A web-based, relational database for studying glaciers in the Italian Alps

(Article begins on next page)

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Corresponding Author: Dr. Guido Nigrelli,

Corresponding Author's Institution: Research Institute for Geo-hydrological Protection

First Author: Guido Nigrelli

Order of Authors: Guido Nigrelli; Marta Chiarle; Angelo Nuzzi; Luigi Perotti; Gianluca Torta; Marco Giardino

Abstract: Glaciers are among the best terrestrial indicators of climate change and glacier inventories have attracted growing interest. In Italy, the first official glacier inventory was completed in 1925 and 774 glacial bodies were identified. As the amount of data continues to increase, and new techniques become available, there is a growing demand for computer tools that can efficiently manage the collected data.
The Research Institute for Geo-hydrological Protection of the National Research Council, in cooperation with the Departments of Computer Science and Earth Sciences of the University of Turin, created a database that provide a modern tool for storing, processing and sharing glaciological data. The database was developed that could store heterogeneous resources. A set of web search queries to retrieve the information was implemented. The adopted architecture is server-side and the software are open source. The website interface was to meet the needs of a distributed public. The interface usability is simple and intuitive. Through this interface, any type of glaciological resource can be managed, specific searches can be performed, and the results exported in a common format.
The use of a relational database to store and organize the vast variety of resources about Italian glaciers collected over the last century constitutes a significant step forward in ensuring the safety and accessibility of such data. Moreover, the same benefits also apply to the enhanced operability for handling information in the future, including new and emerging types of data formats such as geographic and multimedia files.
Future developments include the integration of cartographic data such as base maps, satellite images and vector data. The relational database described in this paper will be the heart of a new geographic system that will merge data, data attributes and maps with a complete description of Italian glacial environments.

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4 Author names and affiliations

5 G. Nigrelli[a]*, M. Chiarle[a], A. Nuzzi[b], L. Perotti[c], G. Torta[b], M. Giardino[c]

6 [a]Consiglio Nazionale delle Ricerche, Istituto di Ricerca per la Protezione Idrogeologica, Strada

7 delle Cacce 73 – 10135 Torino (Italy)

8 [b]Università degli Studi di Torino, Dipartimento di Informatica, Corso Svizzera 185 – 10149 Torino

9 (Italy)

10 [c]Università degli Studi di Torino, Dipartimento di Scienze della Terra, Via Valperga Caluso 35 –

11 10125 Torino (Italy)

12 *Corresponding author. Tel.:+390113977824; fax: +390113977820

13 E-mail addresses: guido.nigrelli@irpi.cnr.it (G. Nigrelli), marta.chiarle@irpi.cnr.it (M. Chiarle),

14 nuzzi_angelo@hotmail.it (A. Nuzzi), luigi.perotti@unito.it (L. Perotti), torta@di.unito.it (G. Torta),

15 marco.giardino@unito.it (M. Giardino).

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17

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and accessibility of such data. Moreover, the same benefits also apply to the enhanced operability

for handling information in the future, including new and emerging types of data formats such as

geographic and multimedia files.

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and vector data. The relational database described in this paper will be the heart of a new

geographic system that will merge data, data attributes and maps with a complete description of

Italian glacial environments.

1. Introduction

Glaciers are among the best terrestrial indicators of climate change because of their sensitivity to

climatic variations and visible growth and shrinkage (IPCC, 2007; Kaab et al., 2007). Glacier

fluctuations are relevant for the impact they have on the surface water cycle (Braun et al., 2000;

Kaser et al., 2010; Koboltschnig and Schöner, 2011), sediment fluxes (Stott and Mount, 2006;

51   Irvine-Fynn et al., 2011), and natural hazards (O'Connor and Costa, 1993; Clague and Evans, 2000;

52   Kaab et al., 2005; Cossart et al., 2008; Chiarle et al., 2011).

53   For these reasons, glacier inventories (including current glacier extent and rates of change) have

54   attracted growing interest (Fig. 1). Some of the longest series of observations of glacier fluctuations

55   have been compiled by the Italian Glaciological Committee (Comitato Glaciologico Italiano, CGI).

56   The first official glaciological survey of Italian glaciers was carried out in 1911. Since then, CGI

57   voluntary surveyors have closely followed glacier evolution (Malaroda, 1995), documenting

58   changes with annual measurement of terminus position, photographs, reports, and maps.

59   As the amount of data continues to increase, and new techniques for data acquisition and analysis

60   become available, there is a growing demand for computer tools that can efficiently store, update,

61   process and share the collected data (Baroni, 2010). Such applications need to take into account

62   concerns about the peculiarity of Italian glaciers, as well as archival documentation management

63   and the integration of existing digital global glacier inventories (Muller et al., 1977; Raup et al.,

64   2007; NSIDC, 2011).

65   Since its beginning, Glacial Risks in Western Alps (GlaRiskAlp) project no. 56 under the 2007-

66   2013 ALCoTra (Alpi Latine Cooperazione Transfrontiera, Franco-Italian Transborder Alpine

67   Cooperation program) has addressed the need for compiling a complete inventory of Alpine glaciers

68   within the interregional area which would enable researchers to examine criticalities and processes,

69   focusing, for example, on glacier displacement in glacial and periglacial zones consequent to

70   ongoing climate change. Under the project protocol, the National Research Council-Research

71   Institute for Geo-hydrological Protection (Consiglio Nazionale delle Ricerche-Istituto di Ricerca per

72   la Protezione Idrogeologica, CNR-IRPI), in cooperation with the University of Turin (Departments

73   of Computer Science and Earth Sciences), created a database to meet the project's specific needs

74   and to provide a modern tool for storing, processing and sharing glaciological data. Besides meeting

75   the routine requirements for data organization, retrieval and sharing, the database was designed to

76   accommodate the historical CGI data and new data acquisition, collection and storage technologies.

77   This paper illustrates the structure, functions, and potential use of the database.

78

79   2. Geographic context and type of data

80   We studied Italian glaciers in the European Alps. This range was selected for developing a

81   relational glacier database because it is by far the world's best known mountain area in terms of

82   weather, climate and related environmental characteristics (Barry, 1994). Geographically, the

83   European Alps sweep in an arc extending from the Mediterranean (French and Italian Riviera) to

84   the hilly areas of Austria and Slovenia. The Alps are bounded to the north by the Swiss and

85   Bavarian Plateaux, to the south by the Po and Venetian Plains. As a whole, the Alpine range has an

86   average ridge height of about 2 500 m, a length of 800 km, and a mean width of about 200 km (Frei

87   and Schar, 1998). Based on their geomorphological features, three classical physiographical regions

88   are distinguished: 1) the Western Alps, a relatively narrow N-S elongated arch at the Franco-Italian

89   border, where Mount Blanc and the majority of the highest peaks are located; 2) the Central Alps,

90   from Lake Geneva to the Grisons (Switzerland), where the range bends in an E-W direction; 3) the

91   Eastern Alps, east of the Grisons, the largest complex of the chain, where the Southern Calcareous

92   Alps fringe on the chain's northern core.

93   These classical physiographical regions show different orographic and hydrographic patterns

94   depending on the interplay between geological and geomorphological factors. In the Central Alps,

95   the main drainage network is mostly longitudinal to the chain with a few prominent valleys (e.g.,

96   the Valais and the Inn valleys), controlled by major tectonic discontinuities in the Alpine structure.

97   On the margins, most valleys show a centripetal trend. In the Eastern Alps, the valleys run

98   northwards or southwards onto the foreland; due to differential uplift, the remnants of ancient

99   longitudinal segments have been incorporated into the present-day drainage system (Bosi, 2004). In

100   the Western Alps, the mountain relief is intersected by a series of major transverse valleys that

101   divide the range into numerous basement massifs characterized mainly by lower erodibility than in

102   the surrounding rock units. Morphologically, cirque glaciers largely predominate over alpine-type

103   valley glaciers.

104   From a long-term perspective of the area's geomorphological history, the onset of Quaternary

105   glaciations in the Western Alps repeatedly and deeply modeled the Alpine relief, with regional

106   features of contrasting competent rocks and high uplift and denudation rates. Holocene deglaciation

107   later reduced the number of glaciers and the surface area they once covered, which led to

108   gravitational and fluvial/torrential processes resulting in widespread instability phenomena (Soldati

109   et al., 2006).

110   From today's perspective, for obvious reasons of exposure and orography, the southern/eastern

111   flank of the Alps (corresponding to the Italian Alps) has far fewer glaciers than the northern side.

112   Based on an inventory of Alpine glaciers dating from the 1970s (Haeberli et al., 1989), the 1 368

113   Italian glaciers account for 27% of the total number and cover an area of 602 km^2 (21% of the total

114   glacierized Alpine area). Most (80% of the total) are small. Ranked by size, 651 glaciers are in the

115   lowest category (0.1-0.5 km^2), with 508 covering less than 0.1 km^2; 89 (17.7% of the total) are in

116   the next higher category (0.5-1 km^2); 99 (1-5 km^2) and 17 (5-10 km^2) in the next higher categories,

117   respectively. Only 4 extend over 10 km^2: the Miage Glacier (Mont Blanc) and the Lys Glacier

118   (Monte Rosa) in the Western Alps; the Forni Glacier (Ortles-Cevedale) and the Mandrone Glacier

119   (Adamello-Presanella) in the Central Alps. Most of the Italian glaciers are concentrated at the

120   highest elevations of the eastern (mainly the Rhaetian and Norian Alps) and western regions

121   (mainly the Graian and Pennine Alps).

122   In addition to elevation, local climatic situations influence the distribution of glacierized areas in the

123   Italian Alps, owing mainly to the relationship between glacier size and position and the source and

124   propagation of masses of humid maritime air (Calmanti et al., 2007). It is clear, therefore, that a

125 more detailed interpretation of their present-day distribution and typology could be achieved with

126 an updated glacier inventory.

127 The first inventory of Italian glaciers was completed in 1925, when 774 glacial bodies were

128 identified and located (Porro, 1925; Porro and Labus, 1927); the original forms report numerical

129 and alphanumerical characteristics of each glacier. The inventory was later updated, coinciding with

130 the 1957-58 International Geophysical Year, and developed in collaboration between the CGI and

131 the National Research Council: 838 existing glaciers and 190 extinct ones were mapped and briefly

132 described (CNR-CGI, 1959). From then onwards, geographic, topographic and morphologic data

133 have been added, yet the records and database remain incomplete, particularly as regards glacier

134 surface area. National inventory updates carried out in the following decades have never been

135 published (Secchieri, 1985; Ajassa et al., 1997). What information there is on current glacier

136 conditions has been provided by local initiatives (Galluccio and Catasta, 1992; Regione Autonoma

137 Valle d'Aosta, 2011).

138 On a global scale, there are two glacier inventories that report information about Italian glaciers.

139 The World Glacial Inventory (WGI) lists information on over 100 000 glaciers throughout the

140 world. The inventory parameters include geographic location, area, length, orientation, elevation

141 and classification of morphological type and moraines (Haeberli, 1989). The Global Land Ice

142 Measurements from Space (GLIMS) project monitors the world's glaciers primarily using data from

143 optical satellite instruments (e.g., the Advanced Spaceborne Thermal Emission and reflection

144 Radiometer, ASTER). GLIMS is a cooperative effort involving over sixty institutions world-wide

145 with the goal to inventory the majority of the world's estimated 160 000 glaciers. GLIMS maintains

146 a geospatial database available via a website featuring interactive maps and a interoperability

147 standard web mapping service.

148 Yet for all the apparent gaps, the history of Italian glaciers over the past century is remarkably well

149 documented. Every year since 1911, volunteer CGI surveyors visit the glaciers, measure the

terminus position and take pictures from fixed points; in addition, they write reports on the general

conditions of the glaciers and the main changes observed, as well as the occurrence of relevant

phenomena (e.g., rockfall, lake growth). The survey results appear annually in the CGI journal

(CGI, 2011), which was first published in 1914 under the title *Bollettino del Comitato Glaciologico*

Italiano. A valuable source of information, the journal has long been the mainstay reference for

Italian glaciological studies. In 1978, the journal changed name to *Geografia Fisica e Dinamica*

Quaternaria, when its objectives were extended to include studies in geomorphology, physical

geography and quaternary geology.

Besides the data from annual surveys, the CGI archives also contain aerial and terrestrial photos,

topographic surveys and maps, thematic maps, mass balances, journals, books, and unpublished

studies. In recent years, however, data type and format have changed dramatically: digital photos,

orthophotos and satellite images, shape files, digital terrestrial models (DTMs) and global

positioning system (GPS) points are rapidly replacing the traditional documentation formats.

As the GlaRiskAlp project continues, new glaciological data for the areas involved in the project are

being acquired, along with historical documentation from archives and libraries other than those of

the CGI. Geomorphological studies are under way to reconstruct glacier evolution since the end of

the Little Ice Age and to update the values of their principal morphometric parameters (e.g., surface,

length, altitude). Finally, the use of modern data and geographic information system (GIS) tools has

permitted the acquisition of more accurate and detailed data on glacial bodies and their recent

evolution.

3. Description of the system

The main goals that have shaped the design and implementation of the computer-based inventory

described in this paper are the following:

174   1) to archive and store the huge amount of glaciological data collected by the CGI and other

175   agencies and to plan for new types of data and data formats in current use;

176   2) to develop a tool that could catalogue the data sources for each glacier according to technological

177   standards and requirements of the major existing international glacier databases;

178   3) to share the collected data, making it accessible and useful for various purposes;

179   4) to meet the above-mentioned demands with low-cost solutions.

180   After a careful analysis of these requirements, we have decided to proceeded as follows: 1) a

181   relational database was designed and created that could store and catalog copious and

182   heterogeneous information and resources (in paper and digital format) and their interrelationships;

183   2) the design of the database was based on the data set documentation of the WGI and a set of

184   rilevant web search queries to retrieve the information and resources was designed and

185   implemented; 3) the adopted architecture was server-side with user level access regulated by six

186   privilege levels; and 4) the choice fell to the use of open source software.

187   The implemented system consists of a relational database and a web interface (see the next

188   sections); it was developed on a Microsoft Windows Server 2003 operating system on top of

189   WAMP (Apache 2.2.4, MySQL 5.0.45 and PHP 5.2.4) open source solutions. A javascript jQuery

190   framework that exploits Ajax technology and Web 2.0 principles was also integrated (Nuzzi, 2011).

191   Data persistence is guaranteed by a RAID 5 server configuration with 3 hard disks and by daily

192   backups through an external NAS unit.

193

194   3.1 Design and structure of the relational database

195   Despite its complexity (59 tables), the high-level structure of the database schema is relatively

196   simple and easy to understand (Fig. 2). The schema is centered on a table representing the main

197   concept of the domain of interest, namely, the glacier. Around this table are several other tables

198 containing additional information related to the glaciers. A special set of tables is devoted to the

199 management and tracking of end-user access to the database.

200 The additional tables are partitioned into six groups:

- *location*, *orographic info*: information on glacier location and orographic classification

- *glaciological surveys & mass balances*, *morphologic/metric info*: information on the
  morphologic characteristics of the glaciers, as well as historical information on
  morphometric characteristics and other measurements taken by human operators

- *attachments*: information on external files containing documents and other digital data
  regarding the glaciers

- *users*: information on end-user access to the database

208 The purpose of the *glaciers* table is to provide basic information about each glacier and to link it to

209 the additional information held in the other tables. The main attribute of *glaciers* for the

210 identification of each glacier is *glac_cgi_cod*, whose value is a unique standard code assigned by

211 the CGI (CNR-CGI, 1959). Each glacier is also identified by its primary (and secondary) name, as

212 well as by a unique code assigned to it by the WGI (*WGI_cod*).

213 The *glaciers* table contains additional basic information, such as whether the glacier is *extinct* or not

214 (and when), and its regional code and classification. This table (like most of the other tables in the

215 database) tracks bookkeeping information on who inserted/last modified each record and when.

216 As mentioned, the remaining attributes are links (foreign keys) to additional information listed in

217 other tables (see below).

218 The *location* tables are further partitioned into: *administrative* tables which specify locations in

219 terms of geopolitical entities (*county*, *province*, *region*, *country*); the *geographic* table specifies

220 location in terms of geographic coordinates; and the *basins* table specifies a sequence of basins that

221 connect the glacier with the sea. Each glacier can be linked to several different records in an

222 administrative table (e.g., a glacier spanning two counties), and with a sequence of basins and a set

223 of geographic coordinates.

224 The *orographic info* tables are used for the orographic classification of the glaciers within the Alps,

225 according to both the Traditional and the Suddivisione Orografica Internazionale Unificata del

226 Sistema Alpino (International Standardized Mountain Subdivision of the Alps, SOIUSA) systems

227 (Marazzi, 2005). The *Traditional classification* consists of a three-tiered hierarchy (from the top:

228 *parts*, *sections*, *groups*), while the *SOIUSA classification* consists of a seven-tiered hierarchy, plus a

229 parallel five-tiered hierarchy. Overall, 15 tables are necessary to store the hierarchies. Each glacier

230 is linked to exactly one record at the bottom tier of each of the two main hierarchies.

231 The *campaigns & mass balances* tables contain data collected from *signals* and *photographic*

232 *stations* installed near the glacier (CGI glaciological surveys), as well as data collected during *mass*

233 *balance*s. Specifically, the *measures* taken during glaciological campaigns refer to the changes in

234 the glacier terminus, while the *mass balances* refer to the changes in the glacier mass.

235 In general, a glacier is linked to several different signals and stations. Since the tables in this group

236 contain historical data, each signal and photographic station can be linked to measures taken on

237 different days, months and/or years. Similarly, a glacier is linked to several mass balances

238 performed at different multiannual periods of time.

239 The *morphologic/metric info* tables contain the morphologic characteristics of the glaciers, such as

240 the *form*, the *frontal characteristic* and the *longitudinal profile*, as well as the measurement of

241 morphometric characteristics such as *area*, *altitude* and *thickness*. Each glacier has a unique value

242 for a given morphologic characteristic. Because a glacier's morphometric characteristics can change

243 with time, the glacier can be associated with several measures of the same morphometric

244 characteristic. Similarly, several *activities* of the terminus, corresponding to different years, can be

245 associated with a glacier.

The *attachments* tables contain information about text *documents*, pictures (including *terrestrial*

photos and *aerial photos*) and cartographic data stored in digital files on the local file system and/or

on remote computers. Such files can be of any kind, e.g., a text document in *pdf*, a *jpg* image or a

drg (Digital Raster Graphic) map.

Each record in the tables of the group provides basic information about a specific attachment, such

as the *author*, *editor* and date of publication of a scientific book, or the textual description of the

subject of a photo. Most importantly, each record points to the file *path* and/or *URL* where the file

containing the attachment resides, allowing end-users to access its content.

Each attachment can have links (not shown in the figure) to the *campaigns & mass balances* tables,

making it possible, for example, to specify the glaciological campaign treated in a text document.

Finally, the *users* tables contain information on database users and their access time. Each user is

given an *access level* which can be used to limit the set of operations allowed on the data (see next

section).

The bookkeeping information also includes descriptions of official *projects* during which the data

on the glaciers were collected and entered into the database, and tracks the participation of the users

in such projects.

3.2 Web interface

The Italian Alpine Glacier Inventory (IAGI) website was designed and developed to meet the needs

of a diversified and distributed public. The interface design is simple and intuitive with a high level

of usability. The server-side architecture permits access to the IAGI from any given point in the

network through the use of a common web browser. The website comprises 306 pages, structured

into two distinct sections: Database management and Search the entire glacier inventory. The first is

subdivided into two levels: one for data entry and the other for data modification. The second

section contains the pages in which users can carry out database searching. In order to query the

271 database and retrieve relevant information, 54 predefined web search queries were created. These

272 are grouped under Glacier (10), Geography (8), Morphology (25), Glaciological Survey (4) and

273 Management (7). With these queries users can browse the entire database and focus the search on a

274 specific resource type (Table 1).

275 Through this website interface any type of acquired glaciological resource can be archived and

276 managed (paper or digital format), specific searches performed (on one or more glaciers, by Alpine

277 range sector, by hydrographic basin, by administrative criteria), and the results printed and exported

278 in a common format (PDF, CSV, JPEG).

279 The database access has six different login levels for each user assigned by the administrator.

280 1. Basic search (access to metadata, query and report print out);

281 2. Advanced search (access to metadata, access to digital resources, query, and report print out);

282 3. Basic use (access to digital resources, data entry and management, query, print out and

283 exportation of results);

284 4. Glaciological operator use (data entry and management of resources related to glaciological

285 surveys, access to digital resources, data entry and management, query, print out and exportation of

286 results);

287 5. Advanced use (data entry and management of all resources in the database, access to digital

288 resources, data entry and management, query, print out and exportation of results);

289 6. Administrator (full access)

290 The advantages to having six different access levels are that the IAGI can be used by many different

291 kinds of users simultaneously and that the database management is kept simple and versatile. The

292 IAGI website is available at http://dbirpi.to.cnr.it/db_cgi/index.php (Italian version, an English

293 version is planned in the near future).

294

295 4. Discussion

296   The integrated database and web interface system was designed and developed to meet clearly

297   defined goals (see section 3). Thanks to the choice of well established open-source, standard-based

298   technologies, both the database and the web interface could be implemented with low set-up cost

299   without compromising on reliability and quality.The use of a relational database to store and

300   organize the vast variety of information and resources about Alpine glaciers collected by the CGI

301   over the last century constitutes a significant step forward in ensuring the safety, reliability,

302   scalability and accessibility of such data. Moreover, the same benefits also apply to the enhanced

303   operability for handling information in the future, including new and emerging types of data

304   formats such as geographic and multimedia files.

305   Another important benefit is that, thanks to its flexibility and comprehensiveness, the database

306   makes it possible to envision future extensions and new applications for enriching, analyzing and

307   extracting the information it contains (see next section for future research directions).

308   As concerns the IAGI web interface, we believe that its principal strength lies in its high level of

309   flexibility – inspired by dynamic content management systems (DCMS) – wich permits the

310   management of a wide range of type of resource and the creation of various different types of

311   reports;

312   Two current weaknesses of the IAGI are:

313   1) a predefined query set that, while permitting faster data search operations, limits the range of

314   information that can be retrieved according to narrow criteria, which may be frustrating for users;

315   2) the lack of a system that can visualize spatial data, although the georeferenced coordinates for

316   each glacier are present in the database. Solutions for this latter issue are currently being sought.

317

318   5. Future work and conclusions

319   This work is an excellent starting point for the management of existing glaciological data. It must

320   however be able to integrate cartographic data such as base maps, satellite images, vector data,

321 etc.etc.. the proposed relational database will be the heart of a new geographic system that will

322 merge data, data attributes and maps with a complete description of glacial italian environment.

323 Future developments are being pursued along two lines of research: 1) ongoing collaboration with

324 the CGI for the collection, analysis and cataloging of data recorded from the early 1900s to the

325 present; and 2) through this joint collaboration, to create an infrastructure of spatial data to be

326 associated with the current database with a view to enhance accessibility and exchange of

327 information (maps and attributes) about Italian glaciers.

328 In recent years, the Ministry of the Environment and Protection of the Land and the Sea (Ministero

329 dell'Ambiente e della Tutela del Territorio e del Mare (MATTIM) is placing its infrastructure of

330 web-based services at the disposal of local agencies in a strategic move to promote and disseminate

331 the use of geographical data and to make environmental and land-use information available to a

332 wider public, including the general public, in connection with national and European projects and

333 initiatives. Through collaboration with the CGI and the Ministry of the Environment the web-based

334 services can be utilized, uniting the information retrieved from the CGI database with those

335 accessible from the national geoportal.

336 The first step is to collect data in digital format, organize and then disseminate the data amassed

337 since the CGI started collecting records, the bulk of which is either not yet accessible or difficult to

338 work with because not interoperable. Specifically, the idea is to create a glaciological geoportal

339 connected to the Ministry of the Environment that will enable access to descriptive data about

340 glaciers and the measurements taken during glaciological surveys and those derived from

341 orthoaerophotography or satellite imaging. The project will be set up according to an infrastructure

342 of spatial data with an architecture that conforms to the principles and standards set forth by the

343 Infrastructure for Spatial Information in Europe (INSPIRE) initiative. The glaciological geoportal

344 will allow users to conduct research on metadata provided by the project partners and to visualize

345 the data published by the partners' services.

14

346   All the databases will be implemented or interfaced with instruments that support the standard Open

347   Geospatial Consortium (OGC) interfaces such as the open source software program PostGIS and

348   the PostgreSQL relational database. The georeferenced data will be accessible through the OGC's

349   web map services (WMS) and web feature services (WFS). Maps can be dynamically created using

350   the WMS spatially referenced data derived from geographic information (Fig. 3). This international

351   standard defines a map as a representation of geographic information, producing a digital image that

352   can be visualized with a web browser.

353   The interesting aspect of this solution resides in the MapServer's capability to integrate in real time

354   local data (from geographic files and/or dbms) with remote data retrieved from servers compatible

355   with the WMS standard, thus achieving full data interoperability.

356   The function flow chart may be summarized as follows:

357   • Map request: the user sends the request to the remote MapServer though the web interface;

358   • Access to local data: the CGI MapServer collects local data held on typical storage systems

359   for geographic data (filesystem and/or geographic rdbms);

360   • WMS layer request: the CGI MapServer requests from the remote server at the Ministry one

361   or more geographic layers though a WMS protocol standardized by the OGC and the ISO;

362   • Fusion of the layers: the MapServer integrates the data (local and remote) to create the final

363   map.

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496   Figure captions

497   Fig. 1. Galambra Glacier (Valle di Susa, Italy) WGI code: I4L01471002, CGI code: 26. A) Picture

498   postcard postmarked 3 May 1954 (courtesy of G. Mortara). B) Photograph taken on 8 August 2009

499   (courtesy of F.M. Tron).

500   Fig. 2. Structure and database schema.

501   Fig. 3. Schematic diagram of geographic interchange data based on OGC/ISO Web Map Service

502   (WMS). From Ministero dell'Ambiente e della Tutela del Territorio e del Mare, modified.

503

504   Table captions

505   Table 1. List of the search queries. >, related to; (), number of queries for this search.

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524 Table 1

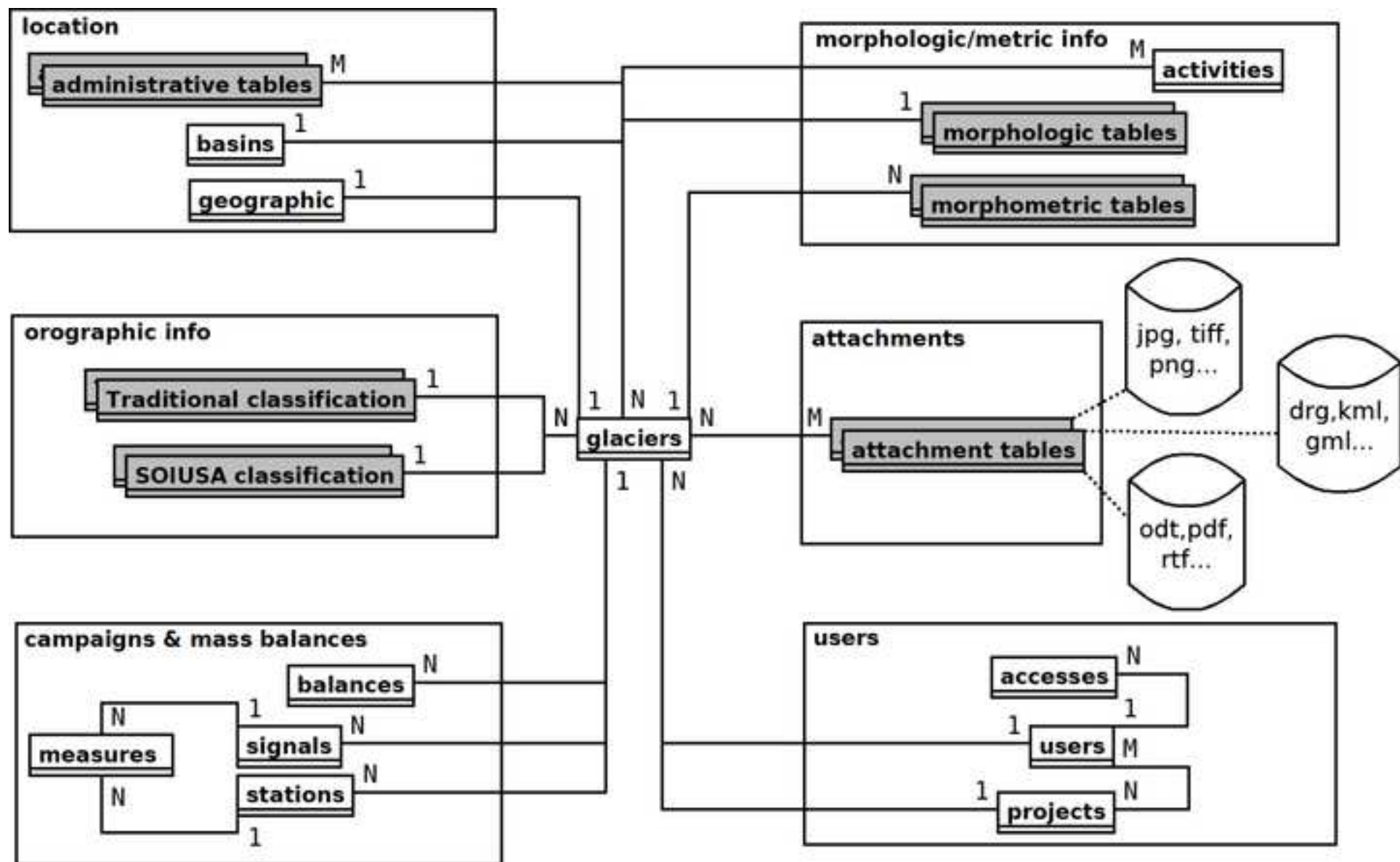| Glacier	Geography	Morphology	Glaciological survey	Management
List of the glaciers	Glaciers > municipality	Glaciers > morphology (7)	Fluctuations > glacier	Project list
Glacier report	Glaciers > province	Glaciers > morphometry (2)	Fluctuation > glacier > year	Glaciers > project
Glaciers > extinct	Glaciers > region	Glaciers > aspect (16)	Mass balances > glacier	Project > start date
Glaciers > operators	Glaciers > country		Mass balance > glacier > year	Projects > manager
Glaciers > compiler	Glaciers > effluent			Glaciers > user
Glaciers > attach. (5)	Glaciers > tributary			Accesses > user
	Glaciers > orographic classification (2)			Delete glacier

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