Nat. Hazards Earth Syst. Sci. Discuss., 1, 5753–5777, 2013
www.nat-hazards-earth-syst-sci-discuss.net/1/5753/2013/
doi:10.5194/nhessd-1-5753-2013

Natural Hazards and Earth System Sciences
Open Access
Discussions

On the use of Web-based-GIS for managing and disseminating hazard and risk spatial information in volcanic areas

G. Le Cozannet[1,2], M. Bagni[3], P. Thierry[1], C. Aragno[3], and E. Kouokam[4]

[1]BRGM, Orléans, France
[2]Université Paris 1 Panthéon-Sorbonne/Laboratoire de Géographie Physique, CNRS – UMR8591, Paris, France
[3]KELL, Roma, Italy
[4]Ministry of Industry, Mines and Technological Development, Yaoundé, Cameroon

Received: 25 July 2013 – Accepted: 25 September 2013 – Published: 22 October 2013

Correspondence to: G. Le Cozannet (g.lecozannet@brgm.fr) and M. Bagni (m.bagni@marcobagni.com)

Published by Copernicus Publications on behalf of the European Geosciences Union.

Abstract

In volcanic areas exposed to multiple geological hazards, the efficient interpretation of the increasing amount of geographical data is a challenging issue. Within the European MIAVITA project, we investigated to which extent WebGIS can facilitate this interpretation through the visualization of such complex hazard and risk database. This analysis was structured around (1) the development of a Web-based Geographical Information System (WebGIS) and of an application for managing the geographical database, and (2) interactions with a group of hazard and risk analysts and managers, civil security officers, GIS analysts and system developers. We tested the system in the Mount Cameroon volcano, taking advantage of a complex hazard and risk geographical database collected previously. Key requirements here related to the need for a structured and flexible GIS-database and to manage user's privileges differently according to their profile and the status of the volcano. In addition, this study showed that it is important for such systems to manage different status for data, from data than can only be interpreted by experts (e.g. some complex remote sensing products) to data that can be disseminated to any potential user (e.g. a regulatory hazard map). While the developed tool is able to provide users with enough flexibility to respond to the users' requirements, it is still necessary to own expertise in WebGIS to manage such tools in the long term in local volcano observatory. Nevertheless, this study shows that WebGIS-based systems can relatively easily integrate some most important working procedures of hazard and risk management in volcanic areas.

1 Introduction

An important challenge of disaster risk reduction is to connect management and decision making practices with scientific and technical knowledge in an efficient way. To achieve this aim, one of the strategies consists in users and scientists co-producing common knowledge and "boundary objects" (Cash et al., 2003). In the field of risk management in volcanic areas, this includes for example scenarios, hazard and risk maps (e.g. Thierry et al., 2008), and tools such as Geographical information systems to disseminate this material (Pareschi et al., 2000). Owing to recent technological developments, web-based cartography has now reached the maturity for disseminating the heterogeneous hazard and risk geographical information (e.g. Mueller et al., 2006; Douglas et al., 2008). However, developing Web-based geographical information systems (WebGIS) is not limited to displaying already existing maps. On the contrary, it requires taking into account the workflows of targeted users (e.g. civil security, decision making authorities), i.e. the way they use spatial information in their day to day work (Culshaw et al., 2006).

Previous WebGIS tools have been developed for volcanic hazards. For example, the Globvolcano and EVOSS tools were focused on the distribution of volcanic-hazard services based on satellite products. The EVOSS tool is a demonstrator of future operational services of GMES, and it is particularly focused on the monitoring of volcanic natural phenomena. The tool developed within the HOTVOLC project is focused on disseminating information on volcanic ash in near real time. One important application of this tool is the management of volcanic ash crisis and the associated threats for airplanes navigation. Finally, the Lav@hazard tool (Vicari et al., 2011) is focused on the production of lava-flow scenarios. Such tool can be used for prevention, preparedness and during the crisis for assessing the threat induced by lava flows and take the appropriate measures. Here, the objective is to develop a WebGIS that disseminates hazard and risk information over a volcanic area, with emphasis on the prevention phase of the disaster cycle (Fig. 1) and on the needs of local populations and authorities in terms of prevention and preparedness actions.

What are the minimum requirements for a risk and hazard GIS data repository? In risk management, risk is a measure of the expected probability of damages induced by adverse events. Risk is therefore a combination of the multiple relevant hazards in a given area, of the exposed assets, their vulnerability and of the capacity of societies to cope with these hazards (e.g. Marzocchi and Woo, 2009; Alberico et al., 2011). At

NHESSD
1, 5753–5777, 2013

least, a territorial GIS risk repository should therefore contain a multi-hazard map (e.g. Kappes et al., 2012; Neri et al., 2013), an inventory of exposed elements together with attributes such as their physical vulnerability or their importance during disaster crisis or recovery, and the associated risk maps. From the risk management perspective, even more important than the detailled accuracy in a particular dataset is its completeness, that is, the fact that it addresses all hazards and type of assets at risk in a given territory.

Within the European MIAVITA project, we examined how WebGIS can be helpful for hazard and risk spatial information dissemination and management. For this purpose, we analysed existing geographical information workflows with a group of stakeholders and designed a Web-based GIS system accordingly (Sect. 2). We tested the system at Mount Cameroon using an existing set of hazard and risk geographical data (Sect. 3). The objective of this tool is here to enable the visualisation, by non-GIS experts, of this complex database (Fig. 2). This experience provides insights for discussing the potential for the development of such tools and their integration within current risk management practices in volcanic areas (Sect. 4).

2 System design

We designed the system from 2009 to 2012, taking advantage of a network of stakeholders in volcanic risk management gathered through the MIAVITA project. The design of the tool followed a classical V cycle for software development and the main steps of the system design are detailed.

2.1 Stakeholder's group

We gathered a group of stakeholders composed of volcanoes observatories scientists, hazard and risk analysts and managers, civil security officers, GIS specialists and the system developers. This group brought together about 12 persons involved in prevention, preparedness and crisis management of volcanoes in Cameroon, Cape-

NHESSD
1, 5753–5777, 2013

Verde, Philippines and Italy. The role of the group was first to formalize requirements for the WebGIS system. At later stages of the project, it was invited to provide comment on two versions of the proof of concept tools.

The approach consisted in formalizing progressively requirements through informal discussions, the elaboration of the data flow diagrams, brainstorming meetings and discussions around an evolving prototype. Similarly to the case studies described by Darke and Shanks (1997), we did not apply one of the existing methods for user requirements collection in the field of information system science; on the contrary, we set up solutions for the practical problems encountered in an empirical way.

2.2 Definition of use cases

Building on the experience in volcanoes case studies in the MIAVITA project, we analysed how hazard and risk information could constituted in an idealised case (Fig. 3). This led to define use cases of the WebGIS application (Fig. 1), i.e. to display information in support to:

- prevention and recovery: map of elements at risks and regulatory hazard and risk maps;
- preparedness: pre-determined hazards or risk scenarios aiming at testing the response capabilities of the authorities in charge of crisis management (e.g. Gehl et al., 2013);
- crisis management: this includes map of strategic infrastructures for the evacuation of people and for sustaining life in non-evacuated areas (e.g. strategic building such as schools or community facilities that can serve as shelter), and possibly near real time information provided by field civil security agents or scientists informing about the ongoing volcanic activity and security operations;
- background geographical information on the zone: e.g. geological map, natural environment, high resolution optical satellite images;

NHESSD
1, 5753–5777, 2013

– scientific information that still requires being interpreted before being released to any user: this includes for example complex remote sensing products such as satellite aperture radar interferogramms, or geolocalised reports from field scientists.

This analysis highlighted the importance of a seamless maintenance of the system through appropriate updates and a clear definition of responsibilities. In practice, a single entity should be responsible for the system. In many cases, this entity would be the local volcano observatory.

2.3 User's requirements

As a first requirement, users wished that the database could be managed in a structured but flexible way. For this purpose, we developed a controlled vocabulary describing the content of the hazard and risk geographical database and organised in a hierarchical form (i.e. a taxonomy; see Fig. 4). This taxonomy was reviewed by users and provided to the system developer as an example for the first implementation of the system. It covers all geographical datasets presently used in risk management practices in the MIAVITA volcanoes.

Secondly, users required a seamless management of the maturity of data, including a clear validation by civil security or by a local volcano observatory. We defined a scheme of information flows between the system, data providers and users (Fig. 5). This scheme was designed to ensure that (1) the control of the database remains the sole responsibility of the local volcano observatory (or of the national organization in charge of volcanoes) and (2) the data provided to each type of user remains adapted to its use.

Other requirements included the possibility to manage a variety of access rights and privileges for each type of users, particularly according to the different phases of volcanic crisis: during volcanic unrest and the eruption climax, the priority should be given to civil security users or to the organizations in charge of the crisis management.

NHESSD
1, 5753–5777, 2013

Because the information disseminated through the WebGIS can be sensitive, an authentication of any user willing to access the application was requested. Finally, we identified the need for accessing to the tool using mobile devices, particularly for helping uploading information from the field directly to the system for avoiding time-consuming copies of notes.

Other potential capabilities of the system were discussed. For example, the development of geoprocessing tools (i.e. applications that enables to modify the geometry of geographical objects) was not considered as a priority since the system was designed for helping untrained users to visualize the geographic database. The potential interoperability capabilities were discussed in details: from the user's perspective, they appeared less relevant in a first volcano's hazard and risk dissemination platform than for other environmental data dissemination systems: in fact, we noticed that in many of the volcanoes case-studies of the MIAVITA project, most of the data are owned or managed by a single organization. However, it was also recognized that the compliance to the interoperability norms would reinforce the ability of the system to manage new data, thus increasing its sustainability.

2.4 System development and functionalities

In order to fit those requirements, the GIS architecture has been designed by dividing the main components into four subsystems each one interacting with the rest of the modules, but nevertheless being independently configurable according to the user needs. This subsystems are the following (Fig. 5): (1) a Web server; (2) an Authentication, Authorization and Audit (AAA) server, which provides security services aimed at applying the access and control rules; (3) a GIS Publisher enabling the final data provisioning and distribution; we enclosed this system into a wrapper to accomplish the security requirements stored in the AAA Server; and (4) repositories that includes applications requested to configure the AAA Server and a file-based or data-base management system (DBMS)-based GIS repository. For reinforcing reliability, each component can be hosted on an independent platform and repositories

NHESSD
1, 5753–5777, 2013

can be hosted on High Availability infrastructure that goes from a Redundant Array of Independent Disks (RAID) of type 1 (mirroring without parity or striping) up to a RAID of type 5 (block-level striping with distributed parity) architecture. The GIS database contains both data and metadata based on the taxonomy (Fig. 3). However, the system provides the possibility to define other taxonomies as wished by the users.

The system administrator can grant different privileges to each user, allowing a very fine configuration tuning, permitting the independent setting of the following privileges on a "per taxonomy node" basis (Table 1). The privileges can be applied to a single GIS layer or a whole branch in the GIS Layers' taxonomy and reflect the different actions that a user can perform on a GIS data, starting with the more general ones:

- **Insert** a new GIS Layer into a specific taxonomy location.
- **Update** the meta information with a loaded GIS Layer.
- **Delete** a GIS Layer from the system.

And continuing with privileges more specific of a GIS publishing server, like:

- **Publish** an already loaded GIS Layer making it available to the users that have granted Web Maps Services (WMS) or Web Feature Services (WFS) privileges; while WMS are standardised protocols to supply georeferenced images (rendered as pictures by the server), WFS enable to request specific features of geographical objects and delivers spatial data in its original vector format.
- **Validate** which affects only the confidence level on the information contained in a GIS Layer as well as its consultation by a broader population of Users (access to Level 1 layers grants access to Level 2 layers but not to Level 0 layers).

We assumed the existence of three different volcano statuses (Inactive, Moderate Activity, Eruption), and the possibility to define different sets of privileges policies pending on the volcano status. Accordingly with a configurable number of alerts, it is possible to define independent sets of profiles that become active when the relative Alert level is selected.

The WebGIS components have been developed using Open Source libraries such as OpenLayers, GeoExt and ExtJS. Since the latest candidate release of the OpenLayers (2.11-rc1) library allows the use of the WebGIS also from a mobile device (e.g. tablet PC), it was not necessary to develop an independent Web thin client (Fig. 2) for facilitating the use of the application on the field. This makes the MIAVITA WebGIS server a dynamically profiled system wholly based on Open Source products that can be scaled on multiple servers solutions in case of a large GIS database and User's community.

2.5 Validation and testing

The validation of the tool was undertaken by providing various kind of privileges to participants of the MIAVITA projects, thus simulating an operational use of this tool. The feedback from users was used to improve the ergonomy of the tool, enabling for example a configurable display of colours in the WEB interface.

3 Mount Cameroon application

3.1 Settings

The volcanic site for testing the capabilities of the system is the Mount Cameroon. Hazard and risk in the Mount Cameroon have been extensively described by Thierry et al. (2008). This work was based on a regional scale geological mapping, including on the slopes and summit of the volcano. In addition, an inventory of exposed elements was undertaken. This study highlighted the multiplicity of hazards affecting this area. In addition to hazards directly linked with eruptions such as lava flows, tephra fall, gas, lahars, ground motions and tsunamis, they showed that the risks associated with landslides was as important as those due to eruptions. In particular, the area eastern

NHESSD
1, 5753–5777, 2013

from Limbe is at very high hazard. An important finding of this study was the significant exposure of the towns of Limbe, and, to a lesser extent, Buea, to geological hazards (Fig. 7).

3.2 Data and motivation

For this study, we used the hazard and risk GIS database collected by Thierry et al. (2008). This database contains GIS layers describing the exposure and elements at risks as well as their strategic importance, single-hazards and multi-hazard maps, "risk maps" (which consist actually of hazard maps superimposed with the assets vulnerable to these assets), topographic maps, and other background information such as optical satellite data and the geological map.

After the completion of the Thierry et al. (2008) study, the hazard and risk GIS database was made available to local and national Cameroonian stakeholders in two formats: a paper atlas and a geographical database accessible through a conventional geographical information system. This GIS was installed on a personal computer in the Ministry of Mines of Cameroon, which is the national entity that coordinates prevention against volcanic risks. While the digital database includes much more information than in the paper atlas, the access to data was limited because few potential users were trained to GIS. This difficulty motivated implementing the Web-based system in Mount Cameroon, with the aim of offering potentially an easier access to hazard and risk digital information.

3.3 WebGIS application

The system can be accessed through two user interfaces: (1) the browsing component, which is commonly referred to as WebGIS (Fig. 8a); and (2) the database and user profiles management interface (Fig. 8b).

Once data have been uploaded on the system, the application enables the visualization of hazard maps together with stake at risk (e.g. water supply

NHESSD
1, 5753–5777, 2013

network, strategic buildings, roads, etc.) and, owing to interoperability features, other geographical resources located elsewhere such as satellite images made available by "Google". The WebGIS application was found rather easy to use by a board of users who reviewed its use in summer 2011. However, the database and user profile management interface still requires GIS and IT skills to be managed.

3.4 Potential of the Mount-Cameroon WebGIS demonstrator to be mainstreamed in risk management practices

We provided the system to the responsible authorities in Mount Cameroon. The main difficulty in sustaining the system beyond the end of the MIAVITA project in the specific case of Mount Cameroon remains to identify a responsible person with sufficient expertise in GIS and Web applications to manage the system. The Mount Cameroon pilot could therefore only be tested virtually by the group of stakeholders, and not in an operational context by the Cameroonian authorities.

However, there are little doubts that if the system can be effectively managed by the local authorities, the situation will be much better than now. Presently, printed versions of the hazard maps developed by Thierry et al. (2008) have been used for prevention planning. Conversely, the interpretation of the numerous risk maps has been considered too complex (see also Gehl et al., 2013). In addition, the GIS data repository is presently accessible through a standard GIS tool, whereas there is still a need for user-training in GIS. If a solution can be found for managing the application locally, the Web application will enable the dissemination of hazard and risk information to many users, enabling them to take appropriate prevention and preparedness measures (for example: relocation of some assets when appropriate, identification of the most suitable sites for new constructions or activities, etc.). However, it is worth noticing that other members of the stakeholder's group (e.g. from the Philippine's institute of seismology and volcanology) required and received copies of the system.

NHESSD
1, 5753–5777, 2013

4 Discussion

4.1 Difficulties met in formalizing user's requirements

The main difficulty encountered during the system development was to formalize requirements with the group of stakeholders. We initially felt that this was due to many participants to the group being unfamiliar with WebGIS or having doubts about the practical utility of such systems in current practices (i.e. hazard and risk information dissemination and crisis management). As a whole, the process of formalizing main generic requirements in a form that is exploitable for the system developer took about 2 yr. Finally, hazard and risk GIS analysts endorsed the role of a facilitator between actual users and the system developers by suggesting potential capabilities of the system to actual users, discussing and specifying this capability with them, and finally evaluating with the system developer how feasible was this capability. Our experience illustrates the fact that user requirement collection is not straightforward in practice, a difficulty that is acknowledged in other fields of research (e.g. Nies and Pelayo, 2010).

4.2 Potential and limitations in using the WebGIS in current risk management practices in volcanic areas

The potential of using the tool during the different phases of disasters were discussed with the initial group of users. In practice, they agreed that such WebGIS application should be more useful for prevention and preparedness than during crisis. During crisis, it is expected that the responsible entities (that is: civil security or the army depending on the country and the dimension of the crisis) will be unlikely to use new tools and would rely on their usual procedure. Conversely, prevention and preparedness can benefit from a simple access to geospatial information such as for example the superposition of hazard maps with assets at risks. Such simple access is accessible from the Web interface.

NHESSD
1, 5753–5777, 2013

Further possible developments have been discussed, including for example the possibility to update the database through the WebGIS application (similarly to in Huang et al., 2013). However, similarly to previous tools (e.g. Salvi et al., 1999), we prefered to limit the scope of our WebGIS to the essential functions of facilitating the visualisation and interpretation of data by untrained users. We also recognize that the range of potential users can be limited, especually in socially and economically disadvantaged volcanic areas. In fact, while there are exemples of WebGIS serving as collaborative decision support tool involving a wide range of users (e.g. Boroushaki and Malczewski, 2010), our application is primarily targeted to an audience of decision makers, scientists and civil security already familiar with IT, although not necessarily to GIS. This is especially true in the case of Mount Cameroon: in this context of strong social vulnerability (Apa et al., 2012), the WebGIS tool has less potential to be useful for people at risk than for national and local authorities concerned with risk management. With respect to local communities at risk, we felt that other tools are more appropriate, in particular the elaboration of participatory 3-dimentionnal maps (P3DM) with local communities. For example, Cadag and Gaillard (2012) present such applications in the Philippines in areas prone to tropical cyclones, storm surge, tsunamis and earthquakes. Within the MIAVITA project, such P3DM tools have been applied around the Kanlaon volcano, with positive feedbacks on their efficiency in facilitating the transfer from risk assessments to actions.

5 Conclusions

In this contribution, we present how we developed and tested a web-based application for managing and displaying a complex geographical database dedicated to hazard and risks in volcanic areas. We formalized key requirements for this application with a group of stakeholders involved in risk management in several volcanic areas. Those requirements are a structured management of the database and of the privileges of users, taking into account the volcano activity. The application in Mount Cameroon

NHESSD
1, 5753–5777, 2013

showed potential for transportability in other volcanic area, provided the local volcano laboratory owns GIS and IT expertise for sustaining the system. The distribution of the prototype to participants of the stakeholders group indicates that there are opportunities for future operational use of such tools.

Acknowledgements. This study was undertaken within the MIAVITA project, which is financed by the European Commission under the 7th Framework Programme for Research and Technological Development, Area "Environment", Activity 6.1 "Climate Change, Pollution and Risks". We thank a group of experts who participated to the design of the WebGIS. Particular thanks to A. Salvati, A. Canestro, F. Doumaz, C. Christiani, V. Bosi, L. Colini, J. Loiseau, B. Faria, J. Berger, A. Daag, R. Solidum and C. Bignami for their most active participation.

References

Alberico, I., Petrosino, P., and Lirer, L.: Volcanic hazard and risk assessment in a multi-source volcanic area: the example of Napoli city (Southern Italy), Nat. Hazards Earth Syst. Sci., 11, 1057–1070, doi:10.5194/nhess-11-1057-2011, 2011.

Apa, M. I. P., Kouokam, E., Akoko, R. M., Nana, C., and Buongiorno, M. F.: An ethnical approach to socio-economic information sources in ongoing vulnerability and resilience studies: the Mount Cameroon case, Ann. Geophys., 55, 393–399, doi:10.4401/ag-5569, 2012.

Boroushaki, S. and Malczewski, J.: Measuring consensus for collaborative decision-making: a GIS-based approach, Comput. Environ. Urban Syst., 34, 322–332, doi:10.1016/j.compenvurbsys.2010.02.006, 2010.

Cadag, J. R. D. and Gaillard, J. C.: Integrating knowledge and actions in disaster risk reduction: the contribution of participatory mapping, Area, 44, 100–109, doi:10.1111/j.1475-4762.2011.01065.x, 2012.

Cash, D. W., Clark, W. C., Alcock, F., Dickson, N. M., Eckley, N., Guston, D. H., Jager, J., and Mitchell, R. B.: Knowledge systems for sustainable development, P. Natl. Acad. Sci. USA, 100, 8086–8091, doi:10.1073/pnas.1231332100, 2003.

Culshaw, M. G., Nathanail, C. P., Leeks, G. J. L., Alker, S., Bridge, D., Duffy, T., Fowler, D., Packman, J. C., Swetnam, R., Wadsworth, R., and Wyatt, B.: The role of web-based

environmental information in urban planning – the environmental information system for planners, Sci. Total. Environ., 360, 233–245, doi:10.1016/j.scitotenv.2005.08.037, 2006.
Darke, P. and Shanks, G.: User viewpoint modelling: understanding and representing user viewpoints during requirements definition, Inform. Syst. J., 7, 213–239, doi:10.1046/j.1365-2575.1997.d01-19.x, 1997.
Douglas, J., Uslaender, T., Schimak, G., Esteban, J. F., and Denzer, R.: An open distributed architecture for sensor networks for risk management, Sensors, 8, 1755–1773, doi:10.3390/s8031755, 2008.
Felpeto, A., Marti, J., and Ortiz, R.: Automatic GIS-based system for volcanic hazard assessment, J. Volcanol. Geoth. Res., 166, 106–116, doi:10.1016/j.jvolgeores.2007.07.008, 2007.
Gehl, P., Quinet, C., Le Cozannet, G., Kouokam, E., and Thierry, P.: Potential and limitations of risk scenario tools in volcanic areas through an example in Mount Cameroon, Nat. Hazards Earth Syst. Sci. Discuss., 1, 1081–1118, doi:10.5194/nhessd-1-1081-2013, 2013.
Huang, R., Huang, J., Ju, N., He, C., and Li, W.: WebGIS-based information management system for landslides triggered by Wenchuan earthquake, Nat. Hazards, 65, 1507–1517, doi:10.1007/s11069-012-0424-x, 2013.
Kappes, M. S., Keiler, M., von Elverfeldt, K., and Glade, T.: Challenges of analyzing multi-hazard risk: a review, Nat. Hazards, 64, 1925–1958, doi:10.1007/s11069-012-0294-2, 2012.
Müller, M., Vorogushyn, S., Maier, P., Thieken, A. H., Petrow, T., Kron, A., Büchele, B., and Wächter, J.: CEDIM Risk Explorer – a map server solution in the project "Risk Map Germany", Nat. Hazards Earth Syst. Sci., 6, 711–720, doi:10.5194/nhess-6-711-2006, 2006.
Neri, M., Le Cozannet, G., Thierry, P., Bignami, C., and Ruch, J.: A method for multi-hazard mapping in poorly known volcanic areas: an example from Kanlaon (Philippines), Nat. Hazards Earth Syst. Sci., 13, 1929–1943, doi:10.5194/nhess-13-1929-2013, 2013.
Marzocchi, W. and Woo, G.: Principles of volcanic risk metrics: Theory and the case study of Mount Vesuvius and Campi Flegrei, Italy, J. Geophys. Res., 114, B03213, doi:10.1029/2008jb005908, 2009.
Nies, J. and Pelayo, S.: From users involvement to users' needs understanding: a case study, Int. J. Med. Inform., 79, 76–82, doi:10.1016/j.ijmedinf.2009.06.007, 2010.
Pareschi, M. T., Cavarra, L., Favalli, M., Giannini, F., and Meriggi, A.: GIS and volcanic risk management, Nat. Hazards, 21, 361–379, doi:10.1023/a:1008016304797, 2000.

Salvi, S., Quattrocchi, F., Brunori, C. A., Doumaz, F., Angelone, M., Billi, A., Buongiorno, F., Funiciello, R., Guerra, M., Mele, G., Pizzino, L., and Salvini, F.: A multidisciplinary approach to earthquake research: implementation of a geochemical Geographic Information System for the Gargano site, southern Italy, Nat. Hazards, 20, 255–278, doi:10.1023/a:1008105621134, 1999.

Thierry, P., Stieltjes, L., Kouokam, E., Ngueya, P., and Salley, P. M.: Multi-hazard risk mapping and assessment on an active volcano: the GRINP project at Mount Cameroon, Nat. Hazards, 45, 429–456, doi:10.1007/s11069-007-9177-3, 2008.

Vicari, A., Bilotta, G., Bonfiglio, S., Cappello, A., Ganci, G., Herault, A., Rustico, E., Gallo, G., and Del Negro, C.: LAV@HAZARD: a web-GIS interface for volcanic hazard assessment, Ann. Geophys., 54, 662–670, doi:10.4401/ag-5347, 2011.

NHESSD

1, 5753–5777, 2013

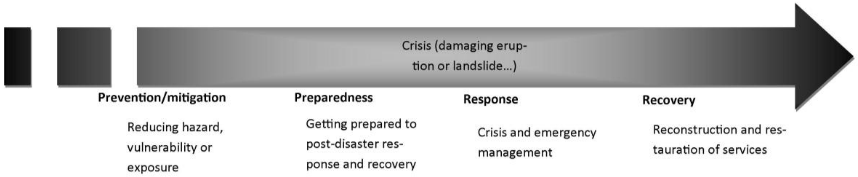
Using hazard and risk Web-GIS in volcanic areas

G. Le Cozannet et al.

Table 1. List of privileges that can be granted to each user on each GIS data layer according to its profile and the volcano status.

Privilege	Description
WMS	accesses to the Web Map services (WMS)
WFS	accesses to the Web Feature services (WFS)
Publish	makes the uploaded GIS Data layer available to the user community
Validate	changes the validation level of a GIS Data layer
Insert	adds a new GIS Data layer to the system
Update	changes the properties of a GIS Data layer already loaded in the system
Delete	removes a GIS Data layer from the repository
Administrator	permits all the above privileges

NHESSD
1, 5753–5777, 2013



Potential use of Web-based hazard and risk GIS system in the case of the MIAVITA volcanoes:	Provision of simple access to hazard and risk information for hazard, vulnerability or exposure assessment & for local or regional planning	Identification of critical infrastructures and net-works during crisis and of possible needs	Indentification of critical infras-tructures for the response (e.g. for use as temporary shelters) Update of the crisis evolution (provided near real time services are available)	Provision of information for local or regional planning (requires up-date of the hazard assessment)
Expected relevance of the system according to the stakeholders group	Very high	High	Low (priority should be given to existing robust procedures or systems)	High

Fig. 1. Disaster management cycle and the potential use of a Web-based GIS information system throughout the different phases of the cycle. In the case of the MIAVITA volcanoes (Mt. Cameroon in Cameroon; Fogo in Cape-Verde; Merapi in Indonesia and Kanlaon in the Philippines), it was agreed among the stakeholder's group that such system would be most relevant in support to the prevention and mitigation phases.

NHESSD
1, 5753–5777, 2013

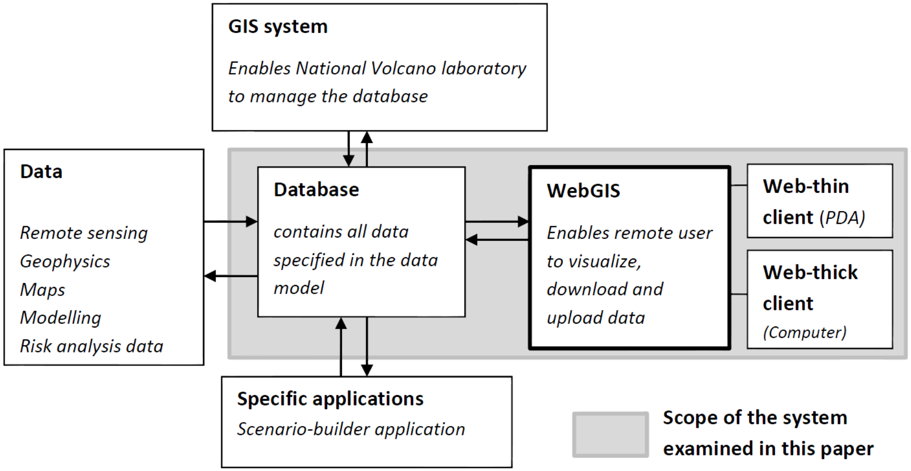


Fig. 2. Scope of the WebGIS developed within this study with respect to other relevant geographical data and systems. Scenarios builder applications refer to (e.g. Felpeto et al., 2007; Gehl et al., 2013).

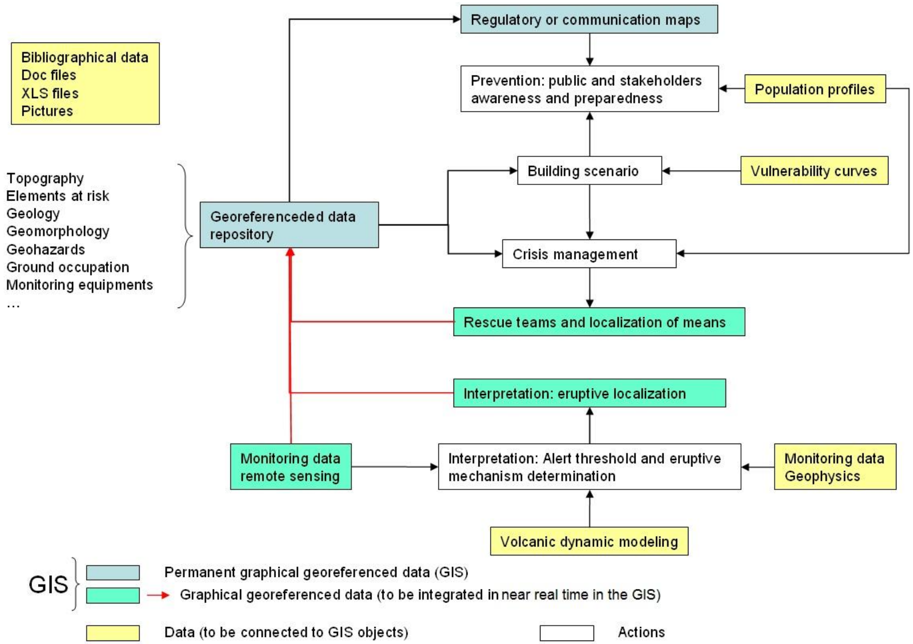


Fig. 3. Idealised hazard and risk information flow chart for volcanic areas. This flow chart has been developed based on the intercomparison of existing practices and needs in the volcanoes of the MIAVITA project.

NHESSD
1, 5753–5777, 2013

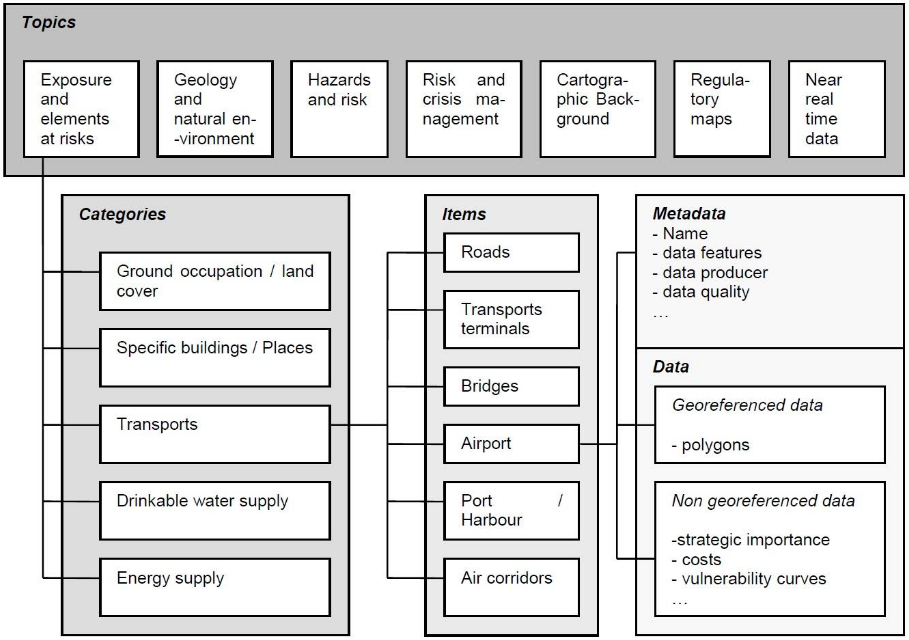


Fig. 4. Extract of the taxonomy (i.e. controlled vocabulary organised in a hierarchical form) describing the content of the hazard and risk geographical database.

NHESSD
1, 5753–5777, 2013

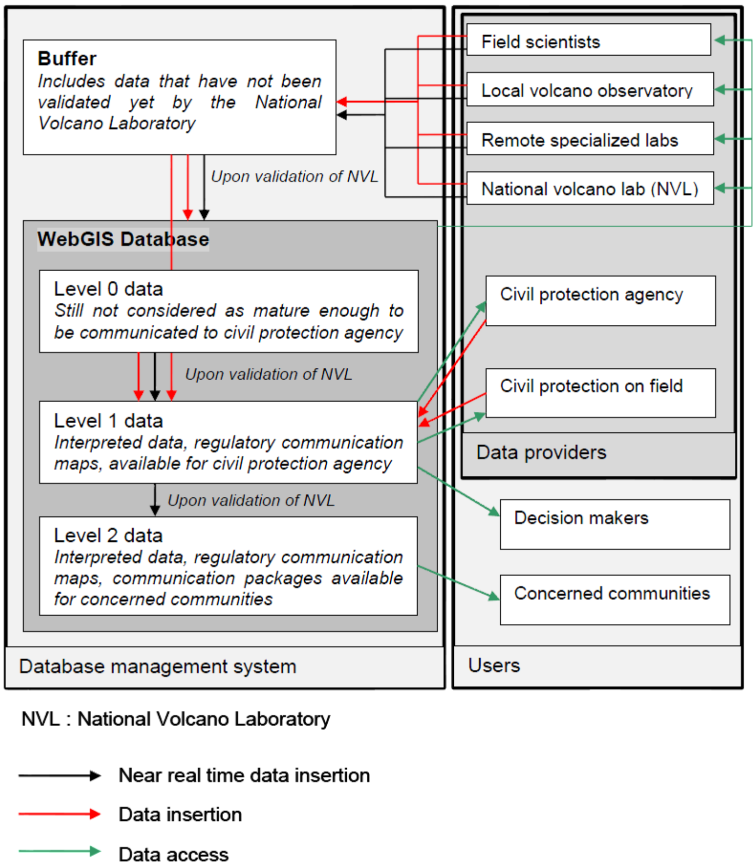


Fig. 5. Use-case scheme of information flows between the database management system, data providers and users. This scheme shows the different possibilities for data insertion, validation and access. All data providers are also considered as potential users of the system. Here, a key role is given to the National Volcano Laboratory in managing the information flow.

NHESSD
1, 5753–5777, 2013

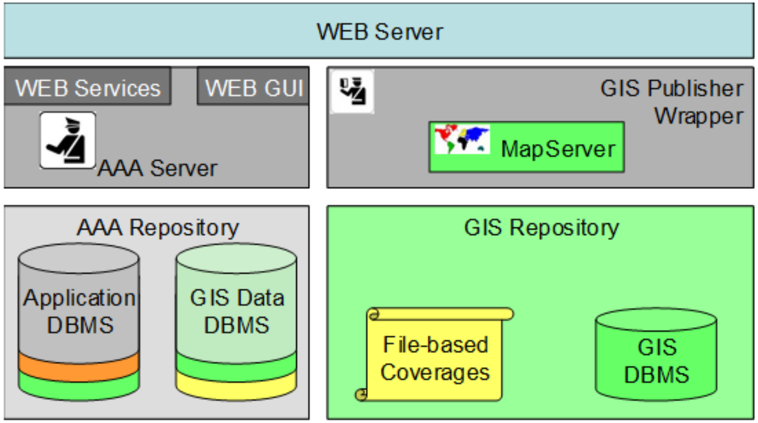


Fig. 6. Scheme of the WebGIS Architecture. The system is divided in several components: one WEB server that manages the exchanges of information through the Web, one AAA server (Authentication Authorization & Audit), which provides security services ensuring that each user receives the relevant privileges for each status of the volcano (here: inactive, moderate activity, eruption). The GIS publisher is the component that finally supplies the data. It includes a wrapper that ensures that the requests are managed according to the rules provided by the AAA Server. Finally, the GIS database and the rules are stored respectively in the GIS and AAA repository. The Applications DBMS (DBMS: data-base management system) refers to the privileges granted to the various components of the system. Conversely, the GIS Data DBMS, refers to the privileges granted on the GIS layers contained in the GIS Repository. For example, the rules that define the privileges of each user to visualize the data are stored in the GIS data DBMS.

NHESSD
1, 5753–5777, 2013

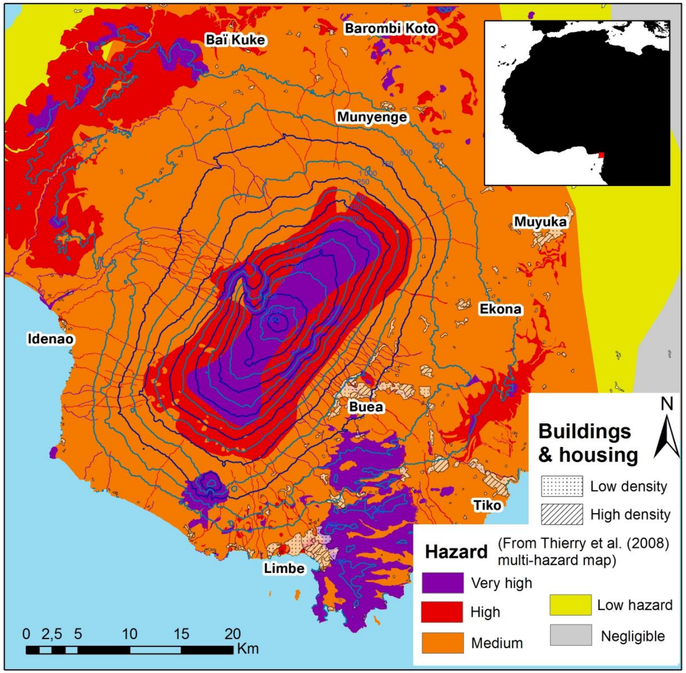


Fig. 7. Map of Mount Cameroon showing the multi-hazard map (Thierry et al., 2008), topographical isolines (bins of 250 m) and the location of towns and villages. The map highlights that besides volcanic hazards, the hilly areas in the east of Limbe are subject to very high hazard of landslides.

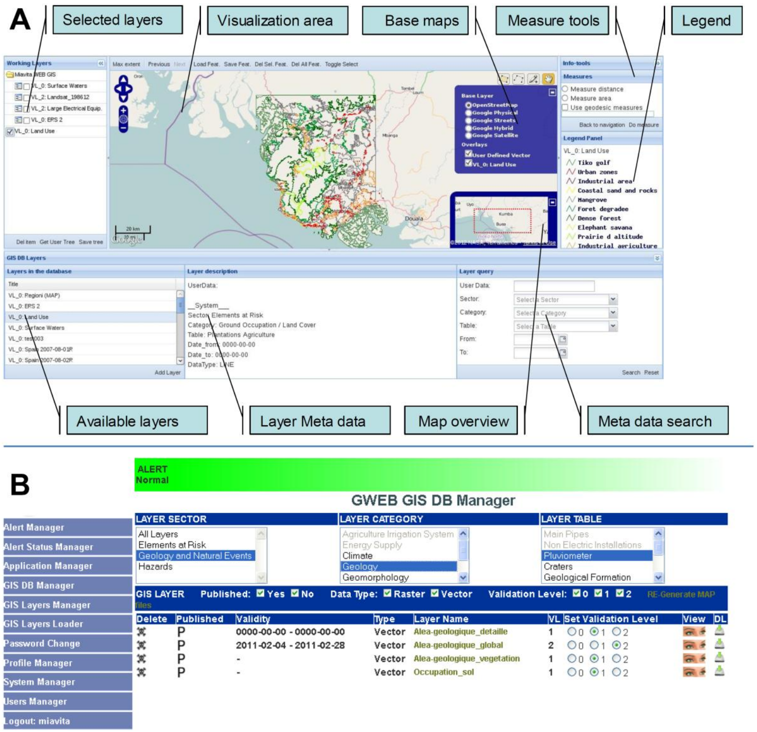


Fig. 8. **(A)** Represents the end user's WEB interface completely programmed in Javascript and running on a standard WEB Browser. Different areas of the screen can be folded to give more space to the GIS central visualization area. The users can search the GIS database using the meta information stored along with the geographical data – screen bottom three panels. The selected GIS layers can be saved as independent scenarios and later retrieved from the server, as well as user's vector features (polygons, lines and points) can be added to the visualization area, saved on the server for further use and shared with the other WebGIS users. **(B)** Shows the server GIS Layers Manager component. This module allows the management of all the GIS data contained in the database, including the promotion/demotion of the "validation level" associated with each GIS layer. In the left side the system shows all the management modules that allow the management and configuration of the whole system, including the switch from one Alert Level to another. Each Alert Levels can be independently configured giving GIS data access priority to the more appropriate users in case of emergency.

NHESSD

1, 5753–5777, 2013

Using hazard and risk Web-GIS in volcanic areas

G. Le Cozannet et al.

Title Page
Abstract | Introduction
Conclusions | References
Tables | Figures
◀| |▶
◀ ▶
Back | Close
Full Screen / Esc
Printer-friendly Version
Interactive Discussion