From Sky to Soil: Monetizing Vineyard Ecosystem Services via Remote Sensing

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BACKROUND

Ecosystem services (ES) are the result of functions, which derive from ecosystems and support below and above-ground biodiversity thus adding to human wellbeing (Costanza et al., 1997). ES can be valuated using monetary units assessing the economic importance of different ecosystems to humans.

High Nature Value Farmlands (HNVfs) are agricultural areas where a large number of species or habitats are supported, such as vineyards, olive groves, orchards, and grasslands (Andersen et al., 2003).Their importance goes beyond their productivity, since they add to biodiversity conservation and the provision of ES in terms of protection from erosion, carbon sequestration, pollination, aesthetics, and cultural value.

In a world where climate change and the urban sprawl are threatening human health and agricultural land and thus food security, we need to invest in sustainable farming techniques and find ways to increase their abilities to provide ES.

This study focuses on valuating one of the Regulating ES, Air Quality Regulation and it aims to shed light on the importance of HNVfs in terms of human health and resilience to climate change.

METHOD

CORINE land cover
- Vineyards in 1990
- Vineyards in 2018

Estimation of PM10 removal
- Nowak, 1994 and Yang et al., 2005
  - $F=V_dC$
  - $Q=Fd \times L \times T \times 0,5$

Estimation of O_3 removal
- Manes et al., 2012
  - $FO_3i = g_s \times [O_3] \times 0.613$
  - $FO_3\,cum = FO_3i \times 3600 \times Ph \times 10^{-9}$
  - $FO_3t = FO_3\,cum/0.3$

The satellite products used were:

- **CLC** based on satellite imagery data (POT-4 and Landsat-7 ETM+,resolution 20/30-m
- **PM10 and O_3** from CAMS in 10 km x 10 km horizontal resolution and
- the **Leaf Area Index (LAI)** derived from the Level-4 MODIS global Leaf Area Index (LAI) and Fraction of Photosynthetically Active Radiation (FPAR) product in a 8-day 500-meter resolution

RESULTS

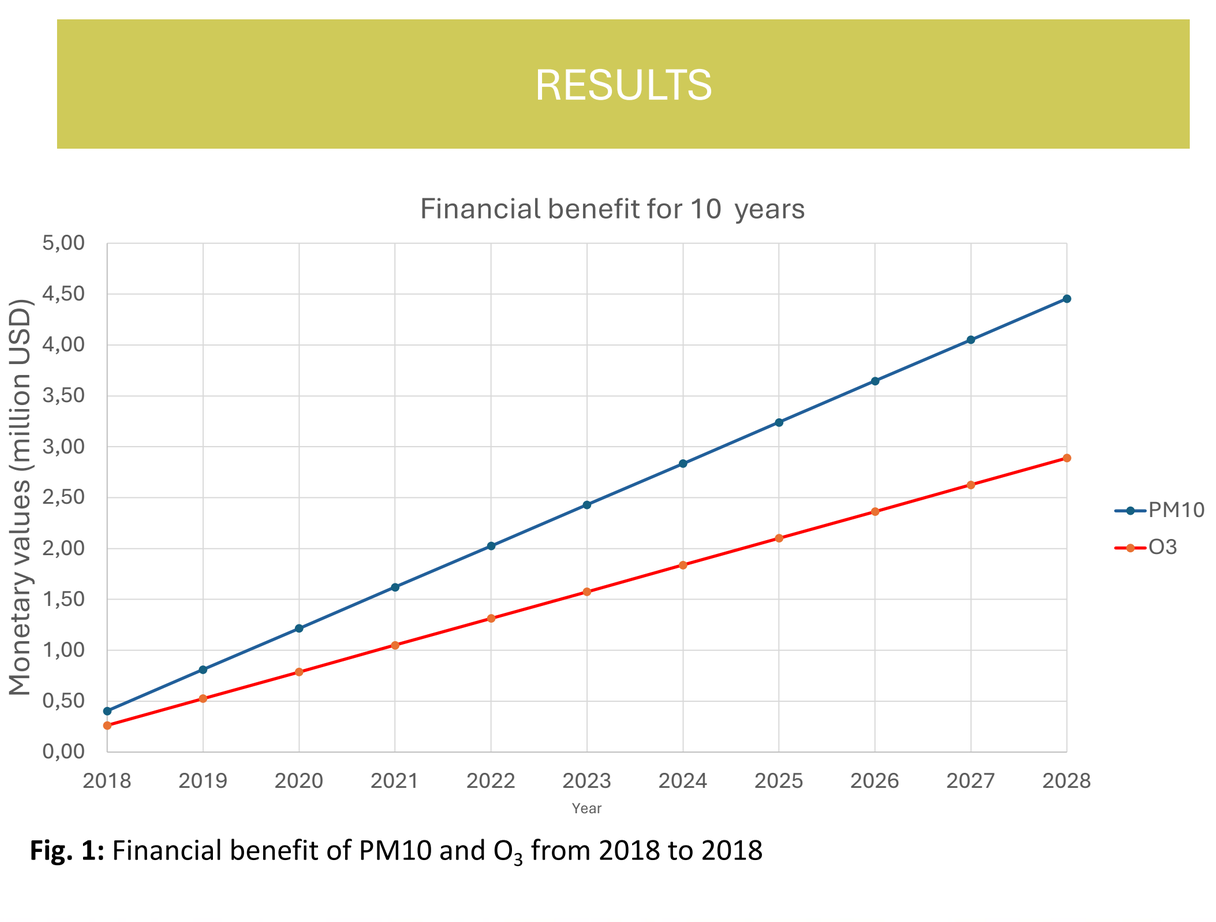

Fig. 1: Financial benefit of PM10 and O_3 from 2018 to 2018

Vineyards can create a benefit of around 667.000 USD per year by removing PM10 and O_3 from the atmosphere. 405 .000 USD that derive from PM10 and 262.000 USD from O_3 removal.

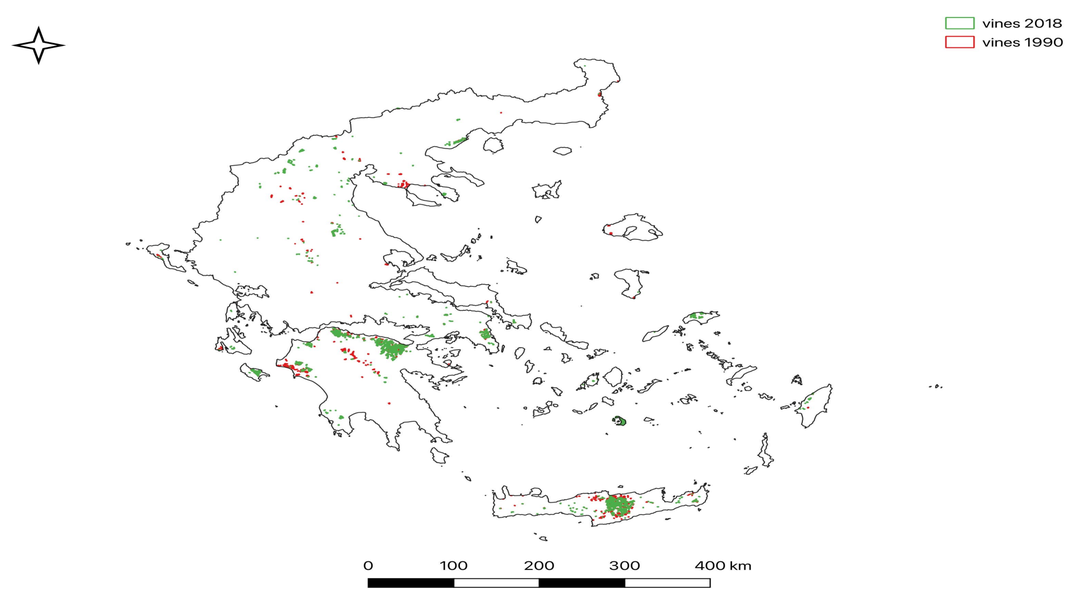

Fig.2: Map of Greece with vineyards in 1990 and 2018 (https://land.copernicus.eu/en/products/corine-land-cover)

The reduction of area can clearly be observed in northern Greece where most vineyards activities stopped completely, whereas in northern Greece viticulture has significantly reduced but not completely disappeared in most cases.

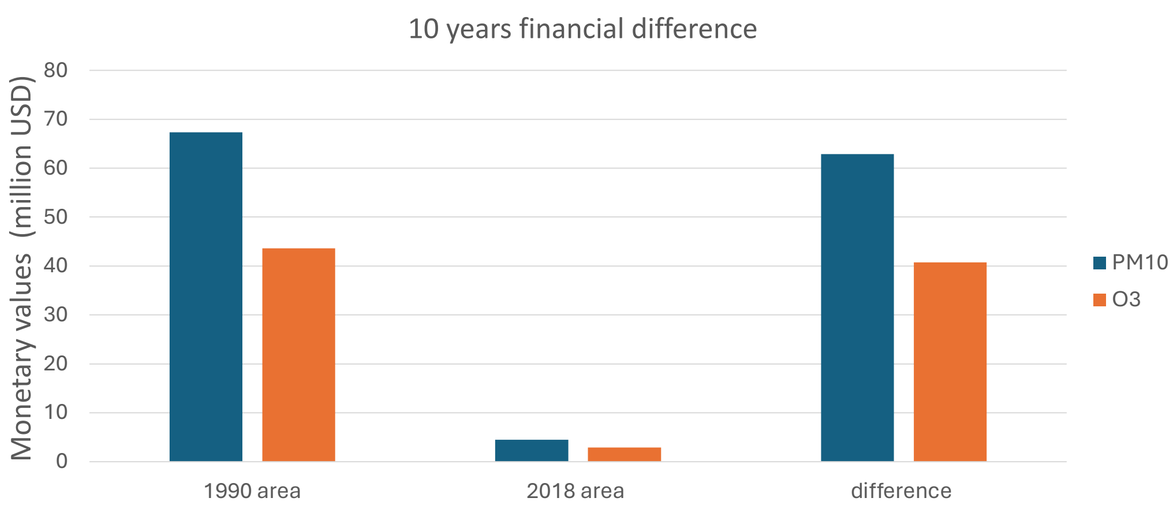

Fig.3: Financial loss in Air Quality Regulation due to shrinkage of the areas of vineyards calculated for a 10 year period.

In 1990 the total area of vineyards in Greece was 345.404 hectares whilst in 2018 it was reduced to barely 81.020 hectares. The difference can potential cost more than 100 million USD in just 10 years in Air Quality Regulation.

DISCUSSION

Air Quality Regulation is not commonly evaluated in agroecosystems since they provide low values of Regulating ES compared with forests. Nevertheless, in HNVfs special conditions occur, thus multiple ES are supported, including Regulating ES, but unfortunately, they are rarely studied.

Current environmental threats, such as climate change call for complicated and well-studied measures in order to tackle multiple issues at the same time. HNVfs is one of the methods that cannot only maintain a high productivity and thus enhance food security, but at the same time it can provide multiple ES with great importance in human health and economy such as Air Quality Regulation.

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