Did ManFor C.BD forest treatments influence carbon stock and sequestration?

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Effect of management on carbon stock and sequestration

Forests are a key component of the global carbon cycle. It has been estimated that of the 480 Gt of carbon emitted by anthropogenic activities (fossil fuel and land-use change related emissions) since the start of industrial revolution, 166 GtC (35%) have been absorbed by forest ecosystems, 124 GtC by oceans (25%), while 190 GtC (40%) remained in the atmosphere, causing the relevant increase of CO_2 concentrations that is the main driver of climate change (House *et al*., 2002). In this respect, the role of managed forests is crucial as several studies attributed to the forests of the Northern hemisphere, a large part of which is managed, a prominent role in the carbon cycle of the last 20 to 30 years (Schimel *et al.*, 2001). The C cycle begins with the process of CO_2 assimilation by plants that determines the delivery of assimilates to the plant internal store, which may then be used for growth, reserve or defense. In trees, growth adds biomass as foliage, wood and roots. The annual cycle of plant part losses, arising in the form of the litterfall derived from above- and below-ground parts, migrates carbon to the soil and feeds back to the heterotrophs of the ecosystem which use the energy stored in the organic matter and recycle nutrients as a major resource for further plant growth (Schulze, 2000).

Methods

In both countries assessment procedures have been carried out on ManForC.BD representatives sampling plots. Basing measurements on a classic forest inventory approach (structure, stocks, increment) and biomass assessment on allometric equations are collected in all sites. Tree diameters at man breast height (DBH), of all plot trees, have been measured and these data, together with tree heights, have been used to assess the total arboreal biomass (carbon stock ~0.5 biomass).

Concerning leaves and fruits annual production, the litter funnel trap method has been used at plot level in three test sites in Slovenia and in beech stands in Italy (Cansiglio, Chiarano and Mongiana sites).

Soil carbon pool was estimated using a systematic sampling in each sub-plot. A quite different approach has been used. In Italy, undisturbed soil cores has been collected down to 40 cm or more (where possible), sampling mineral soil by pedological horizon depth. Sampling size has been of three core for each sub-plot at sites where treatments will be replicated (3 treatments, 3 plot per treatment, a total of 27 sub-plots and 81 soil samples).

On the same point, soil litter has been collected by a 20 × 20 cm metal frame.

In each Slovenian subplot, at three sites (1 m far from subplot centre, according to azimuths of 0, 120 and 240) soil sampling was performed. Mineral soil was sampled by fixed depths (0-10 cm, 10-20 cm, 20-40 cm, 40-60 cm, 60-80 cm), until reaching parent material. Soil litter was collected on square area 25 × 25 cm (area = 625 cm^2) and sampled material from all three points were put together (composite samples).

The humus forms, more recently used as significant indicators of soil organic carbon (SOC) storage (De Vos *et al*., 2015) and coinciding with the sequence of organic (OL, OF, OH, H) and underlying organo-mineral horizons (A, AE, Aa) (Zanella *et al*., 2011) was collecetd in the italian beech stands of Cansiglio, Chiarano and Mongiana sites. Sampling size has been of three core for each plot at sites where treatments will be replicated (3 treatments, 3 plot per treatment, a total of 27 topsoil samples). Soil, humus form and litter sampling was repeated in all sites after silvicultural operations, so near as possible to previous sampling holes.

In each plot, deadwood was assessed within one plot of 13 meters of radius concentric within the plot established for structural measurements. Coarse woody debris were measured when more than half base of their thicker end lied within the plot. A threshold height of 1.3 m was used to distinguish stumps (less than 1.3 m) from snags (higher than 1.3 m). Decay level classification of each deadwood piece was carried out visually by the system proposed by Hunter (1990).

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Result and lesson from ManForC.BD sites

The first and very visible effect of forest management is a decrement of aboveground biomass.

In Italian site, the mean amounts of carbon removed by harvesting operations in innovative and traditional options were 47±13 and 34±13 $MgCha^{-1}$, respectively. The management effects on biomass of the innovative and traditional approach were not different, the amount of carbon stored in stems and branches decreased of 33±9 % and 26±7 %, respectively.

In the Slovenian sites, the cutting percentage were constant 50% and 100% of living above ground biomass, and the mean amount of carbon removed by harvesting operations was 114 $MgCha^{-1}$.

In the Italian sites, carbon stored in deadwood increased of 4.91 and 4.13 $MgCha^{-1}$ in innovative and traditional management, gaining of 202% and 194%, respectively. In all the innovative management options dead downed woods and girdled trees (future snags) were created.

In the Slovenian sites deadwood carbon pool increased of 588% in the plot where half of living biomass was cut and 1154% where all the trees were cut. After harvesting operations, the amount of carbon stored in deadwood increased of 26 and 54 $MgCha^{-1}$, respectively.

Along the north-south transect of the Italian peninsula the lowest values of Soil Organic Carbon (SOC) are in the northernmost site of Cansiglio where the average value is 65 ± 15 $MgCha^{1}$. In Chiarano and Mongiana values are higher: the average content of SOC, indicates similar values in the two sites 93 ± 8 and 94± 9 MgC ha^{-1}, respectively.

In Italian sites the innovative and traditional forest management did not create any significant variation in soil carbon pools. These results suggest first at all the low impact of forest operations upon the soil. Overall to discuss results we have to consider that the changes in soil are very slowly processes with a larger temporal scale, because different input of deadwood, litter aboveground or roots biomass could produce changes in the soil carbon pool in the next years. In fact the effect of different treatments has involved most superficial horizons (OF, OH) of humus form, with a trend from less active forms to other more active, showing a different storage of SOC in topsoil profile, in Cansiglio and Mongiana sites.

In Italian sites Innovative and traditional management options reduced the forest carbon stock of 33 and 41 MgCha1, respectively. In the Slovenian sites the reduction of carbon stock was 67 and 143 MgCha1 for 50% and 100% biomass cutting, respectively (Figure 1).

Effect of management on soil CO_2 emission

Carbon dioxide is produced in soils by roots and soil organism and, to a small extent, by chemical oxidation of carbon-containing materials. CO_2 is released from soils in the process variably referred to as soil respiration. The rate at which CO_2 moves from soil to the atmosphere is controlled by the rate of CO_2 production in the soil, the strength of the CO_2 concentration gradient between the soil and the atmosphere, and the properties such as soil pore size, air temperature, and wind that influence the movement of CO_2 through and out of the soil (Raich and Schlesinger, 1992).

Forest management could influence environmental characteristics that are involved in soil respiration (Tedeschi, 2003; Ma *et al*., 2004).

Methods

In Chiarano, every 15-20 days the measurements has been performed by an IRGA (infra-red gas analyser) technology instrument commercialized as EGM-4 Environmental Gas Analyzer for CO_2, equipped with a soil respiration chamber (SRC1, PPSystems) and a soil temperature sensor. Measurement was carried out overlapping the soil chamber on a 15 cm diameter PVC collars, previously placed on the forest floor.

Three of the nine plots have been selected (one for each treatment). In each plot, measurements are performed in the three subplots, where 6 collars have been placed following the following criteria:

- a first one is randomly placed close to the sub-plot centre;
- a second one at three meters from the centre along the line of maximum slope;
- the other four are placed respectively at an increasing distance from the center, of 6, 9, 12, and 12 m with an angle of 90 degrees from each other starting from the second.

Such design describes a 'spiral arrangement' inscribed in a 13 m radius circle. 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.

CO_2 flux measurements require extensive sampling. Slovenian methodology includes three repetitive cycles on each point of the plot.

The Slovenian protocol foresees also the use of an automatic device (a prototype suitably adapted to the measurements requested for the Project purposes, see Ferlan, 2016).

Result and lesson from ManFor sites

In all sites soil temperature is the main driver of soil CO_2 efflux.

In Chiarano, the sensitivity of soil respiration (SR) to temperature (slope of regression lines) is greater in the plots where the traditional treatment occurred and in a plot without any silviculture operation, than in the plots where the innovative treatments have

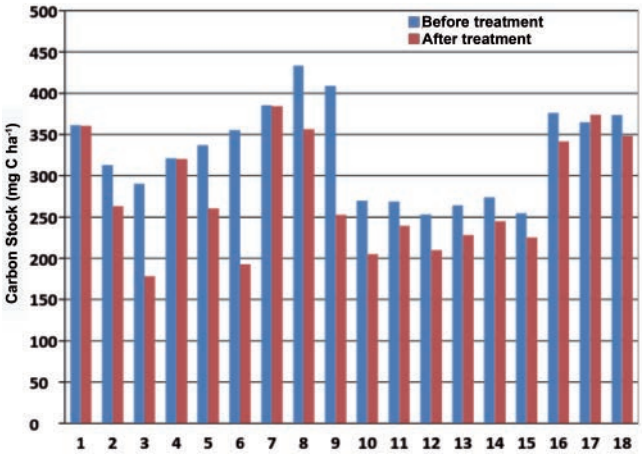

Figure 1. Carbon stock in six study sites. Blue, carbon stock before silvicultural treatments; red carbon stock after silvicultural treatments.

been performed (Figure 2).

A strong correlation between the basal area (the main index structure of forest stands) and the sensitivity of soil respiration to temperature was found in this site. After cutting, in the plot with highest basal area (Figure 3), proxy of root biomass, higher CO_2 effluxes were measured. These results suggest the importance of root respiration (autotrophic component) in this high elevation ecosystem.

The differences among the plot are reflected in the annual soil CO_2 effluxes to the atmosphere.

Analysing the whole growing season (from June 2013 to October 2013) we observed that the plot under traditional treatment lost a greater amount of carbon (576 gC m^{-2}) than Innovative40 (462 gC m^{-2}) and Innovative 80 (394 gC m^{-2}).

In Mongiana site soil respiration ranged from 0.13 µmol CO_2 m^{-2} s^{-1} of February to 2.65 µmol CO_2 m^{-2} s^{-1} of August. Also in this site soil temperature have a significant effect on soil respiration. Also in this site management options had a significant effect on CO_2 soil effluxes. Plots with innovative options showed higher annual mean respiration than traditional and no practice plots.

On Slovenian sites a significant relation between soil temperature and CO_2 soil efflux has been confirmed (Figure 4). Different relation was confirmed for plots with predominating beech (Figure 5).

Evident changes as the result of higher decomposition rates in beech-predominant stands have been evidenced after applied silvicultural measures, compared to silver fir or predominating spruce stands (Figure 5). Decrease in efflux rates during following period was similarly more pronounced in predominating beech stands. Absolute response values were higher on plots of Trnovo and smallest on Snežnik sites.

At the beginning of growing period changes were highly pronounced in beech forest stands, contributed to higher response in broadleaved species than in conifers (fir, spruce).

Level of SR in beech predominating stands was higher on all plots and increased even more after the applied silvicultural measures in September, compared to silver fir and spruce predominating stands.

Results confirm response differences connected with cutting intensity: highest change was measured on plots with 100% intensity and lowest on control plots. Differences between different sampling microsites (within each plot) are also connected with different temperature conditions (Figure 6).

Through experiences of ManFor sites it is possible to suggest that:

1. Carbon fluxes are different in regard to predominating tree species;
2. Soil temperature and forest structure affects soil respiration;
3. Intensity of silvicultural treatments affects release of below ground carbon;
4. Recovery to balanced stage/equilibrium is inversely proportional to silvicultural treatments intensity.

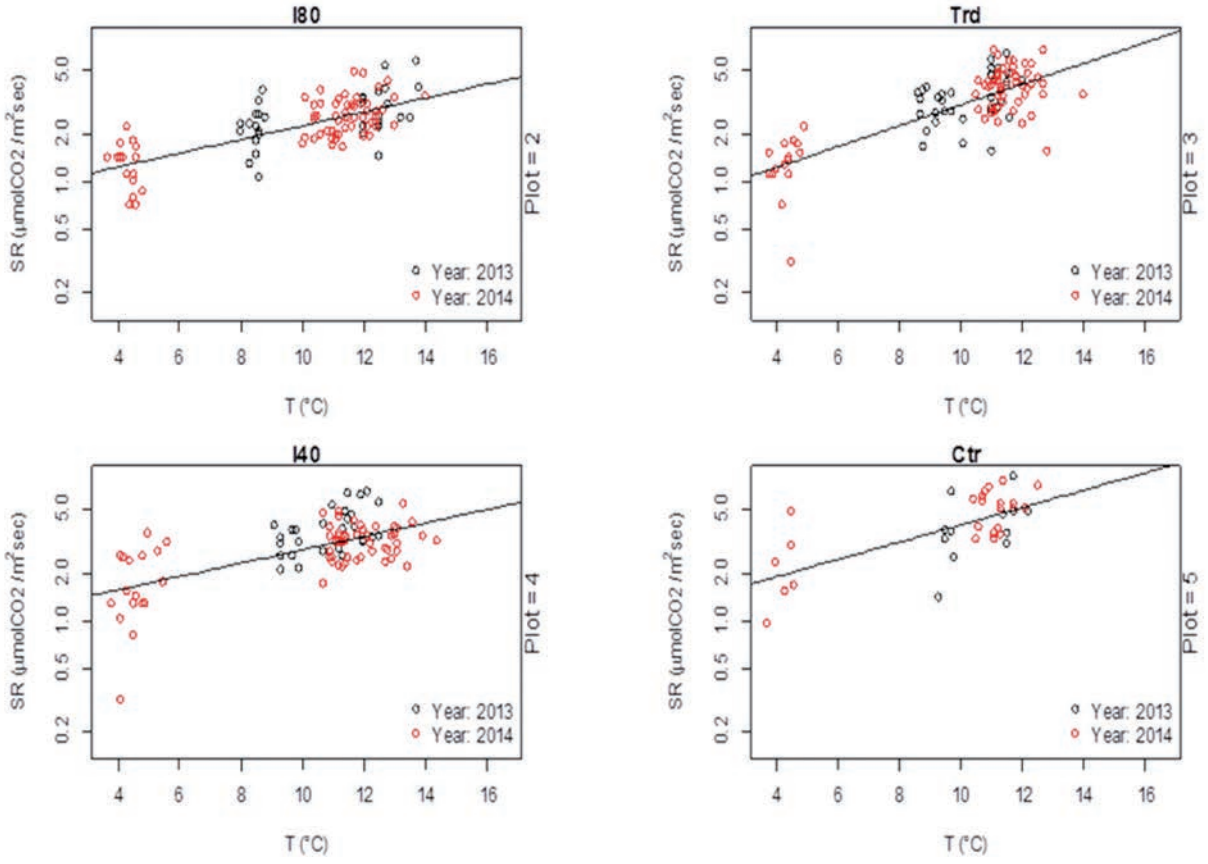

Figure 2. Response of respiration to temperature. The points in black represent the measures in 2013 while the points in red represent the measures in 2014. The vertical axis is a logarithmic scale. I80, innovative 80 management option; I40, innovative 40 management option; Trd, traditional management; Ctr, control without any management.

Effect of management on microclimatic parameters

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 become an essential component of current ecological research (Davidson *et al*., 1998; Epron *et al*., 1999; Buchmann, 2000; Morén and Lindroth, 2000).

Natural modifications (windbreaks or the death of one or several trees) or artificial intervention by the forester (clearfelling, clearing, strip felling, shelterwood, seed felling, thinning) modify the microclimatic characteristics (Tedeschi, 2003; Katayama *et al*., 2009). 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.

Methods

In Chiarano three permanent sensors (ECH2O-TE/EC-TM, Decagon Devices) were installed for measuring the temperature and humidity of soil and air.

Every sensor has a probe, place at a height of 1.80 m, for the measurement of temperature and relative humidity of the air and four probes for the measurement of temperature and humidity (Volumetric Water Content) of soil. Probes for the measurement of soil parameters are place at a depth of 5 and 10 cm (two at 5 cm and two at 10 cm).

In all Slovenian sites continuous measurements were performed on centre, north and south of each plot (27x3=81 measurements points).

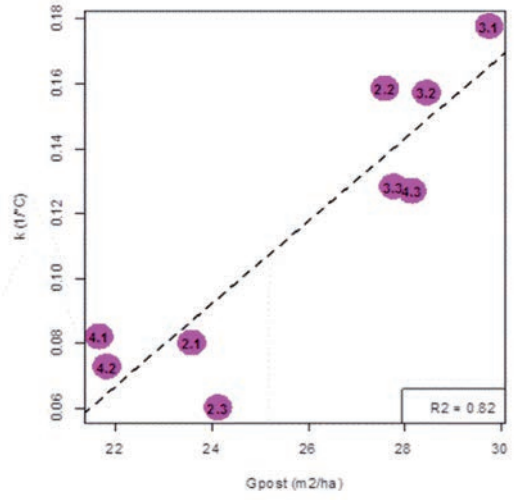

Figure 3. The relationship between the sensitivity of respiration to temperature (K) and the basal area after the silvicultural treatments (Gpost). Each point indicates a sub-plot (13 m radius). The dashed line represents the regression line (R2=0.82).

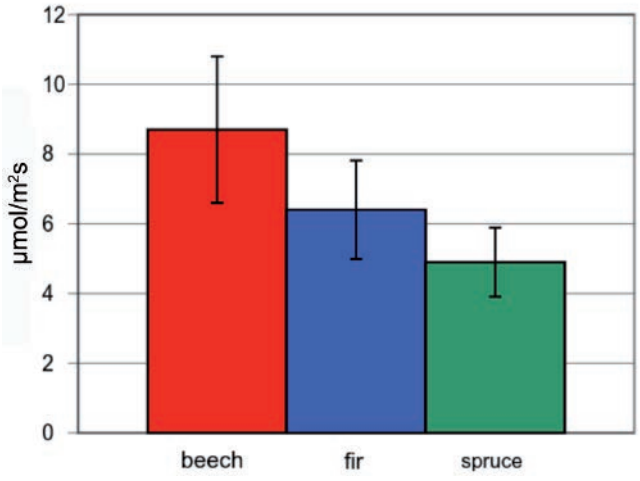

Figure 5. Average soil respiration rate according to predominating tree species.

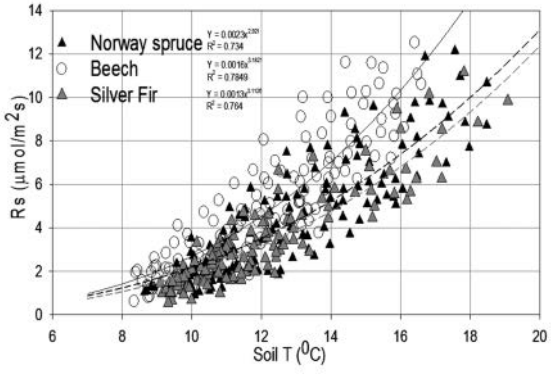

Figure 4. Relation between soil CO2 fluxes and soil temperature on Slovenian sites. Each points represent the mean of a sampling plot (Čater, 2015).

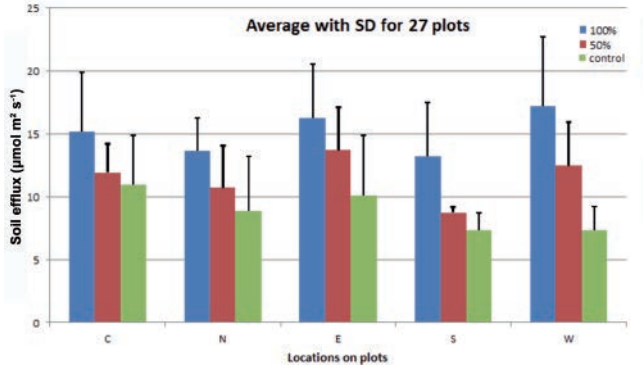

Figure 6. Average values of soil respiration, all 27 plots included.

Result and lesson from ManFor sites

In Slovenian sites a great effect of forest management on maximum temperature was found (Figure 7) differently to air humidity (Figure 8). In case of high temperature a difference of 6°C was observed between the plots where the total aboveground biomass was cut and the control ones.

In Chiarano the different management options do not have significant differences (Figure 9). Curves of temperature and humidity of the air measured in the traditional and innovative 80 are totally overlapped.

Data collected during the project shows that significant effect are evaluable only in case of drastic management options (cutting of 100% living biomass).

In Chiarano innovative ad traditional management options don't have any different effects on the microclimatic parameters.

Wood products and carbon cycling

Long term storage of carbon in products delays or reduces emissions. Use of wood products can also reduce emissions if they substitute for products with higher carbon emission processes. As forest biomass is harvested carbon is shifted from forest ecosystems to forest products held in products and landfills. The rate of accu-

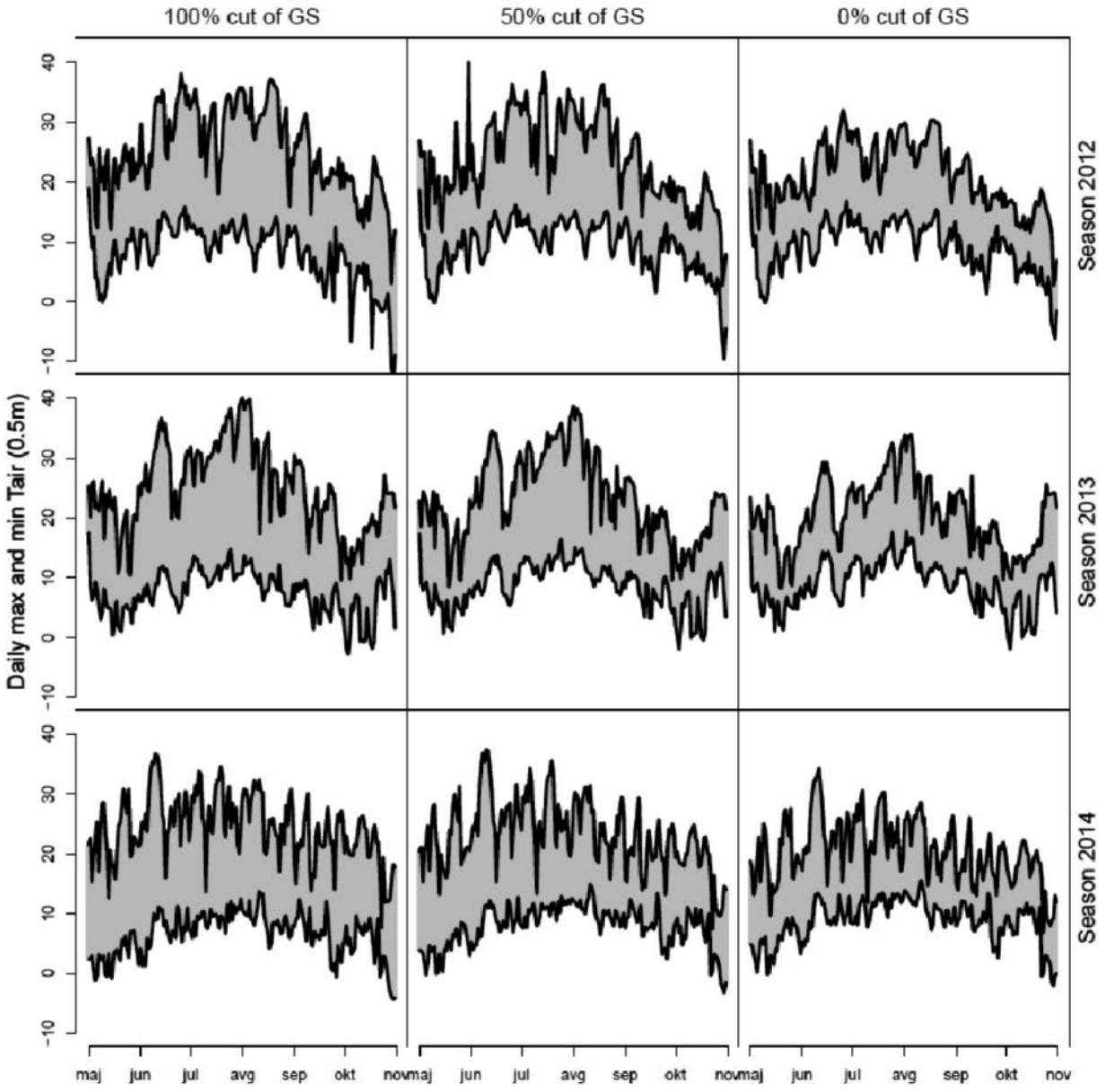

Figure 7. Average daily maximum and minimum temperatures measured in the Slovenian sites during 2012 and 2014 growing seasons.

mulation of carbon in products can be influenced by the mix of products and uses (USDA, 2011).

Consequently forest management plays a central role in providing good quality wood to the production chains, for this reason we compared the potential wood assortments obtainable by the different management options. Also the use of wood biomass for producing heat and energy has an impact on global carbon cycle. Since the burning of wood avoids the emissions of many possible fossil fuels, the avoided CO_2 emissions may be stated in terms of offsetting the burning of fossil fuels (USDA, 2011).

Methods

In the Italian beech forests we estimated the potential obtainable assortments from the different type of management, using a yield table that provide also the obtainable assortments. For each site we used the suitable fertility class comparing the site height and diameter with the values in the table (Castellani *et al*., 1972).

We considered 4 type of assortments: saw log (diameter >30 cm, length >4 m), yule log (diameter 15-30 cm), fuel wood (diameter 10-15 cm) and bundle (diameter <0 cm).

Result and lesson from ManFor sites

The quality of woody products is strongly dependent by the biomass before treatments (Figure 10). Inside the sites, the result of different management options is a different woody production. In the Italian beech forests of the project, the innovative management options could provide higher quality products (Figure 11). In mature forests (Cansiglio and Mongiana) the saw log amount represents 38% and 24% of the total woody products in innovative and in traditional options, respectively.

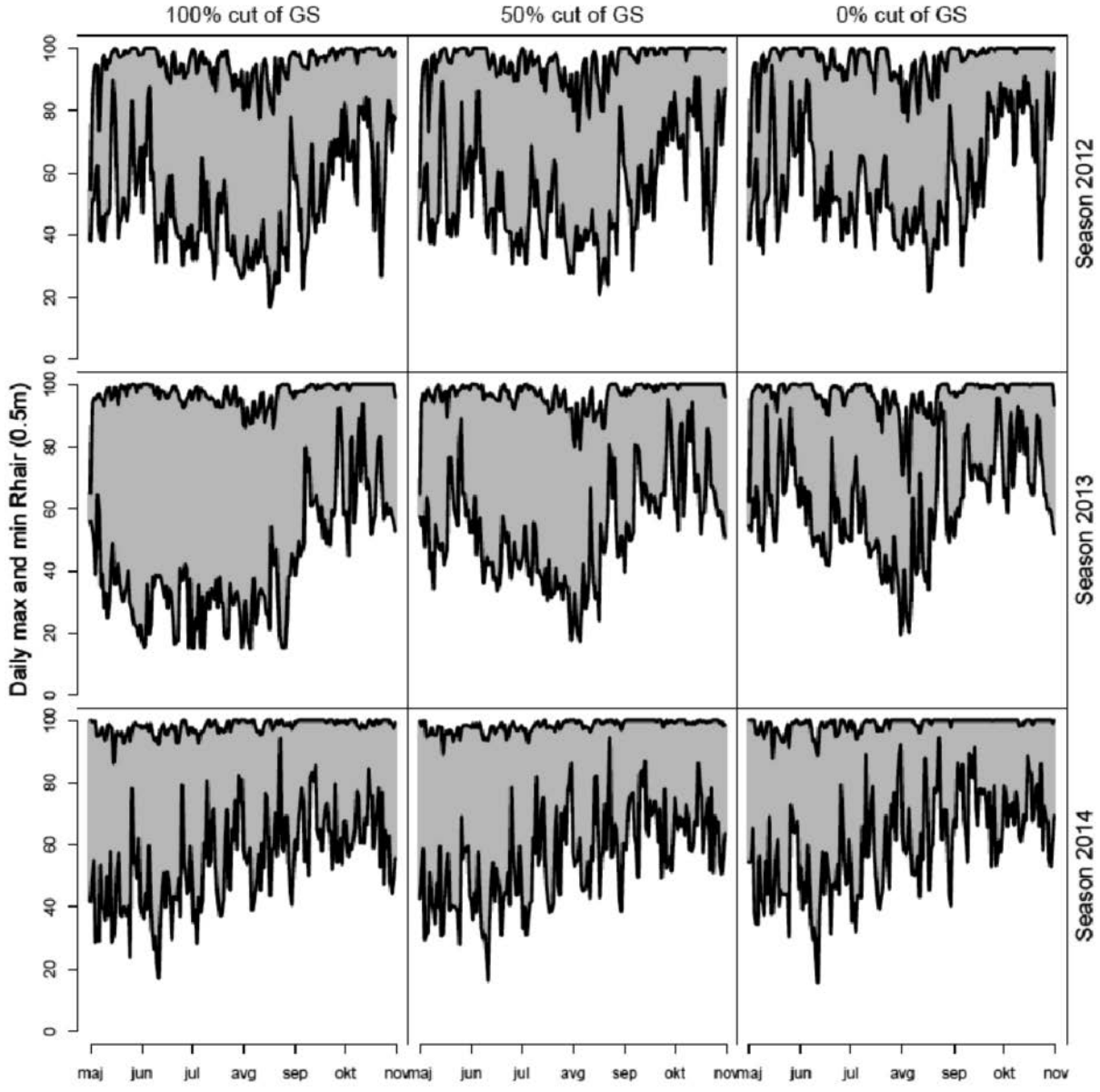

Figure 8. Average daily maximum and minimum air humidity measured in the Slovenian sites during 2012 and 2014 growing seasons.

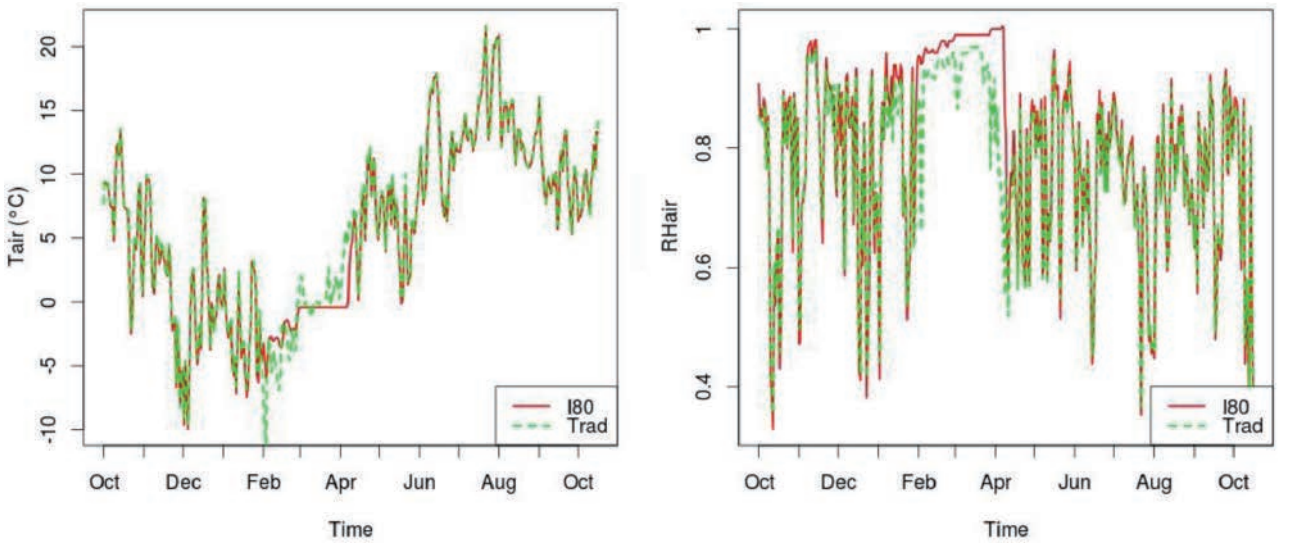

Figure 9. Average air temperature and humidity in Chiarano Forest; red, innovative 80 management option; green, traditional management.

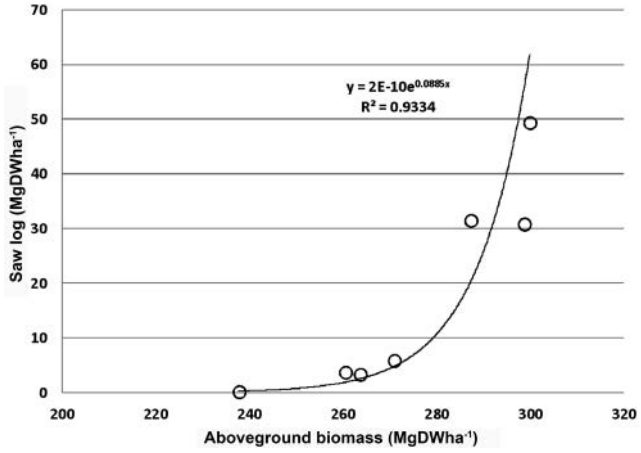

Figure 10. Relation between potential SAW LOG production and aboveground biomass before treatments. Each point represents a management option.

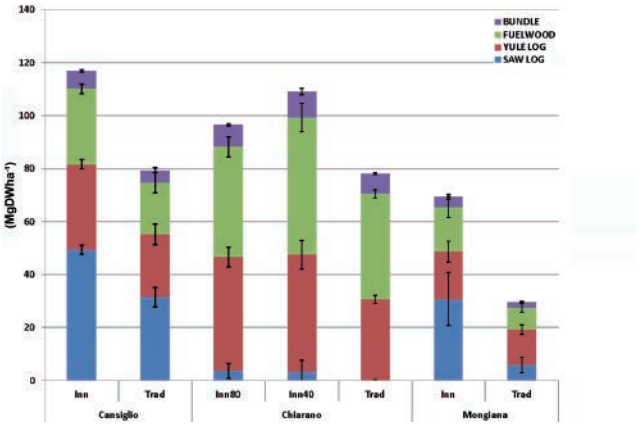

Figure 11. Potential woody products in each site *per* management options.

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Informing people about forest management and field operations

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Forests are an important part of European environment and economy. When well managed, they provide a number of ecosystem services, e.g. clean air and water, wildlife habitats, beautiful scenery, places for recreation and over 5000 wood or non-wood products (MCPFE, 2015). Wood products also play an important role in terms of greenhouse effect mitigation since they store carbon (Penman *et al*., 2003). Wood requires less energy to be extracted, processed and transported than other materials (UNECE) and represents a source of clean energy.

Forestry today is considered more and more marginal, as the focus of modern society in many cases aims towards short-term benefits. The pressures of demands are increasing and without proper tools the basic principles are neglected. Demonstrating the importance and raising general awareness may be achieved only by didactic examples from the praxis.

LIFE+ projects give much importance to the demonstration and dissemination of the achieved results, including publications of manuals, CDs, scientific and popular articles and other editorial products, as we will see later. In the ManFor C.BD project, the first decisive step in communication was to 'talk' with local communities and to provide the right messages to residents and visitors of the test areas - an operation (always needed when it comes to forestry issues), that made smooth flow of the project.

Harvesting operations in managed forests are often perceived by general public as damage to the forest or even as destruction, especially if new methodologies and criteria are introduced. Therefore it is important to communicate to different target groups to dispel the skepticism and communicate promptly through institutional meetings, workshops, meetings with the press, popular articles on newspapers and magazines, with key concepts:

- thinnings are a phase of sustainable forest management, essential for the health and stability of the forests;
- harvesting is one of the essential phases of the forest management cycle, that maintains ecological and economical stability;
- proposed approaches aim to harmonize socio - environmental functions with the productive use of forest resources to benefit local communities. Public would understand and adopt these messages and become a participant, rather than opponent of the process.

The communicating parties should accept and focus on simplicity, the most important principle of communication: a simple, clear and well-explained approach provides the message to everyone, including children.

In case of thinnings, basic concepts have often been misunderstood by non-professionals, and sometimes even by experts from other branches of natural sciences. To maintain clarity we should avoid technical terms and describe them as 'periodical interventions of cutting, that foresters use to adjust the wood density and preserve structure stabile'. Actions are planned by people who are able to interpret the various dynamics of the forests and are provided by experienced personnel.

The communication within the ManFor project also aimed to clarify mistaken assumption, that reintroduction of historically managed forests to natural evolution processes may not involve some short term (unpleasant) consequences, that provide balance and benefits both to the forest stability and society over longer time periods. If such measures would not be taken, short-term benefits would outbalance the long-term forest stability.

We must provide information for the people and whole communities that managed forests require human interventions, apart from old growth reserves, that provide continuous evolution cycle without human interactions. Indeed, if we enjoy today such healthy woods, it is because of the secular, sustainable management approach adopted in the past. Interruption and abandoning such approach would in most cases consequently lead to regression processes, before evident, gradual rehabilitation. Delaying of planned interventions and measures could also inhibit regeneration and close to nature forest processes, that would be hard or even impossible to reach after missed windows of opportunities.

If processes in forests are balanced and tuned, they do not stretch in the contrasts and are in accordance also with other landscape elements.

In view of mitigation of the greenhouse effect and conservation of biodiversity one of the main project objectives was the effective demonstration of multifunctional forest management, in which the key elements are the ability of the forest for CO_2 atmospheric carbon storage, biodiversity management, timber production, *etc*. and then dissemination of results and examples of good practices along other, also different levels. From the technical-scientific to the political decision and the general public message: the entire population, adults and children, as users of the forest and sedentary citizens, scholars and graduate students and by people with different level of qualifications.

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The ManFor C.BD experience has once again highlighted, importance of building an effective communication plan. The bases, in the project, are formed by the local communities from various sites where the project was developed. The population also expects a dialogue with experts and staff who work in nearby field. Through careful work of communication, it is possible to gain the consideration and trust of both involved parties.

What are the most effective means of communication? The ManFor experience shows that the 'dissemination' of the project reaches a significant target, when it varies and is based on different platforms. Not only of sectorial and general publications and, much essential (because exceptionally followed), the worldwide web, but also on various other, sometimes unconventional communication channels.

Under 'dissemination', educational paths were established in stages on every project site. The ManFor C. BD. is accompanied by the 'Life' brand, an EU instrument that is used to finance demonstration projects: we wanted to leave a legacy to the local community and all forest visitors of the test areas, the trails in the woods in which it is explained what is being done, and how, at that particular point.

In nine sites (Tarvisio, Cansiglio, Lorenzago di Cadore, Chiarano, Mongiana, Pennataro, Trnovo, Kočevski Rog, Snežnik), these demonstration routes (Figure 1), trails of forest management, these exceptional instruments of communication 'for all', may now be visited in the forests and will remain there after official conclusion of the ManFor C.BD project, scheduled for spring 2016 (Čater *et al*., 2014a, 2014b, 2014c).

The stages vary from four to six and through illustrative panels explain the key principles of forestry and the development of the European project ManFor C.BD By following the marked path explained on the panels, one can 'touch' the practical implementation of the theories tested by the project in the real forest environment. The panels would help to understand the differences between the traditional and the innovative management approaches of the forest, explain how carbon is quantified, which selected animal indicator species of biodiversity are monitored, and which appropriate management indicators are measured, always using the simple language.

The installation of each path has been accompanied by the official inauguration, an event aimed at involving local authorities and media attention.

A 'Collaborative learning program' for forest practitioners was elaborated in cooperation between Slovenian Forestry Institute and Slovenian Forest service to promote and incorporate new findings into forestry praxis. A visualization tool (software) of forest stands and indicators has also been developed between both Slovenian institutions and University of Ljubljana based on field data from demonstration areas and tested by forest practitioners in field; the tool helps to select appropriate thinning intensity by taking into account timber production, biodiversity and carbon sequestration indicators (Figure 2).

Another example of 'unconventional communication' developed within the project ManFor C.BD is the realization, in collaboration with the State Forestry Corps, an original and courageous editorial initiative, a storybook set in the Cansiglio forest, written and conceived by Paola Favero, commander of the Forest Service of Vittorio Veneto, in collaboration with Bruno de Cinti, technical manager of the Project, and the artist-climber Mauro Lampo, the 'father' of Giauli (Figure 3).

Just the Giauli, creatures half a gnome and a half tree, are the protagonists of the book, which combines science and fantasy and is titled 'The guardians of nature' (Favero *et al*., 2014). The stated

Figure 1. Notice board at Snežnik (left) and Cansiglio sites (right). Courtesy: M. Čater and B. De Cinti.

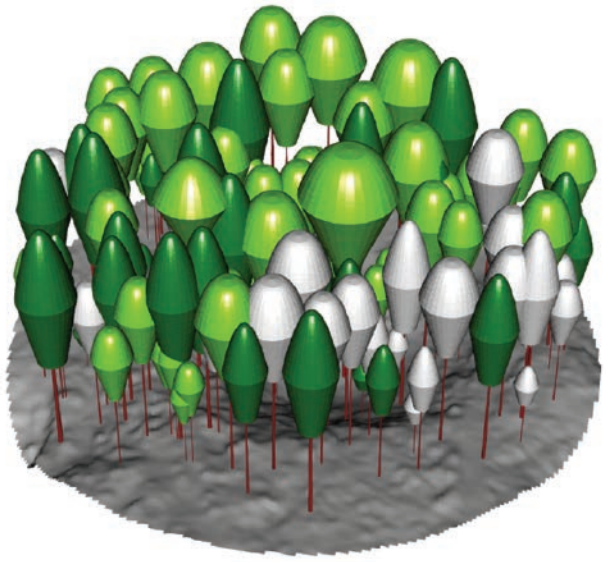

Figure 2. A software visualization tool of forest stands and indicators.

Figure 3. Fairy tale cover 'I custodi della natura'.

objective of the publication is to awake the sense of man's responsibility for the environment, but also to spread the concepts of forestry, carbon sinks, biodiversity. The book has been printed and distributed (for free) as part of Project ManFor C. BD and it is clearly intended for children, in the belief that they can learn more easily the issues described and, why not, also be messengers for the most distracted adults.

Biodiversity conservation, carbon sequestration and wood production objectives were introduced on periodical seminars for teachers in Slovenian kindergartens and schools along with several workshops for children. Events were organized in order to learn and raise awareness on the topics, related to forest ecosystems and natural processes in the forests.

Among other publishing tools that cannot be missed - as seen before - the telematics ones. Since its very beginning, the Project LIFE+ ManFor C.BD had its website (at www.manfor.eu) which has been repeatedly redesigned during the five year period and is regularly updated with news, reports and results.

The site represents a valuable showcase about the project activities that provide clear message to the public. On the home page, there is what may be called the ID of ManFor C.BD Data related to the views of ManFor website, press releases at the end of the project made by website editors, are really astonishing: about 200.000 views in two years, with particular focus during special events, as the inaugurations of Dem paths or for Annual Meetings.

Even more dynamic and easier to create and manage than the website, is the Facebook page of the Project. Social networks became fundamental to keep attention high for every activity, even the scientific one. This section is less concentrated on the theoretic-scientific news spread and more concentrated on news. You can consider it as an agenda of the Project activities.

'Best forest owner award for 2015' with Slovenian Forest Service has been organized at Snežnik demonstration site in Slovenia, where project objectives and results were presented with big interest to the forest owners, forestry practitioners, representatives of Ministry of Agriculture, Forestry and Food and also media.

Another popular tool that has accompanied the project ManFor C.BD from its beginning and has excellent impact results, is the digital newsletter. We published two country-specific periodical newsletters: 'ManFor Novice' and 'ManFor Magazine' (Figure 5), two online magazines that have been regularly realized to provide updated information of the work progress, images, comments and interviews to ManFor team of researchers (to study a forestry issue) or other targeted communities that work in the environmental sector (and have direct link with ManFor activities) (Kutnar, 2013; 2014a, 2014b; Kutnar and Vilhar, 2015; Recanatesi *et al*., 2014, 2015).

The first number of the newsletter, published in 2013, was opened by an exclusive interview to the then Environment Minister Andrea Orlando, who spoke of the importance of forests in terms of the green economy and biodiversity. To achieve (and maintain) such target which includes the institutions, partner organizations and all structures surrounding the project, ManFor Magazine has proved very effective. A similar web magazine has been published in Slovenia: all publications, Italian and Slovenian, in addition to being sent to a selected mailing list, have the advantage of being able to be placed and made available for downloading on the ManFor web site, thus giving a double opportunity of communication.

In spite of worldwide web's significant opportunities, one also should not forget the power of 'traditional' media: printed paper, television and radio broadcasts. To show a message during a show of the most visited channels becomes today more and more important. Within ManFor C.BD, coordinators participated in some shows of the main Italian tv (*Rai*), during main and most reliable private daily news bulletin (*Sky Tg24*), and in several national newspapers: *La Repubblica*, *Corriere della Sera*, *Il Messaggero*, *il Tempo*, just to name a few, and in several local newspapers. Scientific topics are becoming more and more actual in the daily news spread (based on Ansa data), in particular those targeting climate change, biodiversity or ecology. In such context, the timing and the message context have to be well prepared, so the possibilities to be published are bigger. The request to take part in a daily show at Sky Tg24, just to make an example, has been forwarded for March 21st, International Day of Forests. To talk about new ways of woods handling, on that day, immediately looked very

Figure 4. Network of Forest Kindergartens and Schools of Slovenia in Kočevski Rog demo-area (left) and primary school students learning and raising awareness on the topics. Courtesy: M. Rupel.

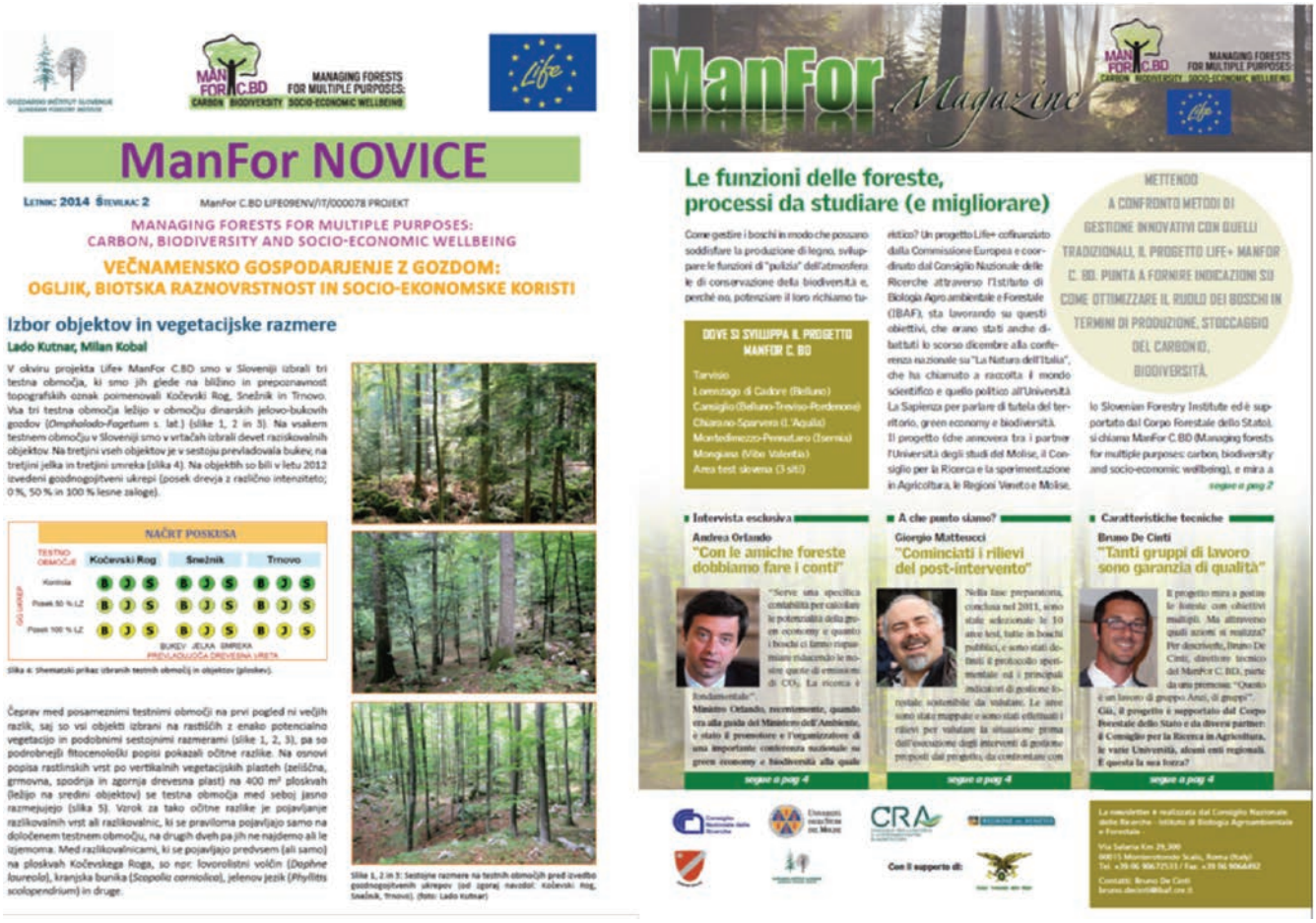

Figure 5. Slovenian and Italian periodical newsletters.

proper to the Editors of Sky Tg24. As well as the concept of carbon absorption from the atmosphere made by forests becomes more and more important every time you talk about greenhouse effect, or climate that keeps on changing. Constantly reading the newspapers, always being informed about not only on the development of the scientific project, but also on the most discussed topics in the world surrounding us, are the essential duties of the communicator. Media are his goals and allies.

We don't have to forget that researchers are, in many cases, the ones who offer a service to newspapers (and not the other), and the community in general. When dealing with environment, forests, biodiversity, as for the group of researchers of the project LIFE + ManFor C.BD, it is essential to send messages and show directions so the relations between man and environment progress in more and more sustainable direction. In such way the benefits for the people and society are obtained and also the key elements of natural heritage are preserved.

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