OPEN SOURCE GIS FOR GEOLOGICAL FIELD MAPPING: RESEARCH AND TEACHING EXPERIENCE

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ABSTRACT

The journey to digital field mapping in the geosciences academic world is far from ending. When it started some years ago, many geoscientists were skeptical about the use of digital tools in the field. Nowadays, the work done in this decade shows clearly that this will be the way of working in the future. The traditional way of mapping can be incorporated and improved in the digital survey. Many of the previously existing limitations have been overcome. Part of this process is possible thanks to the choice of open source tools.

Keywords: Digital Field Mapping, Mobile GIS, Tablet PC, Android

A SHORT HISTORY OF GIS IN THE FIELD

Background

The use of GIS for geological cartography started in the late 80's with commercial ARC/INFO software (ESRI) and heavy learning job. Even if this way of working allowed to reach new frontiers in geological data and information treatment, it discouraged more traditionalist geologists. Few years later, when new software and hardware allowed a simpler approach, many geologists started to work with GIS in the lab after their traditional field data mapping with paper and pencils. The idea of using GIS directly for the fieldwork arose in the 1999, when a slate model of Fujitsu Stylistic LT pen computer with stylus became available. The first experience in the field was very frustrating. The carry bag, the luminosity and readability of the screen, the pen response, the usability of the software (Bentley Microstation Geographics) suggested to give up with digital geological survey.
A few years later, Microsoft released a Tablet PC edition for Windows XP and some computer brands (HP, Acer, etc.) started to sell convertible or slate pc.
The stylus tool for input allowed to keep the traditional way of field mapping (pencil on the paper) whilst using digital devices with large number of advantages (higher precision, control of field work, separation of data and interpretation, simplifying group works, quantification of uncertainty, etc.).

Starting with commercial software (Map IT)

Thanks to the availability of better operative systems and hardware, the idea of bringing GIS in the field for geological survey resurfaced. What we needed at that moment was a real mobile GIS.
A successful collaboration started between *LINEE* (Laboratory of Information technology for Earth and Environmental Sciences) and an Italian software company, Terranova, which was developing an ArcView competitor, named Shark. Thanks to a PhD work, in 2004 we were

able to release the first version of Map-IT (De Donatis & Bruciatelli, 2006), a modified Shark GIS with a number of tools (GPS acquisition, Easy note, Form Editor, hand notes on maps and pictures, etc.; see Fig. 1). Map IT was presented at 32nd International Geological Congress held in Florence on August 2004. It ran on a rugged heavy tablet pc, Xplore iX104 with Win XP tablet edition.

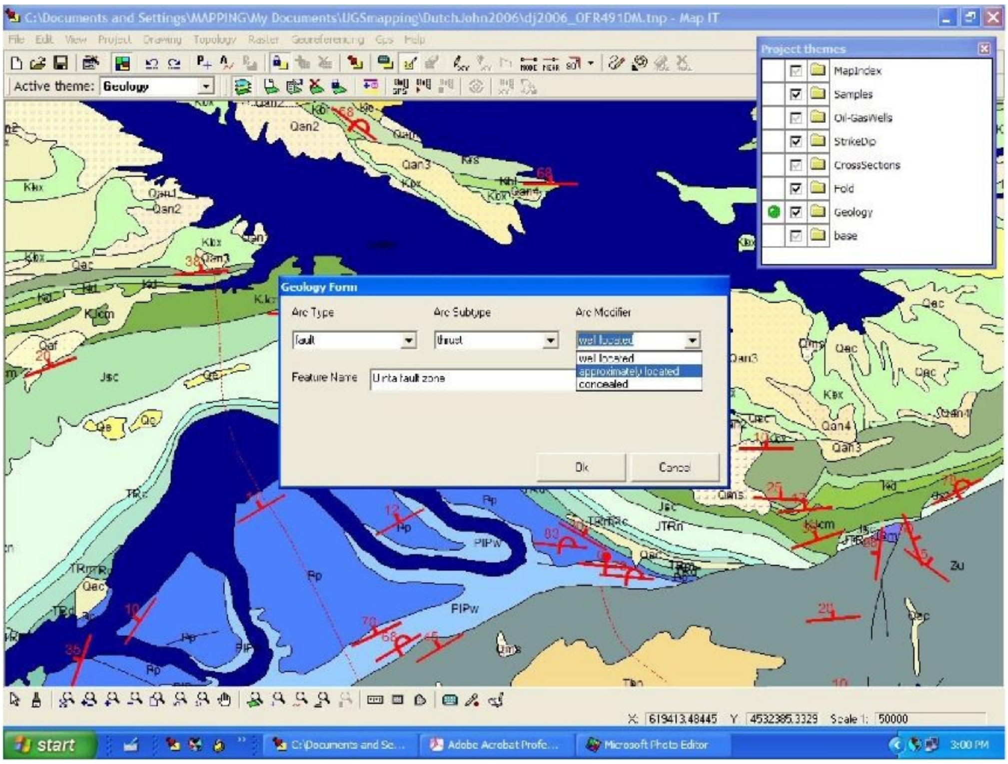

Figure 1. Example of geological field map on MapIT (from Brown and Sprinkel, 2007).

The beginning was promising and the following year Map-IT was presented at DMT '05 (De Donatis *et al.*, 2006), held in Baton Rouge. A few geological surveys adopted Map IT for their field mapping work (Brown & Sprinkel, 2008). Also academic research collaboration was carried out in order to compare different way of digital field work (Clegg *et al.*, 2006; De Donatis *et al.*, 2008). But after a very short period of time the commercial company decided to discontinue the collaboration, due to a change in business policy. Therefore the attempts of bringing GIS in the field received another stop.

Discovery of the open source world (Udig - BeeGIS)

During the first GIT (Geology and Information Technology) meeting held in San Leo (Italy) on June 2006, a new collaboration with one young PhD researcher started, and the idea of transferring the tools already developed for a commercial software into the open source world was conceived. The choice of the programming language, Java, was taken by the developer in order to optimize the coding work. Therefore a number of plug-in was developed on top of uDig (by Refractions Ltd), creating a mobile GIS named BeeGIS (De Donatis *et al.*, 2009; see Fig. 2).

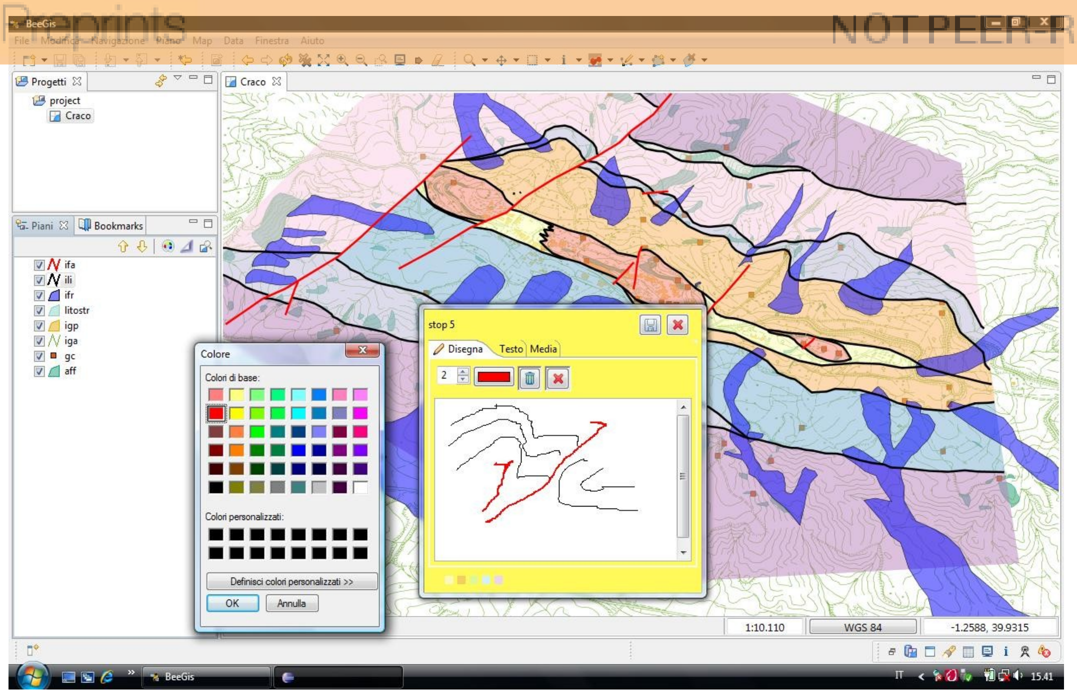

Figure 2. Geological map and Geonote on BeeGIS built on top of Udig.

Also the hardware was different: 21 HP Compaq 2710p running Windows Vista OS were awarded to University of Urbino - LINEE by HP, to be used for research and also teaching activities.
Even if at the beginning BeeGIS presented some annoying bugs, we were able to use it in a large number of research and teaching experiences (for instance, with primary and secondary school mapping the town of Fermignano - Italy on OSM; Fig. 3).

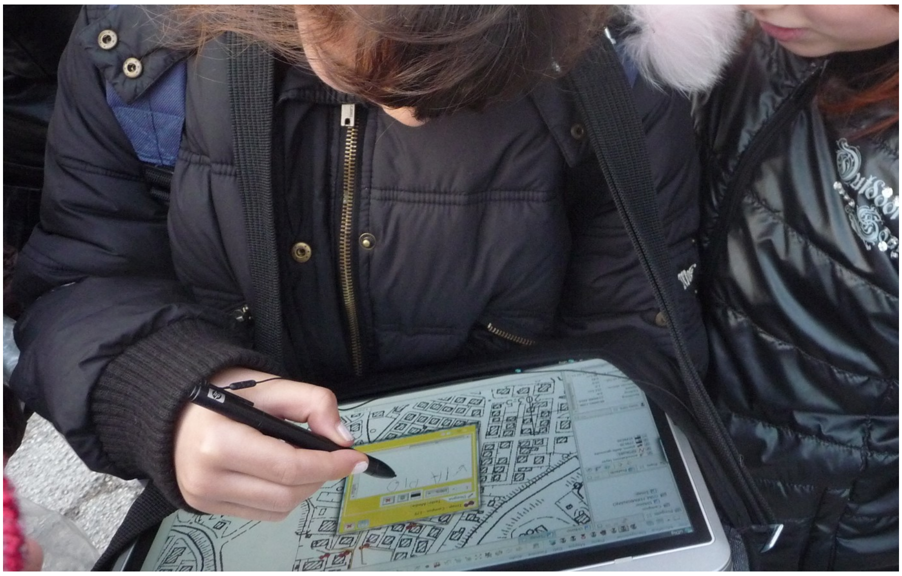

Figure 3. Kids working on town survey with BeeGIS.

A robust GIS (QGIS)

When considering the open source ecosystem, we must consider the developer and user communities contributing and using an open source software. The dynamic and growing community of the "QGIS people" is an important factor helping to have a continuously improved software, with many additional plugins. Tools like Qt Designer, that is very user-friendly, and the Python language help people without a coding background to contribute code and tools to this project. Therefore we chose to port the previously tools to the QGIS ecosystem. Two plugins are presently developed: BeePen, for freehand drawing and BeeGPS, for the import of GPS data in QGIS (Fig. 4).

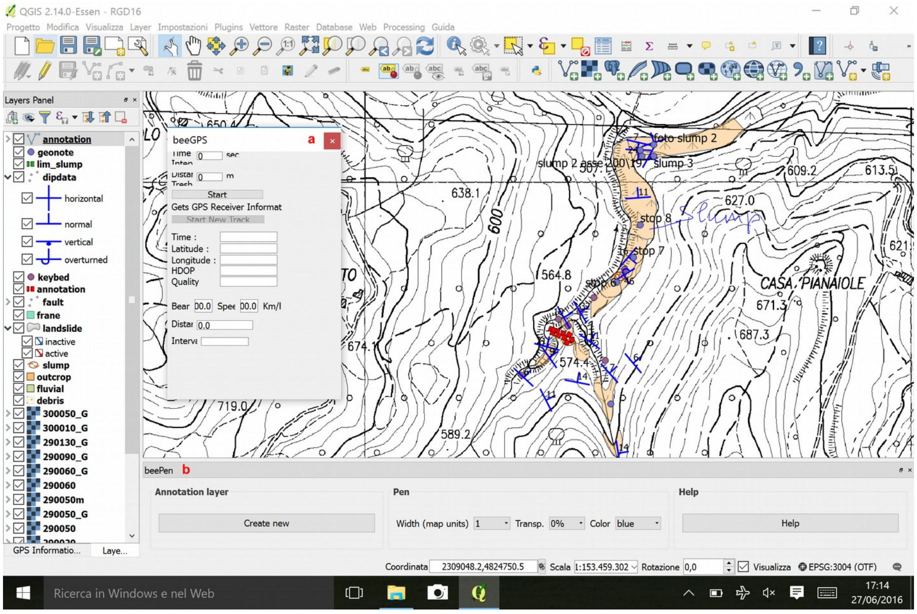

Figure 4. QGIS with mobile tools: a. BeeGPS and b. BeePen.

The Android way

A parallel path was developing tools also for Android. Since the first Android smartphones (HTC) were available on the market, we sustained the development of app which in the first steps were a kind of "light solution" linked to the more powerful GIS world. This was the case of Geopaparazzi which started during a PhD project at Urbino University and currently is maintained by a private consulting company. But the experience was not only limited to that app: in collaboration with another company operating in the open source environment, we started a large project on an app called BeeBook (De Donatis *et al.*, 2014; see Fig. 5). This work is still in progress and open to any collaboration. In synthesis BeeBook is a sort of field book with a "transparent" GIS able to be easily linked to QGIS.

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Figure 5. BeeBook on-the-way.

RESEARCH

The research on digital field mapping software has been focused on the following points.

1. Keeping the traditional way of mapping:
   - Pen-on-the-paper Method thanks to the "Digital-Ink Technology";
   - Minimal "digital" education.
2. Fast acquisition with simple tools:
   - Minimum number of toggle on the tool bars with performing procedures;
   - Easy connection of other digital devices (GPS, photocamera, digital compass, etc.);
   - Avoiding system/driver/IT problems;
   - Right human interface (dimensions, readability).
3. Improving accuracy/precision:
   - Taking in account the limitation (uncertainties, scale, and so on) of "paper" mapping;
   - GPS positioning can improve precision and quality of data;
   - Assessment of uncertainties by knowing the survey area coverage (control on the field work);
   - allowing usage of 3rd and 4th dimensions.
4. Storing and managing all data:
   - Storing all data/info in the same folder/directory;
   - Bringing in the field useful documents (maps, articles, texts, etc.);
   - Differentiating between actual data/info and post-processing interpretations (different layers).
5. Transferring and/or sharing data/information:
   - Possibility of transferring all data/info in other applications/tools;
   - Easy transmission of data/info (e-mail, cloud);
   - Allowing group work.

About the applications of digital field mapping, we were able to work in a number of different projects also outside the geological realm. Among them, we surveyed the pathway network of part of the Apennines for the Marchean pathway cadastre (De Donatis & Selandari, 2013; see Fig. 6).

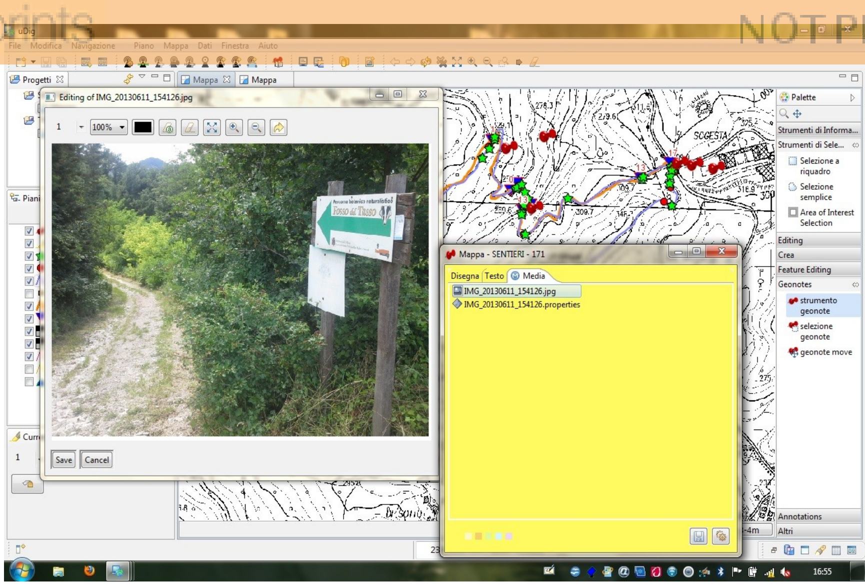

Figure 6. Example of pathway network mapping.

TEACHING EXPERIENCE

Since 2004, we had many university courses in different topics and levels where we used mobile GIS intensively (De Donatis, 2007). In the last two years, the students of Digital Geological Mapping course thought in the Geological Sciences Master degree, use QGIS with *ad-hoc* plugins and Qt Designer. New tools for geological notes and other functionalities are still in progress.
In the meantime, students of Applied Computer sciences have been involved in developing plugins. Sometimes both courses students meet each other. In this way developers known the real needs of users, working together.

CONCLUSION

The Open Source GIS environment is a promising way for developing digital work in the field with proper hardware and software tools. In any case, the number of *Pros* of the digital mapping result larger of *Cons*. Even if it is in its "infancy" and requires a "digital education" with costs for hardware and learning, digital field mapping with open source GIS, has opportunity of: catching, updating and managing data in the field, also for group work; storing data personally by the surveyor (minimal lost of information); evaluating data whilst they are gathered; controlling the field work; georeferencing any kind of information (sketches, photos, thoughts); storing data and interpretations in different layers; allowing quantification of uncertainty.

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