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Towards a decisional system for the seismic risk management

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Abstract In this paper, we propose a tool of decision support for the natural risk management, in particular the seismic risk.
Various fields are interested more and more in the risks in particular in environment. In this context, the objective is to control the natural phenomena through, simulation, prevention and decision support tools. The problem arises even more when they are natural risks such as the seism. Indeed, the disastrous effects of the seism as well on the human lives as on their works (infrastructures, houses...) reach sometimes important proportions. If it is not possible to currently envisage with exactitude a seism, it is possible to evaluate the whole of the socio-economic consequences on the areas where it can occur (Djeddi 1994).
The purpose of the research undertaken in this direction, is to evaluate and manage the effects of this type of "dangerous" phenomenon in order to limit its occurrence. The results of these works generally integrate a strong geographical component which results in the use of the Geographical Information systems (GIS) (Chatelain 1995, Glassey 1997).
Indeed, these tools offer means for the identification of the concerned sectors and the impacted stakes in order to do an evaluation of the damage following a seismic catastrophe. So, the GIS are largely used for the decision support. However, they give a rather static vision whereas the management of an environmental process in general and natural risk in particular requires tools based on dynamic models. (Koch 2001).
In addition, decisional data processing in order to increase the flexibility and the reactivity of the organizations, introduced more and more new information and communication technologies such as the scorecards.

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In this paper, we propose a balanced scorecard for the management of a seismic crisis. It is established on the basis of spatial indicators describing the variations.
It relates to the research works carried out by the laboratory of the information processing systems (LSI) of the data-processing department (USTHB) in collaboration with the Research center in Astrophysical and Geophysical Astronomy (CRAAG) concerning the impact of the use of the GIS for the reduction of the seismic risk in Algeria.
In the first phase, we used an object approach to simulate the scenario of an earthquake. The cross-referencing data are carried out from various maps (geological, topographic,...) as well as data relating to the seismicity of the area of study (Abdat 2005a, 2005b). As principal results of this phase, we can quote:
- a geographical data base is built covering the whole of the concepts handled in seismic management,
- the study of the historical seismicity,
- the real time study of the seisms: the instrumental seismic monitoring is done starting from seismological stations distributed on the whole of the territory. The data collected by the seismometers are centralized and saved in the GeoDataBase;
- graphical documents describing the area seismicity are produced such as the map of the intensities;
- the simulator of seism makes it possible to estimate the intensities of areas touched by a seism. The intensity is

regarded here as a classification of the gravity of an earthquake according to the effects observed in a limited zone. Its calculation is a function of the characteristics of seisms and the areas where they occur: magnitude, depth, the distance epicenter-area, the type of ground, the type of construction and associated intensity according to the European Macro scale seismic (EMS).

- A prototype has been constructed using ARC GIS. It was applied to the seismic risks of Algiers (Abdat 2005c).

This first phase enabled us to show the contribution of the GIS in the seismic risk management. In the second phase, object of the present paper, we present a space balanced scorecard (SBSC) applied to the seismic risk. The indicators of the SBSC are calculated starting from the GeoDatabase.

A scorecard or a dashboard allows to represent a complex reality by using a simplified model. It gives an incomplete and often vague sense of reality but sufficient vision to make fast decisions. The dashboards of decision such as the balanced scorecard (Kaplan 2001), concentrate especially on the quality of information and not on its quantity. Indicators are represented in a comprehensible and suggestive way in order to facilitate their visualization. An outline representative of the situation is represented, thus making it possible to reach the more detailed data. The dashboard must be contextual, and one can select his own indicators, with the preferred representation, in order to produce his personalized dashboard.

Many organizations use dashboards (for example: administrations, banks). International organizations such as the United Nations also use social, economic, geopolitical or environmental indicators. In the field of geomatic, work such as Devillers (2005) proposed a space dashboard for the management of the quality of the geographical data. Other works were made to adapt tools of the Business Intelligence in the field of geomatic, such as Spatial Data Mining, the SOLAP (Spatial On-line Analytical Processing) and the spatial data warehouses (Miller 2001, Rivest 2001).

The GIS users handle the geographical data in order to obtain information being able to be used in a process of decision-making (e.g. to identify the areas of risk, to identify the vulnerable buildings to a seism with a given magnitude or intensity). For that, they perceive signals of the real world, interpret them, and proceed to an abstraction in order to generate a cognitive map being used by this decision-making process. The decisions are aimed to achieve a goal, according to many criterias such as the perceived situation, the experiment and the reference of values of users, and their motivations, according to the measurement of the risks and the available means (Devillers 2004). Klein (1999) suggested that the mental intuition and simulations are central in the decision-making, based respectively on the experiment and imagination. He stressed the importance of the relevant indices which help to recognize a situation. These indices can be used for the construction of a scorecard.

An indicator or indice is an information or a set of information contributing to the general appreciation of a situation (Fernandez 2000). The objective of an indicator is to measure a situation and to initiate a reaction. The value of an indicator can be based on a single data, or can be the outcome of a calculation implying several data. These data must be technically accessible. They can be already available in a database or come from other sources.

In our case, the indicators can represent various types of information, as well quantitative as qualitative. We have defined three types of indicators:

- indicators of status: a status indicator gives information about monitoring network status, GPS network status;
- indicators of measure: a measure indicator gives information on measures relating to recorded seismic waves of soil movements;
- indicators of crisis: useful during crisis, they inform about measures such as magnitude, estimated intensities, aftershocks etc.

Users have access to proposed indicators description in different aspects such as: definition/meaning of the indicator, method used to calculate the indicator value, representation mod of the indicator.

Several representations can be used to visualize the value of an indicator, such as numbers, symbols, icons, pictograms, tables, graphs, texts, sounds, images, etc. It is also possible to use pop-up windows, visual or sound alarms, etc, which are often effective ways to collect the attention of the users.

Our SBSC has the following characteristics:

- can communicate information on a visual basis,
- avoids an overload of information,
- allows the users to adapt their dashboard according to their needs,
- provides indicators in real time,
- allows the users to select the relevant indicators in their context or to define their own indicators,
- allows the users to visualize the indicators at various levels of details: the indicators must be organized in a hierarchical way (indicators and under-indicators),
- offers various representations of the indicators which the users can select (e.g.: histograms),
- automatically activates alarms when certain conditions are reached (aural or visual signals),
- visualizes the descriptive characteristics for each indicator presenting the definition, type of representation, computing modality, etc.

Moreover, the space component must be taken into account. The space dashboard should be able to offer a cartographic mode of visualization of the indicators.
A prototype is constructed using the Visual Basic language. The cartographical functionalities of the prototype are developed using ARC GIS. This prototype is integrated as a part to the prototype of the first phase.
In conclusion, this paper presents a new approach allowing to communicate information relating to the dynamic of geographical data in order to reduce natural risks. In order to avoid an overload of information and to support adequately the decision process, this approach advocate the integration to a GIS a spatial balanced scorecard. The information relating to the dynamic is communicated to the user in forms of indicators of status, measure or crisis which can be selected, modified when needed, and then consulted at different levels of details.

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