LIFE 20 PRE IT/017

C·FARMs
CARBON FARMING CERTIFICATION SYSTEM

BROCHURE
SUMMARY OF RESULTS – REVIEW OF METHODS AND APPROACHES TO REPORT EMISSIONS FACTORS IN LIVING BIOMASS, SOIL AND HWP IN TREE PLANTATIONS

ACTION A.3

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CARBON FARMING CERTIFICATION SYSTEM

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1 Description of Action A3

Action A3 aims to characterize the **different tree plantations within the Lombardy region**, the reference area of the project, focusing the attention on **poplar plantations**, considered as the major plantation type in the area and as such a **practical example of carbon farming practices**. Indeed, considering the scientific literature at European scale, it is the plantation itself being investigated such as carbon farming technique.

The **main pillars** of the action were:

1. **Mapping of poplar plantations**: in order to compensate for the lack of existing data on the distribution of poplar plantations (currently available for 2016-2017), an update to 2021 of the mapping of poplar plantations in the Padan Plain regions (Piedmont, **Lombardy**, Emilia-Romagna, Veneto and Friuli Venezia-Giulia) has been planned and implemented.

2. **Soil carbon stock (SOC) in poplar plantations:** the aim was to investigate and quantify the potential of poplar plantations to mitigate climate change, in the Lombardy region in Italy, by reducing GHG emissions through the capture of g CO2 from the atmosphere and subsequent storage within the soil. Consequently, the SOC stock of poplar plantations of the region or in similar climatic conditions to those of the Lombardy region was derived from the scientific literature using the most common sources of research.

3. **Carbon stock of Harvested Wood Products (HWP):** the aim was to analyse the carbon content of those products harvested from the plantations, net of forestry and production activities. A production accounting approach was adopted, using the available databases and field data collected within the region.

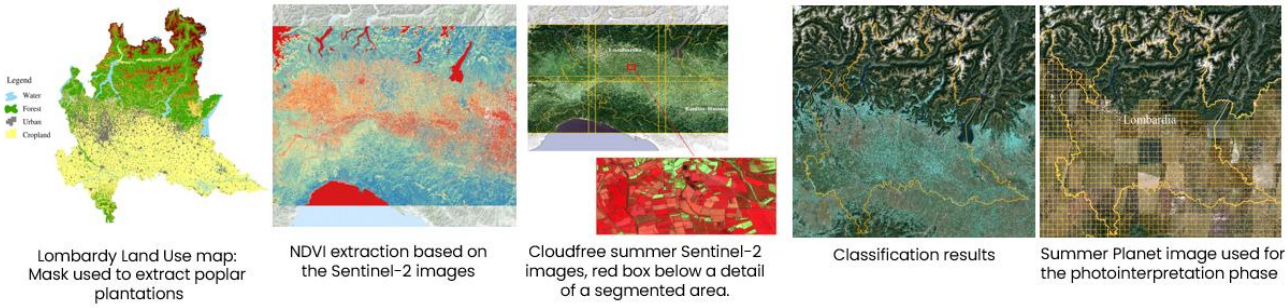
2 Materials and methods

2.1 Mapping of poplar plantations

The **update of the mapping of poplar plantations to 2021 in the Padan Plain regions** (Piedmont, **Lombardy**, Emilia-Romagna, Veneto and Friuli Venezia-Giulia), was carried out through the analysis of the Sentinel-2 satellite images of the Multispectral Instrument (MSI) sensor and vegetation indexes such as Normalized Difference Vegetation Index (NDVI).

The method followed in this analysis is presented below.

- **Existing mappings** represented the starting point for the updates.
- **Areas potentially suitable for poplar cultivation** were identified and selected by **excluding areas with incompatible land uses** (e.g. altitude threshold of 600 meters based on the Digital Terrain Model, water etc.).
- In the selected areas, based on the Sentinel-2 images, a **summer image (cloudfree)** was generated and used for the subsequent segmentation, through which **land parcels with homogeneous spectral behaviour** were aggregated.
- For each detected polygon, **annual patterns of photosynthetic activity** were calculated using Sentinel-2 vegetation indices.
- **Analysing the spectral pattern of polygons**, potential poplar plantations were identified.
- Possible inaccuracies were corrected through a **photointerpretation step**.



Lombardy Land Use map: Mask used to extract poplar plantations | NDVI extraction based on the Sentinel-2 images | Cloudfree summer Sentinel-2 images, red box below a detail of a segmented area. | Classification results | Summer Planet image used for the photointerpretation phase

Figure 1 - Maps development

2.2 Soil carbon stock (SOC) in poplar plantations

The **soil organic carbon stock of poplar plantations within the Lombardy region** was analysed through the following **steps**:

- **systematic review at European level on SOC within poplar plantations**: the bibliographic research was used to build a database collecting all the European studies focused on SOC annual sequestration rate and stock within the soil of poplar plantations.

- **Standardized climatic classification** was carried out for each study involved in the analysis using the spatial data gained from "The Environment Stratification of Europe" (EnS) proposed by Metzger and Marc (2018).

- **Climate zones were used such as driver for SOC clusterization at regional level**: the principle used to study the SOC of poplar plantations within the Lombardy region was guided by climate variability. The latter was used as a driving factor for the data investigation: the SOC stocks found in climates equal to those present in the Lombardy region were grouped and statistically analysed.

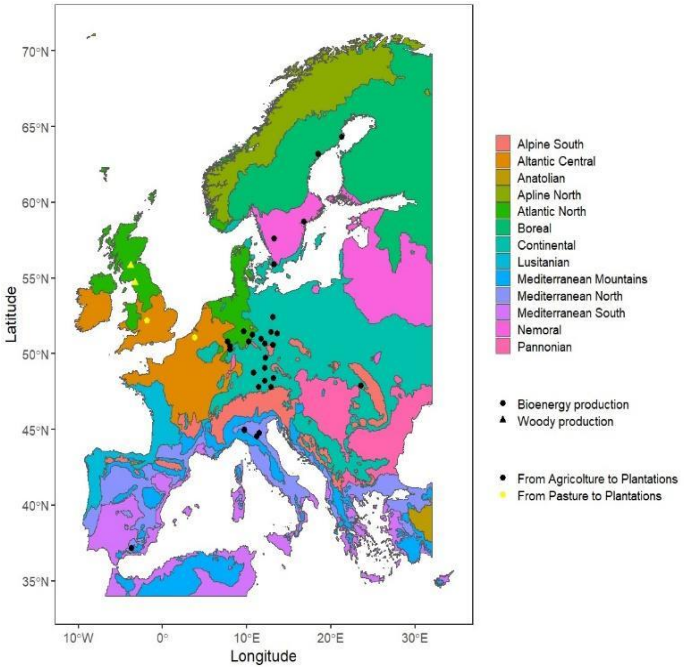


Figure 2 - Location of studies within the European territory overlapped on the climatic zones. Each location may contain more than one SOC data. Triangle identifies the plantations used for wood production while the circle for bioenergy production. The yellow colour corresponds to the land-use change from pasture to plantations while the black colour shows the passage from agriculture to plantations.

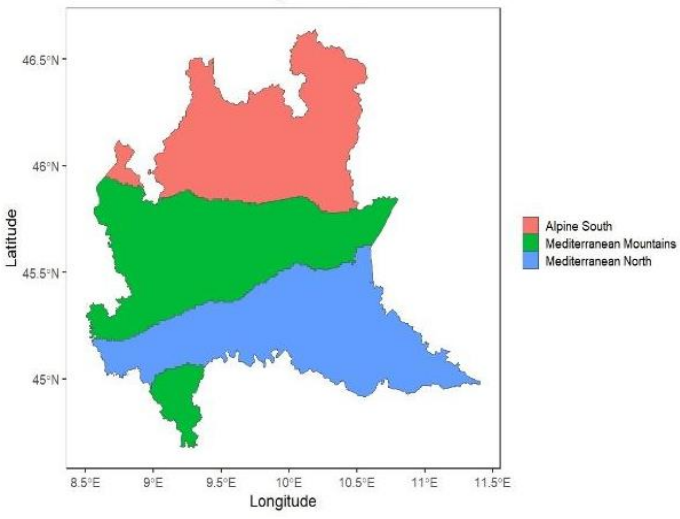


Figure 3 - Climate map of the Lombardy region according to the Environment Stratification of Europe (Metzger and Marc 2018)

2.3 Carbon stock of Harvested Wood Products (HWP)

For the analysis of the **carbon stock in wood products harvested within the Lombardy region**, **a production accounting approach** was adopted using different available databases as well as field data collected for the study region.

Different steps of the value chain were analysed:

- **Carbon Content of Standing Trees**: calculation of the gross amount of Carbon stored in Poplar trees having reached the end of their rotation cycle.

- **Carbon Content after extraction and haulage**: it has been calculated the net value of harvest activities and haulage to the wood processing facilities, where the transformation into final products is carried out.

- **Carbon Content after primary processing**: it has been calculated the Carbon Content in the final products, which are then commercialized in the open market. For these, the production accounting approach was followed, in line with the accounting methods defined by Regulation 841/2018/EU.

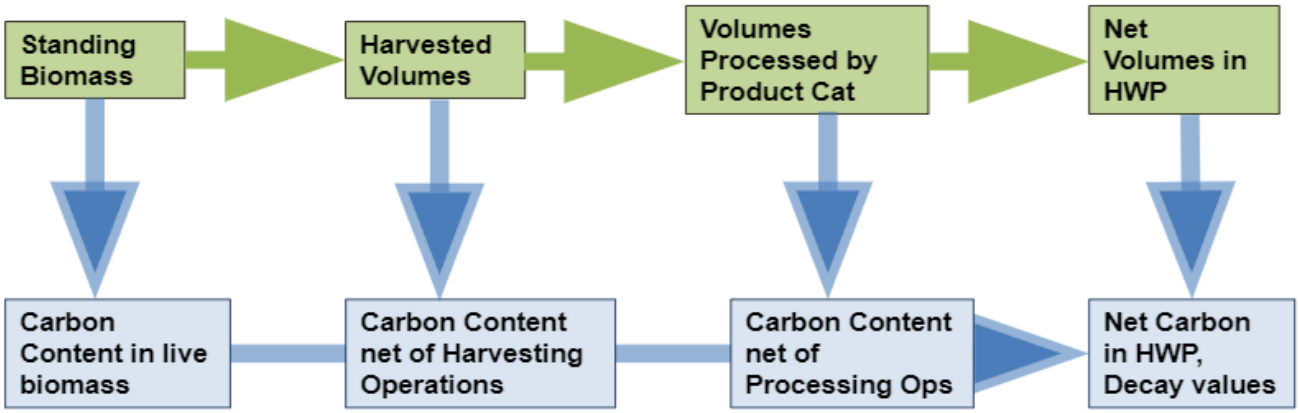


Figure 4 - Workflow

3 Main Results

3.1 Mapping of poplar plantations

- The mapping of poplars has identified areas of poplar plantations with **an area of more than 0.5 ha and an age of more than 4 years**, in the areas close to the Po Valley (**Lombardy**, Piedmont, Emilia-Romagna, Veneto and Friuli Venezia-Giulia) of the years 2021, 2020, 2019, 2018 and 2017.

- Poplar cultivation in Italy, as it plays an important role in mitigating climate change, is an **example of Carbon Farming**. In addition to that, it represents a strategic sector for the forest-wood supply chain, the most significant internal source for the national timber industry, although it occupies a very small area (less than 1% compared to national forest area).

- In accordance with the literature, the mapping has shown that, in the Po Valley area, **Lombardy is the Italian region where poplar plantations are mainly located: 15.379,3 ha** of mapped poplars as of August 31 of the year 2021.

- Within the Lombardy region, poplar plantations are mainly located in the areas of Pavia, Mantua, Cremona and Lodi, in the southernmost part of the region.

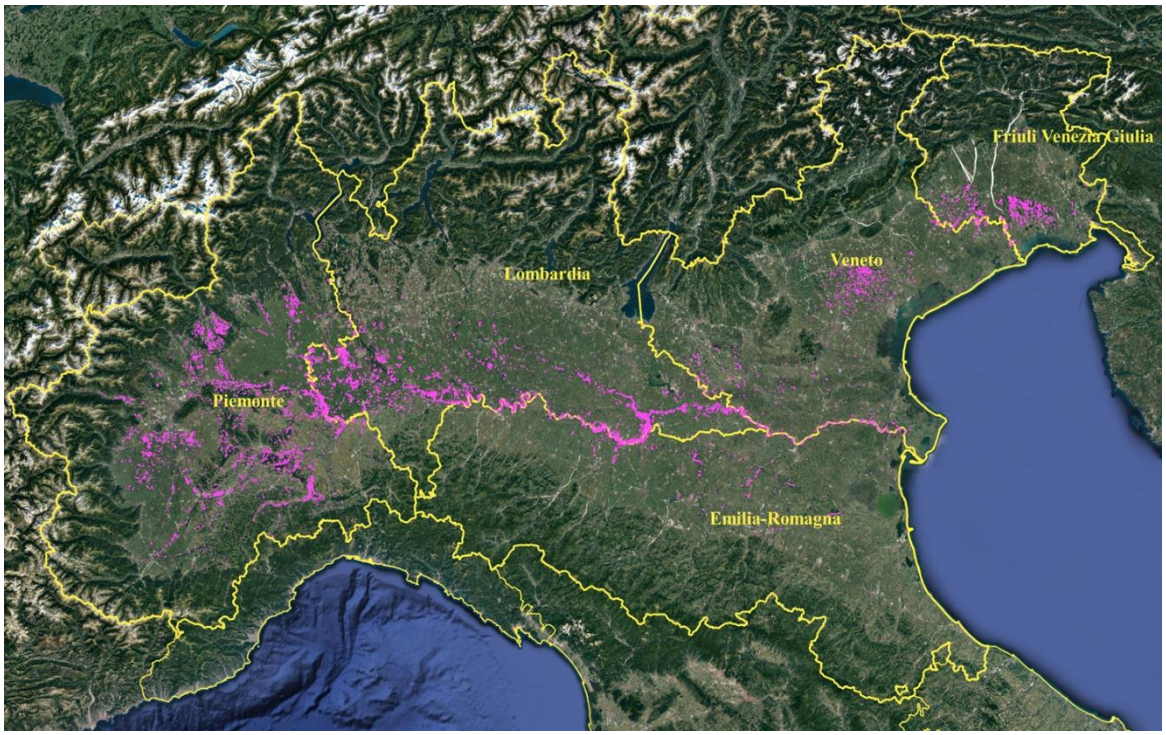


Figure 5 - Poplar plantation map updated to 2021

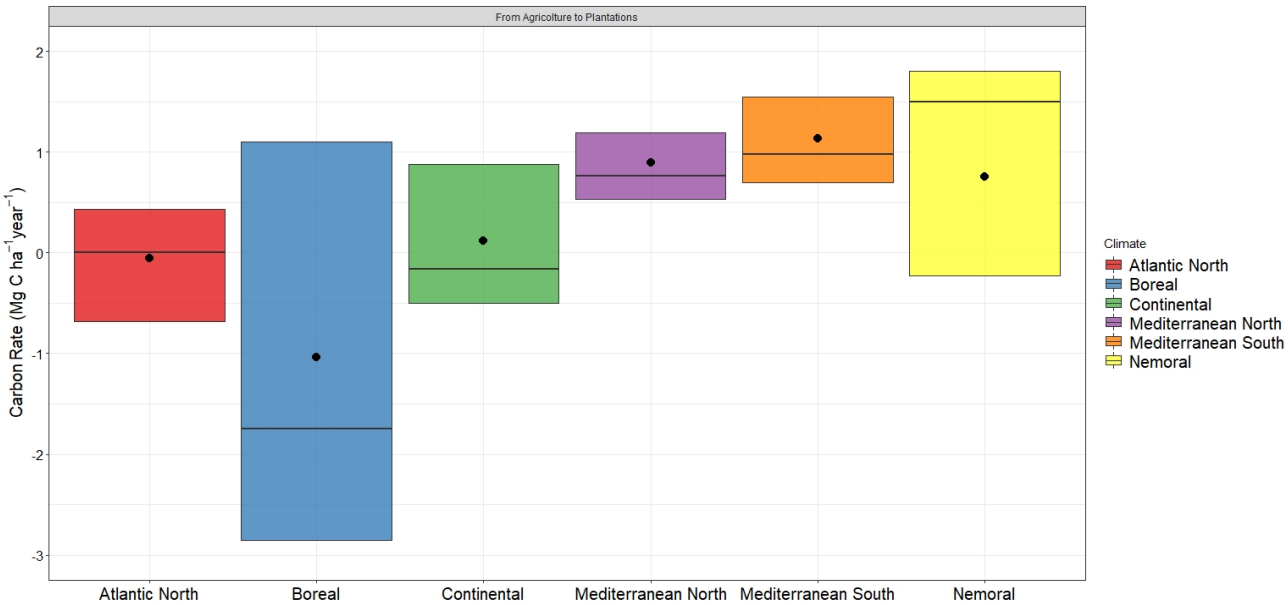
3.2 Soil carbon stock (SOC) in poplar plantations

- The poplar plantations located in the **Mediterranean north and south climate** showed the **highest potential in terms of SOC rate** and are the unique boxplots with the interquartile range that shows only positive values. Mediterranean north climate and relative data about SOC rate found in bibliography are the only one comparable to the region of interest.

- Grouping all the variables under investigation in the **different climates in all Europe**, land use-change, and wood array production, we observe that in 50% of the cases there is a **negative impact of poplar plantations on median SOC sequestration rate** with a range that goes **from -1.75 Mg C ha-1yr-1 to 0 Mg C ha-1 yr-1**.

- The remaining 50% of the observations show a **positive SOC sequestration rate with a range from 0.76 to 1.5 Mg C ha-1 yr-1.**

Graph 1. SOC annual rate expressed in Mg of Carbon per hectare per year is shown through boxplots considering the poplar plantations within different climate conditions of Europe. The x-axis shows the climate type while the boxplot located in the y-axis shows with the black horizontal bar the median annual rate of SOC change, the upper limit shows the 75th percentile, the lower limit shows the 25th percentile. The black circle inserted in each boxplot shows the mean annual carbon rate of poplar plantation within each climate



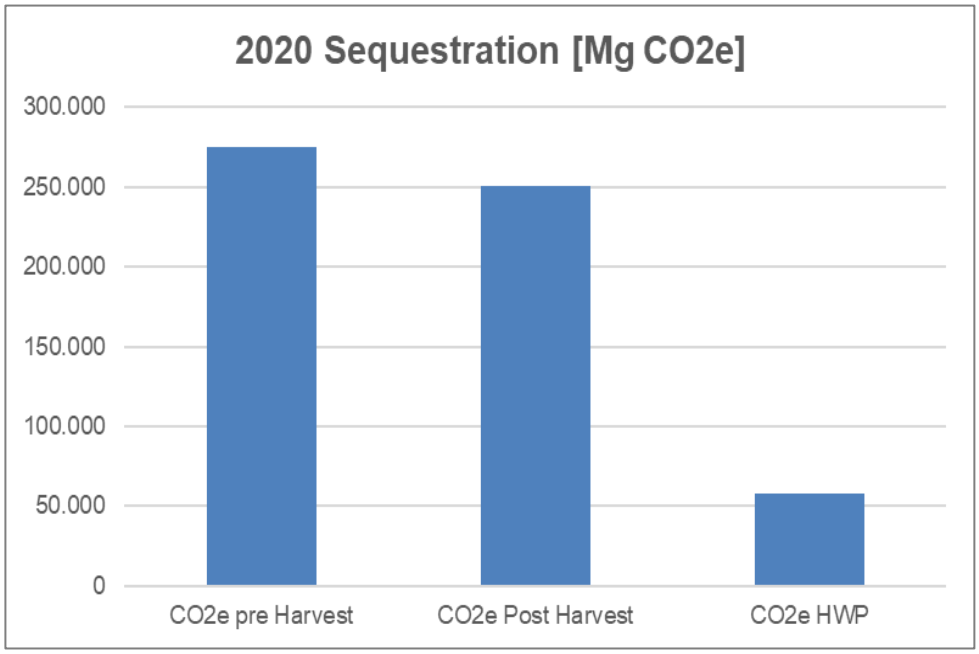
3.3 Carbon stock of Harvested Wood Products (HWP)

- The analysis conducted on the carbon stock of HWP demonstrates how **wood products can play a significant role in the retention of the carbon sequestered by Poplar plantations.**

- At the same time, **the analysis highlights the impact of production processes and recovery rates** in the attrition of the CO2e sequestration along the value chains.

- **Increase in efficiencies, improved use of biomass, and adoption of eco-friendly production processes** (e.g. avoidance of high emitting glues in Plywood production) are all factors that will play a great role in increasing the potential long term sequestration of CO2e

Graph 2. In the graph above, a visual representation of the carbon sequestration of harvested biomass from Poplar plantations as analysed in the study. The three columns represent before harvesting, after harvesting and finally, in the what's retained in the Harvested Wood Products after all production processes have been accounted for.



4 Final Recommendations

- In order to develop support strategies for improving Carbon Farming practices and the contribution of poplar plantations on climate change mitigation, it is essential to always have an **updated and detailed map of poplar plantations**, using advanced methodologies based on remote sensing data.

- Regarding Italy, it is important to **collect information about the distribution of poplar plantations especially in the Padan Plain Regions** (Piedmont, Lombardy, Emilia-Romagna, Veneto and Friuli Venezia-Giulia), where the poplar cultivation is mainly located.

- According to the results of this investigations, the contribution of poplar plantations in terms of SOC rate and stock can be considered **site-specific**, and the following **suggestions** should be followed for future research:

  I. Continue to **evaluate case by case** in order to fully investigate the impact of poplar plantations on SOC in site-specific conditions.

  II. **Extensive research and database development** to aggregate data and relative selected variables (e.g. soil type, plant density, history of the agriculture management)

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The **project C-FARMs**, **co-funded by the 2020 LIFE Programme of the European Commission**, supports the design and implementation of targeted payments for the application of Carbon Farming practices through the development of a **regulatory framework for the certification of Carbon removals** (or Carbon non-emissions) based on a robust and transparent carbon accounting scheme **in connection with the national GHG inventory.**

Objectives of the Project:

1. Creating a **high-resolution demonstrative geospatial information system** (GIS-FARMs), which will identify the mitigation potential of the agricultural sector of Lombardy region

2. **Systematising existing knowledge and data** with relevance for the area of interest useful for the creation of the high-resolution demonstrative geospatial information system (GIS-FARMs)

3. **Identifying information and research gaps**

4. **Supporting the development of a regulatory framework for a carbon certification system** in collaboration with relevant actors and institutions

5. **Exploring the possibility of use of common methods and/or reference data and/or data sets** in combination with GHG reporting institutions as well as an exchange and information mechanism related to greenhouse gas inventories from the agricultural sector

6. **Supporting the design and implementation of targeted payments** for the application of Carbon Farming practice

The project aims to work in close connection with:

- the **Institutions with the official responsibilities of GHG reporting**
- the **offices from Regional authorities dealing with agricultural themes** (e.g. CAP payments)
- the **Institutions dealing with the certification systems**

C-FARMs also involves **public Institutions, Universities and research centres, private companies and farmer and woodworking industry associations** working specifically on themes related to the **LULUCF sector** (Land-use, Landuse change and Forestry)