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Rural Science-Society-Policy Interfaces

MAP Position Paper

LAND USE & CLIMATE CHANGE

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https://rural-interfaces.eu/maps/hungary-land-use-planning-for-climate-neutrality/

Summary and key messages

Climate change poses challenges to land use that cumulate with other non-climate related challenges, such as population growth, increasing demand on limited resources by diverse actors, and land degradation. Moreover, improper land-use management and unsustainable urban development can intensify hazards including flooding and heat stress, hence intensifying the exposure of communities to such hazards.

The land-based sector is distinctive because of its strategic role in food security, the fact that it extends over a large part of the territory and because it impacts on water, air, climate and nature in profound ways. It is managed in mainly fragmented small and micro family businesses on a wide diversity of soils, climate, topography and ecosystems. Land managers are embedded between highly concentrated upstream suppliers and downstream processors, retailers and food service companies. Many farms have no paid workers but there are some with a significant workforce, including a group that are heavily reliant on casual and seasonal workers. Rather exceptionally, there is already extensive policy intervention, not least via Europe's Common Agricultural Policy (CAP).

The United Nations defines sustainable land management (SLM) as "the use of land resources, including soils, water, animals and plants, for the production of goods to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions". Because of climate change and variability, **selecting the right land uses** for given biophysical and socio-economic conditions, and implementing SLM, are essential for minimising land degradation, rehabilitating degraded land, ensuring the sustainable use of land resources (i.e. soils, water and biodiversity) and for carbon sequestration.

Drawing from the IPCC "Climate change and land" study, it is necessary to develop **sustainable land use strategies** as soon as possible, including land-use zoning, spatial planning, integrated landscape planning, regulations, incentives (such as payment for ecosystem services), as well as voluntary or persuasive instruments (such as environmental farm planning, standards and certification for sustainable production, use of scientific, local knowledge and collective action) that can achieve positive adaptation and mitigation outcomes.

Appropriate design of 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 ecological restoration, and foster engagement and collaboration between multiple stakeholders.

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, forest, energy, land, water, finance and planning).

Recommendations of MAP members for future rural policies are the following:

- Development of land use planning and strategy considering the state and services of ecosystems
- Encouraging land use change in unfavourable areas for arable cultivation
- Establishment of local landscape and water management communities
- Consideration of treated wastewater and sewage sludge in the nutrient cycle and their use in the circular economy
- Instead of incentives, more mandatory regulations with a just transition
- The role of environmental added value in the distribution of funds should be strengthened

- Quantification of ecological services and the development of a methodology for the compensation of ecological services
- Collection, support and promotion of social innovations
- Development and presentation of indisputable land use alternatives, and a farmer decision support system and advice would help farmer

1. Introduction

The EEA Signals 2019 'Land and soil in Europe' explains key pressures — such as urban sprawl, contamination, intensive use of agricultural land, landscape fragmentation — impacting Europe's land and soil. **Land use has a global dimension.** Many of the activities linked to land and its resources, in particular food production and resource extraction, are subject to global market forces. For example, **global demand** for fodder, food and bioenergy affect local agricultural production in many parts of the world, including Europe. Droughts and production shortages in exporting countries affect the global prices of, for instance, rice — a staple food for billions of people. Multinational companies can buy productive agricultural land in Africa and South America with a view to selling their products throughout the world.

Our consumption choices, diets or farming practices can have an impact on the health of our soils and land. Market prices for food and land, the productivity of land, climate change and pressure from urban sprawl may all force farmers to adopt monoculture or intensive farming practices to remain economically viable. It is not surprising that many farming communities across Europe face abandoned land and young people migrating to urban areas, especially in areas with low agricultural productivity. Similarly, individual urban planners may choose to limit urban sprawl by converting old industrial sites into new urban areas but authorities may lack the resources needed. In many cases, cleaning and remediating land in industrial areas may be more costly than expanding the infrastructure and building on farmland.

The way we use land and soil is also directly linked to **climate change**. Soil contains significant amounts of carbon and nitrogen, which can be released into the atmosphere depending on how we use the land. Clearing tropical forests for cattle grazing or planting forests in Europe can tilt the global greenhouse gas emission's balance in one way or the other. The melting of permafrost due to rising average global temperatures can release significant amounts of greenhouse gases, methane in particular, and accelerate temperature rise. Climate change can also substantially alter what European farmers can produce and where.

Soil and land have increasingly been recognised as vital and finite resources globally as well as in Europe. They face increasing pressures, including those linked to climate change and biodiversity loss. For example, a recent Special Report from the Intergovernmental Panel on Climate Change (IPCC, 2020) brings a global perspective to the challenges ahead by looking at land degradation, sustainable land management, food security and greenhouse gas fluxes in terrestrial ecosystems in the context of climate change. A report by the IPBES, (the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, 2018) highlights the scope of global land degradation and its implications. A more recent global assessment by IPBES draws attention to the accelerating decline in biodiversity, including land-based species, which is caused by, among other factors, changes in land use.

Given this, many global **policy frameworks**, including the United Nations **Sustainable Development Goals,** in particular Goal 15: Life on Land and Goal 2: Zero Hunger , directly and indirectly address land and soil. European policies, including the EU's Soil Thematic Strategy (EC 2021) and Biodiversity Strategy (EC 2020), aim to tackle land take, reduce landscape fragmentation, pollutant emissions and greenhouse gas emissions, and protect biodiversity and soil. However, in some of these policy domains, protecting the condition of soil in particular, European and global policies fall short of setting targets and commitments — let alone binding ones. In other areas, where targets do exist, including those related to protecting nature and biodiversity, we are not achieving our policy goals.

One of the other challenges in setting and meeting targets is overcoming **knowledge gaps**. There are many aspects of land and soil that we need to understand better in order to address specific challenges such as those regarding biodiversity. To be effective, actions will also need to take into account information on, for instance, the composition of the soil and how much carbon and nutrients the soil contains in a given area. This kind of information requires a **better monitoring system**. Monitoring progress towards a specific target needs to be backed by knowledge, agreed methods and tools.

2. Current situation based on background research and evidence

A 10-year forecast for global agriculture projects that **worldwide food consumption will increase by 1.4 %** per year over the next decade, with the increase primarily concentrated in low to middle-income countries. The agricultural outlook by the UN Food and Agriculture Organisation and the Organisation for Economic Cooperation and Development (OECD/FAO, 2022) highlights the important role agricultural exports from Russia and Ukraine have in global food security. Russia and Ukraine are the first and fifth largest wheat exporters in the world, accounting respectively for 20% and 10% of global exports, the report said. "These rising prices of food, fertilizer, feed and fuel, as well as tightening financial conditions are spreading human suffering across the world," FAO Director-General QU Dongyu said. "An estimated 19 million more people could face chronic undernourishment globally in 2023, if the reduction of global food production and food supply from major exporting countries, including Russia and Ukraine, results in lower food availability hitting worldwide." Income levels will largely determine the changes in food demand and diet. The report said countries with lower incomes are expected to consume mostly staple foods, and that food consumption is not projected to increase enough to reach the United Nations' sustainable development goal of Zero Hunger by 2030. Middle-income countries are expected to increase their food consumption, especially of fats and animal proteins. Countries with high income levels are most likely to decrease their consumption of sugar and animal protein due to health and environmental concerns.

Yield increases are projected to account for 80% of global crop production growth over the decade. **Cropland expansion is expected to account for 15% of the growth**. Cropland expansion is expected to be concentrated in Asia, Latin America, and sub-Saharan Africa.

The *Outlook* projections are made under the assumption that yield growth in high-income countries will be based on better farm management practices as well as the adoption of precision farming technology (namely optimisation in the use of agricultural inputs such as fertiliser and chemicals) and improvements in cultivated varieties. Nevertheless, yield growth will be limited, as yields in these countries are already at high levels and further options are subject to stricter environmental and food safety policies. In Sub-Saharan Africa, as well as in other low-income and lower middle-income countries, yield growth is expected to come from the use of improved crop varieties, increased use of fertiliser and pesticides, as well as better farm management due to mechanisation and improved agronomic skills acquired by farmers through education and extension services.

However, the EUROSTAT agri-environmental indicator of mineral fertiliser consumption shows that in 2020, the EU used 6.9% more nitrogen and 21.9% more phosphorus fertilizers than in 2010. Between 2010 and 2020, the use of nitrogen fertilisers in agriculture increased in the majority of the Member States, with the sharpest growth being registered in Bulgaria (+83.0%), Hungary (+57.5%) and Romania (+53.4%). Similarly, most Member States reported an increase in the use of phosphorus fertilisers, the sharpest rates of increase being in Hungary (+142.2%), Bulgaria (+102.1%) and Latvia (+99.4%). These particular increases may represent the convergence of these countries to the EU average of fertilisers applied per hectare, having started from a relatively low level. It should be noted that the EU's nitrogen-based fertiliser industry is heavily dependent on the gas of Russian origin and that Russia and Belarus are key players in the world production of rock-based fertilisers (phosphates and particularly potassium). The war in Ukraine and the application of sanctions on Russia have led to sharply higher fertiliser prices in 2022, which will likely impact the use of fertilisers in agriculture in the EU.

Several studies (for example Mayer et al., 2022) of fruits, vegetables and grains have suggested a decline in nutritional value over time, one of the main reasons for this is soil depletion. There is considerable evidence also that such problems may be related to changes in cultivated varieties, with some high-yielding plants being less nutritious than historical varieties. Several other issues are involved, like changes in farming methods, including the extensive use of chemical fertilizers, as well as food processing and preparation. Increases in carbon dioxide could also play a role.

According to OECD calculations (OECD 2018), worldwide, 2.7% of (semi-)natural vegetated land has been lost to other land cover types since 1992. Agricultural expansion is the main driver of natural and semi-natural land loss. Losses in (semi-)natural vegetated land are most often due to conversions to cropland. Of OECD countries, Korea, Estonia, Latvia and Portugal saw the most intense conversions to cropland. Urban expansion is another major driver of land cover change. Construction of buildings and other artificial surfaces contributes to the loss of sensitive ecosystems and fragmentation of natural habitats. Among OECD countries, Japan, Switzerland, Belgium, the Netherlands, and Luxembourg saw relatively large conversions from cropland to artificial surfaces. Globally, since 1984, around 180 000 km2 of land was inundated, mainly through dam building, with significant consequences on freshwater ecosystems. During the same period, 90 000 km2 (the area of Portugal) of surface water was lost through drought and unsustainable abstraction for irrigation. OECD statistics show that cropland decreased by 1.2% in the EU in the period between 1992-2019, and artificial surfaces increased by 1.4%. Europe's agricultural land, often of good quality and in favourable locations, continues to decrease at an average rate of 1 000 km2 per year. The fine grained structure and associated biodiversity of traditional rural landscapes in Europe continues to be affected by land take, agricultural intensification and farmland abandonment. The forest area remains stable, but forest land cover flows indicate an intensification of forest land use.

Beyer et al, 2022 have produced a map showing where the world's major food crops should be grown to maximise yield and minimise environmental impact. This would capture large amounts of carbon, increase biodiversity, and cut agricultural use of freshwater to zero. The reimagined world map of agriculture includes large new farming areas for many major crops around the Corn Belt in the mid-western USA, and below the Sahara desert. Huge areas of farmland in Europe and India would be restored to natural habitat. The redesign - assuming high-input, mechanised farming - would cut the carbon impact of global croplands by 71%, by allowing land to revert to its natural, forested state. This is the equivalent of capturing 20 years' worth of our current net CO2 emissions.

Farming and forestry as well as other land use (so-called AFOLU sector) are a significant source of greenhouse gases in the world, accounting for 24% of total human emissions, which is close to the amount emitted by electricity and heat production (IPCC 2014). The average share of agriculture in total GHG emissions (without LULUCF) in the EU between 2005-2018 was 9.3%. Although agricultural GHG emissions changed very little at the EU level between 2005 and 2019, trends varied widely at the national level, with emissions increasing in 14 and decreasing in 13 Member States. The main sources of GHG emissions from agriculture are enteric fermentation (45%, CH4), agricultural soils (37,8%; N2O), the emissions of which are mainly related to the use of natural and mineral fertilizers, furthermore manure management (14,7%; CH4, N2O). The remaining sources (field burning of agricultural residues (CH4, N2O), liming (CO2), and urea application (CO2)) make relatively small contributions (EEA 2021).

Using a model–data integration approach (Xu et al. 2021) that ensures full consistency between subsectors of food production, the global food production contributes around 37 per cent of global greenhouse gas (GHG) emissions, showing the huge impact that our diets have on climate change. What's more, **animal-based foods produce roughly twice the emissions of plant-based ones**. Of these emissions, 57 per cent were related to the production of animal-based foods and plant-based food production accounted for 29 per cent. The remaining emissions came from agricultural land being converted from non-food crops like cotton to food production. The researchers found that rice production had the highest plant-associated GHG emissions, while beef production contributed the most to animal-associated emissions.

The Food and Agriculture Organisation of the United Nations (FAO) recently released a map showing that the top 30 cm of the world's soil contains about twice as much carbon as the entire atmosphere. After oceans, soil is the second largest natural **carbon sink**, surpassing forests and other vegetation in its capacity to capture carbon dioxide from air. Soils can sequester around 20 000 megatons of carbon in 25 years, more than 10% of the greenhouse gas emissions. Through sustainable soil management we could produce up to 58% more food. These facts show that, how important healthy soils are, not just for our food production but also for our efforts to prevent the worst effects of climate change (FAO and ITPS, 2018).

3. Position of the Multi-Actor Platform

3.1. Identified needs

The sustainability of a land-use system is determined by the interaction between land resources, climate and human activities.

Challenges:

- **Ambivalent global trends in food demand:** there is a growing demand for food in the world, which shows significant regional differences. The demand for food grows faster in those areas where faster population growth is coupled with economic growth, so there is an improved ability to pay, e.g. Africa. The consumption of animal products also has an ambivalent character (in Africa it is still increasing, in Europe it is already decreasing), it is expected to decrease drastically in the future, especially in the case of those with a higher GHG impact).
- **Weakening of global food markets:** (e.g. due to the Ukrainian-Russian war) can strengthen the role of self-sufficiency. Some countries are reacting by trying to protect domestic supplies, and have already introduced export restrictions. However, it is not easy to change the agricultural export orientation of a country (for example, where arable land dominates and there is a predominance of grain)
- **Growing demand for healthier food (especially in wealthier regions).** Health and wellness foods are one of the defining trends for the food and drink industry in the past few years. Growth in the global health and wellness foods market is being fuelled by rising focus on healthy eating, growing popularity of organic foods, and increasing sensitivities to foods. Developed markets such as North America and Europe dominate market growth. Health and wellness foods are inherently premium products, and the higher disposable incomes in developed markets of North America and Europe, as well as the higher consumer awareness in such markets have resulted in the larger shares of these regions. Developing markets in Asia-Pacific such as China and India hold the highest growth potential, owing to the growing awareness and increasing disposable incomes in the markets.
- **The intensification of climate change can drastically alter the current production conditions:** For example, projected increases in temperatures, changes in precipitation patterns, changes in extreme weather events, and reductions in water availability may all result in reduced agricultural productivity. Climate change can disrupt food availability, reduce access to food, and affect food quality. The changing climate may change the agricultural suitability of the land, and the main crop growing areas may be rearranged in the future. The impacts of climate change vary across Europe depending on climatic, geographic and socio-economic conditions. (The map developed by the EEA shows the observed and projected climate change and impacts for the main biogeographical regions in Europe.)
- **Water**, **especially water scarcity** will be of fundamental importance - **irrigation**, but how? Dealing with drought could become a challenge in areas where rising summer temperatures cause soils to become drier. Although increased irrigation might be possible in some places, in other places water supplies may also be reduced, leaving less water available for irrigation when more is needed. Water scarcity has a huge impact on food production. Without water people do not have a means of watering their crops and, therefore, to provide food for the fast growing population. Agriculture, which accounts for about 70% of global water withdrawals (FAO 2017), is constantly competing with domestic, industrial and environmental uses for a scarce water supply. In attempts to fix this ever growing problem, many have tried to form more effective methods of water management.

- **Land concentration and intensification can cause damage to biodiversity and water balance**. The amount of land that was used for agricultural production remained broadly unchanged between (+0.2 %) 2005 and 2016, while the number of farms reduced sharply. There were about 4.1 million fewer farms in the EU-27 in 2016 than in 2005, equivalent to a decline of just less than 30 %. The vast majority of the farms lost (about 83 %) were small farms of a size under 5 hectares. At the EU-level, this consolidation of agricultural land reflected the growth in the number of the largest holdings and the land that they used for agricultural purposes (EUROSTAT 2020). According to a report approved by the European Parliament in 2013, in the 27-member EU, only 3.1 % of farms controlled 52.2 % of farmland in Europe, and whereas, by contrast, in 2013, 76.2 % of farms had the use of only 11.2 % of the agricultural land. At the same time farmland areas used for smallholder farming are particularly important for water management and the climate, the carbon budget and the production of healthy food, as well as for biodiversity, soil fertility and landscape conservation.
- **Urbanisation threatens the rural workforce needed for landscape maintenance and agriculture.** Trends in the total population of EU27 and UK from 1961 to 2018 show a decline in the share of population living in rural areas over the total population, while towns and cities experienced a smooth and constant increase. Today, 72% of the EU 28 population lives in cities and urban areas. According to Knowledge for Policy (K4P 2022), the EU Commission's platform for evidence-based policymaking, Europe's level of urbanisation is expected to increase to approximately 83.7% in 2050. The migration of population to cities is one of the factors driving agricultural land abandonment, which is expected to reach 4.2 million ha net over the period 2015-2030, bringing the total abandoned land to 5.6 million ha by 2030, the equivalent of 3% of total agricultural land. Farmers often face labour scarcity and increasing labour costs (competition from other sectors), as especially younger generations often aim to get out of agriculture. Increasing labour costs pressure farmers to adapt farming methods and choice of crops toward less labour-intensive production. Producing high-value agricultural products is another option to compensate for increasing labour costs. Green and net houses are material manifestations of these processes of agricultural intensification.
- **The EU's Green Deal strategies set out several expectations that affect current land use.** The Biodiversity Strategy and Farm to Fork Strategy sets some clear goals to be achieved by 2030. The magnitude of the strategic goals may require appropriate land use planning. The main goals are the following:
    - Significant areas of degraded and carbon-rich ecosystems are restored.
    - Habitats and species show no deterioration in conservation trends and status; and at least 30% reach favourable conservation status or at least show a positive trend.
    - The decline in pollinators is reversed.
    - At least 10% of agricultural area is under high-diversity landscape features.
    - At least 25% of agricultural land is under organic farming management, and the uptake of agro-ecological practices is significantly increased.
    - Three billion new trees are planted in the EU, in full respect of ecological principles.
    - At least 25,000 km of free-flowing rivers are restored.
    - There is a 50% reduction in the number of Red List species threatened by invasive alien species.
    - The losses of nutrients from fertilisers are reduced by 50%, resulting in the reduction of the use of fertilisers by at least 20%.

- The risk and use of chemical pesticides is reduced by 50% and the use of more hazardous pesticides is reduced by 50%.

Despite the uncertainties, **restoring ecosystems** and **improving soil quality** could be a very cost-efficient measure in terms of climate action. There are various methods for increasing land's capacity to capture carbon dioxide from air and improvement local climatic conditions:

- Growing plants (e.g. high diversity landscape features, agro-forestry systems, grasslands) remove carbon dioxide from the atmosphere.
- For arable land, number of measures has a significant impact on soil organic carbon (SOC) stocks, some measures clearly leading to carbon emissions (conventional tillage, the degradation of organic-rich soils through pressures such as erosion, soil sealing and compaction). Conversely, a number of practices can be used to preserve soil and increase its SOC levels e.g. water retention, reduced tillage, crop rotations, use of cover crops. The healthy soils keep the carbon underground.
- Healthy land and soil can absorb and store excess water and alleviate floods. During dry seasons, healthy ecosystems can slowly release the water they have stored underground, mitigating the worst impacts of droughts.

In contrast, decisions to use land differently can also change areas, making them sources of emissions. Notable examples of this are draining peatlands, burning peat from bogs for heating, ploughing up grassland and cropland, which releases previously stored carbon. For forests, the dynamic is the same but with a different timescale.

3.2. Existing policy interventions

Policy interventions

To protect land and its resources and how to use them, different governance structures put in place a series of policies and measures. In Europe, these can range from local **land zoning regulations** to European legislation aimed at reducing industrial pollutant releases to land, or from connecting green areas to reduce fragmentation to extending protected areas to preserve nature's diversity. Some of these measures are closely linked to economic sectors or specific policy areas.

Similarly, the Seventh Environment Action Programme, guiding the EU's environment policy until 2020, includes a non-binding commitment of 'no net land take by 2050', with the aim of halting the spread of urban areas into often fertile agricultural land and forests.

The EU thematic strategy for soil protection and its implementation report emphasise the importance of healthy soil in both climate change mitigation and adaptation. The Paris Agreement highlights the critical role of the land use sector in climate action.

Following suit, a new EU regulation on land use, land use change and forestry requires that Member States, at the minimum, fully offset the sector's greenhouse gas emissions from 2021 to 2030.

The EEA also continues to develop knowledge about the environmental issues associated with land use and forestry and related land management practices, including by using Earth observation data from the Copernicus Land Monitoring Service. Many of the EEA's assessments, indicators and data on soil, land, ecosystems, agriculture, forestry, green infrastructure and other topics also have strong links to climate change.

Since 2013, climate action has been one of the main objectives of the **Common Agricultural Policy (CAP).** The Commission attributed over €100 billion – more than a quarter of the total CAP budget – to mitigating and adapting to climate change during the 2014-2020 period. The Special Report of European Court of Auditors found that the €100 billion of CAP funds attributed during 2014-2020 to climate action **had little**

impact on agricultural emissions, which have not changed significantly since 2010. Most mitigation measures supported by the CAP have a low potential to mitigate climate change. (Livestock emissions, mainly driven by cattle, represent around half of emissions from agriculture and have been stable since 2010; emissions from chemical fertilisers and manure, accounting for almost a third of agricultural emissions, increased between 2010 and 2018, the CAP supports farmers who cultivate drained peatlands, which emit 20 % of EU-27 agricultural greenhouse gases.) Despite the increased climate ambition, cross-compliance rules and rural development measures changed little compared to the previous period. Therefore, these schemes did not incentivise farmers to adopt effective climate mitigation measures. While the greening scheme was supposed to enhance the environmental performance of the CAP, its impact on climate has been marginal.

According to MAP members, the reasons for the above-mentioned failures could be the following:

- despite such measures, there is no land use strategic planning and existing strategy at the Member State level (coherent and comprehensive set of policies targeting land and soil), despite the EU green deal goals, which require significant conversions of land into protected areas, high biodiversity areas, and ecological farming
- the rules on land zones designate the economic activities, green corridors, and arable land that are to be prohibited in the zones, but land use planning and water management planning are not used to influence farmers' land use, e.g., for grants,
- regulations regarding the maintenance of certain types of cultivation (obligation to maintain cultivation) cause difficulties for a flexible transition (e.g., regional water retention instead of production in rainy weather)
- there is no farm-level planning for optimal and sustainable land use (type of farming, applicable measures), except for forestry farm plans
- the goals of the existing strategies are not met one after the other (e.g., Water Framework Directive, etc.), there is a lack of meaningful actions put into practice
- there is a lack of complex and practical training for farmers, which would help them understand the connections between land use and agrotechnical interventions, as well as biodiversity and climate change
- the environmental requirements for direct payments (cross-compliance rules) are still only "complimentary measures", they cannot override the basic market effects of the subsidies,
- interventions that serve real environmental results are voluntary, with low participation in Hungary (e.g., territorial water retention, some agri-environmental protection programs, e.g., erosion, drought, inland water), which is often caused by a complicated and insufficiently motivated support system
- the CAP toolkit changes only slightly (static across support cycles), not flexible enough for individual solutions (this is also highlighted by the European Court of Auditors)
- there is a risk that the increase in crop prices will result in high incomes, that farmers will prefer not to call direct payments, in order not to have to comply with the related mandatory environmental conditions

Starting in 2023, Hungary will allow farmers to receive basic income support for ecologically significant areas (such as field protection forest strips) in the same way as for parts of agricultural land used for production. This is a significant step forward in the fulfilment of the green goals expected by the EU, that the state financially recognises the positive contributions of these basically non-productive areas to mitigating the effects of climate change and preserving the safety of production. With the new measure, the Ministry of Agriculture would increase the eligible areas by around one hundred thousand hectares. In this way, it can

be ensured that the basic area-based income support does not lead producers to unreasonable increase of productive areas at the expense of non-productive areas, and would even encourage the adaptation of production to changed climatic conditions.

3.3. Actions taken by local actors

Table 1 – Examples of actions taken by local actors

Name and short description of the projects
Title: UNISECO - AGRO-ECOLOGICAL KNOWLEDGE HUB **UNISECO** is a European research project aiming to develop innovative approaches to enhance the understanding of socio-economic and policy drivers and barriers for further development and implementation of agro-ecological practices in EU farming systems. Surveys conducted among Hungarian farms have convinced us that, in the case of medium-larger farms, environmentally-oriented farming works even without land use subsidies, because these farms consider the positive effect of environmental aspects on the farmer's income. **Link:** https://uniseco-project.eu/
Title: LIFE LOGOS 4 WATERS - Integrated application of innovative water management methods at river basin by coordination of local governments The overarching goal of the LIFE LOGOS 4 WATERS project – building on the experience and results of the LIFE-MICACC project, which ended in November 2021 – is to improve climate adaptation and coordination capacity of local municipalities. It will be achieved by mitigating the negative water-balance situation through the demonstration of integrated ecosystem-based water management solutions applied at the catchment level. An additional goal of the project is to encourage the dissemination of several domestic and foreign, local and water catchment level Natural Water Retention Measures (NWRMs) good practice by sharing the results, in the coordination of local municipalities. **Link:** https://lifelogos4waters.bm.hu/en/general-information/
Title: RESULT-BASED PAYMENT NETWORK Result based payment (RBP) schemes are increasingly being used as a means of increasing the environmental services from agriculture, such as promoting biodiversity, enhancing landscape amenities and improving water quality. In Europe, the number of such schemes has been steadily growing in recent years. Accordingly, a diverse range of different payment models have now been tested and implemented across the continent. There is significant potential to improve the environmental effectiveness and efficiency of the agri-environmental schemes by employing RBPS, but the knowledge of how to optimise the design of such schemes optimally is missing in some instances. The aim of the RBP network is to be a meeting point for sharing experiences on result based payments, their design, their pros and cons, their applicability for different agri-environmental problems etc. The starting point for the network was a conference in Vienna, where representatives of 17 countries participated. **Link:** https://www.rbpnetwork.eu/
Title: Agri-environmental farm diagnostic tool 'Dialecte' in vocational training (Project Number: 2012-1-HU1-LEO05-05850)

Name and short description of the projects
Solagro together with other institutions have developed a complementary set of on-line tools for diagnosis & decision support (Dialecte) that enable the assessment of the state of the environmental service provision of farms (incl. agro-ecological infrastructure, incl. biodiversity & effects of farming on environment. "Dialecte" is an online tool for environmental assessment of farms which was freely available in French, Portuguese, Spanish, English, German, Italian, Romanian and Hungarian for farmers. It currently has more than 1,700 holdings in all these countries on its database. Besides the evaluation of the environmental performance of each holding (based on a points and indicators system), it is possible to compare holdings on the database for performance on various environmental themes. The aim of the relating AGRIDIAG project was to integrate and adopt these tools and related course material into a teaching pack and transfer it into vocational training module to be tested in HU & PT. The target group of the transfer are innovative professionals incl. vocational teachers, trainers, advisors, trainers/practitioners from agricultural chambers/farming organisations, AE scheme operators. **Link:** https://zenodo.org/communities/agridiag-project/ and http://dialecte.solagro.org/
Title: SOIL REGENERATION AGRICULTURE One of the biggest problems of modern agriculture is excessive soil disturbance and the use of artificial fertilizers and pesticides. Together, these contribute to the reduction of the soil's organic matter content, and also increase water and wind erosion, compaction, and deterioration of the soil's chemical parameters (Ph, nutrient content). The compacted soil structure that is not suitable for receiving precipitation, the reduced biological activity and the disturbance of the balance of nutrients force farmers to carry out expensive soil work before sowing and to rely on external input materials. These represent significant additional costs and increase their exposure to climate change. The goal of Soil Regeneration Agriculture (TMG) is to eradicate these problems as a result of the improved soil, above-average yields can be achieved on any soil with lower costs and less work after 5-8 years. TMG technology is based on 5 principles of soil health: (1) continuous mulching, (2) minimal soil disturbance, (3) diverse plant sequence, (4) living roots in the area throughout the year, (5) integration of livestock. The aim of the TMG association is to adapt the system of soil regeneration agriculture in Hungary. **Link:** https://tmg.hu/en/about-us/
Title: Nature-based solutions in the Hungarian division of the multinational company Nestlé The multinational company Nestlé would encourage the transition to soil-regenerating agricultural practices in Hungary with the program it initiated with Hungarian raw material suppliers. Currently, 60 percent of the 140,000 tons of raw materials delivered to Nestlé Hungária's factory in Bük are produced by Hungarian farmers. Therefore, the business division initiated the launch of the Landscape Enterprise Networks (LENs) program, which is already successfully operating in the United Kingdom, in Hungary as well. LENs, or Landscape Enterprise Networks, is a system for organising the buying and selling of nature-based solutions. Nature-based solutions are land management measures that deliver ecosystem functions, such as water quality management, flood risk management, resilient supply of crops, carbon, or biodiversity outcomes. The company aims to procure a fifth of its key raw materials by 2025 and half of them five years later from areas that are cultivated using soil renewal methods. Thanks to regenerative agriculture, the production of raw materials for the food industry puts less of a burden on the environment, and entire landscape units can be renewed. **Link:** https://www.nestle.hu/talajmegujito-mezogazdasag and https://landscapeenterprisenetworks.com/

Name and short description of the projects
Title: Soil reform and Carbofarm program The soil reform group offers a solution tailored to farming for the application of soil renewal farming. One of the most important properties of healthy soil is the amount of organic matter, which improves soil structure, water balance, nourishes soil life, thereby helping to achieve more efficient and profitable farming. 5 principles of soil health are (1) Continuous mulching, (2) Minimal soil disturbance, (3) Plant diversity, (4) Live roots for 365 days, (5) Integration of livestock. The transfer of knowledge is one of their main missions. Their published scientific articles, videos, farm visits and webinars all serve this purpose. The goal of their Carbofarm program is that these airlines operating in Central Europe can neutralise their carbon footprint with the help of farmers operating in Hungary and neighbouring countries. Thanks to this, the soil renewal farmers who participate in the program get extra income while also improving the health of their soils. The measurement of carbon dioxide sequestration in the Carbofarm program is based on soil testing, strictly following the relevant regulations of the World Food and Agriculture Organisation (FAO) (GSOC MRV). **Link:** www.talajreform.hu
Title: ECO OASIS The aim of the initiative is to create small habitats and small biodiversity hot spots in the intensive agricultural landscape, with a bottom-up initiative. The essence of the initiative is that in areas offered by farmers or municipalities, in an optionally 6x6 or 12x12 meter, ecologically degraded area (arable land, landscape wound created by the elimination of construction ruins, waste deposits, etc.), small patches of habitat will be created by planting tree and shrub species that are considered native to the given landscape, and by fencing the area with a wildlife-exclusion fence. **Link**: https://okooazis.blog.hu/
Title: HUNGARIAN PERMACULTURE ASSOCIATION The organisation was established as an official association in 2016 with the aim of not only practicing permaculture, but also actively spreading it, creating opportunities to learn about it, and organising education in Hungary. Their working groups work in several areas, dealing with research, planning, education, and maintaining contact with organisations dealing with permaculture in other countries. The essence of permaculture thinking is that it combines all the elements of farming (plants, animals, buildings, topography, landscape and hydrographic characteristics) into an ecological system, in which the productivity and usability of the individual elements is improved through the network of connections between them, and the expenditure (care, feed , medicines, accommodation buildings) decreases. **Link:** https://permakultura.hu/en/introduction-2/

3.4. Recommendations from the MAP

SHERPA has the goal of developing recommendations for future research agendas but also for future rural policies. Therefore, the MAP members gave recommendations for future rural policies and for future research agendas.

3.4.1. Recommendations for future rural policies

The most important recommendations for the future rural policies:

Development of land use planning and strategy taking into account the state and services of ecosystems

The continuously growing global demands on a finite land resource will require better strategic policies and management of trade-offs to avoid conflicts between different land-use sectors. Integrated land-use planning involves the allocation of land for different uses balancing economic, social and environmental values at national or sub-national levels. It is the process of supporting decision makers and land users in selecting the best combination of land uses to meet multiple needs of people, while safeguarding natural resources and ecosystem services. Land use strategies and a suitable toolkit are necessary for the transition to achieve sustainable land uses. Integrated land-use planning and management, by selecting proper and sustainable land uses, avoids mismanagement and misuses of resources, preserving the environment from degradation, enhancing resilience to climate change and last but not least, it contributes to the reduction of greenhouse gas emissions. Land use planning can contribute to the territorial optimisation of the EU green deal goals (increasing protected areas, increasing landscape features with high biodiversity, ecological management, increasing forest areas, etc.) Read more about land-use planning in FAO, 2017.

Mapping and Assessment of Ecosystems and their Services should be an important basis for planning, that involves identifying and delineating the spatial extent of different ecosystems through the spatial integration of a wide range of data sets on land/sea cover and environmental characteristics.

The farmer can provide the practical implementation of soil protection (including the reduction of surface water runoff and the increase of soil moisture content). Only at farm level is it possible to determine the specific soil protection problems and determine the necessary interventions (planting structure, agrotechnics, non-productive investments, etc.) For this reason, farm-level planning and action programs are also needed.

Encouraging land use change in unfavourable areas for arable cultivation

Target areas for land conversion should be identified, in particular areas which are environmentally unsuitable for arable farming, where farmers should be assisted by all possible means to switch to environmentally beneficial agricultural practices (e.g. grassing or water retention). These instruments could be the different support elements of the Common Agricultural Policy (long-term agri-environment payments (at least 10 years), agro-ecological funds, non-productive investments). When establishing the amounts of support for land conversion, it is also necessary to compensate for the depreciation of land. Sustainable land-use change should be accepted as an ecological service that should be compensated in the long term. The Hungarian Ornithological and Nature Conservation Society (MME) developed a concept for this in the framework of the LIFE IP GRASSLAND-HU project.

Establishment of Landscape and Water Management Communities

The willingness to cooperate between "local actors" is very weak. Ex-post analysis of the rural development program in Hungary show this. This is a fundamental problem, since a significant transformation of land use can only be imagined on a landscape scale (see e.g. the problem of water retention).It is necessary to strengthen the implementation of complex, coordinated planning and farming actions on a landscape scale

(water body level) through agricultural and rural development support. To encourage this, it is proposed to support the establishment and cooperation of Landscape and Water Management Communities' through CAP. Their task would be to develop land use and river basin management plan at the scale of water body, as well as preparation of investments for water retention, as well as support for the participation of those involved in planning and implementation (planners, farmers, researchers and municipalities). CAP could also support the investments specified in the plans in another phase.

Consideration of treated wastewater and sewage sludge in the nutrient cycle and their use in the circular economy

If we examine the entire nutrient cycle, the organic matter can be of animal or human origin. Horse, cow, goat, sheep and rabbit manure can be used as a means of fertilisation. Because these animals are all plant-eaters, their manure is high in nutrients and organic matter, which can help stimulate the growth of crops and grass. For example, cow manure can be used as a top dressing for crops and for soil improvement. Manure of meat-eating living beings should not be used directly as fertilizer because it can contain harmful bacteria and parasites. 75 percent of human manure is water. The remaining 25 percent is composed of indigestible fiber, dead bacteria and living bacteria. Because there is bacteria in human faeces, there is a risk that it could be carrying parasites or harmful organisms. Therefore, in the case of human sewage, sewage treatment is necessary. Most of the treated wastewater leaving the wastewater treatment plant goes into the distribution system and then either flow directly into a surface watercourse, from where it can be used later or flow away. The nutrients from the biologically treated wastewater and sewage sludge could be recycled through a shorter value chain in the agriculture and these waters to be utilised locally.

The European Commission will develop an Integrated Nutrient Management Plan, with a view to ensuring more sustainable application of nutrients and stimulating the markets for recovered nutrients. In order to ensure the regional water retention and the moisture and organic matter content of soils, we consider it important to create the conditions for the agricultural use of treated wastewater and sewage sludge and to encourage their use in agriculture.

LIFE ENRICH is a European project funded under Life programme whose objective is to contribute to the circular economy through the recovery of nutrients from wastewater and their use as crop fertilizers.

Instead of incentives, mandatory action with a just transition

The evaluation of the previous periods of the CAP highlights that the incentive-based voluntary support schemes did not achieve the desired effect in the field of climate and environmental protection. In general, only those subsidies that are based on mandatory regulations (nitrate, Natura) and farmers receive compensation due to their reduced income or disadvantages are more effective than others are. Even with obligatory environmental conditionality linked to direct payments, there is a risk that farmers who forego direct payments will not meet the environmental requirements of cross compliance. The CAP's strategic plan currently provides an opportunity to compensate for the disadvantages resulting from the mandatory requirements. It would also be appropriate to set up a just transition' fund in agriculture to support the economic diversification and conversion of disadvantaged areas, taking into account their specific territorial characteristics, by financing the necessary investments, relocation of certain economic activities from areas with water scarcity, retraining for new forms of farming, etc.

The transition to a more sustainable and nature-friendly farming system does not benefit everyone, at least not in the short term. This dilemma is highlighted in a recent paper from the Institute for European Environment Policy, too (IEEP 2021).

The role of environmental added value in the distribution of funds should be strengthened

Faced with society's increasing expectations, the European Union's Common Agricultural Policy uses environmental management as an increasingly critical criterion in the allocation of farm subsidies, with a shift

in focus from production and area-based subsidies to payments for supplying public goods. There is an increasing demand to assess the ecological and environmental performance of farms, as public money spent on provision of environmental services requires justification.

Results-based agri-environment payment schemes are schemes where farmers receive payments for delivering specific environmental outcomes. Hence, they differ from the traditional payments that are management based, prescribing when or what the farmer has to do or must not do to get the payment. These results-based approaches offer farmers the flexibility to use their knowledge and experience to manage the land in a way that delivers the environmental outcome/result (e.g. biodiversity, carbon storage, water regulation) alongside their production activities. The farmer is in principle free to do whatever fits the site, the weather of the year, the farm and her or his own situation - it is only the environmental results that counts. More information is available on the Result-based Payment Network's website, which was created to enable Member States share their experience of results-based payments.

Quantification of ecological services and the development of a methodology for the compensation of ecological services

There are environmental public goods that the market does not or only produces to a small extent. The Member States basically tried to encourage the production of these public goods with voluntary subsidies. Ex-post evaluations have shown that this policy tool has proved ineffective.

An example can inability to retain a sizeable extent of forested areas, despite the fact that forests play an important role in reducing GHG gases (as sinks). No matter how much the state would make afforestation relatively cheap, grain products that can be sold at high prices on global markets continue to encourage the increase or maintenance of arable land.

The ecological service practically means the production of a public good, the state, as a representative of society, must order the service of these public goods from the farmers (ordering). Farmers who "produce" the specified environmental value (production), thereby providing a service, as in the case of any other good or service, the "customer" of the good or service, in this case the state, must reimburse the farmers (payment).

Collection, support and promotion of social innovations

A significant number of environmental problems cannot be solved with a one-time technological or business innovation, and often with government tools either. Moreover, it may happen that the government does not necessarily consider solving some problems as a priority, or local solutions can be created that provide a creative response to social needs and problems, and are thus better, more effective, or easier to sustain in the long term than previous solutions or existing state-supported practices. Moreover, these local innovations may be more accepted among farmers than state-supported agri-environmental programs. The development, testing, dissemination and reproduction of these unique solutions and good practices must be supported by the state.

Development and presentation of indisputable land use alternatives, and a farmer decision support system and advice would help farmers

In Hungary, the ex-post evaluation of all the thematic areas of the Rural Development Program (biodiversity, soil, water management, climate protection) pointed out that there is a lack of adequate training of farmers on sustainable farming. The main reason for this is the lack of adequate training for trainers, the lack of designated and publicly accessible demonstration farms, and the complex support for the transition to sustainable farming.

It would be necessary to share the information necessary for the implementation of nature-friendly technologies and extensive land use methods at the national level through a suitable network of specialist consultants, based on the resources of the KAP Strategic Plan and the governmental capacities.

3.4.2. Recommendations for future research agendas

Social, economic and environmental cost-benefit analysis of sustainable and conventional land uses

The environmental advantages of sustainable land uses probably outweigh the economic disadvantages, but they need to be accurately quantified and verified. For example, landscape-scale water management and water retention have greater benefits than irrigation, which can damage biodiversity and soils. As climate impacts intensify, trade-offs between land, as a climate service provider and agricultural land are likely to become increasingly important. Climate protection benefits derived from land may require compromises in other dimensions, such as a decrease in farm income, capital investment requirements. Communicating long-term benefits versus short-term economic interest is important for farmers. The monetised cost-benefit analyses can also help to develop appropriate financial compensation mechanisms.

Possibilities for the development of rural and seasonal workforce

Technological innovation (e.g. satellite-based precision farming) contributes to the improvement of agricultural productivity, however using less labour to achieve similar yields. The higher attractiveness of the industrial and services sector led to strong decreases in agricultural employment. The higher-paid jobs in the secondary and tertiary sectors is thriving, this sustains the downward trend of agricultural employment in many parts of Europe. Young people and people with higher education levels are more likely to be employed in non-agricultural sectors, in particular services.

The maintenance of the rural landscape and food production require rural labour and often-seasonal labour. Diversification of agriculture, making rural life and agriculture attractive, especially for young people, and providing appropriate income may require different solutions in each region and may often require unique, special solutions at the local level.

Self-sufficient agriculture

Ensuring food security is a major problem of the contemporary world. The EU is largely self-sufficient for many agricultural products; however, the agricultural sector is a net importer of specific products, for example feed protein. This vulnerability, together with high input costs, such as fertilisers and fossil energy, is causing production challenges for farmers and risks driving up food prices.

Fundamental question is that whether and to what extent agricultural production of individual EU countries guarantees food self-sufficiency at present and may do so in the future. The degree of self-sufficiency varies in individual EU countries. It is worth looking at the geographical location within Europe where the necessary food raw materials can be produced, while maintaining economic, social and natural sustainability of agricultural production. It is necessary to ensure effective mechanisms for surplus reallocation to regions suffering from shortages thanks to promotion of exchange of goods within the EU.

Common carbon-farming system in the EU

The EU has published a Technical Guidance Handbook is intended to support the development of result-based payment schemes for carbon farming in the EU. In five key thematic areas, the potential for using result-based carbon farming payments is presented in an EU context: peatland restoration and rewetting; agroforestry; maintaining and enhancing soil organic carbon (SOC) in mineral soils; managing SOC on grasslands; and livestock farm carbon audit.

For the introduction of carbon farming at the EU level, it would be necessary to develop indicators and calculation methodology jointly developed by Member States, to implement pilot projects involving farms, to develop a common CO2 trading system, and to share experiences related to the operation of the system.

The role of evaporation in mitigating the effects of climate change

According to Bader, 2021, examining data from Hungary, it can be assumed that changes in evaporation conditions through changes in land use also contribute to the warming. According to the 2019 IPCC report, the temperature rise on land is greater than the global warming average. An increase in the area of land evaporation can be detected until the turn of the millennium, after which the trend reversed. Evaporation and transpiration are a defining part of the hydrological cycle, and they are an irreplaceable medium for heat transport in atmospheric aeration. Where there is a significant lack of evapotranspiration, "landscape heat islands" similar to urban heat islands are formed. Reducing the proportion of greenhouse gases is thus a necessary but not a sufficient condition in solving the problem of climate change. This requires the improvement of water supply at the landscape level, thus supporting sustainable land use and maintaining a healthy hydrological cycle.

We recommend further research into how it can reduce warming and mitigate the risk of climate change on a landscape scale by increasing the extent of biomass or water mass by increasing evapotranspiration.

Precision technologies vs. biodiversity and soil protection

Precision technology is fundamentally expensive and requires IT knowledge, so the spread of precision technology can also contribute to the expansion of larger farms. It should be investigated whether the introduction of more precision agriculture in Europe enables the achievement of food resilience while ensuring biodiversity and job creation at the same time. One important concern with precision farming is that it basically treats the symptoms (e.g., lack of nutrients in the soil, effective protection against pests) and does not eliminate the triggering causes of the problems (erosion, organic matter content of soils etc.).

Conclusions

The United Nations defines sustainable land management (SLM) as "the use of land resources, including soils, water, animals and plants, for the production of goods to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions". Because of climate change and variability, **selecting the right land uses** for given biophysical and socio-economic conditions, and implementing SLM, are essential for minimising land degradation, rehabilitating degraded land, ensuring the sustainable use of land resources (i.e. soils, water and biodiversity) and for carbon sequestration.

Based on the contents of the IPCC "Climate change and land" study, it is necessary to develop **sustainable land use strategies** as soon as possible, including land-use zoning, spatial planning, integrated landscape planning, regulations and incentives (such as payment for ecosystem services). Voluntary or persuasive instruments (such as environmental farm planning, standards and certification for sustainable production, use of scientific, local knowledge and collective action) can achieve positive adaptation and mitigation outcomes.

Appropriate design of policies, institutions and governance systems at all levels 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 ecological restoration, and foster engagement and collaboration between multiple stakeholders.

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, forest, energy, land, water, finance and planning).

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Annex 1 Methodology used by the MAP

Responsibility: Facilitator and Monitor

MAP was founded in 2021. First, the MAP members were invited from the environmental sustainability working group formed for the CAP Strategic Plan. Due to the low interest, additional members were involved in the missing areas of expertise. From the beginning, MAP focused on the agricultural aspects of climate change. First, the "Climate Change and Environmental sustainability" discussion paper were discussed in the framework of a workshop in the autumn of 2021. The workshop was organised online, with the participation of two thirds of the MAP membership. The MAP members answered briefly the questions asked in the Mentimeter software. The main result of the workshop was that sustainable land use planning is the most important challenge. The questions were sent to the absent members via an online questionnaire by Google Forms. However, no responses were received, so additional recruitment was necessary.

The remaining MAP members contributed to the recommendation of keywords for the topic "Land-use management in the context of climate change" of the next MAP cycle.

In the Discussion Paper sent on this topic, little evidence was presented in relation to the offered and considered important keywords, so MAP focused on the topic of the significance and importance of land use planning.

For the second time, the questions to be answered (current situation, identified needs, existing policy interventions, actions taken by local actors, and recommendations) on the above mentioned topic were discussed in the form of an in-depth interview. The formation of the common position was established using the "snowball" method. The proposals of the previous MAP member were always presented to the next member, who could comment on, reject or supplement them with additional aspects of his own. There were no significant differences between the members of the three subgroups (science, policy and society), the comments rather complemented and improved each other. The advantage of this method was that the facilitator got much more and accurate information than in the workshop. The disadvantage is that it is time-consuming.

MAP experts commented on the draft of the position paper and approved the final version.

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