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Free software: A review, in the context of disaster management

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A R T I C L E I N F O

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A B S T R A C T

This article examines the nature of freely available geospatial software and information systems in the context of disaster management. The use of geospatial data is crucial to effective disaster management, from preparedness to response and recovery. However, to make efficient use of available data and information – before, during and after a disaster – reliable software is required. The software applications examined in this paper range from Geographical Information Systems, to the processing of remotely sensed images, crowd-source mapping, web applications and content management systems. Trends and challenges are considered, and guidelines are given, to foster and encourage the provision of information by Freeware and Open Source Software. Free geoinformatics can help to optimize the limited financial, technological and manpower resources that many organisations face, providing a sustainable input to analytical activities.

Contents

1. Introduction

In this article we discuss freeware and open source software, then examine various freeware projects and assign functional categories for a comparative analysis. Guidelines are given on the selection of free software, including criteria that should be considered prior to its use for disaster management applications. With regard to disaster management applications, the most important software belongs to the Geographic Information Systems (GIS) group, with a smaller set of software dealing with the processing of remotely sensed data. Emergency planners, crisis responders or disaster managers can use geoinformatics to maximum effect at the district or city administrative levels, incorporating community knowledge and involving local decision makers (Das, 2012).

2. 'Free Software' – what is it?

The term 'Free and Open Source Software' (FOSS) was introduced in response to restrictions on access to source code for hardware drivers and software, which prohibited unautho-

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rised changes to copyrighted computer code (Stallman, 1999; Grassmuck, 2004). Thus the idea of 'free software' has its origin in free speech, rather than free-of-cost. Steiniger and Hunter (2013) state that: "*. . .a distinction between 'free software' and 'commercial software' is neither correct nor expresses the thinking of the creators of free software [..] that grants freedoms of use, modification and redistribution to the public; whereas commercial or proprietary software [..] takes these freedoms away. . .*" According to the Free Software Foundation (2014), 'free software' grants four freedoms, to: (i) run the software for any purpose, (ii) study and adapt the software for own needs, (iii) redistribute the software, (iv) improve the software and release improvements to the public. Types of software licenses are reviewed by Steiniger and Bocher (2009). Open Source software, under the GNU General Public License (GNU, 2014) is desirable, but it may limit the software that can be used. To gain the interest of potential users in low-income countries (LICs), it is important that software is free and easily accessible. With regard to FOSS applications for sustainable development, UNESCO (2014) recognizes that:

- Software plays a crucial role in access to information and knowledge;
- Different software models, including proprietary, open-source and free software, have many possibilities to increase competition, access by users, diversity of choice and to enable all users to develop solutions which best meet their requirements;
- The development of open, inter-operable, non-discriminatory standards for information handling and access are important elements in the development of effective infrastructure;
- The FOSS model provides tools and processes with which people can create, exchange, share and exploit software and knowledge efficiently;
- FOSS can play an important role in development. . . its free and open format make it a natural component of development efforts in the context of the Millennium Development Goals;
- Consistent support plays an important role in the success and sustainability of FOSS.

To encompass the ideas of UNESCO we define FOSS as 'Freeware and Open Source Software'. We use 'FOSS4geoinfo' as an abbreviation for: 'Freeware and Open Source Software for geoinformatics'. FOSS4geoinfo includes the free-of-charge aspect, as well as software for GIS, GPS data and remotely sensed data.

3. Categories of geoinformatic software

GIS software is used to create, manage, store, analyse and visualize geographic data. Steiniger and Hunter (2013) summarised seven types of GIS software: (i) Desktop GIS; (ii) Spatial Data Base Management Systems; (iii) Web Map Servers; (iv) Server GIS; (v) Web GIS clients; (vi) Mobile GIS and (vii) Libraries and Extensions, Plug-ins and application programming interfaces (APIs). We extend that software classification to include: Data Viewers; Web Applications; Cloud storage/sharing; and specialized Tools (e.g., radar data). A summary can be seen in Fig. 1, which shows geoinformatic software that have disaster management uses.

The remote sensing domain is dominated by proprietary software. However, some free alternatives exist as standalone products, or as modules in FOSS4geoinfo sets. GIS software functionality encapsulates the functionality required to create maps and visualize geographical data. Remote Sensing software focuses on extracting information from geospatial imagery and image classification. GIS and Remote Sensing software capabilities should be used in conjunction to obtain the best results, from data pre-processing, to analysis and map creation or visualization. Remote Sensing software should be considered as a software type that complements GIS software, not as "a special form of desktop GIS" (Steiniger and Hunter, 2009).

The software most relevant for disaster management mapping and geoinformatic analysis can be grouped into: Desktop software, Mobile software and Online software (Fig. 1). These groups could be extended by online-applications and websites, however reliable Internet connectivity is not the norm in all countries. Table 1 shows how the software categories link with the stages of disaster management.

3.1. Desktop and mobile GIS software

The majority of geoinformatic analysis is still performed on workstations with desktop software, despite the increasing opportunities provided by parallel and cloud-computing. With disaster response, typical Desktop GIS software tasks include the display, query, update, and analysis of locational data and their linked information (Steiniger and Bocher, 2009; ESRI, 2012). Software libraries, such as GDAL (for raster data) and OGR (for vector data), are the backbone of many Desktop GIS software. Most recent GIS software has some form of geospatial database and web functionality. Steiniger and Hunter (2013) identified eight "mature Desktop GIS projects" with functionality comparable to proprietary software and an active international user community: (i) *GRASS GIS* (Neteler et al., 2012); (ii) *Quantum GIS* (Hugentobler, 2008); (iii) *ILWIS* (Hengl et al., 2003); (iv) *uDig* (Ramsey, 2007); (v) *SAGA* (Olaya, 2004); (vi) *OpenJump* (Steiniger and Michaud, 2009); (vii) *MapWindow* (Ames et al., 2007); (viii) *gvSig* (Anguix and Diaz, 2008).

Each of the software projects in Fig. 2 can visualize raster and vector data, perform basic geoinformatic operations and most offer plug-in software to extend functionality; they differ in their processing capabilities and support. The GIS user community has shifted its preferred choice of software, from *ILWIS* and *MapWindow*, to *QGIS*, which is now considered to be more user-friendly and versatile than most other FOSS4geoinfo software (e.g., Chen et al., 2010).

Although the number of mobile phones has increased, along with the corresponding network-coverage and network-speed, few disaster management applications run on mobile platforms, such as mobile phones or tablets. There are many navigation software apps for mobile devices, but most cannot export data. Two exceptions, which allow the export of GPS data, are *TangoGPS* (http://www.tangogps.org/) and *FoxtrotGPS* (http://www.foxtrotgps.org/). Data collected by mobile devices might also require processing on workstations with Desktop GIS. Usability of mobile platforms is further limited by the often small display screens, limiting operational activity.

Amongst the geoinformatic software available for mobile devices the Android platform dominates, with the availability of *gvSIG Mobile* and *QGIS*. Notable mobile phone apps with disaster management uses are: *Geopaparazzi*, an Android app for engineering geology surveys: it can store georeferenced notes and images, log GPS tracks, create a map for navigation and export data; *GeoNotes*, an iOS app that works as a notebook tool, automatically associating a data log with its GPS location and showing user-selected "hot spots"; *EpiCollect* and its derivative, *Magpi*: Android apps for epidemiological surveys. Some commercial app-builders provide free basic functionality, but there is also an effective free alternative, with the MIT app inventor. The mobile device apps scene changes rapidly and to assist project continuity a critical mass of users and developers is needed.