NATURAL HAZARDS IN SWITZERLAND: DATA ACQUISITION, ADMINISTRATION, DISTRIBUTION AND USE

THE IMPORTANCE OF CONCEPTUAL DATA MODELS

Wolfgang Ruf[1] and Roberto Loat[2]

ABSTRACT

The availability of data plays an important role within the integral risk management of natural hazards. They provide the basis for most of the activities within the integrated risk cycle. It is therefore essential to make the adequate data disposable for different users. Since data acquisition is distributed over many stakeholders, especially the cantons, it is crucial to harmonize the data needed over entire Switzerland. Conceptual data models are the tool to exchange information between different databases independent on their platform and technical implementation. This process is supported by a new legislation about geoinformation. In the field of natural hazards, different conceptual data models are currently being developed. The whole process brings the stakeholders together and leads to a common understanding. The data models create the basis for a common analysis of existing data, thus providing multiple uses of existing data and supporting the risk management.

Keywords: data modelling, natural hazard assessment, natural hazard management, risk management

INTRODUCTION

Living with natural hazards is one of the key challenges for the society. Especially alpine countries like Switzerland are exposed to natural hazards. The event inventory and the hazard maps showed that over 80% of the communities are endangered by either flooding, landslides, rockfall or avalanches. In order to deal with these phenomena, a profound knowledge about the hazardous situation, the existence and state of protective structures, past events, damage potential, vulnerability and risk is crucial for the success of any measures. It is also essential that the information is easily accessible, spread to all stakeholders, in an understandable way, specifically adapted and illustrated for different needs.

This paper focuses on the data needed and used in the integrated risk management of natural hazards. This covers the question of which data are needed, the data sampling and collection, data assimilation, management, distribution, illustration and use. The case of Switzerland will be described here. The responsibility for the protection against natural hazards lies on a cantonal level, for the emergency planning on a local level. The federation has the guidance competence on a strategic level, subsidises cantonal measures and elaborates legal foundations. Based on legislation, conceptual data models must be developed also within the field of data on natural hazards.

Integrated Risk Management

Nowadays, it is nationally and internationally accepted that the task of dealing with natural hazards and risks can only be fulfilled, if the processes are seen and dealt with in an integrated manner. Integrated means overcoming the past approach of sectoral thinking and the coincident consideration of the entire system in order to optimise the measures, because space, money and manpower are limited. Integrated must be seen in different aspects:

[1] Dr. Wolfgang Ruf. Federal Office for the Environment, Division of Hazard Prevention, 3003 Bern, Switzerland (e-mail: wolfgang.ruf@bafu.admin.ch)
[2] Roberto Loat. Federal Office for the Environment, Division of Hazard Prevention, Switzerland

1. *Processes*: All process types of natural hazards must be considered. The Swiss federal law covers so far only the hazard processes of flooding, landslides, rockfall and avalanches, but however not yet of the processes of storm, hail, earthquakes.
2. *Phases*: Further, integrated is related to all phases of the risk cycle, starting from preparedness over response to recovery. Hazard and risk fundamentals are in its centre, since they are the basis of all measures to be undertaken.
3. *Measures*: Measures of the integrated risk management against natural hazards cover planning measures (especially spatial planning and local protection), biological measures (protective forest), structural protection measures, organisational measures (forecast systems, warning and alarming, emergency planning and intervention measures), and financial measures (recovery by insurance companies).
4. *Procedure*: Considering the measures, risk management is concerned with the following aspects: hazard assessment, risk assessment, planning of measures, implementation of measures, maintenance and replacement, validation of measures resp. protective structures.

DATA MANAGEMENT

Data management comprises a whole chain of different processes, as illustrated in Fig. 1. It starts with an analysis about all stakeholders involved and their needs. It must be considered, under which circumstances and costs data can be collected, and what is their use and benefit. Before starting collecting data, the general characteristics of the target object in itself must be reflected in detail, and then it must be defined, which subset of the characteristics (parameters) should be collected. Then, objects or phenomena are being observed, and the results are recorded on paper forms or in electronic format (data acquisition). Then, data preparation including quality control must take place, the data must be stored, preferably in a database, and be maintained (data administration). Data may either first be analysed and interpreted to make statements and to answer questions and then distributed, or the original data may directly be distributed to all stakeholders (data distribution). They can analyse and interpret them further and use them for their tasks of risk management (data use).

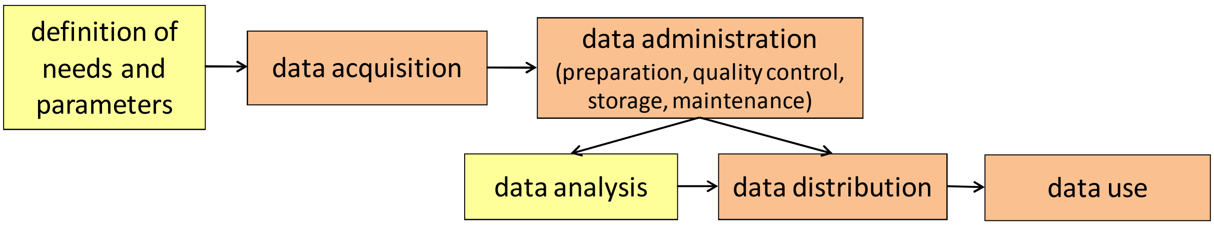

Fig. 1 Different elements of data management

NEED FOR DATA

Different stakeholders need different data for different purposes at different phases within the integrated risk management. It is very important to clarify their needs, but at the same time to consider the effort needed for the data collection. For many evaluations it is crucial to have a homogeneous database, hence claiming more for a complete rather than a too detailed database. The data model, which claims for harmonised data on a national level must therefore fulfil the requirements of the federal authorities as well as other nationwide or intercantonal stakeholders. The federal administration needs only a small part of the data, mostly in an aggregated way, for political purposes and for strategic leadership. On the other hand, data are needed for the risk dialogue and the risk awareness of the population. Consultants have an advantage of harmonised data while having adapted some methods based on the availability of the data in a specific format. For further details see below under chapter “Data Use”. All data, which go beyond these requirements, do not need to be harmonised and included in the data model, but can be left for the data specification for the local authorities.
In the field of natural hazards, data models are being or planned to be elaborated for the following topics, given some prioritisation and current state of development (Tab. 1):

Tab. 1 Overview over the most important fields where data models are being developed or planed. Data models of priority 1 have been completed; those of priority 2 are under development, and those of priority 3 are planned.

Field / Data model	Priority	Remarks
hazard mapping	1	revision of data model after official consultation procedure; illustration model in preparation
inventory of past events (processes)	2	contents of data model defined and revision after first feedbacks; data and illustration model in preparation
protective structures	2	contents of data model defined and revision after first feedbacks; data and illustration model in preparation
damage of past events	3	will be excluded from the inventory of the processes of past events; new strategy still to be defined (together with other stakeholders, which were not yet addressed)
protective forests	3	work not yet started
damage potential and risk	3	work not yet started

NEED FOR HARMONISATION

Harmonisation of the data over the entire country is essential to fulfil the data needs. Data must be analysed and usually illustrated in maps over the whole country, because many stakeholders work on an intercantonal or a federal level, including the federal administration itself. Information being available at the cantons must be selected or aggregated to the standard, which is required on a national level. Besides this, a new legislation framework about geoinformation became effective in 2008 (GeoIG, 2007; GeoIV, 2007), with the following key targets:
1. Conceptual data models must be defined for all geodata based on a federal legislation under the leadership of the responsible federal office, regardless whether the federal or the cantonal governments are responsible for the data. 2. These data models must be applied over entire Switzer-land i.e. harmonized over all cantons. 3. Each body responsible for a specific data set is obliged to provide the data respecting the content and specifications of the data model latest five years after the model became effective. 4. The data must be shown and made accessible to the public. 5. The federal governmental bodies are responsible for the definition of the data models, but must elaborate them together with the authorities, which are responsible for the specific data set. Where desirable, also data illustration models should be elaborated for a homogeneous graphical representation of the model.

On top of the national legislation, the European INSPIRE directive about data specifications has also to be considered because of the Swiss membership of the European Environmental Agency. Data have therefore also to be transmitted to the European level.

Conceptual data models are the tool to achieve the harmonisation of data. They provide the required information about the structure and content of databases independently from the platform or the technical implementation of any database. The data models to be developed on a national level must hereby consider the methods of data acquisitions, data availability in the cantons and existing data formats. Nationwide data models are being developed in all fields of geodata. It will therefore be possible to combine the data of natural hazards among themselves and with any other data sets e.g. such as the spatial planning data.

The harmonisation contains the object classes with all their characteristics. Inside a class, attributes of various types are defined. It is very important to stress that the harmonisation must not only take place in a formal way as being defined by the conceptual data model, but also concerning the content. Each player must have the same understanding of the content of each attribute. Therefore, a detailed description of the data model is equally important as the formal description itself.

Harmonisation refers not only to the data themselves, but also to their illustration. Geospatial data are almost shown also in form of maps. The user must recognise the same type of feature with the same signature over the entire map. Besides this, depending on the user group, different kind of maps might be produced (e.g. degree of details, purpose of the map), which should also be defined by an illustration model.

DATA MODELLING

Process of Data Modelling and Stakeholder Involvement

The development of conceptual data models is a common task – undergoing different stages - both of experts from different stakeholder groups in the domain of natural hazards and of GIS experts. The manifold relations between the stakeholders, but also different processes involved within the chain of the data management have to be accounted for. Furthermore, in most cases data already exist; they must be compatible with the new structure of the harmonized data model.

The process of the development of the data models was initiated by the Federal Office for the Environment, which has the legislative mandate to define the models. In all cases, the process started with the evaluation of the stakeholders. A poll was started to gather the information about their data management resp. data requirements. Both in the case of hazard mapping and of the inventory of past events, a workshop with all possible stakeholders (federal administration, cantons, insurance companies, owners of infrastructure, scientists, consultants etc.) was organised. Important outcomes of these workshops were the evaluation of everybody's needs, the mutual understanding, the development of a common language, and the motivation for collaboration. Finally, these workshops gave the federal administration the legitimisation and support to develop a common data model.

Detailed discussions took resp. take still place in particular working groups, one group for each data model to be elaborated. A draft version was sent to all stakeholders as information about the state of the work. Feedbacks were integrated by the working group prior to the official consultation process. This participation process involving all stakeholders from data acquisition to data distribution are the best prerequisites for a data model, which will be properly implemented and used in practice. It is time consuming process, but the time is well spent with respect to the overall progress and success of the project.

Relation between reality and data modelling

Data modelling is an all-encompassing process. It involves two domains: the reality and the modelling world. Conceptual data models are a simplified, but structured description of reality for the application in the field of structures of databases. For the hazard mapping, many steps are necessary, a lot of information is gathered, modelling results and expert judgement are integrated to the final products. Furthermore, it must be stressed that the maps are not equivalent to the information of the data model, but the maps must be able to be produced out of the information contained in the data model. The federal administration has already published some guidelines (Bundesamt für Forstwesen et al., 1984; BUWAL et al., 1997; BWW et al., 1997) how to consider the natural hazards for spatial planning activities (hazard mapping). In this case, this is given as the "reality", for which the data model has to be adapted to. The needs stemming from the side of natural hazards must drive the modelling process, not vice versa. One has always to be careful not to include features and attributes in the data model, which are desirable, but for which there is no need for.

On the other hand, there do exist feedbacks from the modelling work to the domain of natural hazards. This concerns on the one hand side the terminology, on the other hand those details, which were not clearly described in the existing guidelines of hazard mapping. This is an important perception and experience coming out from the data modelling work. Only being forced to describe the features and attributes in detail and in a formal language, existing misunderstandings and different interpretations of the existing guidelines became obvious. Therefore, the data modelling work helps also to define the existing guidelines more precisely and bring them further. As soon as there are any future developments in the process of hazard mapping, the data model must consequently be adapted.

Modelling language

Conceptual data models are independent from any technical platform or software. They describe the extent, structure and properties of data sets, which can be integrated in a database. If data should be transferred from the database in one system into another database in another system, a transfer interface must be built. For any combination of possible data transfer between different data bases, this would have to be done separately, if no common description of the data structure being independent from any system existed.

Different data modelling tools and languages have been invented. The first step in data modelling is the description of the reality in a prose language reduced to those features, properties and relationships, which should be reflected in the data model. In this step, there is not yet a standardisation. The following step is the description in a graphical format (e.g. UML-diagrams). These diagrams are used to describe the contents and structure of data sets in a simplified way, possible in different levels of details. They show – divided in different "topics" – all feature classes with their attributes and possible data types. Relationships ("associations") can also be shown.
For the more precise and detailed description, formal textual data modelling languages were developed. In Switzerland, the language INTERLIS is prescribed by legislation (GeoIV-swis, 2008). Data models written in INTERLIS may also be translated into the internationally used language GML.

CONTENT OF THE DATA MODELS

The state of the modelling process for the conceptual data models to be elaborated is very different (see Tab. 1). Most proceeded is the model for the hazard mapping, which has recently undergone the official consultation process. After some adaptations, it can become effective. The model structure of the version of the consultation process is shown here, as well as the most important outcomes of the process work itself. For the data models for the inventories of past natural hazard events and of protective structures, the basic concept has already been elaborated and is shown in this paper.

Hazard Mapping

The challenge in the modelling process was the fact that most of the cantons have had already developed their own data model. The existence of the corresponding guidelines from 1984 and 1997 (Bundesamt für Forstwesen et al., 1984; BUWAL et al., 1997; BWW et al., 1997) however guaranteed a similar process of the hazard assessment and a precise definition of the hazard maps (degree of hazard for each main natural process), which is the end product of hazard mapping on an aggregated level.
The data model of hazard mapping (see Fig. 2) is divided in two parts: 1. a mandatory part (the minimal data model regarding the legislation), and 2. a supplementary part.
The mandatory part is legally binding for the cantons and is based on those parts of the existing guidelines of hazard assessment, where the requirements are explicitly defined. It comprises the intensities for given probabilities, the hazard levels for each main process (cf. hazard maps) and the synoptic hazard levels (synoptic hazard maps). The supplementary part consists of the parameters that contain the basis information of the hazard assessment. Despite it reflects the existing practice of the majority of the cantons, it is not explicitly specified in the guidelines. Hence, the parameters cannot be compulsory, despite they are meaningful. There are some differences in the cantonal practice, but it was the wish to proactively create a norm according to this future development so that an adaptation of the cantonal models can take place. Future harmonisation shall therefore be facilitated. Future development of the guidelines and the data model must go hand in hand.

Inventory of past natural events

For the past natural events, different inventories exist so far. Each of the 26 Swiss cantons is obliged by federal legislation (WaV, 1992; WBV, 1994) to keep an inventory, which contains data about events of flooding and debris flow, landslides, rockfall and avalanches. The data stem from field observations of the local forest rangers and water engineers. Besides this, a national database about flooding, debris flow, landslides and rockfall, which is based on information from the media, exists since 1972 and is run by the Swiss Federal Institute for Forest, Snow and Landscape Research WSL. For avalanches, a separate database on field observations exists since the end of the 19th century, run by a different section of the WSL. The University of Zurich holds two databases, one about glacier hazards in Switzerland, the other about permafrost related rockfalls. Furthermore, the SBB (Swiss Federal Railways) and the Federal Roads Office have separate databases on past natural events.

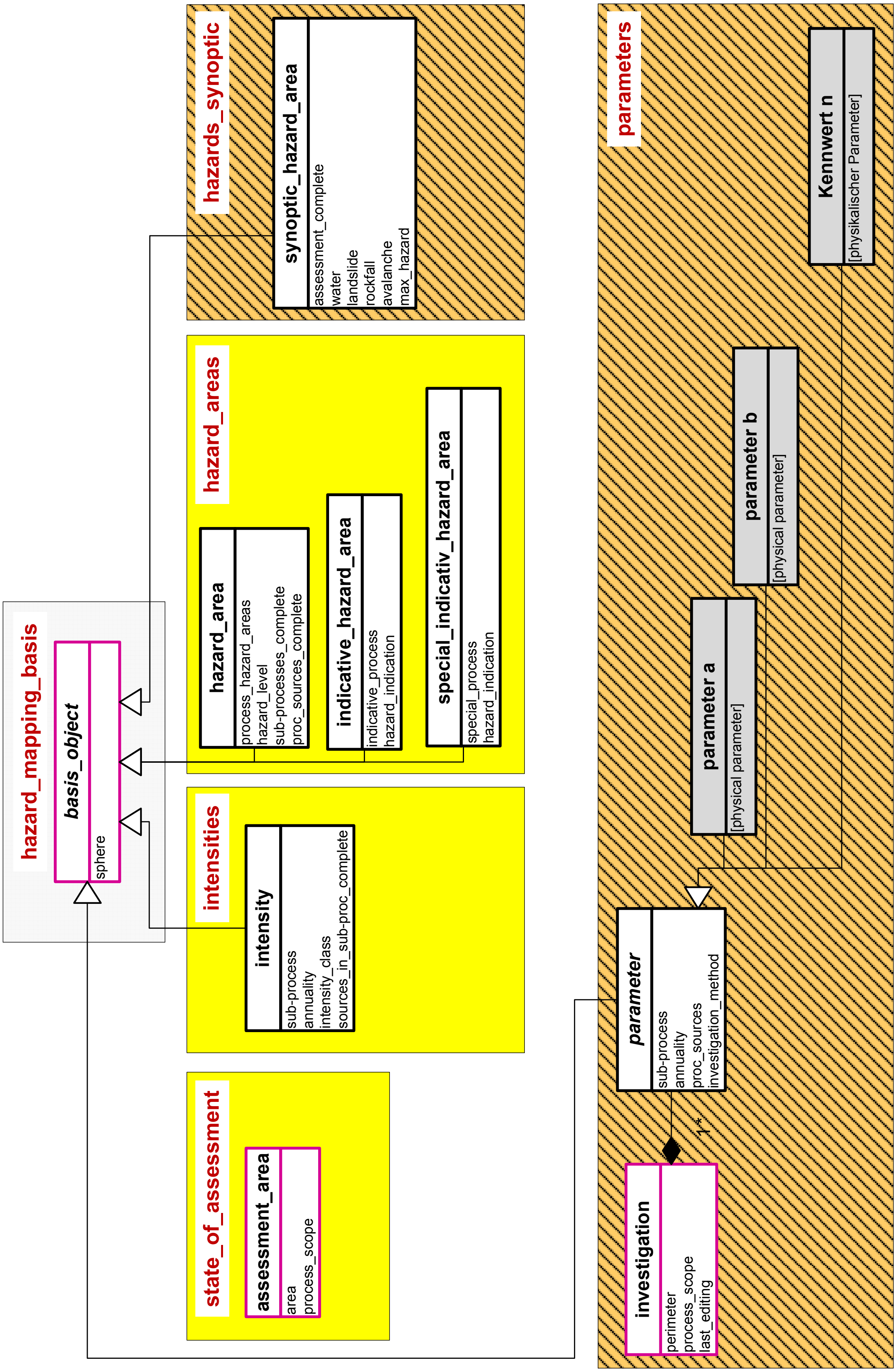

Fig. 2 Data model for hazard mapping: simplified class diagram, state of October 2011.
Yellow (i.e. full colour, bright): mandatory part. Orange (i.e. hatched, dark): supplementary part of the model.

The new data model will combine all these different databases, as it is illustrated in Fig. 3. Therefore, a common block of basic data will be identical for all different data sources. For the 26 cantons, a common database exists already; it has however been decided to be simplified. The data model for the cantons will be the same for all, but single cantons might extend them further according to their specific needs. Between the cantonal part of the data model and all others, there will be also some common features (classes and attributes), which go beyond the bloc of the common data. They will be harmonised as much as possible during the development of the new data model.

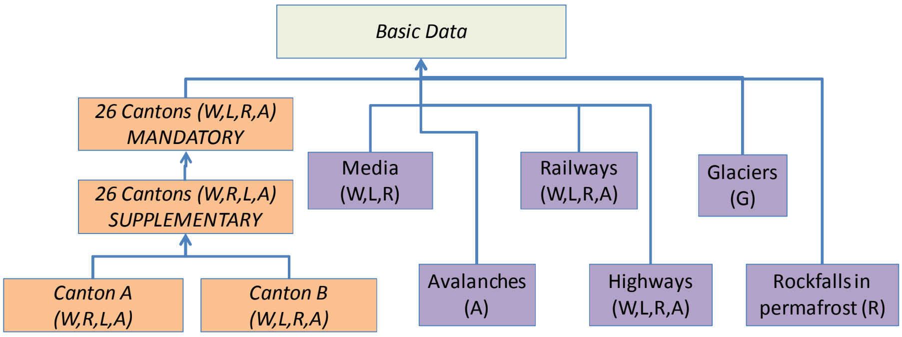

Fig. 3 Structure of the new common data model for the inventory of past natural events.
There will be further common features between the particular parts of the model, which are not shown here for the sake of simplicity. The letters indicate the process types contained in the corresponding database (W: water; L: landslide; R: rockfall; A: avalanche; G: glacier).

The data model being developed and under discussion for the cantonal part of the inventory of past natural events is shown in Fig. 4. In its simplification, it will apply similarly also for all other parts of the model, possibly containing less details.
Up to now, the cantonal database contains also quantitative monetary information about damages related to single events. The experience showed that they cannot be acquired reliably during an event by the local observers. It has hence be decided to exclude these data from this inventory and to plan a separate data model and database containing only the damages. There, each stakeholder having been affected by the event should contribute to the database by delivering the damage information in his own domain.

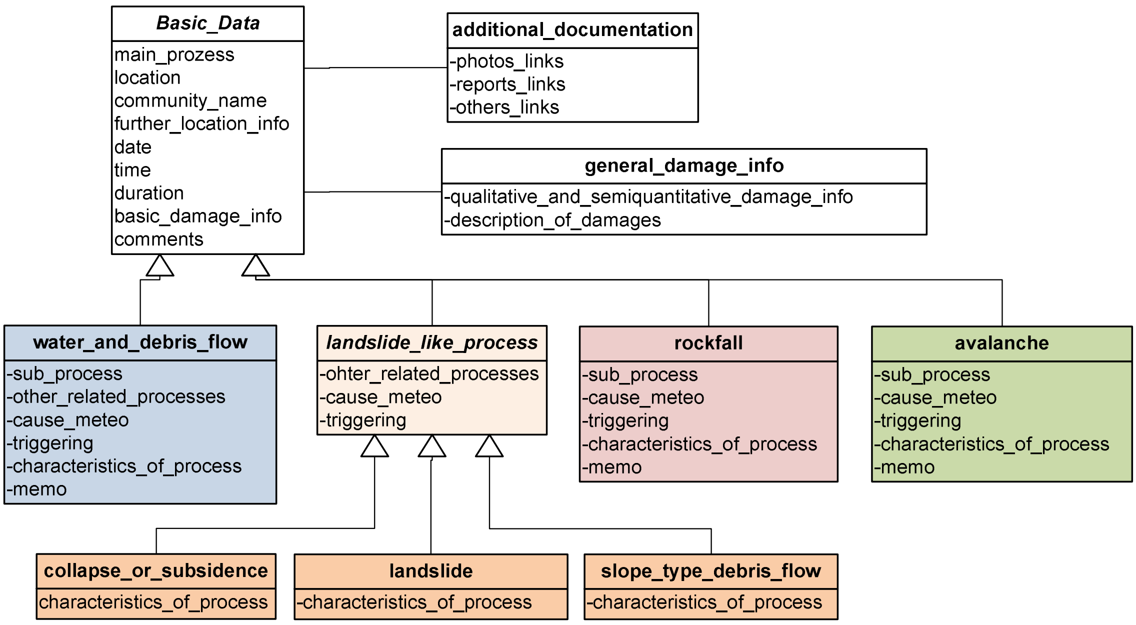

Fig. 4 Data model for the cantonal part of the inventory of past natural events: simplified class diagram, state of October 2011.
With exception of the attributes of the class "Basic_Data", the shown "attributes" must be seen in most cases as groups of attributes, which are subdivided in more detail. Despite they appear manifolds in the different classes of process type, they have type-specific sub-attributes or enumeration lists.

Inventory of protective structures

The data model of the protective structures is still in a concept phase, but the draft of the content exists and is currently under discussion with the cantons. Opposite to the inventory of past natural hazard events, here the needs of the cantons strongly differ. A cantonal inventory of protective structures contains data both about the existence and state of the structures themselves and about the maintenance and projects related to these structures. Due to different cantonal legislation, the responsibilities for the superintendence or the maintenance of the protective structures vary between the cantons. On top of that, also the administrative structures and processes lead to very specific needs for the cantonal data models.

For this reason, a harmonisation of the data model on a detailed level is not desired for the protective structures. Only a small subset of the data needed on a cantonal level will therefore be included in the data model on a national level being used by the federal administration for strategic and political purposes. All maintenance related data will not be part of the model. But although the statements on a national level are made on an aggregated level, it must be assured that on a cantonal level the data must be sufficiently detailed to provide all information needed for the aggregation.

Only protective structures are relevant on a national level according to this definition: „A protective structure is a construction that was erected to safeguard the protection against gravitative natural hazards satisfying the following three criteria": 1. structural measure having an impact on the process, 2. publicly financed, 3. with the intention to influence the process in a positive way.

The model will contain the features shown in Fig. 5, thus allowing to make statements especially about the future financial needs to maintain the protection infrastructure, and the reliability of the control structures.

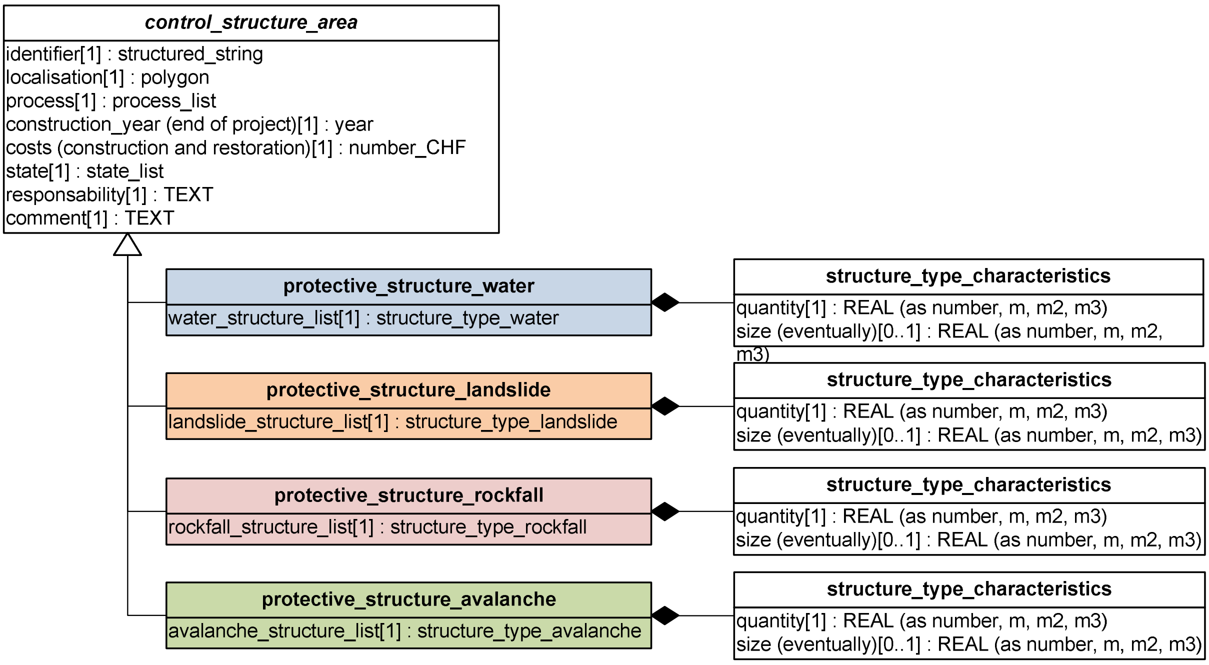

Fig. 5 Data model for protective structures (draft): class diagram, state of October 2011

DATA ACQUISITION

The data acquisition is in all described data modelling fields under the responsibility of the cantons. It differs remarkably between the different fields.

Hazard Mapping

In terms of hazard mapping, data acquisition today differs significantly from the past. In the first period of hazard mapping in the 1990s, the products were given in analogous form, mostly in form of maps, which show the result in an aggregated way. Separately, a written technical documentation had to be delivered.

Nowadays, practically all cantons have their geodatabases, thus requiring digital data. Maps can be derived from the underlying data of the hazard mapping database. Data are the result of modelling the hazard processes, including additional expert knowhow from field investigations. Finally, the data arise on different levels of aggregation: The original modelling results, so-called parameters, which are distributed in space and show for each process and hazard source the physical value of the physical parameters such as e.g. water depth or flow velocity in case of inundation. These data can be considered as fundamental or basic data in terms of data acquisition in the field of hazard mapping. All other data are derived data based on these fundamental data. The intensities or magnitudes, which are the data basis for the intensity maps, illustrate - already aggregated over all hazard sources of a given main process (water, landslide, rockfall, avalanche) and aggregated over all influencing parameters (inundation depth and flow velocity) - the impact expressed in three classes. An even higher aggregation level concerns the degree of hazard, derived by combining probabilities and the corresponding intensities. The highest aggregation level is the synoptic degree of hazard, which shows the maximum degree of hazard out of all different hazard processes.

In the past, where analogous maps were the basis of all data, these products existed independently. At present, having digitized the old maps and having created the corresponding data sets, many cantons still keep the concept of managing the data sets technically independently despite their inherent dependencies, others keep only the parameters as original data sets, the other products are being generated on the fly whenever needed. The advantage of the latter concept is the following: Periodically as well as after large events or implementation of measures, which indicate changes in the hazard assessment, the parameter values have to be determined again. This implies that all derived products must be adapted as well. Using the concept of not storing these data sets but producing them on the fly saves the effort of producing any time after little changes new data sets, which have to be stored, updated and actualised. On the other hand, the aggregation process involves also some algorithms, which can in detail lead to technical complications. Today, both concepts are being used in Switzerland. As a consequence, the federal data model cannot reproduce the inherent relationships between the data sets on the different aggregation levels, because they do not have a correspondence in the cantonal data models of hazard mapping.

Inventory of past natural events

So far, the inventory of past natural events comprises over 20’000 entries within Switzerland. The cantonal practice can differ with respect to the following aspects: collection of only damage events or additionally non-damage events, only within or near the settlement areas or everywhere, detailed or “rough” acquisition, availability of manpower, documentation of photographs or not, acquisition of the location in form of GIS data or not.

The adequate degree of detail is not easy to answer and is the main reason for the recent redesign of the data model. The original idea was to create a database providing information both about damages and in a detailed way also about the processes of the events themselves. The latter was meant to be also a data source for scientific investigations. The experience showed that these data have hardly been used for scientific purposes, supposedly because of the lack of completeness of the database, but also that for research even more detailed data are needed. Due to other duties of the staff involved in coping with the event and the recovery – it is not always possible to fill in all data attributes in the field. Therefore, at now, the completeness of data fields having filled in is very inhomogeneous.

Moreover, with respect to the size and importance of an event, the level of detail required from the perspective of natural hazards strongly differs. Whilst on the one hand side it is the aim to obtain a complete picture of preferably all events in order to get the spatial information about frequency, magnitude and location of events, it is on the other hand important for large events to analyse the data in more detail to learn about the past and to be able to draw consequences in order to improve the preparedness for future events. In these cases, an extended event documentation or a detailed event analysis is accomplished, which the data model cannot comprise. These are supplementary data and documents, which must be linked to the basic data of the inventory.

Inventory of protective structures

So far, only a few cantons keep a digital inventory of protective structures. The data collection in the field and in distributed archives is very time consuming and requires high expertise. The legal obligation to keep such an inventory exists since 1994 (WBV, 1994). Now, there is some political pressure to build a nationwide inventory of protective structures against natural hazards, because data are needed for strategic and financial planning. Even if money were not the limiting factor, the availability of enough experts in this field would limit the rate that this process will proceed with.

There is a clear distinction between retrospective data collection and new data acquisition in current projects of restoring existing or erecting new structures. Many attribute values, which are foreseen in the new data model, will be available only in the case of today's projects, but will not be reconstructable for many of the old structures addressed by the retrospective data collection.

DATA ADMINISTRATION

Since the cantons are responsible for the data acquisition in the field of natural hazards, the data are stored in a distributed way and not in a central database (exception: inventory of past natural events). It is the question, whether this is advantageous with respect to the aim of the accessibility of nationwide data. Nowadays, this question is no longer so relevant due to new technical opportunities of accessing different distributed server systems, as long as the data structure is well defined and harmonised. This will be achieved by the development of the conceptual data models.

More important however is the data maintenance and quality control and actualisation of the data. For this reason, it is opportune to keep the data storage as close as possible to the body that is responsible for the data acquisition, which is in most cases the canton.

DATA DISTRIBUTION

With the new legislation about geoinformation, it is compulsory to make all data public according to the defined data models, in most cases also together with a download service, which is the case for all the topics dealt in this paper. It is crucial that the end users have always access to the up-to-date valid data. The new technologies allow regular and frequent update of data on different databases, as well as direct linkage to the original database. A special feature of the latter is the embedding of web map and web feature services into the own system.

The interface to the end user is the geoportal. In the course of the implementation of the legislation about geoinformation, the federation and the cantons launched the programme e-geo.ch, whose task it is to accompany the process of data modelling of geodata and to build a National Geodata Infrastructure (NGDI). This is intended to be the geoportal as the entry for all geodata from the federation, cantons, communities and industrial (mostly infrastructure) plants. The open question is still, whether it will be a system only for the broad public or also for experts. The latter requires more detailed information, but also more sophisticated functionalities and tools for the analysis of the data. For the entire field of natural hazard data, this development has to be awaited for, before it can be decided, if a separate geoportal for natural hazards has to be built or if the NGDI can comply with this objective. But it is obvious that both an easy system for the broad public and an expert system is needed in order to make use of the data in the sense of the question: Who needs which data for which purpose in which format.

Related to the data distribution is however not only the question of the data itself, but also the illustration of the data. In order to understand the content of geospatial data, in most cases maps will be produced. Readable maps contain a common language throughout the whole extent shown on the map. For data available and relevant in different parts in the country, but stemming from distinct data sources, it is therefore essential to define beforehand a common data illustration model. Only like this, a homogenously looking map is possible while linking to different databases at once or using different WMS and WFS services at the same time. This problem has been recognised already by the legislature, who suggests the development of such illustration models explicitly. They will be developed together with all the data models in the field of natural hazards as well.

DATA USE

The data described by different data models will be used by different stakeholders. Most detailed data will be used on a local or community level. These will be only partly covered by the data models. The number of data used reduces and the degree of aggregation increases with the hierarchic levels from the cantonal over the federal up to the European level. Generally, data tend to be used for operational purposes on a local, i.e. community and cantonal level, whereas political and strategic purposes are important on the European, federal and also cantonal level (see Tab. 2).

Tab. 2 The use of data (described by the data models) by different stakeholders on different levels, and their importance

	Stakeholders	**Hazard maps**	**Inventory of past events**	**Inventory of protective structures**
local level	General public	●	•	
	Administration (decision makers)	●	●	
	Spatial planning authorities	●	•	
	Operations management and intervention bodies	●	•	•
	Consulting engineers	•	●	●
cantonal level	Administration (decision makers)	●	•	●
	Natural hazard authorities	●	●	●
	Spatial planning authorities	●	•	
federal / international level	Administration (decision makers)	●	•	●
	Insurance	●	•	
	Infrastructure owners	●	●	●
	European community	•	●	

OUTLOOK

The whole process of the data management in natural hazard is still an ongoing process. The first step has been finished with the data model for the hazard mapping and the concepts for the inventories for the past event data and the protective structures. The next steps will be the illustration models for the hazard mapping as well, the detailed data models and illustration models for the two inventories. Then, the geoportal must be build in order to bring all data together and to make them available in a harmonized form. Then, the data will be made public for everybody, and on a national level, the data will be evaluated for strategic and political issues.

With a longer time horizon, the data models for the damage potential and risk will be developed, where insurance companies play an important role. Since many of them are private and do not fall under the legislation about geoinformation, and since not all of them have georeferenced data, and since business and private interest claim for data privacy, special solutions must be found.

Even when all data models are established, all data are gathered and made accessible, the process of data management has to go on. On the one hand, data have to be upgraded and actualised, on the other new needs of usage of data will occur, depending on changes in the society, and also new technologies will lead to adaptations in the data collection, data storage and data distribution. The key question: “Who needs what wherefore and in which format” has to be asked again and again.

CONCLUSIONS

The experience of four years in the process of data modelling and data management (in a wide sense) lead to the following conclusions:

- The process of data modelling involves many stakeholders.
- The process is time consuming.
- It leads to a common language and understanding, which is very important for the entire work and the interplay in relation to integrated risk management.
- The process shows existing gaps and give a feedback to the federal guidelines, which have to be accordingly adapted.
- Only with the data models it is possible to guarantee that the important data will be collected in all parts of Switzerland, and in the same structure and format, so that they can be nationwide put together.
- The harmonisation of the data allows the analysis of the data for targets concerning more than one canton respectively entire Switzerland.
- The harmonisation of the data and their illustration is the basis for the common distribution of the data through a single geoportal, thus allowing to make the data easily accessible for everybody.
- The easy accessibility will probably lead to more frequent usage of the data, thus creating an added value.
- The data are the fundamentals for most of the activities within the integrated risk cycle, thus being important for improving the risk situation.
- The process will never be finished, since new demands of the society and new technologies will require the adaptation of the data models from time to time.
- Since for reasons of continuity the core of the data models should be kept constant for a longer time period, they should be built in such a way that they can easily be extended.

REFERENCES

Bundesamt für Forstwesen, Eidgenössisches Institut für Schnee- und Lawinenforschung [Hrsg.] (1984). Richtlinien zur Berücksichtigung der Lawinengefahr bei raumwirksamen Tätigkeiten, Bern (http://www.bafu.admin.ch/publikationen/publikation/00778/index.html?lang=de).

Bundesamt für Umwelt, Wald und Landschaft BUWAL, Bundesamt für Wasserwirtschaft BWW, Bundesamt für Raumplanung BRP, [Hrsg.] (1997). Berücksichtigung der Massenbewegungs-gefahren bei raumwirksamen Tätigkeiten, Empfehlungen, Bern (pdf 2001) (http://www.bafu.admin.ch/publikationen/publikation/00783/index.html?lang=de).

Bundesamt für Wasserwirtschaft (BWW), Bundesamt für Raumplanung (BRP), Bundesamt für Umwelt, Wald und Landschaft (BUWAL) [Hrsg.] (1997). Berücksichtigung der Hochwasser-gefahren bei raumwirksamen Tätigkeiten, Empfehlungen, Biel (pdf 2001) (German: http://www.bafu.admin.ch/publikationen/publikation/00786/index.html?lang=de; English: http://www.bafu.admin.ch/publikationen/publikation/00786/index.html?lang=en).

GeoIG (2007). Bundesgesetz vom 5. Oktober 2007 über Geoinformation (Geoinformationsgesetz, SR 510.62, http://www.admin.ch/ch/d/sr/c510_62.html).

GeoIV (2007). Verordnung vom 21. Mai 2008 über Geoinformation (Geoinformationsverordnung, SR 510.620, http://www.admin.ch/ch/d/sr/c510_620.html).

GeoIV-swis (2008). Verordnung vom 26. Mai 2008 des Bundesamtes für Landestopografie über Geoinformation (GeoIV-swisstopo, SR 510.620.1, http://www.admin.ch/ch/d/sr/c510_620_1.html).

WaV (1992). Verordnung vom 30. November 1992 über den Wald (Waldverordnung, SR 921.01, http://www.admin.ch/ch/d/sr/c921_01.html).

WBV (1994). Verordnung vom 2. November 1994 über den Wasserbau (Wasserbauverordnung, SR 721.100.1, http://www.admin.ch/ch/d/sr/c721_100_1.html).