BESTMAP

BEHAVIOURAL, ECOLOGICAL AND SOCIO-ECONOMIC TOOLS FOR MODELLING AGRICULTURAL POLICY

Introducing agri-environmental measures in Serbia

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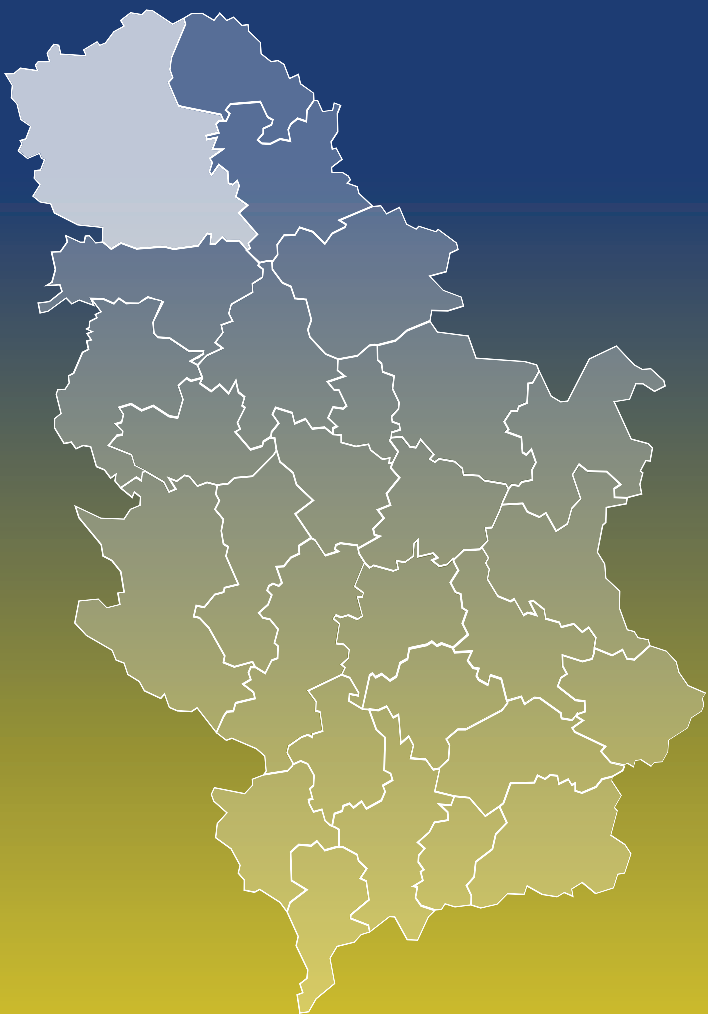

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Agri-environmental measures (AEM) aim to mitigate the environmental impact of agriculture by promoting and financing sustainable agricultural practices. As Serbia is making initial steps towards introducing AEM, informed decision making will be necessary, so as to design measures that are both suitable for Serbian farmers and beneficial for the environment. Through the BESTMAP, an EU funded project, the international team of researchers examined for the first time potential benefits of introducing AEM in a selected region in Serbia.

Executive summary

- BESTMAP identified an initial set of AEM (based on their suitability for the local context) and investigated their potential impact in Bačka, the region with the most intensive agriculture in Serbia.

- BESTMAP provided information on the reasons behind farmers' future (non)adoption of the AEM, on existing surrogate measures (semi-natural vegetation elements already existing in agriculture landscape without any financial support) and their spatial distribution, and on the impact of selected AEM on biodiversity and ecosystem services.

- Based on our findings, we recommend introducing simpler agri-environmental measures for beginning that fit local agricultural practices. This will increase the chance that the response of farmers will be greater, and it will still have a positive impact on the environment.

Policy context

In the past decade, institutional and policy reforms in Serbian agriculture have been significant, but the capacity to address environmental challenges remains limited. Despite the recognised need to introduce agricultural practices that reduce negative impact on the environment (National Strategy on Sustainable Development, Environmental Strategy and Biodiversity Strategy), programmes and measures to fulfil this need were missing. The strategic framework for the implementation of agricultural policy is defined by the Strategy of agriculture and rural development (2014-2024) and the IPARD program (the EU instrument for support in the field of rural development). Although the strategy incorporates environmental dimension, priorities were on social and economic sides thus far. Only organic production and conservation of agrobiodiversity were supported through direct payments. Agri-environmental measures are now incorporated in the IPARD III program (2021-2027), but it is first necessary to form favourable conditions to implement the support for them.

Research objectives

In this context we aim to evaluate options for future AEM in Serbia based on: 1) **simulation of farmers' adoption of AEM** (understanding the decision-making process by the producers themselves) through different options for contracts (duration, level of administrative effort, offered payment per hectare), and 2) **assessment of AEM environmental impact** (predicting the effect of implementing 5 common agri-environmental measures in Europe).

The study area

Study was performed for Bačka district in Vojvodina region. Intensive agricultural land use is prevailing here. Agricultural areas categorised as general cropping are the most dominant farm system archetypes in the Bačka region. Due to flat topography and high soil quality, the region is ideal for growing cereals such as wheat and maize. Horticulture and fruit-growing is also significant. Areas of vegetable production are scattered over smaller or bigger areas across Bačka. Wine growing production is present in Subotica-Horgos sandy terrain. Unfortunately, an increase in arable lands has been happening at the expense of natural areas. In the past 70 years grasslands have radically declined, and today occur as isolated islands, which had negative consequences for biodiversity and the environment.

Fig. 1. Landscapes of Bačka region - Crops as dominant land use pattern vs semi-natural vegetation in agricultural land.

Five groups of commonly applied AEM across Europe were found suitable for the study area: cover crops, flower strips, grassland maintenance, arable land conversion to grassland and organic farming. These were explored from the aspects of farmers acceptance and environmental impact.

BESTMAP approach

The BESTMAP developed a behavioural theoretical modelling framework that takes into account complexity of farmers' decision-making. Computer models, concretely agent-based models (ABM), are linked to existing data on farms and remote sensing products. Through simulation of individual-farm agents and their decisions and interactions with other agents complex scenarios of AEM adoption emerge. BestMap approach further includes economic, biophysical and biodiversity models to quantify the impact of AEM and precisely compare different scenarios.

Diverse types of data were integrated into the BESTMAP framework to run scenarios of AEM adoption and to quantify their impact. Information on farms comes from the National Platform for Digital Agriculture - AgroSens (Fig. 3). More than 200 farmers participated in the targeted survey designed by BESTMAP social scientists that examined conditions under which they would accept certain AEM and 25 farmers took part in interviews . This served for running 9 different scenarios of AEM adoption. In the status quo scenario farmers are offered contracts with following basic characteristics: 5 years long, medium administrative effort, no advisory, implementation and maintenance costs are covered. In the case of the other scenarios, one of these basic contract characteristics was changed each time: increased payments, added advisory, shorter contract, longer contract, low administrative effort, high administrative effort. Two scenarios examined the social influence of neighbours, and the social influence of a village.

Additional data was used to assess the environmental impact of AEM. Land cover maps, detailed crop maps and soil quality estimates were derived from satellite data. Combination of the derived layers and databases resulted in spatial identification of the selected "surrogate" measures: linear elements and fallow land (Fig. 2). Biodiversity data included selection of grassland related species: farmland birds (source: The Society for the Protection and Study of Birds of Serbia) and small mammal grassland specialists (BioSense Institute own database) from observational studies. Additional data needed for the Nutrient Delivery Ratio model (NDR) (Sharp et al. 2020) that quantifies export of nitrogen and phosphorus into water bodies encompass typical fertilisation rates for different crops, digital elevation map and watershed shapefile.

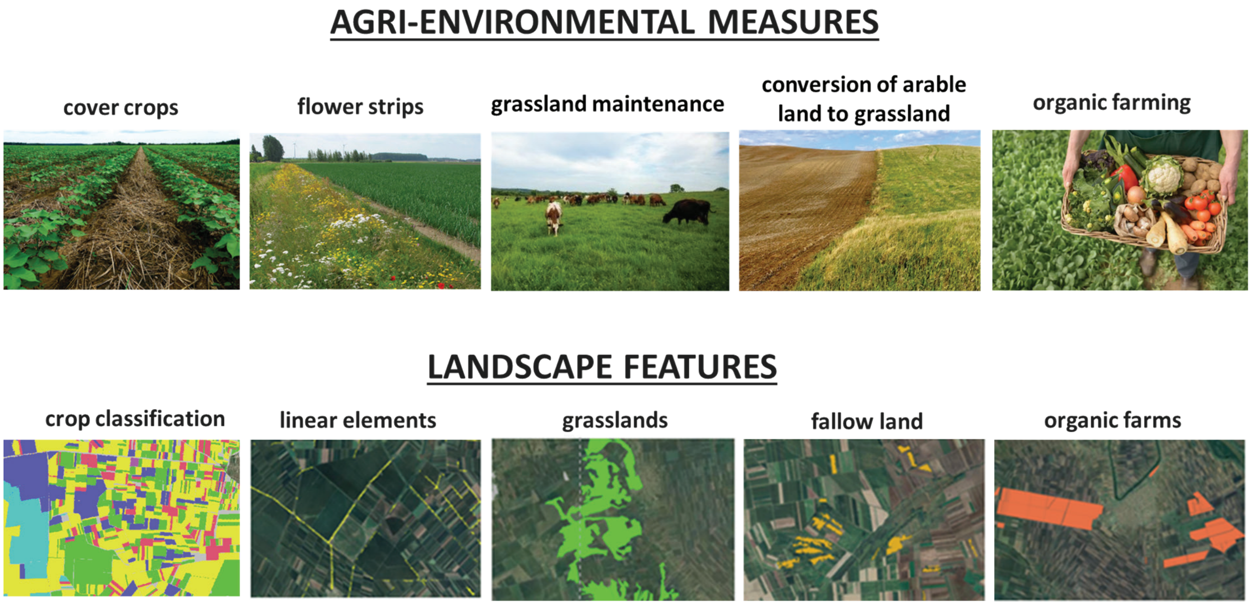

Fig. 2. Selected AEM for the analysis and landscape features generated by ground truth data, remote sensing and machine learning that are further used in biophysical models.

Results

Farmers' future adoption of AEM

- Based on interviews and an experimental survey conducted in Bačka in 2020 and 2021, we found that farmers' willingness to adopt measures is to a great degree influenced by economic considerations. Farmers are unlikely to trade the productive land for environmental payments, and they will rather choose AEM that fit to their agricultural practice or AEM that are easy to implement (Bartkowski et al. 2023). Simulation of farmers' adoption of AEM additionally confirms it (high payments increase the adoption rate; see Fig. 4). Also, it shows that the most favourable AEM among farmers would be: cover crops and flower strips (Fig. 4), which fit best to the prevailing agricultural practice in Bačka.

- The **design of AEM** is an important consideration, and several aspects in particular. Contract duration stands out as the most important (Fig. 4). This is explained by the fact that most farmers use land that is at least partially leased, and tenure contracts are normally short-term. Bureaucratic load is an additional important factor that can discourage farmers from adopting AEM (Fig. 4), especially relevant if considering large numbers of small farmers (a burden with previous applications for the IPARD programme has been highlighted in the interviews). Still, a certain amount of administration can be a sign of transparency for those with less confidence in the fairness of the current agricultural politics. Fig. 4 suggests that advisory services are of somewhat lower importance, but the manner in which they are implemented (who provides, how and what type of information) is perhaps more important to consider (Bartkowski et al. 2023).

- Generally, Serbian farmers show low **trust in policy and administration**, which may turn them away from even considering an application for AEM (Bartkowski et al. 2023).

The impact of AEM on biodiversity and ecosystem services

Since AEM are still not implemented in Serbia, our goal was to evaluate what role non-agricultural vegetation (grasslands 1.8%, fallow land 1.4%, linear elements 1.8%) that farmers keep on their land without any financial support has on the environment. The results show that:

- There is a significant difference in biodiversity outcomes between the current scenario, in which non-agricultural vegetation (denoted as "surrogate" measures) is preserved, and the scenario in which these semi-natural elements are removed from the agricultural landscape (Fig. 5 left). When results are aggregated across all examined species, **removal of semi-natural elements (threatening scenario) leads to a 26% decrease in mean species richness**. Hence, vegetation elements across agricultural parcels are currently preserving biodiversity and thus have a positive effect.

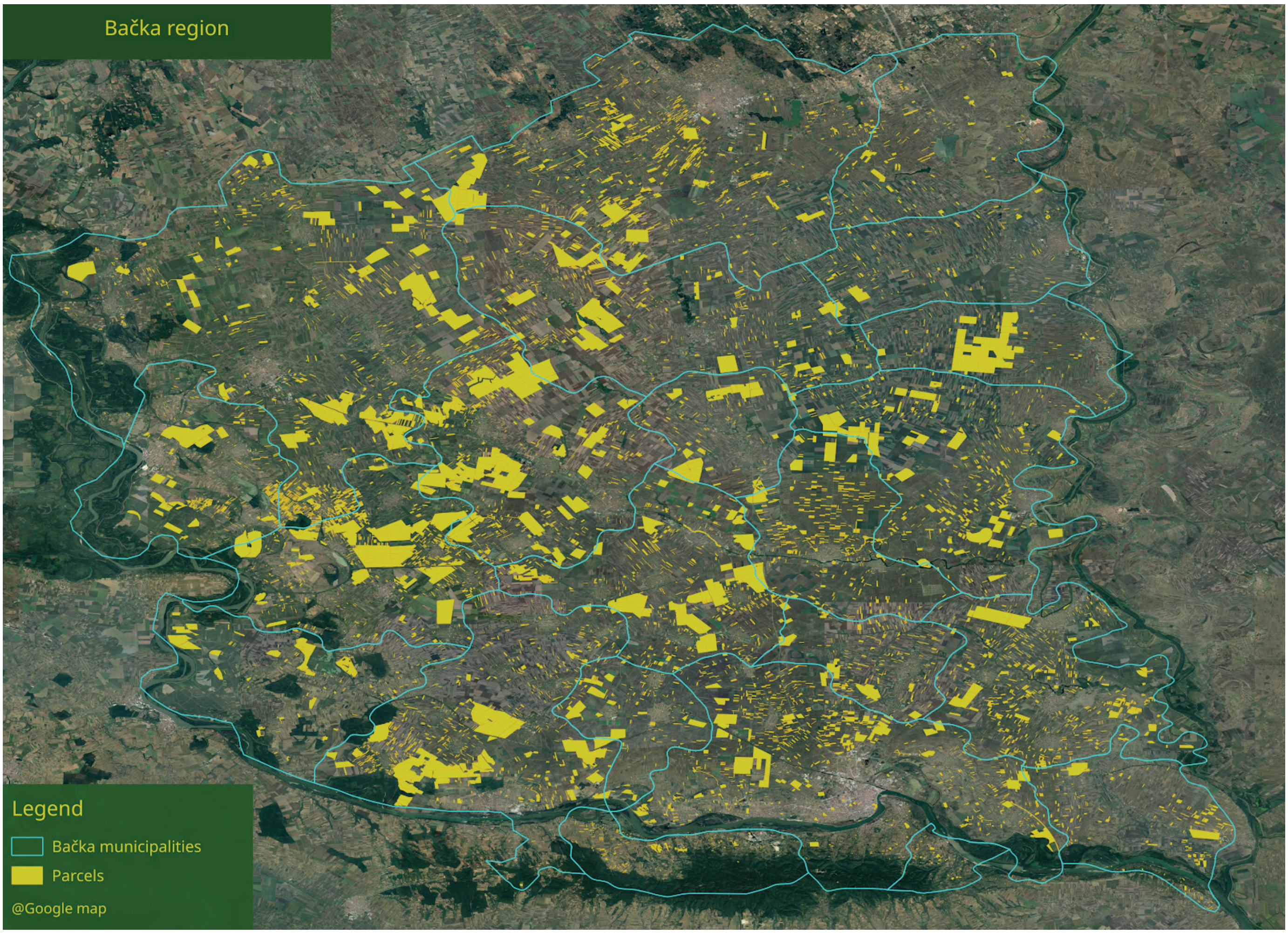

Fig. 3. AgroSens database for Bačka region with 1355 farmers and corresponding parcels with overall coverage of 110064 ha.

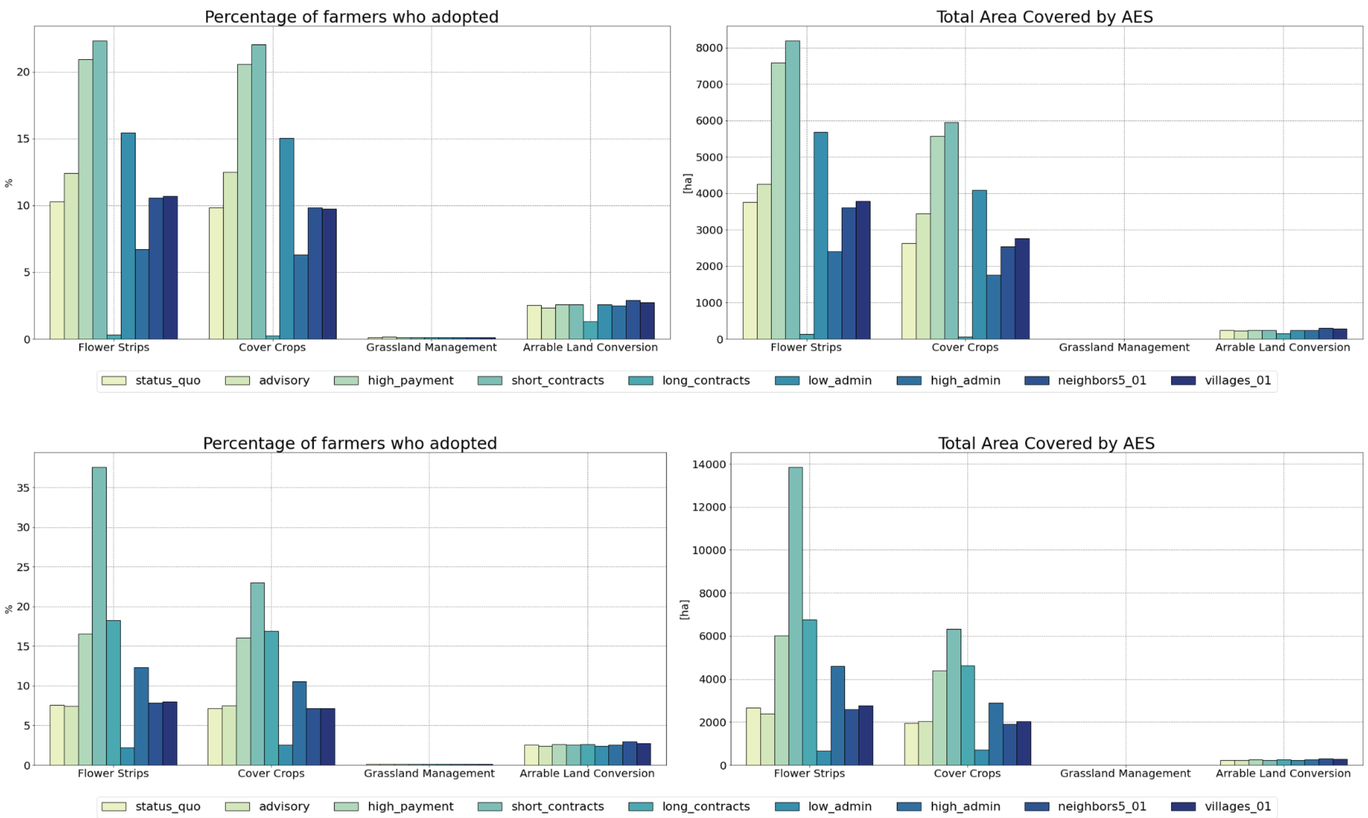

Fig. 4. Adoption rates and total area covered of selected AEM at the farm level for different policy scenarios, when expected payment levels were used from the literature (top right and left) or rely on survey results (bottom right and left)

- The most beneficial landscape features are grasslands and linear elements (i.e. flower strips), along with crop diversity ,at both local and landscape scale (Cord et al. 2022).

- Besides the loss of suitable habitats for biodiversity, if examined land with non-agricultural vegetation is converted to agriculture with average fertilisation rates this could lead to increase of catchment release for 1637 *t* of nitrogen and 977.08 *t* of phosphorus into water bodies and thus further reduce the water quality.

- ABM scenarios for AEM acceptances were evaluated with biodiversity models and potential positive effects were quantified. For example, a high-payment scenario, where grasslands maintenance was the most accepted, jointly with other accepted AEM it would bring the relative improvement of 6.43% (Fig. 5 right). In contrast, the status quo scenario would bring only 3.67% improvement. Implementation of these scenarios could reduce the export of nitrogen and phosphorus into water bodies for 467 t and 279.3 t in the high-payment scenario, and 35 t and 20.5 t in status quo.

Recommendations

To succeed in the future adoption of AEM by farmers, we recommend the following:

- Considering farmers' inexperience with AEM and still unfavourable economic conditions, the most reasonable choice would be measures that fit to local agricultural practices, that are not technically too demanding and will not adversely affect farmers' income. Cover crops and flower strips are such examples (the most preferred option among farmers in our study). Additionally, hidden costs in complicated application procedures should be solved to support farmers, especially those with lower financial and administrative capacities. Providing a trustworthy support for uptaking new practices may help raise their interest and eventually, build more trust in the policy.

- Particular attention should be given to finding solutions for long-term contracts, as short-term contracts or insecure terms of contracts can seriously affect farmers' uptake of future AEM. Moreover, long-term contracts will esure ecological effectiveness of AEM.

To ensure the positive impact of future AEM on biodiversity and ecosystem services, we recommend the following:

- Support farmers in Vojvodina to preserve existing non-agricultural vegetation elements across agricultural parcels as these already have a positive effect on biodiversity. From a long-term perspective, to increase the positive effect, expansion of such areas will be necessary, which may also entail the introduction of AEM on productive lands. Still, for such decisions (where exactly to implement specific AEM and how much land it will be needed), it is first necessary to set clear conservation goals in agricultural settings.

- Grassland areas, in particular, seem to be beneficial for biodiversity. Since our results show the lowest interest of farmers in Bačka for grassland maintenance and mainly accepted under higher payment incentive, it may be that alternative solutions to preserve such areas will be necessary.

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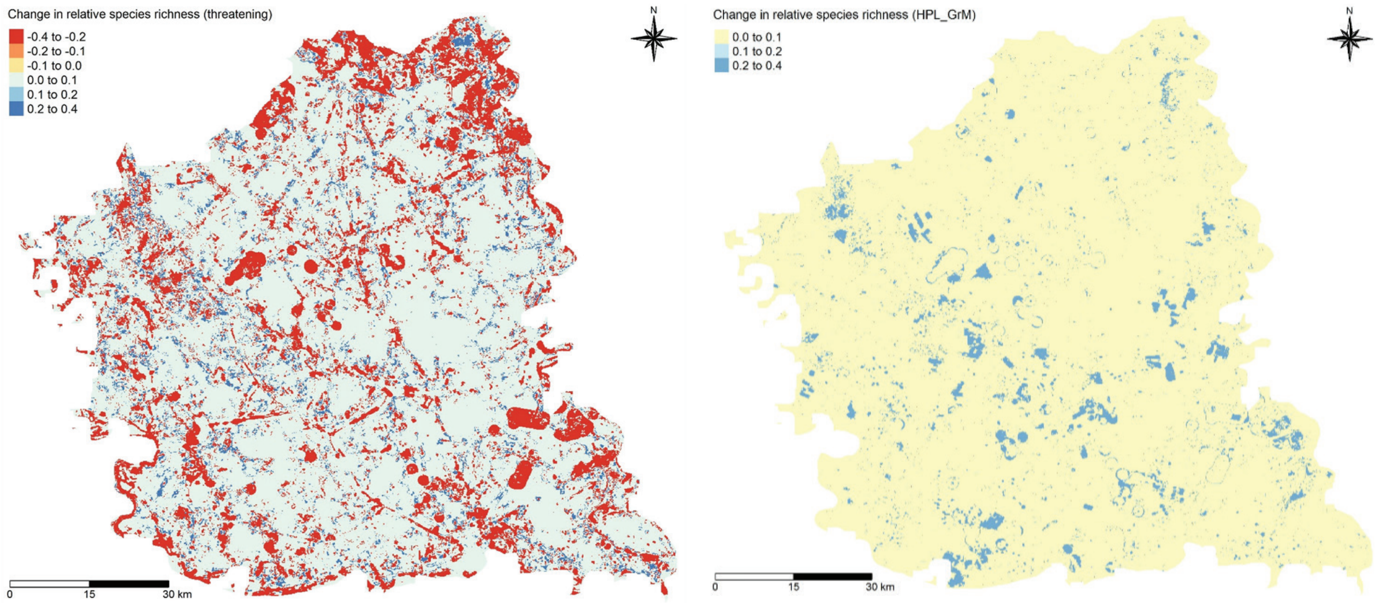

Fig. 5. (left) Evident loss of suitable habitats in a threatening scenario where all semi-natural elements are converted into arable land. Remnants of suitable habitats remain scattered only within formally protected area lands (areas dedicated to nature conservation). (right) Predicted improvements in the suitable habitats with AEM acceptance obtained in high-payment scenarios.

Technical considerations

- While our BESTMAP experience confirms that policy impact assessment tools can be extremely useful in the planning process, scarcity of data that can be used for that purpose was a challenging part. Therefore, we recommend cross-institutional cooperation (between public institutions, academic institutions, NGOs) in building databases to be used for this type of purposes.

- With e-Agrar (electronic registration of farming households introduced in 2023) efficient usage of data and automation of the processing of agricultural subsidies' requests will be accomplished. Further upgrades of e-Agrar with LPIS (Land Parcel Identification System) will provide necessary farm level data to run BESTMAP framework on more comprehensive data.

- Finally, even though learning from the experience of other countries is always useful, each case is specific, and applying the same solution (e.g. the type of agricultural practice or design of AEM) in two different countries can have quite the opposite effect. The same would apply for two different regions within a country. For this reason, careful consideration of the future AEM design supported by predictions from modelling tools is recommended.

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