

# Data-bases and the management of landslides.

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**ABSTRACT** :This paper deals with the description of landslides and the management of them in data bases. It presents a new computer tool for storing information on landslides and exchanging data of landslides on the net. The works of TC 11 are related.

Cet article traite de la description des glissements de terrain et de leur classifications. L'aspect gestion des glissements de terrain et échange de données sur Internet est présenté et les travaux du TC 11 sont évoqués.

**KEY-WORDS** : landslides, data-bases, classification, data exchange

## 1 - INTRODUCTION

For more than a century land planers are looking for a better knowledge of natural risk for the settlement of new buildings, roads and other constructions. One of these natural risks are landslides. During the development of soil mechanic we found the great diversity of this phenomena and we understood why, in the middle age, in Europe, landslides are sometimes called earthquakes.

This great diversity conducts to lot of classifications as each author is interested by some aspects of the phenomena.

In the first part of this paper, we summarise the works done by TC11 for the description of a landslide. It is a very necessary job, if we want to speak seriously of landslide. The international community of searchers needs a common language to exchange data on landslides. So we point out the role of a multilingual glossary for the description of a landslide and main classifications are presented to illustrate the different point of view of authors.

In the second part of this paper we try to find the different kinds of data-bases on landslides used in the world with the analysis of data-bases described in papers presented in conferences, symposiums and revues. Some are quite rich, others quite poor in

information and we try to guess the purpose of their building as the use of them may be different.

The last part of this paper presents a computer tool system for the management of landslides and the exchange of data on landslides to improve research.

As a conclusion, we propose with TC 11, an organisation for an efficient international exchange system, in respect with the personal willing of each researcher.

## 2 - DESCRIPTION OF LANDSLIDES

The description of a landslide is a very difficult purpose as landslides may be observed as different actors.

### 2 - 1 - *Landslides are world crust modellers.*

With the new possibilities of earth detection past landslides are now recognised, and it is obvious that their role in modelling landscape is important. At the Christchurch conference we can heard of the falling of the top of Mount Cook, and New Zealand become not so high. We know that in the Alps, a slide of more than 20 000 000 m<sup>3</sup> occurs each 25 years, that is demonstrated by the analysis of R. Schuster. (see table 1)

Year	Name	Country	Number of deaths	Type of slope failure
1219	Plaine d'Oisans	France	thousands	Failure of a landslide dam
1248	Mont Granier	France	1500 to 5000	Rock avalanche
1348	Dobratsh Massif	Autriche	heavy losses	Earthquake triggered rock falls
1419	Ganderberg-Passeier Wildsee	Italie	~400	Failure of a landslide dam
1486	Zarera	Suisse	300	Rock avalanche
1499	Kienholz	Suisse	~400	Debris flow
1515	Biasca	Suisse	~600	Failure of a landslide dam
1569	Hofgastein	Autriche	147	Debris flow
1569	Schwaz	Autriche	140	Debris flow
1584	Corbeyrier-Yvorne	Suisse	328	Debris flow
1618	Piuro	Italie	~1200	Rock avalanche
1669	Salzburg	Autriche	250	Rock topple and rock falls
1806	Goldau	Suisse	457	Rock avalanche
1814	Antelao Massif	Italie	300	Rock avalanche
1881	Elm	Suisse	115	Rock avalanche
1592	St.Gervais	France	177	Debris flow
1963	Vaiont Reservoir	Italie	~1900	Rock slide in a reservoir

Table 1: Major landslide disasters in Alps. (from Eisbacher et al., 1984 in TRB report 247)

2 - 2 - Landslides can influence human relations.

2 - 2 - 1 - The lost of lives

The lost of lives is one of the dramatic effect of a landslide. Frank landslide in 1902, in Canada killed

70 peoples. In Norway, in sensitive clays the landslide of Verdalen killed 116 peoples, Vaiont landslide more than 1500 and this last autumn mud slides killed more than 300 peoples in South of Italy. (Del Prete et al., 1998).

Year	Name	Number of residents dead or missing	Number of houses destroyed or badly damaged
Juillet 1938	Hyogo	505	130192
Juillet 1945	Hiroshima	1154	1984
September 1947	Gumma	271	1538
July 1951	Kyoto	114	15141
June 1953	Kumamoto	102	
July 1953	Wakayama	460	4772
August 1953	Kyoto	336	5122
September 1958	Shizuoka	1094	19754
August 1959	Yamanashi	43	277
June 1961	Nagano	130	3018
September 1966	Yamanashi	32	81
July 1967	Hyogo	92	746
July 1967	Hiroshima	88	289
July 1972	Kumamoto	115	750
August 1972	Niigata	31	1102
July 1974	Kagawa	29	1139
August 1975	Aomori	22	28
August 1975	Kochi	68	536
September 1976	Kagawa	119	2001
May 1978	Niigata	13	25

October 1978	Hokkaido	3	144
August 1979	Gifu	3	16
August 1981	Nagano	10	56

*Table 2 : Socioeconomic losses in majors Japan landslides disasters (1938 to 1981) from Ministry of construction in TRB report 247.*

About politics, we know that catastrophic events enhance the grants about them, but for what duration? and the example of the fall of Mount Granier in Savoie (France) in 1248, shows that the local Prince use the phenomena for domination purpose. After 1248, the county of Savoy enlarged quickly as the Count of Savoy said that this big slide which killed more than 3000 peoples was a God judgement against men who wanted to belong in the neighbour county.

### 2 - 2 - 3 - Works.

The influence on human works is also important. To avoid landslide zones huge works have to be done. On the motorway leading to the tunnel of Fréjus, between France and Italy, a big bridge was built to overpass a landslide zone. On the same road, a bridge built on a slow landslide is draw up each year as the landslide goes down. Footings and piles of the bridge has to be separated and a sophisticated system allows the displacement of the pile on the

footing. Height piles are equipped. (Garnier et al.,1987)

### 2 - 3 - Landslides is also a local phenomena.

As local phenomena a landslide can be described with its own words.

#### 2 - 3 - 1 - Vocabulary.

The vocabulary use to describe landslide is in all the books about them. A special attention must be done when using this words. In the multilanguage glossary made by TC11, the definition of the words is done. (WP/WLI,1993) It is not easy to have in different countries the same meaning, because slides depend of local geology and their approach by a specialist depend of his scientific background. So, it is a good reason to read and use this kind of glossary.

Year	Name	Country	Volume
1940	Prats de Mollo la Preste	France	1 000 000 m <sup>3</sup>
1984	Le Thoronet	France	2 000 000 m <sup>3</sup>
1970	Corny	France	4 500 000 m <sup>3</sup>
1980	Le Friolin	France	10 000 000 m <sup>3</sup>
1987	Val Pola	Italy	30 000 000 m <sup>3</sup>
1982	Ancona	Italy	100 000 000 m <sup>3</sup>
1800	Valezan	France	150 000 000 m <sup>3</sup>
1963	Mont Toc	Italie	280 000 000 m <sup>3</sup>
1248	Mont Granier	France	500 000 000 m <sup>3</sup>
1911	Usoy	Pamir	2 200 000 000 m <sup>3</sup>
1980	Mont Saint Helen	USA	2 300 000 000 m <sup>3</sup>
- 15 000 BC	Flims	Switzerland	12 000 000 000 m <sup>3</sup>
- 30 000 BC	Alika	Hawai (USA)	300 000 000 000 m <sup>3</sup>

*Table 3 : Some volumes of landslides.*

### 2 - 3 - 2 - Shape.

The shape of a landslide is sometime simple but usually it is complex and the measurements of it have to be clearly defined. TC 11 recommendations

give sketches for a better knowledge. One of the most useful measurement is the volume, but to attempt its value it needs lot of data. And the range of volumes is very large as it is shown in the table 3.

### 2 - 3 - 3 - Activity.

The activity of a landslide attempts to include the time in the description. A landslide may be active, suspended, reactivated, inactive. An inactive landslide may be dormant, abandoned, stabilised or relict. (WP/WLI, 1993)

### 2 - 3 - 4 - Distribution of activity.

The distribution of activity indicates how the landslide evolves. It can be advancing, retrogressive, widening, enlarging, confined, diminishing, moving. (WP/WLI, 1993)

### 2 - 3 - 5 - The style of activity.

The style of activity indicates the manner in which different movements contribute to the landslide. A landslide can be single, multiple, successive, composite or complex. (WP/WLI, 1993)

### 2 - 3 - 6 - Speed.

The speed of a landslide can take a very huge range of value. The works of TC 11 propose seven classes, the limits of each class being in a ratio of 100. (see table 4.)

Speed Class	Description	usual measure	speed in mm/s
7	Extremely rapid	> 5 m/second	> 5000.
6	Very rapid	> 3 m/minute	> 50.
5	Rapid	> 1.8 m/hour	> 0.5
4	Moderate	> 1.3 m/month	> 0.005
3	Slow	> 1.6 m/year	> 0.00005
2	Very slow	> 16 mm/year	> 0.0000005
1	Extremely slow	< 16 mm/year	< 0.0000005

Table 4 : The speed scale

Velocity class	Name	Estimated speed	Damage
7	Elm	70 m/s	115 deaths
7	Goldau	70 m/s	457 deaths
7	Frank	28 m/s	70 deaths
7	Vaïont	25 m/s	~1500 deaths indirectly
7	ST Jean Vianney	7 m/s	14 deaths
6	Aberfan	4,5 m/s	144 deaths
5	Panama canal	1m/min	people escaped

Table 5 : Speed and damage.

It is obvious that more the landslide is faster, more its destructive effect is higher. The table 5 shows this effect. At small speed, and with GPS system we can now measure speed in the range of cm/year, so, we can prevent disaster but structures are destroyed if we cannot stop the mouvement.

### 2 - 4 - The usual classification.

The more common classification contains only five classes that are :

- Fall
- Slide
- Topple
- Spread

### Flow

in three kinds of material : rocks, debris or colluvial materials, soils.

This classification gives the usual terms that have to be completed with words of the previous paragraphs for giving a more accurate description of a landslide. (see chapter 3)

### 2 - 5 - The description used in SSIDB.

In the conference of Copenhagen, (Faure et al., 1995) presented a complete description of a landslide for feeding a data-base called Slope Stability Information Data Base. (SSIDB)

The use of this description was heavy and time waster because of the too numerous fields to fill. So

we had to improve this description using the news computer tools available on the networks. In chapter 5 a new proposal for describing a landslide in a more simple manner is presented.

### 3 - CLASSIFICATIONS

As landslides are difficult to describe, the use of classifications is natural for enhancing vocabulary, each class becoming a type. But the selection of the limits of the classes depends of the author. For him, the view of a landslide is different if he is geologist or geotechnician or land planner. The Watanabe theorem (Ugly little duck theorem) shows us that a complete classification is impossible. But the willing of searcher is strong and many classifications exists. We list below some of them.

#### 3 - 1 - *Historical classifications*

1875 Balzer made a difference between earth, rocks and mud.

1882 Heim made a difference between solid rocks and detritic material.

1935 Ladd used nature of material and their structure.

1938 Sharpe saw only slides and flows.

1945 Ward used the depth of the landslide as a discriminant factor.

1950 Terzaghi tried to classify the mechanisms of landslides

1953 Skempton used the ratio depth to length.

1968 Hutchinson made the first complete classification and introduced creep. (Hutchinson, 1988)

1969 Zaruba et Mencl made differences with the kind of deposit involved in the slide.

1973 Blong proposed to use morphologic attributes to distinguish landslides.

1973 Crozier used morphological attributes. (tenuity, flowage, dilatation, fluidity, D/L ratio)

1977 Coates combined types of material and types of movement differentiated by speed.

1978 Varnes enhanced the Hutchinson's classification with lateral spread and used the particles size for differentiating the engineering soils.(Varnes, 1978).

1985 Sassa proposed a geotechnical classification. (Sassa, 1985)

1994 Vaunat directed his classification for risk management. (Vaunat et al., 1994)

1995 The WASSS project defined a representation of a landslide for the data-base SSIDB. (Faure et al, 1995)

1996 L'USGS detailed the Varnes' classification and added the WP/WLI's works. (TRB report 247)

#### 3 - 2 - *Some details on three classifications.*

##### 3 - 2 - 1 - The geomorphological classification.

It is the works of Hutchinson, Varnes and Word Landslides Inventory that drive to a complete description of landslides. (TRB report 247). The main aspect of this classification is the shape of the landslide and the geology. We have so lot of different schemes for helping the user. As the aspect of landslide is very versatile, the tables of this classification are huge and to be certain that all kind of landslide is described, complex landslides are introduced.

##### 3 - 2 - 2 - The geotechnical classification.

Sassa proposed in 1985 a simple but general classification. (Sassa, 1985) The sixteen classes are the combination of four behaviours (pick strength, residual strength, liquefaction and creep) and four sizes for materials that are distinguished by cobbles, gravels, sands and clays. When we use this classification it appears that classes for sands and clays contains lot of slides, but for teaching, the differentiation by behaviour leads to a clear introduction to calculus methods.

##### 3 - 2 - 3 - The risk classification.

Following the works on the expert system XPENT, (Faure et al., 1992) Vaunat proposed a new approach based on risk analysis. (Vaunat et al., 1995). The trunk of this classification is the time that allows to consider that a slide is at a pre failure stage, during failure, at a post failure stage or reactivated. To process with risk, analysis of aggravating factors and triggering factors must be known. This classification would be useful for the management of landslides of a territory. More details are presented in, (Leroueil et al, 1998) and the Rankine lecture, done in 1999 by S. Leroueil uses this classification.

#### 3 - 3 - *Conclusion.*

We have seen the great diversity of landslides and the lot of manners to consider them. To make an useful tool for storing and exchanging data on landslides is a difficult challenge. In the fifth part of this paper we shall try to give a solution.

### 4 - DATA-BASES

Since the beginning of the computer era, data base, or data-bank making is an important activity as computers allow quick research in powerful applications. For landslides the main difficulty is in the description of an element as we have seen before. Firstly we present data-bases, then the new tools that may be used on our computer networks, and finally the teaching of the WASSS experiment and the Séchilienne observatory. (Faure et al.,1998)

Risk mapping is the beginning of data-bases. In the 1970 years, in France was decided the ZERMOS program (Champetier, 1987) for mapping some districts with lot of movements. Brabb (Brabb, 1984) give us useful examples for risk mapping. As risk mapping begun by an inventory of landslides, and because computers come more common, the use of data-bases increases and we can find in the literature lot of descriptions.

The table 5 lists the most significant data-bases presented in three conferences.

#### 4 - 1 - Data-bases through the world.

Authors	Country	N of cases	Analysis	Purposes
<i>The following data-bases are presented in the proceedings of Christchurch ISL 1992 (Tome 1)</i>				
Sithamparapillai, de Silva, Senanayake	Sri Lanka	64	- Causes - Numerical rating	- Assessment of landslide hazard
Chermouti Gribici	Algeria	378	- Dimensions of landslides - Typology	- Inventory along main roads
Bazynski, Frankowski, Kaczynski Wysokinski	Poland	>11500	- classification depending of soil types.	- location of hazardous areas.
<i>The following data-bases are presented in the proceedings of Trondheim ISL 1996(Tome 3, p1843 à 1978)</i>				
Amaral, Vargas, Krauter	Brasil, Rio de Janeiro area	593	- Yearly distribution - Seasonal distribution - Spatial distribution - Landslide types and material types - Volume - Damages	- Improvement of knowledge of geologic factors. - Communication with urban planners - distribution of landslide features and impact parameters
Bajgier, Kowalska	Poland	>200 (from a map)	- Deep rocky landslides	- date of landslides - geomorphological impact - correlation with faults.
Bahgat, Mehrotra, Sarkar	India, Himalaya	14	- Types of landslide - Causes - types of material	- Mitigation with local control measures.
Bandhari, Kotuwedoga	Sri Lanka	114	- Shapes, areas, length, width	- Mobility of landslides and vulnerability of structures
Chandra	India, NW-Himalaya		- Studies of slopes - Risk zones	- Assessment of vulnerability of slopes - Control measures
Cruden	Alberta, Canada	156	- Historic landslides - Time repartition - Use of landslide report	- Land planning - Hazard evaluation
Faure, Pairault	France	50	- WASSS/SSIDB project	- A complete description of landslide
Fernandez, Irigaray, Chacon	Spain, Los Guajares Mountains.	134	- Correlation between 18 factors	- Definition of a methodology
Forero-Dueñas, Caro-Peña	Colombia		- Zonation of mass movement and erosion.	- A guide for land-use planners
Frangov, Tvanov, Dobrev	Bulgaria	160	- correlation with triggering factors and geology	- Time analysis
Irigaray, Fernandez, Chacon	Spain, Granada bassin	542	- Use of a GIS - 11 factors - 6 Types of landslide	- Determination of main factors
Jurak, Mihalic,	Croatie	1036	- Zonation	- Better solutions for

Matkovic, Miklin			- 8 models of slopes - from geology to computer	mitigation
Koukis, Tsiambaos, Sabatakis	Greece	1116	- Historic landslides - Frequencies of lithology, sliding material, causes, consequences, measures, etc	- Landslide control - Remedial works
Naithani, Prasad	India, Himalaya	10 areas	- Thematic maps - Geological aspects	- Remedial measures
Polloni, Casavecchia	Northern Italy	>100	- Outstanding rainfall	- Rain triggering condition
Rybar	Czech		- Landslides and geology	- Basic geological structure
Schoeneich, Bouzou	Niger		- Huge landslides and geology	- Influence on water storing capacities
Shunmin, Huiming	China, Tibet		- Complexity of landslides and fractal dimension of soils.	- Use of fractal dimension
<i>The following data-bases are presented in the proceedings of 8<sup>th</sup> IAEG congress Vancouver 1998(Volume 2)</i>				
Chowdury Flentje	Australia, Wollongong area	328	- Use of GIS - Historical record - Monitoring	- Hazard mitigation - Urban planning
Agostoni Laffi Mazzoccola Sciesa Presbitero	Italy, Lombardia	1700	- Landslides and floods - Historical records - Use of GIS	- Prevention of risk - Hazard mitigation - Urban planning
Ghayoumian Shoaei Shariat Jafari	Iran	1300	- Different aspects of landslides	- To avoid the loss of agricultural grounds.
Allegra Barisone Bottino	Italy, Susa valley		- Adapted landslide form.	- Hazard map - Risk map
Rodrigues Pejon	Brazil	67	- Adapted sheet for mass movement and erosion	- Inventory map

*Table 5 : Some data-bases of the literature.*

This table shows that numerous data-bases can be found easily. When we consider older papers we observe that the word data-bank is no longer used and with the help of faster computers more and more cases are stored. The purpose of each data-base is well defined. Generally it is for a local study about risk. When data-bases are filled with a kind of landslides the author wants to demonstrate a theory about geology or calculation. None of these data-base is built for a general use, and the main reason that we can guess is the difficulty to access to the large amount of the necessary knowledge, although some papers present very interesting data-sheet. The structure of the data-base is never described, it may be simple as the purpose of the data-base is never complex. The exchange of data is never mentioned. Each author treating a problem attached to a territory or making an inventory, sometimes with the help of a GIS for more recent data-bases, it seems that the exchange of data is without use. But we can be sure that, among all the cases stored some are full of interest for research purposes.

#### 4 - 2 - Details about two data-bases.

We present here two data-bases, this one built by Cruden in Alberta (Cruden et al. 1990) and this one built in France at LCPC.

#### 4 - 2 - 1 - Landslide report.

WP/WLI, 1990 gave on one sheet a landslide report on which we find the following data :

Date of the report and the date of the landslide.

The locality and the co-ordinates, with elevation of the crown, the toe and the tip.

The references of the reporter. (name, affiliation, address, phone)

The geometry, length, width, depth of surface of rupture and displaced mass.

The volume

The damage that is, values, injuries, deaths.

With this kind of report Cruden (Cruden, 1996) gives an interesting occurrence analysis of landslides in Alberta. But the information is minimum, no technical features are displayed, and any scientific conclusion is impossible.

#### 4 - 2 - 2 - A French data-base.

In 1989 the LCPC, in France started a data-base on landslides. (Lacube et al., 1989). Recently, the BRGM joints it to improve this data-base that we briefly present here.

Seven screens are used for the description of a landslide. The use of lists facilitate the entry of data and all is stored in an relational data-base under MS Access.

##### a) Identification

The identification and localisation are based on the use of French administration references.

##### b) Description

The description contains three parts : geometry, geology and geotechnics. A scheme with measurements is used for the geometry, stratigraphy and facies and materials are the geology, the measures of shear characteristics are used for the geotechnical aspect.

##### c) Genesis and evolution

This part is for the causes, natural or man made, and the induced phenomena.

##### d) Damages

Dead and injured peoples, cost of destroyed buildings and indirect cost are noticed.

##### e) Studies, survey and works

The kind of studies, survey and works is defined.

##### f) Costs and decisions

Legal features are written on this sheet with an estimation of the cost.

##### g) Information

The origin of the information is clearly registered.

#### 4 - 2 - 3 - Comments.

In the second data-base an effort is done to define more completely the landslide but the aspect of classification is missing. These data-base are oriented towards administrative purposes and it would be difficult to use them as research data, although some geological descriptors are used.

#### 4 - 3 - *The available tools in 1999.*

The list of the previous data-base never shows exchange intention of data. But for the international community an exchange challenge of data exists for allowing a more powerful research and facilitate common works. We have now networks, like Internet, that give the possibility of quick exchange, but in a specific format. This format HTML (Hyper Text Mark up Language) is the most used language

on the Net, and its versatile possibilities must be explored to assume the exchange challenge.

The GIS systems (Geographical Information System) are also new tools that allow the use of maps, but the use of them is very heavy. For landslides it is not necessary to have so powerful tool as we need only a position on a map. The appartenance to a district can be efficiently managed with literal input.

#### 4 - 4 - *Two experiments.*

##### 4 - 4 - 1 - The WASSS system.

The WASSS (World Area Slope Stability Server) was decided when we find the necessity of a data-base to get new rules or to confirm the rules used in the expert system XPENT. (Faure et al; 1992) With the time the WASSS system evolves and grows. We can now identify five releases. (Table 6)

WASSS tried to simulate a world wide organisation, without a real leader, gathering different complex events for exchanging data for a research use. WASSS4 installed two years ago partly failed, about the data-base itself but the comparisons between calculus methods is very appreciated. Some letters of readers are friendly encouragement to continue. Nevertheless it gives interesting observations that we use for building WASSS5. Thanks to my students going through the world and Canadian and Japanese colleagues.

##### 4 - 4 - 2 - The Séchilienne observatory.

The very huge landslide of Séchilienne, near Grenoble which can dam the valley of Romanche is an important risk that the authorities want to mitigate. (Faure and al, 1998) The actors involved in the escape and survey process are very numerous and the specialities of each one are very different. What is the common language between an historian, a town planner, a geologist or a law man? For this pre rupture case, it is all the data about a small territory that we have to store. As to manage with efficiency the coming crisis, all the data of any kind, the site with its urban zones is studied and surveyed since 1985, were stored on a CD-rom. The definition and the realisation of it, was a three years long job, with lot of meetings and give us some ideas about storage and exchange of complex data.

System release	Characteristics
WASSS 1 (1994)	Fist trials, we used Visual Basic and a PC
WASSS 2 (1995)	Extension on Internet, the description of cases is very simple
WASSS 3 (1996)	Utilisation of the description elaborated by TC11, the number of fields grows up and the multilanguage aspect is truly evident
WASSS 4 (1997)	Local bases and central base co-exist, but with great difficulties to maintain the compatibility between them.
WASSS 5 (1999)	Combined use of HTML features and small bases, introduction of maps as front-end.

*Table 6 : The five releases of WASSS*

At the opposite of WASSS4, we have there a local big problem, with a well known manager and a team of near 30 specialists and the main difficulty is in the presentation of data and a common language for sharing them. The aim of the observatory is to present to the population living near the menace, the best solution of mitigation. For this a CD-Rom is now pressed every 3 months to be up-dated with the last measurements, but the main part of it is the history of the site and the compilation of all the studies done. Some similar recent cases are also presented in it for convincing people that it really may happen. All the past studies are also presented as to avoid the desire of some manager to get time through new studies that are already done. The hanged 25 millions cubic meters of rock, are since ten years, advancing at the rate of 2 to 4 cm each month. It is urgent to do something.

## 5 - WASSS 5, FOR EXCHANGING LANDSLIDE DATA.

### 5 - 1 - *The philosophy of the project.*

From the two previous experiments, we can say that the exchange of data is one of the most powerful mean to improve knowledge and make easier management. But for complex localised events, such are landslides, floods, tunnels, etc..., the free exchange of data is difficult for the following reasons :

- The owner believe that his data is not worthy enough to be displayed. As each owner is a specialist of his domain, he is never sure of the interest of his data for other specialist. In fact, that is not important for one may be very useful for another man.
- The owner is frightened by the incompleteness of his data. This point is very important because it is always

difficult to masters a wide range of subjects.

- For management reasons some data are confidential and their use is specific.
- The centralisation of data is heavy to manage.

Most of these reasons belong to human behaviour, and in the team for the Séchilienne project, two social observers were very active. They shown that the property of data is a very sensible point.

So we try to bypass these difficulties by a new approach in WASSS 5. The philosophy or approach of this problem, can be defined by the following points :

- The data are shared in two parts for management and exchange.

Firstly : Meta-data (some elementary important data and data on the data) are stored in a small local data base (with MS Access for example) for management and owner purposes. The meta data are identification, localisation, classifications and main measures on the event.

Secondly : Detailed and complete data are stored on HTML pages, linked with the previous data base. In these HTML pages, it is possible to define with great accuracy any kind of event with sketches, maps, spread sheets, text and photographs. The first HTML page represents the meta-data and is automatically generated when feeding the small local data base.

- The data created by one is stored and remains on his own computer until he decides himself to give them directly to his colleagues. Each owner manages his own data base, as he wants, and can also store some partial data.

The conditions of exchanging the data in WASSS 5 are summarised by:

- The existence of a well known site where a very small data base with only the net addresses of the different owners of local data bases on landslides is displayed for all. So every one can contact and can be contacted by anyone.
- A glossary of terms about the landslides can be down load from this site, as to use a common language for describing the facts in the more accurate manner. This glossary is made in several languages. Some models and instructions for feeding the data-base are also provided, and all documents for a common culture of exchange are available.
- As every one knows all the owners of landslide data-base, one can ask directly (a forum is projected), for a special kind of event. The answer is send by e-mail.

With this organisation the exchange of data is only the exchange of HTML pages. This very simple exchange is decided by the owner of the data when he is asked by a colleague. When the addressee receive the desired pages, he add them in his own data base, the meta data for feeding its own data-base being on the first HTML page. He can so improve, with its personal representation, his data for a better research or management.

By this manner we solve:

- The integrity and the full customisation of all data bases. No data-bases are similar as they give an answer to different needs or specifications because organisation and laws are different in each country. There is no leader for this project, links are only between researchers.
- The property of data : on each HTML page the name of the builder and references are clearly written, and the exchange is triggered by the owner who attaches at his e-mail, the only pages he decides to send.
- The simplicity of the exchange as only HTML pages go on the net or intranet.
- and we enhance the contacts between searchers at the most effective level.

The code MAG-RMF is small and can be used on any kind of usual computer. As it manages pictures of maps a wide screen give some comfort. Oriented object technology is used to produce it. MAG-RMF is the visual front-end for managing the links between four units.

- A set of image of maps (bitmaps) for land representation.
- A set of contextual object representations (icons) for visual representation of any kind of view (aspect of the landslide) enable on the system. For example, with a mouse click, one can choose a location view, a risk view, a damage quantification view or an accesses view.
- A data-base for storing and managing the meta data. To day, with MS-Access but any kind of relational data base is possible.
- A set of HTML pages for an accurate description of landslides.

We present hereafter the data-base through its front end. This front end (one screen) for feeding the data base is shared in four equal parts. (figure 1)

The first one is called 'references'. In it, we find the name of the landslide, its rank in the data base, the date of the landslide, the date of its first entrance in the data-base and the update date, the link to the most representative image of the event, the link to the first HTML page, the WGS coordinates and the parameters of objects icons.

The second part is called 'classification' and is a set of ten pre-defined lists, each list being the item of a classification corresponding to one aspect

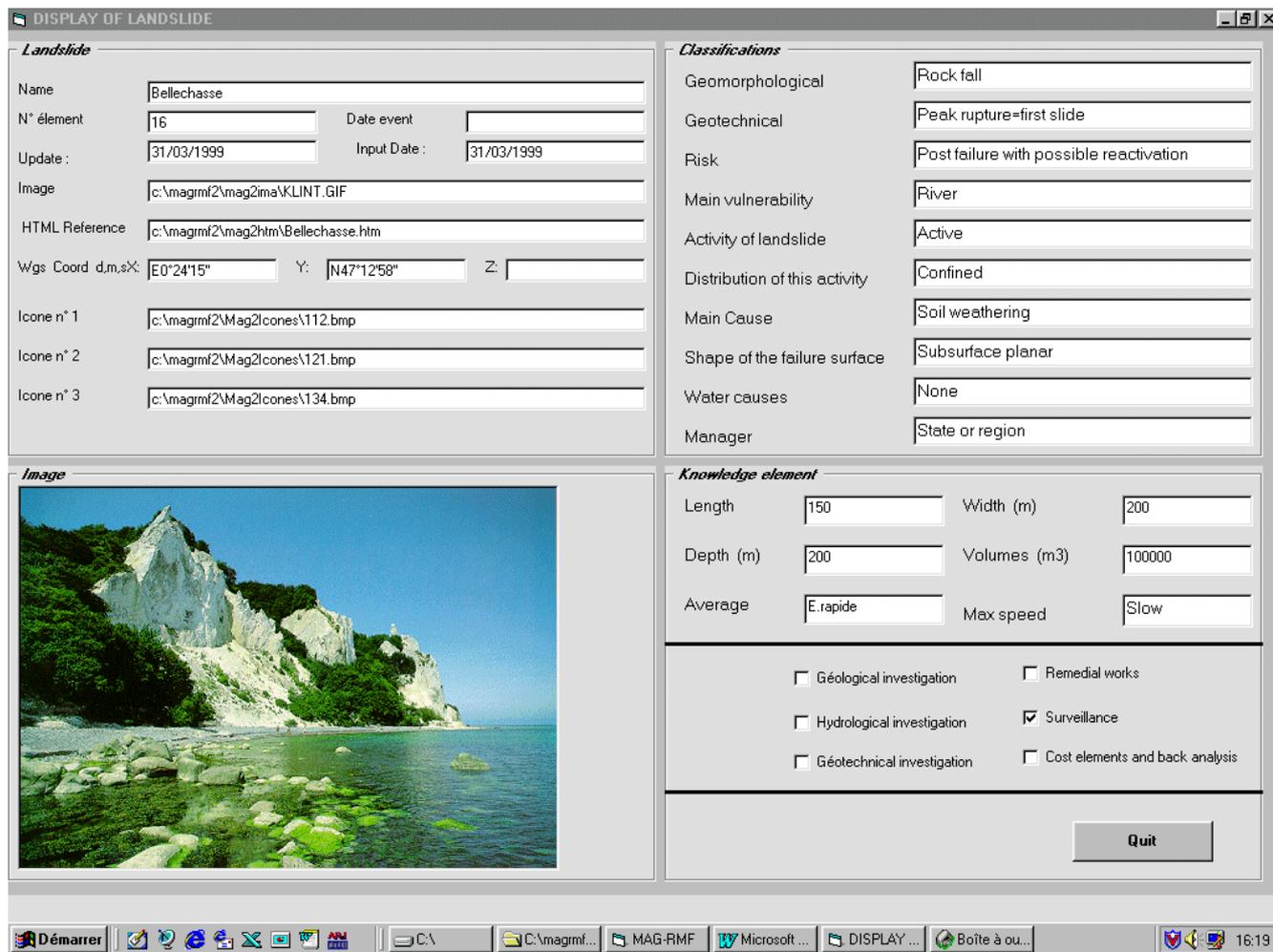


Figure 1 : The display of the meta-data

of the event. When one decides an application, it is the more difficult part of the analysis. Because the use of classifications is not easy, a lot of considerations must be taken in account depending of the potential users of the software. Happily the code is easily versatile and an incremental process to the final definition can be done. We propose a set of classifications for landslides hereafter.

The third part is called 'knowledge' where the user can store, six measures about the landslide and six binary numbers (yes or no) which indicate if some information is developed in the HTML pages.

The fourth part is a working place for searching the references and the links to image, HTML pages and other data base when one enters in the data-base a new event. When we use MAGRMF for managing the data-base, this fourth part is used for the display of the image attached to the event.

The description above shows the meta data and how they are defined. As they are stored in a relational data-base (MS Access) queries can be made by a SQL language which allows any combination of parameters.

The varied data about the landslide (maps, sketches, profiles, pictures and text like report) are stored in HTML format and these pages are linked with the meta-data. It is possible to reach any information in these pages with a browser (like Altavista) dedicated to the computer in which are the data.

### 5 - 3 - The general use of MAGRMF.

#### 5 - 3 - 1 - Maps front-end.

When one enters MAG-RMF application, he can feed the data-base or manage it.

As all stored landslides are localised, a map front end is use for a quick view of the positions of them. Displayed maps are only bitmaps, so the user can works with its own usual (home made) maps.

Zooming is going from a father map to a son map, all maps being stored in a tree with a maximum of nine maps at each level.(see figure 2). All the maps are referenced in WGS co-ordinates.

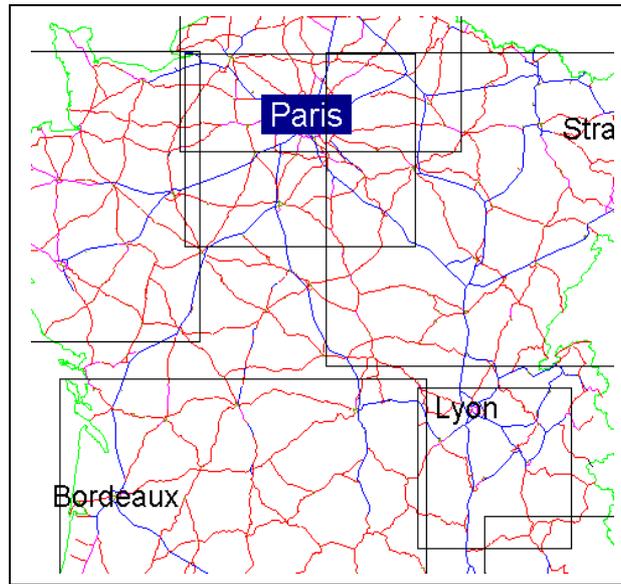
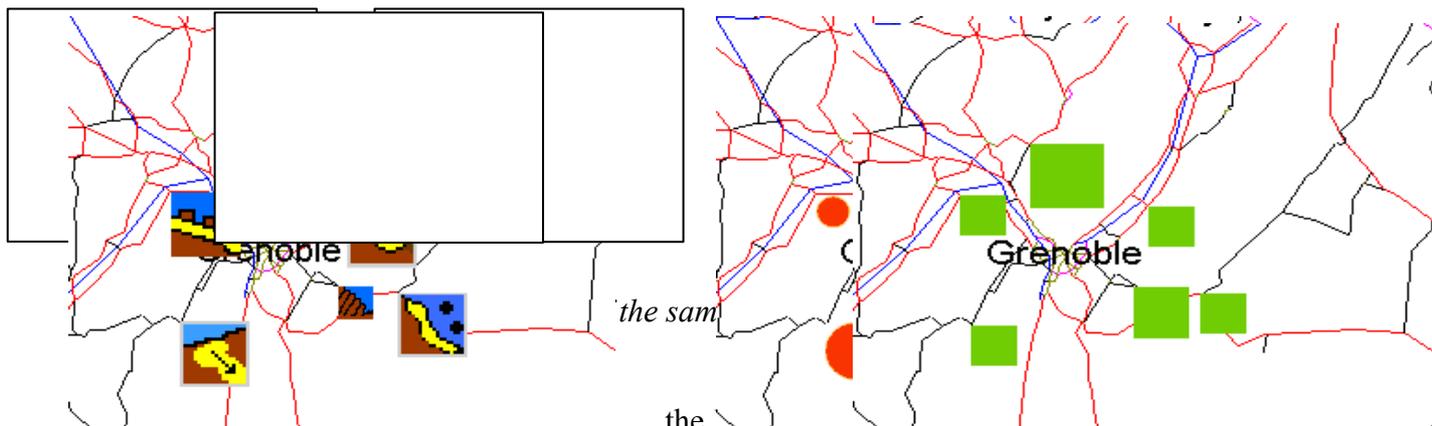


Figure 2 : Displaying the son maps of a map (Zoom)



### 5 - 3 - 2 - Icons representation.

Each landslide is marked by three icons. The meaning of each of icons must be decided before building the data-base. These three icons are chosen among different icons, that are small bitmaps. For my own data-base the three types of icon I use are:

for the first one a small draw, representing either a fall, a slide, a spread, a topple, a flow.

for the second I use five orange circles, with growing radius corresponding to the importance (volume) of the slide. The circle is red if there is loss of lives.

for the third icon I use coloured squares corresponding to the risk. Green when the landslide is stabilised or without risk (inactive), orange when

the is a heavy risk caused by the landslide. For management, one can chose the display on the maps through the symbol of object icons, a click of mouse is the user choice of the rank of icons. And, if for example, icons of rank two represent the damage made by the events, a damage map is automatically built. We obtain so, different views of the data-base. (figure 3)

### 5 - 3 - 3 - Links between different types of information.

A click on the icon leads to a choice of display for meta data, image, or HTML pages. After this choice all the corresponding information is displayed.

As the meta data are stored in a relational data base, queries in SQL manner can be done. On the maps

only the selected icons are displayed. And one can also use a browser for searching a chain of characters in the HTML pages.

5 - 4 - The ten classifications used for landslides in WASSS 5.

The MAG-RMF code includes ten classifications. For WASSS 5 we have chosen the following ones and a list of item for each classification allows a quick input.

1) Geomorphological,

Block fall, rock fall, rock topple, soil topple, rock slide, soil slide, debris avalanche, rock spread, soil spread, flow, subsidence.

2) Geotechnical,

Peak rupture = first slide, residual rupture = reactivated slide, creep, liquefaction, unknown.

3) Risk,

Pre-failure with low risk, Pre-failure with high risk, Post failure, Post failure with possible reactivation, unknown.

4) Activity of the landslide.

Active, suspended, reactivated, inactive dormant, inactive.

5) Distribution of the activity

Confined, advancing, retrogressive, widening, enlarging, diminishing, moving.

6) Main vulnerability.

People, goods, main road, road, river, railways, other network, agricultural lands, small value land, other, multiple menace, unknown.

7) Main cause.

Soil weathering, rainfall, erosion at toe, earthquake or volcanism, deforestation, man work, unknown.

8) Water causes.

Water table raise, irrigation, artesian, surface infiltration, none, unknown.

9) Shape of the failure surface.

Subsurface planar, deep planar, subsurface circular, deep circular, non circular, multiple, composite.

10) Manager.

Government, state or region, city, experimental

5 - 5 - *Main measurements as meta-data.*

Some data are declared as meta-data for their importance and meaning. For example the length of a landslide is a useful information and the existence of a survey give quickly the evidence of the dangerousness of the landslide. In this application of MAG-RMF, the six retained measures are the length, the width, the depth, the volume, the average speed and the maximum speed. The information on existence of detailed data are about survey, remedial

works, geological or hydrological investigation, geotechnical investigation, cost elements and back analysis. If, for these last item, the answer is yes the user can find an HTML page giving details of the item.

6 - PERSPECTIVES.

In a next future, we want to enhance MAG-RMF on four ways.

- The set of icons must be enlarged for giving a great choice of representation, although each user can add its own icons. The number of icons for the display of one event will be increase to five. So, the display of information will be more powerful. But other kinds of icons shall be added such are, linear shape, surface shape, proportional icon to a field of the data-base, icon showing a direction. Linear shape and surface shape are drawn, reading a set of points stored with a link to the landslide, so it is possible to draw in scale, on all the maps, the limits that the user wants to display. With this, MAG-RMF will allow an accurate representation of all the landslide on the map. When input, these contours can be drawn with the mouse, at the greatest scale to be more accurate, and with different drawings.

- A link between two data-bases will be set. So it will be possible to change of scale representation, as maps can be different. Information will be also of an other type. For example, about landslide, we can have a data-base only for one landslide when it is and experiment field. The main data base is for all landslides, and others one are only for some very well documented landslides, including escape scenario, monitoring features and so on.

- Each element may have several parts corresponding to different classification. For them we shall enlarge the data-base adding only a counter on the screen for entering each classification. The first use will be for a data-base about tunnels, which cross different geological soils.

- An other release will allow the total customisation of MAG-RMF giving to the user the possibility of changing all the labels and the writings.

Other subjects can be treated with MAG-RMF. As said before, we are working for a French data-base about tunnels and cut and cover, that are numerous in urban areas. With an appropriate use of icons, we are also carrying MAG-RMF as a tool for the management of versatile risk on an administrative area. Certainly lot of other domain exists.

But, for the user, MAG-RMF is a small code, friendly using, that can give a strong help in managing localised events. All data being stored in HTML pages, they are easily used in other applications. It is possible, with the use of icons, and the choice of the maps, to customise the application, as to give to the decider the best representation of its domain.

The basic release of MAG-RMF for developing a local data-base is available on the net at : <http://wasss.entpe.fr>

## 7 - CONCLUSION

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As the MAG-RMF system, in its basic release, is free on the net, we hope that lot of local data-bases will grow. It is an help for all landslides managers. The main interest of MAG-RMF used with the WASSS5 concepts, is certainly the soft management of the exchanges of data and the possibilities of customisation. The exchange triggered by the owner when he is ready to do it, is a good feature for the system and can win some shyness in the presentation of data. The list of all data-base will be maintained on the WASSS server if searchers indicate the existence of their data-base. With this tool the concepts of the WASSS 5 project can be easily set up. We hope so a rapid increase in the exchange of data about landslides.

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