

Mapping the role of agricultural and forest management in the delivery of environmental and social benefits

PEGASUS, Public Ecosystem Goods And Services from land management – Unlocking the Synergies (<http://pegasus.ieep.eu/>), is a pan-European Horizon 2020 project seeking to transform approaches to rural land management to stimulate long-lasting improvements in the delivery of social, economic and environmental benefits from EU agricultural and forest land. The aim is to provide recommendations on how policy and practice should change to address environmental and social issues more successfully in the future in order to meet societal expectations.

Advances in data availability at a suitable resolution and associated mapping capabilities have allowed new ways of representing a suite of public goods/ecosystem services (PG/ESS) provision supplied by agriculture and forestry systems in the EU. Parallel mapping of PG/ESS provision, where feasible, and of cropping/forestry patterns allows the relationship between the two to be explored in spatial terms and in new ways. However, the number of PG/ESS indicators for which this is possible remains limited at this stage and further work would be needed to create a fuller picture of the position of Europe over time. A substantial improvement to the mapping approach would be provided by making available

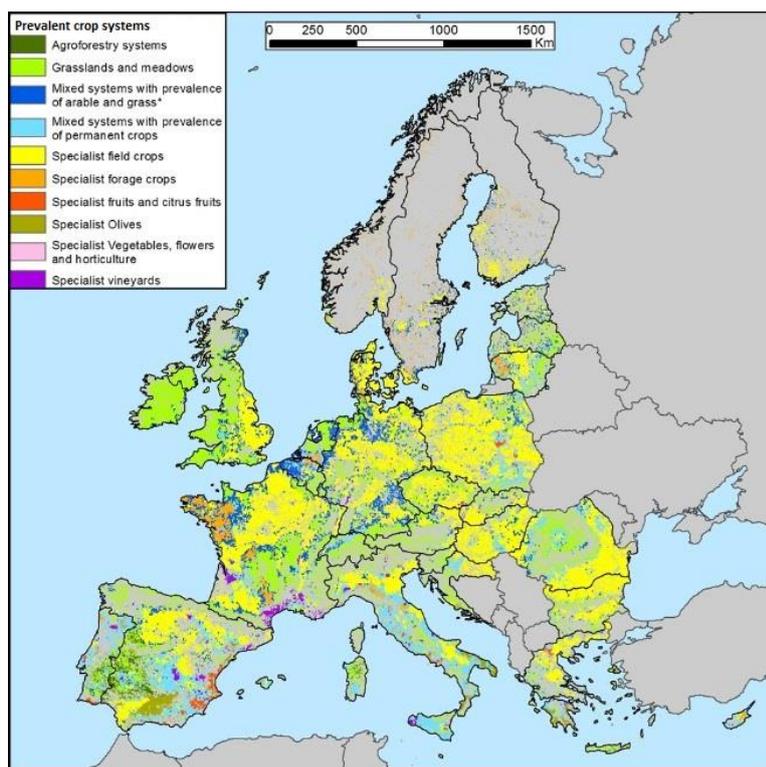


Figure 1. Crop systems in the EU, Switzerland and Norway

existing data/statistics such as IACS/LPIS and attributes (e.g. farm size, labour, farmers' age) from FSS micro-data aggregated at i.e. 5 km² resolution, and improving the knowledge about the spatial distribution of landscape elements in the agricultural landscape.

The core of the work undertaken in the PEGASUS project is the combined analysis of management intensity with PG/ESS indicators¹. For agriculture, the availability of Farm Structure Survey crop data aggregated at 5 km² has allowed producing a novel map of EU crop systems (Figure 1). Such map has then been combined with an indicator of management intensity, summarising energy inputs from machinery, labour, fertilisation, crop protection, irrigation.

In the case of forestry, a representative set of data on predicted forest use intensity, categorised in three classes from passive/low to very high, was available.

¹ Alterra and JRC, 2017. *Report on patterns and trends of PG/ESS in relation to land management systems*

How management impacts on the supply of PG/ESS has been investigated by overlaying data on crop and forest management intensity and a set of proxy indicators to estimate the patterns of PG/ESS delivered.

Concerning **agricultural crop systems**, although the provision of the examined PG/ESS (soil organic carbon loss, pollination, natural pest control, water consumption, rural vitality –expressed through jobs in agriculture and population change) varies greatly across crop systems and geographic contexts, some broad geographic trends can be identified: an east-west gradient of management intensity still characterises Europe, with Eastern countries featuring, overall, less intensive systems.

As would be expected, a trade-off can be identified between management intensity and agricultural biomass production (not considered as PG/ESS in PEGASUS, but used as a benchmark), which is comparatively higher in more intensive systems regardless of the cropping system. It is also interesting to note that higher pollination and natural pest control potentials are positively correlated to low management intensity crop systems, and strictly depend on the presence of semi-natural elements in the agricultural landscape. Significantly higher water consumption is associated with high-intensive crop systems, but no significant differences emerge between low and medium-intensity ones. Finally, avoided soil organic carbon loss shows a clear negative relationship with high management intensity (soil organic carbon loss is avoided to a higher rate in low-intensity systems). Overall, results suggest that the presence of Green Infrastructure ameliorates the impact of high-intensity management.

Two socio-economic indicators were used to explore different aspects of rural vitality - the number of jobs in agriculture and changes in population densities over time. These seem to be relatively weakly correlated to the intensity of crop management and more associated with other factors, such as the degree of rurality and the specific socio-economic conditions of individual countries.

In the case of **forestry**, evident trade-offs between wood production and the supply of other forest services (soil erosion protection, carbon storage, tree species diversity) can be found.

Ecological zone	Soil erosion protection	Carbon storage	Tree species diversity	Wood production
Boreal mountain system	2	3	3	3
Boreal coniferous forest	3	3	3	3
Temperate oceanic forest	3	2	3	3
Temperate continental forest	3	3	3	3
Temperate mountain system	3	3	3	2
Subtropical dry forest	3	3	3	2
Subtropical mountain system	2	3	2	3

Legend Positive Negative Mixed

Summary assessment of the effects of forest use intensity on ecosystem services. Numbers represent significance differences between pairs of categories of forest use intensity. For example, 3 means that there is a significant statistical difference in the mean of three categories of forest use intensity for a given ecosystem service in a given ecological zone. The table clearly shows the trade-offs between wood production and other forest PG/ESS.



The table illustrates a positive relationship between forest use intensity and wood production in five out of the seven investigated ecological zones. In contrast, forest use intensity is inversely related to soil erosion protection, carbon storage and tree species diversity in five, four and six out of the seven investigated ecological zones, respectively. Associations in boreal coniferous forest between forest use intensity and wood production, carbon storage and tree species diversity appear to be less robust. However, the reasons of this remain to be determined.

The trade-offs between wood production and other forest public goods/ecosystem services show that more intensively managed forest systems, e.g. with increased wood production for round-wood or bio-energy, often have negative effects on the public goods/ecosystem services provided by forests examined. When considering the effects of forest use intensity on the ecosystem services examined as a whole, results indicate synergistic relationships between soil erosion protection, carbon storage and tree species diversity. In most cases (red cells in the table), the availability of public goods/ecosystem services decreases with increases in forest use intensity.

Maps and layers describing crop/forestry systems and their management intensity and those public goods/ecosystem services examined in this assessment have a sufficient resolution to establish patterns at EU and Member State levels although more accurate analysis at the local level would rely on more detailed datasets often available at regional/local levels. The methods underpinning the analysis can be easily expanded when new public goods/ecosystem services proxies and datasets become available.

