ID= 3947430

LIFE09·ENV/IT/000078¶
ManFor·C.BD.·"Managing·forests·for·multiple·purposes:· carbon,·biodiversity·and·socio-economic·wellbeing".

Action 6 – ForC

Report no. 3 (2014-02)

(Action ForC & ForC-SI)

Start date of project: 01/10/10 Duration: 60 months

Due date of deliverable: February 2014 Actual Submission date: 28/04/2014

Lead Partner for deliverable: CNR (for Italy), SFI (for Slovenia)

Authors: D'Andrea E., Čater M., De Cinti B., Ferlan M., Kobal M., Micali M., Sicuriello F., Simončič P., Matteucci G.

Table of Contents

1. Brief summary of contents

In the present report are exposed the activities performed in the period March 2013 and February 2014 and the preliminary results of project.

In reporting period, field sampling was performed in the sixth Italian site (5-Pennataro and Monte di Mezzo) following the project methods.

In Vallombrosa (site 7), we realized only the sampling to assess biomass but because of wind storm of 11 November 2013 we didn't collect soil and litter.

At the end of summer field activities pre management were concluded in all Italian sites, and post management activities has finished in a site (1) and started in two (2-3).

A lot of time and energy were spent in laboratory activities, to prepare collected samples in the first part of project, and especially for chemical analysis of soils and litter.

In the reporting period, soil flux measurement continued in all planned sites in Slovenia and Italy, and preliminary results are yet available.

2. Report on performed activities

2.1. *Aims of the action ForC*

The aims of ManFor C.BD project are testing and verifying in the field the effectiveness of forest management options in meeting multiple objectives (production, protection, biodiversity, etc.), providing data, guidance and indications of best-practice.

The Action ForC is devoted to assess how forest management can influence carbon cycling of forests, by monitoring indicators related to forest carbon. Indicators will range from the basic one of MCPFE: 1.2 Growing Stock; 1.4 Carbon stock for biomass and soil and to indicators connected to carbon cycle processes of carbon stock change, such as Growing Stock change, Net Primary Production (NPP), soil CO2 emissions (before and after forest management), harvested biomass/volume.

2.1.1. Sub-action 1– Assessment of the influence of forest management on carbon cycle in forests

The objectives of this sub action is to evaluate the effects of forest management on carbon cycle. It is the core of the whole action.

Assessment of management influence is performed using both classic forest inventory techniques and specific activities. These experiments, performed during all the project, are very import to well understand specific effects of some management decisions on carbon cycle (i.e. CO2 soil emissions, girdling, mule extractions).

Management effect influence microclimatic characteristics of the forest and consequently CO_2 soil emissions, for this reason in sites 1-2-4-8-9-10 soil respiration is measured.

Collateral activities are the key to join Action ForC to others. Girdling was performed to improve deadwood amount but offered an occasion to study the contribution of dying trees in carbon cycle. The experiment on the impact of bunching and extraction by mules was important because it studied not only the effects on soil physical characteristics but also on the soil microfauna and vegetation (biodyversity).

2.1.2. Sub-action 2 - Implementation of classic forest inventory techniques

Classic forest inventory techniques will be applied before and after the management operations and, for the test areas treated in the first phase of the project, also in the last project year.

The forest inventory techniques are used to estimate the carbon pools of biomass, deadwood, litter and soil.

3. Field samplings

3.1. *Sub-action 2 - Implementation of classic forest inventory techniques*

One of the objectives of this period was to complete the pre- management sampling in all Italian sites.

In the same period we started the post management sampling in sites 1-2-3-8-9-10 to evaluate the effects of management on stands.

At the end of reporting period the situation of field sampling and activities is reported in table below:

Table 1: situation of field samplings , (* only biomass samplings because of wind storm of November 2013)

Site #	Field Sampling before treatment	Field Sampling after treatment
1	yes	yes
2	yes	yes (50%)
3	yes	yes (50%)
4	yes	no
5	yes	no
6	yes	no
7	yes*	no
8	yes	yes
9	yes	yes
10	yes	yes

3.1.1. Biomass and deadwood

During reporting period we sampled entirely site -5 (Pennataro - Monte di Mezzo), that is the 6th italian site, partially site -7 (Vallombrosa) because of wind storm of November 2014 and the new areas of site-3 (Lorenzago di Cadore).

In these sites we measured the basic forest parameters, that are necessary for biomass and deadwood amount estimation.

3.1.2. Litter and soil

In the sites 5 -7, as in the other project sites, in each sampling area we collected, by pressing a 0.04 m^2 square sampling frame into the forest floor, 3 samples of litter and in the same points we collected undisturbed soil cores.

In both nations, during report period laboratory activities and chemical analysis were conducted on litter and samples soil collected.

Litter was oven dried until it reached a steady weight, than it was weighted and minced to be analyzed.

Undisturbed soil samples were oven dried and sieved for dividing fine component (< 2mm), stones (>2mm) and roots. Using the weight of fine component bulk density was estimated.

A sample of fine soil was analyzed to estimate percentage of carbon and nitrogen content.

Using below formula soil carbon stock was estimated:

$$SOC\ stock\ (\mathrm{Mg\,ha^{-1}}) = \sum_{horizon=1}^{horizon=n} \left[SOC \times BD \times Depth \times \left(1 - \left(\frac{frag}{100}\right)\right) \right]$$

where SOC stock is Soil organic carbon, SOC is the percentage of carbon, BD is bulk density, Depth is horizon depth, *frag* is the percentage of stone.

Laboratory activities and chemical analysis situation is reported in table 2.

Table 2: Soil and litter samples situation

Site #	Number of sample collected		Number of sample preparated		Chemical analysis	
	Pre treatment	Post treatment	Pre treatment	Post treatment	Pre treatment	Post treatment
1	171(soil)+81(litter)	165(soil)+81(litter)	171(soil)+81(litter)	165(soil)	171(soil)+81(litter)	in progress
2	148 (soil)+81(litter)	65 (soil)+36(litter)	148 (soil)+81(litter)	in progress	148 (soil)+81(litter)	in progress
3	79(soil)+16(litter)	27(soil)+16(litter)	79(soil)+16(litter)	in progress	79 (soil)	in progress
4	262(soil)+81(litter)	-	262(soil)+81(litter)	-	262(soil)+81(litter)	-
5	152(soil)+81(litter)	-	152(soil)+81(litter)	-	152(soil)	-
6	205(soil)+81(litter)	-	205(soil)+81(litter)	-	205(soil)	-
7*	-	-	-	-	-	-
8	214(soil)+81(litter)	214(soil)+81(litter)	214(soil)+81(litter)		214(soil)+81(litter)	in progress
9	244 (soil)+81(litter)	244 (soil)+81(litter)	244 (soil)+81(litter)		244 (soil)+81(litter)	in progress
10	271(soil)+81(litter)	271(soil)+81(litter)	271(soil)+81(litter)		271(soil)+81(litter)	in progress

3.2. *Sub-action 1- Assessment of the influence of forest management on carbon cycle in forests*

During reporting period, collateral activities were performed in Manfor C.BD. sites related to Action forC. These activities are useful to understand the effects of the different management options in the project.

3.2.1. Soil CO_2 emissions

During reporting period CO2 soil emissions measurement continues in Slovenia and Italy.

An EGM-4 Environmental Gas Analyzer for CO_2, equipped with a soil respiration chamber (SRC1, PPSystems) and a soil temperature probe was used in Italy.

Measurement were carried out overlapping the soil chamber on a 11 cm diameter PVC collars, previously placed on the forest floor.

In Sites 2 intensive measurements (every 20 - 30 days) have been performed, three of the nine plots have been selected (one for each treatment). In each plot, measurements were performed in the three sub-plots, where 12 collars have been placed according a "spiral arrangement" inscribed in a 13 m radius circle. Six collars are measured with litter and six collars without litter to evaluate effect of litter on CO_2 soil emission. In order to avoid measuring soil respiration too close to trees, the collars positioning occurs at a distance not less than one meter from the plants.

Soil flux measurement in Slovenia has been conducted by a slightly different method than in Italy. Manual measurement includes a LI-6400 console with battery pack, 6400-09 soil chamber and soil temperature probe that connects to the LI-6400 system, which allows for temperature measurements to be integrated into the data set (http://envsupport.licor.com/docs/640009Brochure.pdf).

3.2.2. Leaf area index and forest management

Forest management modify stands canopies and from these modifications many processes start inside the ecosystem (i.e. regeneration, productivity). Leaves are the active interface of energy, carbon and water exchanges between forest canopies and the atmosphere. Crowns seem to be more sensitive and react more quickly to disturbances than other stand structural components. Monitoring crown and canopy characteristics (Leaf Area Index) is a crucial issue for understanding effects of management on forest ecosystem. In sites 2 -4 a field measurements, using LAI2000 Canopy Analyzer, to assess the effect of management on crown were carried out.

3.2.3. Effect of different management options on microclimate

Microclimate is the suite of climatic conditions measured in localized areas near the earth's surface. The importance of microclimate in influencing ecological processes such as plant regeneration and growth, soil respiration, nutrient cycling, and wildlife habitat selection has became an essential component of current ecological research.

Natural modifications (windbreaks or the death of one or several trees) or artificial intervention by the forester, (clearfelling, clearing, str p felling, shelterwood, seed felling, thinning) modify the microclimatic characteristics

The sensitivity of the microclimate to structural transformation (e.g., timber harvesting and the resultant stand-level changes in over-story height) offers strong potential for monitoring ecosystem at multiple spatial scales.

3.2.4. High resolution measurements of radial increment

Since May 2012 we have installed electronic dendrometers on six silver fir (Abies alba) trees on plot 10. Electronic dendrometer is instrument that measures minute changes in radial increment (point el. dendrometers) and/or changes in the circumference (band el. dendrometers). In our case we use dendrometers that measures changes in circumference and radial increment is calculated using a simple formula. Electronic dendrometers are very precise instruments; they can detect changes as little as 0.01 mm. This gives us a completely new insight into tree growth and tree response to the environment on diurnal and seasonal scale. Growth is a continuous process within the growing season, however cambial division and physiological processes in tree are controlled by the availability of the water, carbon dioxide and sun light. In particular availability of water in the soil and the intensity of solar radiation are affecting growth as well as swelling and shrinkage of the stem. All this can be seen from high frequency electronic dendrometer reading. Early morning stem diameter is larger in comparison to late afternoon diameter due to shrinkage, which is caused by the photosynthesis and lack of water, after sunset photosynthesis stops and stem can get rehydrated. Difference between the two peaks is radial increment of the last 24 hours.

3.2.5. Impact of bunching and extraction by mules

Silvicultural activities have an high impact on forest ecosystems. Although in recent times significant innovations have become available in forestry utilization, both in terms of technology and methodology, the majority of private and public forests in Italy are still harvested by applying traditional methods, i.e., motor-manual felling (chainsaw) and low mechanized extraction methods (mules and/or agricultural tractors). In site 2 Logging was performed by 6 workers according to the

"Short Wood System" (SWS), with the intent of producing firewood. All trees were cut by chainsaw and bunching and extraction were performed by mules. In particularly, we carried out a study to assess the impact of bunching and extraction by mules on European beech (*Fagus sylvatica* L.) standing trees, soil physical and biological characteristics.

3.2.6. Physiology of girdled trees

In innovative thesis of project, girdling was performed to increase the amount of deadwood to improve biodiversity. In site 2 we studied the effect of girdling on trees physiology, comparing girdled trees with control trees. Aims of the experiment are: to study the seasonal changes of growth, photosynthesis and carbohydrate dynamics and to evaluate the effects of girdling on source-sink relationships during the season.

4. Preliminary results

4.1. *Sub-action 2 - Implementation of classic forest inventory techniques*

4.1.1. Effect of different management options on Biomass

The first and very visible effect of forest management is a decrement of aboveground biomass. In this paragraph we show the effect of different management options where operations were performed.

In site 1 (figure 1) three management options were proposed a traditional (planned in plot 2-6-9) and innovative (planned in plot 1-7-4) thesis, plus the no-intervention or delayed-intervention thesis (planned plot 3-5-8).

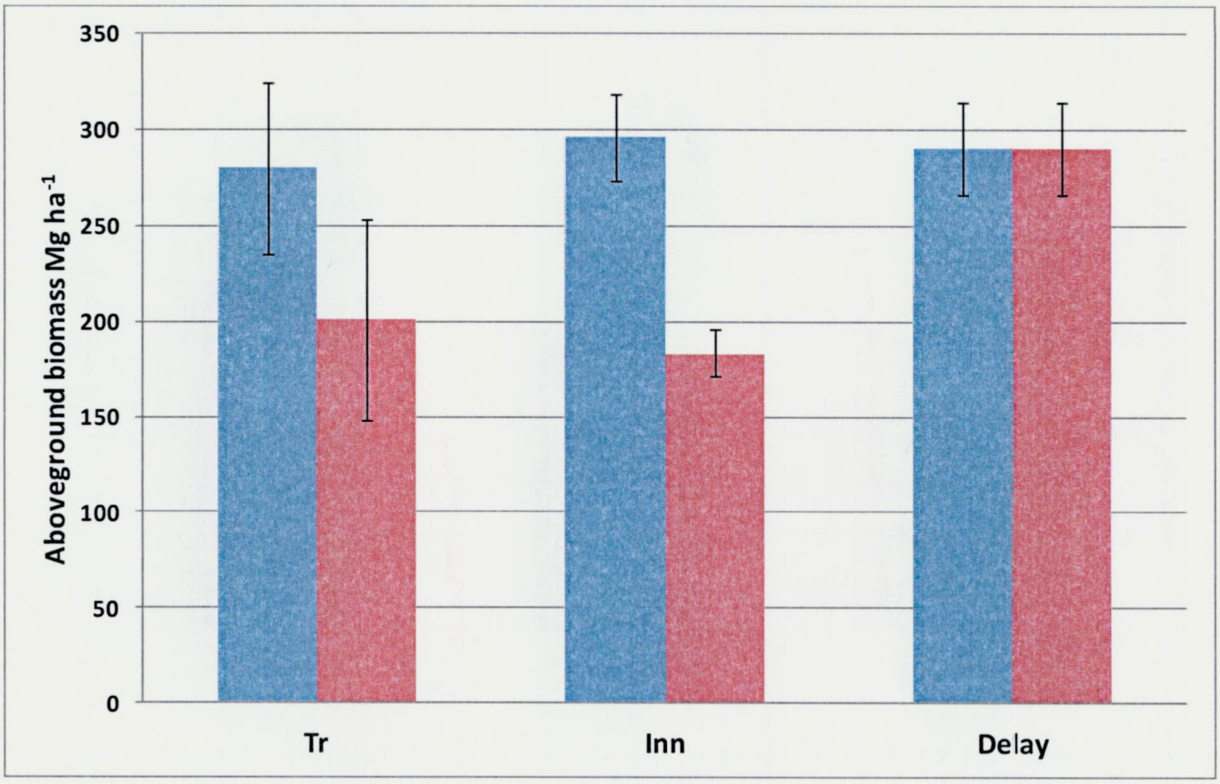

Figure 1: Effect of management on aboveground biomass in site 1 (Cansiglio forest), Tr= traditional option, Inn= innovative option, Delay= treatment delayed in time; blu= aboveground biomass before treatment; red= aboveground biomass after treatment

In innovative thesis the percentage of aboveground biomass removed from the forest is 38% in traditional one is 28%.

In site 2, a traditional management and two innovative thesis different as for the selected tree number (40 and 80) per unit area were proposed.

In the traditional option the percentage of aboveground biomass removed is 34%, and innovative option with 40 selected trees 39% and in the other innovative is 31%.

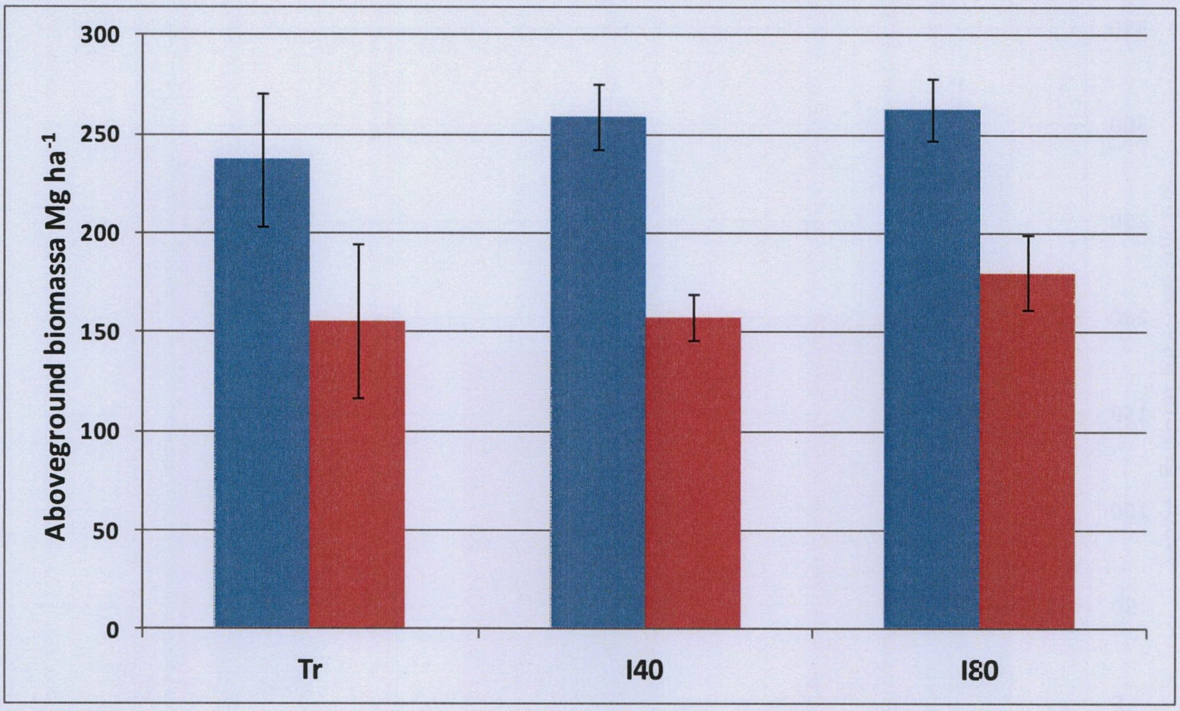

Figure 2: Effect of management on aboveground biomass in site 2 (Chiarano -Sparvera forest); Tr= traditional option, I40= Innovative 40, I80= Innovative 80; blu= aboveground biomass before treatment; red= aboveground biomass after treatment

In site 3 three options were proposed a traditional management according to the selection system (plot 4), a demonstrative/innovative practice has been implemented by the opening of strip clear-cuttings 60 m long and 20 m wide (plot 1), and a no-intervention or delayed-intervention thesis.

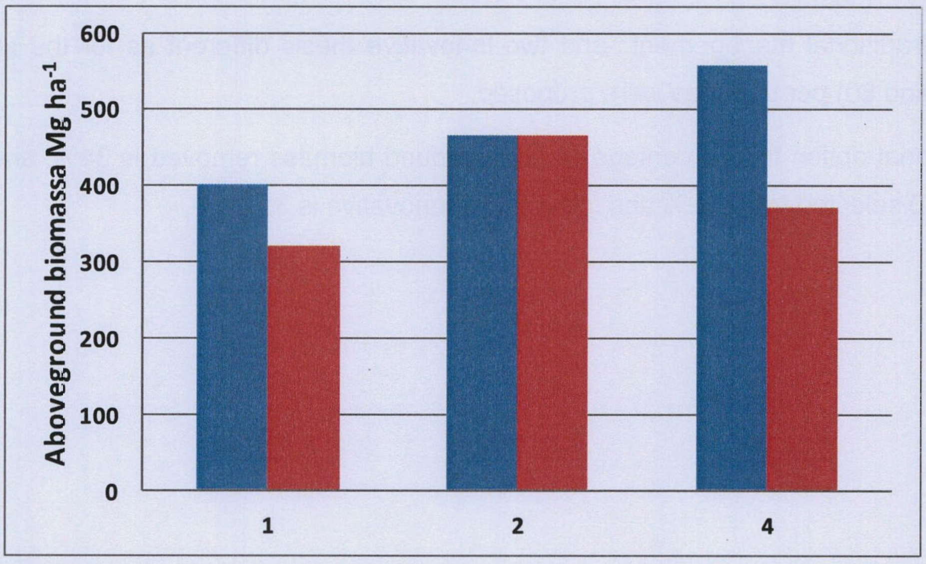

Figure 3: Effect of management on aboveground biomass in site 3 (Lorenzago di Cadore forest)); blu= aboveground biomass before treatment; red= aboveground biomass after treatment

In the innovative option 20% of aboveground biomass was removed, and 33% for traditional one.

In site 4, the demonstrative/innovative criterion consisted of the identification of 45-50 trees per hectare i.e. "the candidate trees" and removal of direct competitors.

Also couples of neighbouring trees have been selected at the purpose. No thinning has been applied in the space between candidates.

In innovative plots the percentage of removed biomass was 22% and in traditional one was 17%.

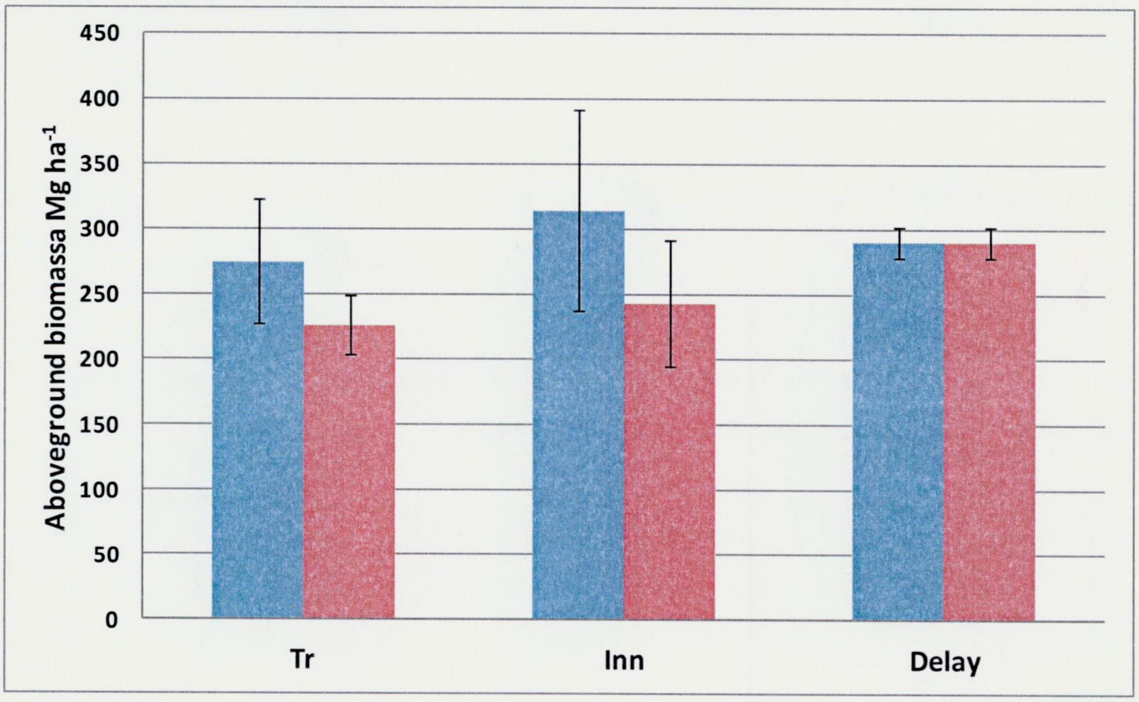

Figure 4: Effect of management on aboveground biomass in site 4 (Mongiana Forest); Tr= traditional option, Inn= innovative option, Delay= treatment delayed in time; blu= aboveground biomass before treatment; red= aboveground biomass after treatment

In Slovenian sites silvicoltural treatments are similar in all the sites, below is presented carbon stock before and after treatment connected with different type of management.

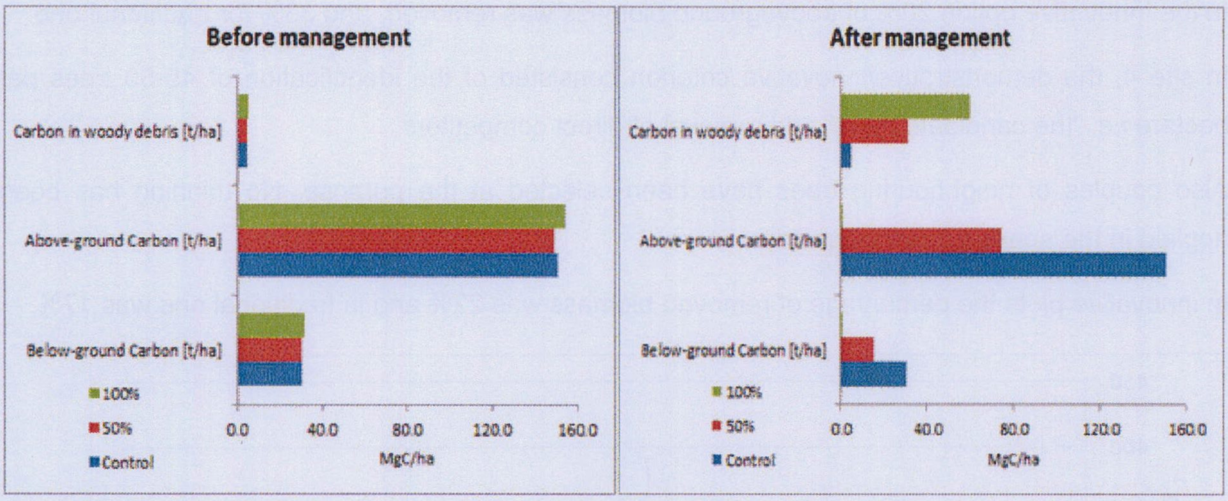

Figure 5: Mean situation in Slovenian Sites

4.1.2. Soil

Laboratory for Forest Ecology at Slovenian Forestry Institute finished the analyzes of 729 soil samples on January 2014. Below are some aggregated results.

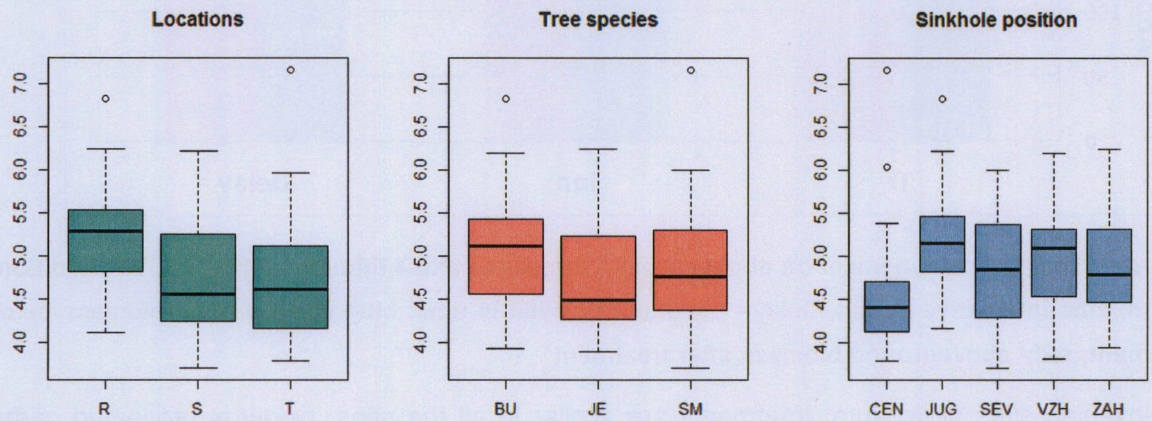

Figure 6: pH value; locations: R= Kočevski Rog (site 8), S= Snežnik (site 9), T=Trnovo (site 10); Tree species: BU= European Beech, Je= Fir, SM= Spruce; Sinkhole position: CEN=Centre, JUG=North,SEV=south, VZH= East, ZAH=West

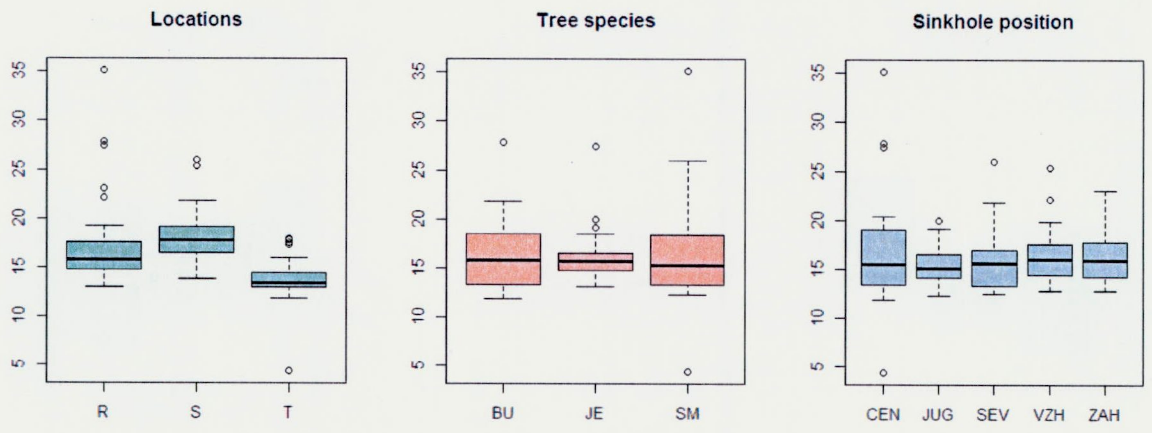

Figure 7: CN ratio in first 10cm of mineral soils; locations: R= Kočevski Rog (site 8), S= Snežnik (site 9), T=Trnovo (site 10); Tree species: BU= European Beech, Je= Fir, SM= Spruce; Sinkhole position: CEN=Centre, JUG=North,SEV=south, VZH= East, ZAH=West

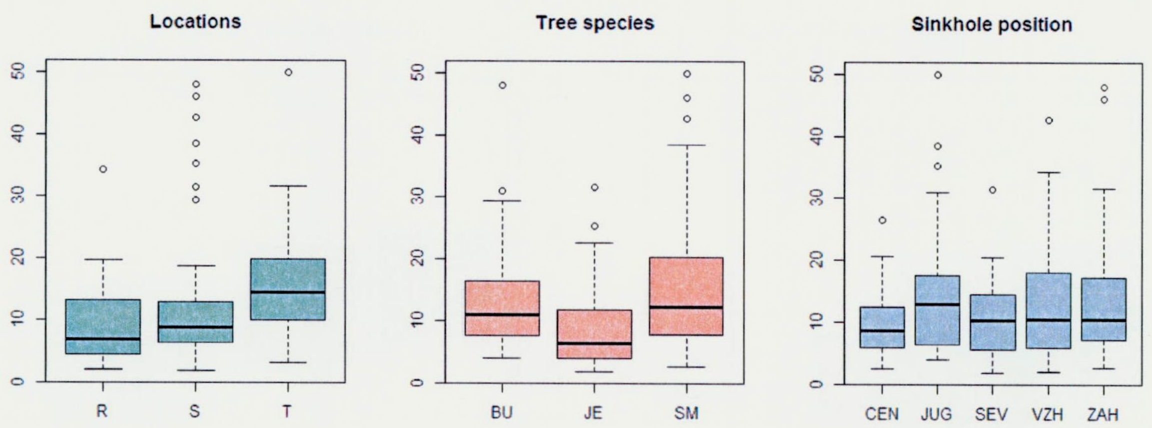

Figure 8: C_{org} in organic part of soil (t / ha); locations: R= Kočevski Rog (site 8), S= Snežnik (site 9), T=Trnovo (site 10); Tree species: BU= European Beech, Je= Fir, SM= Spruce; Sinkhole position: CEN=Centre, JUG=North, SEV=south, VZH= East, ZAH=West

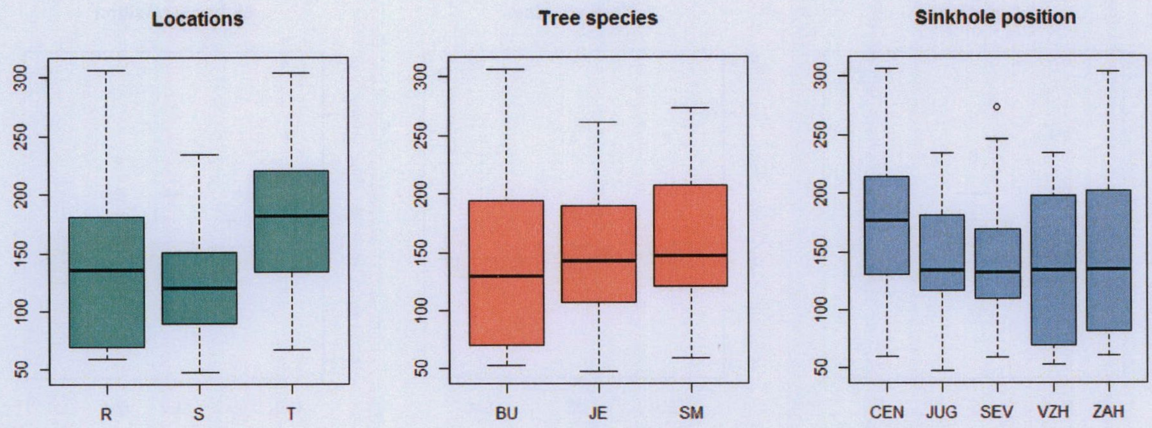

Figure 9: C_{org} in mineral part of soil (t / ha); locations: R= Kočevski Rog (site 8), S= Snežnik (site 9), T=Trnovo (site 10); Tree species: BU= European Beech, Je= Fir, SM= Spruce; Sinkhole position: CEN=Centre, JUG=North,SEV=south, VZH= East, ZAH=West

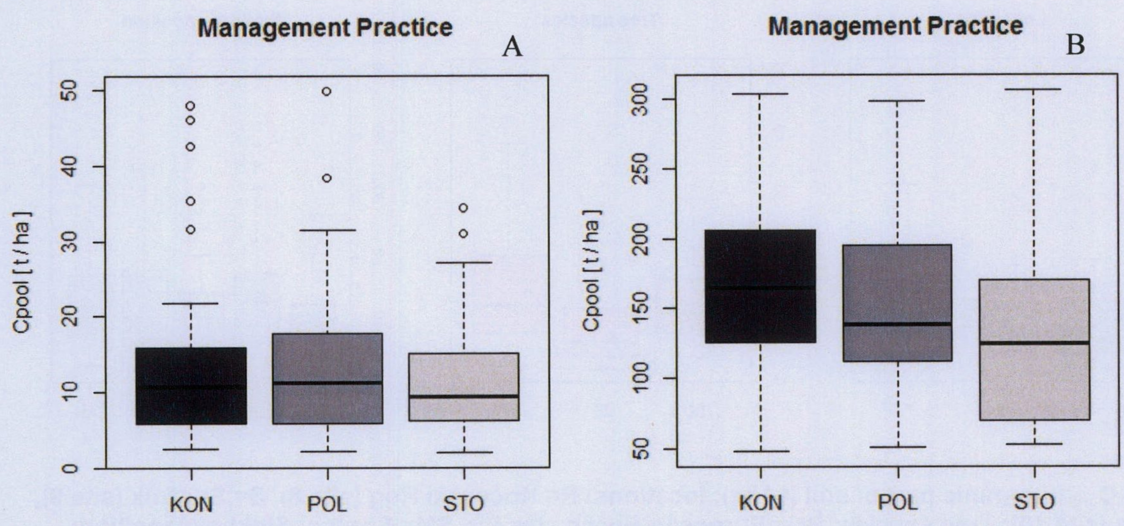

Figure 10: Carbon pool in organic (A) and mineral (B) part of soil; KON= control 0% cutting intesity, POL= 50% cutting intensity, STO= 100% cutting intensity.

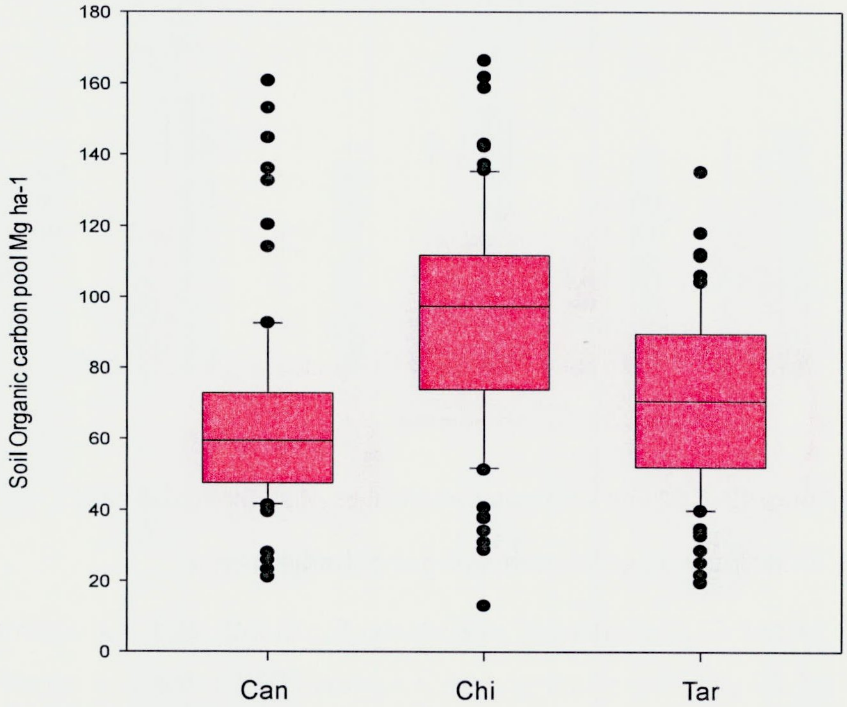

Figure 11: Soil organic carbon pool in 3 Italian sites, Can=Site 1, Cansiglio, Chi= Site 2, Chiarano, Tar= Site 6, Tarvisio

4.2. *Sub-action 1- Assessment of the influence of forest management on carbon cycle in forests*

4.2.1. CO_2 soil emission

On the figure 12 is presented soil respiration according to azimuth (abscise) and intensity of cutting regime (color, 100%, 50% and 0%-control). Measurement were obtained using portable system among all three locations.

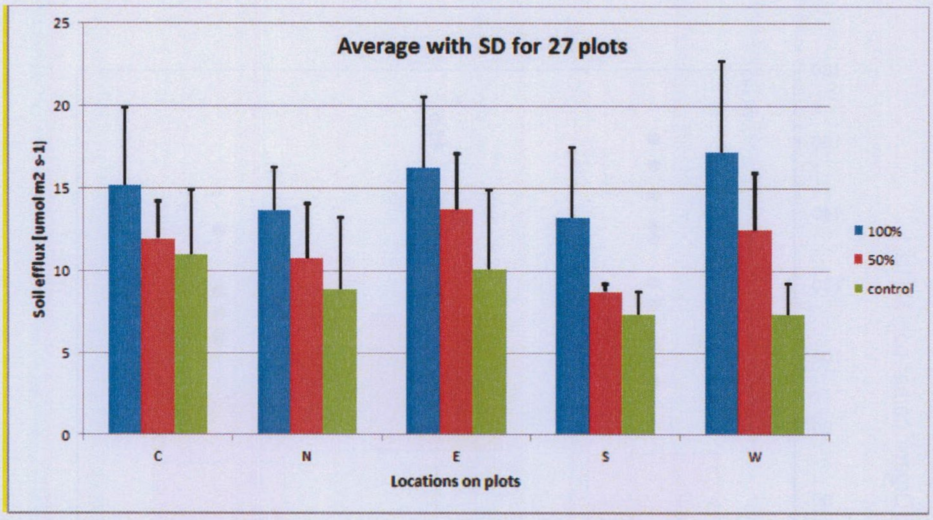

Figure 12: CO2 soil emission mean values of all Slovenian sites

In site 2 CO2 soil emission was estimated using a portable device.

In figure 13 and 14 soil CO2 emissions are shown for month and management options. Max value is 4.45±1.23 μmolCm^{-2}s^{-1} measured in August 2013 in the plot where silvicoltural Innovative 40 option was performed. Lowest value is 0.84 ±0.37 μmolCm^{-2}s^{-1} measured in August in the innovative thesis with 80 selected trees.

This variability is due to different management and also to seasonal changes in soil water content and soil temperature.

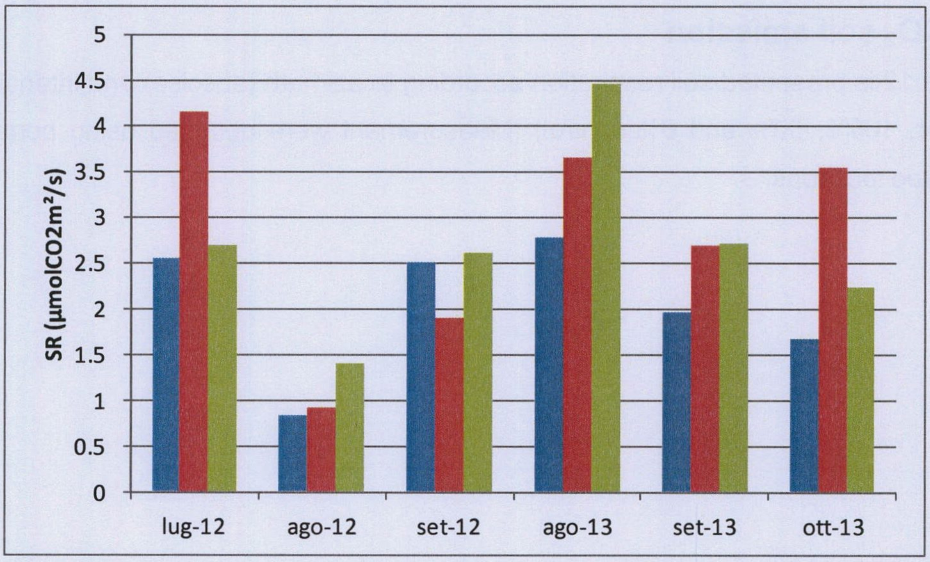

Figure 13: CO2 soil emission in site 2 in measurement point with litter, blu= Innovative 80, red= traditional, green= Innovative 40

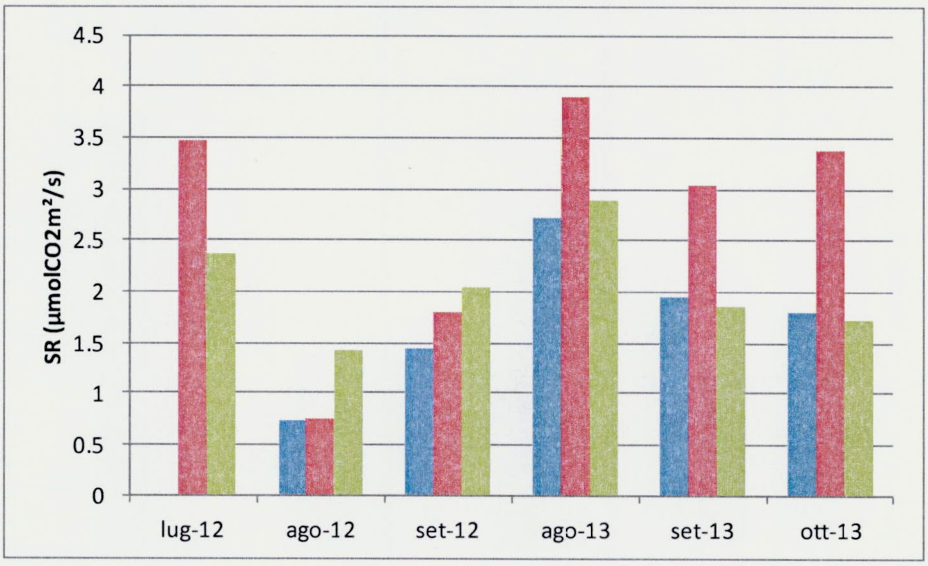

Figure 14 CO2 soil emission in site 2 in measurement point without litter, blu= Innovative 80, red= traditional, green= Innovative 40

4.2.2. Leaf area index and forest management

Different silvicultural treatments have different effects on the crowns. The effect of the different thesis on LAI was assessed by comparing values measured in different treatment plots with those of the control area (i.e. not cutting area)

In site 2, in traditional plots LAI was 1.50 ± 0.11 m^2 m^{-2} (39% of control), in innovative 80 1.59 ± 0.32 m^2 m^{-2} (41% of control) and innovative 40 1.72 ± 0.41 m^2 m^{-2} (45%).

In site 4, in control area LAI was 4.31 ±0. 76 m^2 m^{-2}, in traditional plots LAI was 2.27±0.20 m^2 m^{-2} (52% of control) and in innovative ones 2.57±0.30 m^2 m^{-2} (59% of control).

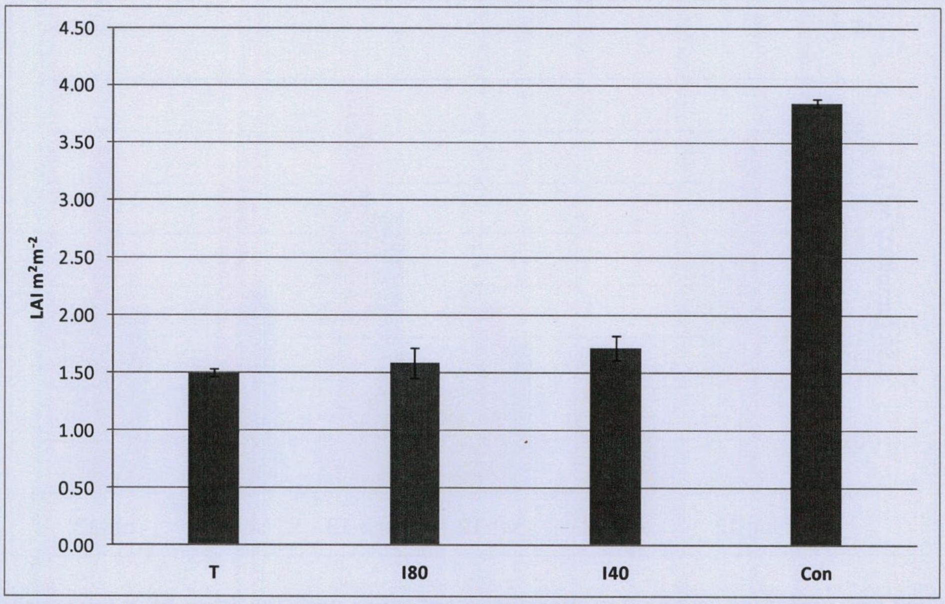

Figure 15: Leaf area Index in site 2 (Chiarano), T= traditional thesis, I80= innovative 80, I40=innovative 40, Con= control

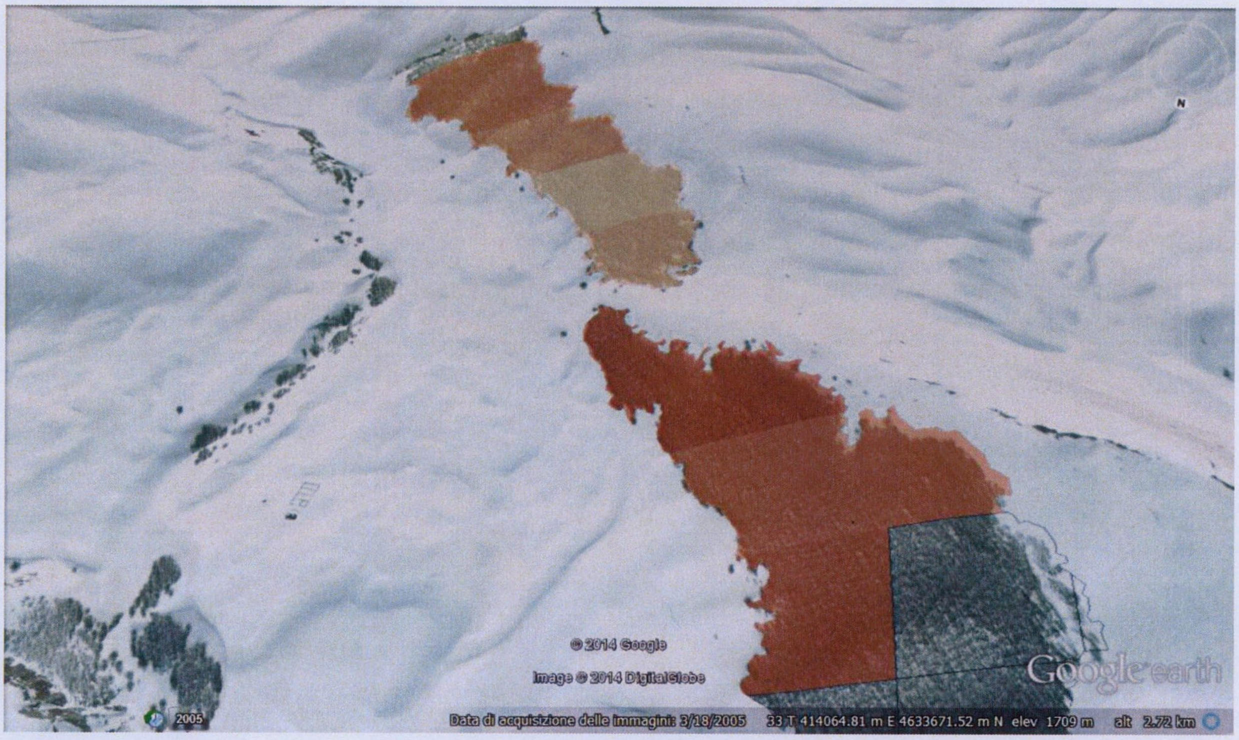

Figure 16: Site 2, map of LAI, intensity of colour is related to LAI

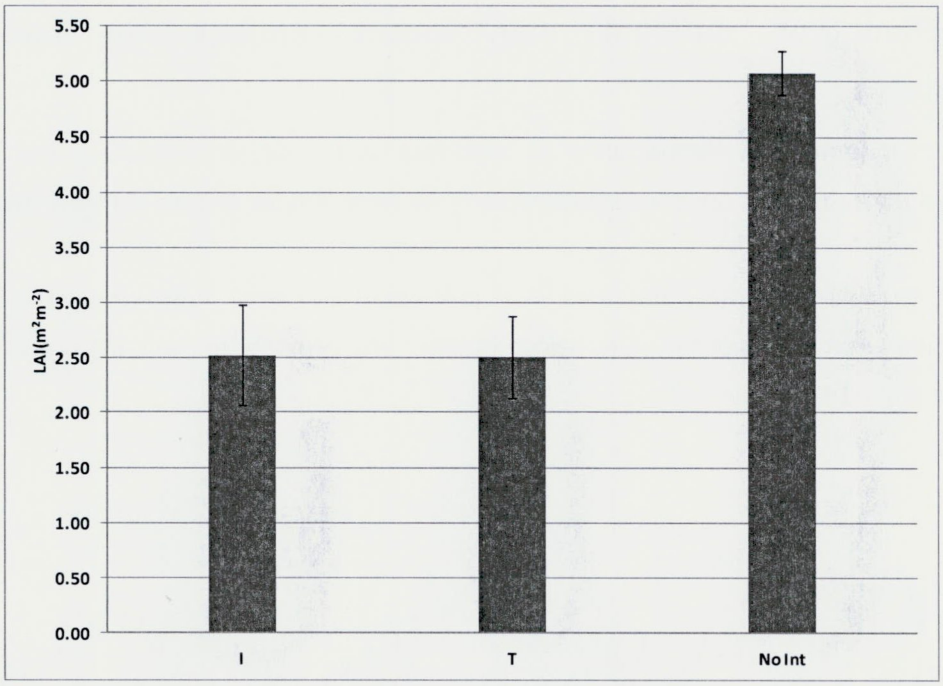

Figure 17: Leaf area Index in site 4 (Mongiana), T= traditional thesis, I= innovative thesis, No Int= delay of treatment

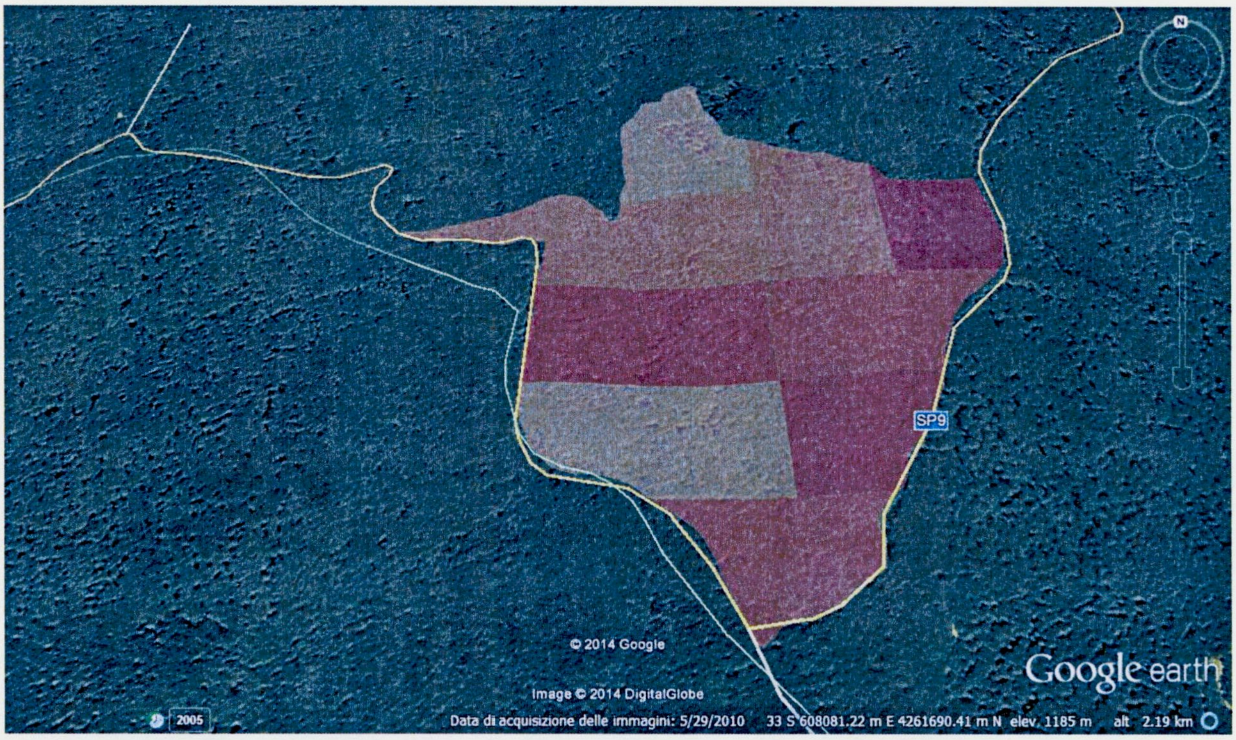

Figure 18: Site 4, map of LAI; Intensity of colour is related to LAI

4.2.3. Effect of different management options on microclimate characteristics

Air and consequently soil temperature is important factor which controlling soil respiration. Therefore we perform continuous measurements of air temperature and air humidity inside sites 2 - 8-9-10.

In Slovenian sites (8-9-10) measurements were performed on center, north and south of each plot (27x3=81 measurements points). On below graphs are presented daily max and min of air temperature and air humidity.

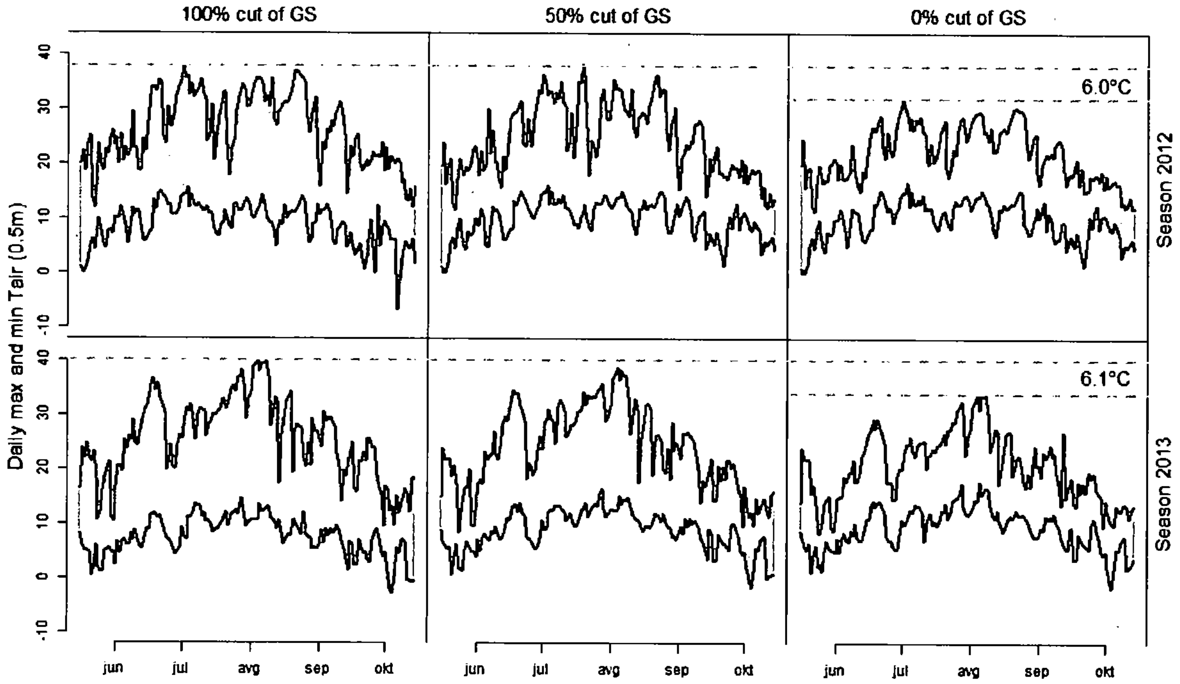

Figure 19: Temperature trend in Slovenian sites

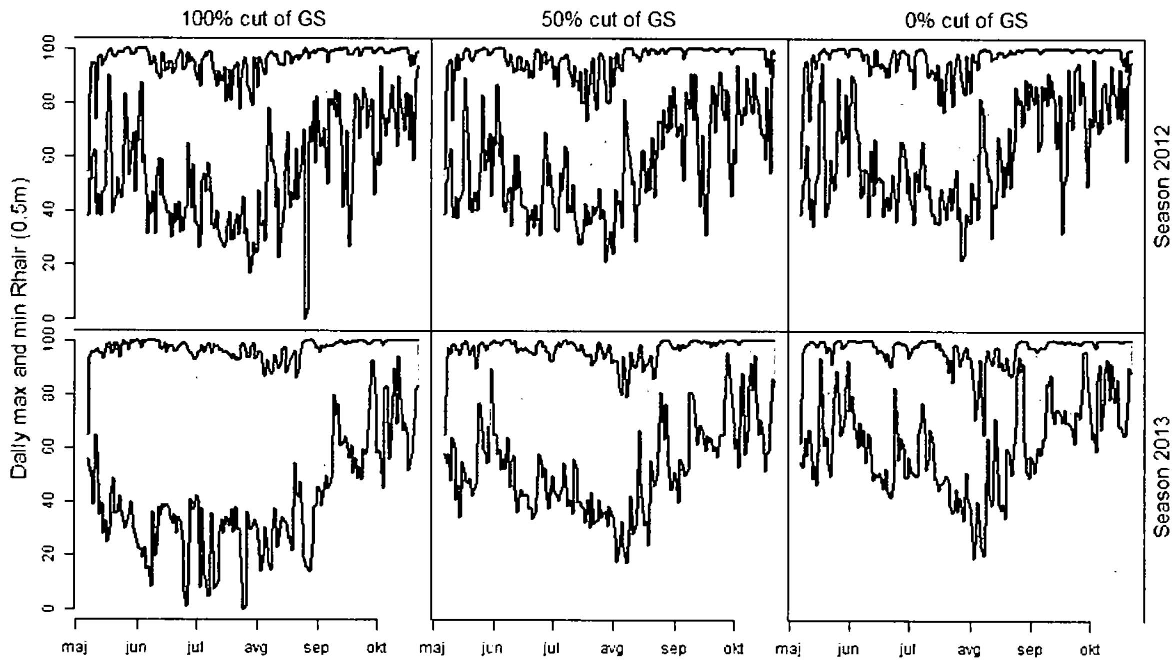

Figure 20: Humidity trend in Slovenian sites

We can observe how management mpact on environmental condition. It can increase the temperature for up to 6 °C. Examples on temperature-dependence of soil respiration shows that can increased temperatures from 21 to 26 °C increase soil carbon flux for up to 0.6 MgC/ha/month (Eler K., Plestenjak G., Ferlan M., Cater M., Simoncic P.in sod. 2013. Soil respiration of karst grasslands subjected to woody-plant encroachment. European Journal of Soil Science, 64, 2: 210-218).

In site 2, measurements were performed using 4 device, one out the stand and one per each management option, to register temperature and humidity of soil and air (ECH$_2$O-TE/EC-TM, *Decagon Devices*).

In this case the effects of different management options are not significant, as shown in fig.21.

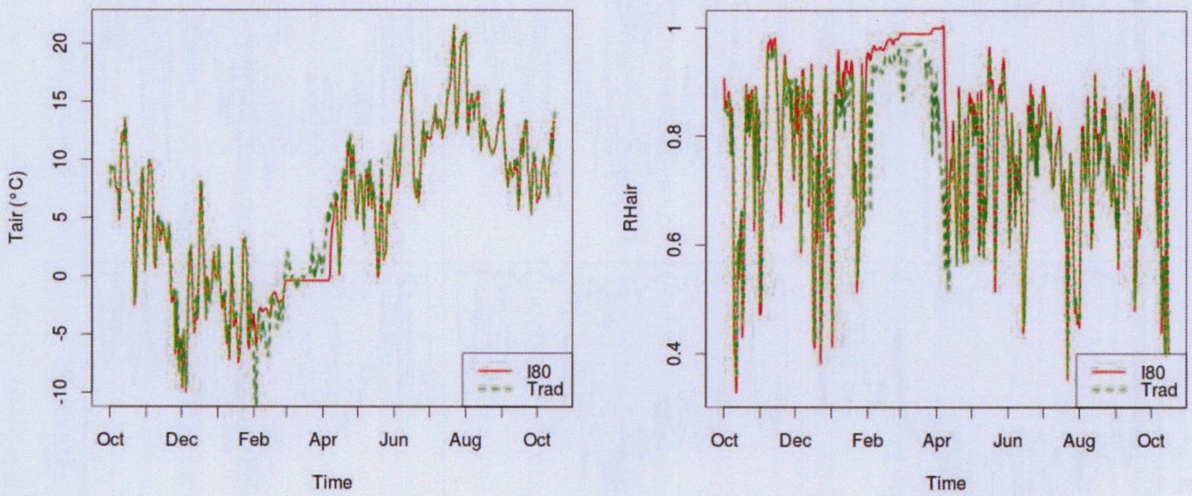

Figure 21: Temperature and humidity of the air in Site 2 (Chiarano), red= innovative 80, green = traditional

4.2.4. High resolution measurements of radial increment:

On a seasonal scale, monitoring of the radial growth gives a good insight into beginning, duration and finish of the growth season. Beside this we can also identify period of most active growth and the period of the growth cessation.

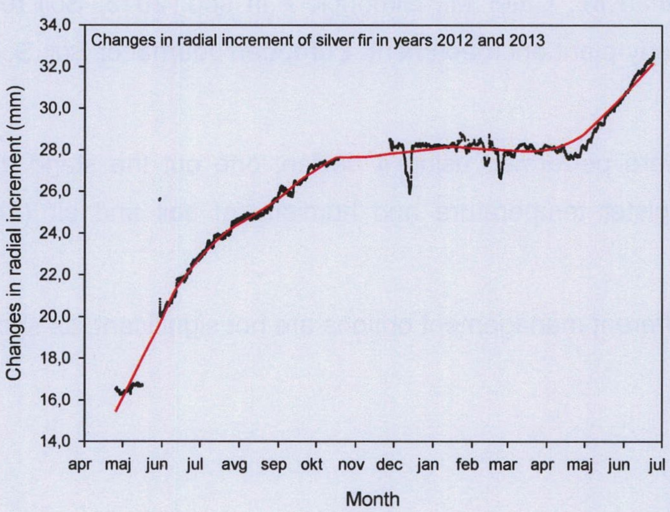

Figure 22: radial change in a fir

In particular period of the most active growth is crucial for the understanding of tree's response to environmental factors, such as influence of temperature or precipitation on cambial activity (=

radial increment). On figure below, we can see the entire growing season of 2012, with relative steep curve, meaning fast cambial division and fast growth. Plateau of the curve represent late autumn and winter period with some shrinkage due to ice formation within the stem and the beginning of growing season 2013. Just before the onset of the growth there is a typical shrinkage of the stem, which is connected with the beginning of the water movement within the stem and not yet fully functioning root system.

4.2.5. Impact of bunching and extraction by mules

Effect of silvicultural activities can affect soil characteristics, that has a very important role in carbon cycle.

Preliminary results of the study performed in site 2 (Chiarano) showed interesting effect of different treatment on soil.

Logging operations (e.g. bunching and extraction by mules) affected over 18±4% of the stand surface for the three areas, with a maximum for the plot 4 (I40) and a minimum for the plot 2 (I80).

Soil bulk density was significantly affected by extraction in all the three areas. Within each single plot there was a significant difference between disturbed (compacted from mules) and undisturbed soil. Among the three areas, bulk density was not significantly different in disturbed soil, with an average increase compared to the undisturbed soil of about 15%.

Resistance to penetration was significantly affected by the logging operations, and in each plot there was a significant difference between disturbed and undisturbed soil. In disturbed soil, resistance to penetration was significantly different in plot 2 (I80), with an average increase compared to the undisturbed soil of about 162%. In the other areas, this parameter was not significantly different, with an average increase between disturbed vs undisturbed soil of about 66%.

Shear strength showed the same trends recorded for resistance to penetration, with significant differences between disturbed and undisturbed soil. Among the three areas, for the disturbed soil, this parameter was significantly different for the plot 4 (I40) (with an average increase compared to the undisturbed soil of about 38%), while in the other two areas the average increase (123%), was not significantly different between disturbed and undisturbed soil.

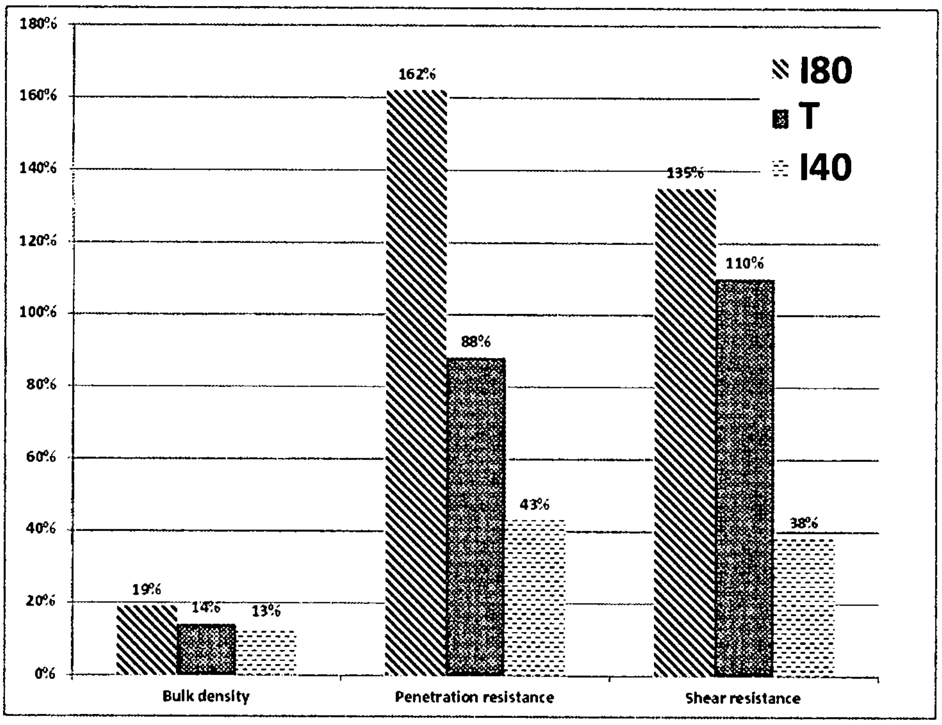

Figure 23: effect of silvicultural activities on soil characteristics in site 2

4.2.6. Physiology of girdled trees

In the experiment about girdling we measured growth of 6 girdled trees and 6 control trees during the growing season using dendrometer tapes (UMS). The growth of the groups is not different and it shows that also girdled trees grow. This can be explained with the use of reserve by the trees.

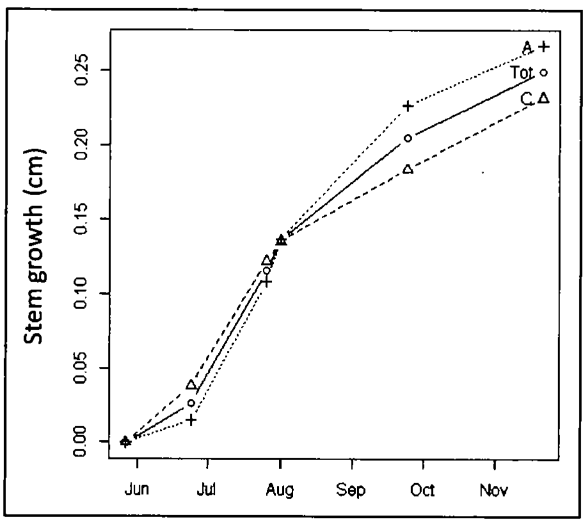

Figure 24: Mean growth of girdled trees (A), control (C) and the total trees (Tot)

In June and in September, we measured photosynthetic activity of 3 girdled trees and 3 control. A/Ci curves provide detailed information about biochemical potential of photosynthetic apparatus at the level of single leaf. In both dates photosynthetic activity of control trees is higher than girdled ones. In our study we didn't observe difference in control trees assimilation among the two dates. Differences were found in girdled trees among the measures of June and September.

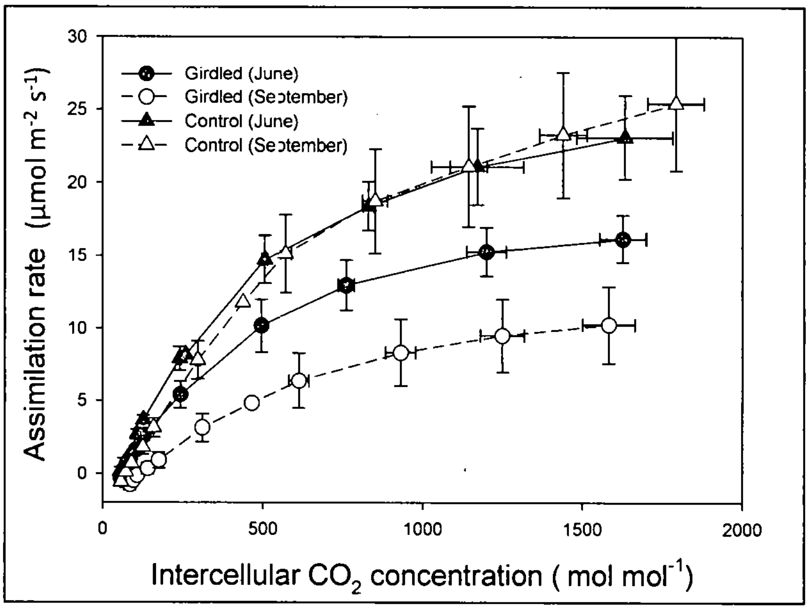

Figure 25: A/Ci curves

Effect of girdling is clearly showed in figure 26, where it is possible to see in the girdled trees a difference between the amount of phloem sugar above and below the woodcut, while in the control trees amount there aren't any differences. In this way we demonstrated that phloem cannot transfer sugar from sites of sugar production to the roots that are one of the most sink of the tree.

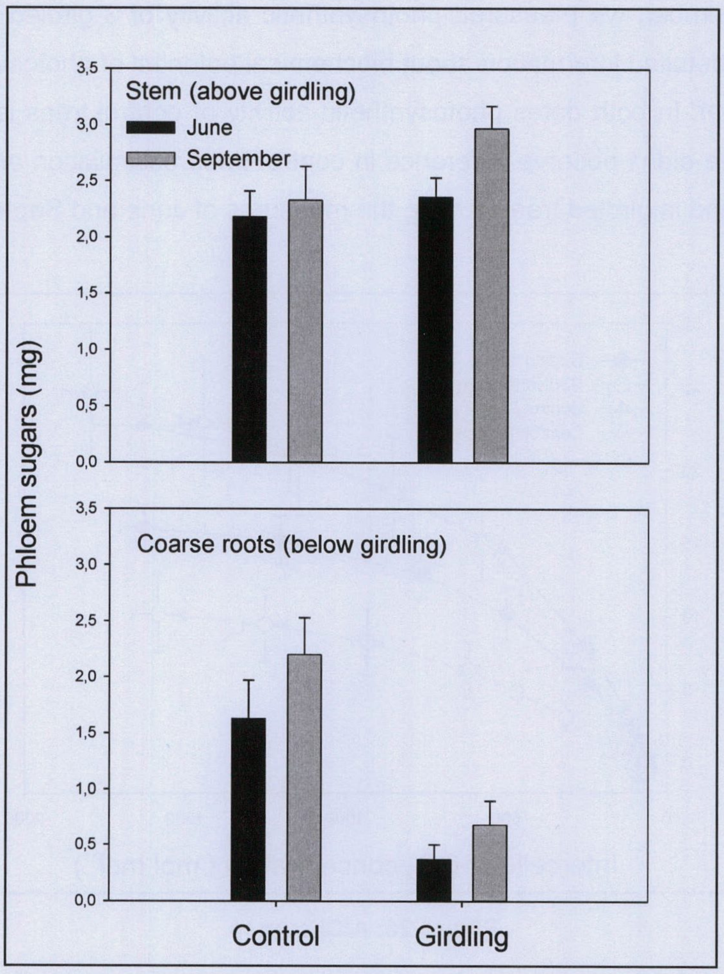

Figure 26: phloem sugars amount in stem and coarse roots in the girdled and control trees

5. Comparison of achieved vs. expected results

5.1. *Expected results in the reporting period*

The expected results for reporting period were planned in previous report as it is possible to see in table 3.

In this reporting period, planned activities were the conclusion of measurement operations ante harvesting in all sites, the continuation of CO_2 soil emission measurement and laboratory activities and chemical analysis.

All preliminary results, reached at the end of reporting period, are reference to arrive to the final result, related to the forest response to the different harvesting criteria.

Table 3. Timetable of activities and milestones planned in second Action ForC report

Year	Month	Activities	Milestones
2013	March	Collected Samples preparation and chemical analysis	
	April		Data on indicators of forest carboncycle (various media)
	May		
	June	Soil respiration in both countries/Collected Samples preparation and chemical analysis/measurement of harvesting operation emission in site 1	
	July	Soil respiration in both countries/ Field activities pre management in site 5/measurement of harvesting operation emission in site2	
	August	Soil respiration in both countries/ Field activities pre management in site 5 and 7	
	September	Soil respiration in both countries/ Field activities pre management in site 7 /measurement of harvesting operation emission in site 6	End of field activities pre management in all Italian sites
	October	Soil respiration in both countries/Field activities post management/ Collected Samples preparation and chemical analysis	Beginning measurements after forest management operation have been performed (3 sites)
	November		
	December	Collected Samples preparation and chemical analysis/Data elaboration	
2014	January		
	Febraury		Estimation of ecosystem carbon stock in all sites pre management/data on indicators of forest carbon cycle/Action Report delivery

5.2. *Evaluation of performance during the reporting period*

Activities planned in the previous ActionFor C report are all performed on time.

After field survey in sites 5 and 7, at project level, ante measurements have been completed at 10 out of 10 sites (100%, 7 in Italy, 100%; 3 in Slovenia, 100%) and the actual operation progress can be considered very positive (promised progress: 100% of sites before June 2014). are completed and some results are already available (text before). Preparation and chemical analysis of field samples are proceeding as expected.

Measurements after forest management operation have been performed totally in sites 1-8-9-10, and partially in 3-4, this represents more or less of 50% of post treatment activities higher than activities planned 30% of sites before Jan 2014.

CO_2 soil emission measurements are continuing in all planned sites and preliminary results are yet available.

5.3. *Overall future estimation of planned Action's objectives*

The main objective of Action ForC is to assess how forest management can influence carbon cycling in forest ecosystems. This objective is central for the project aim and its attainment is sure, as the Action is in line with prevision.

Many tools as the monitoring indicators related to forest carbon, are crucial anyway to demonstrate how and "how much" the stocked carbon and the carbon cycling of forest, are influenced by the different management criteria. The determination of these indicators can be considered as an intermediate objective and the accuracy in their estimation fix "how" the action objective (in terms of reliability),is achieved.

In the Action ForC structure, the assessment of the following expected results has been planned:

a. MCPFE* Indicators on the carbon cycle in managed forests 1, 2

b. Leaf Area Index and woody debris of differently managed forests

c. Indicators on some detailed processes of forest carbon sequestration and/or emissions

d. Data on biomass and soil carbon stock and stock changes in differently managed forests along geographical transects

e. Report on the effect of forest management options on the carbon cycle of forests

f. Determination of change from the baseline (reference management options or no intervention)

To reach these expected results, several parameters and intermediate objectives will be used.

Then the expected results and the parameters/objectives have frequently the same meaning and are easily interchangeable. Action ForC more practical objectives are listed below:

1. growing Stock
2. carbon stock for biomass and soil

3. biomass of woody debris
4. Leaf Area Index (LAI)
5. soil CO_2 emissions
6. harvested biomass/volume
7. Net Primary Production (NPP)
8. Litterfall

6. Indicators of progress

6.1. *Planned indicators*

Indicators of progress status, divided between the two countries, is following reported (Table 4).

Structural measurements (crucial for biomass assessment), dead wood survey and soil sampling before performing forest management, have been completed in all sites of the project.

In reporting period post management activities have begun in both nations.

Table 4: Indicators of progress of Action ForC, * = percentage referred to whole sites, **= percentage referred to activities inside site

Indicators of progress	Report 1	Report 2	Report 3	Total
Numeber of plots measured	85	9	18	112
Numeber of plots assessed for more detailed indicators	27			27
Measurements before performing forest managament	4 sites (57%*)	1 site (14%*)	2 (28%*)	7 sites (100%*)
Numeber of plots measured after management			17	17
Measurements after forest management operation have been performed	not planned in this reporting period	not planned in this reporting period	1 site (100%**) 2 site (50%**)	1 site (100%**) 2 site (50%**)
Second sampling at sites where management operations will be performed first	not planned in this reporting period	not planned in this reporting period	not planned in this reporting period	not planned in this reporting period
Numeber of plots measured	27			27
Numeber of plots assessed for more detailed indicators	in progress	9		9
Measurements before performing forest managament	3 sites (100%)			3 sites (100%*)
Numeber of plots measured after management			27	27
Measurements after forest management operation have been performed	not planned in this reporting period	not planned in this reporting period	3 sites	3 sites (100%*)
Second sampling at sites where management operations will be performed first	not planned in this reporting period	not planned in this reporting period	not planned in this reporting period	not planned in this reporting period
Numeber of plots measured	112	9	18	139
Numeber of plots assessed for more detailed indicators	27	9		36
Measurements before performing forest managament	7 sites (70%*)	1 site (10%*)	2 (20%*)	10 sites (100%*)
Numeber of plots measured after management			44	44
Measurements after forest management operation have been performed	not planned in this reporting period	not planned in this reporting period	4 sites (100%**) 2 sites (50%**)	4 sites (100%**) 2 sites (50%**)
Second sampling at sites where management operations will be performed first	not planned in this reporting period	not planned in this reporting period	not planned in this reporting period	not planned in this reporting period

7. Envisaged progress until next report

At the reporting time, the planned objectives are respected (in some cases have been overcome), the future progress are thus to go on following the Project plan.

In detail the future steps are to sample the remaining 2 Italian sites (Site 5-7) in time to enable silvicultural operations to start as planned. It will complete the ante measurements in all sites, including data collection in order to enable the estimation of forest carbon cycling indicators.

More detailed information is reported in Table below.

Table 5: Timetable of activities and milestones until next Action ForC report

Year	Month	Activities	Milestones
2014	March	Collected Samples preparation and chemical analysis	
	April		Data on indicators of forest carboncycle (various media)
	May		
	June	Soil respiration in both countries/Collected Samples preparation and chemical analysis/beginning measurement of sampling after management	
	July	Soil respiration in both countries/Field activities post management	
	August	Soil respiration in both countries/ Field activities post management	
	September	Soil respiration in both countries/ Field activities post management	
	October	Soil respiration in both countries/Field activities post management/ Collected Samples preparation and chemical analysis	End of field activities post management in all Italian sites
	November		
	December	Collected Samples preparation and chemical analysis/Data elaboration	
2015	January		
	Febraury		Estimation of ecosystem carbon stock in 3 sites post management/data on indicators of forest carbon cycle/Action Report delivery