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GREENChainSAW4Life

Project n° LIFE18 CCM/IT/001193

"Description of local forests, climate smart sylvicultural approache guidelines and forest carbon fuxes baseline reports"

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1 OBJECTIVES

This document aims to give a key to understanding the current state of the forest areas of the Po, Bronda and Infernotto Valleys. The qualitative and quantitative characteristics of these areas have been described using data resulting from field surveys carried out in spring 2021. The data collected were used to define strategies for forest operations in accordance with "Climate Smart Forestry' as reported in bibliography. In the end has been modelled a medium-scale carbon flow calculation scheme to evaluate how "Climate Smart Forestry" can have positive effects in the fight against climate change and in the mitigation of its effects on forest surfaces.

2 STUDY AREA

The study area is included in the section of the Alps of the Cottian Alps. The area is included in the Province of Cuneo, namely in Valle Po, Valle Bronda and Valle Infernotto for an amount of 19.952 hectares. In this territory is included the Monte Bracco Massif.

Po Valley: The valley develops from Monviso (3.841 m) till the city of Saluzzo. This territory includes the municipalities of Crissolo, Ostana, Oncino, Paesana, Sanfront, Gambasca, Martiniana Po and Revello;

Bronda Valley: the Valley develops from south-west of the city of Saluzzo and includes the municipality of Pagno and Brondello;

Valle Infernotto: The valley takes its name from the Infernotto torrent that comes from the eastern side of Punta Ostanetta (2.385 m) with the name of Rio Rocca Nera. The territory includes the municipality of Bagnolo Piemonte and Barge.

Monte Bracco: the massif of Monte Bracco is included within the territory of the municipalities of Rifreddo, Paesana, Sanfront, Revello, Envie and Barge. It is located between the Valle Infernotto, the Po Valley and the piedmontee plain.

Considering the anagraphic trend the case of these valleys do not follow the national trend of population growth. On the mountain territory the depopulation is easily found following a criterion of descending altitude. The depopulation phenomenon on the mountains is linked to several factors which includes the operational difficulties in carrying out agricultural and forestry work in inhospitable areas for a good part of the year. This abandonment has involved in a very impactful way the vegetational resources in the territory. The cultivations and the pasture-meadows have been almost completely abandoned and have left room for shrub and trees invasion.

3 METHODOLOGY

The used methodology consists of four different points:

- Preliminary analysis of standing biomass;

- Temporary test areas (TFS)
- Permanent test areas (PFS);
- Lidar, Remote sensing and Mobile Laser scanner surveys.

The first step was the bibliographical collection of information on the forest characteristics of the study area. There are not many studies on the region and the most reliable data are those contained in the PFT (Territorial Forest Plan) dating back to 2000. Combining the information contained in the PFT, those present in the PFR (Regional Forest Plan) of 2015 and in the regional forest map of 2016 it was possible to estimate the increases and biomass standing in 2020.

These informations were then supplemented by data collected in the field regarding biomass, presence of natural risks and effects and emergencies related to climate change. The data collection was carried out using the Forest Buddy APP, developed within the WPC4 of this project, to simplify the transfer and processing of data collected in the field. In addition, to facilitate field operations and to ensure maximum precision in the positioning and detection of areas, the detectors have employed a GNSS GeoMax Zenith 40 receiver that ensures an accuracy of (+/-) 2 m under tree cover and sub-metric precision in open field.

The positioning of the 162 TFS was made first by taking into account the area occupied by the individual forest category, the possible productive interest and the relevance of the likely impacts of climate change on the category itself.

The following informations were collected through the Forest Buddy APP:

- General data on the location, date and author of the survey;
- Forest category, forest type and structure;
- Total sampling of the diameters and partial heights measurement;
- Possible assortments, function, possible future interventions and priorities;
- Random sampling of increments and ages;
- Information on accessibility, disturbance, renewal, natural hazards, deadwood and "Climate Smart Analysis"datas.

In addition, where forestry interventions have been scheduled, we placed 3 PFS with the aim of monitoring the effects of "Climate Smart Forestry" over the years. For each area has been chosen a control one, with similar stationary, physiographic, managerial and structural conditions.

The PFS will be used to monitor over time:

- Changes in carbon stocks;
- Changes in the rate of increase in the forestry interventions area;
- The response of renewal to interventions;
- Changes related to climate change impacts;
- Variations in soil quality and composition.

Most of the surveys areas were palced on private ownership in order to have a complementary framework with other planning tools as the PFA of the Po Valley, Bronda and Infernotto that will be released in mid-2022.

The data collected and processed had to be integrated with the LIDAR data of the Piedmont Region or those obtained with portable laser scanning instruments. This integration, after some elaboration and

survey tests on the ground and considering the results obtained with the traditional survey campaign, was not necessary.

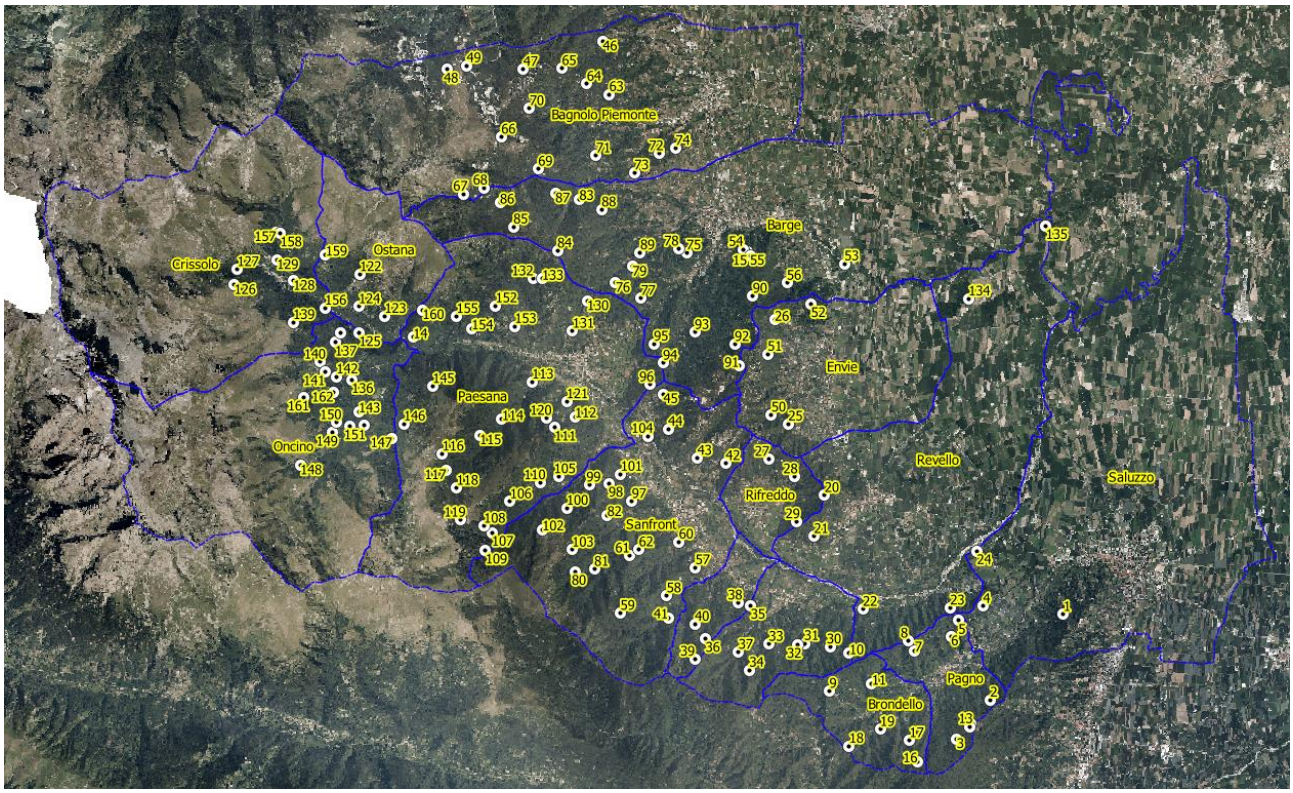


Figure 1: Map of the field survey areas.

4 FOREST RESOURCES

At the end of the survey activities of the forest resources, data processing was carried out with the aim of obtaining average values for the forest categories present. The data collected differ from the data in other area plans (PFA Valle Po, Bronda and Infernotto - currently in preparation and PFT year 2000) because in the present paper have been made voluntarily chosen private property that usually are located in the most fertile and more accessible areas and therefore more easily usable by mechanized means.

Field data were processed to produce the height/diameter curve by stand. Were also calculated the basal area per hectare (G/ha), the average number of plants per hectare and the average height

The following values refer to biomass only, deadwood has been considered separately. The forest resources were been classified according to the hierarchical units of the forest types of Piedmont. In the investigated area have been identified 27 forest typologies belonging to 12 forest categories.

CATEGORIA FOR.	TIPO FOR.	N° RILIEVI	SUP.(ha)	N PIANTE/ha	G/ha	VOLUME/ha	H media
Acero-tiglio-frassineti	AF40X ATF di forra	4	452	1.548	42,9	484,29	18,87
	AF50X	25	3.443	1.425	40,69	390,34	16,87

	ATF d'invasione						
Boscaglie pioniere e d'invasione	BS20X Betuleto montano	3	1.316	1.764	36,09	205,7	10,35
	BS32X Boscaglia d'invasione st. montano	8	488	1.517	24,39	128,33	9,88
Castagneti	CA10X Castagneto da frutto	12	812	670	51,36	530,79	18,08
	CA20X Castagneto mesoneutrofilo a Salvia glutinosa delle Alpi	44	5.406	1.132	49,11	411,53	15,46
	CA30X Castagneto acidofilo a Teucrium scorodonia delle Alpi	26	3.342	1.361	42,32	316,85	13,88
Faggete	FA60X Faggeta oligotrofica	17	1.829	1.273	46,21	459,49	17,19
Lariceti e cembrete	LC10X Lariceto pascolivo	2	170	786	38,03	336,46	16,48
	LC20X Lariceto montano	5	340	821	49,09	460,84	18
Querco-carpineti	QC10X Querco-carpineto della bassa pianura	1	105	557	31,16	378,15	10,31
Querceti di rovere	QV10X Querceto di rovere a Teucrium scorodonia	1	32	688	23,9	197,55	14,93
Rimboschimenti	RI10X Rimboschimento del piano planiziale e collinare	4	36	976,58	75,38	728,6	21,09
	RI20X	6	512	921	56,53	569,4	19,05

	Rimboschimento del piano montano						
Robinieti	RB10X Robinieto	2	383	859	16,3	132,44	14,63
	RB13X Robinieto st. di greto	1	84	955	17,72	135,16	15,02

Table 1: medium silvicultural parameters of main forest typologies referring to the study area.

The further elaboration of some of these parameters made it possible to evaluate the current increases for the three prevailing forest categories, namely chestnut, maple-lime-ash and beech woods. The chestnut and maple-lime-ash, due to the strong inhomogeneity and the large amount of data collected, have still been differentiated by fertility classes.
For each of these classes it was possible to elaborate the current increase curve of the entire population depending by the average age of the population.
This elaboration, which provides a completely theoretical data, allows to model to obtain the moment of maximum increase of the average current of the stand and, from this, to assume a turn to maximize the storage of CO2.

5 PROBLEMS AND EMERGENCIES

5.1 CLIMATE CHANGE

In the climate change impact assessment have been considered different types of scenarios developed by different research and development institutes. The employed main scenarios were implemented by IPCC (Intergovernamental Panel on Climate Chang):

- Special Report on Emissions Scenario (SRES) from 2000;
- Representative Concentration Pathways (RCP), from 2014.

For the quantification of the impacts at the local level we based on two studies, both published by ARPA Piemonte. The first study, entitled "Climate change, future scenarios", is emblematic of the complexity and uncertainty in working with climate models and it has been calibrated up to 2100. The second study, deriving from the recent (2019) report of the "State of the environment in Piedmont", includes a section dedicated to "Climate changes - future scenarios".

The main results of our interest as regards of the mountain area:

- the trends of the maximum temperature over the entire period 2006-2100 are + 0.22 C/10y according to the RCP4.5 scenario (with an increase of about +2.1 C to 2100) and + 0.55 C/10y in the period 2006-2100 in RCP8.5 (with an increase of about +5.2 C to 2100);

- The trends of the minimum temperature over the entire period 2006-2100 are of + 0.23 C/10y in RCP4.5 (leading to an increase of about + 2.2 C to 2100) and 0.54 C/10y 2006-2100 in RCP8.5 (leading to an increase of about +5.1 C to 2100).

Both studies show that climate change has a greater impact on mountain environments both from the point of view of increasing temperatures and from the point of view of decreasing rainfall. Therefore if we consider these scenarios as likely for the future of the study area, the application of Climate Smart forestry is essential. These observations are also reinforced by the current state of the woods of the Po valley, as described in this document, which present signs of decay linked to several anthropic and natural causes that have occurred in the last century.

The primary effect of this changing in the climate conditions is the modification of optimum climatic conditions of each forest category. Each climate scenario has been analysed in three different time periods that start 25 years after the hypothetical year zero (2025). The adaptation of the characteristics of each species has been calculated using a gradient that puts in relation altitude and temperature equal to a decrease of 1 °C every 160 m of altitude increase. This variation allowed the height limits of the forest categories concerned to be recalculated in relation to the expected temperature increase. In annex it is possible to see the forecasts of adaptation of the altitude limits of the different forest categories.

5.2 WILDFIRES

The Po Valleys has characteristics that make it subject in a peculiar way in the municipalities of low and medium valley to events of ignition and propagation of fire.

From the analysis of the PFT the total area covered by fires in the period 1980-1998 appears to be highly variable with very high peaks (6.556 ha in 1990) alternating with most of the average low years (4-7 ha). The fire registry of the Piedmont region, for the period 2002 - 2020 in the study area considered, reports a total of 175,22 ha burnt, that it means an average of about 9 ha per year. It was also found that around 13 % of the survey areas show signs of fire passing through.

In addition, more than 95% of the events occur in abandoned chestnut coppices and 90% of these stands are abandoned or unmanaged, in which there are strong accumulations of dry deadwoo on the ground (coarse woody debris) and standing (snag).

For example, we reported the various parameters related only to the deadwood. The data were processed from surveys carried out during the 2021 season. The parameters of the volume per hectare and of the plants per hectare were also compared with the same parameters related to the total mass (biomass plus deadwood).

Category	V/Ha (m3)	% V.Tot/ha	N.piante/ha	% N. Piante/ha	G/ha (m2)	H media (m)
Maple-Lime-Ash	7,38	1,80%	126	8,11%	1,90	14,55
Invasive woodland	1,36	0,88%	48	2,98%	0,58	8,94

Chestnut	23,20	5,45%	478	16,98%	6,60	12,66
Beech	5,11	1,10%	95	6,99%	1,34	13,79
Larch	12,35	2,86%	65	7,66%	2,69	11,58
Oak-Hornbeam	1,73	0,46%	16	2,78%	0,47	10,68
Oak	9,42	4,55%	322	31,88%	3,07	13,66
Planted forests	9,17	1,50%	74	7,29%	2,05	15,35
Black locust	1,31	0,97%	64	6,56%	0,46	12,03

Table 2: main silvicultural parameters concerning deadwood and percentage rate on the total mass (biomass plus deadwood)

6 CARBON FLUXES ESTIMATION

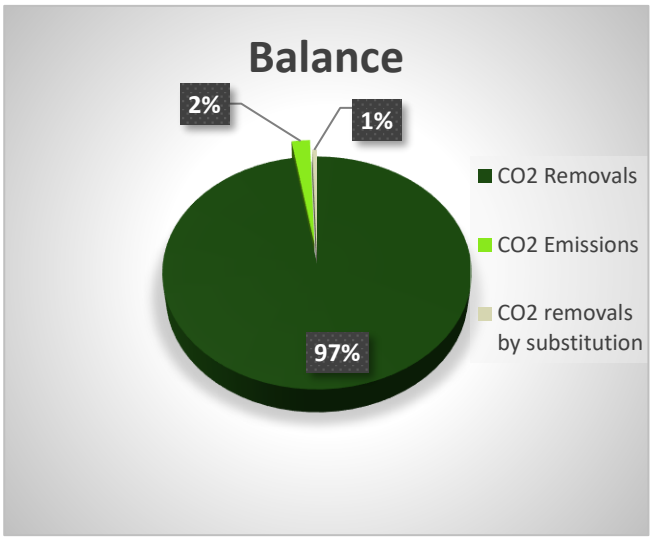
The tool used for the valorization of the carbon flows of the analyzed territorial system was the spreadsheet developed in WP C4 of this project. This tool allows, through the input of inventory forest data from field surveys, to quantify emissions, storage and carbon substitution effects. Concerning the emissions, it considers losses related to forest uses and fires; in the counting of stocks, instead, we consider aboveground biomass, belowground biomass, soil organic matter and dead organic matter. The substitution effects are instead counted considering the wood products deriving from the utilisations of the stands and the wood used in the production of energy.

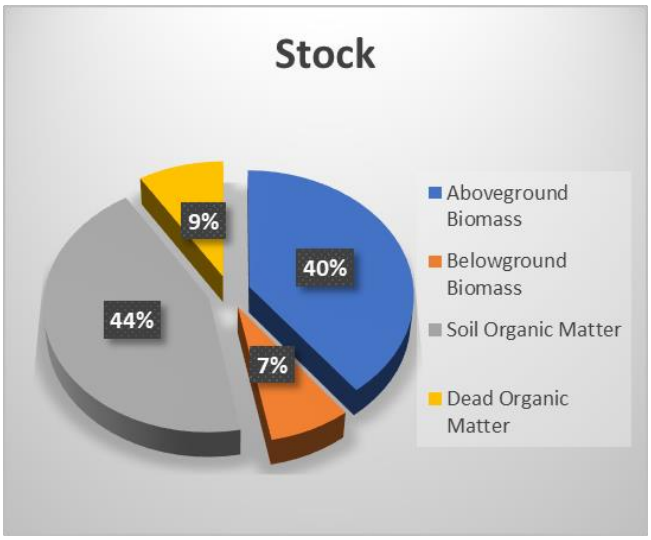
The data entered are the same for each forest category present in the study area: the area covered by the stand, the total volume (mc/ha), the current increase in volume per year, the biomass removed by interventions per year (mc/ha/y), the area covered by wildfires (ha/y) and finally the wood used for energy production.

The tool returns the total data of removal, removal with replacement and emission and the annual carbon balance in tons of CO2 equivalent.

Categoria Forestale	Aboveground Biomass	Belowground Biomass	Soil Organic Matter	Dead Organic Matter	Overall yearly increment (sink)	Forest Fires losses	Harvests losses	Wood products (sink)	Wood products (subst. Effect)	Bioenergy (subst. Effect)
Maple-Lime-Ash	2.242.437	396.622	2.470.608	505.352	88.989	89	139	3	6	74
Alder	1	0	1	0	0	-	3	0	0	1
Invasive woodland	529.830	93.712	583.741	119.402	28.583	106	8	-	-	4
Chestnut	4.602.448	899.727	5.150.973	1.053.608	178.911	4.741	1.362	27	57	721
Beech	1.278.346	244.390	1.425.540	291.588	26.707	-	216	2	5	115
Larch	327.386	69.771	371.806	76.051	11.282	-	121	86	181	19
Subalpine bushes	35.482	6.406	39.215	8.021	556	-	-	-	-	-
Oak-Hornbeam	61.461	12.484	69.226	14.160	956	-	7	2	4	3
Oak	13.139	2.334	14.486	2.963	277	-	23	6	12	9
Black Locust	92.758	15.763	101.594	20.781	4.627	-	274	-	-	148
Planted forest	372.715	68.728	413.265	84.532	10.781	-	261	165	346	52
Willow-Poplar	16.365	2.239	17.417	3.563	864	-	270	-	-	146
Totale	**9.572.370**	**1.812.175**	**10.657.872**	**2.180.019**	**352.532**	**4.936**	**2.685**	**291**	**611**	**1.293**

Table 3: output data (expressed in t co2eq) per forest category in the study area.





RESUME
Totale stock (t CO2eq)
24222435
CO2 Removals
352823
CO2 Emissions
7621
CO2 removals by substitution
1904
Yearly Carbon Balance
347106

Table 4: Cumulative Balance and Carbon stock output data.

The data produced lead to the following results:

- A total stock of tons CO2eq equal to more than 24 Mtons, an annual removal equal to 352.823 tons CO2eq which it is necessary to add 1.904 tons CO2eq by substitutions and subtract 7.621 tons CO2eq of emissions The Yearly Carbon Balance is equal to 347.106 tons CO2eq;
- The total CO2 stock is 53% contained in soil as Soil Organic Matter (SOM) and Dead Organic Matter (DOM) while 47% resides in living biomass (40% epigeal biomass and 7% hypogeal biomass);
- In the Carbon balance the CO2 emissions of the stands in the valley occupy only 2% of the total C traded.
- The use of wood as raw material for the production of finished and semi-finished products is fundamental to balance the emissions due to losses for use and wildfires.

ANNEXES

ANNEX A: REPORT IN ITALIAN LANGUAGE

ANNEX B: ECOLOGICAL CHARACTERISTICS

ANNEX C: ADAPTATION OF ALTITUDE LIMITS

ANNEX D: FORESTRY MAP

ANNEX E: MAP OF THE MAIN DESTINATIONS

ANNEX F: MAP OF OPERATIONS

ANNEX G: MAP OF FOREST TRACK AND ROAD