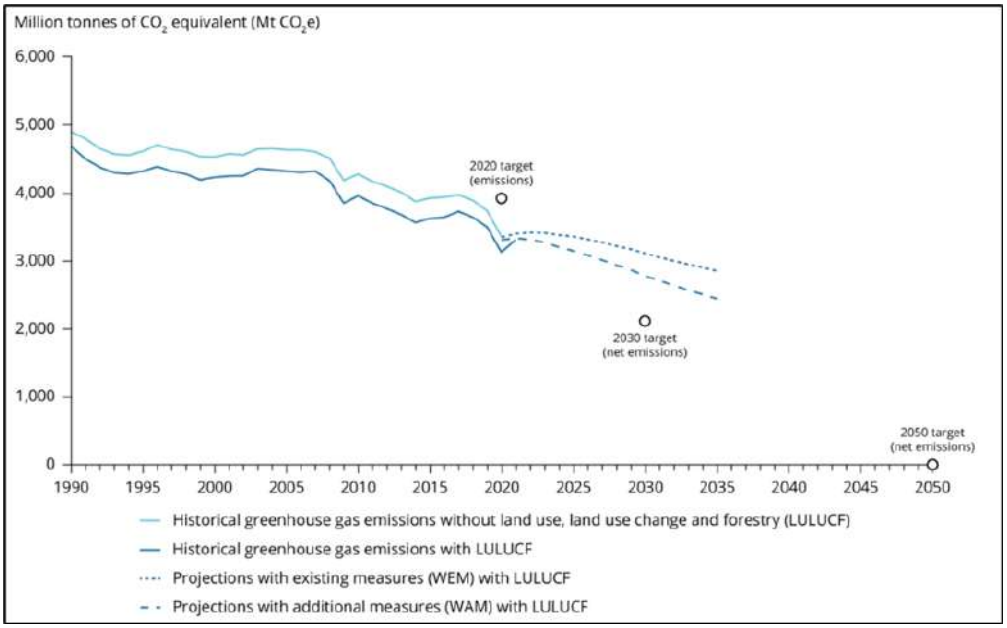


Figure 3. Historical trends and future projections of greenhouse gas emissions (Source: European Environment Agency, 2022).

The reduction in GHG emissions from the EU reduction is driven significantly by the change linked to the provision of energy (i.e. uptake of renewable energy), dropping from 3,217 M tonnes in 2009 to 2,488 M tonnes in 2020 (Figure 4a). Emissions from agriculture have remained broadly unchanged over the same time period (381 M tonnes in 2009 and 382 M tonnes in 2020; Figure 4b; Hungary Land Use MAP). However, the most significant sink of GHG emissions, provided by the LULUCF sector has reduced, from -336 M tones in 2009 to -229 M tones in 2020 (Figure 4c).

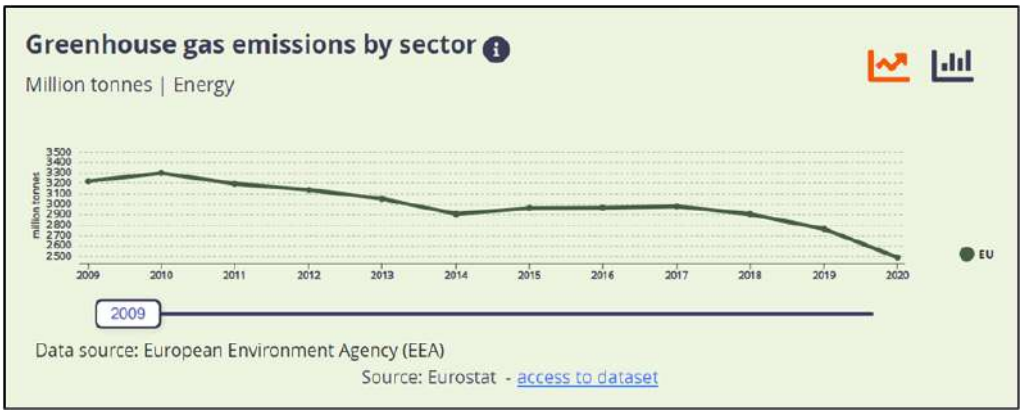


Figure 4 (a). Change in greenhouse gas emissions for the energy sector, within the European Union (2009 to 2020; Source: European Environment Agency, Statistics for the European Green Deal).

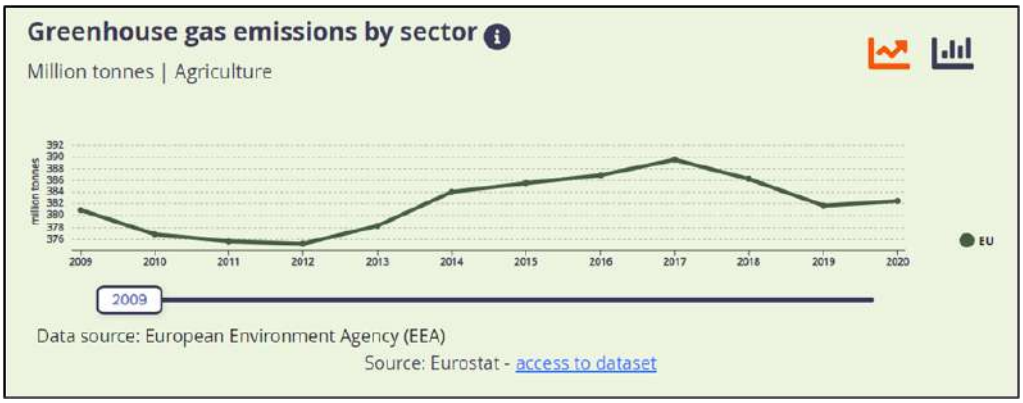
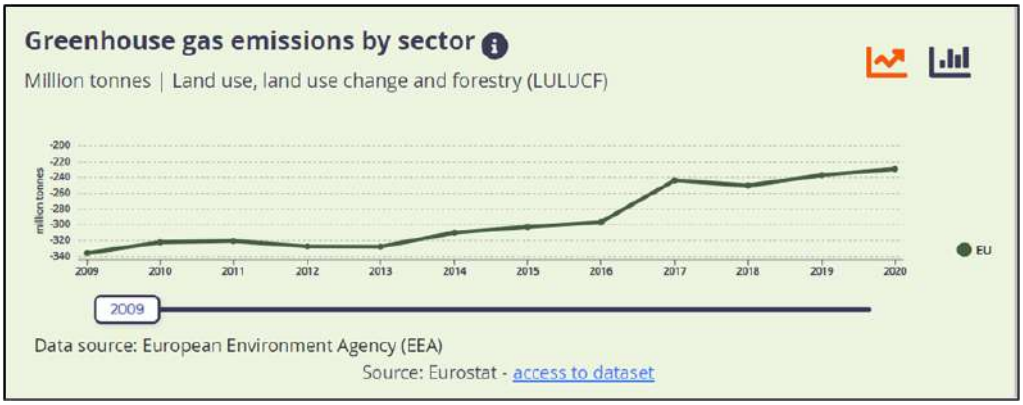


Figure 4 (b). Change in greenhouse gas emissions for the energy sector, within the European Union (2009 to 2020; Source: European Environment Agency, Statistics for the European Green Deal).



Figure(c). Change in greenhouse gas emissions for the Land use, land use change and forestry sector, within the European Union (2009 to 2020; Source: European Environment Agency, Statistics for the European Green Deal). [note values are negative indicating a net sequestration of greenhouse gas emissions).

The United Nations Framework Convention on Climate Change explains the importance of land and its uses in relation to climate change. It has a key role in global cycles of GHGs of carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O), and its uses result in emissions to, or removal from, the atmosphere. The accumulation of carbon dioxide (CO2) in soils and vegetation reduces its build-up in the atmosphere, providing 'sinks' ("any process, activity or mechanism which removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas from the atmosphere", United Nations, 1992). It also influences the climate through the effects of albedo, evapotranspiration, and aerosols in the atmosphere.

The IPCC (2022a) 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. The management of this sector to tackle climate change is intimately linked to reversing the loss of biodiversity and enhancing the health of ecosystems, which have fundamental roles in mitigating and adapting to climate change (IPCC, 2022a). The IPCC and IPBES argue that 'mutual reinforcing of climate change and biodiversity loss means that satisfactorily resolving either issue requires consideration of the other', noting that more than 50% of anthropogenic CO2 emissions are absorbed through photosynthesis and subsequent storage of carbon in biomass and organic material Pörtner et al. (2021).

The IPCC (2022b) reports that "forests and other natural ecosystems provide the largest share of the LULUCF mitigation potential between 2020 and 2050", identifying reducing deforestation as the most significant followed by carbon sequestration in agriculture and ecosystem restoration (including afforestation and reforestation) (Figure 5). The assessment highlights the significant contributions that wind and solar energy can make within the energy sector, and within the AFOLU sector that of a shift to balanced, sustainable healthy diets. It also estimates the net lifetime costs of different levels of contribution of each option, except for those where the data are not available or highly variable (e.g. shifting human diets). Rural areas will be at the forefront of making these contributions, reflecting the locations of activities (e.g. agriculture) and availability of land.

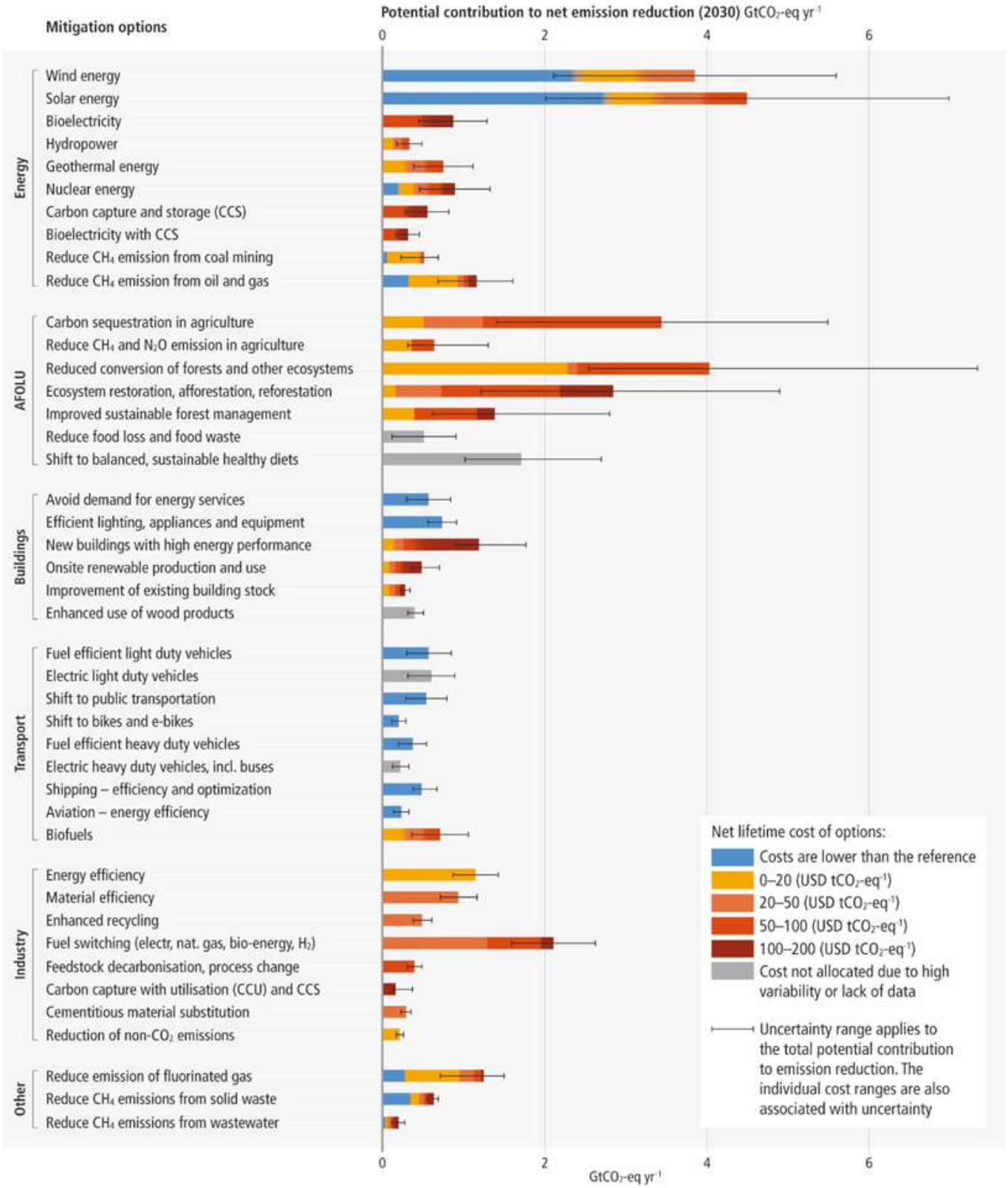


Figure 5. Potential of sectors to reduce net emissions by 2030, and their levels of uncertainty. (Source: IPCC, 2022b; Figure SPM.7).

In addition to the need to fund the implementation of the options for mitigation set out by the IPCC, consideration is required of the timescales for their selection, planning, design, operationalisation, monitoring and refinement. These vary significantly between options and across Europe, with issues arising regarding legislation, regulation, governance and societal attitudes, all of which can slow implementation, and create frustrations amongst citizens and actors, which reduces the prospects of them contributing to tackling climate change and increases the risk of climate change targets being missed (SHERPA, 2023). As noted in the SHERPA paper on Climate Change and Environmental Sustainability (Miller et al., 2022), the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2022) concludes that …

> 'Projected global GHG emissions from NDCs [Nationally Determined Contributions] announced prior to COP26 would make it likely that warming will exceed 1.5oC and make it harder after 2030 to limit warming to below 2oC'.

Subsequently, the IPCC (2023), in its AR6 Synthesis Report, published in March 2023, concludes that "it likely that warming will exceed 1.5°C during the 21st century". This is based upon what it identifies as a "substantial 'emissions gap' between global GHG emissions in 2030 associated with the implementation of NDCs announced prior to COP26 and those associated with modelled mitigation pathways that limit warming to 1.5°C (>50%)".

This Position Paper follows that on Climate Change and Environmental Sustainability (Miler et al., 2022) with updated reflections of a set of SHERPA MAPs on tackling climate change through the lens of land use, and the recommendations of a further five MAPs. Recommendations from the previous Position Paper are reiterated, and modulated 1 year on.

Over the period of the two rounds of consultations with SHERPA MAPs international discussions have taken place at COP26 (November 2021) and COP27 (November 2022), and on biodiversity at COP15 (December 2022). Changing international circumstances have impacts for tackling climate change. In 2022, the most significant of those is the conflict in Ukraine and the consequences for sources of energy for Europe (e.g. gas supplied from Russia; LPG from the Middle East, Australia and the United States), and how that impacts upon strategies for energy transitions (e.g. VENUS Czechia MAP; Schleswig-Holstein Germany MAP; UK MAPs).

Through Multi-Actor Platforms (MAPs) in Czechia, Denmark, France, Germany, Italy, the Netherlands, Portugal, Poland and the United Kingdom, and its EU-level MAP, the SHERPA process has gathered evidence from across Europe, at multiple levels. This set of SHERPA Multi-Actor Platforms identified opportunities to contribute to that objective, challenges that could be encountered, and priorities for policy, practice and research. Those deliberations are provided in the Position Papers of the MAPs of the Climatically Friendly Villages (Czechia), VENUS (Czechia), Denmark, South Region (France), Schleswig-Holstein MAP (Germany), Hungary Land Use MAP (Hungary), Emilia Romagna (Italy), Greenport Gelderland (Netherlands), P10 (Netherlands), Zachodniopomorskie (Poland), Alqueva (Portugal), River Dee Catchment (UK), Rural Scotland (UK), and the perspective of the EU level MAP. A synthesis follows of the issues identified and the positions adopted.

These MAPs were invited to discuss the topic of climate change and the roles of land use in its mitigation and adaption, reflecting upon:

1. The needs of the area covered by the MAP in relation to climate change and land use.
2. The policy interventions already in place, and what are examples of actions taken by local actors addressing these needs implemented in the area covered by the MAP.
3. Policy interventions they would recommend be implemented at the local, regional, and/or national levels, and how can the EU support these interventions
4. Identification of knowledge gaps, and the new research evidence is needed.

The outputs of the deliberations and reporting from the MAPs are recommendations for policy and research on the roles of land use, and its influence by people, on mitigating and adapting to climate change.

2. Policy Commitments to Limiting Global Warming

European Union and the policies of European states towards tackling climate change are underpinned by the United Nations Paris Agreement (United Nations, 2015) and its overarching aim of limiting global warming to 1.5°C above pre-industrial levels. Measures agreed at COP26 (Glasgow, UK, November 2021) maintained a prospect of achieving this target. Commitments included the Declaration on Forests and Land Use, which refers to "promoting an inclusive rural transformation", and building resilience, enhancing rural livelihoods, and the Global Methane Pledge to reduce global anthropogenic methane emissions across all sectors by at least 30 percent below 2020 levels by 2030.

Recommendations from COP27 include continuing to limit warming to 1.5oC, and that by 2030 global GHG emissions decline by 50% or more below the levels of 2020. To achieve this, the United Nations High Level Expert Group on Climate Change (UN HLEGCC) recommend that non-state actors should have "short-, medium- and long-term absolute emissions reduction targets", and "where appropriate, relative emissions reduction targets across their value chain that are at least consistent with the latest IPCC net zero GHG emissions modelled pathways." (UN HLEGCC, 2022). They recommend the creation of Just Transition plans which address all elements in value chains, ensuring social consequences and impacts of mitigation actions (e.g. on race, gender and intergenerational equity).

Amongst detailed recommendations are how to achieve changes throughout supply chains that avoid the conversion of natural ecosystems, specifically eliminating deforestation and wetland and peatland loss by 2025 (UN HLEGCC, 2022). The COP27 Presidency also launched the Food and Agriculture for Sustainable Transformation (FAST). The aim is to "improve the quantity and quality of climate finance contributions to transform agriculture and food systems by 2030, supporting adaptation and maintaining a 1.5-degree pathway whilst supporting food and economic security", trends which create challenges for producers (Hungary Land Use MAP). An increased investment of US$8 Bn was also agreed upon for the Agriculture Innovation Mission for Climate (AIM for Climate), doubling the value committed at COLP 26. Contributions from government partners include the EC, and European countries Denmark, Finland, Hungary, Republic of Ireland, Lithuania, Romania, Spain, Sweden and the United Kingdom.

The European Union has played an important role in setting targets and long-term goals (e.g. reverse loss of biodiversity, water quality and supply, energy reduction), and through the Green Deal (European Commission, 2019a) and Long Term Vision for Rural Areas (European Union, 2021a). It has set the ambition for Europe to be the world's first climate-neutral continent by 2050, meaning "net zero greenhouse gas emissions for EU countries as a whole" (European Union, 2021b). This is enshrined in the European Union Climate Law (European Union, 2021b), as an irreversible transition, to be achieved in a socially fair (i.e. just) and cost-efficient manner. National targets for reducing GHG emissions are also enshrined in law in several countries such as Denmark, France (the ADEME), the Netherlands and the United Kingdom, including means of independent monitoring and reporting (e.g. in the UK the Climate Change Committee, 2021). However, in some rural areas there prevailing perceptions are of restrictions to taking action rather than of opportunities and support, and of there being a low level of activity towards tackling climate change (e.g. P10 Netherlands MAP). Combined, these perceptions contribute to societal feelings of dissatisfaction and separation from the government.

Countries and regions have different starting points in their transitions towards climate neutrality and have different human and financial capacities to take action, or timescales over which actions are feasible. However, some actions are required in the very short term to have a credible prospect of having impacts in time to achieve the target of climate neutrality by 2045 (SHERPA, 2023).

Achieving the aim of climate neutrality will require strong political leadership, as stressed by the South Aegean Greece MAP (Kriezi et al., 2022): "strong political will and commitment is of utmost importance to change the conditions (and habits) that contribute to climate change". There is a need for EU and national policy authorities to communicate the rationale for policy objectives, and how area-based processes contribute constructively to the bigger global, European and national pictures. The effectiveness of tackling climate change, and the roles played by land use, will be greater if it is seen in the context of stimulating and supporting confidence of rural areas to develop area-based approaches to solve the puzzle of societal challenges (P10 Netherlands MAP).

In 2021, the EU increased its targets of reducing GHG emissions to at least 55% below 1990 levels by 2030, as set out in the European Union 2030 Climate Target Plan (European Union, 2021b). It includes commitments to coherent, sector-specific roadmaps, including enhancing the carbon sink in the EU through a more ambitious LULUCF regulation, whilst protecting the natural environment.

Supporting the delivery of the target is the EU "Fit for 55" package, which has still to receive approval. The package includes a proposal for the EU to be climate neutral in the land use, forestry and agriculture sectors by 2035. This is to include agricultural emissions than CO2, such as those from fertilizers and livestock, and an overall target for CO2 removal from natural sinks of 310 million tonnes of CO2 emissions by 2030. It also includes changes in emissions trading (EU ETS), effort sharing regulations (ESR), an amendment to the Renewable Energy Directive to implement the ambition of the new 2030 climate target (RED II), a Directive on energy efficiency, regulations setting new CO2 emission standards for cars and vans, revision of the Energy Tax Directive, and revising the carbon border adjustment mechanism.

Policies of EU Member States for tackling climate change from 2021 to 2030 are set out in the National Energy Carbon Plans (NECPs). These are "a policy tool and an investment agenda that provide business and investors a forward-looking framework" (European Commission, 2020a), due to be updated by each country in 2023/24. These provide a means of mapping national plans onto EU and international aims and ensure consistency with other cross-cutting objectives such as the symbiosis of the climate crisis with the biodiversity crisis, and the close links between climate justice and social justice.

The synergies of tackling the climate and biodiversity crises are reflected in the "Kunming-Montreal Global Biodiversity Framework" (GBF) adopted at the 15th Conference of Parties to the UN Convention on Biological Diversity convened under UN auspices, chaired by China, and hosted by Canada in December 2022. The Framework comprises goals and targets to be achieved by 2030. Those include:

- **Target 8**: Minimize the impact of climate change and ocean acidification on biodiversity and increase its resilience through mitigation, adaptation, and disaster risk reduction actions, including through nature-based solutions and/or ecosystem-based approaches, while minimizing negative and fostering positive impacts of climate action on biodiversity.

- **Target 11:** Restore, maintain and enhance nature's contributions to people, including ecosystem functions and services, such as regulation of air, water, and climate, soil health, pollination and reduction of disease risk, as well as protection from natural hazards and disasters, through nature-based solutions and ecosystem-based approaches for the benefit of all people and nature.

- **Target 19:** Optimize co-benefits and synergies of finance targeting the biodiversity and climate crises.

In the period 2014 to 2020, the Common Agricultural Policy (CAP) contributed approximately half of the EU expenditure on tackling climate change, with €100 billion of funds attributed to climate action (e.g. agri-environment climate schemes). However, the European Court of Auditors' assessment of the Common Agricultural Policy and Climate (European Court of Auditors, 2021) report that despite the investment through the CAP there had been no significant impacts on reducing GHG emissions and is not sufficiently flexible.

It recommended that the European Commission:

1. takes action so that the CAP reduces emissions from agriculture;
2. takes steps to reduce emissions from cultivated drained organic soils;
3. reports regularly on the contribution of the CAP to climate mitigation.

In the current programming period, one aspect of the European Union reviews of each of the draft National CAP Strategic Plans submitted by Member States (see SHERPA CAP Programming documents) is how they support objectives of "support and strengthen environmental protection, including biodiversity, and climatic action and to contribute to achieving the environmental and climate-related objectives of the Union including its commitments under the Paris Agreement." This enables a verification of objectives and resources allocated in the Plans with respect to the means of mitigating and adapting to climate change identified in the IPCC Working Groups (e.g. afforestation, peatland restoration, managing soil carbon, nature-based solutions), and those which can advance human and social capital (e.g. through AKIS mechanisms) and rural infrastructure (e.g. digitalisation). For example, the Finnish National CAP Strategic Plan states that it "plays a crucial role in supporting the national goal of carbon neutrality by 2035 and reducing climate emissions from agriculture by 29% of the 2019 level by 2035." The Poland National CAP Strategy proposes measures to support improvements in land use in relation to the issues of climate change and biodiversity, including eco-schemes, such as carbon farming or water retention.

A further new mechanism for realising the social potential and economic dimensions of a green transition is in making a Just Transition a reality in the EU. The EU Just Transition Mechanism "provides targeted support to help mobilise around €55 billion over the period 2021-2027 in the most affected regions, to alleviate the socio-economic impact of the transition." It comprises three pillars of the Just Transition Fund (JTF), the EUInvest Scheme, and loans facilitated by the European Investment Bank (EIB). Investment from the JTF has to be consistent with "environmental sustainability requirements, in line with the biodiversity objectives of the European Green Deal" (European Commission, 2021a). Eligibility for funds from the Just Transition Fund will be informed by Territorial Just Transition Plans, and the 2020 European Semester Country Reports which include many of the rural areas of Europe, the sites of which reflect the locations of the natural or economic resource (e.g. peatland, for its restoration).

The Rural Action Plan of the Long Term Vision for Rural Areas (LTVRA) provides focal points for many of the topics within policy areas which are planned to direct support for tackling climate change with direct or indirect roles for land use. Those likely to be of most direct relevance are:

1) Stronger Rural Areas

- Flagship of Creating a stronger innovation ecosystem for rural areas (e.g. results from rural research projects funded through Horizon Europe);
- Enhanced networking for LEADER and Smart villages under the framework of the EU CAP Network;
- Optimising land use planning to foster the optimal development of land use planning to promote sustainable farming;

2) Connected Rural Areas

- Further promoting the digitalisation of the agricultural sector;

3) Resilient Rural Areas

- Flagship of addressing climate change in peatland areas through carbon farming;
- Flagship of a soil deal for Europe;

4) **Prosperous Rural Areas**

- Flagship of supporting entrepreneurship and the social economy in rural areas;
- Encouraging education, training and employment opportunities for young people in rural areas;
- Promoting the development of a sustainable bioeconomy in rural areas;
- Supporting the role of producer organisations and producer groups for sharing knowledge on effective means of changes in land management, labelling (e.g. low carbon) and so contributing to rural development.

Collectively, these contribute to a form of well-being economy in which climate neutrality and just transitions, health and equality are at the core (UK MAPs).

Further requirements for policy and research

Policy:

- European and national policies should ensure long-term goals for tackling climate change are unambiguous, and that short and medium-term goals are up-to-date with requirements to tackle climate change.
- European and national policies should set out ambitious visions for rural development, coherent with policies and measures for tackling climate change.
- A cross-cutting principle of spatial planning to tackle climate change should be that uses of land should enable responsive adaptation that handles perturbations to pathways to climate neutrality through flexibility in timing, funding and the short-term goals of individual measures.

Research:

- To develop scenarios representing possible directions for place-based land use change.
- To better understand interactions between climate variability and its impacts on land use change. Objectives would be to analyse the occurrence of regionally most important climate change effects (e.g. drought, freeze-thaw, excessive precipitation); develop climate scenarios and the related methods of agricultural production.
- To determine how to produce updated and improved information on the likely impacts of climate change on agricultural production at national and regional levels.
- Review of the effectiveness of measures planned in National CAP Strategic Plans and National Energy Carbon Plans being translated into Nationally Determined Contributions.
- Review the coherence between National CAP Strategic Plans, National Energy Carbon Plans, and European Semester Country Reports.
- Qualitative evaluation of how investments of the Just Transition Fund have or have not had the intended impacts on communities at local levels.

3. Climate Change Impacts and Threats

The economic losses due to climate change, by EU Member State, for the period 2010 to 2020 are estimated at €145 Billion (European Environment Agency, 2022). These costs reflect extreme weather and climate-related events, including heat waves, floods, hail, high winds and storms. Variety in weather between years is also significant, with areas experiencing periods of too much precipitation as well as water shortages, which have particularly adverse impacts on some sectors of agriculture (e.g. fruit sector, Greenport Gelderland Netherlands MAP). Such variety in weather between years makes planning challenging and increases the level of risk that businesses must be willing to tolerate and capable of taking on (UK MAPs).

In 2020, the cost of climate change in the EU was estimated to be €12 billion, with a peak in 2017 of €27.9 Billion attributed to heatwaves that had consequences of creating conditions for drought and wildfires (European Environment Agency, 2022). For the time period 1980 to 2020, the economic impacts of climate change are realised across all areas of Europe (Figure 6).

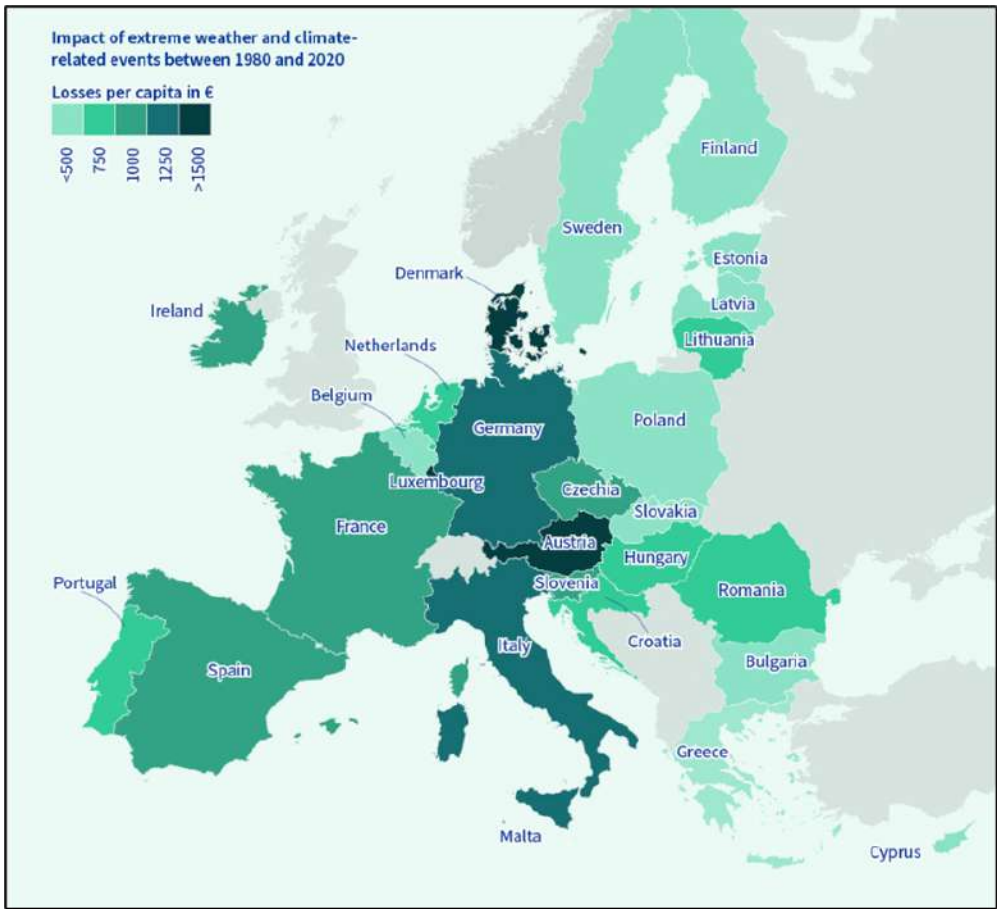


Figure 6. Estimated economic losses due to climate change between 1980 and 2020 (Source: European Environment Agency, 2022).

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". Further details on trends of climate change and geographic variations in physical, economic and social impacts are described in Hagyo et al. (2020) in Maes et al. (2020), and the SHERPA Discussion papers on Climate Change and Environmental Sustainability (Miller et al., 2022a), Climate Change and Land Use (Miller et al., 2022b), and individual Position Papers from SHERPA MAPs.

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 (Hungary MAP).

Examples of the impacts arising or expected in the regions represented in the MAPs are:

1) Deterioration of infrastructure (e.g. transport networks, UK MAPs);

2) Economic activities (e.g. damage to horticulture, Greenport Gelderland Netherlands MAP; damage to forests; Alqueva Portugal MAP; UK MAPs);

3) Loss of soil and organic matter (Emilia Romagna Italy MAP; UK MAPs);

4) Water stress and drought are impacting the feed supply for the dairy industry for PDO products such as Grana Padano and Parmigiano Reggsiano, and peats and disease led to increased imports of maize from EU and non-EU countries (Climatically Friendly Villages Czechia MAP; Emilia Romagna Italy MAP, Pellegrini et al., 2022);

5) Supply chains in which with crop varieties or crop types are being changed to increase the use of those with resilience to water stress (e.g. sorghum instead of maize, Emilia Romagna Italy MAP)

The nature of the example impacts is varied, aspects of which are also addressed later in this Paper. However, their diversity provides an indication of the range of topics, and areas of policies and practices which have to take account of climate change. In the EU, policies for handling such threats and impacts are spread across responsibilities for the environment, climate change adaptation, development, cohesion, agriculture, transport, energy, health, and research and innovation.

The impacts of events such as wildfires in future can contribute to exacerbating climate warming, such as if they occur in a period when there is an overshoot in the time taken to reduce global warming to 1.5oC. In such circumstances, wildfires contribute to feedback loops that in turn cause additional warming, and so make resolving such an overshoot even more challenging (IPCC, 2023).

Aspects of requirements for policy and research on the broad theme of impacts and threats of climate change summarised below, would contribute to the aims of a LTVRA Action Plan flagship under Increasing environmental, climatic and social resilience.

Further requirements for policy and research

Policy:

- Support for enhancing knowledge from scientists and actors on the ground on the measurement and interpretation of GHG emissions with respect to impacts on climate change, and their communication.
- Support for the maintenance of ongoing calculation of projections of climate change, with improvements in the quality and spatial and temporal resolution.
- Stimulate support for research and innovation and the translation of outputs into new processes, products and uses that can contribute to tackling climate change (e.g. crop breeding, water management, supply chains, and governance structures).
- into crop varieties that are resilient under projected climate conditions, treating such investments as public goods and making them available with minimal Intellectual Property Rights (IPR) constraints.

Research:

- A deeper understanding of rural vulnerability to the climate crises, with the identification of potential solutions to enhance the adaptive capacity and transformability of rural communities, and through this build and strengthen their resilience in both the short and long term.
- Broadening of the types of land uses, soils and land management practices at which GHG emissions are monitored and reported, through digital sensors and the Internet of Things.
- Increased availability of easily accessed and understood data and information, forming part of a strategy for communication and societal engagement regarding changes in climate, and tangible links to actions of businesses and citizens.
- Development of effective means of communication of changes in GHG emissions.

4. Land Use Change in Relation to Climate Change

4.1 Spatial Planning and Governance

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.'

Land use, "The social and economic purpose to which we put the earth's surface" (Mather, 1986), should be interpreted in the context of the multiple functions provided (see SHERPA Discussion Paper, Miller et al., 2021), at different geographic and temporal scales. Meyfroidt et al. (2022), in a major review of literature, note that land use generally entails trade-offs between benefits delivered (e.g. food, habitats, recreation), rather than win-wins, and that the "level of congruence between different environmental indicators such as biodiversity and carbon stocks is highly heterogeneous across scales and geographies."

However, changes in land use should be consistent with the biophysical and cultural contexts of local areas, and cognisant of the roles they have in wider natural, economic and social systems (Meyfroidt et al., 2022;). This recognises the minimisation of trade-offs noted by the IPCC (2023) of "giving emphasis to capacity building, finance, technology transfer, investments; governance, development, context-specific gender-based and other social equity considerations with meaningful participation of Indigenous Peoples, local communities and vulnerable populations."

The use of land is 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). All functions of land should be considered together, in the wider contexts of landscapes, water catchments and habitat networks, the aim of which should be for developing integrated land systems rather than land uses. Natural assets of rural areas are a shared cultural heritage the damage to which would adversely affect society as a whole. For example, alongside its functions of sequestering or holding carbon, natural 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)(UK MAPs).

Selecting the right land uses for given biophysical and socio-economic conditions, and implementing sustainable land management, are essential for minimizing land degradation, rehabilitating degraded land, ensuring the sustainable use of land resources (i.e. soils, water and biodiversity) and for carbon sequestration (Hungary Land Use MAP). Decision-makers, whether land owners and managers, communities, or public authorities should be encouraged to take account of the breadth of options available for the use of land in tackling climate change, and consider whether they can be future-proofed from prospective changes (e.g. markets, competing land use priorities) (Alqueva Portugal MAP; UK MAPs). In so doing they should also be conscious of what future generations will inherit and inter-generational responsibilities (SHERPA, 2023).

Achieving positive outcomes of climate adaptation and mitigation schemes requires sustainable land-use 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). In most countries and regions, land use planning is not used to guide or influence the uses of land by farmers (Hungary MAP), but it is used to direct strategic planning of forestry (UK MAPs).

Where appropriate, a spatial perspective should be taken to inform geographic and place-based considerations of territories, their dynamics (e.g. Alqueva Portugal MAP), and linking spatial plans with development strategies designed to lead to sustainable landscapes (Climatically Friendly Villages Czechia MAP). Well-designed integrated spatial land-use planning and management can reduce the risk of mismanagement and resource misuse, protecting sensitive environmental elements from degradation, enhancing resilience to climate change and contributing to the reduction of GHG emissions (Hungary Land Use MAP). However, a note should be taken of what may be poorly represented in a spatial plan, such as differences in opinion amongst public audiences on attitudes towards measures of mitigation (e.g. woodland expansion, UK MAPs; adverse impacts of wind turbine development on protected areas, animals and tourism, South Aegean Greece MAP).

To achieve the goals of climate neutrality requires close collaboration across sectors to gain benefits of shared thinking and insights from different perspectives (Denmark MAP), the aim of which should be to achieve synergies and the best results across different, and potentially competing, agendas. Spatial plans should reflect the biophysical and social contexts, recognising the differences within and between regions and nations, and the stages of different places in human, social and technological transitions (UK MAPs).

The IPCC (2022a) note that the prospects of designing climate-resilient development pathways are enhanced when 'supported by formal and informal institutions and practices that are well-aligned across scales, sectors, policy domains and timeframes.' The UN HLEGCC (2022) recommends multi-actor and multi-scale governance approaches to the management of multifunctional 'scapes' at different scales. The most appropriate governance mechanisms and level of cooperation between local actors in the planning and management of land varies across Europe. Ex-post analysis of the rural development programmes in some countries shows a limited willingness to collaborate (Hungary MAP). Forums for collaboration should strengthen:

1) the involvement of citizens to move from simple involvement to the co-construction of public policies for a renewed territorial approach (South Region France MAP)

2) inter-sectoral working that provides insights to relationships, dependencies and implications of land use on climate change (Portugal MAP).

Currently, some new such mechanisms are being piloted in Scotland, UK. These are the Regional Land Use Partnerships, RLUPs) as set out in the Scottish Land Use Strategy 2021 to 2026 (Scottish Government, 2021) the aims of which are to provide mechanisms for tackling climate change through place-based planning, investment in natural capital, through and with engagement and participation of communities and civil society. In 2023, an output from each RLUP is planned to be Regional Land Use Frameworks which focus on tackling the climate and biodiversity crises (UK MAPs). Five pilot RLUPs were set up in 2021 in different types of rural areas with the aim of testing "governance options and partnership working on a regional scale to understand how best to work collaboratively", and adoption of structures that meet regional requirements, and that facilitate and signpost funding opportunities for land owners, managers and community group (UK MAPs).

Responsibility for actions is across all actors, and sectors (South Region France MAP). The Regional Plan for Planning, Sustainable Development and Territorial Equality (SRADDET) in France provides a strategy for the future of 11 territories of the South Region between 2030 and 2050 (South Region France MAP). The strategy aims to: (i) combat climate change by reducing energy consumption, emissions and pollution; (ii) improve the resilience of the territory by protecting the population, biodiversity and the CO2 storage sinks of natural areas. Suggestions for governance structures at a national level is of level cross-sectoral collaboration (e.g. in Denmark, the Danish Agricultural Agency, Danish Nature Agency, Danish Environmental Protection Agency, Danish Energy Agency and Danish Housing and Planning Authority).

Tackling climate change, with a particular perspective on the role of land use, is knowledge intensive. For actions by any actor in a land system to be effective requires sourcing and synthesising data, information, guidance on approach, and monitoring impacts (SHERPA, 2023). Collaboration and partnership forums that facilitate effective sharing of knowledge between public, private, research and civil society sectors offer considerable potential to inform influencers within institutions. The membership and operation of forums need to be designed to be relevant to the region, including its land systems (e.g. farming, forestry, natural capital management), the size of businesses (e.g. multi-national, SMEs, micro-business) and communities (e.g. remote rural, rural/urban interface). Such groupings can be effective in providing points of contact that act as interfaces between national bodies and initiatives of the public, private, third and academic sectors, supporting multiple perspectives on specific topics (e.g. eradicating invasive plants, Climatically Friendly Villages Czechia MAP).

Governance structures require clear definitions of authority, one means of which is to have the responsibility, protected in statute, of allocating funds. Providing more direct roles to citizens in deciding how budgets are spent could increase the motivation of community inputs and the credibility of policies to involve people in decision-making. The IPCC (2023) notes that "International climate agreements, rising national ambitions for climate action, along with rising public awareness are accelerating efforts to address climate change at multiple levels of governance." However, awareness of issues and motivation to act is not necessarily followed by actions (SHERPA, 2023).

Citizens, civil society and businesses often provide key insights to local needs and contexts (e.g. challenges to raising or managing finance, practicalities of proposed solutions), providing evidence of the types of challenges they face in taking actions to mitigate or adapt to climate change. Providing a safe space for local actors to collaborate and share in the development of place or area-based solutions to tackling societal challenges strengthens the capabilities and social cohesion and the quality of life in rural areas (P10 Netherlands MAP; UK MAPs; SHERPA, 2023). The process of enabling collaborative activities in the co-construction of visions, strategies and actions on the ground for tackling climate change can also contribute to building trust and confidence of and between actors in local land systems and social networks (SHERPA, 2023). An example of such responsibility is the use of Participatory Budgeting in Scotland which enables prioritisation (within guidelines) to areas not otherwise well supported (e.g. increased attention to climate justice and a Just Transition; UK MAPs).

New approaches to effective means of governance of land with respect to tackling climate change is consistent with the EU Rural Action Plan of Increasing environmental, climatic and social resilience (European Commission, 2021a). However, in supporting such initiatives, attention should be paid to the design and promotion of financial instruments that are inclusive, and notably, those which are accessible by young entrepreneurs (e.g. South Aegean Greece MAP 2021).

Further requirements for policy and research

Policy:

- Spatial land use plans and frameworks should be coherent and applicable, across all sectors, tailored to national and levels of governance.

- Spatial plans for land use should be structured in a way that enables them to be informed by relevant new evidence (e.g. GHG emissions estimated from updated data on land use and land management practices), and be responsive to the changing circumstances of territories.

- The incorporation of natural capital into processes relating to strategic planning (e.g. of land use), payments under the CAP (e.g. land management measures), and levering resources for communities or businesses (e.g. valuation of carbon). The outcome sought is an increase in the investment in natural capital to reduce GHG emissions and benefits for environmental sustainability.

- Support for developing governance infrastructures and human capital to enable the design and implementation of citizen-led prioritising of funding for tackling climate change.

- Policies relating to climate change and land use or land use change should recognise the types of trade-offs which might be required, identification of the actors who may experience negative impacts, and what new opportunities and transition pathways might mitigate these impacts.

- Funding schemes that empower community and citizen participation, and actions on-the-ground, and which are tailored to the needs and characteristics of their areas, which can be directed by citizens at national or regional levels (e.g. a component in the EU Innovation Fund or EU Cohesion Fund in the 2028-34 multi-annual funding framework; levy on infrastructure projects, including largescale renewable energy developments, carbon capture and storage)

Research:

- The identification of principles to guide spatial planning of land use that would support tackling climate change, and which are consistent across geographic levels, jurisdictions, and equitable for all stakeholders in their responsibilities and the benefits they accrue.

- Tools and methods are needed to support informed decision-making for the development of national land-use strategies and action plans across sectors (e.g. agriculture, environment, forestry, energy, soil, water, finance and planning).

- Research is required into the governance structures and human capital for enabling citizen-led decision-making within the relevant regional and national legal and cultural contexts.

Discussion follows of particular opportunities which focus on rural areas.

4.1.1. Renewable energy generation

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, 2022c). Investing in and supporting such systems contributes to both mitigating GHG emissions and adapting land systems for business, farmer and community benefits (South Aegean Greece MAP 2021; Climatically Friendly Villages Czechia MAP; P10 Netherlands MAP; Alqueva Portugal MAP; Zachodniopomorskie Poland MAP; UK MAPs).

The international conventions on climate change (November 2021 and 2022), Russian invasion of Ukraine (February 2022), and rapid sourcing of energy from non-Russian sources has led to Governments updating targets, regulations and plans for tackling climate change, including the generation of renewable energy (e.g. Denmark adopted a Green partial agreement to secure further reductions in CO2 and more renewable energy, December 2021, quadrupling production of energy from solar and onshore wind; Denmark MAP).

In 2021, renewable energy accounted for 37.5% of EU electricity generation, 22.3% for heating and cooling, and 10.2% for transport (European Commission, 2022a). Figure 7 shows the additions to European renewable energy capacity 2022 to 2027, and the changes in wholesale electricity prices for selected markets (International Energy Agency, 2022). Projections are for a cumulative increase of 60% in renewable energy capacity between 2022 and 2027, led by growth in solar PV, then onshore wind, offshore wind, bioenergy and hydropower. In some regions, the increase in renewable energy production has been dramatic (e.g. from 5.5% to 58.5% in Zachodniopomorskie, Poland). Projections to 2027 are for 75% of the increase in Europe to be in Germany, Spain, the UK, Turkey, France the Netherlands and Poland.

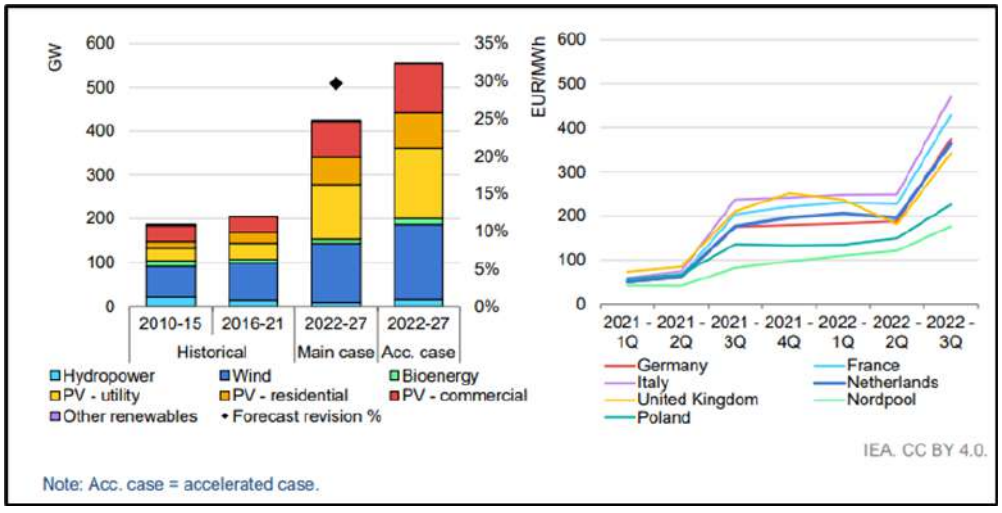


Figure 7. Europe renewable electricity capacity additions, 2022-2027 (left) and wholesale electricity prices for selected markets (right).

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 (SHERPA, 2023). There is also likely to be a need for more mixes of energy renewable systems with other land uses, and in places where the potential for energy generation is restricted.

The sequence of uptake of space for the development of renewable energy has varied across countries reflecting local opportunities (e.g. access to land), the design, use and ownership of buildings, and access to technology (tested or early in development). So, in some areas, the development of solar photovoltaic has followed a sequence of disused airfields or other public spaces, and large flat roofs of agricultural storage sheds, before development on agricultural land (UK MAPs). In other areas, development on agricultural land has been early in the sequence of options, and now the use of roof space is an underutilised opportunity (e.g. Denmark MAP).

Transferring land use from agriculture to the production of renewable energy can include increasing space available for biomass production (e.g. 6.5% of agricultural land in Zachodniopomorskie, Poland MAP). The development of renewable energy (especially biomass) is closely linked to future agricultural production, and the significant potential of energy efficiency in rural housing and ways in which villages can develop decentralised heating systems (Denmark MAP). New opportunities are emerging, such as solar farms floating on inland water bodies which can deliver multiple benefits of reducing evaporation from reservoirs and maintaining the operation of the solar farm at working temperatures (e.g. Portugal MAP; UK MAPs).

The use of hydrogen is also offering significant opportunities, particularly in agriculture and transport. More investment is required in infrastructure to ensure security during transitions from petrol and diesel to electric vehicles, and infrastructure to support the generation of hydrogen from renewable sources to fuel farm and industrial vehicles (Alqueva Portugal MAP; UK MAPs).

Differences between countries in planning regulations mean that in some places renewable energy development has limited requirements for permission or oversight (e.g. solar farms on agricultural land, Denmark MAP). In some areas, progress on expanding renewable energy production is reported to be constrained or slowed due to regulations (Zachodniopomorskie Poland MAP; VENUS Czechia MAP). As reported by SHERPA in relation to climate change and environmental sustainability (Miller et al., 2022), public administrations also need resources to handle the tasks associated with the planning and regulations which are key to maintaining public confidence in processes (e.g. complaints boards in Denmark; Denmark MAP; planning permission, UK MAPs). The capabilities, human resources and finances of such organisations vary considerably between and within countries, as do the requirements and administrative systems, sometimes as a consequence of previous forms of government. The lack of resources can create barriers to the achievement of objectives.

Examples of other barriers are a lack of information on requirements for the planning, installation and maintenance of renewable energy systems (e.g. solar), resilient links to the electricity network and maintenance in times of natural hazards (e.g. wildfire, storms, flooding), and sources of funding (e.g. crowdfunding) (South Aegean Greece MAP).

Complementary approaches to tackling climate change are through technical (e.g. Carbon Capture and Storage) and product innovation, such as replacing existing materials with new ones that have lower energy inputs. For example, in The Netherlands, proposals for developing local bio-based insulation materials for buildings could contribute to the transition in agriculture, reduction of nitrogen and energy, and creation of employment opportunities (P10 Netherlands MAP).

The EU identify Carbon Capture and Storage (CCS) as one of the approaches towards decarbonisation. Technologies and opportunities are emerging, and support for which is identified in Horizon Europe (e.g. Cluster 4 Digital, Industry and Space, and Cluster 5 Climate, Energy and Mobility). Although expectations appear to be for large-scale projects to focus on sites in industrial or urban areas, some of the potential may be realised in areas which are otherwise characterised as rural. Those sites in proximity to large-scale storage, notably from oil and gas or mineral extraction. Such areas include rural communities in coastal sites (e.g. north-east Scotland) which have traditionally had economic exposure to fishing and trade in primary products, and more recently in hydrocarbon extraction and now renewable energy support. These areas are amongst those directly affected by transitions from hydrocarbon to renewable energy generation. Approaches to their financing are mixed, with scope to include a mechanism of supporting funds managed by communities, examples of which are well-established under related contexts (e.g. Shetland Charitable Trust, set up to receive and distribute money paid by the oil industry to the local community; UK MAPs).

Following the successful uptake of changes in practices and the maturing of renewable energy in rural businesses and farming systems in many areas of Europe, public policy should move towards components in the supply or value chains (P10 Netherlands MAP; UK MAPs).

Community energy

An increasingly significant aspect of renewable energy generation is that of community-led renewable energy development (notably in wind, solar, hydropower and biomass), reflecting European Union and national policy to support developing community energy as a specific form of decentralised, low-carbon and resilient energy. For example, in Czechia, a target for the development of community energy by 2030 is to cover 40% of settlements, area and population (i.e. a minimum of 2,500 municipalities, 32,000 km2 and 4 million inhabitants) (VENUS Czechia MAP). These sources of energy (typically onshore wind, solar PV, hydropower, and biomass) contributes to achieving the overall targets for renewable energy, albeit likely to be a relatively small proportion of total installed capacity.

Several regions have mature mechanisms for enabling communities to take steps in the generation of energy, albeit this is still a significant undertaking in time and effort. Models of community leadership in renewable energy development (e.g. ownership, rental, shareholding) and operation are increasingly understood and deployed (Slee, 2020; UK MAPs). Typically, such developments are social innovations, contributing to rural development through place-based or issue-based groups in community energy, particularly in communities with the technical and human capacity to deliver renewable energy projects.

However, developing such human capacity is essential in empowering communities to identify and realise local aspirations (SHERPA, 2023).

It is at local levels where social connectivity can be high, and understanding of biophysical or cultural constraints is greatest (P10 Netherlands MAP; UK MAPs). However, although social innovation may happen as a result of citizen action alone, its impacts can be significantly enhanced by supportive policies. The European Union Common Agricultural Policy (CAP) 2021-2027 identifies the need for innovation and solutions that are sustainable from economic, environmental and social perspectives. It highlights the importance of involving rural communities in the design of interventions and the development of structures that can facilitate social innovation in rural areas. Support is needed to enable such involvement, for example through mechanisms of LEADER or equivalent.

The direct effects of rising energy prices are mitigated where energy generation and use are on a local grid (e.g. UK MAPs). It has significant roles in providing resilience of energy supply in island and remote rural communities (e.g. Island of Eigg, Scotland, UK MAPs), and can be a focus for developing community cohesion and sources of income. The number and extent of areas which are in such a situation are small and limited, but provides evidence of what is possible, offsetting some of the disadvantages of remote areas. However, the resilience of energy supply in such areas may be weak (e.g. exposure of energy infrastructure to weather conditions; slow response to maintenance needs), and all areas are impacted by energy costs on supply chains.

To realise community renewable energy developments requires suitable means of bringing together the right types of support (financial, technical, social), at the times they are needed for realising the generation of energy (conceptualisation, planning, design, construction, operation), and of handling the ongoing system (maintenance, planning replacements, managing funds). However, there is a wide disparity in the legal and institutional arrangements across Europe for providing such forms of support (e.g. Hewitt et al., 2019), forms of participation (e.g. in the renewable energy site or in the process of its development; Denmark MAP, P10 Netherlands MAP, Zachodniopomorskie Poland MAP), and opportunity for creating local value (e.g. design, construction, maintenance of systems at the Hvide Sande wind farm, Denmark MAP). Other mechanisms of support are in the form of access to technical assistance, such as the service provided by the Opavsko Local Action Group (Czechia), which also maintains a register of sources of technical assistance for use by entities with their implementation of energy-saving projects (VENUS Czechia MAP).

In some regions, new businesses have emerged, specialising in certain sectors (e.g. hydropower, solar, wind, biomass), with the requisite skills. Some such skills are learnt and located in rural areas, others will be by the relocation of the relevant skilled people into rural areas, foreseen in the LTVRA (UK MAPs). On a voluntary basis, such businesses are contributing to raising awareness of what can be achieved by communities and other rural businesses. There are limits to the time which can be dedicated to such public good, indicating a need for effective knowledge infrastructures.

Not all areas have access to the relevant skills or sources of knowledge. A general principle of public policy should be one of facilitating an equitable green transition (e.g. in generating renewable energy) in which disparities should not arise as a consequence of some communities having the requisite human and social capital to bring a proposal for renewable energy to fruition.

Recommendations for policy

Policy:

- Strategic planning should be encouraged to take account of future phases of renewable energy generation, such as returbining of existing onshore windfarms, in the context of wider strategies on land use with remits to contribute to pathways to net zero GHG emissions by 2050.

- Reshaping regulations (regional and national) to reduce constraints on renewable energy development whilst ensuring the protection of natural and cultural heritage, and agricultural production as appropriate.

- Measures should be designed and implemented to support reductions in energy consumption and increase energy efficiency throughout supply chains (e.g. upgrading infrastructure and production units of livestock informed by criteria of energy use), thus contributing to the broader aims of the EU Green Deal of a 'modern, resource-efficient and competitive economy'.

- Support for investment in on-farm renewable energy production as part of transitions in farming systems (wind, solar, bioenergy).

- Resilience and fairness should be built into the provision of renewable energy through public strategies that support investment across a diverse range of sources and increase the benefits to rural areas of components of their value chains (e.g. micro- and small business, landowners and managers, residents).

- Policy recognition of the creation of ecosystems that enable the sharing of technical knowledge and facilitate access to finance at territorial levels with a particular emphasis on empowering community-led initiatives. This would help support:

    - equitable access to knowledge and skills by communities for the development of local energy systems, with mechanisms for overcoming disadvantages in place, human, social or financial capital;

    - the scaling out of innovation, recognising the successes of transformations of individual businesses or communities, with means of sharing knowledge and experiences, and providing credit and returns to innovators for their subsequent investment in transformations.

Recommendations for research

- Systematic evaluation of the development of community energy programmes (economic, social and environmental), to identify the elements that have been proven to work and those which have shortcomings. (VENUS Czechia MAP).

- Improve understanding of how different types of cooperation, sharing of knowledge, and development of social capital evolve, and the key moments when barriers to uptake could have the greatest adverse impacts, and when enablers could be most beneficial.

4.1.2. Land management and system

Well-designed and implemented land management practices can deliver multiple benefits of mitigating climate change through maintaining its carbon content (Alqueva Portugal MAP; UK MAPs), enhancing biodiversity (above and below ground), increasing water retention capacity (Greenport Gelderland Netherlands MAP), and contributing to characteristics of landscapes (Climatically Friendly Villages Czechia MAP; UK MAPs). The EU Farm to Fork Strategy identifies a significant role for agroecological farming systems in achieving these aims, reflected in the proposed EU Partnership on Accelerating farming systems transition: agroecology living labs and research infrastructures. It is also in line with the EU Soil Strategy which promotes "the development and use of digital and remote sensors, apps and handheld samplers to assess soil quality" (European Commission, 2021b).

Land management and systems are continuing to evolve and will continue to do so, reflecting changes in crop suitability and productivity, soil characteristics (e.g. moisture), time to access land, and the impacts of intense rainfall, and the availability of crop varieties (Emilia Romagna Italy MAP; Zachodniopomorskie Poland MAP). Activities linked to lands, such as food production and resource extraction, are subject to global market forces, such as energy prices, with consequences for local land uses, such as acceleration of the development of solar farms on agricultural land (Denmark MAP; Hungary Land Use MAP; UK MAPs). Such uses may form valuable additions to the individual farm system but may require compromises in other dimensions, such as a decrease in farm income, and requirements for capital investment, and removal of land from existing production (e.g. for food, drink). Greater understanding is needed of the consequences of compromises required when primary uses of land compete (e.g. food, energy, fibre, biodiversity), how synergies can be identified and realised (e.g. through additional landscape features), and the timescales when competition may be greatest or synergies maximised (e.g. key times in a growing season of crops, or longer lifecycles of land uses). Knowledge of these aspects of the land systems should be shared with actors of relevant levels of governance (e.g. using in-field demonstrations; strategic planning), and their significance with respect to food security and the sustainability of food systems.

The transformation of farming systems is a greater challenge, entailing motivation and benefits that are system-wide, recognised by all actors in the system, and with means to enable the technical and social changes to take place. The timescale required for the transition is longer. Tensions may arise due to different types of competition, for example, pressures for change which compete (e.g. agricultural businesses with vehicles fuelled by electricity or hydrogen). The requirement for investment in multiple technologies at broadly the same time creates pressures on finances and time (e.g. gaining operational level skills in new equipment; capital purchases and maintenance costs) (UK MAPs).

The nature and levels of trade-offs require to be understood, in national and local contexts, to inform debate about the types of changes in land use and land systems are required, and the costs and benefits that can be expected to accrue. Such understanding can also inform the design of incentives and compensation payments (Alqueva Portugal MAP; Hungary Land Use MAP). Mechanisms and instruments are required to balance the sharing of costs and benefits between public and private actors (P10 Netherlands MAP).

The realisation of changes in land management and systems can have high transaction costs for producers individually, but collectively they can drive changes in entire supply chains. For example, transitions to agroecological systems may lead to lower demands for inputs, and greater use of land for small livestock herds for on-farm manure production, whilst also maintaining productivity (Schleswig-Holstein Germany MAP; UK MAPs). These types of changes in a farm system and products require the organisation of new supply chains that are sustainable and profitable, and the investment of time by relevant actors (Emilia Romagna Italy MAP; Zachodniopomorskie Poland MAP). Such changes can create opportunities and risks for businesses and actors, with a new range of products that can attract price premiums, and jeopardise businesses that do not align with the changes taking place (Emilia Romagna Italy MAP; Zachodniopomorskie Poland MAP; UK MAPs). However, awareness is needed throughout supply chains of how changes in farming systems and value chains contribute to policy objectives of reducing GHG emissions, reversing the loss of biodiversity, and rebalancing social inequalities (South Region France MAP; UK MAPs).

Recognition is needed of which changes in land systems are required and will take are taking place in rural areas. 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. Interventions require to be coherent across geographic levels and through time and designed and implemented in partnerships between sectors, and across policy, society, business and research. This will require motivating and facilitating the active participation of stakeholders to develop shared visions for planning approaches to tackle climate change.

A systemic approach is required innovations in land use for tackling climate change, reflecting the integral nature of links between climate, ecosystems and biodiversity, and cycles of carbon, water and energy, and how they support food systems. These approaches need to consider the roles of stakeholders in different land systems, with sensitivity shown to the positions of different sectors relative to each other. There should also be recognition of the need to differentiate within groups to understand the motivations of each (e.g. agri-business, food retail, investors).

Transitions in land use and systems in one place may not be appropriate in another. For example, in Denmark, the 170,000 ha of carbon-rich lowland soils make up just under 7% of arable land, but contribute more than half of the total emissions from land cultivation (Denmark MAP; Climate Council 2020). Individual farm systems can be transformed to be climate-neutral or positive (UK MAPs). The challenge is considerable, effort significant, motivation for innovation in products and processes, and likely to require expert knowledge input. To a large extent, the transformation is under the control of an individual or single business, with attendant business risks and benefits.

Decarbonisation of the agriculture and forestry sectors will require greater uptake of new technologies as they become operationally viable. However, there is evidence of caution or prejudices that inhibit investment or adoption. Incentivisation (e.g. by tax relief) is required to encourage transitions in the uses of machinery (on-farm vehicles, off-farm transport). In some countries, support mechanisms are only available to private citizens and not businesses (e.g. electric vehicles, Portugal MAP), and replacements to the types of tax relief for hydrogen and electric machinery as currently provided for diesel fuel equipment (Alqueva Portugal MAP; UK MAPs).

Enabling new entrants to farm and land management can be one valuable means of introducing innovations or greater willingness to adopt new technologies. However, opportunities for new entrants to try a career in farming are constrained by limited access to land due to, for example, land price, forms of tenure, traditions and public policies towards land ownership. The most appropriate means of overcoming these barriers will differ by jurisdiction but include Share Farming, Contract Farming, Tenancies, Partnerships, Short term leasing or licencing, and buy-outs by individuals or communities. Facilitation of means of overcoming such a barrier requires finance (e.g. public funds to support community buy-outs), the provision and access to information about approaches for new entrants to farming (e.g. technical and legal advice), and the sharing of experiences of those who are recent entrants to farming and land management (e.g. Emilia Romagna Italy MAP; UK MAPs).

The lack of suitably designed measures will inhibit farmers and land managers from transitioning to new farming systems and practices, with some locked into existing practices (e.g. due to contractual obligations, traditions or lack of human capital in the land management system) (Climatically Friendly Villages Czechia MAP). A similar argument can be made for the support of specific measures. For example, the CAP 2020 to 2027 proposes a specific good agricultural and environmental condition (GAEC 7) regarding crop rotation, but with the flexibility of Member States to retain the GAEC 6 in the CAP 2014 to 2020, which has been reported as having had limited effects. Flexibility in the choice of measures can represent an obstacle to achieving more ambitious objectives (Emilia Romagna Italy MAPs), but enables sensitivity to local circumstances (SHERPA, 2023). Greater rigour is required in the implementation and monitoring of such GAECs (Alqueva Portugal MAP).

Tackling climate change from the perspective of food systems can provide insights to the linkages and dependencies between land uses, supply chains, and impacts and mitigation of climate change, including the provision of nutritious food to all citizens. The elements of food systems should be understood and designed to maximise the protection and promotion of carbon-positive farming, which are low in resource use and circular in nature (Alqueva Portugal MAP; UK MAPs). For example, the climate-positive Nàdar products were developed using peas, which yield without synthetic nitrogen fertiliser application, and new biorefining methods, by means of an international and multidisciplinary research collaboration. The high-protein co-product is used to feed livestock (UK MAPs).

Investigation and testing of alternative sources of protein to replace imported soy for use in livestock production is developing rapidly. Options being explored include clover grass, starfish and other invasive marine crustaceans, which are processed to provide protein for monogastric animals such as pigs and chickens, and the residue used in biogas production (Denmark MAP). Findings from research into the uses of seaweed and legume-based green manures show them to be more effective than grass-based green manures, indicating opportunities to move to systems which rely less on inorganic nutrient inputs and utilise legacy nutrients more effectively (UK MAPs).

Plant-based food production has also identified been as an alternative to growing feed for animal production (e.g. Organic Plant Protein). The restructuring of food systems goes beyond land use, to include the handling of food waste and the development of foodstuff purchasing agreements that support locally produced food (Denmark MAP; Schleswig-Holstein Germany MAP; UK MAPs). Such change has to be synchronised with changes in public attitudes towards food (See Section 4.4).

Community-led initiatives can also change existing systems of uses of land. They can create demand for certain types of products that are part of a portfolio of approaches to address climate change, notably agroecological farming systems that also produce nutritious and affordable food (e.g. Project "Fruta Feia", Alqueva Portugal MAP).

Although there are many successful or promising examples of transitions in farm systems, little attention is being paid to identifying actors who are unprepared for the types of changes taking place in products and value chains. There is a risk they will be left behind with no specific reason for protecting the systems they pursue (e.g. for reasons of cultural heritage), which can lead to environmental, social and economic damage, and negative impacts on the mental health of those who become disadvantaged (Romanello et al., 2022).

Recommendations for policy and research

Policy:

- National CAP Strategic Plans should include measures to incentivize practices that reduce GHG emissions or increase the role of on-farm carbon sinks, water retention, and enhance biodiversity, while ensuring that the value created is internalized on the farm.

- Greater rewards should be offered for collaboration between holdings to leverage benefits above the level of individual farms.

- Policies should provide leverage for farmers to adopt agricultural techniques that increase levels of soil organic carbon, supported by mechanisms that explain and demonstrate the benefits to encourage uptake and implementation.

- Regulations need to remain up-to-date to reflect new and emerging technologies (e.g. gene editing, vertical farming, artificial intelligence).

- Guidance is needed for land managers on phasing implementation of transitions to climate neutrality. Evidence suggests there is less advice available to land managers once they start implementing innovations and embedding them in businesses. Yet, this is the stage when modifications are needed to suit businesses and farmers are at risk of 'dropping' the innovation if it appears too complicated.

- The incorporation of natural capital into processes relating to strategic planning (e.g. of land use), payments under the CAP (e.g. land management measures), and levering resources for communities or businesses (e.g. valuation of carbon). The outcome sought is an increase in the investment in natural capital to reduce GHG emissions and benefits for environmental sustainability.

- Reiteration of the need to respect the rights of all actors in just transitions of farming systems, ensuring that no one is left behind in transitions to new land management practices and structure of land systems due to lack of access to technologies, or human, social or financial capital.

Research:

- Research is needed to understand the trends and nature of future food production, identify alternative crops and farming systems that are viable in different local contexts, and how to steer the associated transitions.

- Understanding is needed of the levels of risk of where and what types of actors may be left behind during transitions in crop and farming systems.

- Understanding of lock-ins experienced by land managers and communities which may prevent or inhibit the realisation of new opportunities (e.g. regulatory restrictions on land use change towards new forms of food production; land management contracts that do not draw on latest knowledge; commitments to customers which restrict the uptake of agro-ecological farming systems).

- Determining costs and benefits of implementing changes in farm management, changing systems of agricultural production, changing land use from agricultural to non-agricultural, use of water for irrigation, and the role of biotechnology in climate change adaptation.

- The identification of techniques for optimizing specific adaptation actions to maximize the likelihood of successful adaptation.

- Methods for measuring and reporting of characteristics of land under practices that deliver sustainable management (e.g. GHG emissions in real time, carbon stocks in soils, predictive model of carbon dynamics) should be prototyped and mainstreamed, and assessments made of the effectiveness of practices on reducing adverse impacts.

- Understanding of the costs and benefits of carbon-neutral or positive farming practices through payments in carbon credits which are exchangeable between entities in different territories.

- Better understanding of GHG emissions of different farming systems designed around sustainable intensification and agroecology, under different biophysical and social contexts, and identification of pathways for how such systems could change through time and trade-offs between environmental, economic and social factors;

- Understanding whether increasing digitalisation in agriculture in Europe contributes to improved food resilience, biodiversity and job creation.

- The development of scenarios of what crops may be grown in the future, viable alternatives, and the types of supply chains required. Building upon these findings, understanding is needed of the potential barriers to development of supply chains and uptake of crops and associated products.

- Understanding of what characteristics of local biophysical, social and economic contexts influence where or how changes in land management and systems will take place.

- Understanding the impacts of alternative sources of inputs, such as seaweed and legume-based green manure, on nutrient stoichiometry, biological interactions, and pollutants, and how to mitigate any adverse effects.

4.1.3. Peatland 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 (UK MAPs). The protection or restoration of peatlands and wetlands is identified in the EU Biodiversity Strategy for 2030 (European Commission, 2020b), National CAP Strategic Plans and other national and regional strategies (e.g. National Peatland Plan, Scotland, UK). The Netherlands CAP Strategic Plan allocates €174 Million to increase the water levels of peat meadows; Finland's Plan strengthens the protection of peatlands in agricultural areas with new rules on ditches and banning extraction and burning. It is also referenced in the NECPs of several countries referring to the restoration of peatlands and the phasing out peat-fired electricity generation (e.g. Germany, Finland, Ireland, Estonia and Lithuania).

The Climate Change Committee (2019) note that for the UK, there is potential to increase the extent of restored peatland from the current area of 0.6 million hectares, to over 1.4 million hectares by 2050, estimating that such an increase could reduce emissions form this source to c.7 Mt CO2e. Most of the UK's peatland is in Scotland, which has allocated £250 million to restoration over a ten year period. As of 2021, there were 691 registered peatland restoration sites in Scotland, covering a total of 25,000 ha of land in the process of restoration since 2012/13.

Restoration is only one step in the overall process over which natural systems takes time to recover and achieve restored status. For every 10 cm the watertable is raised there could be a reduction of 3 tonnes CO2 ha-1y-1 (Evans et al., 2021), potentially requiring 50 years for the restoration of peat drained to 1m depth. An indicative recovery trajectory is shown in Figure 8. During the period of land being under restoration management, practices are required which are consistent with achieving the goal of restoration, such as monitoring water levels, presence and growth of vegetation, modifying interventions as appropriate (UK MAPs).

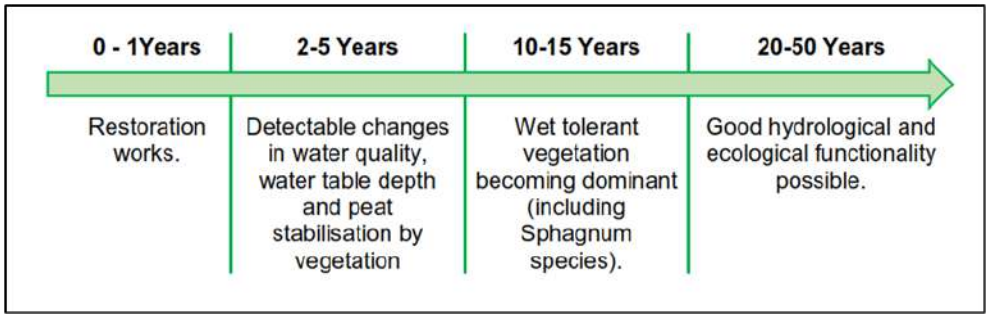


Figure 8. Plotting a recovery trajectory for blanket bog (Source: Defra, 2021, adapted from RSPB; page 37).

Tackling climate change should be part of a wider approach to rural development The restoration of peatland is providing new opportunities for rural development, built around new streams of income for land managers and owners (including public authorities). This is reiterated by the IPCC (2023), which notes the potential for synergies from 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."

Strategies are being developed that link the delivery of public goods with equipping businesses and citizens with the provision of new skills (e.g. shaping ditches, monitoring of water levels using digital sensors), and stimulating new micro-businesses (e.g. in use of drones to measure and monitor restoration sites), and community-led initiatives (South Region France MAP; UK MAPs).

Scaling up of capabilities between restoration sites (e.g. land managers, communities) is required to enable a sufficient area of degraded peatlands to be placed onto pathways to recovery. This stimulus is leading to centres of expertise being established in remote rural areas where significant peat reserves are located (e.g. north and south-west Scotland, UK). [Also reflected in recommendations in Sections 5.3].

Lessons are being learnt from the approaches of sharing expertise and experiences between communities developing renewable energy, and peer-to-peer learning in agriculture (e.g. supported through Rural Development Programmes). As resources consolidate in each pace, so scope emerges for transnational learning (i.e. across countries and regions in networks of Living Labs, as in the new Horizon Europe project, Wet Horizons).

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).

Further requirements for policy, practice and research

Policy:

- Reviewing the status of peatlands which have reached as good hydrological and ecological functionality as is achievable at a site, and whether that status is compatible with the generation of economic return from their enhance natural capital value.

- Strategies for education and training should have appropriate alignment with the provision of new knowledge and skills to enable implementation of peatland restoration (e.g. understanding links between peatlands, their restoration, and sequestering GHGs; monitoring the presence and types of vegetation and water table levels).

- Strategies for training should support increasing capabilities at local levels, including SMEs and micro-businesses and community initiatives, with a view to peatland restoration actions being hubs for natural capital innovation, investment and economic activity.

- Examine the legal and regulatory issues associated with different forms of funding for investment in natural capital (e.g. peatland restoration) such as crowdfunding through reputable banks and platforms.

Practice:

- Support for communities of practice of 'peat citizens', similar to those of energy communities and energy citizens.

- Sharing perspectives on what might constitute reached as good hydrological and ecological functionality as is achievable at a site, and when management practices change to monitoring and maintenance rather than focusing on restoration.

Research:

- Understanding 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.

- Identifying any changes in perceptions of the functions and values of peatlands, by citizens and land managers, living or working in close proximity to such sites or more remotely.

4.1.4. Woodland expansion

The UN HLEGCC (2022) estimates 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, 2020), 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).

At COP27, the Forest and Climate Leaders' Partnership (FCLP) was launched, which aims to unite action by governments, businesses and community leaders. President of the European Commission, Ursula von der Leyen said:

> "Only with healthy forests can we deliver on our shared climate commitments under the Paris Agreement. And only with intact, lively forests can we address biodiversity."

At an EU level, the EU Forestry Strategy envisages, among others, planting three billion trees across Europe by 2030. At national and regional levels, ambitious plans are set for expanding woodlands. For example, in Denmark, 100,000 ha lowland, including some of marginal lands, is to be set aside for afforestation (Denmark MAP). Similarly, in the UK the targets for expanding woodland as elements of strategies that tackle crises of climate change and loss of biodiversity with transformations in uses of land including an increase from 13% woodland in the UK to 18% by 2050 (UK MAPs), of which the aim in Scotland is to plant 18,000 trees each year by 2024.

The NECPs and National CAP Strategic Plans provide indications of the types of approaches to woodland management and expansion being considered by each EU Member State. Broadly, the approaches are informed by current levels of woodland cover, the contributions of woodlands and wood products to the economy, and cultural functions. Countries with such references in their Plans include Lithuania and Romania (promoting carbon accumulation with extensions of forestry), the Netherlands (expanding the extent of natural areas, restoring landscape structures, limiting deforestation and planting new trees), and Greece (promoting energy crops including woody biomass and coppice plantations).

However, achieving the aims of net carbon sequestration (i.e. more carbon sequestered over the lifetime of the tree than might be released due to planting operations) requires an account to be taken of the environment in which the woodlands are planted, the soil type, the choice of forest management regime, and antecedent land cover type (Matthews et al., 2020). Such factors influence the timescales of carbon uptake, with examples in areas with carbon-rich soils of a net loss of carbon over 30 years before sequestration becomes positive (UK MAPs). Recognition should also be given to evidence that suggests the role of woodland expansion in sequestering carbon is principally above ground, based upon research shows no net ecosystem level increase in carbon storage in areas of carbon-rich soils under certain tree species.

A contribution to woodland expansion can be realised by changing land use systems to include agroforestry (Figure 9). Such systems are common in many countries, particularly in the Mediterranean area (Alqueva Portugal MAP 2022). However, in some countries, it is a very small component of rural land systems (e.g. UK), unfavoured because of a reluctance to incur reduced economic return, whilst requiring more complex management systems, diverse skills, and equipment. There is a need to raise understanding of the characteristics, functions and requirements for agro-forestry (e.g. South Region France MAP) among practitioners, policy advisors and prospective investors. This lack of understanding appears to cover the functions of agro-forestry (e.g. carbon sequestration, biodiversity, diversity of sources of economic return, landscape diversity; Hungary Land Use MAP; UK MAPs), the types of options that may be appropriate in different environmental conditions (e.g. silvopastoral system), jurisdictions (e.g. types of animal permitted to be in an agroforestry system), and the contemporary attitudes of land managers towards its uptake (Climatically Friendly Villages Czechia MAP).

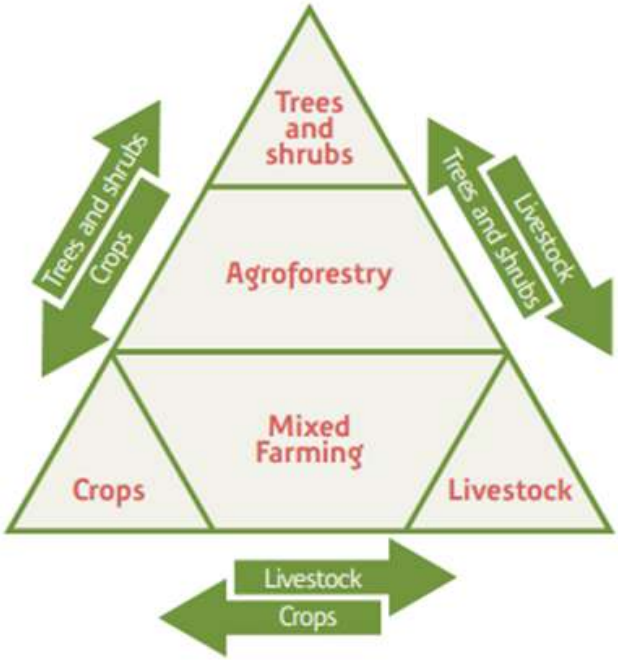


Figure 9. Schematic of typical combinations of trees, crops and livestock in agro-forestry systems (Source: Raskin and Osbourne, 2019, The Agroforestry Handbook).

As with land managers so the attitudes of the general public are relevant to policies for expanding woodlands. 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. There are also inconsistencies within countries or regions on approaches to issues such as site planning (e.g. planting plans, approach to eradicating invasive species; Climatically Friendly Villages Czechia MAP).

Woodland expansion can also contribute to combinations of land use for tackling climate change other than agro-forestry systems. Those include integrating wind turbines into coniferous woodlands, taking advantage of existing forest roads and uploading areas with significant wind resources (UK MAPs), and their use in screening adverse landscape effects of solar PV farms (Denmark MAP).

For woodland expansion to be taken up widely, and over a sufficiently long time, there is a need to ensure public and land manager support and to recognise factors that can be expected to change which may lead to accelerating or decelerating rates of change, and changes in the trade-offs associated with woodland. The increased requirement of the use of carbon payback calculators in planning processes should provide appropriate information in assessing the trade-offs in different combinations of land uses.

Further requirements for policy and research

Policy:

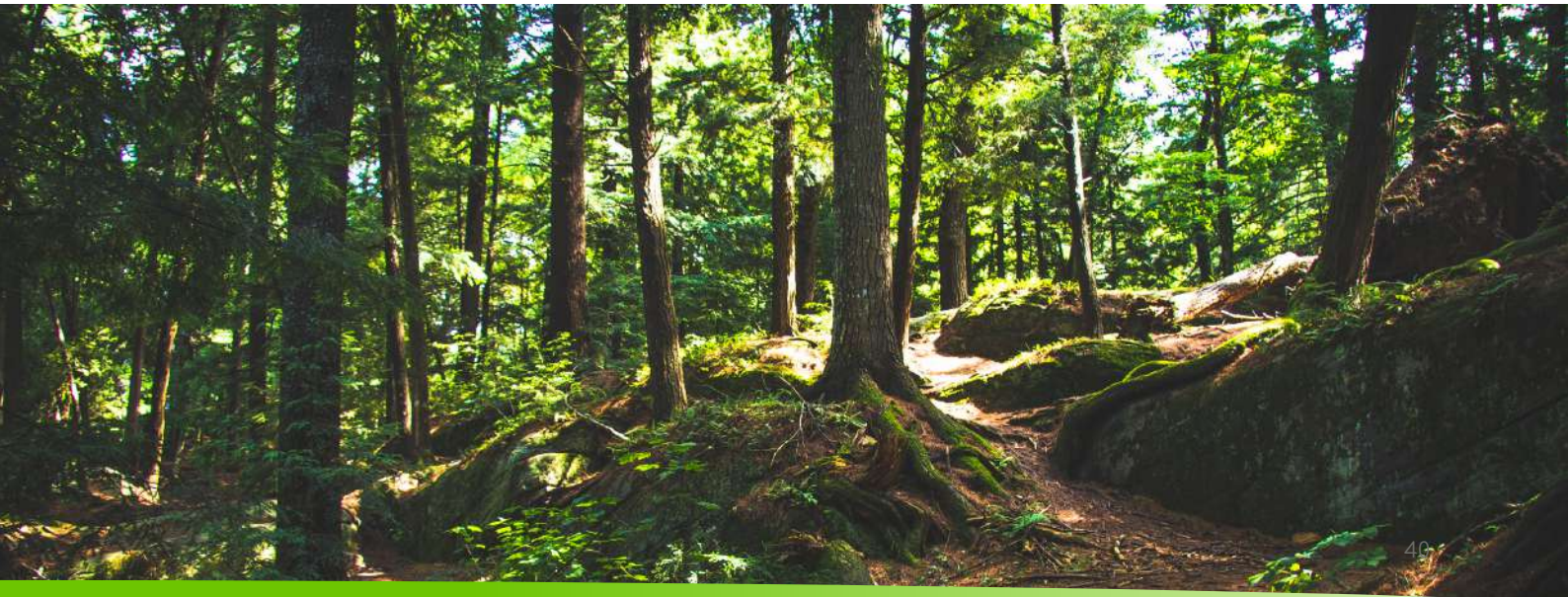
- Coherent spatial planning of woodland expansion that recognises geographic specificities, expressed at different scales, which set out pathways and timelines to achieve targets for reducing GHG emissions and enhancing biodiversity.

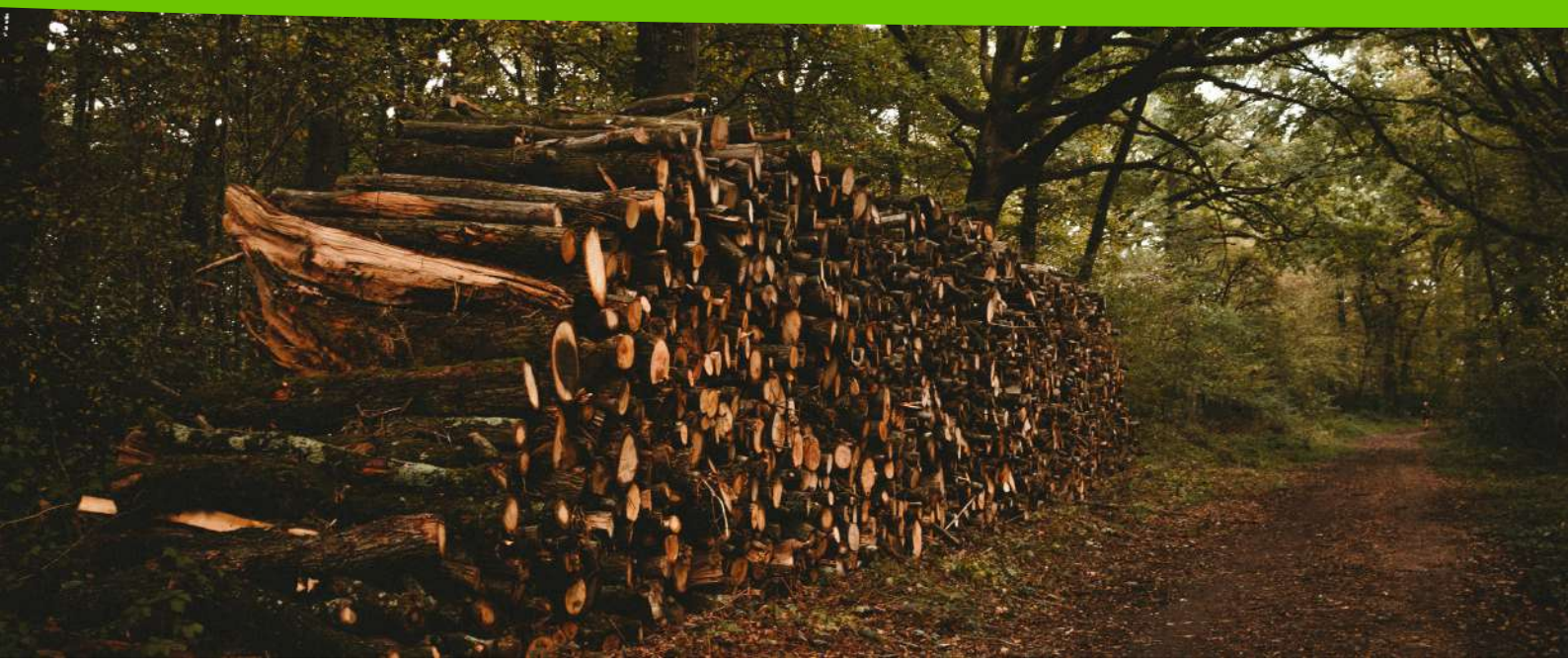
- At relevant national or regional levels, revise legislation to remove barriers to the development of agroforestry (e.g. prohibited planting on land designed for arable use).

Research:

- To inform place-based planning, there is a need to understand 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).

- Understanding of the functions and processes of agroforestry in different biophysical and socio-economic contexts, and effective mechanisms for its uptake in practice.





- Capturing public opinions on woodland expansion, combining quantitative information gathered through Eurobarometers augmented by evidence from qualitative studies that provide insight to community and stakeholder motivations and attitudes towards woodland expansion [Also reflected in recommendations for Section 5.7].

- Understanding barriers to the realisation of future benefits from assets originally secured through initiatives and policies not directly related to climate change (e.g. land reform).

Water management

The EU and national governments have long-established policies and regulations relating to water management. These have been updated or introduced as the priority of tackling climate change has increased. For example, 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).

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, and water quality preserved. It stresses the risks of 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 NECPs, the (European Commission, 2020a) 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).
Significant transformations of land use can only be realised at a landscape scale (e.g. water retention) for which cooperation between communities of place is key. However, in some areas, there are low levels of willingness to cooperate between local actors, which needs to be addressed in policy and education (Hungary Land Use MAP).

Water supply management presents a particular challenge for many areas of Europe. In some there are severe problems with water supply and droughts, in turn causing high energy consumption for the production and collection of water from various sources (e.g. desalination, drilling, transport of water by tankers). A challenge for regulators, businesses and land managers is how to manage tensions in the use of an increasingly constrained resource.

Approaches require reductions in the use of water, innovation and greater efficiency, and collaboration between upstream and downstream, between towns and countryside, sectors of the economy, and territories (South region France MAP). Cross-border cooperation is essential for planning the mitigation of the impacts of climate change, notably flooding, and ensuring the security of water supply (P10 Netherlands MAP). Cooperation is also accompanied by responsibilities over access to public goods and promoting greater equity between territories (South Region France MAP).

Improvements are required in the water supply at the landscape level to support sustainable land use and maintain a healthy hydrological cycle (Hungary Land Use MAP). Increased uses of Nature Based Solutions can decrease reliance on inputs, provide resilience to abiotic and biotic stress, enhance plant, microbe and animal biodiversity, and mitigate against climate change (UK MAPs).

Interventions that have prospects of producing meaningful environmental results are largely voluntary (e.g. territorial water retention, some agri-environment programmes), with low levels of participation in several countries or regions (Hungary Land Use MAP). There is some evidence of stakeholders unwilling to commit to long-term water retention or flood prevention measures (e.g. Climatically Friendly Villages Czechia MAP; South Region France MAP), and a lack of understanding amongst the responsible authorities of the potential benefits of nature-based solutions. However, a good quality collaboration between all actors in science, policy and society, with suitable levels of funding, can deliver effective interventions that modify draining infrastructure (i.e. canalised water course) on land of private owners to wider public benefit (UK MAPs).

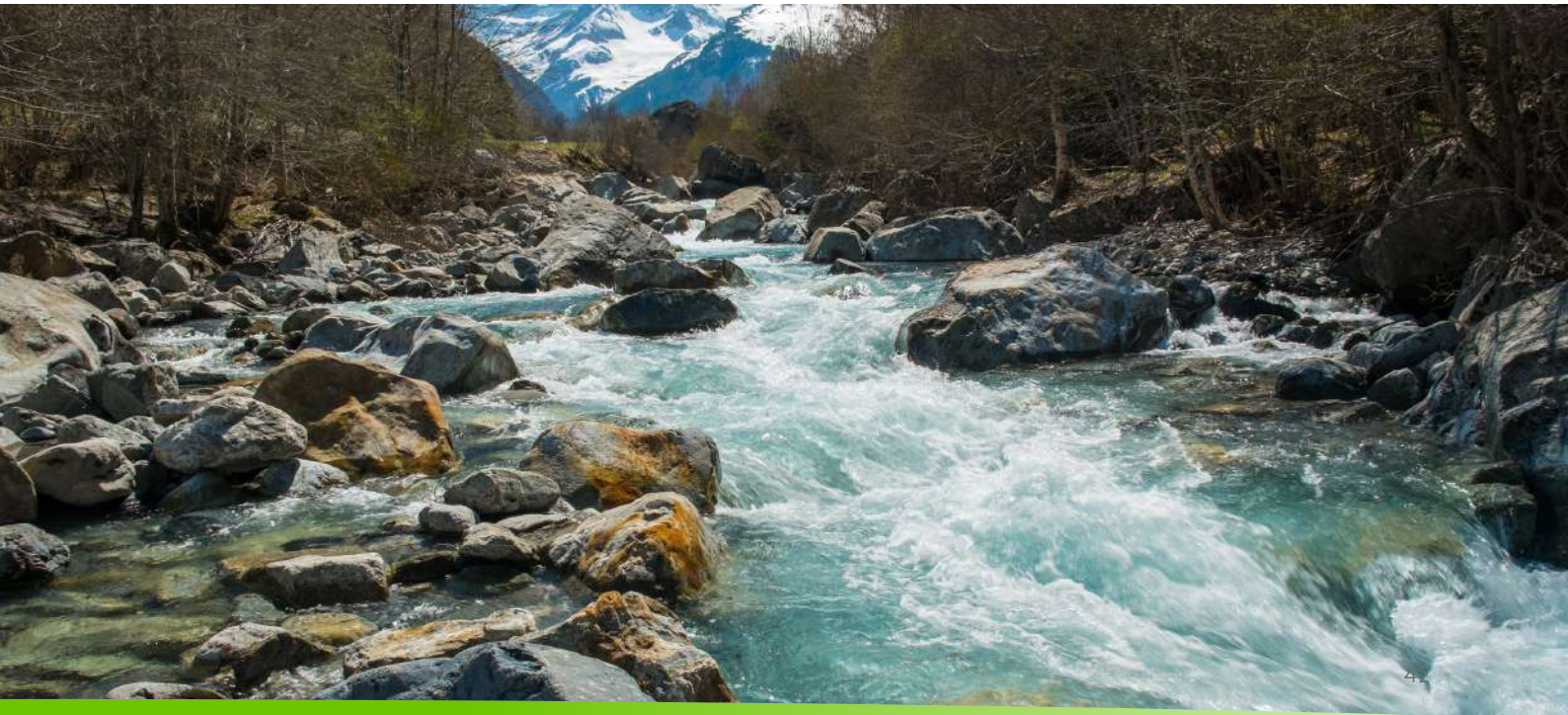
Further requirements for policy and research

Policy:

- Establish Landscape and Water Management Communities, the purpose of which would be to develop land use and river basin management plan at the scale relevant to a water body, taking account of technical challenges, governance and scope for innovation (technical, product, social).

- Ensure eligibility of investments in water retention measures, through the CAP, and support for the participation of those involved in planning and implementation.

- Policies for an efficient use of water resources should include solutions that address infrastructure (e.g. basins), water reuse, and efficient irrigation techniques.



Research:

- Improve understanding of the role of increased evapotranspiration on the extent of biomass or 'water mass' at a landscape scale as a means of reducing global warming.
- Understand the motivations and attitudes of stakeholders relevant to the design and implementation of nature-based solutions.
- To understand multiple uses of water in the context of increasing scarcity, with particular emphasis on suitable governance arrangements that can facilitate collaboration amongst water users.

4.2 Education, Training, Reskilling and Communications

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 directly guide the environmental, social and economic contexts for future generations of 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) (UK MAPs). The need is to ensure:

1) capabilities to design, plan and implement an appropriate pipeline of skills required for required for enabling tackling climate change;

2) lifelong and life wide learning that informs the decision-making by land managers, rural businesses and citizens of actions that tackle climate change through the use of land;

3) changes in behaviours by rural citizens (South Region France MAP; Alqueva Portugal MAP; UK MAPs);

4) effective and equitable access to education, training and reskilling using a suite of delivery mechanisms;

5) communications about climate change and means of its mitigation and adaption, tailored to types of audiences and levels of awareness or understanding.

The means of education and learning should enable inputs by young people, reflecting their different cultural and geographic contexts, which also forms an important element of enabling a just transition to climate neutrality. 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.

The approach for children should recognise differences in starting points and pathways through formal education, eligibility of access at all ages, and approaches that are inclusive of all abilities. This reflects the interactions between climate change and social justice (South Region France MAP; UK MAPs). Evidence suggests impacts can be realised in short timescales, particularly on lifestyles and sharing cultural and social values (e.g. recycling, energy use), representing children's roles within families, and longer timescales of action through responsibilities (e.g. in business, land uses) (e.g. Climatically Friendly Villages Czechia MAP).

Account has to be taken of the influences on the content of curricula to ensure that strategic perspectives on the skills required for transitions to climate neutrality are available to be learnt. Young farmers who want to take over the family farm are not always at the forefront of such considerations, with approaches to financing institutions heavily influenced by the student demand for courses (P10 Netherlands MAP). This implies a need for communications to excite land managers about how their responsibilities contribute to rural areas and public services more widely, and that interests need to be stimulated while they are at primary and secondary stages of education (Schleswig Holstein German MAP; P10 Netherlands MAP; UK MAPs).

Teachers and trainers have also to be equipped with the relevant knowledge and skills to understand and communicate the aspects of the transitions to climate neutrality of relevance to their remits. Beyond their own professional qualification and training, Continuing Professional Development and life-long learning will be of critical importance for developing the capacity of those responsible for teaching and training, and the 'peers' providing 'peer to peer' learning. Such life-long learning has the additional benefit of increasing the pathways that can lead to enhanced citizen capabilities and societal understanding (South Aegean Greece MAP 2021; Alqueva Portugal MAP; UK MAPs).

There is a need to mainstream discussion about approaches required to tackle climate change and the roles of land use. Explanations of the relevance of evidence and discourse about climate change should be facilitated through mechanisms such as demonstrations of good practices and sharing of knowledge relevant to tackling climate change at local levels (Alqueva Portugal MAP), supported by a regional or local communication strategy. Recognition is also required of the differences amongst elected representatives and officials in some countries and regions in their appreciation of the significance of tackling climate change, what is required, and the prioritisation of tasks. The requirement overall is to broaden the extent, and raise the quality, of the discussion, and not assume that the topic has the same level of priority in every country or region of Europe (SHERPA, 2023).

The opportunity to enhance public understanding should be viewed with a long-term perspective, reflecting the magnitude and complexity of the societal challenge, and the various means by which transformations will be required by all citizens. So, the strategy should include means of reaching out to the public in rural and urban areas reflecting their roles as consumers (of public and private goods), with information and education campaigns to increase climate literacy amongst citizens and actors in land uses, contextualised appropriately, targeting issues specific to local areas, and accelerate adaptation through changes in attitude and behaviours (Alqueva Portugal MAP; also see Section 4.4).

Policies to facilitate behavioural change should recognise and leverage rural specificities, with investment in resilient infrastructure in rural areas. Recognition is also required of the more limited scope for changing behaviours in many rural areas. For example, options for public transport are more limited so converting from the use of private vehicles is less practical, and charging points for electric vehicles may be more limited in number or geographic density making travel planning more significant (SHERPA, 2023).

Further understanding is required of the roles of media in communicating between actors, and those of traditional mass media, social media and other means. That understanding needs to include the influences that different forms of media can have on the attitudes of actors and stakeholders in relation to transitions in land uses to tackle climate change. Responsible reporting is required in all forms of media, with renewable energy an example of where sections of the mass media can take advantage of polarised opinions to promote a particular position rather than explaining difficult choices to be made (Denmark MAP).

There is variety across Europe in the availability of training for farmers to help them understand the connections between land use, climate change, biodiversity and land management practices (Hungary Land Use MAP). Options for mechanisms for exchanging knowledge include the development around a network of regional platforms based on the exchange of knowledge between science and society. The aim of such a platform would be to create more space for dialogue in which experiences can be shared, innovations in one area scaled out to another, joint ventures developed or promoted, and solutions for climate change and land use co-constructed. Consideration should also be given to illustrating examples of bad land use practices (e.g. in agriculture) as part of improving a general understanding of factors which will exacerbate climate change (Alqueva Portugal MAP). Tackling climate change through land use requires contemporary knowledge and understanding, enabled by suitable parts of EIP-Agri, an AKIS, or science-society-policy interfaces (e.g. SEFARI Gateway, Scotland, UK MAPs), and models of Living Labs and Multi-Actor Platforms.

Skilled labour is required in rural areas that are appropriate to mitigation actions. Such skills come with training of the existing workforce, across its stages of career, or attracting new skills into rural areas as part of their revitalisation and reversing depopulation (Schleswig-Holstein German MAP; Hungary Land Use MAP; Alqueva Portugal MAP; UK MAPs).

All types of actors benefit from mentoring. Such mentoring should be available for staff involved in planning and handling processes of applications for measures of support (e.g. agricultural, rural development), and the recipients of those measures. It should be provided on a professional basis, with systems of accreditation available for those providing the mentoring. An aim of such accreditation systems should be to provide recipients of mentoring with confidence in the quality of the support received, and to safeguard those providing support (UK MAPs).

Existing options for funding for training, education and information dissemination exist through the European Regional Development Fund (ERDF) and the European Social Fund Plus (ESF+). CAP funds and the LEADER/Community-Led Local Development (CLLD) instrument can also be used for the training of farmers, foresters and rural communities. The EU Mission on Adaptation to Climate Change also supports the creation of citizen awareness and engagement programmes.

Recommendation for policy, practice and research

Policy:

- Funding mechanisms are required to enable the upskilling of all sectors of the workforce in the types of skills required to enable uptake and utilisation of materials made available through open science, in line with the commitment to training and lifelong learning in the European Pillar of Human Rights, and regional levels.

- Provision of frameworks for training and learning through which actors can receive credits for professional development.

- Broaden the roles of agricultural advisory services in which advisors can act as initiators of land use change and climate change adaptation.

Practice:

- Support land managers in transitions to alternative land uses, with mechanisms designed for gaining relevant new skills, training and information on the implementation of new land uses (or new to them), and the application of new technologies and practices.

- Creation of voluntary mentoring systems for all types of actors, providing one-to-one access for sharing experiences, with coordination by recognised bodies (e.g. farmers unions; NGOs).

Research:

- Review programmes of Continuing Professional Development in sectors relevant to tackling climate change through uses of land to identify availability, relevance and any evidence of their significance in tackling climate change.

- Identification of the skills required for delivering each stage of change in land use, and equitable access to such skills locally.

- To understand the roles of training and education in the identification of opportunities, design of activities, and their implementation in adapting to climate change.

- Review structures that facilitate the transfer of knowledge within and between countries and regions, and the types of models which might be most impactful.

4.3 Measurement and Monitoring

The expansion of the use of digital tools in land sector businesses, public agencies and by citizens is introducing new means of detecting, measuring and reporting the physical impacts of climate change and of its characteristics (e.g. GHG emissions).

Digitalisation in agriculture offers considerable potential for more efficient use of resources (e.g. reducing inputs), minimising adverse impacts (e.g. soil compaction), monitoring GHG emissions (e.g. with eddy covariance flux towers; with sensor networks for near real-time site and field level reporting of GHG emissions), flexibility in land management (e.g. virtual fencing), and managing for animal and plant disease (e.g. animal tracing). Investment is being made by land managers, public authorities and communities in such digitalisation of land management, some funded by CAP mechanisms or equivalents (e.g. UK MAPs).

Investing in technology and the infrastructure required can be expensive and requires appropriate knowledge for it to be usable, and does not eliminate the triggers of problems (e.g. soil erosion, organic matter content of soils) (Hungary Land Use MAP). Principal beneficiaries may be large farms reflecting the costs for systems (e.g. fertiliser spreading and mapping). Smaller farms risk being left behind.

Technologies that support digitally enabled data measurement (e.g. on-farm LoRaWAN networks) should be supported, and consideration given to the access and governance of the data generated for use at local, regional and national levels, and whether such data are public or private goods, and reporting at multiple levels (UK MAPs). The feasibility of digital solutions is aided by their low cost, flexibility and ease of deployment. However, further development is likely to be required to ensure they are durable under the practicalities of field conditions in different biophysical environments, and able to operate under extreme climatic occurrences (e.g. heat, cold, precipitation).

The development and roll-out of digital solutions is having additional consequences of creating demand for skills in the land sectors (e.g. agriculture, forestry, water management, peatland restoration, renewable energy systems) which can be expected to offer higher paid jobs than many traditional areas of rural employment. The consolidation of such jobs in rural areas can contribute to the wider aims of the LTVRAs, attracting younger people and women into the sector (Schleswig Holstein MAP Germany; UK MAPs). However, benefits packages will require to be tailored to reflect local competition for labour and economic return from land-based industries (Hungary Land Use MAP; UK MAPs).

The Horizon Europe Climate Mission calls for science to support communities develop a deep understanding of current socio-ecological changes, building their capacities to imagine and shape innovative future pathways. Programmes such as Horizon Europe and its Innovation Actions are a further source for small sums through mechanisms such as cascade funding. They provide technical expertise to accompany participation by civil society, business and public authorities. Although individual projects are not long-term in nature they can be the basis of longer-term relationships with research and innovation organisations. Efforts should be redoubled to encourage the involvement of all types of eligible organisations (UK MAPs).

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, 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).

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). The use of such scientific knowledge together with the rural community's experience in mitigating and adapting to climate change can enable the development of region-specific adaptation plans (programmes). (Poland MAP).

> "A well-executed climate change forecast for a region is the basis for taking appropriate adaptation measures." (Zachodniopomorskie Poland MAP).

The provision of spatial, or georeferenced data, from private sector suppliers continues to increase, with a trend towards imagery which is available at higher spatial and temporal resolutions (e.g. from satellites, aircraft or drones). The low entry cost for drone technology is creating conditions for the provision of services by rural location micro and small businesses, such as monitoring peatland restoration or deployment of natural flood management interventions (UK MAPs).

Environmental and socio-economic data, accessible by all interested parties, is one of the three main policy goals for EU research and innovation, which argues that participation of citizen groups, academia, industry and public authorities in the research and innovation process increases creativity and trust in science. Data collected and provided by citizens and civil society organisations are becoming more common (citizen science), through formal or informal routes, potentially significantly broadening the sources and basis of observations and the institutional arrangements. Such sources of data have strengths and weaknesses, requiring clear processes of governance and quality control to ensure that data are objective and subject to advocacy groups and politicising (SHERPA, 2023).

Examples are the online topographic mapping from Open Streetmap, and portals enabling access to citizen collected data with enhanced contextual information or narratives (e.g. the UK National Biodiversity Atlas). The portal EU-Citizen.Science provides an extensive resource of such datasets, many of which are dedicated to climate mitigation or adaptation.

The voluntary provision of data from sectoral stakeholders is also increasing, some as a component of transitions towards new processes of monitoring environmental conditions such as carbon stored in soils in arable fields (e.g. soil sampling, Scotland, UK). In the future monitoring could be augmented by data measured by digital sensors and transmitted into central databases for analysis.

A prospective direction of travel is for digital approaches to data collection to inform result-based carbon farming payments. Such results-based approaches to considering carbon in farming is set out in the EU Technical Guidance Handbook (COWI, Ecologic Institute and IEEP, 2021), in five thematic areas: peatland restoration and rewetting; agroforestry; maintaining and enhancing Soil Organic Carbon (SOC) in mineral soils; managing SOC on grasslands; and livestock. For carbon farming to be implemented at the EU level, it would be necessary to develop indicators and a calculation methodology to implement pilot projects involving farms, to develop a common CO2 trading system, and to share experiences related to the operation of the system (Emilia Romagna Italy MAP).

There are gaps in capturing information on human emotions and well-being in relation to climate change and its consequences. Some aspects are captured in Eurobarometers, but little in terms of links of climate change to key characteristics of human quality of life, and how those change over time (UK MAPs).

The introduction of these types of new concepts, technologies, and their interpretation need to be trusted, with authoritative and accurate evidence and information. Despite the significant expansion of means of monitoring, measurement and use of digital tools, in some countries, there is a lack of information on technical standards to which environmental management and interventions should adhere to have the desired outcomes (Alqueva Portugal MAP 2021). Adherence to such standards may be in interventions at different levels (e.g. farm, regional), and may require collaboration between actors (e.g. multiple land owners; Climatically Friendly Villages Czechia MAP).

Enabling access, validation and quality control align with the expectations of a LTVRA Action Plan flagship Rural Observatory, and is consistent with policies on open science.

Recommendations for policy and practice

Policy:

- Create more effective mechanisms for facilitating open access to scientific knowledge and data for policy, business and communities in the development of climate change risk assessments, adaptation programmes and plans.
- Expand the series of capturing information about social attitudes to time series of human wellbeing.
- European Open Data and Science Policy should be updated to improve support for citizen science and business models that promote monitoring of climate change and its characteristics using digital tools, and tackle inequalities and exclusion from making such contributions (e.g. due to constraints of finance, attitudes, understanding benefits).

Practice:

- Easily understood guidance is required on the rights of data providers, IPR and ethical considerations in support of widening the basis of the provision of data in rural areas (e.g. citizen science).
- Research organisations would benefit from improving means of reaching out and mentoring prospective partners from civil society and businesses who may not have the knowledge or experience of requirements and processes of applications.

Research:

- Assessments are required of the risks and potential significance of cyber attacks on the measurement and monitoring of environmental characteristics (e.g. sensors reporting site-level GHG emissions), in preparation for their use in relation to payments schemes.
- For reporting at a European level, where and how many eddy covariance flux towers would be required to improve the accuracy of models of GHG emissions?
- Understanding what motivates individuals to get involved in citizen science. This is necessary for the recruitment and retention of individuals in such efforts and so broadening the means of capturing environmental observations.

4.4 Stakeholder and Public Attitudes

To motivate effective actions to mitigate or adapt to climate change requires public support. As reported in the SHERPA Position Paper on Climate Change and Environmental Sustainability (Miller et al., 2022), 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). The fieldwork of the survey was in the first year of the COVID-19 pandemic (spread of infectious diseases ranked 2nd, 17% respondents), and prior to the conflict in Ukraine in February 2022 (4% cited armed conflicts). So, the relative significance assigned to climate change by European citizens could have changed.

The majority of respondents consider it very important that the EU (53%) or national governments (51%) set ambitious targets to increase the amount of renewable energy used by 2030, ranging from 32% (Latvia) to 74% (Portugal). There is significant support for the belief that the costs of damage due to climate change are greater than the level of investments needed for a green transition (74%). The majority of respondents also 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.

Not all actors agree with the nature of the changes required, or the actions that may be required of them or their sectors (Climatically Friendly Villages Czechia MAP). Particular views emerging relate to the roles of different land uses, in different areas of Europe. For example, in Portugal there is evidence of regional populations considering agriculture as part of climate change's cause, not a solution. In parts of the UK there is concern about the dominance of land use by coniferous plantation forestry.

Changes in farming systems can be expected to require accompanying changes in consumer preferences and behaviours, lifestyles and human diets (as intimated in Section 1) (South Region France MAP; Schleswig-Holstein Germany MAP; Hungary Land Use MAP; UK MAPs). Findings reported in the Eurobarometer (European Commission, 2021c) indicate that in 2021 16% of respondents considered implications for climate change when purchasing food (18% in 2019).

Indications of further actions by consumers regarding preferences and diets are indicated by those who would eat more organic food (32%), with responses varying nationally between 12% (Hungary) and 49% (Slovenia) and buying and eating less meat (31%), with responses varying nationally between 12% (Romania) and 55% (Netherlands). Further research is needed to understand the barriers to changes in human diets, and the roles of labelling (e.g. consumer preferences and trade-offs between high animal welfare, organic meat products, local food, low-fat, carbon footprint, and fair-trade).

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

Success in achieving these targets would be in line with Principle 1 of the European Pillars of Social Rights, of Education, Training and life-long learning, in particular, the element of maintaining and acquiring … "skills that enable them to participate fully in society and manage successfully transitions in the labour market." At an EU level, the strategy would contribute to the EU Youth Strategy, building "a bridge between the EU and young people to regain trust and increase participation." (European Union, 2018).

Further requirements for policy and research

Policy:

- Programmes for capturing evidence of public attitudes towards climate change should be complemented by analysis of actual human behaviours in greater depth than the examples in the recent Eurobarometers.

Research:

- Target audiences in surveys of public attitudes towards climate change, at international, EU and national levels should be extended to enable insights which are valid at greater levels of spatial granularity (e.g regions, mountains, islands) and demographics beyond gender and age (e.g. abilities)

- To understand changes in public associations of land management practices with cultural heritage with an aim of identifying approaches to addressing potential resistance to new regulations or best practices (e.g. use of peat and peatlands; expansion of woodlands; water usage).

- Understanding 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

- Improved 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.

4.5 Legislation and Regulations

The design, implementation and monitoring of impacts of policies and measures relevant to achieving those aims operate under different regulatory and administrative systems and geographic levels (e.g. European, national, regional). They are also codified in ways that carry different levels of authority such as legislation, agreements, protocols, guidance and best practice.

Changes in land use in mitigating or adapting to climate change are unlikely to be replacements one for another or take place in isolation in place or time, with subsequent impacts as the social, economic and environmental systems evolve. As noted elsewhere, the principles of social justice intersect the need and mechanisms of tackling climate change. There can be spatial dependencies (e.g. downstream in a water catchment, within a landscape view, exposure to the air breathed) that transfer impacts to neighbours or other members of the population and for which collaborative forums may be required to share an understanding of actions, impacts and their mitigation (e.g. South Region France MAP).

There is also a question of who has the right to decide on a change in land use, who benefits (e.g. income from a new source), who has the liabilities, and who has responsibilities for managing the area in the long term. Some countries have constraints on who, or what types, of organisations, can own or manage land (e.g. Agriculture Act, Denmark) recognising challenges that can arise from absentee landlords (e.g. Denmark MAP). Scotland (UK) is proposing the introduction of a public interest test for land ownership brought forward under its planned legislation on Land Reform in a Net Zero Country.

Suitable conditions can and should be created for the effective management of land and water by enabling the effective planning and arrangement of land parcels in ways that take account of factors such as erosion and flood control. Therefore, collective benefits can accrue by designing environmental sustainability into the infrastructure of processes of allocating land to owners (e.g. the Complex Land Consolidation, Climatically Friendly Villages Czechia MAP; Multifunctional land reparcelling, Denmark MAP). Restructuring land parcels also offers a range of opportunities for rural development, and the development of attractive and vibrant villages, if approached in an inclusive and multifunctional manner. Such attention is being directed towards village renewal (Denmark MAP).

Restructuring land ownership parcels and land consolidation offer opportunities for changing the spatial arrangements of units, the details of which differ between countries. In Czechia, Complex Land Consolidation (CLC) of non-forest land is undertaken to ensure accessibility of land, and use for rational management, and to improve its economic, natural and landscape functions. Rearranging land ownership parcels in new and more efficient ways progressively removes legal inconsistencies created by land reform during the socialist era, whilst also a rare opportunity to reorganise the layout of land uses to reduce the impacts of climate change (e.g. drought, overheating, flooding, extreme weather events, land degradation). However, the process is slow, with a need to adjust its objectives, revise the governing legislation to make it more flexible (e.g. prioritise areas most at risk of drought and soil erosion when CLC is commencing), and stimulate the interest of municipalities and the owners of large farms of the opportunities for pressing for more rapid opportunities for implementing change.

Further requirements for policy

Policy:

- Accelerate processes which have the prospect of changing the basis of decision-making regarding land use in relation to the structure of its ownership and management, with country-specific aims and implementation.
- Review the eligibility of land consolidation for financial support of the process (e.g. of the implementation of CLC in Czechia).
- Adopting a principle of the wording of regulations being subjected to a plain language test the aim of which would be to improve adherence and enhance uptake of measures.
- Simplification of the administrative complexity of applications, progress and financial reporting. Investment is required in mechanisms that build the capabilities of prospective applicants and project management teams. Such mechanisms should include effective means of online help, mentoring and training, tailored to the intended audiences and the differences in their levels of capability.

5. Contribution from the SHERPA EU MAP

The EU-level MAP met in January 2023 to discuss the topic of climate change and land use, informed by the results of the MAP Position Papers of the SHERPA national and regional MAPs. During the meeting, MAP members reflected on the recommendations developed by the MAPs and discussed how these recommendations regarding rural policies related to climate change and land use in rural areas can be supported at the EU level, as well as which research gaps and needs to be addressed by EU programming. The main takeaways of the meeting are summarised below.

The challenges for fighting climate change

The role of land use in climate change presents a series of complex issues that need to be prioritised against a tight timeline. Climate change is considered to be one of the most serious problems in the world; nearly one in five Europeans believe that climate change is even the most serious problem[1]. Nevertheless, tackling the problem of climate change is not straightforward.

Firstly, due to the rapid consequences of climate change, public authorities and private investments oftentimes struggle to catch up and provide solutions to tackle the emerging problems. Furthermore, despite experiencing political momentum that can help advance ambitious goals and targets to counteract the immediate effects of climate change, there is an increasing discontent in rural areas (i.e. geography of discontent) building on a growing scepticism towards climate change when compared to urban areas[2]. This can be due to a lack of knowledge, available information, or understanding of research among others, which creates fertile ground for extremist political parties, known for denying even the existence of climate change or its effects on nature and livelihoods.

Additionally, the diversity of land use across the EU (e.g. northern Europe vs southern Europe) needs to be considered as well when considering how to fight climate change, as this presents a varied range of challenges (e.g. water management, drought, etc.).

[1] https://europa.eu/eurobarometer/surveys/detail/2273
[2] Weckroth, M., & Ala-Mantila, S. (2022). Socioeconomic geography of climate change views in Europe. Global Environmental Change, 72, 102453.

The energy potential of rural areas

The development of renewable energies is a key element in tackling climate change and ensuring energy security and rural areas can play a crucial role in this. However, there is a need to bridge the capacity gap between medium and large-scale developments, and the benefits that these can bring to the rural community. In this regard, rural energy communities can be a part of the solution: their role in (remote) rural areas is highly relevant and can enhance the resilience of these areas. However, the type of technology that is used by rural energy communities needs to be prioritised based on the community benefits it can bring, and its effectiveness in tackling climate change. In turn, this will ensure less disruptive changes and more ownership of the community/rural area over the decision-making process.

One aspect to consider in regard to energy generation in rural areas is the use of land (i.e. as efficient as possible) while also taking into consideration public acceptance. Energy investments are changing the value of land in terms of pricing and competition. As a consequence, there is a (moral) dilemma on how the land should be utilised: for developing energy infrastructure (e.g. solar panels, wind farms, etc.), for agriculture, for producing food to ensure self-sufficiency, etc. These decisions need to be viewed within a wider context; for instance, coastal environments, which are mostly remote and rural areas, comparatively play a more prominent role in renewable energy generation, alongside the production of biomass.

The food value chain and climate change

Climate change is not only affecting agriculture but also all other elements of the food value chain, from processing to storage, as well as transport and distribution. Contradictory, when it comes to public perception, agriculture is seen as the primary responsible for carbon emissions in Europe of the food value chain. This narrative needs to change and be aligned with the reality that agriculture does not play this role. Additionally, the importance of circular economy in relation to the food value chain should not be underestimated, as it plays a vital role in regard to food waste and food loss. Furthermore, to counter the impact of climate change on food and the related value chains, the entirety of the food system needs to be closely monitored and actively worked with, in order to improve its sustainability and act upon opportunities it can bring to tackle climate change.

The future legislation and framework on sustainable food systems that the EU aims to establish by autumn 2023 presents an excellent yet challenging opportunity to further address sustainability along the food value chains. The impacts this will have on rural areas and land use need to be considered, potentially driving the ecological transition in the agri-food ecosystem.

The governance of land use

To address climate change, a collaborative cross-sectoral approach is needed as it is not a linear problem; each area spills into and influences another. There is also a switch that needs to happen, from a purely agricultural focus towards a rural environment and community perspective. It is important to step away from thinking and acting in silos, as this will not solve systemic issues and only patch the problem instead of providing a holistic solution. Furthermore, a collaborative cross-sectoral approach would facilitate learning from other transition processes (e.g. just transition, rehabilitation of land, land repurposing) that are taking place and could show which paths to take (or which not) and learn from their best and worst practices.

Additionally, it will be crucial to combine the aforementioned collaborative cross-sectorial approach with a multi-level governance approach in the development of adequate solutions to address land use in rural areas. Rural proofing, a systematic process to review the likely impact of policies, programmes, and initiatives due to their specific circumstances or needs[1], has the potential to adapt all policies (no matter the topic) at multiple governance levels to better account for rural areas' challenges and respond to their immediate and future needs. In addition, the EU is already contributing by financing a multitude of multi-actor projects that test and experiment with diverse application methods in finding suitable solutions to fight climate change via Horizon Europe (the EU's key funding programme for research and innovation). Such dedicated research can enable EU citizens, decision-makers and economic and social actors to understand the consequences of continuing with the status quo. However, this information needs to be shared in a relatable and adaptable manner in order to avoid the risk of scepticism on the topic.

Suggestions for future research at EU level

Two main aspects are to be considered to address the research and knowledge gaps in relation to climate change and land use: data and the lack thereof, and the development of available and transferable models for foresight/forecasting at the necessary levels. There is a clear need for a deeper understanding of rural areas' vulnerability to the climate crisis, which is linked to the lack of granularity of data necessary to understand the tangible effects of climate change. Similarly, the development of different models that could be applied to a variety of land types and land usages in order to analyse the change dependencies over time, could bring opportunities for disadvantaged communities.

Similarly, an avenue for new research could build on the work undertaken by 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).
The contribution of the SHERPA EU-level MAP has been developed based on oral and written comments from its members, each participating in a personal capacity as an individual expert.

[3] https://enrd.ec.europa.eu/sites/default/files/background_paper-rural_proofing-jane_atterton_220127.pdf

6. Local, Regional, National or European Level Recommendations

The detailed recommendations for policy, practice and research are set out in relation to each topic in the preceding sections. Most recommendations have relevance to several levels of governance, but possibly vary by country as a reflection of differences in remits and authorities of public administrations.

Some recommendations have explicit relevance at local, regional/national or European levels of territorial governance. Where appropriate those are summarised below.

European level recommendations

Recommendations for policy at a European level are broader and more aspirational in nature, and include some principles and proposals for responding to weaknesses in current arrangements or actions.

Most significant amongst those are that European policies should ensure long-term goals for tackling climate change are unambiguous, and that short and medium-term goals are up-to-date with requirements to tackle climate change. Policy measures should be coupled with ambitious visions for rural development.

A cross-cutting principle of spatial planning to tackle climate change should be that the uses of land should enable responsive adaptation that handles perturbations to pathways to climate neutrality through flexibility in timing, funding and the short-term goals of individual measures. Such planning should be coherent across spatial scales at national and regional, through to local levels. There is also a need to ensure coherence between National CAP Strategic Plans, National Energy Carbon Plans and the European Semester Country Reports, and the effectiveness of their translation into the Nationally Determined Contributions. Otherwise as noted by the IPCC (2023), there is an 'implementation gap' in the timing of policy implementation compared to estimates of emissions set out in the NDCs.

However, recognition is required of the types of barriers to transformations of land required to tackle climate change, and how they vary across Europe. These include political leadership (e.g. tackling climate change not being a priority at local or regional levels), regulatory issues (e.g. access to land), institutional frameworks (e.g. legal bases for formalising community authority for handling funds, ownership or equity in business ventures), business systems (e.g. locked into unsustainable contracts or practices), attitudes and perceptions of current and new land managers (e.g. on the uptake of new technologies), human capital (e.g. skills, knowledge of how to access information), and social capital (e.g. community organisation).

A particular focus should be on place-based approaches to the design and tailoring of actions to the needs and characteristics of local areas. Progress has been made in recognising the importance of community involvement in visioning, planning and acting on tackling climate change, and mechanisms for its operationalisation. However, a further enabler is required which empowers communities to allocate and direct resources to actions on the ground, such as participatory budgeting, which could be a component in the EU Cohesion Fund in the 2028-34 multiannual financial funding framework.

There is a need for insights into the impacts on communities at local levels created by investments in the EU Just Transition Fund, for which qualitative evaluations are appropriate, to complement the quantitative approaches outlined in the Just Transition Mechanisms.

Effective means of measuring and monitoring greenhouse gas emissions is an essential element of informing policy across Europe of what and how quickly actions are required to achieve targets of limiting global warming to 1.5oC above pre-industrial levels, which should include a Europe-wide strategy for monitoring. Such measurements should also form part of an overall communications strategy and open access to data and information on trends for public and stakeholder audiences. In support, the European Open Data and Science Policy should be updated to improve support for citizen science and business models that promote the monitoring of climate change and its characteristics, and tackle inequalities and exclusion from making such contributions (e.g. due to constraints of finance, attitudes, understanding benefits).

At an EU level, the Eurobarometer and equivalent surveys provide evidence about public attitudes, including in relation to climate change. However, such evidence is limited in scope and nature. Surveys of public attitudes towards climate change, at international, EU and national levels, should be extended to enable insights which are valid at greater levels of spatial granularity (e.g. regions, mountains, islands) and demographics beyond gender and age (e.g. in relation to abilities). Qualitative research should be included in these continent-wide surveys to provide greater prospects of understanding why actions and behaviours do or do not change.

National and regional level recommendations

Legislative or regulatory measures for tackling climate change through the lens of land use generally fall within the remits of national or regional governments (e.g. EU Member States and devolved administrations). At these levels of governance, some recommendations for policy have associated proposals for practice or research. It is at this level that frameworks most closely aligned to financial support and legal constraints operate.

Regulations across countries and regions vary in terms of constraints in relation to land such as its uses and tenure, and changes in each. Four examples are highlighted.

1)In some countries processes of land consolidation offer the potential for changing the allocation of land resources to individuals or organisations, and so the decision-makers on tracts of land. However, the processes can be slow and expensive. There is a need to review the eligibility of land consolidation for financial support through EU and national mechanisms.

2)Regulations relating to the development of renewable energy systems (e.g. wind energy, solar, biomass) also require to be reshaped at relevant national and regional levels to reduce constraints on development whilst ensuring the protection of natural and cultural heritage, agricultural production and other assets as appropriate. For example, best practices in the development of peatland and carbon-rich soils should be full account taken of the overall balance of carbon saved and released.

3)Legislation at relevant national or regional levels should remove barriers to investment in agroforestry, such as reconsidering the prohibition of planting on land designed for arable crop production.

4)Where not currently in place, Landscape and Water Management Communities should be established with aim of developing land use and river basin management plans, taking account of technical challenges and governance, and encouraging technical, product, and social innovations.

As with the recommendations at a European level, those at national and regional policies should ensure long-term goals for tackling climate change are unambiguous and up-to-date. They should include spatial frameworks that direct the investment in mitigation and adaptation actions for maximum returns, recognizing the changes in types and magnitude of benefits through time, such as temporal pathways of GHG emissions sequestered due to woodland expansion or peatland restoration. Such spatial frameworks and associated land use plans should be coherent, applicable across all sectors, and tailored to the relevant levels and forms of governance. They should be structured in a way that enables them to be informed by relevant new evidence (e.g. GHG emissions estimated from updated data on land use and land management practices), and be responsive to the changing circumstances of territories. They should also be informed by contemporary information on the likely impacts of climate change on agricultural production at national and regional levels.

Spatial planning for rural areas should take into account the potential to incorporate natural capital into its processes (e.g. of land use), payments under the CAP (e.g. land management measures), and leveraging resources for communities or businesses (e.g. the valuation of carbon). They should be linked to clear mechanisms of governance that demonstrate the empowerment of local communities to contribute to planning. As noted under recommendations for an EU level, community empowerment should include the directing of financial resources (e.g. participatory budgeting).

At national and regional levels, sources of funding should be identified that are of the most relevance. For example, a levy on large-scale infrastructure projects, including those of renewable energy (e.g. windfarms, solar farms, hydro-electric schemes, large-scale biomass production, Carbon Capture and Storage), and prospective returns on investment in natural capital (e.g. carbon credits associated with peatland restoration, rewilding, woodland expansion; UK MAPs) should be designed and available for investment in, or directed by, governance structures that involve or are led by communities.

National CAP Strategic Plans should enable the retention of value on-farm from when measures are taken to manage carbon, and water and enhance biodiversity, whilst also rewarding cooperation between farm holdings. Farm plans should address how levels of soil organic carbon can be increased, and carbon losses be reduced. This should be supported by the provision of knowledge and information that increase the level of land managers' understanding of associated benefits (e.g. improved outputs, reduced inputs, public goods enhanced).

National and regional innovation ecosystems are required that enable equitable access to knowledge of technologies, business development and soft skills, and facilitate access to finance at territorial levels, with a particular emphasis on SMEs, micro-businesses and community-led initiatives. Such ecosystems should include mechanisms for overcoming disadvantages in place, human, social or financial capital, and a particular emphasis on scaling out innovations, and sharing knowledge and experiences.

Agricultural and Knowledge Information Systems (AKIS) should include information and evidence targeting the management and enhancement of natural capital, with an identifiable grouping within the new EU CAP Network (e.g. Focus Group, Thematic Working Group). The outcome sought is an increase in the investment in natural capital to reduce GHG emissions and benefits for environmental sustainability.

Local level recommendations

The impacts of climate change on individual citizens are felt most directly at the local level. It is at this level that actions are realised on the ground, and thus some types of barriers or enablers are evident. No definition of 'local' is used in this summary, but certain recommendations have been identified as of particular relevance to policies developed or delivered at levels characterised by water catchments, landscape types and clusters of communities.

To enable decisions to be made about changes in land management to be well-informed and with successful outcomes, there is a requirement for training and development of skills. Mechanisms should be supported that equip current and new land managers with the knowledge and skills necessary for gaining relevant new skills, training and information on the implementation of new land uses (or new to them), and the application of new technologies and practices.

These mechanisms should provide means by which aspiring new land managers can become aware of the range of opportunities already available, as well as those of new topics for skilling. For example, strategies for training in relation to peatland restoration should support increasing the capabilities of SMEs, micro-businesses and communities, with a vision of developing hubs for natural capital innovation, investment and stimulating new forms of economic activity. This should be accompanied by support for communities of practice of 'peat citizens', similar to those of energy communities and energy citizens with on-site demonstrations of good practices. Information should be disseminated about progress on restoration linked to estimates of GHG emissions mitigated, updated through time. In this example of a need for developing skills, the aim should be to reinforce messages of what is being achieved by restoration, to encourage scaling out of similar practices, and to contribute to minimising frustrations amongst the public and stakeholders of the time taken to translate plans into actions.

All types of actors benefit from good quality mentoring. Independent sources of advice and guidance can help overcome challenges and avoid problems that may have been reported elsewhere. The potential benefits of mentoring can be expected to be greater for citizens, communities and small organisations which have no or limited in-house resources to build capabilities. Mechanisms should be designed to offer relevant forms of voluntary mentoring systems, providing one-to-one access for sharing knowledge and experiences. Such mentoring should be made accessible through appropriately recognised bodies (e.g. farmers' unions; NGOs; business support teams) with a view to ensuring the quality of content of materials shared, within a framework that safeguards both mentees and mentors.

7. Concluding Remarks

Transitioning to net zero GHG emission is a collective challenge for institutions, places, and individuals. Generally, the starting point for each differs across Europe and by the level of governance. The objective remains of limiting global warming to a rise no more than 1.5oC, and net zero GHG emissions by the mid-21st century. Achieving those objectives must be coherent with addressing other challenges of reversing the loss of biodiversity and reducing societal inequalities (territorial and access to resources), all three of which have interdependencies. However, the IPCC (2023) highlights the prospects of an overshoot of the target of 1.5oC above pre-industrial levels. They note the 'implementation gap' in the timing of policies being enacted compared to their inclusion in the NDCs, and that "without a strengthening of policies, global warming of 3.2 [2.2–3.5]°C is projected by 2100."

The design of appropriate policies, institutions and governance systems, at all scales, can contribute to land-related adaptation and mitigation while facilitating the pursuit of climate-adaptive development pathways. Mutually supportive climate and land policies have the potential to save resources, amplify social resilience, support the ecological restoration, and foster engagement and collaboration between all stakeholders.

The use and management of rural land have multiple roles in tackling these objectives. It offers extensive opportunities for absorbing the impacts of climate change, mitigating greenhouse gas emissions, and adapting to new environmental, social and economic contexts. However, it is not indestructible. It is a resource with shared benefits, delivering on multiple common and private goods, under different types of stewardship and organisation which are also undergoing changes, albeit slowly.

Such transitions will not be linear, with uninterrupted pathways, requiring changes in approach on the journey. Citizens, businesses and organisations all suffered losses over the 3 years of the COVID-19 pandemic and subsequent cost of living crises and conflict in Europe. A challenge for leaders in politics, business and civil society is to manage the pathways of transitions within their remits, and in recognition of interactions between sectors, places, and levels and types of governance.

Those able to move quickest, to have the greatest positive impacts, or require the least direct support should be encouraged to do so whilst respecting and not disadvantaging the actions of other actors who may have to operate over longer timescales. Transitions also provide opportunities to tackle inequalities between areas in terms of access to resources, the basis for means of support, and achieving on aims of the EU LTVRA of being stronger, connected, resilient and prosperous and a securing a desirable future (Chartier et al., 2021).

The responsibilities of European organisations and citizens for how the land can be used in tackling climate change are not restricted to Europe. Food and energy systems which are part of the ways of life of European citizens have extensive dependencies on land uses in neighbouring countries and further afield around the globe. Understanding that global connectedness on the uses of land is one aspect of managing transitions within the rural areas of Europe that are demonstrably just for all citizens.

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Appendix 1. List of Position Papers of SHERPA Multi-Actor Platforms on Climate Change and Land Use

The SHERPA Position Paper on Climate Change and Land Use was developed from the evidence and positions set out by the Multi-Actor Platforms of Climatically Friendly Villages (Czechia), VENUS (Czechia), Denmark, Schleswig-Holstein MAP (Germany), Hungary Land Use MAP (Hungary), Emilia Romagna (Italy), Greenport Gelderland (Netherlands), P10 (Netherlands), Zachodniopomorskie (Poland), Alqueva (Portugal), River Dee Catchment (UK) and Rural Scotland (UK).

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