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IMPROVING THE INTEROPERABILITY AND USER-FRIENDLINESS OF THE FRENCH SNOW AVALANCHE INFORMATION SYSTEMS

Laure Vidaud-Barral*, Jean-Marc Tacnet*, Michael Deschâtres*, Mylène Bonnefoy*, Didier Richard*

ABSTRACT:

Snow avalanches are rapid mass movements that put humans and material assets at risk with dramatic consequences. Risk reduction is reduced through structural and nonstructural measures such as zoning control but also through preventive information. In France, the official information system dedicated to snow avalanches consists of two different devices.

On one hand, The Permanent Avalanche Survey (Enquête Permanente sur les Avalanches, EPA) and the Localization Map of Avalanche Phenomena (Carte de Localisation des Phénomènes d'Avalanches, CLPA) provide information about historic chronicles and maximum extents of avalanches, respectively. For more than a century, avalanche field data have been collected throughout French mountain areas only as paper documents. Nowadays, geographical and textual data continue to be collected and analyzed through complex databases. All this information is used either by the population, experts and local authorities responsible and is an essential part of most hazard and risk expert assessments and maps.

On the other hand, the Sensitive Avalanche Paths Survey (Sites Sensibles Avalanches, SSA) proposes a classification of avalanche sites according to their susceptibility to risk.

Traceability of information collection processes and data quality assessment are recent and new requirements. This paper presents the overall characteristics and architecture of this global information system, recently updated to permit online data input by observers through web-based interfaces and to manage the network of operational observers. The design principles now provide full interoperability between its different components while other features such as web-mapping applications are still under development.

KEYWORDS: snow avalanches, risk management, information systems, data quality, information sharing, software engineering, interoperability.

1. INTRODUCTION

The French Ministry for Ecology, Energy, Sustainable Development and Sea (MEEDDM) has defined seven main axes to prevent natural hazards. Information collection and dissemination as well as improvement of knowledge on natural phenomena, hazards, vulnerability and risk make up the first essential goal of the risk prevention policy in France. Several technical devices exist to reach this goal for snow avalanche data (www.avalanches.fr).

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The Localization Map of Avalanche Phenomena (CLPA) (Bonnefoy et al., 2010), the historical avalanche events permanent survey (EPA) (Deschâtres et al., 2010) and the Sensitive Avalanche Paths Survey (SSA) (Rapin et al., 2006) are the essential components of the information system devoted to snow avalanches. They gather data field information collected by different sources such as Cemagref investigators for CLPA but also technical staff from the French National Forest Office (ONF) for the EPA and SSA systems. For these two systems, a technical network composed of more of than 200 persons collect field data that are first checked and then added to these databases. In the past, surveys were carried out through manual and paper reports sent to a centralized coordinator in charge of integrating those data in the databases. The different systems were also totally independent of each other even if the same individuals and the same geographic areas were involved. Information was therefore duplicated and cross-queries between the different systems could not be cross-queried easily. To improve its efficiency, the

system has recently been transformed into an on-line system. Substantial reengineering of the database management architecture has also been required to share data and manage information quality between the different databases management systems (DBMS).

This paper describes the main features of the system and shows how the business expertise and needs have been implemented according to specific design principles and technical architecture. It presents the initial requirements but also the way how the objectives of interoperability, traceability and quality evaluation are reached within the choice of ad-hoc technical architecture and software design principles.

In section 2, the global framework and objectives of the information system are described. The information acquisition and tracking processes are described, focusing on both the roles of the different persons involved and on the spatial areas corresponding to their responsibilities in the system. This part concludes on the importance of interoperability between the different systems.

Section 3, first introduces the importance of information traceability in evaluating and improving the expertise process. Then, the overall information system architecture is described, focusing on cross-relations existing not only between its different internal parts of but also with the external systems such as technical infrastructures (risk portals, web map servers WMS, etc.) as well as specific decision-support systems. Web-based applications are essential parts of this new framework. Finally, the DBMS design principles are presented.

Section 4 concludes with a description of the main features and issues related to the development of this information system development. A more general vision of the role of information systems in the risk management process is proposed. Further developments, perspectives and relations with other projects are also described.

2. SYSTEM REQUIREMENTS: INFORMATION COLLECTION, TRACKING AND VERIFICATION

This section describes the information management process from input steps to results presentation, including the description of the respective tasks carried out by the persons involved in the technical system.

2.1 *EPA, CLPA, SSA information acquisition and tracking processes*

The global network involves several tasks :

- data acquisition by observers of avalanche events (EPA), maximum extents of and eye witness accounts of past avalanches (CLPA) or sensitivity assessment (SSA) ;
- Tracking, validation and verification of input data ;
- Network management by operators and members of the networks.

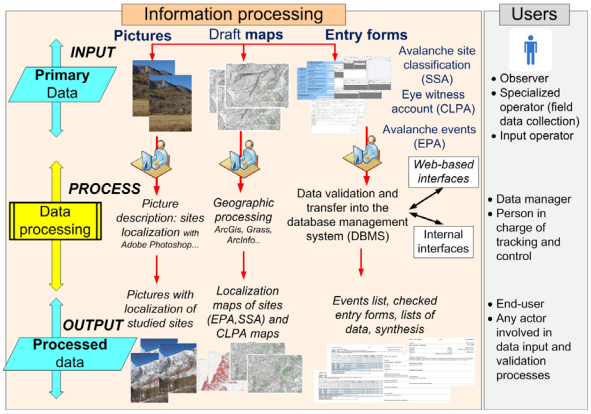

Figure 1 : Information processing in the avalanche information system including EPA, CLPA and SSA systems

The collected information can be either textual (entry forms), graphical (pictures) or geographical information (maps). A single person can have several different functions (figures 1,4) in the technical devices EPA, CLPA or SSA. To be fully efficient, the Avalanche Information System must meet several essential requirements:

- It must be able to collect data provided by observers, store it and track the input process;
- The different actors will be allowed access to according to their assign tasks. Observers may be authorized to access only one or several of the different available technical devices (e.g. EPA, CLPA or SSA).

From input to its entry in the DBMS information follows a validation chain involving actors with

hierarchic roles (input only, validation, verification...) (figures 2 and 3).

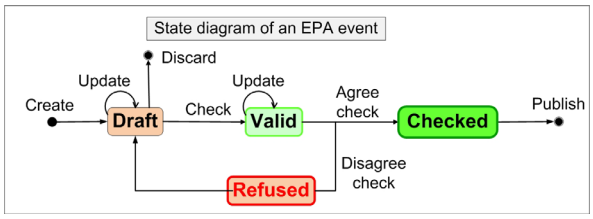

Figure 2 : Different states of an EPA. event from input to publishing

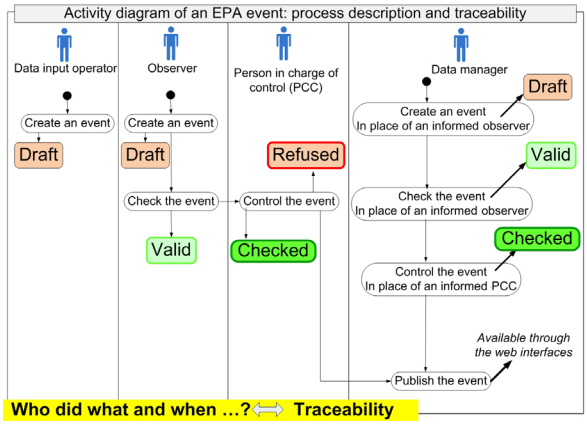

Figure 3 : Description of the EPA process from data input to validation entry in the information system and publishing

2.2 *Interoperability is required to consider user-profiles*

A single user can be responsible for several tasks related to the different technical devices. For each device, its management access (input, input and verification, top level validation, etc.) can be linked to several spatial zones: a user may have high-level access for EPA device (input and control on a wide area) but only low-level responsibility for SSA for a reduced geographic zone (simple observer). The information system design principles consider these different profiles and prevent duplication of information related to the same user but involved in different technical devices: this is called interoperability between the devices (figure 4).

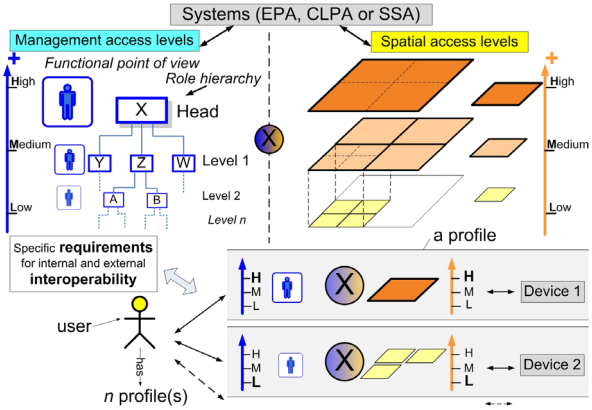

Figure 4 : Multi-interoperability is required from spatial and management points of view

2.3 *User-friendly Interfaces for data input*

The web-based interfaces are dynamically created and updated depending on the access level of persons connected to the system: an observer will not have the same access as a person in charge of verification (figure3).

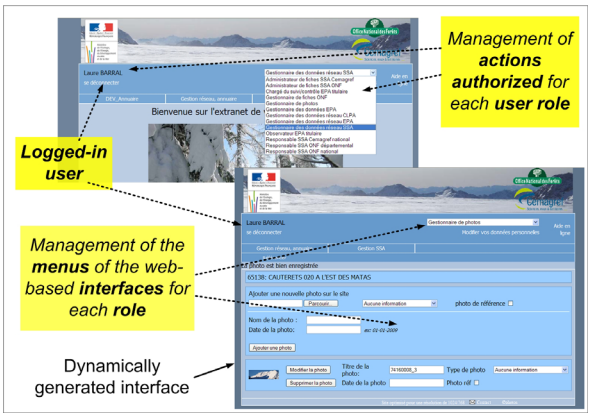

Figure 5 : Examples of dynamic generation of the EPA web-based interface

2.4 *Requirements for system information design and developments*

To implement these requirements, a specific technical architecture and a versatile and generic data model have been proposed. These developments and principles are essential to fulfill interoperability requirements.

3. TRACEABILITY AND INTEROPERABILITY

3.1 Why are traceability and information quality closely linked?

Decisions related to risk management processes closely depend to a great extent on information availability and quality. Information management implies a continuous chain from data field collection to risk management decisions (figure 6). The reliability of event assessment is linked to traceability and ad-hoc methods are needed to consider both information imperfection and sources reliability (Tacnet, 2010). Therefore, information systems are not only a technical infrastructure but are an essential part of the decision framework.

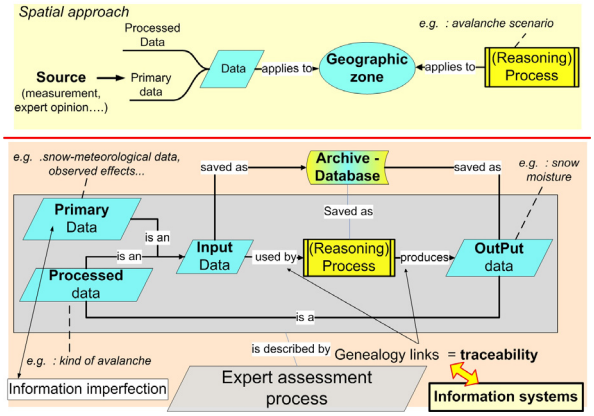

Figure 6: Metadata are used to trace links between primary and processed data (Tacnet et al., 2006) (Tacnet, 2009)

Many information systems exist that collect information on natural hazards. Some of them have proposed to include some information quality index (Hübl and al., 2002). Many of them were designed claiming their "generic and universal" approach. In fact, sharing information between them remains difficult: interoperability is still a great challenge from both semantic and technical points of view. Evaluation of reliability index cannot be the only goal for improving expert assessment data. This information must be connected to the initial data, included in and propagated through information systems as a fundamental part of them. The first level for interoperability is to adopt a common terminology for post-event description.

Data quality indicators are added to basic information so that this information can be used more profitably within the global risk management process. These metadata can describe the way the information is produced and used. Primary, processed data and reasoning processes should be clearly identified in Information systems (figure 6). Therefore, reliability index must be included in metadata developments.

In snow avalanche tracking, various features improving the traceability of data and reasoning processes have been developed. Metadata and special patterns for genealogy (based on ISO 19115) are still under construction. (figure 9).

3.2 Technical interoperability: ad-hoc architecture

An information system dedicated to natural hazards can be described by its content (Jaedicke et al., 2009) but the technical architecture must also meet the operational requirements (Pradhan and al., 2007). In this section, we describe the "hidden part" of the system, e.g. the technical architecture and the DBMS design principles, which are necessary but not visible for one of the system's final users.

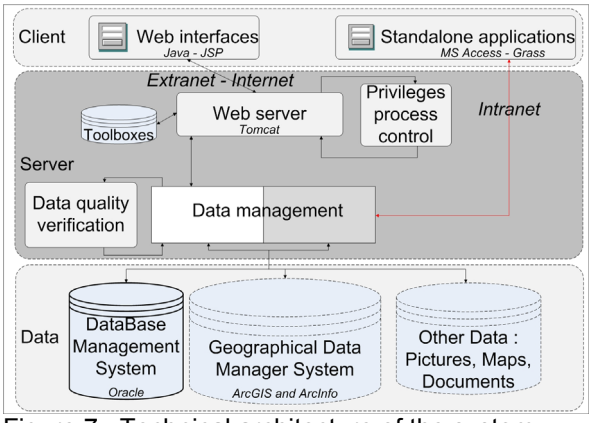

Figure 7 : Technical architecture of the system

The originality of the system consists in its multiple functions. On one hand, it offers both web-based interfaces for data input, verification and storage and the ability to share information from the different systems related to snow avalanches information (figure 7).

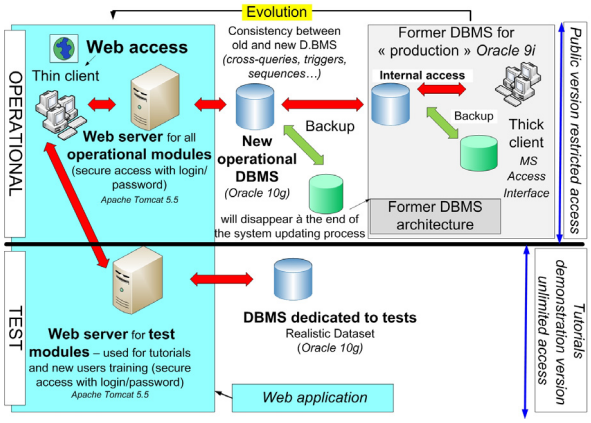

Figure 8 : Web-based applications and upgrading processes from the old to the new technical framework

In comparison with a classical database management system (DBMS), this snow avalanche information system provides original features but also constraints for its development. To collect and store data and manage the network of observers are being implemented while the information system is under production (figure 8).

Web-based applications are an essential part of the new information system. It is progressively replacing the former FTP server and will soon include web-servers for metadata cataloging and webmapping still being development and tested (figure 9).

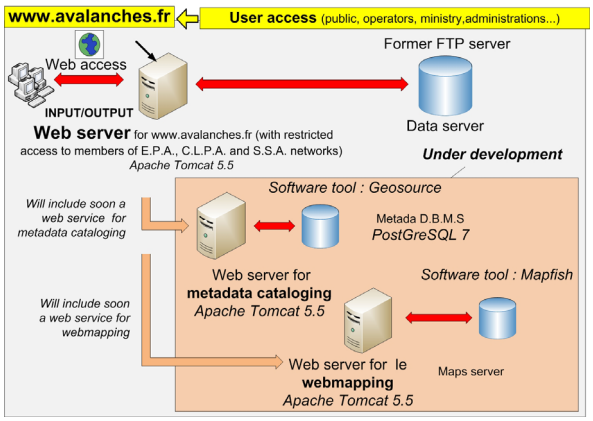

Figure 9 : Web-based architecture for dataflow management, cataloging and web-mapping applications.

3.3 *Interoperability-compliant entity-relations models must be defined*

The operational requirements induce specific design principles. They are implemented through entity-relations models that provide the interoperability between the different technical systems EPA, CLPA and SSA (figures 8 and 9) with respect to the functional and spatial aspects. The persons involved in the technical network have different tasks related possibly overlapping spatial zones.

From a functional point of view, this structure manages three main functionalities (figure 10):

1. Role creation (role hierarchy) (figure 4): a network manager (head) can create roles that are lower in the hierarchy (e.g. EPA observer) ;
2. It make it possible to manage the actions related to the different roles: a network manager can "Update a person's description" for any other person in the system;
3. Creation of the different menus whose access is authorized for to the different persons depending on their respective roles: a network manager, who can to "Update a person's description" will have access to this choice in the web-based interface.

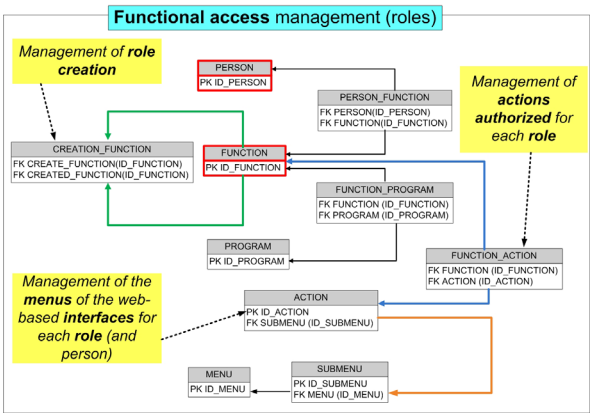

Figure 10 : Entity relation model for functional access

From the spatial and temporal points of view, the system assigns a temporary validity of a role to precise spatial zones related either to the technical systems EPA, CLPA and SSA or to the administrative areas.

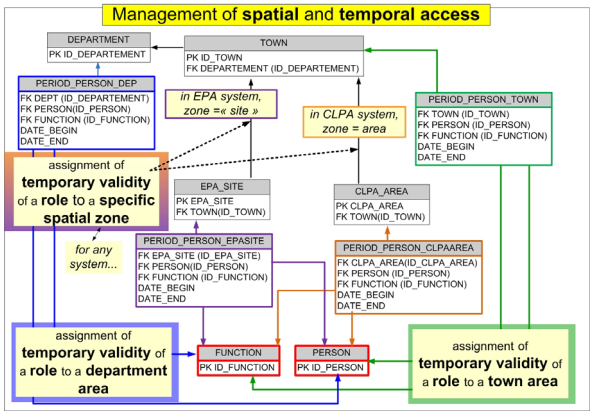

Figure 11 : Entity-relation model for spatial and temporal access management

EPA, CLPA and SSA spatial reference zones (denoted as « sites », « areas », etc.) differ from each other and do not necessarily overlap precisely with the existing administrative areas(a site can belong to several towns and/or departments). All cases must be considered and the system can therefore assign (figure 11):

1. a role to a person involved in EPA (respectively CLPA) is linked to a single EPA site (respectively CLPA area) for a given period ;
2. a role for a person involved in EPA (respectively CLPA) is linked to a single EPA site (respectively CLPA area) for a given period ;
3. a role for a person for each administrative entity such as towns and departments

4. CONCLUSION

The global framework of the information system related to snow avalanches in France has been presented from an internal point of view. This framework improves the quality of information and traceability of the major avalanche data system in France collected since 1970's: the permanent survey for avalanches events, the Localization Map of Avalanche and the Sensitive Avalanche Paths Survey (SSA). Their contents have been checked and substantially updated. They have evolved mainly in terms of data collection and management chains through web-based applications. One of the major innovating features of the new system, in comparison with the former heterogeneous former databases, is the global interoperability between these applications.

4.1 *Integration tools from data collection to decision making are still needed*

From a more general point of view, information systems are essential to decision-making related to natural hazards: they collect and store all the information used in the risk management process. For any information system related to natural hazards and risk management, information quality assessment and interoperability should always be considered an important issue. On a given area, any user should be able to know what kind of information about snow avalanches is available and how it has been collected and verified.

Information, more or less imperfect, and decisions are indeed closely related. An integrated framework is required to collect as well as to use information for risk assessment, decision-making and management. In this context, information systems must be able to (figure 12):

- evaluate and trace data collection quality elicitation;
- develop and use decision support systems including information imperfection management;
- share and publish information.

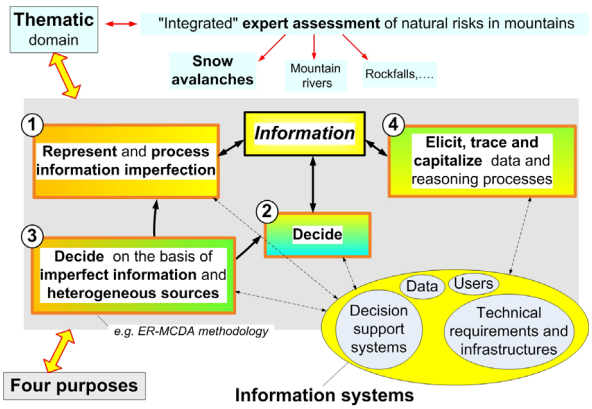

Figure 12 : Information systems are not only a technical infrastructure

4.2 *Further developments*

The *Cemagref research programs* (Snow Avalanche Engineering and Torrent Control Research Unit – ETGR) are developing this type of framework ranging from information system design and development to information imperfection representation and decision support system development (figure 12).

Research and development is therefore attempting to integrate the data collected into information systems. Several needs remain to be evaluated (Bonnefoy and al., 2010a), to link quality information and contents within the same information systems and secondly, to trace the information the data quality in the risk management process.

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