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Rural Science-Society-Policy Interfaces

MAP Position Paper

LAND USE & CLIMATE CHANGE

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1. Summary and key messages

This position paper identified few priorities for what concerns land use and water management in the Emilia-Romagna Region and in the context of climate change. Notably, these are: the need of increasing carbon stock in soils, a more efficient management of water resources both in case of drought and of heavy precipitations, and the importance of steering the transition to alternative crop systems. Specific recommendations to policy and research have been outlined for each of these aspects. Above all, the consultation with the Emilia-Romagna Multi-actor Platform (MAP) have revealed a cross-cutting aspect that need to be addressed: the importance of adopting system thinking in the design of future policies and research agendas. Indeed, system thinking can recognize the intrinsic complexity of these issues and orientate policies accordingly. In addition, the consultation underlined the importance to embed the local dimension (including physical and social characteristics) to develop the most appropriate strategies for rural development.

2. Introduction

In 2021, the Emilia-Romagna MAP focused its discussion on the topic of climate change and environmental sustainability. As result of the outcomes of the discussion in 2021, the Emilia-Romagna MAP Position Paper (Pellegrini et al., 2021) was developed. This paper described, the main effects of climatic variations on the regional agro-ecosystems as follow:

"Climate variability, together with the direct effects of the increase in CO2 concentration (generally positive effects), may cause significant consequences on agro-ecosystems, such as: a decrease in production of the main agricultural crops, a shift in cultivation areas towards the north, the need to introduce varieties and species more tolerant of water and heat stress, increases in the frequency of extreme weather events (heat waves, heavy rainfall, drought periods), changes in the spread of plant diseases and pests, and a shortage of water resources."

In the same year, The Emilia-Romagna MAP was asked to identify what were the priority areas of intervention at regional level in order to boost the transition towards carbon neutrality by 2050. Land-use and water resources management were voted as the areas where action is needed more urgently.

Hence, in 2022 the Emilia-Romagna MAP decided to delve further into the topic of land use and climate change starting from the SHERPA Discussion paper (Miller et al., 2022). By means of six interviews and one workshop, the Emilia-Romagna MAP addressed the following questions:

- What are the needs of the area covered by the MAP in relation to land use and climate change?
- What are the policy interventions already in place, and what are examples of actions taken by local actors addressing these needs implemented on the area covered by the MAP?
- Which policy interventions (i.e. instruments, measures) are recommended by MAP members to be implemented at the local, regional, and/or national level? How can the European Union support these interventions?
- What are the knowledge gaps and what research projects are needed?

Information collected from the MAP have been organized around three main topics, that are: i) the need to increase the content of organic carbon in soils, ii) a more efficient use of water resources in a context of increasing water crises, and iii) the importance of being prepared towards the change of cropping systems (especially maize).

The following paragraph provides a brief overview of the current state in relation to the three topics, while the other paragraphs systematize all the information received from the MAP in needs, recommendations to policy and recommendations to research.

3. Current situation based on background research and evidence

Soil Organic Carbon

Rural areas of Emilia-Romagna (NUTS2) are very heterogeneous (Figure1), and so are the soil typologies. Most of agricultural activities are concentrated in the Po River plain, characterized by alluvial and extremely fertile soils. Hilly areas are also featured by soils with good fertility mostly specialized in valuable crops (e.g. vines, fruit). However, since the second half of the 20th century, both plain and hilly areas have undergone significant changes due to the specialization of cropping systems and consequent disappearance of traditional farm livestock activities (Regione Emilia-Romagna, 2009). This change has caused a significant increase in soil erosion in hilly areas and a decrease in Soil Organic Carbon (SOC) in flat areas (Figure2). SOC represents about 60% of the soil organic matter and it is fundamental to ensuring the quality and fertility of soils, but also to preventing erosion, retaining water and reducing the negative environmental effects of pesticides, heavy metals and many other pollutants (Regione Emilia-Romagna, 2009). Moreover, SOC is important for its potential for carbon sequestration. A study conducted in Emilia-Romagna estimated that the total sequestration SOC potential is nearly equivalent to the annual total CO2 emission for the whole region (Ungaro et al., 2010)

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Figure 1 Emilia-Romagna region by different type of rural areas. Blue: predominantly rural areas (mountain and hills); Orange: Intermediate rural areas; Green: Urban-rural transitional areas; Yellow: Urban areas. Source: Reterurale.it.

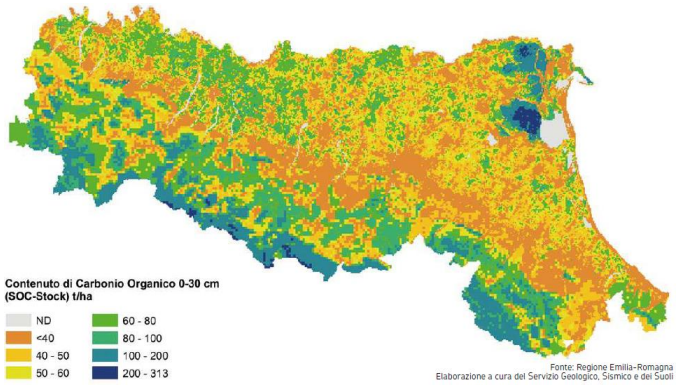

Figure 2 Map of organic carbon stock in the surface layer (0-30 cm) of Emilia-Romagna soils (2019). Orange/yellow colour identify lower SOC stock. Source: Regione Emilia-Romagna, 2020

Drought

Drought is undoubtedly one of the worst consequences of climate change faced by the Emilia-Romagna region. As highlighted by Pérez-Blanco et al. (2016), Emilia-Romagna is a region characterized by *"drought-prone but otherwise water-rich areas"*. The Emilia-Romagna region belongs to the Po River Basin District, which is the largest (86,859 km²) among the seven Italian River Basin Districts created following the implementation of the EU Water Framework Directive (2000/60/EC). Since the beginning of the 21st century, the Po River has been hit by several droughts (2003, 2006, 2007, 2015), and the latest one, in 2022, has been extremely severe. The Permanent Observatory of Water Uses of the Po River Hydrographic District (*Osservatorio Permanente degli utilizzi idrici*), that monitors the hydro climatic and water situation in the Po District and forecast possible evolutions, has reported increasing levels of water severity since spring 2022 (Figure 3). These levels reached critical points during summer 2022 (Figure3).

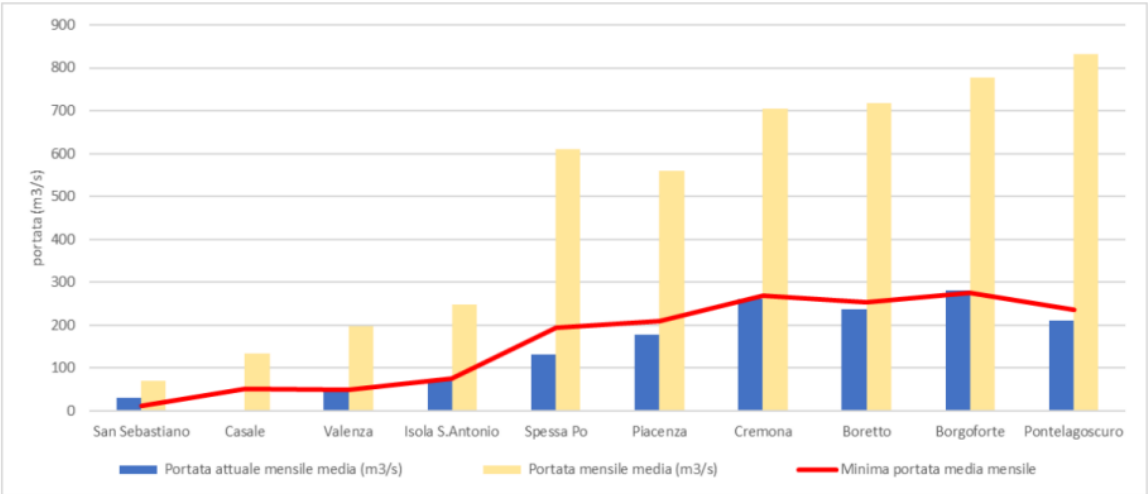

Figure 3 Comparison between current flow rates (blue bars) and historical flow rates (yellow bars) of the Po at different observation points. Data from July 2022. Source: Osservatorio permanente

Changes in maize production

Lower availability of water resource has significant impacts on maize, one of the main forage crops of the region. Together with alfalfa, corn silage is the main feed for livestock at the base of milk production for Grana Padano and Parmigiano Reggiano, among the main Protected Designation of Origins at regional and national level (Mantovi et al., 2015).As corn yields are dependent on the availability of water resources, water scarcity jeopardizes the degree of forage self-sufficiency of farms. In addition, rising temperatures are causing significant consequences for the feed industry and dairy supply chain due to mycotoxin contamination of corn caused by thermophilic pests. As pointed out by Mantovi et al. (2015), contamination, especially in 2003, 2013 and 2014, led to a raise of maize imports from EU and non-EU countries with consequent increases in production costs. In parallel, there has also been a substitution of maize for sorghum, which is a more resilient crop to water stresses.

4. Position of the Multi-Actor Platform

4.1. Identified needs

Higher temperatures tend to accelerate the loss of SOC. **This makes more urgent the need to find techniques to maintain organic matter at adequate levels**. Deep tillage, for instance, does not favour the storage of SOC and should be reduced whereas possible. Nevertheless, some MAP's members pointed

out deep tillage is still needed in specific cases in order to counter the spread of pests, that have also increased due to climate change. This is the case of maize where specific guidelines suggest the removal of crop residues through deep tillage to reduce the spread of thermophilic pests. Beside few specific cases, however, deep tillage should be reduced. Good practices to increase SOC mentioned by MAP's members are crop rotations, conservation agriculture and efficient management of soil organic conditioners. One actor said that, through a monitoring of SOC levels nearby big livestock farms in the Po River plain, they found high levels of carbon because of the presence of animals. Another MAP's member, however, claimed that intensive livestock farms may undermine other types of environmental indicators, such as water quality, and hence should be carefully considered. This debate provided an interesting example of the complexity linked to environmental problems.

Drought frequency, as well as their severity, highlight the need of **rethinking water management towards more efficient uses of water resources**. During an interview, the director of a cooperative farm located in the Po River plain reported the consequences of drought on agricultural production. The farm recorded a loss of production of approximately 15-20%for cereals like wheat and, to a lesser extent, for other spring crops. These losses are due to the fact that irrigation demand increased for all crops, while the supply remained the same or even lowered, with visible effects on both on yields quantity and quality (e.g., smaller size of fruits). The consequences of climate variability, however, are not only limited to drought. Heavy precipitation, hailstorms and late frosts have also produced significant losses to agricultural production. The same interviewee reported that late frosts in 2020 had significantly affected orchards production with a loss of about 13,000quintals. Beyond economic loss – it was stressed – this had also an impact on employment due to the reduced yields.

The potential of an **increase of water re-use** was also mentioned by one MAP member in the view of the implementation of the EU regulation 741/2020. This regulation sets out the minimum requirements for water reuse in agriculture and its implementation might encourage a wider application of water re-use. Nevertheless, there is the need to understand whether the characteristics of reclamation systems of the region will allow for a wider use of wastewater.

Changing crop choices towards more resilient alternatives was mentioned by many MAP's members, although it was recognized the rigidity of agricultural systems. These choices entail high transaction costs and should be based on site-specific data and considerations. One actor argued that the focus should not only be on crop alternatives, but also on building new supply chains. Building sustainable and profitable supply chains requires time but, at this moment - it was argued - not much attention is dedicated to this with the risk of being unprepared when these changes inevitably will happen.

4.2. Existing interventions and actions

All MAP's members agreed that Emilia-Romagna is a region at the forefront in terms of participation in EU-funded projects and in other relevant partnerships. Many projects and collaborations have been conducted, and are still on-going, on the topic of land use, often based on bottom-up approaches. Examples are the Operational Groups (OG) funded by the last Common Agricultural Policy (CAP). Emilia-Romagna is, indeed, the first Italian region by number of OG: more than 200OG with more than € 44 million funded by the CAP. They cover several thematics, some of which specifically addressing land use.

Good practices for soil management in the territory of the Emilian Apennine are at the heart of the Life AgriCOlture project. On one hand, this territory, suffers from an increase in soil erosion, landslides and abandonment, on the other, is characterized by strong forage and livestock systems linked to the production Parmigiano Reggiano. While recognizing the exceptional strengths and potentials of the Parmigiano Reggiano supply chain, the AgriCOlture project also identifies the weaknesses of such production system, characterized by a high specialization, that is not always compatible with the hydrogeological instability of this territory. For this reason, the Life AgriCOlture proposes a work protocol that is composed of best practices indicated

by scientific research as effective to protect the SOC, reduce GHG emissions and increase the economic and environmental performances of mountain livestock farms. Moreover, the project envisages the creation of an innovative territorial contract, called "Pact for soil", for those farmers and land managers undertaking the work protocols and who are accredited as "soil guardians" by the public bodies.

Other EU-funded projects implemented in the region, with relevant implications for land-use, are H2020 CONSOLE and LIFE Forage4Climate that have been discussed in the previous position paper (Pellegrini et al., 2021).

Finally, one MAP member working for a Land Reclamation and Irrigation board observed that, as a result of the drought experienced in 2022, users of water resource initiated several collaborations on a local level. For instance, agreements among irrigators and dam operators, or between industrial and irrigation services. These collaborations are often informal but still very relevant because may represent solutions to the potential conflicts that drought may generate among water-use sectors.

4.3. Recommendations from the MAP

4.3.1. Recommendations for future rural policies

Even if touching different aspects, some of the points raised by the MAP can be grouped under a same overarching recommendation: **the need to adopt system thinking in the design of public policies.** System thinking, in fact, allows for the identification of interconnectedness, trade-offs and multiple dimensions that characterize environmental problems.

Some examples where already highlighted in paragraph 4.1 where possible trade-offs between the objective of increasing SOC and other environmental objectives were explained. Other examples made by the MAP concern the fact that, in order to orient farmers choices towards sustainable land management, policies should address those levels and actors that have an influence on farmers' choices.

First of all, this paper highlights the need to consider the role that farmers' organizations have in providing advice to farmers regarding their choices and investments. One actor claimed that, often, farmers' organisations do not provide adequate support to farmers for measures that would allow the achievement of higher sustainability standards (e.g., agri-environmental-climate schemes). For this reason, these intermediate actors should receive **training**, possibly provided by public institutions. Only if those who advise farmers provide them with clear messages on the worthiness of these interventions, then farmers' perception might change.

Second, farmers – it was noticed – can change their practices if stimulated by the agroindustry. Hence, public institutions (e.g. regional administration) should promote **partnerships and projects among large companies and their farmers to stimulate the adoption of good practices for soil management**.

Third, adaptation and mitigation strategies require the collection and management of a large amount of data. **Large datasets should be treated in a coordinated manner**. Data collected at farm level, for instance, should converge into an information system that can support decisions at territorial level.

Bottom-up approach was also mentioned. It is, indeed, this kind of approach that triggers cooperation among local actors and, hence, should be encouraged.

There was a debate within the MAP regarding the type of **policies to promote a more efficient use of water resources**. One actor explained that there are some areas of the Po River Basin District still characterized by highly inefficient use of water resources. For instance, rice and maize, in some areas, have been grown on permeable soils (e.g. gravel) that are inadequate for these water-intensive crops. According to this actor, a policy recommendation to undermine these cases would be **to increase water tariffs based on volumetric consumption**. Another actor, however, did not agree with volumetric tariffs because – he

argued – water demand elasticity for rice is rigid so higher tariffs would not achieve the expected goal. This actor agreed that situations like the ones described above should be avoided but did not agree on the type of policy instrument. In his view, **rules and regulation are more effective than economic incentives**.

As said, crop rotation is an important practice to avoid monoculture. The new CAP, in fact, foresees a specific good agricultural and environmental condition (GAEC 7) on crop rotation. It was argued, however, that the flexibility given to EU Member States in adopting the regulation, made some Member Station to keep the GAEC 6, foreseen by the CAP 2014-2020, and which had limited effects. In some cases, **flexibility, although needed, can represent an obstacle to achieve more ambitious objective as well as also affecting competitiveness among countries**.

4.3.2. Recommendations for future research agendas

There are still significant knowledge gaps on how far different agricultural practices contribute to the increase of carbon stock in the regional soils. For instance, the models currently used to predict the contributions of the measures of Rural Development Program (RDP) to SOC are too simplistic or not suitable for all cultivations. Conversely, the SOC has been constantly monitored in Emilia-Romagna with the result that there are many soil maps available (see for instance Figure2) that make possible to track C evolution. Hence, **progresses in research are needed for what concerns predictive models of C dynamics** that could support for the allocation of resources of the RDP towards the most effective measures.

Regarding water management there are many different fields where research can contribute. First, the issue of multiple uses of water resources is becoming increasingly important. Hence, research could support in the identification of **governance arrangements (e.g. norms, contract solutions, policy) that can ease collaboration among water users**.

Second, there are many **technical solutions for an efficient management of water resources** that need further enquiry also in terms of their applicability and economic feasibility in the local contexts. Some of the examples mentioned by the MAP's members are related to increasing water productivity, efficient irrigation techniques, and retention basins.

As mentioned, crop systems will inevitably change in the future. Hence, on one hand, there is the need to develop **scenarios** regarding what will be grown and how in the future, on the other, **research should support the identification of viable alternatives**. As said, alternatives should not only consider the type of crops that will be produced, but also the organization of new supply chains around these more resilient cultivations.

One actor pointed out that **knowledge transfer is still too slow** and there is the need to fill the gap between research and/or innovation and what is done within the farms. Beside training and awareness campaigns, another aspect is to connect research to funding schemes, such as RDP, that have an impact on farmers.

Lastly, if soil and its services are conceived as a public goods, then **socio-economic research can contribute to the understanding and valorisation of the different roles of farmers**. Research projects which identify and pay attention to the different functions of farmers should be part of future research agendas.

Conclusions

Thanks to the consultation carried out with the Emilia-Romagna MAP, it was possible to identify some of the priorities for land use in the context of climate change at the regional level. Notably, these are: i) the need of increasing carbon stock in soils, ii) a more efficient management of water resources both in the case of drought and of heavy precipitations, and iii) the ability to steer the transition to alternative crop systems. Following, a summary of the main recommendations by priority.

The need of increasing carbon stock in soils

- **Recommendations to policy.** Policies should provide leverage for farmers to adopt agricultural techniques that increase the level of SOC. However, it is important to recognize that farmers will not change their attitudes if policies do not also address those levels and actors that influence their choices. System thinking is, indeed, needed in policy design to understand and tackle the main barriers that prevent a change of farming practices.
- **Recommendations to research.** Progresses in research are needed for what concerns predictive models of C dynamics that could support the allocation of financial resources towards the most efficient land management practices.

More efficient management of water resources

- **Recommendations to policy.** Policies for an efficient use of water resources should include a wide range of solutions like, for instance, infrastructures (e.g. basins), water reuse, and efficient irrigation techniques. In general, policies should intervene on the cases in which there is inefficient use of water resources. However, MAP's members could not agree on what type of policies should be preferred (if economic incentives, such water tariffs, or regulation).
- **Recommendations to research.** Socio-economic research should investigate the issue of multiple uses of water in a context of increasing scarcity for instance through the identification of governance arrangements (e.g. norms, contract solutions, policy) that can ease collaboration among water users. Moreover, research could study the applicability and economic feasibility of technical and infrastructural solutions in local contexts.

Steering the transition to alternative crop choices

- **Recommendations to policy.** Crop systems are already changing and will inevitably do the same in the future. Therefore, policies should be able to provide alternatives to farmers, not only in terms of crops selection but also of building new supply chains. Moreover, policies should discourage unsustainable practices more effectively than what is being done, for instance through a more rigorous application of the GAEC 7 on crop rotation.
- **Recommendations to research**. Research is needed to understand the trends of what will be produced and how in the future but also to support policies in the identification of viable alternatives.

The consultation process done by the MAP highlighted the importance of adopting system thinking in the design both of policy and research agendas due to the several interdependencies and trade-offs that the topic of climate change and land use entail. It also underlined the importance of the local dimension (including physical and social characteristics) to understand the most appropriate strategies.

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Annex 1 Methodology used by the MAP

The consultation with the Emilia-Romagna MAP was organized in two rounds.

First, seven MAP members were invited for an interview based on the four questions presented in the introduction phase. MAP's members were selected to represent different societal groups (science, society and policy) and because of their knowledge of the chosen topic. Six out of seven members accepted, and interviews were conducted on-line and lasted between 40 min and one hour.

The second round of consultation was carried out through an on-line workshop to discuss the results of the interviews and collect additional inputs from the whole MAP. Before the workshop, the SHERPA Discussion Paper was sent to the group. Invitations were sent to 17 stakeholders, but only four took part to the workshop. limited participation to the workshop highlighted the difficulty of engaging actors in these types of consultation (with broad topic of discussion and limited practical implications). Limited participation, however, did not prevent different perspectives from being presented and discussed because of the heterogeneous composition of the MAP's group. The workshop was very interactive and the actors participating showed a great knowledge and interest in the topic.

Overall, the whole MAP (interviews and workshop) included: one representative from public administration, three representatives from research and consultancy, four representatives from civil society. This group was the most heterogeneous with two actors coming from Irrigation boards, one from a cooperative farm, and one private citizen. Compared to previous the MAP's cycles, this time we managed to a farm representative and a citizen (that in the past had a role in public administration). It is also worth mentioning that for some actors participating in the consultation the differences among the group members was blurred, because their experience and knowledge spammed across different fields (e.g. science and project management).

In terms of methodology, mixing interviews and workshop proved to be effective to have both individual discussions and exchange of ideas among members.

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