Project acronym: WoodForCE

Project title: Wood formation and carbon balance in forest species growing in cold environments

Project leader: Alessio Giovannelli, Consiglio Nazionale Ricerche (CNR), Italy

Discipline: Earth Sciences & Environment: Ecosystems & Biodiversity

Station(s): Hyytiälä Forest Research Station (SMEAR II) (Finland)

The proposal is based on the results obtained in the previously granted INTERACT project 'WoodForCE' (2019) and it is proposed to extend the findings by further samplings and analyses. The proposed approach is supposed to provide new insights filling the gap of knowledge on the nexus between cambium phenology, wood formation and carbon balance. These efforts are necessary to clarify not only the biological process responsible for timber quality but also to give crucial information about the vulnerability of the cold environments. The understanding of mechanisms involved in the response of conifers growing in cold environments to warming and drought, represents a key step to forecast forest productivity and health of boreal ecosystems in next centuries. In this context, the general aim of the WoodForce II project was to describe the effects of warming and soil humidity/site fertility on the carbon balance, stem growth and wood quality in Pinus sylvestris. In the previous project we studied the effects of site fertility and soil humidity on the activity of cambium during the growth to dormancy transition phase. On the basis of our results we observed that the timining of the earlywood-latewood transition was delayed (in average fifteen days) in trees growing at dry site in comparison to those growing at wet ones. Thus at DOY 199, only earlywood-like cells were observed within the wood forming-rings whilst 3-4 latewood-like cells were already formed in the wet site. Sucrose and RWC mirrored the pattern of cambium activity being higher in dry sites than wet ones during earlywood formation while no differences were recorded for starch content in phloem and xylem. Although our results described the dynamic of cambial dormancy during earlywood to latewood transition phase in Pinus sylvestris in two contrasting sites, we did not have full information about the features of woody ring formed during the growing season 2019 yet. In fact after mitosis, cambial derivative cells differentiate into fibre tracheids through multistep processes as cell expansion, cell wall apposition, cell death and lignification. Each phase has its own rate and duration and the final ring features can be deciphered only at the end of the lignification process (approximately in winter of the following year). Thus the collection of woody rings in winter 2020 give us the possibility to define the ring

features formed during 2019. On each of woody sample we could verify if the differences in the timing of cambium activity in wet and dry sites can be related to differences in ring width, xylem morphology, wood density and hydraulic related parameters. Furthermore the collection of the woody stems by felling trees will permit us to estimate the relationship between environmental parameters and xylem morphology during all the tree life span extending our findings beyond the last ten years.

As the effect of soil humidity/class fertility were evident on cambium phenology and xylem differentiation in Pinus sylvestris growing at SMEAR II, we hypothesised that warming could exacerbate the difference in the cambium phenology and timing of xylem cell differentiation between trees growing in dry/low fertility site and wet/high fertility ones. To verify this hypothesis we used a dendrochronological approach combined with biochemical analyses with the aim to analyse ring width, basal density as well as cellulose and lignin content along the radial profile of woody slices collected from trees growing in dry/low fertility and wet/high fertility sites.

Objectives: The aim is to describe the acclimation strategies occurred during growth to dormancy transition phase to warming in Pinus sylvestris (porous ring wood) and how these can influence stem growth, xylem morphology and wood density. We would verify the hypothesis that: 1) the lengthening of the growing season due to warming induce a longer growth to dormancy transition phase of the cambium resulting in higher amount of structural carbon fixed in the latewood cells and an increase of latewood density; 2) the increase of the latewood density decrease the hydraulic conductivity of the latewood. On the basis of these aims we propose to analyse tree growth climate-relations by dendrochronological approach in order to correlate xylem cell morphology to meteorological parameters at least during a 30 years long period. The AAVA database will be used for meteorological data.

The research team was composed of: Giovannelli Alessio (Team leader) and Maria Laura Traversi of the CNR_IRET (already involved in the previous INTERACT granted project ‘WoodForCE’); Claudia Cocozza Associated Professor at the University of Florence, Dept of Agriculture, food, Environment and Forestry with a background in dendrochemistry and dendrochronology; Silvia Traversari with aPost Doc position at the Scuola Superiore Sant’Anna of Pisa with experience in sugar metabolisms and cell wall components analyses.