Abstract of the Master Thesis of:

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ELABORATION OF DENDROCHRONOLOGICAL CURVES (*Larix decidua* Mill.) AND DENDROCLIMATICAL ANALYSIS FROM THE LITTLE ICE AGE TO THE PRESENT ON THE NORTHERN SLOPE OF THE PRESANELLA GROUP (RHAETIAN ALPS)

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INTRODUCTION

The Adamello – Presanella group is an important area for both climatological and glaciological aspects. The group is the southernmost massif of the Rethic Alps area and it holds the biggest glacier of the entire Central Alps: the Adamello Glacier (Baroni & Carton, 1996). In order to reconstruct the climatic events which occurred in this delicate sector of Italian Alps, dendrochronology is a science that gives a valid contribution to characterizing the clime of the past (Büntgen, 2006, Briffa *& alii,* 2008; Leonelli *& alii*, 2008, 2009) and the glacial history (Nicolussi *&* Patzelt, 1996; Watson *&* Luckman, 2004; Linderholm *& alii*, 2007). In special manner, in this thesis a dendrochronological and dendroclimatical analysis was carried out on the northern slope of the Presanella massif.

Principal targets of this thesis are:

i. Build the dendrochronological curves of different valleys and for the entire area of study.
ii. Do dendroclimatic statistical analysis to evaluate the capability of softwood to record climatic signal.
iii. Improve the dendrochronological dataset of the Adamello-Presanella massif.

Results agree with previous dendroclimatical studies done on the some massif (Coppola, 2010; Coppola *& alii*, 2012; 2013) and on the entire alpine area (Büntgen, 2005).

AREA OF STUDY

Four valleys on the northern slope of the Presanella massif were studied (***Figure 1***).
The area can be divided in two zones:

- The first one, easternmost, include three adjacent valleys; three new chronologies were built from the samples collected here. The three valleys are, from E to W, Valpiana, Val Barco and Val Palù.
- The second one, westernmost, includes only the Val Presena valley which was sampled to improve an existing chronology.

SAMPLING AND LABORATORY ANALYSIS

From each tree, chosen for its topographic and geomorphological position and for its macromorphologic characteristics, at least two cores were extracted from the sides perpendicular to the slope. Some transversal sections of larch were obtained with the help of the Italian Forestry Department. The chosen cores and biscuits were prepared for the analysis of growth trend. This operation was made by polishing samples with sandpaper, followed by the measuring of tree-ring width with the help of an optical microscope (Cook *&* Kairiûkštis, 1990).
Dendrochronological curves obtained from each tree were averaged in order to create a new chronology relative to each valley. New chronologies from Val Presena were averaged with existing curves of previous studies. At the end, a curve relative to the entire study area was built utilizing samples from Val Barco, Valpiana and Val Palù valleys. This chronology was renamed "BPP". The chronologies were standardized with ARSTAN software (Cook & Holmes, 1996) to obtain adimensional index curves useful to statistical analysis. Correlation indexes between standardized curves relative to each valley, BPP chronology and climatic parameters such as mean monthly temperature and mean monthly precipitation were calculated. Climatic parameters were obtained by HISTALP and CRU-TS ver. 3.21 database (Auer *& alii*, 2008; CRU, 2014).

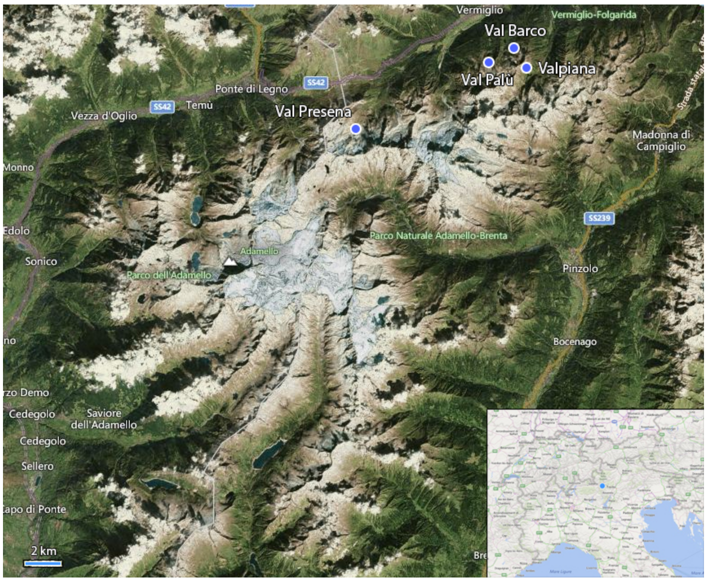

Figure 1 Sampling area

Statistical correlations were calculated with R Project software (utilizing dplR package) (Bunn, 2008; R Core Team, 2014), DendroClim2002 software (Biondi & Waikul, 2004) and Microsoft Excel software.

RESULTS AND DISCUSSION

Three new chronologies of annual tree-ring width were built; these are relative to an equal number of Presanella massif valleys, improving existing information regarding this area. Furthermore, a curve limited to 2008 was upgraded to include the year 2013.

The obtained chronologies cover a period of time between 1605 and 2013.

Tree-ring widths show periods of progressively reduced growth from the beginning of both the XVIII and XIX centuries up to an absolute minimum in the middle of the same centuries. Starting from the middle of the XVIII Century the rings highlighted a progressive but discontinuous increment in growth, interrupted by phases of decreased growth at the begin of the XX century and again between the '60s and '80s of the same century (***Figure 2***).

In agreement with other results of previous studies done in other valleys of the same massif (Coppola 2010; Coppola & alii, 2012, 2013), the chronologies of the new valleys showed a strong influence of summer temperatures, in special manner the mean temperatures of June and July, on larch growth in this site. (***Figure 3***).

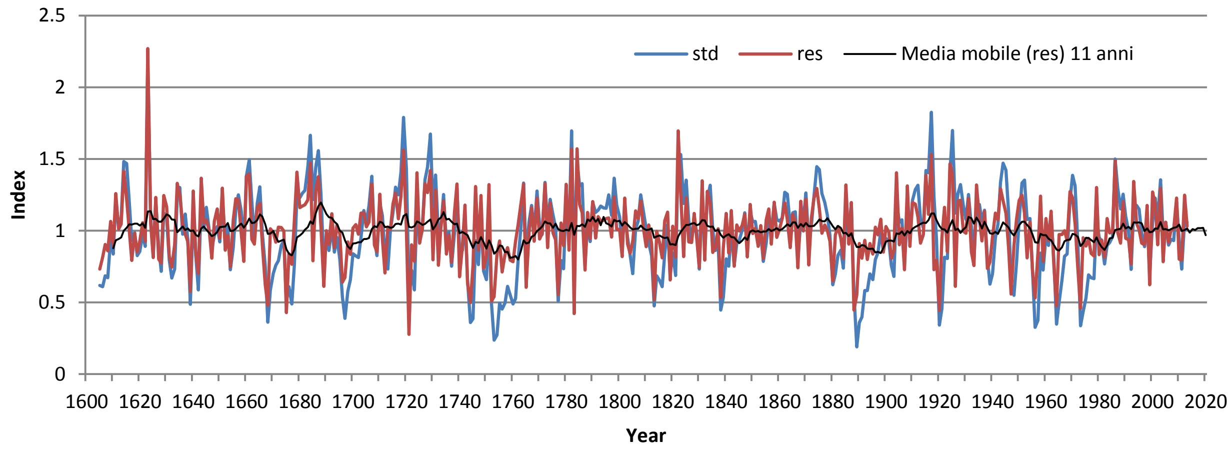

Figure 2 Standard, residual and 11 years moving average of BPP chronology

At the same time, there are no evidences of a statistically stable or significant correlation in time between tree growth and rainfall quantity, not even at lower altitude sites, further from the vegetation limit (the tree-line).

In special manner it was observed that concerning Val Presena and Val Barco curves, built from samples situated near the tree-line, the correlation index calculated with temperature data showed statistically significant and continuous values in time, with a maximum equal to or higher than 0.52 for Val Barco.

The clear relationship between mean summer temperatures and annual larch growth showed how at the beginning of XVIII and XIX Centuries, there occurred two periods of relative cold temperature, identified as the last pulses of the Little Ice Age (LIA) recorded through dendrochronological data. Starting from the middle of the XIX century temperatures generally rose in a discontinuous trend, interrupted by colder periods in the twenties and from 1965 to the end of eighties.

Relating standardized dendrochronological curves and time distance curves relative to alpine glaciers, it was highlighted how the first are strictly related to the others, correlating the periods of lesser growth in the XX Century with stationary or slightly advancing phases of the alpine glaciers.

From the end of the eighties, furthermore, the values of correlation indexes between growth curves and average summer temperature values decreased and were not statistically significant, highlighting an anomaly known as the divergence problem in literature (Büntgen & alii, 2008).

For the Valpiana and Val Palù curves, built from samples chosen at lower altitude, correlation index values between chronologies and average summer temperatures decreased, losing continuity and importance for the Val Palù curve.
The decrease in correlation between climatic and dendrochronological data was interpreted as the result of attacks to the larches at lower altitude by the Lepidoptera *Zeiraphera diniana* Gn. This data was confirmed by the analysis of pointer years (Schweingruber, 1988) that result to be double circa in the low altitude curve (Valpiana and Val Palù) in contrast to the high altitude curve (Val Barco).

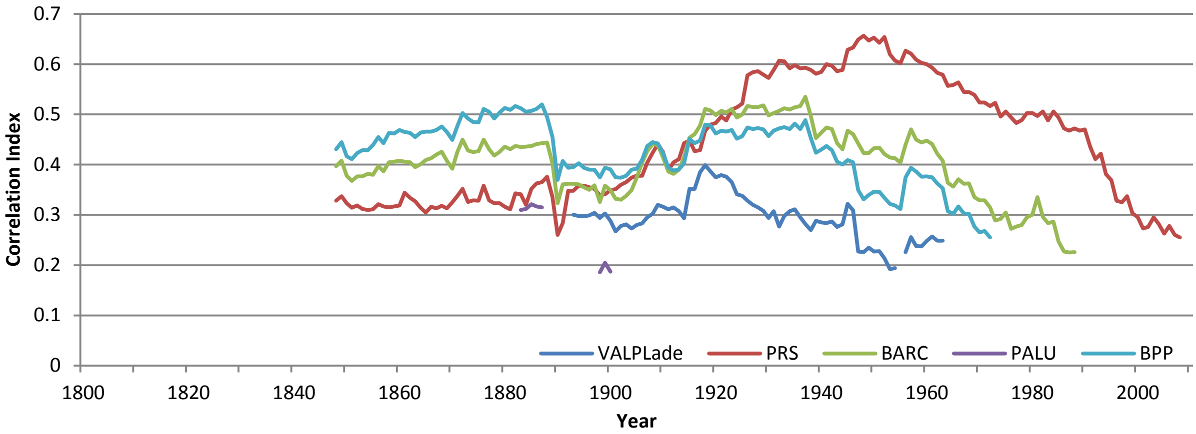

Figure 3 Correlation index values between valleys chronologies and Jun mean temperature values (moving correlation function)

CONCLUSION

The elaboration of dendrochronological curves of *Larix decidua* Mill. created with samples taken from trees situated nearest the tree-line showed the importance of this instrument in paleoclimatic analysis of the alpine environment. In special manner, the annual growth of larch is sensitive to the average monthly summer temperatures, in particular to the months of June and July, and shows considerable correlation potential with the variation of the glaciers present in the studied area.
Is was also verified that precipitation quantity is not an important limiting factor, not even where the temperatures lost statistical significance, denoting the probable interaction of others factors (edaphic, ecologic, entomologic) in determining larch growth at altitudes far from the tree-line.
The dendrochronological curves thus created, cover the lapse of time from the beginning of the XVII Century to today, permitting growth trend analysis in this period. It is clear that reduced tree annual growth in this site is in correspondence to periods of climate cooling identifiable as the last pulses of the LIA.
The closest position of the sampling area to the position reached by the glaciers during the last maximum Holocene expansion, permitted recording of these variations in the dendrochronological record. This data is highlighted by the high similitude between dendrochronological curves and time/distance curves created for some alpine glaciers near the study area (Baroni & Carton, 1991, 1996; Carturan & *alii*, 2013, 2014).

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