



Project of Strategic Interest NEXTDATA

Scientific Report
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WP 1.4 Environment and climate data from non-polar ice cores

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1. Scheduled activities, expected results and Milestones

Due to the general revision of the NextData Project, some of the WP1.4 activities and related deliverables have been modified. In particular, the activities of this WP have been included under the “Italy 2K *Grand Challenge*” umbrella and all the data produced within this WP will be included in the databases managed by WP2.3.

2. Deliverables expected for the reference period

D1.4.1: Collection of the available palynological studies in Northern Italy and in the Alpine area

D1.4.2: Revision and harmonization of the EMPD (*European Modern Pollen Database*) data useful for paleoclimate reconstructions.

D1.4.3: Reconstruction of the mineral dust record from the Colle del Lys ice core drilled in 2012 (CdL/12), and preliminary dating

D1.4.4: Complete reconstruction of the 1930-2012 stacked record through overlapping of the two Colle del Lys dust records “CdL/03” (2003 drilling) and “CdL/12” (2012 drilling).

D1.4.5: Reconstruction of the climatic and environmental variability on decadal timescales using data from the Monte Bianco, Monte Rosa, Fiescherhorn ice cores and from other sites of interest for the Project.

D1.4.6: Retrieval of dendrochronological data provided by the Universities and Research Centres other than the NextData project partners; the data will be structured and organized according to the NextData standards and incorporated into the Project databases.

D1.4.7: Application and validation of a “Minimal Glacier Model” to simulate the historical retreat of the Careser glacier (Ortles-Cevedale, North-Eastern Alps).

3. Activities which have been actually conducted during the reference period

3.1 Research activities

D1.4.1, D1.4.2.

The palynological studies available in the literature and focused on the last 3000 years and the northern Italian region have been collected and carefully evaluated.

More than 60 published palynological stratigraphic successions from limnic/wet environments, partially or entirely covering the last 3000 years, were picked up. The detected palynological sequences have been critically analyzed, with a special attention to the quality of their chronostratigraphical resolution.

Subsequently, the acquisition of the numerical data (pollen percentages) began, in order to obtain the numerical data that are important for further graphical and statistical elaborations. While collecting the data published in the literature as well as the unpublished data owned by the Laboratory of Palynology and Paleoecology of the CNR-IDPA, the database devoted to the data storage, archiving and dissemination has been set up.

The EMPD (*European Modern Pollen Database*) dataset was also acquired, revised and harmonized. This dataset contains pollen and observed climatic data at the continental (euroasiatic) scale, to be used for a comparison with fossil and modern pollen spectra usable for paleoclimate reconstructions. Preliminary tests on the transfer functions were carried out to assess the potential of information retrievable from pollen data for quantitative paleoclimatic reconstructions in the late Holocene.

D1.4.3 and D1.4.4.

The mineral dust record from the Colle del Lys (Monte Rosa, Vercelli) ice core drilled on October 2012, was completed. The 34 m-deep ice core provides information on the size distribution and concentration of mineral dust from local events as well as from long-range transport to the central-western alpine chain. The measurements were performed at 5-10 cm resolution, allowing for seasonal reconstructions of the dust concentration and for the ice core dating.

The record highlights also important transport events from North Africa and the Middle-East region, to which high concentrations of dust particles over Europe are associated. These high concentration values are of the order of 5 to 10 ppm and they are typically found during Spring and Summer. Clear signs of these high concentration values are represented by the yellow to brown-reddish colour of the ice core surface. During the winter, on the other hand, low concentrations are detected (no higher than a few hundreds of ppb), mainly associated with local transport events.

The size distribution is quite homogeneous along the record, probably due to the initial selection that the particles undergo while they begin to be transported. The typical log-normal distribution of these particles exhibits a 2 μm diameter mode. Only high concentrated events (such as those of Saharan origin) show a more symmetric distribution with a larger mode from 3 to 5 μm . The high annual accumulation on this sector of Monte Rosa, with values around 1.3 m of water equivalent, does not provide long time records but exhibit a clear seasonality that can be used to perform climatic and environmental studies and to date the ice core. The 34 m-deep ice core drilled on 2012 (Lys-2012) represents the ice deposition occurred during 10-12 years dating back to 2001-2002 (ice core base).

Other data will be needed to obtain a more reliable dating; however, it is yet possible to identify a 2 year-long overlapping period with the Lys 2003 ice core, providing the longest ice core record from this glacier dating back to 1930. Even though the short overlapping time period of the two ice cores hampers the application of sophisticated statistical analyses, preliminary studies have shown that the low concentration values found from 2001 to 2003 in the Lys-2003 ice core are very similar to those found in the Lys-2012 ice core for the same years. Once the dating will be refined, the dust anomalies may be compared to similar records from other Mediterranean and European sites.

D1.4.5

In the framework of the contribution of this WP to the Italy-2k *Grand Challenge*, it is worth pointing out that the ice cores we are analyzing cover the alpine area but not entirely or homogeneously. Most data refer to the central-western part of the Alpine chain, hosting the highest glaciers and 3 out of 6 sites. The Col du Dome (Monte Bianco) and the Colle Gnifetti and Colle del Lys (Monte Rosa) are the highest sites in the Alps (higher than 4000 m a.s.l.) and their records date back to more than 100 years ago.

More than 40 core drilling have been performed in the last 45 years in the 6 sites, characterized by different depth and resolutions.

Many records have been collected and the most significant ones used for climatic and environmental purposes. One issue is related to the inhomogeneity of the measurements and the differences among the different the records.

A detailed analysis has been performed using typical indicators of dust transport such as fine particles and Calcium ions. . Inoltre sono stati raccolti i dati isotopici del Colle Gnifetti, unico sito che riunisce oltre un secolo di misure. Moreover, stable isotope records from Colle Gnifetti, the longest record providing more than one century data, have been collected for the aims of the Italy-2k *Grand Challenge*. The Vasto Cave ice core, drilled in the ice body close to the top of the Canin Mnt. (Friuli Venezia Giulia) has allowed to recover ice dating back to about 2000 years ago. Preliminary dating has highlighted the surface melting occurred as a consequence of the recent global warming.

D1.4.6

The activities performed over the period July, 1st - December, 31st can be divided into four main groups: data analysis, preparation of a database of metadata and data, publications, communications.

The activities of data analysis have been focused on the creation of a methodology for increasing the summer temperature signal in reference chronologies from high-altitude Alpine sites. This methodology allows the selection of individual chronologies that better respond to required quality levels and it has been applied to the 1° x 1° Alpine grid point lat. 46°N long. 10°E region rich in dendrochronological data. These elaborations allowed us to reconstruct summer temperatures for the periods not covered by instrumental records and to underline the different contribution, in terms of climatic information, provided by the different employed species. These are conifers, including in particular the European larch (*Larix decidua*), the Swiss stone pine (*Pinus cembra*) and the Norway spruce (*Picea abies*).

The period from July to December was dedicated to the creation of a system for the collection of dendrochronological metadata and data. First of all, the collection system has been set-up; secondly the various groups operating in Italy in the dendrochronology field have been contacted and involved and, finally, the collection, quality control and elaboration of all metadata and data realized. The collection system of metadata and data from groups within and outside the Project has been a crucial step, within the Italy-2k *Grand Challenge* in particular, to gain an overall picture of all available data at the national level and of their spatial distribution. 6 Groups from the University of Milan, the University of Pisa, the Second University of Naples, the University of Molise, the University of Basilicata and the Civic Museum of Rovereto (former Italian Institute of Dendrochronology) have sent their metadata. Other information regarding the Italian territory was derived from the ITRDB database (<http://www.ncdc.noaa.gov/>) and other groups have expressed their intention to share their metadata. Overall, metadata on 89 sites and 25 chronologies (data) have been collected so far. A dedicated free-access website has been set up (<http://geomatic.disat.unimib.it/dendro>) to access metadata information.

As for the publication and dissemination activities, some elaborations in GIS environment have been performed in September-October aimed at one publication on the forest recolonization dynamics in the glacier forefield of the Forni Glacier (Sondrio), according to glacier retreat phases and ongoing climatic trends. In particular, by means of a dendrochronological analysis and the data spatialization, it has been possible to underline the role of active geomorphological processes in modulating the colonization patterns in the various physiographic units along the proglacial area defined by the morainic arches and the hydrographic network. In November the manuscript has been submitted to the journal *AAAR* for the peer review process and in December some elaborations have been initiated for the new paper on the dendroclimatic reconstruction for the grid point 46°N 10°E. The communications to scientific congresses have been performed in September (*SGI-SIMP*, at University of Milan) and in December (*Italy 2k NextData*, Accademia Nazionale dei Lincei, Rome) focused on the developed innovative multispecies methodology for summer temperature reconstruction and on the tree-ring based climate reconstructions in the Italian Alps, respectively.

D1.4.7

Theoretical work on glacier dynamics has opened the door to the development of mathematical models for estimating the response of glacier systems to different climate change scenarios. One objective of this WP was to implement a simple version of such kind of models (so-called Minimal Glacier Models, MGMs) and include it within a GIS framework, to better understand, evaluate and reproduce the glacier response to climate fluctuations.

The activities performed in the reference period, in particular, were threefold: (I) formulation of the MGM using the Fortran programming language; (II) description of a GIS algorithm to

calibrate and to validate the simulated results; (III) application of the MGM to the Careser glacier, to reproduce its historical time series and to evaluate its future behaviour.

The MGM tries to reduce the complexity of glacier dynamics to a very simple description based on essential physical laws. The output variable is the variation of glacier terminus along the flow-line direction and the length for a given year is an input data for the further cycle, because the MGM is built as an iterative process year by year. The MGM parameters and initial conditions are derived from the glacier geomorphology provided by a Digital Terrain Model (DTM) using a GIS. DTMs allow to reconstruct the glacier evolution with a multi-temporal analysis and the glacier flow lines that respond to the accumulation-ablation dynamics. An algorithm aimed at extrapolating from the DTMs all the features needed to calibrate and validate the MGM has then been implemented based on QGIS tools, using several libraries and interoperability of different open source software such as GDAL, GRASS, and SAGA. Finally, the historical and future behaviour of the Careser glacier (Ortles-Cevedale, North-East Alps) was estimated using climate drivers provided by a set of global climate models (GCMs) participating in the Climate Model Intercomparison Project phase 5 (CMIP5) effort. In particular, to estimate the uncertainty of the glacier projections we focused on a multi-member ensemble of the CSIRO-Mk.6 model. We do think that the ensemble of tools developed in this WP could be effectively used to estimate the response of glaciers to climate change and forcings, in particular over the Alpine Region.

3.2 Applications; technological and computational aspects

3.3 Formation

3.4 Dissemination

3.5 Participation in conferences, workshops, meetings

FURLANETTO et AL., (2014): When did the modern landscape emerge in the Northern Italy? Reconstructing the last 2k years landscape history by a multidisciplinary approach, *9th EPPC*. Padova, August 2014.

PINI et AL. (2014): From fossil pollen to climate: preliminary quantitative climate reconstructions for the last 3 ky in northern Italy. *La variabilità climatica in Italia negli ultimi 2000 anni - Italy 2k*, Accademia dei Lincei. Roma, December 2014.

LEONELLI G., COPPOLA A., BARONI C., SALVATORE M.C., PELFINI M., (2014): An innovative approach to high-resolution summer-temperature reconstructions for the last centuries using large tree-ring datasets from the Central Alps. *87° Congresso della Società Geologica Italiana e 90° Congresso della Società Italiana di Mineralogia e Petrologia: The Future of the Italian Geosciences - The Italian Geosciences of the Future*. Milano 10-12 September 2014.

PELFINI M., BONETTI A., MASSEROLI A., LEONELLI G. (2014): Glacier fluctuations and forest limits changes in the Central Italian Alps. *Congresso del Comitato Glaciologia Italiano: The future of the Glaciers: from the past to the next 100 years*. Torino, 18-21 September 2014.

PELFINI M., LEONELLI G., (2014): Tree-ring climate reconstructions in the Italian Alps. *Convegno Accademia Nazionale dei Lincei, Climate variability in Italy during the last two millennia – Italy 2k*. Roma, 1-2 December 2014.

MAGGI et AL. (2014): Mediterranean Climate Reconstruction from Ice Cores. *Convegno Accademia Nazionale dei Lincei, Climate variability in Italy during the last two millennia – Italy 2k*. Roma 1-2 December 2014.

MEYER C., PFLITSCH A., HOLMGREN D., and MAGGI V., (2014): Schellenberger ice cave (Germany): A conceptual model of temperature and airflow. PROCEEDINGS of the *Sixth International*

Workshop on Ice Caves, Idaho Falls, Idaho, USA, August 17-22: NCKRI Symposium 4. Carlsbad (NM): National Cave and Karst Research Institute.

COLUCCI R., FORTE E., STENNI B., BASSO BONDINI M., COLLE FONTANA M., DEL GOBBO C., FONTANA D., BELLIGOI D., MAGGI V. and FILIPAZZI M., (2014): The MONICA (Monitoring of ice within caves) Project: A multidisciplinary approach for the geophysical and paleoclimatic characterization of permanent ice deposits in the southeastern Alps. PROCEEDINGS of the *Sixth International Workshop on Ice Caves*, Idaho Falls, Idaho, USA, August 17-22: NCKRI Symposium 4. Carlsbad (NM): National Cave and Karst Research Institute.

4. Results obtained during the reference period

4.1 Specific results (Data libraries, Measurements, Numerical simulations, etc)

See WP 2.4

4.2 Publications

MAGRI et AL., (accepted): Holocene dynamics of tree taxa in Italy. *Review of Palaeobotany and Palynology*.

LEONELLI G., BONETTI A., PELFINI M. (submitted): Decreasing ecesis intervals along the Forni Glacier forefield, European Alps: a climate-driven dynamics locally altered by geomorphological features. *Arctic Antarctic and Alpine Research*.

BACCOLO G., MAFFEZZOLI N., CLEMENZA M., DELMONTE B., PRATA M., SALVINI A., MAGGI V., PREVITALI E.,(submitted): Low background neutron activation analysis: a powerful tool for atmospheric mineral dust analysis in ice. *Journal of Radioanalytical and Nuclear Chemistry*.

4.3 Availability of data and model outputs (format, type of library, etc)

See WP 2.3

4.4 Completed Deliverables

All Deliverables have been completed.

5. Comment on differences between expected activities/results/Deliverables and those which have been actually performed.

No significant deviations from scheduled plans

6. Expected activities for the following reference period

D1.5.1: Population of NextData palynological and stratigraphical database, and starting the processing to depict the history of vegetation in Northern Italy during the last 3 thousand years.

D1.5.2: Application of “Minimal Glacier Model” within GIS technology, to reconstruct the simulated retreat of glacier front with spatial resolution from flow-line.

D1.5.3: Reconstruction of the climatic and environmental records fro ice cores from Lys Glacier, dating of the Vasto ice Cave cie core (Monte Canin, Italy) and drilling activities in Schellenberger Eishoehle (Untersberg massif, Germany).

D1.5.4: Update with new dendrochronological metadata and new chronologies, and climate reconstructions will performed for Alpine, Apennines and the Mediterranean areas.

D1.5.5: The test bench and research the best solution of GIS – Minimal Model for the Rutor glacier (West area of Val d'Aosta).