

Deliverable D1a – Detailed monitoring and carbon pools assessment protocol



LIFE14 CCM/IT/000905  
*"Recovery of degraded coniferous  
Forests for environmental sustainability  
Restoration and climate change Mitigation"*



## **Deliverable - Action D1**

**Detailed monitoring and carbon pools assessment protocol**

**Deadline: 31/01/2016**

## Measurements protocol

### Sample design and monitoring units nomenclature

There are three compartment level (Figure 1):

- 1 Demonstrative plot (DP): it is the plot where the treatment is applied uniformly. It should range from 0.5 to 2 ha and it can have irregular shape. They can be also non-contiguous.
- 2 Monitoring area (MA): it is the maximum extent where observations can refer to avoid edge effects from contiguous plots. It is preferably a square or a rectangle and it ranges from 0.25 to 0.5 ha. It must be as representative as possible of the demonstrative plot. All variable values referred to the MA can be measured in all the MA (e.g. Total calliperling, Terrestrial Laser Scanner etc...) or in sub-areas (to reduce time and costs)
- 3 Monitoring sub-area (MSA): it is circular with 13 m of radius. There are two MSAs for every MA and they must be representative of the MA itself. In every complete MSA the following variables will be measured (Figure 2):
  - a. The litterfall (MSA.Lf);
  - b. the forest floor (MSA.Ff);
  - c. the GHGs fluxes with and without deadwood or litter, using big (B) or small (S) static chambers (MSA.Bdw and MSA.B, MSA.Sff and MSA.S);
  - d. soil physical and chemical properties (SPC).

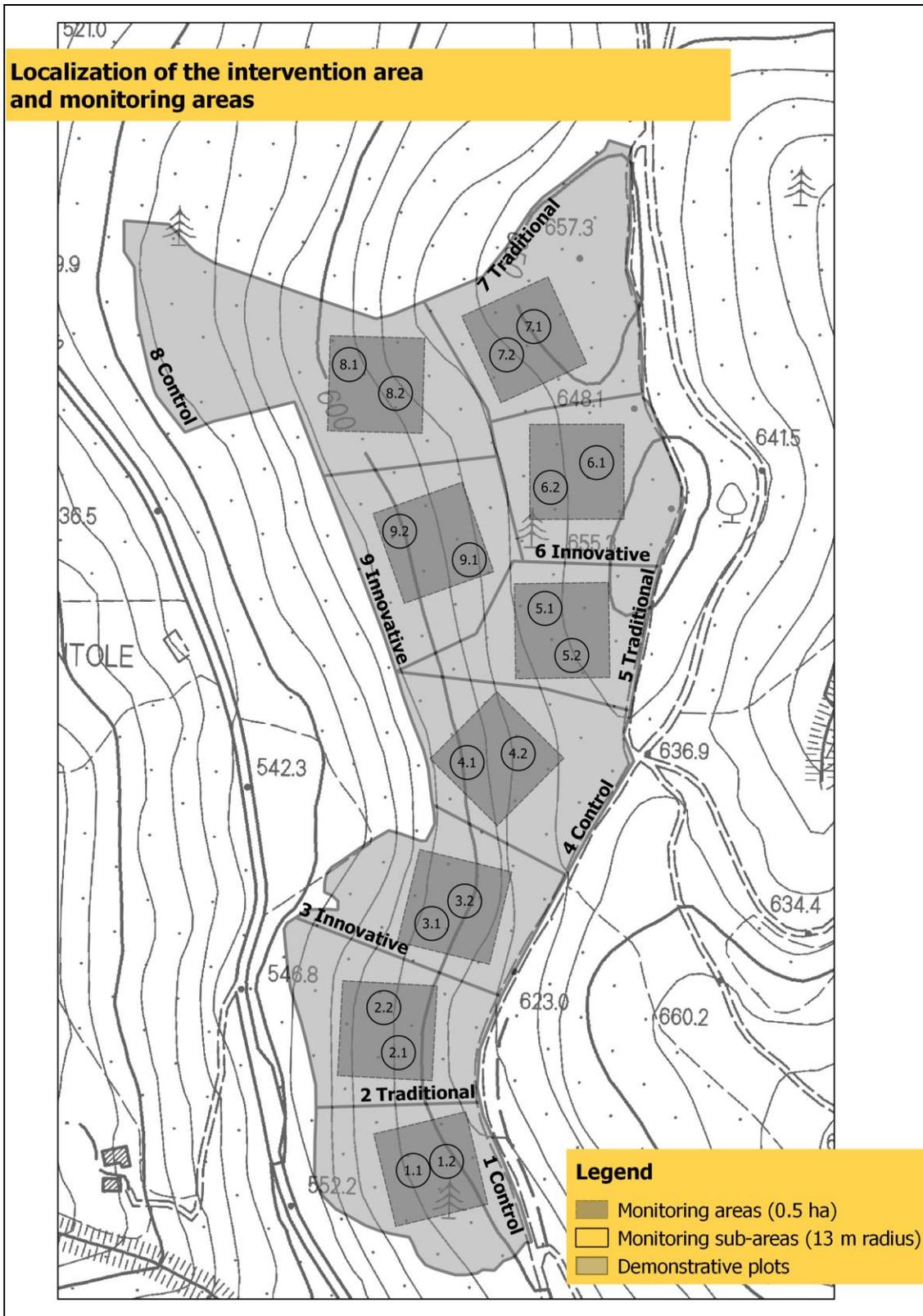


Figure 1. Localization of intervention area and monitoring sample units (example for the Italian site).

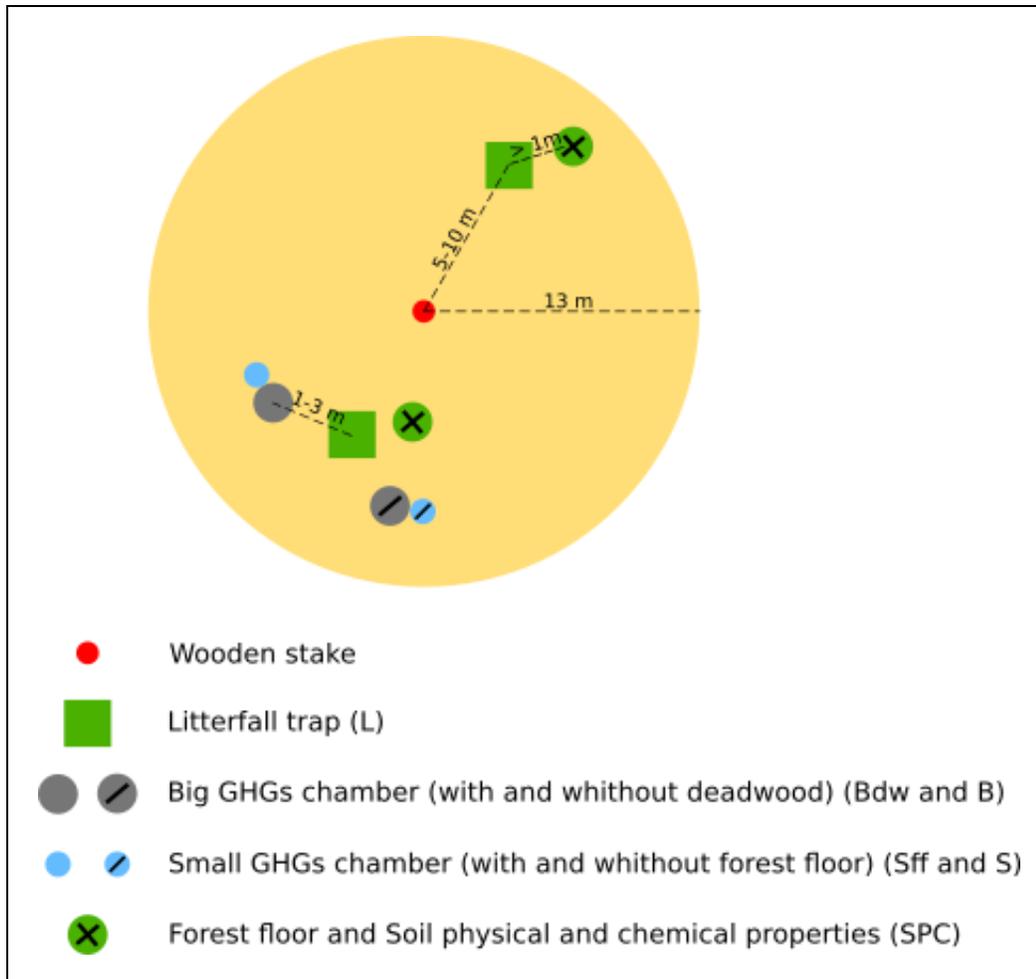


Figure 2. Scheme for the implementation of the complete monitoring sub-area (MSA). Note that Bdw and B sample points are present in only one MSA per DP.

### GHG emissions – static chambers preparation

Two types of chambers will be used in the plots:

- 1- Big gas chambers for CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O.
- 2- Small gas chambers for CO<sub>2</sub> with portable IRGA instruments (PP-system or LICOR, depending on availability)

### Preparation of big gas chambers for CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O:

The chambers will consist of one collar inserted into the soil and one lid to collect gases. One collar for each sampling point (total 18 chambers: 9 MSA.Bdw + 9 MSA.B) and two-four lids are needed (the lids will serve to collect gas samples, so you need a number of lids equal to the number of gas chambers that can be sampled simultaneously, depending on the number of people collecting gas and the proximity of the chambers).

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For the preparation of the chambers see the annex 1.

### **GHG emissions – collar installment**

- i) Big gas chambers for CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O (gas sampling only): 2 chamber in at least one MSA for each plot (total 18 chambers: 9 MSA.Bdw + 9 MSA.B):
  - 1 → soil + litter + deadwood collected in the same MSA (4.5-14.5 cm diameters, decay classes 4 and 5, see annex 2)
  - 1 → soil + litter
  
- ii) Small gas chambers for CO<sub>2</sub> with portable IRGA instruments (PP-system or LICOR, depending on availability): two for each sub-plot (total 36 chambers: 18 MSA.Bdw + 18 MSA.B):
  - 1 → with litter collected in the same MSA,
  - 1 → without litter (covered with a net to avoid litter input)

Conditions for collars distribution and positioning:

- 1) minimum 20 cm soil depth, 2) flat or sub-flat slope e 3) under canopy cover

Collars, prepared as reported in the annex 1, should be placed in the soil and rest until the end of the project, so be sure the collars don't move. The collars should be inserted in the soil approx. 10-15 cm and get out from the soil about 5 cm. The collars can be fixed with an hanger deeper into the soil.

### **GHG emissions – sampling**

See the annex 1 for the protocol.

### **Litter**

#### Litterfall

2 traps for each MSA (Figure 2) placed close to the GHG collars (total 36 traps). The main litter components (conifers vs. broadleaves: pine needles, deciduous leaves, twigs and branches < 4.5 cm, reproductive structures and bark) is collected every two weeks using traps (50 x 50 x 30 cm, at 1m height from ground) (Figure 3), sorted, dried and weighed, providing leaf dry mass per unit of ground area (g m<sup>-2</sup>).



Figure 3. Litterfall trap

### Forest floor litter

Forest floor litter is collected once a year in two positions within each sub-plot by pressing a 600-700 cm<sup>2</sup> steel sheet sampling frame 10 cm deep (or similar) into the forest floor and collecting all litter material above the soil.

Litter is separated into three representative fractions (L, F and H horizons) (Figure 4), then dried and weighed.

The L horizon is composed of fresh or slightly discoloured, with no or weak breaking up, material (almost undecomposed litter).

The F horizon is composed of medium to strongly fragmented material with many mycelia and thin roots (recognizable, but fragmented).

The H horizon is a completely decomposed amorphous material un-recognizable.

Freshly fallen litter is distinguished from older litter based on foliage color (brightly or lightly colored litter is considered fresh) and friability (friable litter is considered old).

To separate fractions use 4 sieves with progressive meshes: 20, 10, 5, 2 mm mesh starting from the top.



Figure 4. Examples of the different fractions of the forest floor.

## Soil

At least 3 soil profiles will be opened and soil horizons identified.

Soil is collected once a year from the same position as forest floor litter. If possible, soil samples should be collected from samples at a depth of 0-100 cm, at intervals reflecting soil horizons. Soil bulk density is collected simultaneously using 100 cm<sup>3</sup> cylinders. If soil sampling is performed before soil profiles opening then sample at 0-10, 10-30, 30-60 cm depth.

## Deadwood

See the annex 2 for the protocol.

## Summary list of attributes

The following summarizing table reports for every attribute the level at which every attributes are collected.

Table 1. List and description of attributes per each monitoring sub-area (MSA).

Attribute	Type	Level	Method description
Main tree species	Classified	MSA	Main tree species according to the forest type of the Management PLOT
Canopy cover	Estimated	MSA	Visual estimation of the vertical projection of the forest floor that is obscured by forest canopy
Slope	Measured	MSA	Instrumental assessment (from GIS if a high resolution DEM is available)
Stoniness	Estimated	MSA	Visual estimation of four classes: <ol style="list-style-type: none"> <li>1. nonstony</li> <li>2. slightly stony</li> <li>3. moderately stony</li> <li>4. very stony</li> </ol>
Tree ID	Classified	Tree	To be reported physically on the tree stem
DBH	Measured	Tree	Minimum threshold: $\geq 3$ cm
Tree species	Classified	Tree	For each tree whose DBH is measured
Social rank	Classification	Tree	For each tree whose DBH is measured (Figure 5): <ol style="list-style-type: none"> <li>1. Dominant (main crop layer)</li> <li>2. Codominant (main crop layer)</li> <li>3. Intermediate or Dominated (main crop layer)</li> <li>4. Overtopped (subsidiary layer)</li> </ol>
Total tree height	Measured	Tree	For a subsample of selected trees (it should be better for all trees)
Height of crown insertion	Measured	Tree	For a subsample of selected trees: height of the insertion of last green branch, epicormic branches excluded.
LWN	Counted	Tree	Living whorls number for a subsample of trees where the total height is measured.

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Attribute		Type	Level	Method description
Tree health		Classified	Tree	For each tree whose DBH is measured: 1. Live and undamaged: 2. Live with light damages (less than 1/3 of crown): 3. Live with moderate damages (from 1/3 to 2/3): 4. Live with heavy damages (more than 2/3): 5. Dead
Tree coring		Collected sample	Tree	For a subsample of selected trees; In order to perform a short- (few years) and long-term (ten or more years) monitoring of the radial growth response to applied practices and climate.
LAI		Measured	MSA	Instrumental assessment (PCA-LAI/2000)
Litterfall		Collected sample	MSA.L	The main litter components is collected every two weeks or one month, sorted, dried and weighed providing leaf dry mass per unit of ground area ( $\text{g m}^{-2}$ ).
Forest floor		Collected sample	MSA.SPC	Litter collection, one a year
Soil		Collected sample	MSA.SPC	Soil profiles (single sampling) Soil sampling for physico-chemical analysis + bulk density once a year
GHGs	N <sub>2</sub> O	collected samples	MSA.B(dw)	Field gas sampling + instrumental assessment (GC-2014 gas chromatograph) See annex 1
	CH <sub>4</sub>	collected samples		
	CO <sub>2</sub>	collected samples		
	CO <sub>2</sub>	Measured	MSA.S(ff)	Instrumental assessment (PP System)
Deadwood		Measured + collected samples	MSA	See annex 2

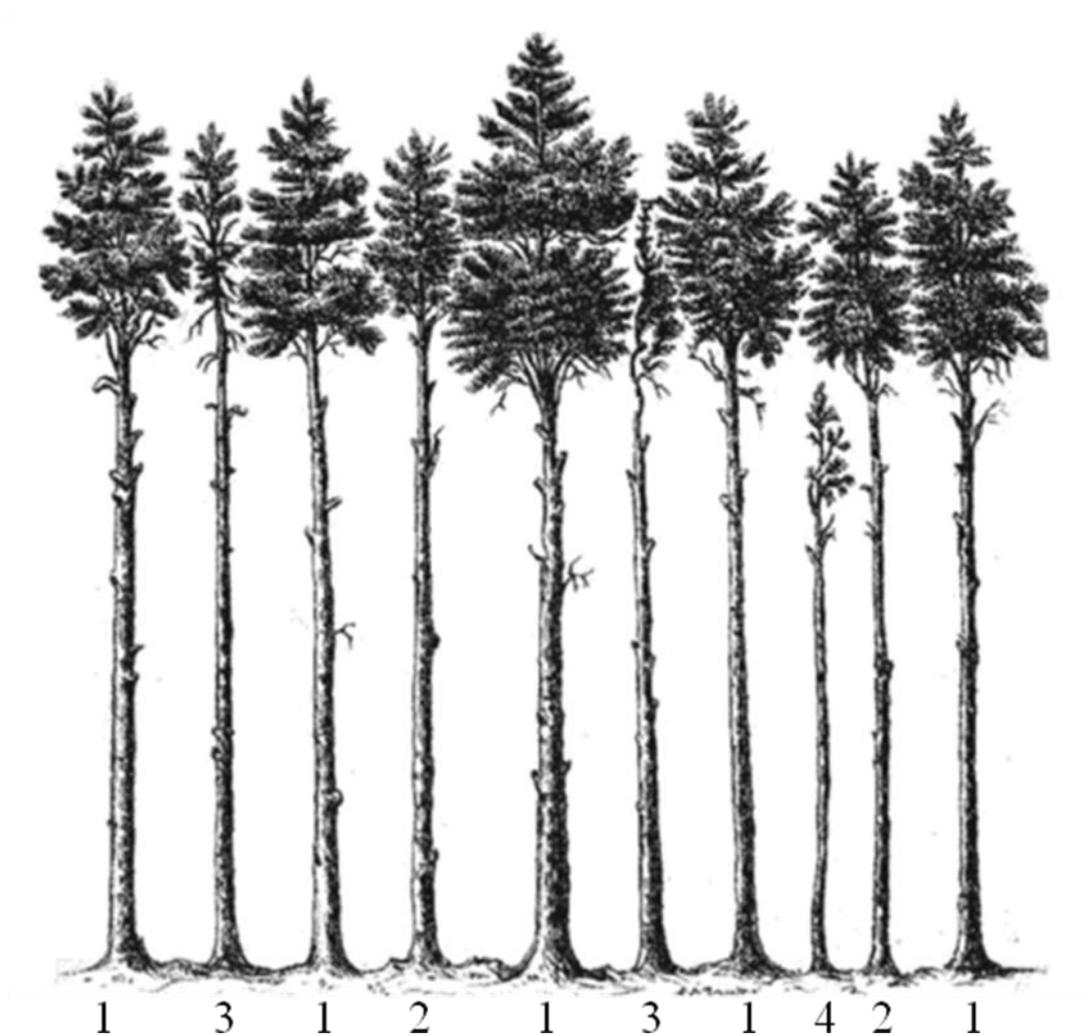


Figure 4. Examples of the different social rank classes.