COST Action ES1203:
Enhancing the resilience capacity of SENSitive mountain FORest ecosystems under environmental change (SENSFOR).

Picture: Francesca Ferranti

Environmental change in sensitive mountain forests: integrating scientific and practical knowledge

Short Term Scientific Mission report

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1. Aim and scope of the report

This report aims at describing the Short Term Scientific Mission (hereafter STSM) carried out by Francesca Ferranti at the Department of Agriculture, Forestry and Food Sciences of the University of Torino. Francesca is a researcher and editor in the fields of forest and nature conservation policy and management. She is the founder of Nature&Society Consultancy in Research and Publishing and she is a PhD candidate at the Open University of the Netherlands.

The STSM here described took place between 1 and 31 October 2015 and it was funded by a grant awarded to Francesca Ferranti by COST Action ES1203: Enhancing the resilience capacity of SENSitive mountain FORest ecosystems under environmental change (SENSFOR). The Action aims at integrating scientific methods and results related to biodiversity conservation and sustainable use related to treeline and sensitive mountain forest ecosystems under climate and land use change. Moreover, the Action is investigating the drivers and the extent of contemporary and future environmental changes in European mountain forests, developing methods for estimating their resilience and for identifying the consequences for society. The STSM consisted in organizing two events aimed at strengthening relations between science and practice in the analysis of the effects of environmental changes on sensitive mountain forests. The first event was a seminar for researchers and PhD students affiliated to the Department of Agriculture, Forestry and Food Sciences of the University of Torino. This event focused on explaining the importance of including social aspects in the study of environmental issues, as well as on training participants to the use of theories and methods for the application of scientific approaches that rely on public participation. The second event consisted in a workshop for forest technicians of Piedmont and Valle d'Aosta regions. Researchers and PhD students were invited also to this second event and they could participate with the role of observers. The workshop aimed at testing the practical validity of scientific indicators developed by the SENSFOR project, with the support of the forest practitioners that joined the event. It also represented an occasion for researchers to experience a practical application of the participation theories and methods explained during the seminar for researchers.

This report starts by showing the steps taken before the start of the STSM and needed to set up the work that later on would be carried out at the Department of Agriculture, Forestry and Food Sciences of the University of Torino. It proceeds by explaining the procedure adopted to organize the two events reported above and the outcomes of these events. Finally, it describes possibilities for future collaborations between Nature&Society and the institutions involved in the STSM of Francesca Ferranti.

2. Purpose of the STSM: overview on objectives and approach adopted

Mountain forests are important ecosystems as they provide ecosystem services like the conservation of endemic or endangered habitats and species, the enhancement of soil stability, the retention of water in the soil and the maintenance of forest-related aesthetic values (Grêt-Regamey et al., 2008; Hoff, 2013). Moreover, they are important indicators of environmental changes as they are strongly affected by climate and land use changes and clearly show the consequences of these changes (Theurillat, and Guisan, 2001; Grace et al. 2002; Gehrig-Fasel et al. 2007). For example, processes of land abandonment and reforestation of formerly treeless areas drive environmental changes affecting mountain forests. These processes, just like those driven by climate change, are most of all visible in treeline ecosystems. Treeline ecosystems (Figure 1) are ecotones, i.e. transitional systems, concentrated around the altitudinal limits of arboreal vegetation (the treeline). The resilience of mountain forests and of treeline ecosystems to environmental changes is a topic of interest for scientific literature (Thompson et al., 2009). The concept of resilience has been defined as the capacity of an ecosystem to return to the original state following a perturbation, maintaining its essential characteristic taxonomic composition, structures, ecosystem functions and process rates (Holling, 1973). The concept of resilience considers the capacity of a system to absorb disturbance and still retain its basic function and structure- and therefore its identity (Walker and Salt, 2006). The resilience of mountain forests is the main focus of the SENSFOR project, which has identified a set of resilience indicators that can be used to univocally define and measure resilience (see section 3.4 of this report).

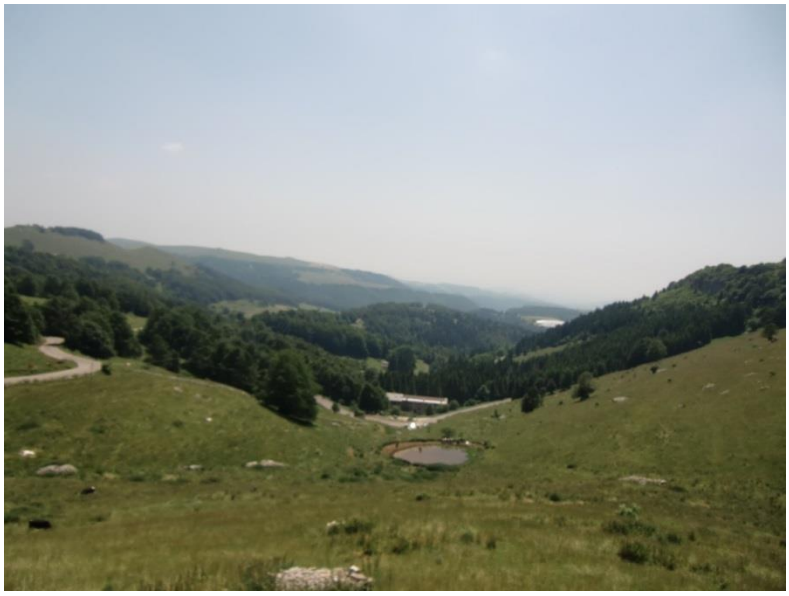

Figure 1: Treeline ecosystem. Picture: Francesca Ferranti

The ecology of mountain forests and the way in which these ecosystems respond to environmental changes are among the main objectives of forest-related scientific efforts in Piedmont region, Italy (Motta and Nola, 2001; Motta and Edouard, 2005; Motta et al., 2006). The northern part of the region is characterized by alpine and sub-alpine climates and hosts characteristic ecosystems, which are particularly sensitive to climate change, as they are gradually moving upwards substituted by species and habitats that were traditionally located at lower altitudes (Motta and Nola, 2001; Carrer et al., 2007). Moreover, land abandonment in Piedmont has relevant effects on forest biodiversity due to tree encroachment of open habitats that are considered important for biodiversity conservation also in international contexts like the European Union (Motta and Nola, 2001). Scientific research projects in the region already focused on identifying and analyzing the effects of drivers of change on mountain and sub-alpine forests (see for example Motta and Nola, 2001; Garbarino et al., 2011; Vacchiano et al., 2012). These studies concerned most of all forest ecology and management-related aspects but they often overlooked social perspectives on changes regarding ecosystems and their services. This STSM aimed at integrating the work on these ecology and management-related aspects carried out at the Department of Agriculture, Forestry and Food Sciences of the University of Torino with information on social perspectives on the effects of climate and land-use change.

Stakeholders' perspectives are important when analyzing the effects of environmental changes for two main reasons. The first reason is that acknowledging these perspectives allows science obtaining a

feedback from practitioners and local actors on the validity of its findings (Fürstenau et al., 2007; Peters et al., 2005). The second reason is that taking into account the opinion of the people involved in the practice of environmental problems allows designing valuable management strategies for ecosystems and their services (Berkes et al., 2000; Hjortsø, 2004). Stakeholders' perspectives are considered relevant also by the SENSFOR project, which, among other things, aims at collecting the knowledge that is necessary to develop and adjust management strategies together with local and regional stakeholders. In light of these considerations, this STSM combined an analysis of existing scientific knowledge on sensitive mountain forests (and in particular the knowledge developed by the SENSFOR project) with the collection of stakeholders' perspectives on scientific data. In doing so, it contributed to accomplish the goals of COST Action ES1203 concerning the combination of new and existing data and the integration of scientific and professional knowledge on environmental change in sensitive mountain forests and treeline ecosystems.

The STSM described in this report was concerned with a twofold objective:

1) Organizing a seminar aimed at training researchers and PhD students affiliated to the Department of Agriculture, Forestry and Food Sciences of the University of Torino in the application of scientific approaches derived from social sciences to the study of environmental phenomena. The focus of the seminar was transferring knowledge on the application of participation strategies and on the valuation of local environmental knowledge. Such training session represented a moment for researchers and PhD students to get familiar with research strategies that the participants to the seminar could apply to other projects run by the Department they are affiliated to. It was designed to respond to the needs of the Department that hosted the STSM to expand researchers' familiarity with social science techniques; but also to pursue the professional goals of the researcher who carried out the STSM who is laying down a carrier path devoted to raising awareness over the importance of social aspects in environmental studies.
2) Organizing a workshop aimed at consulting forest practitioners from Piedmont and Valle d'Aosta regions on the perceived practical validity of forest resilience indicators developed by the SENSFOR project. This interactive event represented an occasion for stakeholders who deal with the everyday effects of environmental changes on mountain forests to increase their knowledge about recently developed scientific findings and discuss their validity among each other and with the researchers that were present at the workshop. This workshop was designed to respond to the needs of the Department that hosted the STSM which organizes periodical meetings with forest stakeholders to pursue its science divulgation goals; but also to allow the SENSFOR team receiving a feedback from local stakeholders on the indicators developed within the SENSFOR project.

In order to achieve these objectives, the STSM was performed during a month stay at the University of Torino. Spending time in close contact with researchers affiliated to the Department of Agriculture, Forestry and Food Sciences was essential for achieving the two objectives. It positively contributed to local researchers' and PhD students' willingness to participate to the seminar and it allowed collecting the information on forest management and planning in Piedmont and Valle d'Aosta regions, which was necessary for organizing the workshop. Establishing personal relations with local researchers provided also the chance to use the researchers' networks of contacts and advertise the workshop for forest technicians outside the academic arena. The most important contacts made thanks to the support of local researchers were those with the Federation of Agriculture and Forest Practitioners of Piedmont and Valle d'Aosta regions.

The STSM was confronted with a difficult challenge, namely that of ensuring a good attendance of the two events organized. It is never easy to get stakeholders from both the scientific and the professional arenas to spare some of their time to join events and meetings that represent additional activities to their usual occupations. Therefore, successfully performing the two events required using specific strategies to reach an adequate audience in terms of number of participants. The strategy included shaping the two events in a light that would attract the interest of the audience. In particular, the seminar for researchers and PhD students was framed in terms of transferring knowledge that could be used by participants to improve the quality of the project proposals they submit for obtaining European funds for research. Also, by

participating to the seminar, PhD students had the chance to accumulate credits which they need to complete their studies (see the European Credit System ECTS). These two factors were enough to ensure a high attendance to the seminar, which was the basis for active discussions during the event. With respect to the workshop for technicians, the key strategy was contacting the Federation of Agriculture and Forest Practitioners of Piedmont and Valle d'Aosta and establishing a collaboration with this institution. The collaboration was aimed at making the workshop an occasion for forest technicians affiliated to the Federation to update their professional curriculum vitae. Participants to the workshop had the chance to have their attendance officially recognized through the system of the CFP (Professional Educational Credits). Forest technicians are obliged to accumulate these credits to guarantee that they are up to date with latest forest related issues (see the system of Professional Educational Credits established by the National Council of the Order of Doctors of Agronomy and Doctors of Forestry and entered into force in 2014- CONAF, 2013). This strategy too proved to be successful for ensure a high attendance to the workshop.

The two events organized within the STSM have been defined by participants as well attended, innovative, exciting and engaging occasions to deal with issues that are not often treated in traditional and conventional seminars and workshops organized at the Department of Agriculture, Forestry and Food Sciences (for example, public participation in scientific processes). This alone demonstrates the effectiveness of the approach adopted during the STSM.

3. Description of the work carried out prior and during the STSM: activities, methods and results

Timetable	Activity
Prior to the STSM	Creating fliers and informative documents for the seminar and the workshop
	Verifying possibilities to allow the participants to the seminar and workshop to have their attendance recognized through official credits
	Advertising the seminar and the workshop among potential participants
	Retrieving information from the SENSFOR team about scientific findings and activities not yet published online
1st week of STSM	Getting acquainted with the researchers affiliated to the Department of Agriculture, Forestry and Food Sciences of the University of Torino
	Analyzing the information retrieved from the SENSFOR team
2nd week of STSM	Organizing and performing the seminar for researchers and PhD students
3rd week of STSM	Organizing and performing the workshop for forest technicians
4th week of STSM	Analyzing the data retrieved during the workshop for forest technicians

Table 1: timeframe of the STSM with an indication of the activities performed

3.1 Creating fliers and informative documents for the seminar and the workshop

Prior to the start of the STSM it was necessary to diffuse the advertising material for the seminar and the workshop. This had to be carried out in time to allow interested people to book their agendas for the events. Preparing the fliers and the informative material required considering the target audience that was likely to attend the two events and focusing the communication strategy on this audience. All the material was prepared in Italian language, as using the native language of the people that were likely to attend the events was considered as a suitable strategy to increase the level of attendance.

The creation of the flier for the seminar dedicated to researchers and PhD students (see Annex 1) involved adapting style and content to the target audience. To appeal the audience, reference were included to theoretical and methodological issues concerning the consideration of social topics in the study of environmental aspects. Such strategy acknowledged the limited experience of the researchers and PhD students with theories and methods inspired from the social sciences. Moreover, in creating the flier attention was put on highlighting the usefulness of the information provided during the seminar for the work of researchers and PhD students for example concerning the drafting of project proposals to receive European funds. The flier made clear that the topics of the seminar could support the improvement of these proposals through the employment of a sound scientific approach to the study of

socio-related issues. This was the case of theories and methods relate to public and stakeholder participation in research activities and on techniques to value local and professional knowledge in scientific processes. The flier mentioned that calls for the provision of European funds for research such as LIFE, INTERREG and HORIZON 2020 often mention the importance of participation and local knowledge. It also suggested that the idea behind the seminar was special insofar as it offered the chance to collect information that had a practical applicability rather than mere theoretical knowledge. Finally, the flier made clear that PhD students could have their attendance to the seminar officially recognized through the collection of study credits that contributed to their doctoral carrier. In order to underline the international charaetc of the event, the flier mentioned that the performance of the seminar was funded by a COST Action.

The flier for the workshop dedicated to forest technicians (Annex 2) observed the same strategy used for the previously described flier concerning the choice of suitable language and style to address the target audience. The flier used grammatically simple phrases to address the main topic of the workshop, namely the comparison of scientific and professional knowledge on the effects of climate and land use change on sensitive mountain forests. The flier made clear that participants to the workshop could express their opinion on the scientific findings divulgated to them during the event. Moreover, the flier addressed the concept of forest resilience to environmental change, explaining its meaning and usefulness. The usefulness consisted in the obtainment of forests able to adapt to environmental changes thanks to the inclusion of this concept to the objectives of forest management. The usefulness of the concept derived also from its application in the preparation of proposals for territorial projects aimed at obtaining European funds. The flier underlined the importance attributed by the SENSFOR project, which offered the funds to organize the workshop, to professional knowledge in the field of forest resilience. SENSFOR gave the chance to forest technicians of having an impact on scientific processes dealing with this concept. This impact was ensured by the involvement of participants in interactive processes like a consultation on the practical validity of forest resilience indicators developed by the SENSFOR project and the delineation of scenarios of development for sensitive mountain forests.

The flier for the workshop was prepared together with an informative sheet that deepened the explanation of the topics that would be treated during the workshop. Creating such informative document was needed because some of the issues that the workshop was going to deal with could have been difficult to understand for people whose profession was not directly linked to scientific research on sensitive mountain forests. Moreover, such document was used to make the Federation of Agriculture and Forest Practitioners of Piedmont and Valle d'Aosta aware of the focus of the workshop and request the inclusion of the workshop in the yearly program of the Federation. This allowed the workshop representing an official meeting that could offer a possibility to participants to accumulate professional credits. Finally, providing an in depth explanation of the topics treated in the workshop was a strategy to increase the interest of eventual participants in joining the event. The informative sheet introduced the concept of forest resilience and explained that the SENSFOR project was in process of developing indicators that describe and measure resilience. It stressed the idea that the workshop aimed at establishing an active communication between science and practice. Moreover, it explained that the workshop had a twofold objective: informing participants on recent scientific discussions over forest resilience and collecting the opinion of practitioners on the issues treated to evaluate their practical validity.

3.2 Verifying possibilities to allow the participants to the seminar and workshop to have their attendance recognized through official credits

This step was part of the strategy to ensure a high attendance of participants to the seminar and the workshop (see section 2 of this report). Two different procedures were adopted for the seminar and the workshop respectively:

1) The administrative office of the Department of Agriculture, Forestry and Food Sciences was contacted to ask whether it was possible to allow PhD students to collect study credits when participating to the seminar. The administrative office approved the proposal but requested that the seminar would be carried out in the afternoon after the end of the doctoral courses.
2) The Federation of Agriculture and Forest Practitioners of Piedmont and Valle d'Aosta was contacted to ask whether the workshop for forest technicians could be included in the yearly list of events patronized by the Federation. This corresponded to allow participants to have their attendance to the workshop recognized through the accumulation of professional credits that they need to update their experience yearly. After examining the informative sheet related to the workshop, the Federation approved the proposal and allowed including its logo (Figure 2) on the workshop's flier.

Figure 2: logo of the Federation of Agriculture and Forest Practitioners of Piedmont and Valle d'Aosta

3.3 Advertising the seminar and the workshop among potential participants

This represented a crucial step for the success of the seminar and the workshop. The advertisement had to be carried out about 1 month before to the start of the STSM, in order to allow people interested in joining the events to book their calendars. The seminar was advertised by distributing the flier to the mailing list of the Department of Agriculture, Forestry and Food Sciences of the University of Torino. Moreover the personal network of contacts of the performer of the STSM and of some of the researchers affiliated to the Department of Agriculture, Forestry and Food Sciences were used to spread the news of the event also outside the Department. The workshop was advertised by contacting several institutions that deal with the practical side of forest management, planning and policy making and by distributing the flyer and the information sheet for the workshop to their administration offices. These institutions were requested to send these documents to their mailing lists. Among the institutions contacted figure the Federation of Agriculture and Forest Practitioners of Piedmont and Valle d'Aosta, the technical office of the regional administration dealing with forest planning, several forest consortia and the offices of a few natural parks.

3.4 Retrieving information from the SENSFOR team about scientific findings and activities not yet published online

Unexpectedly, this represented one of the hardest tasks to accomplish in the STSM. One of the reasons for the complexity of retrieving information from the SENSFOR team was that the STSM was planned for a period that fitted a specific moment of the more general timeframe of the SENSFOR project. According to the planning developed in the proposal, the STSM would have been performed just after the completion of Deliverable 2 and the publication of the Working Group 3 report- and immediately before the drafting of Deliverable 5. Flexibility in this time planning was very low, as information from Deliverable 2 and the report of Working Group 3 were needed to perform the STSM. These documents were supposed to include information on the forest resilience indicators that were to be tested with stakeholders during the STSM. Acknowledging the low level of time flexibility characterizing the STSM as well as the negative consequence that could have derived from failing to respect the time planning, brought the performer of the STSM to commence the retrieval of information from the SENSFOR team before the start of the STSM. Despite this precaution, important challenges were represented by the fact that Deliverable 2 and the report of Working Group 3 were not yet available online nor ready to be shared with the performer of the STSM. Also, some of the representatives of the SENSFOR team showed a rather limited availability to provide information on the forest resilience indicators.

Most of the information retrieved from the SENSFOR team regarded the methods for the selection of the forest resilience indicators, which more specifically were indicators of change for treeline ecosystems. The selection of indicators was based on the Drivers, Pressures, States, Impacts and Responses (DPSIR) framework, a causal framework used to describe the interactions between society and the environment. The components of this framework are. The DPSIR approach allows treeline ecosystems to be studied holistically and in relation to the socio-ecological systems in which they are embedded. Working Group 1 of the SENSFOR project applied this framework by collecting data and information relating to the components (Drivers, Pressures, States, Impacts and Responses) for various case study regions across Europe. Data were collected by distributing a questionnaire to researchers from the case study regions and then analyzed to identify the present state and recent trends in change of ecosystem structures. Results of this analysis (SENSFOR Deliverable 3, 2014) show that "*the main drivers for the treeline ecotone ecosystems in Europe are the climatic and land use changes. […] The major pressures related to climate change are warmer climate in the north and drought in summer in the south, while main pressures related to land use changes are land abandonment and the increased tourist activities. Among the negative impacts of pressures is the increase in tree diseases, the increasing risk of wild fires especially in the south, as well as the decrease of alpine and subalpine grasslands which results in the reduction of forage production and loss of biodiversity. On the other hand, an advance of treeline ecotones and as a consequence a potential increase of forested areas have been widely recognized by the respondents as positive, while in a few study cases (e.g. Spain, Greece and Norway) they have been reported among the strongest threats to the ecotone and its biodiversity. The state of the ecosystem in response to human activities, such as overgrazing by domestic or semi-domestic animals, and intensive tourism provides the majority of problematic conditions. The results of the survey highlight*

the lack of policies, governance or management instruments (mitigation measures; adaptation practices; restoration projects) focused on treeline ecotone ecosystems".

The SENSFOR team provided also a few different lists of indicators of resilience for treeline ecosystems. The team developed these indicators at the SENSFOR meeting held in Krakov and then elaborated them afterwards. These indicators describe and measure the response of mountain forests and treeline ecosystems to environmental impacts caused by climate and land use changes, and are categorized in ecologic, socio-cultural and holistic indicators. Boxes 1, 2 and 3 include examples of the three types of indicators, taken from the lists of indicators provided by the SENSFOR team.

- Seed and pollen production
- Species composition
- Green and non-green biomass
- Decomposer activity
- Food production (meat, fish & game)
- Disturbance factors (forest fires, insect & fungus attacks, windfall)
- Fungal community structure, e.g. mycorrhiza
- Phenology
- Regeneration (e.g. seedling density)
- Berry and mushroom production
- Timber production

Box 1: examples of ecological indicators identified by the SENSFOR project

- Conflicts and disputes
- Land ownership
- Economy (jobs, local entrepreneurships, income, investments, taxation
- Income structure
- Migration (permanent and seasonal population)
- Population structure
- Age structure
- Sex structure
- Health & well-being (objective & subjective)
- Governmental funding & support
- Cultural heritage taken into consideration in management plans
- Traditional knowledge taken into consideration in management plans
- Access for education and healthcare
- Self determination
- Identity
- Possibilities for hunting and gathering, recreational use
- Is participated and collaborative management out there?
- Transparent and non-corrupted governance

Box 2: examples of socio-cultural indicators identified by the SENSFOR project

- Ecological services
- Treeline landscape properties
- «Link indicators» from climate & land use change
- Conflict identification
- Economic compensation
- Degree of participation in land use planning
- Cost of ES

Box 3: examples of holistic resilience indicators identified by the SENSFOR project

Information on the meaning and definition of the indicators was retrievable only for the socio-cultural indicators and it was provided during a Skype call with a representative of the SENSFOR team. This information was essential for the performance of the workshop dedicated to forest technicians, as having a univocal description of the meaning of the indicators allowed deepening the discussion with stakeholders over the practical validity of these indicators. Dealing with indicators whose definition was not exactly communicated and therefore resulted not completely understandable represented a challenge for the testing of the ecological indicators during the workshop.

The definition of the socio-cultural indicators was related to the sustainability of mountain forests. The idea behind the indicators was that a high sustainability of the forest ecosystem would mean a high resilience to environmental changes. Sustainability encompasses a balance among ecologic, social and economic aspects of forest management. In this perspective, the definitions of socio-cultural indicators underlined the importance of considering aspects related to society, traditions, culture, employment and local economy in the approach towards treeline ecosystems. The explanation of the meaning of these indicators recognized that the indicators had the potential of measuring effects of climate and land use change in terms of sustainability of the ecosystem, but that the negative or positive effects on sustainability could also be caused by factors other than climate and land use change (for example policy related issues). Box 2 reports some example of the socio-cultural indicators. Some of these indicators are here defined:

- The definition of the indicator “Conflicts and disputes” was referred to the fact that the existence of conflicts among different uses of forests like nature conservation and tourism could be a sign that the management of the forest does not take all interests into account. It could also mean that the people involved in or affected by the management of the forest are not happy with its management.
- The indicator “Land ownership” was defined through the consideration of eventual changes in the ownership of forests as well as disputes concerning the legal right to use the land.
- The indicator “Migration (permanent and seasonal population)” considers the idea that shifts in the local population could be a sign of land use changes or of a limited access to resources.
- The indicator “Cultural heritage taken into consideration in management plans” regards the fact that forest management and planning should be done in accordance with local people’s traditions and culture.
- The indicator Self determination” related to the ability of local populations to have a say in or determine forest-related decision making processes

The representative of the SENSFOR team who provided the definition of the socio-cultural indicators mentioned that the lists of indicators were not final and could be changed in the future by eliminating or merging some indicators. This researcher perceived the testing of the indicators’ practical validity with forest practitioners as a very important input for the SENSFOR project.

3.5 Getting acquainted with the researchers affiliated to the Department of Agriculture, Forestry and Food Sciences of the University of Torino

The first days of the STSM were dedicated to getting in touch with the colleagues of the Department of Agriculture, Forestry and Food Sciences of the University of Torino. This was essential to ensure a high attendance to the seminar for researchers, as well as to acquire information on the situation of forest planning and management in Piedmont and Valle d'Aosta regions. This information was needed to perform the workshop for forest technicians. This step was carried out both by joining informal meetings and lunches organized by researchers and by setting formal meetings to discuss with researchers the contents of the seminar and the workshop. A first meeting was set with two scientists (Davide Ascoli and Giorgio Vacchiano) who supported the elaboration of the seminar's content. They made clear that in order to attract the attention of the participants and keep their interest alive during the seminar, the event needed to focus on increasing possibilities of obtaining European funds for research through the inclusion of social aspects in project proposals. A second meeting was organized with the Professor who hosted the STSM. (Renzo Motta) During this meeting the content of both the seminar for researchers and the workshop for forest practitioners were discussed. The Professor highlighted that researchers could have been interested in gaining experience on establishing a relation between their scientific activities and the contexts of policy and practice. Instead, with respect to the workshop for forest technicians, it was essential to address the concept of sustainability in combination to the one of forest resilience. A last meeting was organized with a researcher (Roberta Berretti) who had a broad experience with forest technicians from Piedmont and Valle d'Aosta regions, as well as their interests and needs. The meeting treated the performance of the workshop for forest practitioners. The researcher reported that forest technicians could have been very interested in experiencing a comparison between science and practice on the topic of forest resilience, as these stakeholders perceive a broad distance between scientific findings regarding their everyday work and the practical problems they are faced with. Dealing with forest resilience would need explaining this concept thoroughly, from both a scientific and a practical perspective. Talking about climate and land use change could have required making an introduction on expected future trends in these contexts.

3.6 Analyzing the information retrieved from the SENSFOR team

During the first week of the STSM the information provided by the SENSFOR team was analyzed in order to decide what data would be used for preparing the content of the seminar and of the workshop. The methods used to apply the DPSIR framework resulted relevant for preparing the seminar and in particular for transferring information to researchers on how to incorporate social issues in the study of environmental problems. The results of the DPSIR analysis as well as the information collected on the indicators of forest resilience resulted relevant for preparing the content of the workshop for forest technicians. The results of the DPSIR analysis was important for showing to forest technicians the current state of treeline ecosystems in Europe and verify whether the practical experience they held would confirm or contradict the findings of SENSFOR. The information on the indicators was relevant for consulting forest technicians on the practical validity of these indicators and for the elaboration of scenarios of future development of treeline ecosystems in the Alpine region.

3.7 Organizing and performing the seminar for researchers and PhD students

The seminar covered two hours of presentation and it was organized in a room at the Forestry Area of the Department of Agriculture, Forestry and Food Sciences of the University of Torino. About 30 participants joined the workshop About 30% of the participants were PhD students and 70% researchers and professors. Participants were affiliated to the Department of Agriculture, Forestry and Food Sciences of the University of Torino as well as to other institutions like the Department of Life Sciences and System Biology of the same University, Agroinnova (Competence Center for Innovation in the Agro-Environmental Field) and CNR-IMAMOTER (Research Institute of the National Council of Research).

During the seminar, researchers and PhD students were trained to the inclusion of social aspects in the study of environmental phenomena. The presentation started with an introduction on the importance of the relations between society and environment and it presented an holistic approach to the study of environmental themes. This approach did not only consider physical, chemical and biological aspects but also the stakeholders who are involved in or affected by the issue at study, as well as perceptions and interests proper of these stakeholders. This holistic approach included information on the environmental governance framework and it employed the concepts of multilevel and polycentric governance. In a multilevel governance approach, the actors to be considered when studying environmental problems are not only governmental ones but include also non-governmental actors at various levels. In a polycentric governance approach, not only the actors directly connected with the environmental problems at stake are to be considered but also those indirectly connected with the topic and whose actions are embedded in contexts that present relations with the topic at study. Different frameworks for taking social issues into account were presented. These included the Strengths, Weaknesses, Opportunities and Threats (SWOT) , the DPSIR and the multicriteria analyses. The presentation proceeded with showing the importance attributed to the relations between environment and society in European policies like Biodiversity Strategy to 2020, Rural Development, Forest Strategy, Climate and Energy package to 2030 and Resource Efficiency Policy. Participants to the seminar were provided with a text reporting the main documents produced at European level and referring to the policies treated in the seminar. These documents could then be used by researchers and PhD students as future reference for their work. The presentation treated also the main European funds for environmental research (e.g. LIFE and HORIZON) and the importance attributed by these funds to the relations between society and environment. Participants were provided with a set of keywords used in the calls for the provision of European funds and with an explanation of these keywords.

In the second section of the presentation, researchers were trained to use participation approaches in the performance of scientific studies. Participation was explained in terms of public, stakeholders and targeted participation and different intensities of participation were illustrated to them: information, consultation, informed consultation and interactive meetings with stakeholders. The presentation addressed the details for the various forms of participation and explained the methods to apply them. In-depth methods were explained for information of the public; information of policy makers through divulgation of scientific results; performance of stakeholder analyses; preparation of questionnaires for stakeholders; preparation and performance of interview questions; and organization of interactive meetings with stakeholders. Participants to the seminar were invited to attend as observers the workshop for forests technicians that would have been organized in the week after the seminar and which represented an example of the interactive meetings format presented at the seminar. The seminar concluded with a space for questions by

the participants. The majority of questions regarded the provision of examples for the application of the methods explained during the seminar taken from the professional experience accumulated by the performer of the STSM.

3.8 Organizing and performing the workshop for forest technicians

The workshop was organized in a room at the Forestry Area of the Department of Agriculture, Forestry and Food Sciences of the University of Torino. It lasted four hours and 13 forest technicians and 5 researchers (Figure 3) attended it. Some of the technicians were self-employed. Their work consisted in advising forest planning and management in private as well as public forests, in advising management and planning in pastoral areas and in dealing with matters related to forest soils. The other technicians were affiliated to various public institutions among which the Municipality of Torino, the Agricultural and Natural Resources Department of the Valle d'Aosta region (Forest Office) and the Valle Susa Forestry Consortium. The researchers were all affiliated to the Department of Agriculture, Forestry and Food Sciences of the University of Torino.

Figure 3: the forest practitioners joining the workshop. Picture: Francesca Ferranti

During the first part of the workshop, participants attended a presentation (Figure 4) that had the aim of informing them about the goals of the workshop and about the scientific findings of the SENSFOR project, which regarded the topics they would be asked to discuss in the second part of the workshop. The presentation was titled "Mountain forests and environmental changes: a science-practice comparison". It started by explaining the complex relation between science and practice in the forest context and by assessing the reasons for this complexity. The distance between the two realms was examined with respect to causes and possible solutions.

The presentation proceeded by focusing on mountain forests and treeline ecosystems. A description of these ecosystems and of their characteristics was followed by an analysis of the environmental changes that are affecting them, namely climate and land use changes. Participants to the workshop were informed about the results of the SENSFOR project with respect to drivers, pressures, states, impacts and responses related to these changes and their effects on sensitive mountain forests and treeline ecosystems. Participants were then asked to provide insights based on their experience with the effects of climate and land use changes on sensitive mountain forests and treeline ecosystems. The expression of opinions by stakeholders was recorded for analyzing these opinions afterwards.

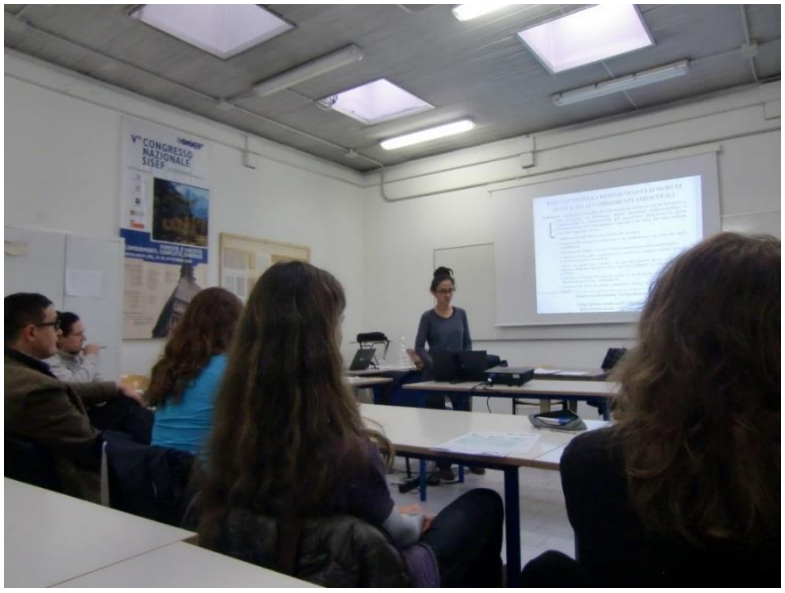

Figure 4: the presentation at the workshop. Picture: Roberta

The experience of the participants with respect to current effects of climate change on forest ecosystems consisted in noticing flowering out of season and a general increase of temperatures which had an effect on trees' growth. However, it was deemed impossible to judge whether this effect on trees' growth was positive. The early attack of pathogens that in 2015 occurred earlier than usual was noted as another effect of temperature growth. However it was not clear to participants whether these effects were due to a general increase in average annual temperature or to inter-annual temperature variation. This is because these effects had been recorded only for a short period of time. People who had been working in the field for longer time than the participants to the workshop might notice a clearer effect of increasing average temperatures. Participants said that the data the Piedmont Regional Agency for Environmental Protection provided them confirm the increase in average annual temperature that was detected by the SENSFOR project. However, technicians mentioned that in their daily work they were not much dealing with data like average temperatures. They rather dealt with data that express the intensity of events. For example, they noticed more intense rainfalls and snowfalls in latest years if compared with the past. Participants mentioned also strong wind events that are often causing important damages to trees. The increase of damages by wind has been verified not only in Piedmont but also in all the Alpine area. They also experienced the concentration of extreme atmospheric events in specific periods of the year. With respect to the effects of increasing temperatures, one of the participants mentioned that it was difficult to discern the effects of this driver from those of land abandonment, as the two causes of change had started to affect the forests of Piedmont in the same years.

With respect to summer drought as an effect of climate change, participants mentioned that in the Alpine region this was a relevant topic only in the current year, while in previous years they rather experienced an increase in precipitations and consequent wetter weather. One of the researchers present at the workshop mentioned that the last dry period with negative effect on trees occurred in 2012 in the Maritime Alps but it did not affect Central Alps and the Piedmont region. The same researcher remembered about a project dealing with reforestation of an area in the Maritime Alps, which failed due to the drought of 2012. One of

the technicians commented this statement by saying that the main reason for this failure must have been the lack of common sense embedded in the performance of the territorial project, showed by the fact that the people that carried out the study decided to plant small trees in a moment of limited rainfall. The researcher replied that models which offer projections of future rainfall did exist, but the results of these models were not available to technicians who carry out territorial projects like that one. It was also mentioned that funds for carrying out reforestation projects are provided for a certain year regardless of the climatic condition of that year and that it was often not possible to carry out reforestation in another year due to the bureaucratic constraints imposed by the public funding system. The discussion concluded with the statement that participants did experienced the occurrence of dry years, but this did not mean that the average doughtiness of the weather has increased. What is sure though, is that practitioners will have to deal with shorter return periods for the occurrence of extreme weather events. This will have to be taken into account in forest planning and management.

With respect to land use changes in the Alps, participants to the workshop did not experience the reduction of pastoral areas and the pasture abandonment recorded by the SENSFOR project. Rather, they experienced a different way of performing pastoral activities compared to the past. Nowadays, animals' grazing is concentrated in areas that are more comfortable to reach and is less frequently interesting those difficult to access areas. This was said to be caused by a change in people's livelihood. In the past, the people that owned pasturelands were the same people that were performing pastoral activities. Nowadays mostly farmers from the lower valleys lead the pastoral activities in the Alps. Farmers are not owning but hiring the lands for their pastoral activities. Carrying out these activities without feelings of ownership and willingness for conservation of the land is typical of these farmers. This was demonstrated by the fact that farmers hire unexperienced foreigners to take the animals to the pastures. The changing style of pastoral activity in the Alps was considered as positive for forests and treeline ecosystems as the grazing pressure is reduced. Forests have the chance to colonize the areas where grazing intensity is low. For example, this was the case of open areas in the forest which are easy to colonize for trees when grazing pressure decreases. However, the change in pastoral activities was considered as negative for biodiversity, as it causes a reduction of the variety of grass species in the areas where animals are concentrated as well as a reduction of biodiversity due to colonization of open areas in the forest by trees and bushes. In addition, the decreasing frequency with which pastures undergo agricultural activities aimed at obtaining forage is negative for the biodiversity of grasslands in the Alps. It was mentioned that the changes in the ways of managing pastoral activities were linked to policy drivers like the Rural Development Plan for Italy and they did not have a relation with climate change.

When asked about the pressure of touristic and recreation activities on sensitive mountain forests, participants mentioned that during the 70's, due to strong snowfalls in the Alps, ski resorts were built in areas where nowadays it is not possible to do winter sports anymore. This is because snowfalls in the areas have drastically reduced. As last, the topic of wood extraction from forests was addressed in the discussion related to land use changes. Participants experienced a change in the typology of forests that was exploited for wood. In particular, due to the increasing use of wood for heating, forests that were abandoned for the last 50 years started to be exploited again for wood in recent times. In Piedmont, this happened especially in beech forests located at low altitudes and less in high altitude forests. This was said to be mainly caused by the effects of the economic crisis that, together with a crisis of the construction sector, triggered a lower demand of softwood and a consequent lower pressure on conifer forests. This phenomenon was seen as something temporary and linked to this specific historical period. Indeed, this return to using wood for heating was perceived as linked to a need to save money in the production of energy and was described as

a reversible trend, which will probably be abandoned once the economic crisis will be over. Participants to the workshop did not feel that the environmental benefits of substituting fossil energy sources with wood had a real effect on current trends of wood utilization. According to forest technicians, this was demonstrated by the fact that many producers and users of wood for heating started using pellets. Pellets are characterized by very low environmental benefits and mostly by economic ones. In the context of wood for heating, forest technicians mentioned that also chipped wood was frequently used. Mostly old reforestation areas of eastern white pine and chestnut that had been created in the 50's or the 60's were exploited to produce this energy source. One of the participants mentioned that a part of the wood that is destined to the energy industry was made available by wind damages in the forests. The need of managing forests to create stable ecosystems which are resilient to extreme wind events was also mentioned as a cause of the production of more wood for energy in larch, spruce and mixed chestnut forests of the Alps.

After the collection of stakeholders' opinions on the state of the art of environmental changes affecting sensitive mountain forests, the workshop proceeded by completing the informative presentation for forest technicians and addressing future trends of climate and land use changes in the Alps. The presentation then zoomed into the main topic of the event, namely the concept of resilience of mountain forests and treeline ecosystems to the environmental changes that are affecting them. Participants were illustrated the importance of the resilience concept for management practices and how forest resilience can be improved through sustainable practices. This explanation considered the idea that a type of forest management which balances ecologic, economic and social factors and interests is likely to allow the development of a forest ecosystem that is resilient to environmental changes. The importance of the forest resilience concept was examined also in relation to the provision of and application for European funds for the performance of territorial projects. Participants showed great interest in this part of the presentation, as their occupations partly dealt with producing proposals for the obtainment of these funds, or with the management of national funds provided through the European financing and co-financing systems. The European policies and related funds addressed in the presentation were the EU Rural Development Policy and the EAFRD; the EU Biodiversity Strategy to 2020 and the LIFE fund; the EU Cohesion Policy 2014-2020 and the INTERREG fund; and the EU Regional Development policy and the ERDF. A coffee brake then interrupted the presentation (Figure 5). During this phase of the workshop, participants had the chance to have informal talks with each other and with the performer of the STSM (Figures 6 and 7), while enjoying a coffee and some snacks offered by the Department of Agriculture, Forestry and Food Sciences of the University of Torino. The organization of a coffee brake just before starting the main phase of stakeholder consultation was tactically designed in order to allow the workshop participants taking a break from the presentation and establishing personal relations with the performer of the STSM as well as among each other.

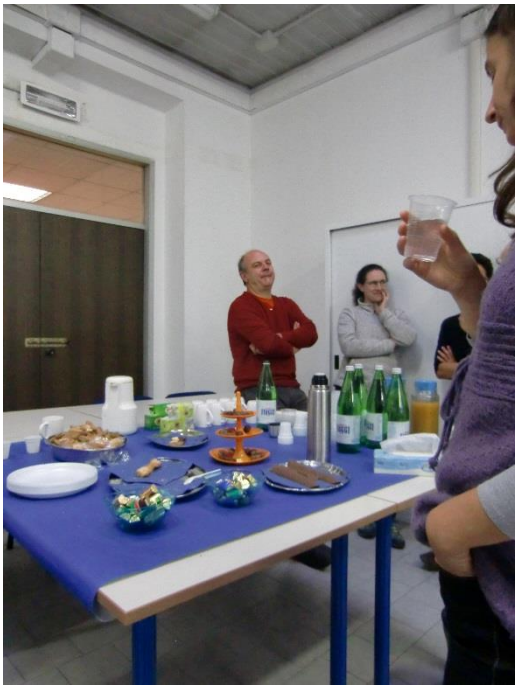

Figure 5: the coffee break. Picture: Francesca ferranti

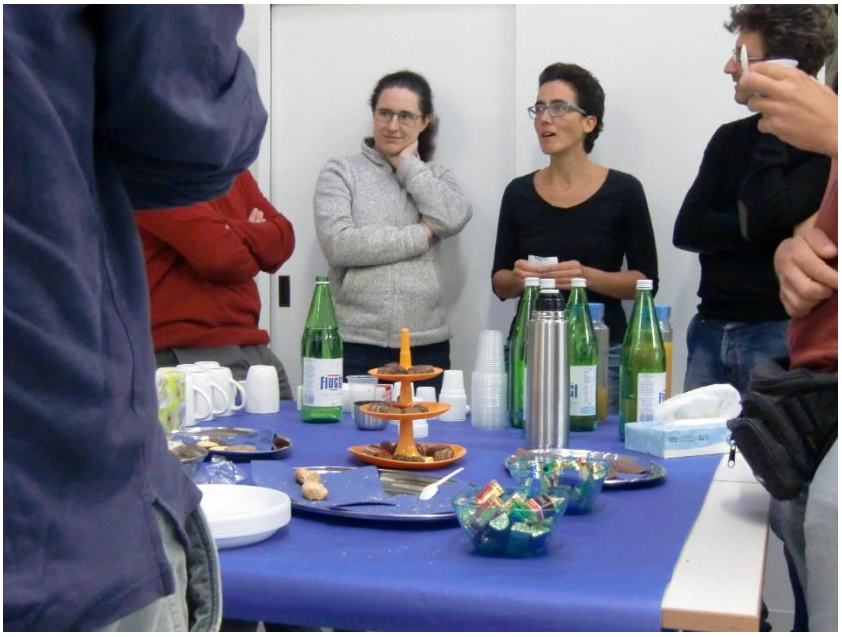

Figure 6: informal talks among participants. Picture: Francesca Ferranti

Figure 7: informal talks among participants. Picture: Francesca Ferranti

After the coffee break, the presentation proceeded with addressing the indicators of forest resilience. This phase of the presentation was essential for allowing an informed consultation of participants in the next sessions of the workshop. Participants were first explained what indicators are and what they are used for. Afterwards they were illustrated the approach used by SENSFOR for identifying indicators of forest resilience and in particular the subdivision between ecological and socio-cultural indicators. A set of selected indicators for both categories was presented to participants together with a short definition. Participants were provided with a document listing the selected indicators and reporting their definition, which served as basis for the following consultation sessions. The presentation ended by informing

participants about possible practical utilizations of the forest resilience indicators, in order to make clear the relevance of these indicators for their daily work.

After the presentation two consultation sessions took place, the first one dedicated to the verification of the practical validity of the forest resilience indicators identified within the SENSFOR project and the second one focused on developing scenarios for future developments of sensitive mountain forests. Both consultation sessions were recorded for analyzing stakeholder opinions afterwards. The first consultation session consisted in distributing a questionnaire to participants that requested them to evaluate the forest resilience indicators based on their practical validity (Figure 8). Afterwards, the audience openly discussed some of the answers to the questionnaire.

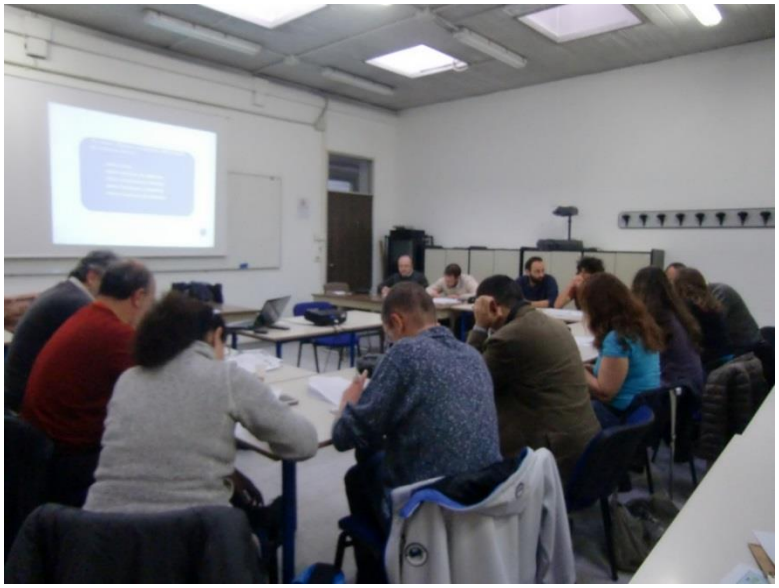

Figure 8: individual consultation of forest technicians on the practical validity of forest resilience indicators. Picture: Francesca Ferranti

The selection of indicators for the consultation was based on the availability of a clear definition for the indicators. Indeed, consulting stakeholders on indicators for which it was impossible to provide a univocal definition was considered not effective. Practical validity was meant in terms of five characteristics of the indicators, which would ensure their applicability on the ground. These characteristics were 1) the clarity of indicators' definition, 2) the easiness of their application, 3) the relevance of the information encompassed in the definition of the indicators for defining forest resilience, 4) the easiness with which the information encompassed in the definition of the indicators could be measured and 5) the affordability of measuring the information encompassed in the definition of the indicators. For each indicator, the questionnaire included"yes" and "no" checkboxes for the five characteristics, which participants could tick in the case in which they perceived the indicators to have (or have not) these characteristics. It was chosen not to include checkboxes labeled "I do not know" to avoid retrieving answers provided with impulsivity and lead respondents to think about their answers in light of the informative sheet they were distributed. For each indicator, a space for comments was provided in the questionnaire. Table 2 shows the data collected through the questionnaire. For each of the characteristics attributable to the indicators, the table shows how many respondents considered the indicator to have the specific characteristic. Despite the choice of not including "I do not know" checkboxes, in a few cases respondents to the questionnaire reported

indefinite answers (they ticked in between the "yes" and "no" checkboxes or they answered by using a question mark) or they did not provide their opinion for some of the indicators and related characteristics. For this reason, it was decided to only present results on sure positive answers regarding the indicators and their characteristics. The text that follows the table reports the comments on the indicators collected through the questionnaires and the results of the discussion on the indicators that took place after the completion of the questionnaires.

Indicator	Clear definition	Easy to apply	Relevance for defining and measuring forest resilience	Easy to measure	Cheap to measure
Species composition	13	12	12	13	10
Phenology	12	3	12	5	1
Timber production	13	9	11	11	7
Berries and mushrooms production	13	4	9	3	1
Disturbance factors	12	8	11	7	5
Conflicts and disputes	7	3	4	2	2
Economy	12	8	7	7	8
Population structure	11	6	5	9	6
Self determination	13	4	5	6	5
Possibilities for hunting, gathering and recreational use	13	7	4	4	3

Table 1: list of indicators used for the consultation of forest practitioners and of the characteristics that make the indicators valid in the practice. For each indicator and each characteristic, the numeric cells report the number of participants that considered an indicator to have a specific characteristic.

The table shows that most of the definitions provided for the indicators were clear to the audience. The definition that was clear to the lowest number of participants to the workshop was that of "Conflicts and disputes". Both in the comments to the questionnaire and in the discussion that followed the completion of the questionnaire, participants brought forward the idea that a clear definition of the indicators is essential for their utilization. This definition should include a judgment on whether specific values of an indicator are positively or negatively affecting forest resilience. For example "Conflicts and disputes" could be considered in a negative or positive light. It could either refer to a lack of sustainability encompassed in a missing balance among different forest-related interests (as suggested in the definition of the indicator provided by the SENSFOR team), or that strong albeit different interests in the forest exist and consequently the management of the forest is a high priority for society. The first definition could point towards a negative

impact of high values of this indicator on forest resilience, while the second could imply a strong positive contribution of social factors to forest resilience. Also “Possibilities for hunting, gathering and recreational” use was addressed in this context. It was mentioned that according to the specific ideological approach used towards forests, frequent hunting activities in the forest could be considered as either having a positive or a negative impact on forests and their resilience. Another indicator that technicians mentioned in this context was “Self determination” which was considered as having a positive impact over forest resilience only in the case in which the local populations involved had a conscious approach towards forest utilization. Moreover, participants highlighted the ambiguity encompassed in this indicator. According to the audience, the definition of this indicator was strongly influenced by policy-related factors that depended on local processes and were not easy to quantify on a national or international scale. An example was made concerning the difference between Italian regions. Alike other regions like Trentino and Toscana, Piedmont region was described as an administrative territory where local populations in mountainous areas are not regarded by policy-makers as important actors who deserve to be empowered.

With respect to the question whether the indicators addressed in the consultation were easy to apply, only “Species composition” scored very high and was considered as easy to apply by a broad portion of the audience. The indicators “Timber production”, “Disturbance factors”, “Economy” and “Possibilities for hunting, gathering and recreational use” were perceived to be easy to apply by a moderate number of participants. One of the respondents who indicated “Disturbance factors” as not easy to apply commented that this indicator was hard to use in private forests, which constitute a high percentage of Piedmont’s forests. Another respondent believed the same indicator to pose the difficulty that meteorological data were difficult to estimate through field activities. The other indicators of the table were perceived as easy to apply only by a low to very low number of respondents. For example, the indicator “Phenology” was perceived as not easy to apply because its measurement needed a broad set of observations repeated in time.

Some of the indicators used for the consultation session were considered relevant for defining and measuring forest resilience by a very high portion of participants. This is the case of “Species composition”, “Phenology”, “Timber production” and “Disturbance factors”. For “Species composition”, comments to the questionnaire confirmed that climate-related factors contributed to select species that might be adapted to future climatic situations. Two indicators (“Berries and mushrooms production” and “Economy”) were perceived to be relevant for defining and measuring forest resilience by a moderate number of participants. Comments to the questionnaire mentioned that “Berries and mushrooms production” is a relevant indicator but that the provision of these goods was not constant. Instead, comments on the indicator “Economy” reported that in the context of the Alps, society hardly considered forest exploitation as a source of income. Only a limited to very limited portion of the interviewees attributed relevance to the rest of the indicators. “Possibilities for hunting, gathering and recreational use” was perceived as an indicator whose relevance is questionable because its effectiveness in defining and measuring forest resilience strongly depends on ideologies embedded in the values attached to the forest. In relation to this, during the discussion that followed the completion of the questionnaires, one of the participants to the workshop mentioned that the relevance of this indicator could be higher if applying a Scandinavian perspective towards forests rather than an Alpine perspective. However, “Possibilities for hunting, gathering and recreational use” was perceived by some participants as a relevant indicator because these activities contribute to create a sense of belonging in mountain areas. One of the respondents who perceived “Population structure” as a relevant indicator commented that in the last years the Alps experienced a very consistent process of depopulation. This indicator though, was perceived also as not relevant for measuring forest resilience in the Alps by some technicians. This is because the population depending on the forest in this area was very small. “Conflicts and disputes” was considered as not relevant to define and measure forest resilience due to the fact that this indicator was linked to social processes which are mutable. “Self determination” was deemed as an indicator which is not very relevant to define and measure forest resilience because it was too much linked to regulations and policy making.

With respect to the easiness of measuring the information included in the definition of the indicators, only "Species composition" and "Timber production" were considered as characterized by this feature by a high number of interviewees. Forest practitioners commented that "Species composition" can be easily measured through Aerial Infrared Thermography technology. This is the indicator which was attributed the highest overall practical validity for defining and measuring forest resilience because it well summarizes the effects of climate change and management choices characterizing different approaches to the exploitation of the forest. Management choices in mountainous areas have varied consistently in the last centuries and have affected the composition of the species, for example causing the alternation of pastures and forests in some zones. Also the construction of new roads that made some forested areas accessible influenced management choices to the point that some forests, traditionally unexploited, recently started to be managed again. Participants reported that by applying the "Species composition" indicator, it was possible to notice that on the one side, some species that were traditionally located at lower altitudes are gradually moving upwards, but at the same time, other species are following the opposite trend. This is for example the case of silver fir, Scotch pine, Swiss pine and beech, which nowadays can be found at lower altitudes than in the past. Participants to the workshop described this phenomenon as odd because climate change should hinder the diffusion of this species at low altitudes. They claimed that they expected science to be able to offer insights on this topic, which instead remained an unresolved question. In general, participants deemed anthropic influence to have more drastic effects on forest composition than climate change, both in terms of speed and extent of change. Forest technicians mentioned that climate change and land use change were having a combined effect on species' composition and that these effects were triggering sudden modifications in forest composition. Forest technicians described the current historical period as a propitious moment for experiencing and studying changes in forest composition, as anthropic pressure on forests has diminished considerably after World War 2 together with the decreasing interest towards the creation of uniform forest structures. These phenomena made it possible for the changes in species composition to occur in a more natural way and to be more easily understandable. According to a forest practitioner, rather than the inability of some species to adapt to climate change, the combined effect of climate and land use changes was the most realistic explanation to the dislocation of species at different altitudes. He mentioned that in order to use the "Species composition" indicator to talk about climate change, this indicator should have not been applied to all forested areas but only to transitional areas (like treeline ecosystems) where the composition of tree species was varying at a considerable pace and where less anthropic interference took place.

According to participants, "Timber production" was an indicator that could be easily measured but only in forests which were managed and accessible. Moreover, measuring the production of timber was deemed possible only in a forest management context where forest planning played an important role. A consistent number of participants to the workshop considered the indicator "Timber production" as valid in the practice. However, participants mentioned that if such indicator was to be used, its definition needed to be specified. A technician said that attention should be directed at which parameters were used to measure the timber produced by a forest. For example, current wood increment was considered a rather complex parameter to measure in areas like Piedmont where a chronological register of wood production covering the last 40-50 years was not existing. In some areas indeed, forest planning was performed for some years and then this activity was abandoned for a period. Also wood increment was defined as a parameter that could be used, but only taking into account the historical period in which the measurement was made. For example, measuring wood increments in the current historical period would give high values because during World War II forests in Piedmont had been intensively exploited and they had undergone strong land abandonment processes in the years after the war. Nowadays many of these forests are being newly exploited and measuring current wood increments in these areas could provide results near to 4 or 5 m^3. This result is to consider as unrealistic and as affected by the management history of these forests. According to the participants of the workshop, other parameters could be needed to define an indicator like "Timber production", possibly parameters which are not strictly linked to dendrometry. For example, forest technicians mentioned that it could have been interesting to evaluate "Timber production" through remote sensing, not only in a single forest patch but also on a broad territorial scale. Forest technicians

agreed that similar parameters and the methods to apply them should be determined in the scientific arena and then the tools to measure the parameters could be passed on to practitioners who would carry out the actual measurement on the ground.

"Disturbance factors" and "Population structure" were deemed as easy to measure by a moderate number of interviewees. One of the interviewees who believed "Disturbance factors" to be not easy to measure commented that in order to measure this indicator he perceived the need to set up specific and detailed research projects. Among those that considered "Disturbance factors" as easily measurable referred through remote sensing, one of the respondents mentioned that much depended on the type of disturbance to assess. For example, the effects of forest fires was defined as measurable though Aerial Infrared Thermography technology. Wind damages were described as easy to detect in forests where forest planning and management were carried out, but information on these types of damages was only available for public forests. Damages from floods were deemed as easy to determine by using the reports created by public administrations after the events. The main problems were pathogen attacks. Besides rare cases like latest attacks from larch budworms that were so consistent to be easily visible, the effects of attacks from other types of pathogens like root rot were reported as complex to detect. The other indicators were perceived as being easy to measure only by a low to very low number of respondents. For example, "Economy" was not considered an easy indicator to measure, as characteristics of the market in mountainous areas were very varied. "Phenology" required a high degree of experience by the personnel employed in its measurement. Despite being considered less easy to measure than most of the other indicators, "Phenology" scored rather high with respect to overall practical validity. Participants to the workshop referred to this indicator when mentioning that, compared to the past, flowering of some tree species was starting to occur earlier in the year. They also mentioned that the gradual variation of leafs' color in the fall was being influenced by climate change to the extent that the lower temperatures characterizing the mentioned season in latest years prevented leafs from turning into bright shades. However, this indicator was considered to be more complex to apply and measure than the "Species composition" indicator. This was particularly due to the burden encompassed in the technical measurement of phenological aspects carried out by personnel in the forest and to the limited time available to forest technicians for carrying out these measurements. If this is indicator could have been measured though Aerial Infrared Thermography technology though, its application would have become much simpler. Finally, the majority of respondents perceived "Possibilities for hunting, gathering and recreational use" as not easy to measure, because the possibility of organizing a system in the Alps for the control of these activities and their outcomes did not exist.

Finally, when asked if the information included in the definition of the indicators was cheap to measure, a consistent number of respondents gave a negative or uncertain answer or did not reply at all. Only "Species composition", "Timber production" and "Economy" were perceived as cheap to measure by a moderate number of interviewees. "Timber production" was deemed cheap to measure by technicians using the data provided by institutions like the Chamber of Commerce. The other indicators were perceived as cheap to measure only by a limited or very limited part of the audience.

A result that emerges from the analysis of the table is that a smaller number of participants recognized the overall practical validity of socio-cultural indicators compared to the ecological indicators. During the discussion of the indicators that followed the completion of the questionnaire, the performer of the workshop suggested that this could be due to the fact that the participants of the workshop were expert of ecologic and technical issues regarding forest management and had less experience with socio-related topics. However, the audience disproved this statement and referred that also socio-cultural aspects made part of the knowledge base participants were relying on in their daily work. For example, the PEFC system, which they regularly dealt with in their professional activities, considers socio-cultural factors. Participants perceived that the main problem with the socio-cultural indicators discussed during the workshop was that it was not possible to measure them in concrete and reliable terms. The audience defined these indicators as interesting but impossible to apply. An observation was made with respect to the ideology behind the

selection and definition of some of the indicators proposed- and in particular that of the socio-cultural indicators. It was noted that a perspective on forests and their value that is typically Scandinavian (and has little application in contexts like the Mediterranean forests and the Alps) affected some of the indicators discussed in the workshop, such as “Conflicts and disputes” and “Possibilities for hunting, gathering and recreational use”. This last indicator for example was defined as valid for forest areas where hunting is a frequent and accepted activity, while it was deemed as not valid where environmental forest values are a higher priority.

Final comments on the indicators regarded few recommendations directed to the SENSFOR team which is working on the indicators. These comments were aimed at improving the practical validity of the forest resilience indicators:

1) The definition of the indicators should include threshold values which can be used also to define whether certain values assumed by the indicators have positive or negative impacts on forest resilience.
2) Indicators should be defined through parameters which are measurable through remote sensing technology rather than through the engagement of forest practitioners, as the measuring process is time consuming.
3) The number of indicators chosen to define and measure forest resilience should not exceed 10 as it is not realistic in terms of time and economic resources to expect forest practitioners to work with a higher number of indicators.

The second consultation session consisted in involving the participants to the workshop in the creation of scenarios of future development for sensitive mountain forests. The scenarios aimed at linking some of the indicators that were the focus of the questionnaire previously distributed to the forest practitioners. To carry out this consultation session, the audience was divided into groups of 2 to 5 persons. The groups were distributed a second questionnaire made of open-ended questions that members of each group were asked to fill in jointly, after discussing the answers to the questions within the group (see Figures 8 and 9). The questionnaire regarded the description of the current state of a mountain forest according to general parameters and forest resilience indicators specified in the questions, as well as the description of an imaginary scenario of development for mountain forests related to the year 2100. The questionnaire asked the respondents to choose the forest typology they were more familiar with as well to answer the questions by relying on both verified information for that forest type and imaginary data that would render realistic the situation they were describing. The description of the current state and of future developments of mountain forests encompassed the following factors: altitude of the location, yearly precipitations, ownership type, species composition and altitudinal distribution of the species, timber produced, disturbances influencing the forest and consequent damages to the forest, demography of the local population, percentage of men and women in the local population, percentage of local population employed in forest-related activities, utilization of forest products, possibilities to hunt and possibilities for recreation.

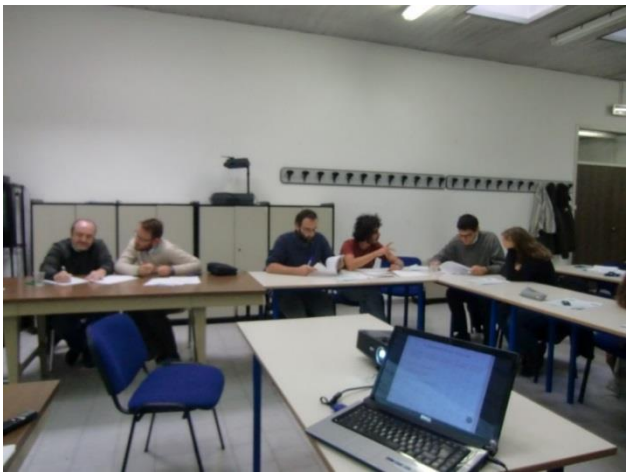

Figure 8: individual consultation of forest technicians over the practical validity of forest resilience indicators. Picture: Francesca Ferranti

Figure 9: individual consultation of forest technicians over the practical validity of forest resilience indicators. Picture: Francesca Ferranti

The four groups that the audience was divided in described the following situations characterizing current state and future development of the selected typologies of mountain forests.

1) Group 1 chose a mountain location with an average altitude of 1800 m.a.s.l. characterized by precipitations of about 1000 mm/year. The typology of forest chosen for the exercise was a mixed forest composed by spruce, larch, Swiss pine and various deciduous species. Timber was produced from spruce and larch. Strong winds affected the forest, which was also undergoing attacks of root rot from Heterobasidion. These two disturbance factors caused limited damages as less than 10% of the forest surface was affected. The Group mentioned also anthropic activities among the disturbance factors. The local population was very small and slightly increased in the seasons that attracted mountain tourism. The population was made up of 60% women. The main economic activity carried out in the area was wood production but also tourism and recreation played a role due to the existing ski resorts and to the presence of visitors who performed downhill and hiking. The 2100 scenario consisted in a forest composed by the same species though with a different proportion among species (increase in the amount of deciduous species). Moreover, the Group reported a possible invasion by Scots pine. Wood production in 2100 would still be focused on the exploitation of spruce and larch. The forest would experience the same types of damages from disturbance factors but anthropic pressure would be lower because many activities would move towards higher altitudes. Demography of the local population would stay unvaried, as would the performance of economic activities in the area (with the sole difference that some activities would be performed at higher altitudes).
2) Group 2 chose a mountain location at 1000-1800 m.a.s.l. with precipitations of about 900 mm/year. The forest was publicly owned and composed by a mix of deciduous species (1000-1500 m), larch (1200-1800), Scots pine (1200-1800 m) and Swiss pine (1800 m). The forest was exploited for wood and the amount of timber extracted was 500 m3/year for larch wood, 50 m3/year for Scots pine wood and 50 m3/year for hard wood. Limited damages from disturbance factors like wind and avalanches affected the forest. The local population was small and distributed with a low density on the territory. The population was characterized by demographic fall and aging. Women made up 51% of the population. About 2% of the population was employed in occupations related to the forest (lumberjacks, carpenters, nurserymen and gamekeepers). Some of these workers were affiliated to the regional administration. Mushrooms' collection and hunting (roe deer, chamois, wild boar, mouflon, and hare) were carried out in the forest and various touristic activities were performed in the area. The 2100 scenario consisted in a forest composed by the same species: a mix of deciduous species (1000-1800 m), larch (1500-1800 m), Scots pine (1200-1800 m)

and Swiss pine (1500-1800 m). Silver fir was foreseen to be also part of the species composition (1000-1800 m). The exploitation of the forest would produce lower amounts of timber. Disturbances to the forest would include also attacks from exotic pathogens which would have a medium-level impact. The local population would become multiethnic and the percentage of women would raise to 52%. The percentage of the population employed in forest-related occupations would stay unvaried but new types of occupations would be created in relation to ecotourism. Touristic activities would increase their incidence on the territory. Mushrooms would become one the main forest products and hunting would not be allowed anymore.

3) Group 3 chose a location between 400 and 700 m.a.s.l., with precipitations of 1000 mm/year. The ownership of the area was 90% public and 10% private. The forest was composed of an oak and hornbeam mix together with noble hardwood species, chestnut and black locust tree. The main species exploited for wood were hornbeam and chestnut (coppice management). Summer droughts affected the forest and damages from insects (moths) on the oak trees verified, which were causing falling of the leafs and low tree vitality. The local population was made up of about 1000 inhabitants. Part of this population was employed in a natural park that had been designated in the area. The main products derived from the forest were mushrooms and meat (wild boar hunting). Tourism was carried out especially in the form of hiking, mountain biking and horse as well as donkey riding. The 2100 scenario consisted in a dominance of maple, cherry, oak and hornbeam species. The wood produced would be mainly used for energy. In some areas, the wood extracted would come from hydrological protection areas. Disturbances to the forest would result in damages of low and medium extent. Demography would stay constant. Low to medium percentages of the population would be employed in occupations related to the forest such as forest technicians and forest planners. Non-wood forest products like mushrooms and meat would still be provided by the forest. Wild boar hunting would be a growing activity. Tourism would be intensified.
4) Group 4 chose a mountain location between 1200 and 1350 m, characterized by precipitations of about 780 mm/year. The forest was publicly owned and composed by Scots pine. Wood production was about 80 m^3/ha and come from trees damaged by wind and snow. Wood was used for energy purposes as well as for carpentry works. Damages from fire as well as from wind and snow affected the forest and would impact about 40% of the biomass. The local population was located in the valley and composed by 25 people (30% were women). 5% of the population was employed in occupations related to the forest and in particular linked to the technical management of the forest. The area was included in a Natura 20000 site where hunting activity was allowed. Hiking tourism was performed in the area. The 2100 scenario consisted in a more varied species composition: 70% Scots pine, 25% broadleaves and 5% larch. The wood extracted from the forest would derive from the increased damages caused by wind and snow. In the case of pinewood, that would represent 60% of the wood extracted. Forest management would start to take place for broadleaves like birch and ash. Hardwood would represent 40% of the wood extracted. With respect to damages to the forest caused by forest disturbances, the amount of split trees would increase, damages from fire would decrease and damages from wind would stay unvaried. Forests would also be interested by pathogens attacks and hydric stresses. Local population would slightly decrease while percentage of men and women would stay the same. The level of employment in occupations related to the forest would decrease. The use of wood for energy purposes would increase. Hunting would most likely be prohibited and tourism would decrease in unmanaged paths, but increase along managed paths.

3.9 Analyzing the data retrieved during the workshop for forest technicians

During the last week of STSM, the questionnaire filled in by the participants to the workshop as well as the recordings made during stakeholders' consultations were analyzed to produce the current report.

4. Future collaboration with hosting institution

Future collaborations between Nature&Society, the Department of Agriculture, Forestry and Food Sciences of the University of Torino and the Federation of Agriculture and Forest Practitioners of Piedmont and Valle d'Aosta were discussed after the performance of the two events described in this report. These collaborations could consist in the setting up of a calendar of periodical occasions to meet, which would involve practitioners and scientists dealing with forest related issues. These meetings could treat different topics of interest for the two audiences and support the knowledge sharing between science and practice.

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Annex 1: flier of the seminar for researchers and PhD students

SensFor

13 Ottobre 2015, ore 13.00-14.30

Università di Torino- Dipartimento di Scienze Agrarie, Forestali e Alimentari
Largo Paolo Braccini 2, Grugliasco (TO)

SEMINARIO PER DOTTORANDI E RICERCATORI

QUESTIONI AMBIENTALI E TEMI SOCIALI: PARTECIPAZIONE E RIVALUTAZIONE DELLA CONOSCENZA LOCALE

(accumulazione di Crediti Formativi Universitari- CFU)

I temi sociali sono sempre più importanti nella gestione di questioni ambientali. Con sempre maggior frequenza i **programmi di fondi europei** come INTERREG, LIFE e HORIZON 2020 pongono attenzione sul **binomio ambiente e società** che sono visti come ambiti interconnessi da studiare in concomitanza per coglierne le molteplici relazioni. La scienza spesso fatica ad **incorporare i fattori sociali nell'analisi di problemi ambientali** e di questo risentono **proposte di progetti** che mirano a ottenere fondi europei. Durante il seminario qui pubblicizzato, dottorandi e ricercatori impegnati nello studio di temi ambientali prenderanno familiarità con tecniche indirizzate a incorporare i fattori sociali in proposte di progetti di ricerca. In particolare, ai partecipanti saranno esposti metodi scientifico-qualitativi per consultare gli stakeholder del territorio e rivalutare le conoscenze ed esperienze proprie di questi attori nelle loro attività di ricerca. Questo permetterà a ricercatori e dottorandi di rispondere alle richieste dei programmi di fondi europei su temi di **partecipazione, consultazione pubblica e rivalutazione della conoscenza locale.** Il seminario sarà organizzato da *Nature&Society Consultancy in Research and Publishing* nell'ambito del progetto europeo SENSFOR (COST Action ES1203).

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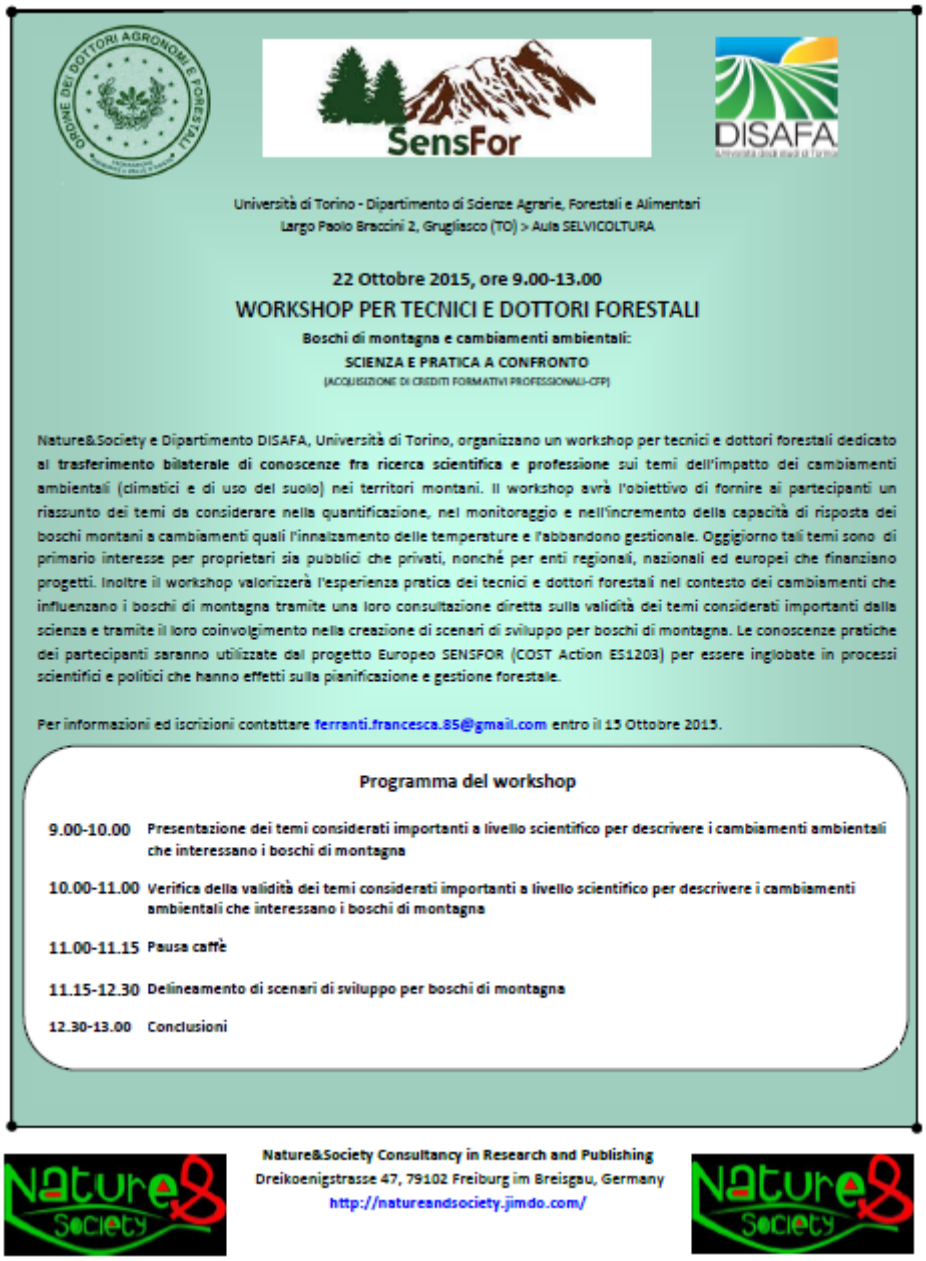
Annex 2: flier of the workshop for forest technicians



Annex 3: confirmation by the hosting institution of successful execution of the STSM

UNIVERSITA' DEGLI STUDI DI TORINO
DISAFA
DIPARTIMENTO DI SCIENZE AGRARIE, FORESTALI E ALIMENTARI
Via Leonardo da Vinci, 44 – 10095 Grugliasco (TO) IT

To whom it may concern

I undersigned Renzo Motta confirm that Francesca Ferranti has been successfully carrying out her Short Term Scientific Mission funded by COST Action ES1203: Enhancing the resilience capacity of SENSitive mountain FORest ecosystems under environmental change (SENSFOR). During her staying at the Department of Agriculture, Forestry and Food Sciences of the University of Torino (1 to 31 October 2015), Francesca performed:

- a seminar for researchers where she trained local researchers and PhD students to the inclusion of social topics in the study of environmental issues;
- a workshop for forest technicians where she provided information to participants on recent scientific findings about the effects of land use and climate change on mountain forest ecosystems, as well as she consulted participants on the validity of the forest resilience indicators identified within the SENSFOR project.

For this reason, I consider the Mission of Francesca Ferranti accomplished.

Best Regards

Signed by: Renzo Motta
Title: Full Professor of Silviculture
Contact Details: renzo.motta@unito.it

Date of Signature 02.11.2015