Project of Strategic Interest NEXTDATA

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WP.2.3 Archive of data from non-polar ice cores

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1. Activities and expected results

In the second year, the survey and collection of information on drill ice cores in non-polar glaciers will continue and, after the complete installation of WDB database on the DISAT server, the data and metadata on ice cores will be included in the GeoNetwork portal. The cartographic Geodatabase of world glaciers, linked by means of the GLIMS project to the archive containing information on already drilled glaciers, will be set up. At the same time, we will proceed with the collection of the available satellite data (images, DTM, etc.) for the analysis of Alpine and Himalayan glaciers. These data will be included in the GeoDataBase and will be also used in the future works contributing to the creation of a Decision Support System (DSS) for the identification of drillable glaciers. In particular, we will process and analyse the satellite images from ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer), from LANDSAT TM and Landsat Enhanced Thematic Mapper (already used in the recent past to generate the GLIMS database), and the surface temperature and albedo data from multi-temporal MODIS images.

Digital terrain models will be used to estimate glacier topography; we are evaluating the possibility to use national models to this purpose. Digital terrain data from SRTM (Shuttle Radar Topography Mission) will be also archived, providing a global homogenous information with 30 m spatial resolution. The topographic data will be used to infer a set of primary attributes related to the slope and shape of the glacier slopes, size and aspect, relief energy and convexity/concavity; these parameters will be integrated with those derived from satellite imagery to obtain information on glacier drillability.

The ice cores storage site will be implemented at the EuroCOLD Laboratory of the University of Milan Bicocca; a feasibility study for the construction of a popular science exhibition (permanent or temporary, to be implemented in collaboration with the Italian Glaciological Committee) on the state of glaciers and paleoclimatic research in mountain areas will be done.

2. Deliverables for the reference period:

D2.3.2: Report on the ice core archives; transmission of information to the General Portal.
D2.3.3: Report on the archive of paleodata from continental regions; transmission of information to the General Portal.

3. Carried out Activities

3.1 Research activities

Research activities of WP 2.3 have followed two lines; the first one is the fulfillment of Ice core DataBase (IDB) to archive data from ice cores, the second is the achievement of a methodology to evaluate glacier suitability to ice core drilling. The database structure was defined during the first year in agreement with other WP, so that in the second year of activities the realization of IDB database and its publication on the UNIMIB research unit Portal has been carried out.

A database has been created using the spatial DBMS already used in Share, WDB (Weather and Water Database), that allows to upload all the ice and marine cores data in the same DB. WDB is based on PostgresSQL with PostGIS extension. PostGIS follows the OGC standard (Open Geospatial Consortium) allowing the interoperability with all GIS applications. IDB allows to process the geospatial information by a couple of coordinates that identify the drilling point inside the non-polar glacier. Relational structure of IDB has been defined by 5

tabs that store data such as: geographic area, altitude, drilling year, length and diameter of the core, drilling method (tab.1).

During this year a total of 178 different ice cores were found from 4 different sources, NOAA-NIDC database, NICL table, DISAT ice cores and scientific literature. Of these 178 ice cores, 56 come from NOAA and NICL, 2 from DISAT and 120 are new ice cores, georeferenced and stored for the first time.

The main feature of IDB is the capacity storage of the parameters that identify the chemical-physical characterization of the ice cores. Information collected on all the 178 ice cores has been analyzed and 80 main parameters, common to all ice cores, have been identified. The name of the parameters has been defined as provided by the IUPAC standard and the measurement units follow the IS standards.

A web page (http://geomatic.disat.unimib.it/wp2.3) was created on the server of the Geomatic laboratory of DISAT–UNIMIB. This page, linked with IDB, offers the possibility to the stakeholders, without a login, to search data by query and download all the data uploaded in the geodatabase. It has been also developed a cartographic visualization using a webGIS. WMS, WFS e WCS services were created, as required by OGC standard, to visualize data of the ice cores using GIS tools or Webmapping services.

For each ice core uploaded in IDB, a set of metadata has been uploaded in the SHARE GeoNetwork, the web portal chosen by NextData Project to share metadata. All the 178 metadata of the ice cores stored in IDB has been gathered together following an organized structure: Project, Champaign, Ice core and upload in the SHARE GeoNetwork, (http://geonetwork.evk2cnr.org/webapp/).

The second research activity focused on the implementation of a methodology to evaluate the glacier suitability to ice core drilling, along with a literature review of the principal factors that determine glacier drilling suitability. A glacier can be drilled if there is the possibility to recover an ice core with a high temporary resolution and a well-conserved stratigraphic continuity. This kind of evaluation has been made using as source of information the glaciers that are already drilled.

The glacier morphology is important to properly evaluate the suitability to ice core drilling, and it is therefore necessary to find and analyse Digital Elevation Models (DEM) of the glacial area to derive the principal morphometric and morphologic characteristics of the glaciers. To obtain the data, a comparison between DTM derived from ASTER (G-DEM) sensor and SRTM (Shuttle Radar Topography Mission) has been made. STRM was chosen because it delivers a better spatial resolution and a worldwide coverage. Some tests have been conducted to identify the useful morphometric indices.

The analysis has been conducted on 62 glacier (23 Alpine, 39 Himalayan); we encountered accuracy and location problems about the ice cores data found in literature. Therefore, a classification for the spatial accuracy has been made. 4 different classes have been identified. This classification will be the starting point to create a methodology for ice cores repositioning. This methodology will be applied to the ice cores in IDB.

3.2 Application, technological and informatics development

A database to archive data from ice core has been developed and shared with the scientific community on the web portal of the Geomatic Laboratory of Earth and Environmental Science Department of University of Milano Bicocca (http://geomatic.disat.unimib.it/wp2.3). At the same time, the database has been uploaded in the SHARE Geonetwork web portal.

3.3 Formation:

3 PhD positions have been activated starting from 1ˢᵗ January, 2013. As for WP 2.3, the formation activities followed by the PhD students and by collaborators are:

18-28 June 2013, XXI course on "Climate Change and the Mountain Environment", Valsavarenche, Valle d'Aosta (Italy), CNR-ISAC, LTHE, LEGI-CNRS Grenoble, Ev-K2-CNR, 60 hours + 2 day on field.

29 July – 4 August 2013, European Geosciences Union Summer School, "Understanding Earth-Surface Processes in the Alpine Environment from High Resolution Topography", Centre of studies on the Alpine Environment (San Vito di Cadore, Dolomites, ITALY), Department TESAF, Università di Padova, 32 hours + 14 hours field survey).

Short courses on the open source software GeoServer 2.4, Gfoss day, Bologna, 10 October 2013.

Short courses on the open source software QGIS Web Gfoss day, Bologna, 10 October 2013.

Short courses on the open source software GeoNode 2.0, Bologna, 10 October 2013.

Short courses on the open source software MapStore, Gfoss day, Bologna, 10 October 2013.

Short corse on ArcGis, Politecnico di Milano, 3 December 2013.

February 2013: Short Courses on Python and Pygrass in the XIV Meeting of Italian GRASS and GFOSS users, University of Genova.

April - October 2013: Introduction to Glaciology, organized by SGL (Servizio Glaciologico Lombardo), 35 hours + 3 day on field + 2 field survey.

3.4 Dissemination and divulgation activities

A web page of Geomatic laboratory of DISAT UNIMIB has been implemented, see

http://geomatic.disat.unimib.it/?q=nextdata.

3.5 Conferences and seminaries

GIT – Geology and Information Technology - VIII riunione del Gruppo di Geologia informatica Sezione della Società Geologica Italiana. Chiavenna (So), 17-19 giugno 2013.

I. FRIGERIO, M. DE AMICIS, D. STRIGARO, M. MATTAVELLI, E. VULLEIRMOZ, F. LOCCI, F. DESSI, M.T. MELIS, A. PROVENZALE (2013): A Structured Server Architecture To Stock And Share Ice Core Data From Database To Webgis Application, *GIT – Geology & Information Tecnology* (speech).

XVII Conferenza Nazionale A.S.I.T.A. - Riva del Garda, 5-7 novembre 2013.

F. LOCCI, F. DESSI, M. DE AMICIS, I. FRIGERIO, D. STRIGARO, E. VULLEIRMOZ, M.T. MELIS (2013): WDBPALEO 1.0: database per la raccolta di dati paleo-climatologici, *17a Conferenza Nazionale A.S.I.T.A.* (speech).

4. Results obtained during the referent periods

4.1 Technical results (Database, measurements results, model output)

IDB Database creation and its dissemination by the website
http://geomatic.disat.unimib.it/wp2.3

4.2 Publications:

I. Frigerio, D. Strigaro, M. Mattavelli, F. Locci, M.T. Melis, M. De Amicis (2014): A Structured Server Architecture To Store And Share Ice Cores Data For NextData Project. *GeoInformatica* (In review).

F. Locci, F. Dessi, M. De Amicis, I. Frigerio, D. Strigaro, E. Vulleirmoz, M.T. Melis (2013): WDBPALEO 1.0: database per la raccolta di dati paleo-climatologici. *Atti 17a Conferenza Nazionale A.S.I.T.A.*

F. Fussi, H. Barry, M. Beavogui, R. Garzonio, A. Keita, L. Patra, M. Sartorelli, and M. Louise: Characterization of shallow geology based on direct borehole data and field reports and identification of suitable zones for manual drilling in Guinea. *Geophysical Research Abstract,* Vol. 15, EGU2013-10662, 2013, European Geoscience Union; EGU, Vienna, Austria 2013. (Poster presentation).

B. Di Mauro, B. Delmonte, M. Fagnani, F. Fava, R. Garzonio, R. Colombo: Model simulation and Hyperspectral measurements of snow albedo and Light absorbing impurities. Submitted abstract. *DUST 2014, the International Conference on Atmospheric Dust.* Castellaneta Marina (TA), Italy, June 1-6, 2014.

4.3 Data availabilities and models output

File CSV with searched data can be downloaded from the website.

4.4 Accomplished Deliverables

D2.3.2: Report on the ice core archives; transmission of information to the General Portal.
D2.3.3: Report on the archive of paleodata from continental regions; transmission of information to the General Portal.

5 Comments and gaps between expected and achieved results

The Deliverable 2.3.3 (paleodata from continental archives) has been postponed to the third year to include the new paleo proxy data identified during the second year.

6 Future activities and developments

IDB that was created this year represents a first release that needs integration to overtake some limitation imposed by WDB and also to create maps about the paleoclimate history of the last 3000 years. One of these limitations concerns the possibility to archive temporal data of the Quaternary period.

During the second year a new version of the database will be released, which will allow to store spatial information about glacier derived from other DB such as GLIMS, WGI etc and also parameters from DTM elaboration useful to evaluate the suitability for ice core drilling.

A research line was opened, in order to reconstruct vegetation and climate of the last 3000 years in North Italy using stratigraphic data and pollen data from limnological sediment cores. Hence in the third year a literature review will be made to find pollen succession available in North Italy. Pollen and chronological data useful to derived climate parameters will be extracted and stored in IDB. Database construction and data and metadata upload will be concluded in 2014.

About the suitability for ice core drilling, the maps generation for the drilling evaluation will be concluded in 2014. In particular, when the maps useful to the characterization will be completed, some statistical analysis will be set up to select the principal variables useful to identify a probable perforation site. According to the Factorial Scoring System implemented by Vogt et al. (2003), a methodology to extract drillable area will be proposed. This area will be used to create a suitability map for ice core drilling of the Alpine and Himalayan glaciers.

Parametername	Measurementunit
d18O	Ratio
Calcium	Ppb
Chloride	Ppb
Ammonium	Ueq/L
Cerium	Ppb
Conductivity	µS per cm
Fluoride	ppb
…	…
Other72 parameters	

Tab. 1. List of parameters and measurements unit in the IDB database

	Project	Perforations	Icecores
America	17	24	56 (30)
Europe	9	30	44 (44)
Africa	2	2	8 (0)
Asia	24	40	70 (48)
TOT	52	96	178

Tab. 2. Summary of Project, Perforation and Ice cores found. Numbers in parentheses show new ice cores never censed for each geographic region.

Fig. 1. IDB web page

Fig. 2. Web page of Geonetwork Project with the DISAT metadata.