Project of Strategic Interest NEXTDATA
WP1.4
(Coordinator: Valter Maggi, UNIMIB)

D1.4.A Comparison of summer temperature reconstructions obtained using tree-rings and pollen data and technical report on the quantitative results

INTRODUCTION

Multi-proxy approaches in past climate reconstructions require, in the first steps, a selection of appropriate climate sensitive records and a deep evaluation of their inner variability. Moreover, as regards tree rings and pollen-stratigraphical records, they typically cover different time periods and show different time resolutions. In order to assess the relationships between the variability of these two proxy records, it is therefore necessary to restrict any comparison between the two proxies over a selected common period (usually the most recent) and to perform an adaptation of the annually-resolved resolution of the tree rings to the generally lower and variable resolution of the pollen-stratigraphical records.

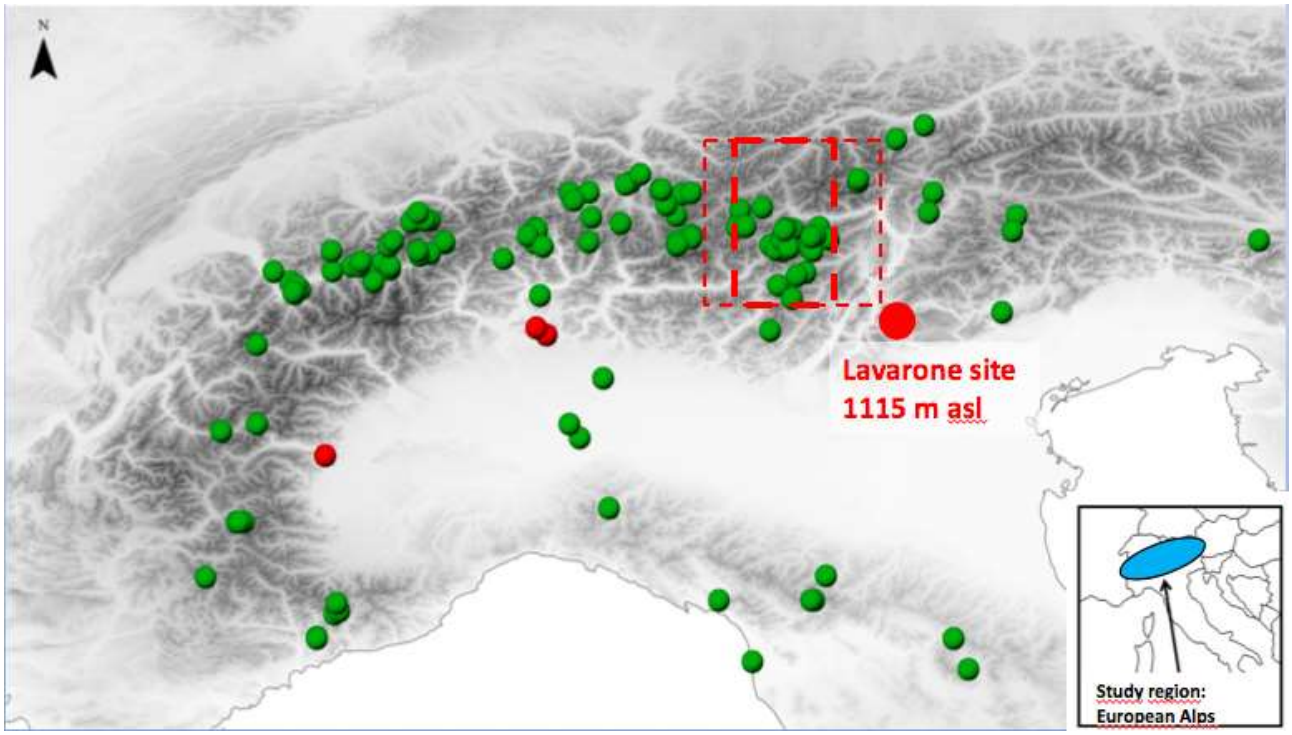

Fig. 1 - Available tree-ring and pollen-stratigraphical records covering the last 200 years in northern Italy. In the red area, the study region where the first test was conducted, comprising the Lavarone

Lake pollen-stratigraphical record (1115 m asl). Green dots = tree-ring series; red dots = pollen series; the red square is the grid cell used for the summer temperature reconstruction from the tree rings.

METHODS

A first comparison between two summer temperature reconstructions derived from these two proxy records was performed in the central sector of the Italian Alps by selecting an area of approximately 150 km of diameter, comprising tree-ring series of European larch (*Larix decidua* Mill.), Norway spruce (*Picea abies* Karst.) and Swiss stone pine (*Pinus cembra* L.) from 42 sites located in five mountain groups - namely the Silvretta Group (Switzerland), the Ötztaler-Venoste Alps (Austria, Italy), the Bernina Group (Switzerland, Italy), the Ortles-Cevedale Group (Italy) and the Adamello-Presanella Group (Italy) and the pollen-stratigraphical record from the Lavarone Lake (Trento), located at 1115 m a.l.s.. The entire methodology is well explained in the Deliverable 1.4B.

1) TREE-RING CHRONOLOGIES

The summer temperature reconstruction was performed starting from 42 high-altitude sites in a region of the European Alps centered over the 1° × 1° grid cell 46°N 10°E (red square in the fig. 1), using a classical approach based on site chronologies (avgALL) and an approach based only on highly temperature-sensitive trees (HSTT).

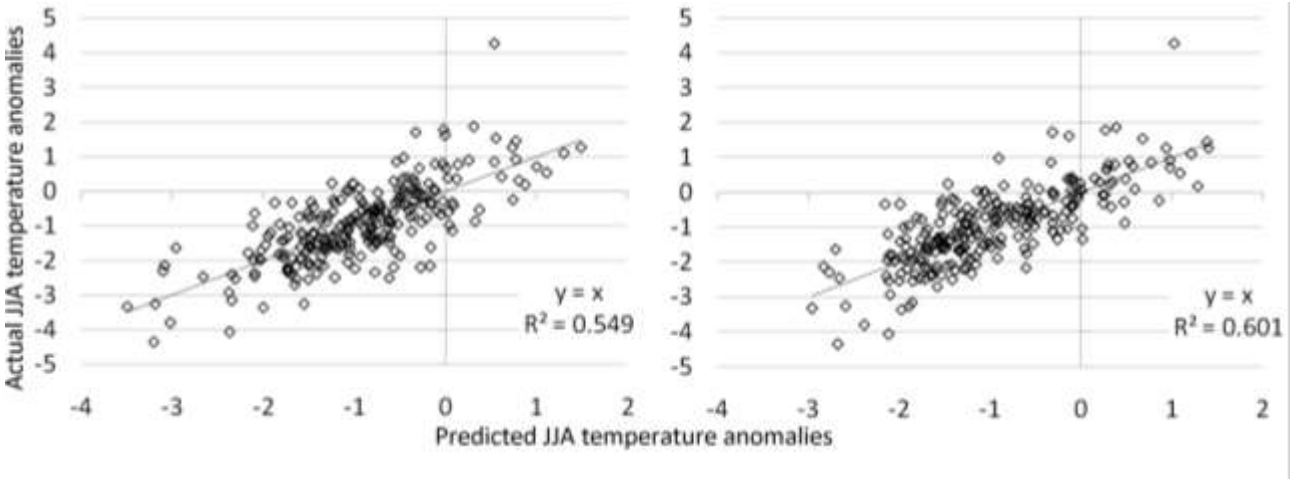

Fig. 2 - Scatter plot of actual JJA values on predicted JJA temperature anomalies obtained by the avgALL (left) and HSTT (right) models. Regression equations and their respective determination coefficients are also reported (Leonelli et al. 2016, Climatic Change 137).

The temperature reconstruction based on the HSTT chronology is consistent with other reconstructions already available in the European Alps, well preserves the long-term temperature variability and suggests lower summer temperatures than those derived from the chronology avgALL (based on the entire dataset) during the periods 1725–1800 AD and 1845–1910 AD. Since 1935, the HSTT reconstruction is more efficient than the avgALL in recording the recent temperature trends.

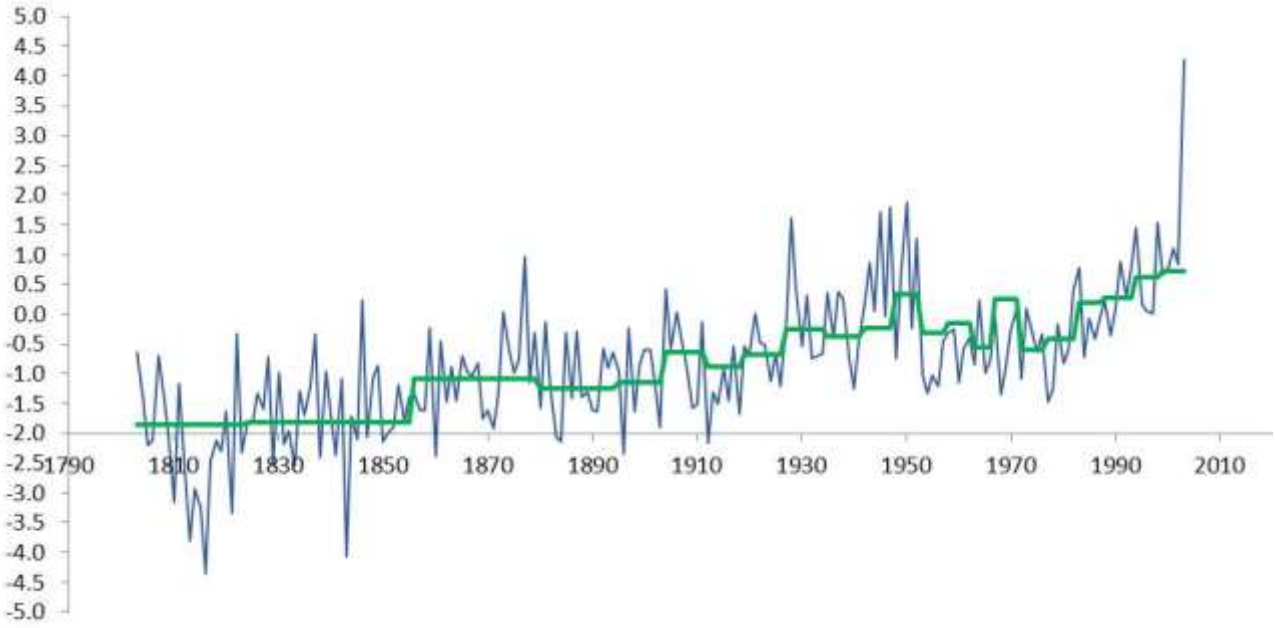

Fig. 3 - Reconstruction of the summer temperature anomaly over the period 1971-2000 using the tree-ring HSTT model (green line). The blue line with annual resolution is the instrumental series; the tree-ring based reconstruction has been adapted to the time resolution of the pollen record for the further analyses.

2) POLLEN-INFERRED RECONSTRUCTION

Pollen-climate calibration models (or transfer functions) were developed using the weighted averaging method (WA), the Modern Analogue Technique (MAT) and the modern calibration set composed by 268 modern pollen assemblages distributed in the alpine, sub-alpine and apennines regions associated to site-specific climate data were applied to the Lavarone pollen record (Arpenti and Filippi 2007) to reconstruct summer temperatures at this site over the last 200 years (Vallé et al. 2018). The methodology is better detailed in the Deliverable 1.4 B. Lavarone pollen record was selected because it has a good chronological control and mean temporal resolution of ~9 years, over the last 200 years (Fig. 4).

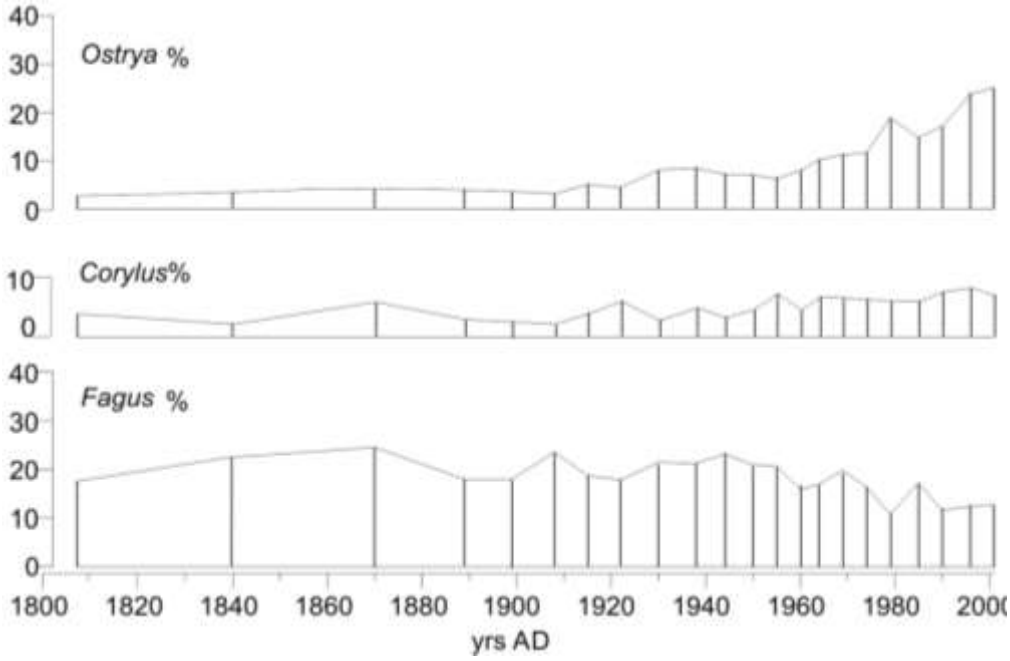

Fig. 4 - Selected pollen percentage curves of *Ostrya*, *Corylus,* and *Fagus* from Lavarone pollen record from 1803 to 2001 (modified from Arpenti and Filippi, 2007). These pollen taxa show unimodal responses along the summer gradient covered in the modern calibration set allowing a good optima estimation.

At first, the reconstructed summer temperature series have been evaluated by direct comparison with the instrumental secular series specifically obtained at Lavarone site. The pollen-inferred reconstruction showing the highest correlation (r^2=0.7) with the instrumental series over the all interval, is the one obtained with the weighted average (WA) model (Vallé et al., 2018, see also Deliverable 1.4 B). The reconstructed absolute temperature values were converted in temperature anomalies from the 1971-2000 range (Fig. 5).

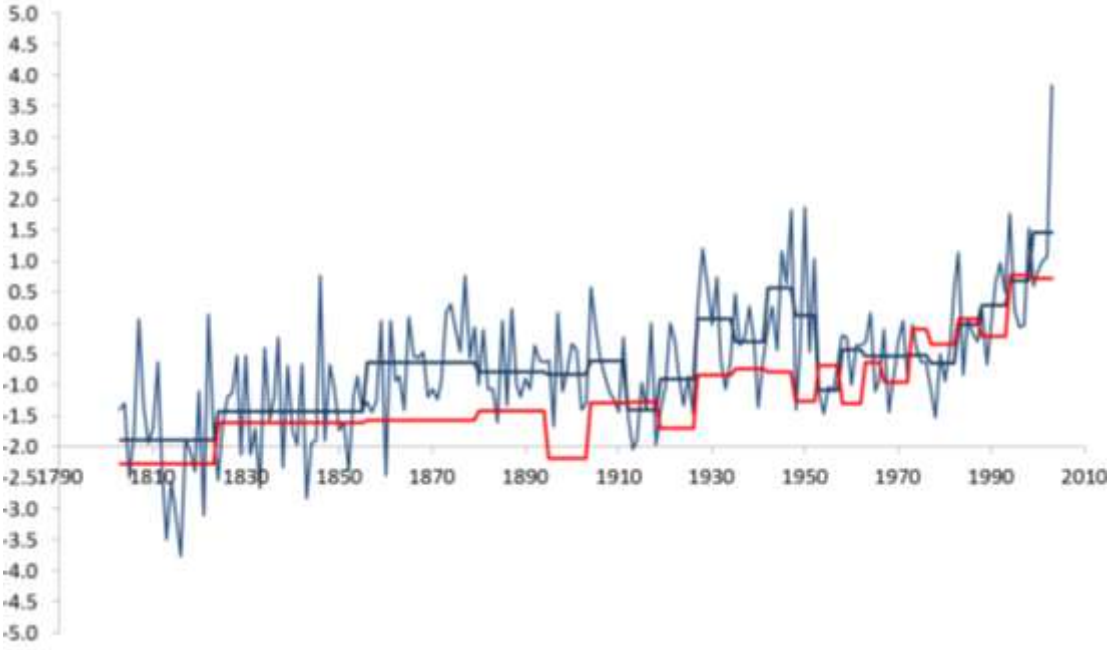

Fig. 5 – Comparison between instrumental summer temperature anomalies (thin blue line: annual resolution; thick blue line: averaged series at pollen resolution) over the period 1971-2000 for

Lavarone (computed by Michele Brunetti, CNR, ISAC) and the pollen-inferred summer temperature anomalies obtained by means of WA method and “expanded” around the sample point (red line).

RESULTS

Both the tree-ring (Leonelli et al., 2016) and the pollen-inferred reconstructions were calibrated using the modelled site specific temperatures from an improved version of the dataset of Brunetti et al. (2006).
The independently obtained summer temperature reconstructions, after adapting the tree-ring series to the time resolution of the pollen series, showed a good correlation (r^2=0.6) over the common period 1803-2003 (Figs. 6, 7).

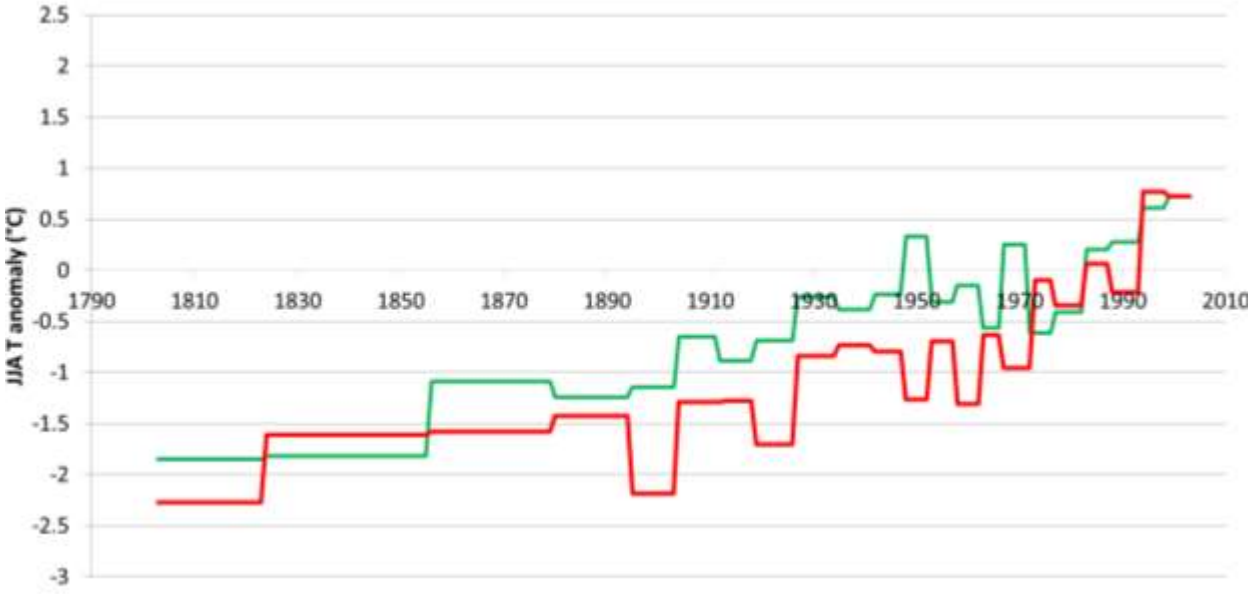

Fig. 6 - Comparison between the tree-ring (green line) and the pollen (red line) reconstructions (WA model) of summer temperature anomalies. The tree-ring reconstruction was adapted to the resolution of the pollen record.

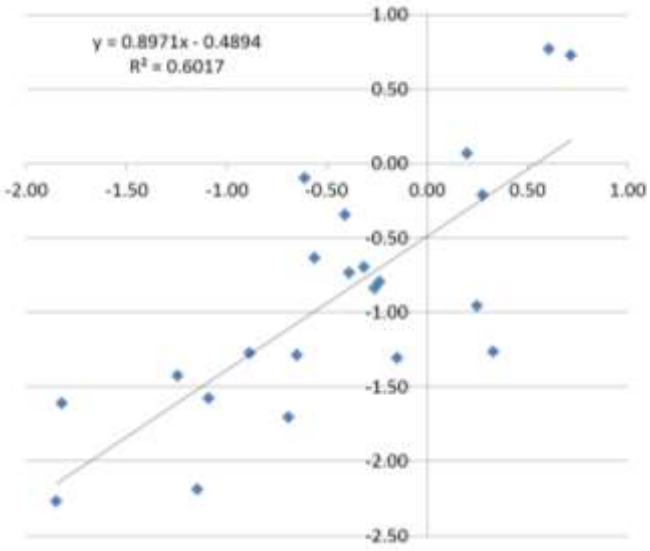

Fig. 7 - Regression between the pollen (y) and the tree-ring (x) reconstructed series. The two independently reconstructed anomalies of summer temperature show a correlation r = 0.77.

The results obtained open the possibility of performing integrated multi-proxy climate reconstructions including more sites from the whole arch of the Italian Alps.